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FUNCTIONAL SERVICING REPORT

FOR

GREEN LANDS WEST & EAST LAFFIN LANDS (WESTERN DEVELOPMENT LANDS)

CAIVAN (RICHMOND NORTH/SOUTH) LTD.

CITY OF OTTAWA

PROJECT NO.: 20-1183

AUGUST 2021
3RD SUBMISSION

FUNCTIONAL SERVICING REPORT
FOR THE
GREEN LANDS WEST /EAST &
LAFFIN LANDS
(WESTERN DEVELOPMENT LANDS)

CAIVAN (RICHMOND NORTH/SOUTH) LTD.

PROJECT NO: 10-1183

TABLE OF CONTENTS

FIGURES

DRAWINGS

TABLES

APPENDICES

FUNCTIONAL SERVICING REPORT
FOR THE
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1.0 INTRODUCTION

This functional servicing report is submitted in support of a draft plan application for property parcels within the Western Development Lands (WDL) in the Village of Richmond on behalf of the Richmond Village Development Corporation (RVDC).

The following figure provides a site context for the WDL area in the within the Village.

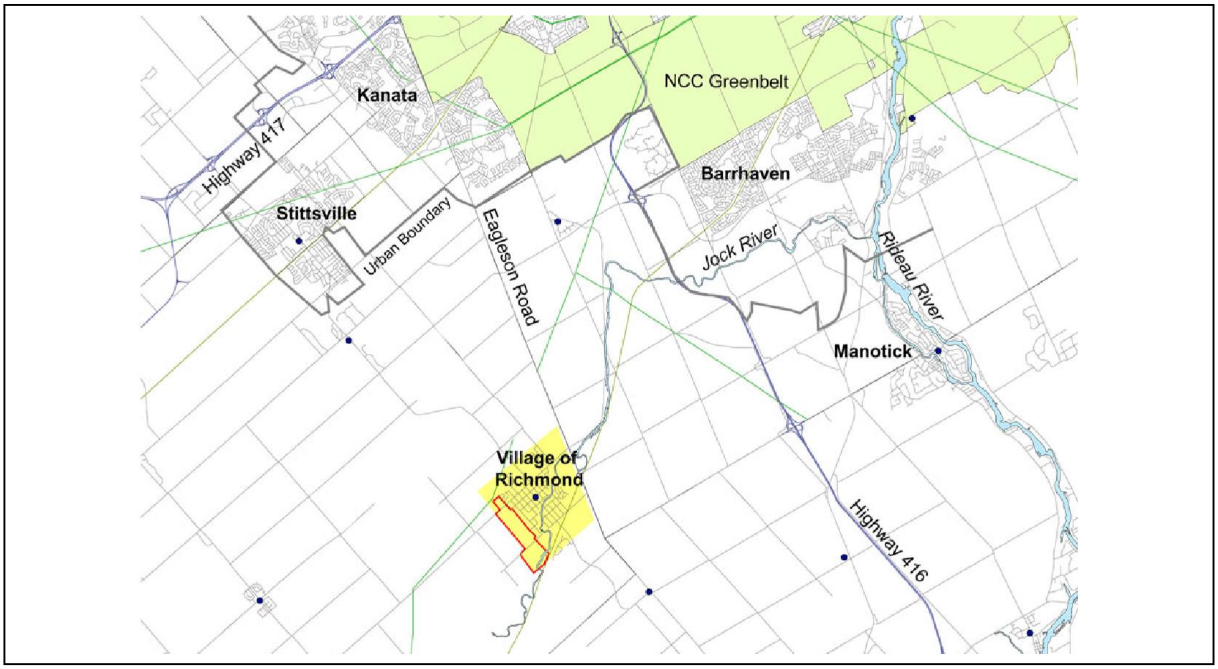


Figure A: Western Development Lands within Richmond

The ***Figure 1*** Site Location plan in the ***Figures*** section at the back of the report illustrates the land parcels that are the subject of the current draft plan application and are identified as "Green Lands West", "Green Lands East" and the "Laffin Lands". The draft plan for the areas is included for reference and identified as ***Figure 2***.

1.1 Green Lands West & East

Green Lands West is proposed to be comprised of 160 single family homes and 175 townhomes (total 335 units).

Green Lands East is proposed to be comprised of 33 single family homes.

Figure 1 also demonstrates the surrounding areas of development that have been advanced within the WDL to date:

1. The first phase of development within the WDL was Fox Run Phase 1 (located south of Perth Street) and consisted of 220 single family homes, an interim stormwater management (SWM) pond and a sanitary trunk sewer outlet upgrade for the WDL along Martin Street. Phase 1 has been constructed to base course asphalt and home construction activities are ongoing;

2. Subsequent to Phase 1, detailed design submissions were made for:

    a. Phase 2 (North) (between Green Lands West and East) which has been approved and is currently under construction at the time of the writing of this FSR. This phase of development also included an expansion to the interim SWM Pond to its ultimate footprint which will also service the Green Lands West (see further discussion in Section 5 of this FSR). Phase 2 (North) consists of 31 single family homes and 163 townhomes;

    b. Phase 2 (South) design approval is anticipated in July 2020 with servicing construction to commence upon approval. Phase 2 (South) consists of 200 single family homes.

1.2 Laffin Lands

The ***Master Drainage Plan Western Development Lands for Richmond Village (South) Limited*** prepared by David Schaeffer Engineering Ltd., dated November 2013 (***MDP***) and the subsequent ***March 2020*** update (***MDP Update*** approved in April 2020) proposed the lands east of the Fox Run Phase development to be serviced by two stormwater management ponds (“Pond 1” and “Pond 2“). The Laffin Lands, located in the central portion of the WDL south (between Perth Street and Ottawa Street) is where the site of Pond 2 was originally located. However, in order to optimize land usage, the Pond 2 is proposed to be removed from the Laffin Lands and utilization of the Pond 1 as one centralized facility. See discussion in Section 5 of this report.

The Laffin Lands are proposed to be comprised of 114 single family homes and 63 townhomes (total 177 units).

This FSR is provided to demonstrate conformance with the design criteria of the City of Ottawa, background studies, including the Master Servicing Study, and general industry practice.

1.3 Existing Conditions

Green Lands West: The majority of this 12.3ha site is currently undeveloped and is active farmland. The site area surrounds an existing BMR commercial property that fronts onto Perth Street. Immediately west of the BMR property is a residential property/structure at 6387 and 6409 Perth Street which will be removed as part of the site development. The general terrain is relatively flat and the majority has been previously cleared of trees, with the exception of some minor hedgerows along the some ditches, along the periphery of the site and in the vicinity of the existing residential buildings.

Existing ground elevations are on average between 96.10m to 94.40m (with some isolated higher elevations at the existing dwellings).

As identified in the ***Green Lands Geotechnical Report*** prepared by Golder Associates, the subsurface conditions within the development area are anticipated to consist of topsoil overlaying a silty clay over sandy silt and glacial till. For additional details please see the borehole logs and descriptions found in ***Appendix F***. The geotechnical investigation of the area indicates that the deposit of generally firm unweathered grey silty clay has a limited capacity to support additional stress and as such there are recommended grade raise restrictions of 1.3m to 1.5m at future home locations and approximately 2 meters at roadways.

Green Lands East: The majority of this 3.62ha site is currently undeveloped and is active farmland. The general terrain is relatively flat and the majority has been previously cleared of trees, with the exception of a hedgerow along the frontage of Mira Court. The future alignment of the Van Gaal Drain borders the west side of the property and the east side fronts onto Mira Court (the proposed south units) or back onto the adjacent Richmond Oaks Subdivision (the proposed north units).

Existing ground elevations are on average between 95.35m to 94.40m (with some isolated higher elevations at the existing dwellings) with a gradient to the southeast.

As identified in the ***Green Lands Geotechnical Report*** prepared by Golder Associates, the subsurface conditions within the development area are anticipated to consist of topsoil overlaying a silty clay over sandy silt and glacial till. For additional details please see the borehole logs and descriptions found in ***Appendix F***. The geotechnical investigation of the area indicates that the deposit of generally firm unweathered grey silty clay has a limited capacity to support additional stress and as such there are recommended grade raise restrictions of 1.3 m to 1.5 m at future home locations and approximately 2 m at roadways.

Laffin Lands: The majority of this 7.26ha site is currently undeveloped with approximately 80% as agricultural land and the remaining 20% an existing woodlot in the northeast quadrant of the property. Existing ground elevations are between 94.00 m to 97.15 m with the general terrain being relatively flat with a land gradient to the northwest.

As identified in the ***Laffin Lands Geotechnical Report*** prepared by Golder Associates, the subsurface conditions within the development area consists topsoil overlaying a silty sand fill (thickness ranging from 500 to 800 mm), sandy clayey silt (boreholes 20-306 and 20-307) and silty sand to sand and silt. Glacial till over rock was encountered in the majority of the borehole locations with auger refusals indicating potential bedrock or boulders within the till. Bedrock was encountered in boreholes 20-307 and 20-309 at depths of approximately 3 m. For additional details please see the borehole logs and descriptions found in ***Appendix F***. The geotechnical investigation of the area indicates that the site is generally underlain by loose to very dense native silty sand and silty sand till and therefore grade raises typical for low-rise subdivisions (assumed to be 1.5 to 2.5 m) are deemed acceptable.

The WDL development is located within the jurisdiction of the Rideau Valley Conservation Authority (RVCA).

1.4 Summary of Pre-Consultation

The following provides a summary of the pre-consultation:

1.4.1 Ministry of the Environment, Conservation and Parks (MECP)

Prior consultations associated with the Western Development Land area have previously been undertaken for the approval of the Martin Street Sanitary Trunk Sewer , the interim SWM ‘Pond 1’ that services the initial phases of development, and the sanitary/storm sewers associated with the Phase 1 development area.

1.4.2 City of Ottawa

The following is a list of the pre-consultation meetings with the City of Ottawa for the Green and Laffin Lands:

- March 13, 2020 – a formal pre-application Consultation with Municipal Staff for the Green Lands was held. The intent of the meeting was to discuss the proposed development, review technical considerations and identify/confirm studies required to accompany the submission of a Plan of Subdivision application.

A copy of the above noted pre-consultation minutes are enclosed in ***Appendix A*** for reference.

1.5 Existing Permits / Approvals

The existing approvals for surrounding infrastructure, related to the proposed development areas, are presented in the following table. Prior ECA approvals are provided in ***Appendix B*** for reference.

Table 1: Existing Permits / Approvals

Agency	Approval Type	Approval Number	Remarks
Ministry of the Environment, Conservation and Parks (MECP)	Environmental Compliance Approval	1608-BPHMBF (May 19, 2020)	Stormwater Management Pond 1 expansion which accounts for future drainage from the Green Lands West
Ministry of the Environment, Conservation and Parks (MECP)	Environmental Compliance Approval	5426-A5PMR (January 6, 2016)	Martin Street Sanitary Trunk Sewer for conveyance of sanitary flows from the WDL development area.
Ministry of the Environment, Conservation and Parks (MECP)	Environmental Compliance Approval	1528-BLFNVH (February 24, 2020)	Caivan Communities – Richmond Phase 2 (North) for sanitary and storm sewers
Ministry of the Environment, Conservation and Parks (MECP)	Environmental Compliance Approval	9297-AV9KAL (January 25, 2018)	Caivan Communities – Richmond Phase 1 for sanitary and storm sewers
Rideau Valley Conservation Authority (RVCA)	Alteration of Waterways Permit under O.Reg. 174/06	RV5-4619 (October 1, 2019)	Authorization related to the construction of the Ultimate Stormwater Management Pond 1 located partially within the Regulatory Floodplain of the Jock River and Arbuckle Municipal Drain.
Rideau Valley Conservation Authority (RVCA)	Alteration of Waterways Permit under O.Reg. 174/06	RV5-2919 (January 23, 2020)	Authorization related to the realignment of the Van Gaal Municipal Drain to accommodate development in the WDL development area.

1.6 Required Permits / Approvals

The Green/Laffin Lands development areas are subject to the following permits/ approvals:

Table 2: Required Permits / Approvals

Agency	Approval Type	Trigger	Remarks
City of Ottawa	Commence Work Notification (CWN)	Construction of new sanitary and storm sewers throughout the subdivision.	The City of Ottawa will issue a commence work notification for construction of the sanitary and storm sewers once an ECA is issued by the MECP.
City of Ottawa	MECP Form 1 – Record of Watermains Authorized as a Future Alteration	Construction of watermains throughout the subdivision.	The City of Ottawa will review the watermains on behalf of the MECP through the Form 1 – Record of Watermains Authorized as a Future Alteration.
Ministry of the Environment, Conservation and Parks (MECP)	Environmental Compliance Approval for sanitary and storm sewers	Construction of new sanitary/storm sewers throughout the subdivision areas.	The MECP will issue an ECA for the sanitary/storm sewer design through the transfer of review process.
City of Ottawa	Permission for a storm outlet from the Green Lands East to the Van Gaal Municipal Drain.	Condition of subdivision approval.	The City of Ottawa will issue a permission letter for the connection via the development review process.
Rideau Valley Conservation Authority (RVCA)	RVCA Letter of Permission: Fill Permit	Removal of a minor area of floodplain located in the northwest corner of the Green Lands West area.	Authorization related to a balanced cut/fill placement in a regulated area.
Rideau Valley Conservation Authority (RVCA)	RVCA Letter of Permission: Fill Permit	Alterations to SWM Pond 1 and work within the setback of the regulated area.	Authorization related to a balanced cut/fill placement and underground services within a regulated area.
Lands Owned by Others	Permission of installation of infrastructure where required	Construction of new sanitary/storm sewers or watermain.	Proof of authorization to be provided when required.

2.0 GUIDELINES, PREVIOUS STUDIES, AND REPORTS

2.1 Existing Studies, Guidelines, and Reports

The following studies were utilized in the preparation of this report.

- Ottawa Sewer Design Guidelines
  City of Ottawa, October 2012
  (Sewer Design Guidelines)
    - Technical Bulletin ISDTB-2014-01
      City of Ottawa, February 5, 2014
      *(**ITSB-2014-01**)*
    - Technical Bulletin PIEDTB-2016-01
      City of Ottawa, September 6, 2016
      *(**PIEDTB-2016-01**)*
    - Technical Bulletin ISTB-2018-01
      City of Ottawa, March 21, 2018
      *(**ISTB-2018-01**)*
    - Technical Bulletin ISTB-2018-04
      City of Ottawa, June 27, 2018
      *(**ISTB-2018-04**)*
- Ottawa Design Guidelines – Water Distribution
  City of Ottawa, July 2010
  *(**Water Supply Guidelines**)*
    - Technical Bulletin ISD-2010-2
      City of Ottawa, December 15, 2010.
      *(ISD-**2010-2**)*
    - Technical Bulletin ISDTB-2014-2
      City of Ottawa, May 27, 2014.
      *(**ISDTB-2014-2**)*
    - Technical Bulletin ISTB-2018-02
      City of Ottawa, March 21, 2018
      *(**ISTB-2018-02**)*
- City of Ottawa Official Plan,
  adopted by Council 2003.
  *(**Official Plan**)*

- Stormwater Planning and Design Manual
  Ministry of the Environment, March 2003.
  *(**SWMP Design Manual**)*
- Erosion & Sediment Control Guidelines for Urban Construction
  Greater Golden Horseshoe Area Conservation Authorities, December 2006
  *(**E&S Guidelines**)*
- Ontario Building Code Compendium
  Ministry of Municipal Affairs and Housing Building Development Branch,
  January 1, 2010 Update *(**OBC**)*
- Village of Richmond Water and Sanitary Master Servicing Study
  Stantec Consulting Ltd., July 2011 *(**MSS**)*
- Village of Richmond Community Design Plan
  City of Ottawa, July 2010 *(**CDP**)*
- Master Drainage Plan Western Development Lands for Richmond Village (South) Limited
  David Schaeffer Engineering Ltd., November 2013 and March 2020 as amended
  *(**MDP and MDP 2020 Update respectively**)*
- Preliminary Geotechnical Investigation Report, Proposed Residential Subdivision Perth and Ottawa Streets Richmond Area, Ottawa, ON.
  Jacques Whitford Consultants, June 2007
  *(**Geotechnical Investigation**)*
- Preliminary Geotechnical Report, Green Lands West and Green Lands East
  Golder Associates, June 2020 (Project No. 20144864-3000-01)
  *(**Green Lands Geotechnical Report**)*
- Geotechnical Investigation, Laffin Parcel.
  Golder Associates, July 2020 (Report No. 20144864-3000-01)
  *(**Laffin Lands Geotechnical Report**)*
- Groundwater Impact Assessment, Proposed Residential Development, 6305 Ottawa Street West - Richmond
  Paterson Group, June 2020 (Reference No. PH4034-LET.01)
  *(**Paterson Groundwater Report**)*
- Design Brief for Ultimate Stormwater Management Pond 1, Western Development Lands, Richmond
  JF Sabourin & Associates and David Schaeffer Engineering Ltd, March 2020)
  *(**Ultimate Pond 1 Design Brief**)*
- Sanitary Design Brief (Off-Site Trunk Sewers) for Richmond Village (North & South) Ltd, Village of Richmond

David Schaeffer Engineering Ltd., October 26, 2015 (2nd Submission)
(Off-Site Trunk Sewers)

- Stormwater Management Report for Fox Run Subdivision – Phase 2 North
JF Sabourin and Associates, March 2020
*(**PH2 North SWM Report**)*
- Stormwater Management Report for Fox Run Subdivision – Phase 2 South
JF Sabourin and Associates, May 2020
*(**PH2 South SWM Report**)*
- Stormwater Management Report for Fox Run Subdivision – Phase 1
JF Sabourin and Associates, October 2017
*(**PH1 SWM Report**)*
- Design Brief for Caivan Communities Richmond Phase 1
DSEL, November 2017
*(**PH1 Design Brief**)*
- Technical Memorandum No. 1A – Richmond Population and Wastewater Flow Projections
Parsons, March 2019
*(**TM No.1A**)*
- Technical Memorandum No. 2 – Proposed Richmond Pumping Station Upgrade
Parsons, May 2019
*(**TM No.2**)*
- Village of Richmond Wastewater Collection System Upgrades Functional Design Study
Parsons, September 2019
*(**Wastewater Functional Design**)*
- Western Development Lands – Richmond / Expansion of Drainage Area to SWM Facility 1
JF Sabourin and Associates, August 2021
*(**JFSA 2021 Pond1 Memo**)*

3.0 WATER SUPPLY SERVICING

3.1 Existing Water Supply Services

The existing City of Ottawa water distribution network currently terminates in Kanata and Barrhaven, approximately 10km from the subject site.

The majority of existing residences and businesses in the Village of Richmond are supplied with potable water by both shallow and deep private wells. Parts of the Village of Richmond are supplied with potable water by a public communal well system (King's Park Water Treatment Facility).

In tandem with the construction of Phase 1 of the Fox Run development area, a new communal well system was constructed (referred to as the Richmond West Pumping Station), and is now commissioned, and will provide water supply service to the entire future *WDL* area. With the advancement of the Phase 2 (North) and (South) development areas, the water supply network will be available to the boundaries of the Green Lands West development area at Perth Street at two locations as seen in ***Figure 3A*** and ***3B*** in the ***Figures*** section.

3.2 Proposed Water Supply

3.2.1 Green Lands West Water Supply

Water servicing for the Green Lands West area was contemplated in the ***Village of Richmond Water and Sanitary Master Servicing Study*** prepared by Stantec Consulting Ltd., July 2011 (***MSS***). The preferred design concept indicated by the ***MSS***, for development of the WDL, consisted of a new public communal well system connected to the deep aquifer. The facility is now operational.

The Green Lands West area will be serviced internally by 150 mm, 200 mm and 300mm diameter watermains designed in accordance with the ***Water Supply Guidelines*** and ***2013 Water Master Plan***. Various design criteria are summarized in the following table.

Table 3: Water Supply Design Criteria

Design Parameter	Value
Residential - Single Family	3.4 p/unit
Residential - Townhome	2.7 p/unit
Institutional	28,000 L/ha/day
(1) Residential – Basic Day Demand (BSDY)	180 L/cap/day (Singles); 198 L/cap/day (Townhomes)
(1) Residential - Maximum Daily Demand (MXDY)	As per 2013 WMP
(1) Residential – Peak Hour Demand (PKHR)	As per 2013 WMP
Fire Flow	Calculated as per the Fire Underwriter's Survey 1999.
Minimum Watermain Size	150 mm diameter
Service Lateral Size	19 mm dia Soft Copper Type 'K' or approved equivalent
Minimum Depth of Cover	2.4 m from top of watermain to finished grade
Peak hourly demand operating pressure	275 kPa and 690 kPa
Fire flow operating pressure minimum	140 kPa

Extracted from Section 4: Ottawa Design Guidelines, Water Distribution (July 2010), ISDTB-2010-2

(1) See page 2 for "Demand Projections" discussion in Stantec Water Analysis found in ***Appendix C****.*

The internal watermains will connect to watermain stubs that were installed as part of the Phase 1 (a 300mm diameter stub to be extended from Equitation Circle across Perth Street) and Phase 2 (north) construction from Oldenburg Avenue (and from future watermain installations from extensions of Oldenburg Avenue). The proposed and existing watermains are depicted in ***Figure 3A***.

Stantec has completed a review of the Green Lands West area given that the prior projected number of units assessed for this land area, during evaluation of the Fox Run Phase 2 (North) development, is increased from 150 single family homes (SFH) with a population of 510 (based on 3.4 p/unit) to 162 SFH and 175 townhomes (~1024 people). Refer to the technical memorandum ***Richmond Caivan Green & Laffin Lands – Potable Water Capacity Analysis*** prepared by Stantec Consulting Ltd. dated February 2021 ***(Stantec Water Review)***, enclosed in ***Appendix C*** which indicates that the additional populations and unit counts can be accommodated. Note: The draft plan layout has been updated slightly from the February 2021 Stantec report. However, the overall unit count and population in the Green West/East and Fox Run Phase 3 development areas is slightly reduced so the results and findings remain valid. Planned future expansion of the Communal Well storage will ultimately be dictated by the rate of progress of the WDL development area up until demand approaches the current 28 L/s supply with the largest well (40 L/s) out of service.

3.2.2 Green Lands East Water Supply

Similar to the Green Lands West, it is proposed that watermains will be extended to provide water service to the Green Lands East area. Two crossings of the Van Gaal Drain are proposed to provide sufficient system pressures for this water supply connection. The preliminary analysis completed by Stantec indicates that the required system pressures are satisfied with the proposed configuration shown in ***Figure 3A***.

3.2.3 Laffin Lands Water Supply

Similar to the Green Lands West, the Laffin Lands were contemplated in the ***Village of Richmond Water and Sanitary Master Servicing Study*** prepared by Stantec Consulting Ltd., July 2011 (***MSS***) and is serviced by the Communal Well. The internal watermains will connect to the extension of watermains installed at the Communal Well which will extend through the Mattamy property located between Fox Run Phase 1 and the Laffin Lands. Any watermain services required will have to be coordinated with the future advancement of the detailed design of the Mattamy property (including any required watermain looping). The Laffin Lands area are anticipated to be serviced internally by 150mm, 200mm and 300mm diameter watermains designed in accordance with the prior Stantec evaluations. The proposed and existing watermains are depicted in ***Figure 3B***.

Stantec has completed a review of the expanded Laffin Lands area given that the prior projected number of units assessed for this land area, during evaluation of the Fox Run Phase 2 (North) and (South) developments, is increased from 98 units (80 SFH and 18 TH) to 177units (114 SFH and 63 THs). A projected increase in population from 321 to 558 people. This is due to the removal of SWM Pond 2 as discussed further in Section 5 of this report. Refer to the ***Stantec Water Review*** for review of the Laffin Lands.

3.2.4 Water Demand Calculations

A summary of water demands taken from the ***Stantec Water Review*** is presented in the following table:

Table 4 – Summary of Water Demands(1)

Development Area	Unit Type	Population	Area (ha)	Water Demands		
				BSDY (L/s)	**OWD (L/s)**	**MXDY (L/s)**
(1)RVDC Fox Run Ph1	SFH	748	-	1.56	2.67	4.23
RVDC Fox Run Ph2 (North)	SFH	105	-	0.22	0.38	0.60
	MLT	440	-	1.01	-	1.01
RVDC Fox Run Ph2 (South)	SFH	680		1.42	2.43	3.85
RVDC Fox Run Ph3	SFH	751	-	1.57	2.68	4.25
Mattamy Ph1	SFH	449	-	0.94	1.60	2.54
	MLT	127	-	0.29	-	0.29
Green Lands West (Caivan (Richmond North) Ltd)	SFH	391	-	0.81	1.40	2.21
	MLT	702	-	1.61	-	1.61
Green Lands East (Caivan (Richmond North) Ltd)	SFH	126	-	0.26	0.45	0.71
Laffin Lands (Caivan (Richmond South) Ltd)	SFH	367	-	0.76	1.31	2.08
	MLT	178	-	0.41	-	0.41
Interim Conditions (Sub-total)		***5,064***	***0***	***10.85***	***12.92***	***23.78***
Mattamy Buildout	SFH	2,176	-	4.53	7.77	12.30
	MLT	635	-	1.45	-	1.45
	INS	-	2.63	0.85	-	0.85
	MLT	146	-	0.33	-	0.33
Buildout Conditions (Total)		***7,875***	***2.63***	***17.69***	***20.69***	***38.39***

(1) Extracted from "Richmond Caivan Green & Laffin Lands – Potable Water Capacity Analysis" by Stantec Consulting Ltd. dated February 2021. See report in Appendix C for further population details and allocation for Phase 2 South and Phase 2 North.

(2) RVDC = Richmond Village Development Corporation

SFH (Single-Family Home); MLT (Multi / Townhouses); BSDY (Basic Day); OWD (Outdoor Water Demand of 1049 L/SFH/d)); MXDY (Maximum Day).

3.3 Water Supply Conclusion

The proposed development areas will be serviced by 150 mm, 200mm and 300 mm diameter watermains which will be connected to the existing water distribution network currently in place. Coordination with the advancement of any detailed design of adjacent properties will be undertaken at the time of the design advancement of the Green West/East or Laffin Lands properties.

The ***Stantec Water Review*** indicates that the proposed watermain layouts will satisfy the demands under all conditions and the proposed layout conforms to the water servicing plan as conceptualized in the Communal Well design.

4.0 WASTEWATER SERVICING

4.1 Existing/Approved Wastewater Services

The existing Village of Richmond is serviced primarily by City of Ottawa sanitary sewers that convey wastewater to the Richmond Pumping Station located south of the Jock River, on the northwest corner of Cockburn Street and York Street. The Richmond Pump Station (RPS) discharges to the Glen Cairn Trunk Sewer just south of Hazeldean and Robertson Road in Kanata.

The WDL is serviced via the new sanitary trunk sewer that has been recently constructed along Martin Street from Cockburn Street to the boundary of the Fox Run Phase 1 development area.

Wastewater collection services for the WDL was contemplated in the ***MSS*** and there are currently system capacity constraints requiring upgrades in order to facilitate servicing capacity for the balance of the WDL. The recommended solution is expanding the current wastewater collection system and to continue to pump wastewater to the City’s central wastewater treatment facility.

The preferred design concepts for the improvements to the wastewater service includes:

- Upgrades to the existing gravity collection system (City program to remove extraneous flows and pipe size and length improvements for the gravity collection system along specific road segments). ***This was accomplished via the approved Martin Street trunk sewer upgrade.***
- Operation upgraded to facilitate emergency use of the Richmond Lagoon Cell C in extreme wet weather conditions. Twinning of 1200 m of existing forcemain with new 600 mm sewer and repairs to the existing 500mm diameter forcemain. ***Partially Completed*** *(twinning still ongoing at the time of this FSR preparation).*
- Extension of 5.9 km forcemain twinning from the current termination point with an additional 600 mm diameter forcemain along Eagleson Road. ***Design being initiated.***
- Upgrades / expansion of the existing Richmond Pump Station. Analysis/design ongoing by Stantec with design expected to be completed in 2021.

- New 600mm forcemain twinning from Richmond to the City's central collection system in Kanata. ***Future work.***

Ongoing coordination with the wastewater upgrades/analyses will determine how much flow from the advancing development of the WDL will be allowed. The City of Ottawa has previously retained Parsons to review wastewater within the Village of Richmond. They have prepared Technical Memorandums (***TM No.1 – Richmond Population and Wastewater Flow Projections (March 2019)*** and ***TM No.2 – Proposed Richmond Pumping Station Upgrade (May 2019)***) to review the sanitary system in order to facilitate growth within the Village of Richmond. Follow up analyses and consultations are continuing and will ultimately determine system capacity allocations and timing.

4.2 Wastewater Design

The Green and Laffin Lands will be serviced by new gravity sewers designed in accordance with City of Ottawa design criteria which will connect to the existing sanitary sewer infrastructure constructed during the development of Fox Run Phase 1 and Phase 2 (North) areas. The proposed sanitary sewer layouts are depicted in ***Drawings 2A and 2B*** in the ***Drawings*** section at the back of this report. The following table summarizes the ***City Standards*** which are used in the design of the proposed wastewater sewer system.

Table 5: Wastewater Design Criteria

Design Parameter	Value
Residential - Single Family	3.4 persons/unit
Residential - Townhome	2.7 persons/unit
Residential - Average Daily Demand	280 L/d/person
Residential - Peaking Factor	Harmon's Peaking Factor. Max 4.0, Min 2.0
Harmon - Correction Factor	0.80
Institutional – Average Flow	28,000 L/ha/day
Institutional – Peaking Factor	1.5 if ICI in contributing area is >20% 1.0 if ICI in contributing area is <20%
Infiltration and Inflow Allowance	0.33 L/s/ha
Park Flow	9,300 L/ha/day
Sanitary sewers are to be sized employing the Manning's Equation	$Q = \frac{1}{n} A R^{2/3} S^{1/2}$
Minimum Sewer Size	200 mm diameter
Minimum Manning's 'n'	0.013
Minimum Depth of Cover	2.5m from crown of sewer to grade
Minimum Full Flowing Velocity	0.6 m/s
Maximum Full Flowing Velocity	3.0 m/s
Extracted from Sections 4 and 6 of the City of Ottawa Sewer Design Guidelines, October 2012 and Technical Bulletin ISTB-2018-01.	

The *Fox Run Phase 1* sanitary design sheets are provided in ***Appendix D*** as a frame of reference for the previously anticipated sanitary flows from the future Green and Laffin properties. It is noted that the prior design for the ***WDL*** sewers was based on older City guidelines with an average daily demand of 350 L/d/person while the new guidelines specify 280 L/d/person. The prior infiltration allowance of 0.28 L/s/ha was also used while the current guidelines specify 0.33 L/s/ha as per the table above.

The updated design parameters from the above table are used for the Green Lands and Laffin Land areas.

4.2.1 Green Lands West

The draft plan demonstrates 160 single family homes and 175 townhomes (total 335 units) which results in an increased population that was projected from this external area in the Fox Run Phase 2 (North) sanitary design sheet (which was based on a per hectare population due to uncertainty about the future development unit mix) . As per the sanitary design sheet for the Green Lands West area found in ***Appendix D***, the overall projected flows tributary to the connection point at the previously constructed trunk sewer (at existing sanitary manhole MH150A at the Perth Street and Meynell Road intersection) are lower than the flows assessed in the Fox Run Phase 1 design (i.e. *41.93 L/s* from the Fox Run Phase 1 design and **37.67 L/s** in this FSR design sheet). As such, the proposed unit mix and population results in design flows through the Fox Run Phase 1 development area that are lower than previously anticipated flows that were used for trunk sewer designs.

4.2.2 Green Lands East

The draft plan demonstrates 33 single family homes for the Green Lands East development area. As per the sanitary design sheet in ***Appendix D*** this area generates flows of approximately **2.42 L/s** that will be connected to existing sanitary sewers located within the Richmond Oaks development to the east.

Within the ***MSS,*** various infill and future development scenarios were reviewed in order to assess system capacities. For the Green Lands East area the *MSS Figure 5.7* (provided in ***Appendix D***) demonstrates that there are no local system bottlenecks for capacity (other than the Martin Street sewer which has already been upgraded and future pump station and forcemain upgrades which are planned to be implemented). It is anticipated that this small increase in flows can be readily incorporated into the sewer networks and will ultimately be captured in the future sanitary system upgrades for the Village of Richmond.

4.2.3 Laffin Lands

The Draft Plan demonstrates that the Laffin Lands are proposed to be comprised of 114 single family homes and 63townhomes (total 177 units).

The Fox Run Phase 1 sanitary system is designed to accept external flows from the future Mattamy and Laffin Lands. A summary of the Laffin external flows is as follows:

- Drainage Area = 7.12 ha
- Population = ~580
- Total Peak Flow = ~8.65 L/s

Refer to ***Drawing 2B*** Sanitary Servicing Plan in the ***Drawings*** section and the sanitary sewer design sheet in ***Appendix D*** for details.

The peak sanitary flow contributions from the proposed development areas south of Fox Run Phase 1 were previously estimated to be ***62.33 L/s*** at the stub from the Fox Run Phase 1 development outlet (see the marked up sanitary design sheet from that phase in ***Appendix D***). As per the FSR design sheet for the Mattamy/Laffin Lands the projected flow is **59.50 L/s** therefore the downstream infrastructure up to the sanitary pump station has sufficient capacity as designed/constructed and that the flows will ultimately be captured in the future sanitary system upgrades for the Village of Richmond.

4.3 Sanitary Hydraulic Grade Line – Richmond Pump Station Failure Scenario

Stantec Consulting has previously prepared a memo (see ***Appendix D***) that was circulated to City staff reviewing the level of service of the RPS (*Richmond Pump Station – Design Level of Service, Stantec, Oct 5/12, File No. 163401146*). In the event of a catastrophic failure of the RPS, the estimated HGL starting point at the RPS would be at approximately the 100-year water level at the overflow outlet point at the Jock River (~93.80m per page 4). Given this starting HGL, it will theoretically be above the underside of footings (USFs) of the proposed units (and most of the Village). City staff have commented that per guidelines, there is a requirement for the USFs to be established at an elevation above the 25-year water levels in the Jock River at the sanitary pumping station. The RVCA flood mapping in this area (Jock River Reach 3, cross-section 18224) indicates that this elevation would be ~93.44m. Based on the functional grading for the Green and Laffin properties the proposed USFs would be above this elevation. Notwithstanding, within a grade raise restricted development area, all units are established at as high an elevation as possible and will be protected by backwater valves in the sanitary sewer laterals to the dwellings as required per Section 4.4.5 of the Design Guidelines.

4.4 Wastewater Servicing Conclusion

The Green Lands West and Laffin Lands will connect to existing downstream sewers previously constructed as part of the Fox Run Phase 1 development area. When comparing the projected flows from the areas, the downstream sewer systems were designed for flows that were greater than the projected flows therefore capacity exists in those sewers..

Green Lands East units will outlet to existing sewers in the adjacent Richmond Oaks development. A review of the MSS indicates that there are no downstream contstraints in the downstream sewers up to the sanitary pump station.

In a greater context, there are ongoing studies and agreements being formulated in order to increase the sanitary capacity for the Village of Richmond through downstream twinning of forcemains and planned expansion of the Richmond Sanitary Pump station.

The functional sanitary sewers have been designed adhering to all relevant *City Standards*.

5.0 STORMWATER CONVEYANCE

Stormwater conveyance for the Green Lands West and Laffin Lands properties were contemplated in the ***Stormwater Management Report for Richmond Village (South) Limited*** (now known as RVDC) prepared by David Schaeffer Engineering Ltd., November 2013 ***(MDP)*** and the subsequent ***March 2020*** update (to be referred to as the ***MDP 2020 Update*** that was approved in April 2020). The Green Lands West area conforms to the ***MDP 2020 Update*** however it is proposed that the Laffin Lands will deviate from the document and pursue an alternate servicing arrangement. This will be reflected in a ***MDP 2021 Update*** process that will accompany the functional design submission for draft approval. See discussion later in this section.

The Green Lands East area was not previously contemplated within the ***MDP*** studies and the proposed solution is based on maintaining post-development flows to pre-development levels for quantity control and quality controls via an oil-grit separator (OGS) unit as noted in the pre-consultation minutes.

5.1 Master Drainage Plan Updates

The original 2013 ***MDP*** for the WDL conceptualized the stormwater management systems based on the City of Ottawa standard criteria at the time (i.e. 5-year level of service for sewers and 30cm of ponding etc). The ***MDP 2020 Update*** was prepared at the request of City of Ottawa staff to reflect a number of important updates to the ***Sewer Design Guidelines*** subsequent to the preparation of the 2013 ***MDP***. As presented in the ***MDP*** and ***MDP 2020 Update***, the recommended stormwater servicing solution consists of a major system, a minor system, and homes with basements equipped with sump pumps to provide foundation drainage.

The *Drawing 3* (*Storm Servicing Plan*) draft from the ***MDP 2021 Update*** can be found in ***Appendix E*** for reference.

The following were the most relevant aspects of the recent ***MDP 2020 Update*** for the WDL:

- Technical Bulletin ISTB-2019-02 dated July 8, 2019 regarding the use of sump pumps;
- Technical Bulletin PIEDTB-2016-01 dated September 6, 2016 regarding the updated sizing for the minor system (i.e. 2-year for local streets, 5-year for collector streets and 10-year for arterial roads);

In addition, the ***MDP 2020 Update*** included the following:

i. Updates to reflect small revisions in the drainage split between the proposed Pond 1 and 2 based on a design concept by Mattamy Homes;
ii. A section of the report regarding the Moore Tributary was added to describe some design elements of the Realignment of the Moore Tributary (north of the Laffin Lands);
iii. Maintained the proposal for a two pond servicing concept for the southern WDL area (discussion on the deviation from this aspect is detailed in the Laffin Lands discussion that follows); and
iv. To reflect optimized design, where sump pumps are eliminated for areas south of Ottawa Street and foundations are drained by gravity

The ***MDP 2021 Update*** will be adjusting items (i), (iii) and (iv) above to reflect the updated approach as it relates to the Laffin Land development area. Please refer to the ***MDP 2021 Update*** under separate cover for full details and discussion in Section 5.4 of this report.

5.2 Green Lands West

5.2.1 Minor System

The Green Lands West development area will be serviced by a storm sewer system designed in accordance with the amendment to the storm sewer and stormwater management elements of the Ottawa Design Guidelines – Sewer (Technical Bulletin PIEDTB-2016-01).

The minor storm sewer system will be sized as follows:

- 2-year event for local streets;
- 5-year event for collector streets; and
- 10-year events for arterial roads

The storm sewers are sized using City of Ottawa IDF curves. The proposed storm sewer layout for the development is depicted in the schematic ***Drawing 3A*** *Storm Servicing Plan* in ***Drawings***. The storm sewers for this development area will outlet to future sewers to be constructed along Oldenburg Avenue as approved in the Fox Run Phase 2 (North) development and to the future extension of Oldenburg Avenue and sewer network as development progresses. The downstream sewers in Phase 2 (North) were designed with the Green Lands West considered. As illustrated in the Green Lands West and Fox Run Phase 2 (North) design sheets in ***Appendix E,*** the projected storm flows of ***1,936 L/s*** are less than the 2,201 L/s within the previously designed Oldenburg Avenue sewer segment MH263 to MH264 with sufficient capacity within the previously designed sewers all the way to the SWM Pond 1 inlet.

The sewers ultimately outlet to SWM Pond 1 as per the recently approved design for the ultimate pond that was designed and approved as a component of the Fox Run Phase 2 (North) development (see further discussion in Section 5.2.3 of this FSR report).

The following table summarizes the relevant ***City Standards*** employed in the design of the proposed minor storm sewer system.

Table 6: Storm Sewer Design Criteria

Design Parameter	Value
Minor System Design Return Period	2-Year (Local Streets), 5-Year (Collector Streets), 10-Year (Arterial Streets) – PIEDTB-2016-01
Major System Design Return Period	100-Year
Intensity Duration Frequency Curve (IDF) 5-year storm event. A = 998.071 B = 6.053 C = 0.814	$i = \frac{A}{(t_c + B)^C}$
Initial Time of Concentration	10 minutes
Rational Method	$Q = CiA$
Runoff coefficient for paved and roof areas	0.9
Runoff coefficient for landscaped areas	0.2
Storm sewers are to be sized employing the Manning's Equation	$Q = \frac{1}{n} AR^{2/3} S^{1/2}$
Minimum Sewer Size	250 mm diameter
Minimum Manning's 'n'	0.013
Service Lateral Size	100 mm dia PVC SDR 28 with a minimum slope of 1.0%
Minimum Depth of Cover	2.0 m from crown of sewer to grade (insulation when not possible)
Minimum Full Flowing Velocity	0.8 m/s
Maximum Full Flowing Velocity	3.0 m/s
Extracted from Sections 5 and 6 of the City of Ottawa Sewer Design Guidelines, October 2012 and PIEDTB-2016-01	

The paved area and grassed area runoff coefficients of 0.9 and 0.2 were used to calculate average runoff coefficients that were applied across the site. The storm drainage areas are found in ***Drawings*** and the storm design sheets are enclosed in ***Appendix E*** for reference.

The storm sewers will be sized using City of Ottawa IDF curves. In keeping with the design for Fox Run Phase 2 (North) and (South), the system will not be designed with inlet control devices (ICDs) for catchbasins. The prior analyses for the adjacent phase of the development (which included the Green Lands West) have been modelled with no ICDs and modeled the catchbasins and surface storage dynamically as part of the XPSWMM storm sewer model. This was undertaken in order to confirm the performance of the system when high hydraulic gradeline elevations interact with catchbasin and surface storage. A 100-year hydraulic grade line (HGL) analysis will be completed at the time of detailed design (with detailed grading in place) to confirm that the HGL will be maintained below the gutter line elevation, given that the development will be on sump pumps.

5.2.2 Major System

The major system flows will be conveyed through the internal road network where the 100-year event will be captured by required 100-year inlets prior to discharge to the SWM Pond 1 where they are managed for quality/quantity control prior to release to the Arbuckle Drain. Major events in excess of the 100-year event will outlet to the Van Gaal Drain through the adjacent development to the east (i.e. Fox Run Phase 2 (North) and subsequent phases) in accordance with the ***MDP 2021 Update*** (see MDP *Grading Plan Drawing 2* in ***Appendix E*** for details). The emergency overflow is via a 6m land block, proposed behind the existing residential property at 6305 Perth Street, as well as a curb cut along the south side of Perth Street. The JFSA stormwater modelling design for Phase 2 (North) provided "*Calculation Sheet 2E: Required Capacity of Phase 2B Overland Flow Route"* in its Appendix D and projected that minimal overland flow will occur due to 100-year surface storage within the development areas. The modelling conceptually considered future contributing areas (i.e. the Green Lands) as well. The JFSA calculation sheet is provided in ***Appendix E*** of this report for reference.

The major system will be designed in accordance with the amendment to the storm sewer and stormwater management elements of the Ottawa Design Guidelines – Sewer (Technical Bulletin PIEDTB-2016-01).

5.2.3 Quality and Quantity Control

As per the ***MDP 2020 Update***, the storm outlet for both the minor/major systems (up to the 100-year event) from the Green Lands West will be to an Ultimate SWM Pond 1. This wet pond facility provides the required erosion, quality, and quantity release components and outlets to the existing Arbuckle Drain. Water quality control is provided by the permanent pool sized for enhanced level of protection per MECP guidelines (80% TSS Removal). The SWM Pond 1 facility was designed and approved during the design of the Fox Run Phase 2 (North) subdivision lands to the east and accounted for the subject lands within in the design. Further details of the SWM Pond 1 modelling and sizing are included in the ***Design Brief for Stormwater Management Pond 1,***

Western Development Lands – Richmond (Project No. 15-764 dated March 2020) prepared by J.F. Sabourin and Associates provided under separate cover.

5.2.4 Floodplain

In association with the development of the Fox Run Phase 2 (North), and other RVDC lands to the northeast of Green Lands West, the Van Gaal Drain that previously bisected those properties has been realigned (based on prior approvals already received) to the perimeter of that development area. Construction is essentially complete (landscaping work remaining) with asbuilts submitted as of January 2021. There is currently ongoing coordination for the update of the floodline overlay with RVCA in order to officially remove the floodplain designation for those properties.

As seen in the FSR *Grading Plan* (***Drawing 1A***) and *Storm Servicing Plan* (***Drawing 3A***) there is a minor encroachment of the floodline into the proposed lot areas shown for Green Lands West property (northwest corner). The prior Van Gaal Drain realignment work downstream does not specifically remove the floodline from the Green property as it did for the other WDL lands. It is proposed that similar to the adjacent development area to the northeast, the proposed Block 50 Open Space area (as shown in the ***Figure 2*** Draft Plan) will be used to provide channel and riparian improvements in order to contain the 100-year water levels within the corridor. It is noted that unlike the adjacent development, the Van Gaal Drain will be shifted and will not have to be significantly re-routed as its current alignment is at the periphery, and parallel, to the site boundary. Based on the minimal extent of floodline impacted, as shown in ***Drawings 1A/3A,*** it is anticipated that the same methodology and similar fluvial cross-section for the prior Van Gaal adjustments are feasible.

The attached analysis memorandum prepared by JFSA entitled "*Richmond Village Development / Proposed Realignment of the Van Gaal Drain Adjacent to the Green Lands*" (August 2020) evaluates the pre and post development conditions proposed and concludes that flows can be maintained within the proposed corridor and riparian storage volumes will be equal or greater than existing riparian storage. This Block 50 area of the draft plan is currently active farmland with no significant features or tree cover

5.3 Green Lands East

5.3.1 Minor System

The Green Lands East development area will be serviced by a storm sewer system designed in accordance with the amendment to the storm sewer and stormwater management elements of the Ottawa Design Guidelines – Sewer (Technical Bulletin PIEDTB-2016-01).

With an individual local street being introduced for this infill development, the minor storm sewer system will be sized as follows:

- 2-year event for local streets;

The relevant ***City Standards*** summarized in Section 5.1.1 will be used for the design of the proposed minor storm sewer system.

The storm sewers will be sized using City of Ottawa IDF curves and are proposed to outlet to the adjacent Van Gaal Drain which is the natural receiver of stormwater runoff from these lands (similar to the nearby Mira Court sewers). Given that this is a Municipal Drain, the appropriate consultation with the City's Drainage Engineer and City staff will be undertaken.

A 100-year hydraulic grade line (HGL) analysis will be completed at the time of detailed design (with detailed grading in place) to confirm that the HGL will be maintained below the gutter line elevation, given that the development will be on sump pumps.

5.3.2 Major System

The major system flows will be conveyed through the internal road network where the 100-year event will be captured by required 100-year inlets prior to discharge to the Van Gaal Drain. Major events in excess of the 100-year event will outlet to the Van Gaal Drain as demonstrated in the conceptual *Grading Plan* ***Drawing 1A***, along with any required erosion control treatments.

5.3.3 Quantity and Quality Control

Unlike the Green Lands West area, ICDs will be employed to ensure that storm flows entering the minor system are limited to the pre-development limits. The evaluations related to ICDs for other WDL development areas was based on those areas being hydraulically connected to the SWM Pond 1 which is not the circumstance for the Green Lands East.

Quality control will be facilitated by an appropriately sized OGS unit prior to discharge to the adjacent Van Gaal Drain. A preliminary conservative sizing for the unit (CDS Model 3020) can be found in ***Appendix E*** for reference and will be confirmed during future detailed design.

5.3.4 Floodplain

The newly realigned Van Gaal Drain (VGD) is parallel to the western boundary of the Green Lands East area. The VGD, in its former state, imposed a floodplain overlay over a portion of the property (see the *Storm Servicing Plan* (***Drawing 3A***) in ***Appendix E*** for reference). As noted in Section 5.2.4, through a separate process, design and construction has been completed for the realignment of the Van Gaal Drain. The design has been vetted/approved through consultation with the City's Drainage Engineer, Rideau Valley Conservation Authority and the Department of Fisheries and Oceans.

The revised alignment and configuration defines a revised floodline within the limits of the Drain and ultimately removes the floodplain designation from the Green Lands East development area once the realignment construction of the Drain is accepted. Full details can be found in the ***Richmond Village Development / Proposed Realignment of Van Gaal Drain*** analysis prepared by JFSA (April 20, 2017) and other supporting documentation under separate cover.

5.4 Laffin Lands

5.4.1 Deviations from Master Drainage Plan

As noted in Section 5.1 of this report, the ***MDP 2020 Update*** contained various updates related to the stormwater design for the WDL. The currently proposed storm design for the Laffin Lands deviates from the ***MDP 2020 Update*** and will be reflected in an ***MDP 2021 Update*** as follows:

- The ***MDP 2020 Update*** continued with the concept of two SWM ponds to service the WDL area (as per the *Drawing 3* (*Storm Servicing Plan*) from the ***MDP 2020 Update*** in ***Appendix E)***. The ~2.75 ha block of land for SWM Pond 2 was proposed to be within the Laffin Lands development area in the ***MDP 2020 Update*** and would have had 38.66 ha of subdivision drainage and 71.8 ha of undeveloped external lands drainage from the southwest draining through it (total of 110.46 ha). The SWM Pond 2 outlet was to be to the Jock River via a storm sewer along Ottawa Street. The proposal is now for the removal of SWM Pond 2 and to service Ottawa Street, and all WDL area north of Ottawa Street, to a revised SWM Pond 1 instead of having two separate SWM ponds. The previous land area tributary to SWM Pond 1 from the development area south of Fox Run Phase 1 in the ***MDP 2020 Update*** was ~23.5 ha. With the revised drainage boundary the new drainage area to be managed within SWM Pond 1 is ~42.0 ha;

- In order to mitigate the overall changes to SWM Pond 1 the proposed design redirects 39.2 ha of external drainage area (north side of Ottawa Street), that was originally proposed to drain to Ottawa Street then to SWM Pond 2 in the ***MDP 2020 Update***, to now drain to a new sewer along Ottawa Street and directly to the Jock River (as opposed to passing through a Pond). This will be reflected in the ***MDP 2021 Update***.

- The design also proposes to redirect the 32.6 ha of external drainage area (from the Ottawa Street south ditch) noted in Section 6.2 of the ***MDP 2020 Update*** (report excerpt in ***Appendix E***). These flows, in the existing condition, are directly conveyed southward to the Jock River via open ditches. Rather than conveying the flows through any SWM pond, it is proposed that the flows be conveyed through a new sewer along Ottawa Street and outletting to the Jock River (see ***Drawing 6*** in the ***Drawings*** section of the ***Appendices***). The Jock River does not require any quantity control measures and the stormwater would continue to outlet to the Jock River further downstream.

- Lastly, given the proposed storm sewer outlets noted above, for external stormwater flows that will be directed along Ottawa Street to the Jock River (similar to the previously proposed pond outlet alignment when SWM Pond 2 was considered), the development lands south of Ottawa Street are proposed to be collected and treated by proposed Etobicoke Exfiltration/Filtration Systems for quality controls prior to discharge eastward to the Jock River (see Section 5.4.6 for discussion). This alternative will also serve to mitigate impacts to SWM Pond 1 operating levels and its Arbuckle Drain outlet. See ***Drawing 6*** for the proposed infrastructure. Ottawa Street local stormwater will be captured and conveyed to SWM Pond 1.

Based on the deviations to the ***MDP 2020 Update*** proposed, a technical review of the modelling has been completed by JFSA in support of the ***MDP 2021 Update***. See the ***JFSA 2021 Pond1 Memo*** in ***Appendix E*** for reference. The analysis confirms the drainage area of SWM Pond 1 can be modified (under the premise of the above changes) to include lands that were originally intended to go to the SWM Pond 2, that was conceptualized within the Laffin Lands property, but will require various adjustments/conditions for SWM Pond 1 in order to facilitate this update as follows:

i. The erosion control orifice will be revised from a 300mm diameter circular orifice with an invert of 92.65 m to a 260 mm diameter circular orifice at an invert of 92.65 m.
ii. The baseflow control orifice, quality control orifice, and quantity control weir are unchanged from the March 2020 Pond 1 design brief. Refer to Calculation Sheet B-1 in the ***JFSA 2021 Pond1 Memo*** for the proposed pond control summary;
iii. The Summer 100-year water level will be raised from 93.791 m to 93.831 m and the 100yr spring water level will be raised from 94.198 m to 94.202 m from the March 2020 ***Ultimate Pond 1 Design Brief***;
iv. Portions of the current pond access road were designed to be above the prior 2-year water lever of 93.55 m. With a new 2-year water level of 93.62 m, the access roads will be assessed with City Staff to determine sections to be raised if deemed absolutely necessary. Similarly, the access road adjacent to the north forebay was designed at 93.81 to be above the prior 100-year summer level of 93.791. With a new water level of 93.827 this access road there is a minor exceedance at the edge. It is presumed that this would be deemed acceptable for this location

v. Sediment management areas in their current configuration would be able to accommodate 9 years of sediment accumulation as opposed to the desired 10 years.
vi. The existing SWM Pond 1 southern forebay headwall and inlet sewer from the Mattamy/Laffin Lands will need be removed/replaced with a larger storm sewer size of 2250 mm (instead of the previously installed 1650 mm sewer).

The following additional Pond 1 characteristics are also noted:

a. The broad-crested quantity control weir set in the berm of the pond, which also functions as an emergency spillway will remain the same;
b. The lowest point of any sediment management areas are set at 93.85 m which is still above the new 100-year SCS event.
c. A review of the hydraulic grade line in the ***JFSA 2021 Pond1 Memo*** demonstrates a minimum freeboard of 0m between the HGL of the top of manhole elevations in all areas of development. There are instances in Fox Run Phase 2 where the HGL is slightly above the gutter line but maintained within road ponding depths. This was previously assessed during development of those areas and deemed acceptable.
d. A review of the existing SWM Pond 1 southern forebay, based on the expanded tributary area, confirms that the existing forebay is sufficiently sized to provide adequate settling and dispersion. The forebay calculation by JFSA is provided in *Calculation Sheet B-2* in the ***JFSA 2021 Pond1 Memo***.
e. The above details demonstrate the feasibility of the proposed stormwater servicing approach. Details will ultimately be finalized in the MDP 2021 Update.

5.4.2 Minor System

The Laffin Lands development area will be serviced by a storm sewer system designed in accordance with the amendment to the storm sewer and stormwater management elements of the Ottawa Design Guidelines – Sewer (Tech. Bulletin PIEDTB-2016-01).

The minor storm sewer system will be sized as follows:

- 2-year event for local streets;
- 5-year event for collector streets; and
- 10-year events for arterial roads

The minor storm sewer systems are sized using City of Ottawa IDF curves along with the relevant ***City Standards*** summarized in Section 5.2.1. The proposed storm sewer layout for the development is depicted in the schematic ***Drawing 3B*** *Storm Servicing Plan* in ***Drawings***. The storm sewers for this development area will outlet to the SWM Pond 1 forebay previously established during the development of the Fox Run Phase 1 land area. The Phase 1 design has previously provided for a 1650mm diameter storm sewer stub to service the development lands south of Fox Run Phase 1 in accordance with the ***MDP*** and ***MDP 2020 Update***. However, as noted in previous sections, the advancement of the Laffin Lands will be based on the removal of the previous SWM Pond 2 proposed on those lands and instead proposes to direct more stormwater flows to SWM Pond 1. Due to the increase in lands tributary to SWM Pond 1 the 1650mm diameter sewer is proposed to be upsized to a 2250 mm pipe as illustrated in ***Drawing 3B*** and based on the rational design sheet determinations and SWM modeling.

5.4.3 Major System

The major system flows will be conveyed through the internal road networks and discharge to the SWM Pond 1 where they are managed for quantity control prior to release to the Arbuckle Drain. The major system will be designed in accordance with the amendment to the storm sewer and stormwater management elements of the Ottawa Design Guidelines – Sewer (Technical Bulletin PIEDTB-2016-01).

5.4.4 Quality and Quantity Control

The proposed revision to the SWM Pond 1 will provide the required quality and quantity control requirements noted previously.

SWM Pond 1 outflows require quality, quantity and erosion control prior to discharge to the Arbuckle Drain and then ultimately discharge to the Jock River. Quality control will be provided by 80% TSS removal as per MECP Enhanced Protection and quantity control by limiting the 2- and 100-year release rates to pre-development levels. Erosion control will be provided by controlling the 2-year release rate to 330 L/s or less and the velocity to 0.225 m/s or less to the Arbuckle Drain.

5.4.5 Realignment of the Moore Tributary

As per Section 6.5 of the ***MDP 2020 Update***, and subject to review and approval by the RVCA and City Drainage Engineer, the adjacent Mattamy development area includes the realignment of the existing Moore Tributary in order to align with the proposed Mattamy development plans as shown on the draft ***MDP 2021 Update*** *Storm Servicing Plan Drawing 3* provided in ***Appendix E.***

The realignment of the Moore Tributary in the ***MDP 2020 Update*** (and maintained in the current ***MDP 2021 Update***) is to convey the 94.2 ha external flows through the subject site to eventually outlet to the Jock River.

In prior submissions/coordination for the Mattamy development area by that proponent, the proposed Moore Tributary channel sizing is to be comprised of 3:1 slopes with a 6.5 m bottom width, and is approximately 0.95 m deep as per Channel Cross Section 2-2 in the draft ***Figure 22*** from the ***MDP 2021 Update*** (provided in ***Appendix E*** for reference). The existing ditch from Ottawa Street, and along the southwest edge of the Mattamy property, draining to the realignment of the Moore Tributary, is approximately 0.75 m deep with a 3.0 m wide bottom and 3:1 slopes as per Channel Cross Section 1-1. The realigned Moore Tributary consists of the following features from southwest of the subject site to Queen Charlotte Street (see *Figure 22 in* ***Appendix E*** *from the* ***MDP 2021 Update***):

- 250 m Ditch length at a slope of 0.1%;
- Proposed 3300x900 mm dia., 33.0 m long box culvert at a slope of 0.35% (capacity ~6,700 L/s);
- 255.5 m Ditch length at a slope of 0.13%;
- Proposed 3300x900 mm dia., 27.5 m long box culvert at a slope of 0.35% (capacity ~6,700 L/s);
- 56.4 m Ditch length at a slope of 0.58%.

This channel sizing would be able convey the 94.2 ha external drainage area for the 100-year 24-hr SCS design storm as documented in the future ***MDP 2021 Update***. The Moore Tributary conveyance calculation provided in ***Appendix E*** shows a capacity of 3,387 L/s as per preliminary calculations from JFSA***.***

5.4.6 Pervious Pipe Systems – Etobicoke Exfiltration/Filtration Configurations

Two types of Etobicoke systems have been conceptualized for the development lands south of Ottawa Street:

1. A Modified Etobicoke Filtration System (MEFS) in areas with rock near the surface; and

2. An Etobicoke Exfiltration System (EES) for areas where rock is not a factor.

5.4.6.1 Modified Etobicoke Filtration System (MEFS)

The contemplated Modified Etobicoke Filtration System (MEFS) is proposed alongside mainline storm sewers in areas where rock is closer to the surface south of Ottawa Street. The proposed MEFS has been derived from the Braecrest Avenue filtration system that is found in the A.M. Candaras Associates publication "*City of Etobicoke Exfiltration and Filtration Systems Pilot/Demonstration Project (1995)*". An excerpt from the report and conceptual MEFS configuration is provided in ***Appendix E*** for reference. *Figure 25.3* of the Candaras study illustrates the general configuration of the perforated pipe system as well as the filtration trench surrounding the mainline storm sewer network. Generally, road catchbasins have a lower and upper sewer lead. The lower lead (for first flush flows) is connected to the filtration system while the upper lead will manage higher flows during larger events and is connected to the storm main. The full description of the system is in Section 25.2.2 of the Candaras study excerpt. The general proposed configuration for the development areas south of Ottawa Street and profile for the MEFS can be found in the excerpted *Figure 4.14* from the MECP's *SWM Planning & Design Manual* in ***Appendix E***.

In addition to the MEFS it is also proposed, as part of the treatment train approach, that deep sump catchbasins equipped with catchbasin inserts such the CB Shield™ (certified with third party testing (i.e. ETV verified)) will further reduce catchbasin sump sediment re-suspension and optimize TSS removal. These elements working together will provide the required Enhanced Level of Protection per MECP guidelines, via treatment of the stormwater captured by the storm sewer network.

5.4.6.2 Etobicoke Exfiltration System (EES)

The contemplated Etobicoke Exfiltration System (EES) is proposed in areas of the WDL where rock is not a factor.

The EES has been most recently implemented within the Barrhaven South Urban Expansion Area (BSUEA) and configurations were vetted through the BSUEA Master Servicing Study (MSS). The BSUEA MSS selected the EES to meet infiltration targets and with silty sand soil conditions within this development area of the WDL, and imported fill material, is a suitable approach. The general proposed configuration for the development areas south of Ottawa Street and generic profile for the MEFS can be found in the excerpted *Figure 4.13* from the MECP's *SWM Planning & Design Manual* in ***Appendix E***.

5.5 Sump Pumps

Similar to Fox Run Phase 1 and Phase 2 (North/South), the proximity of the development area to the stormwater receiver (Arbuckle Drain), high HGL, and grade raise restrictions, the proposed centerline of road grades do not allow for standard basements with a gravity connection to the storm sewer system. Therefore the Green/Laffin areas will also be serviced entirely by sump pumps due to the site constraints imposed. This is consistent with the original ***MDP*** and ***MDP 2020 Update***.

In 2018 and 2019, the City published Technical Bulletins ITSB-2018-04 (June 27, 2018) and ITSB-2019-02 (July 8, 2019), which outline the criteria for sump pumps, the requirements for hydrogeological assessments areas with sump pumps, and revised information on HGL for storm sewers with sump pumps. In detailed design, the proposed sump pump design will conform to Technical Bulletins ITSB-2018-04 (June 27, 2018) and ITSB-2019-02 (July 8, 2019). The sump pump detail can be found on ***Figure 4***, and the sump pump components and requirements are outlined in the following table.

Table 7: Sump Pump Design Criteria

Component	Requirements
Sump Pump (General)	Shall be: ○ In accordance with City of Ottawa Technical Bulletin ISTB-2018-04 (June 27, 2018); ○ A submersible pump; ○ Automatically controlled and set to maintain the water level at the same elevation as the foundation drain; capable of discharging a minimum flow of 0.9 L/s at 3.6 m head.
Sump Pump (Primary)	Shall be: ○ CSA Approved; ○ Connected to an electrical circuit that supplies no other outlets, switches or equipment; ○ Equipped with a self-resetting thermal overload protection switch; ○ Rated for continuous duty.
Sump Pump (Backup)	Shall be: ○ CSA Approved; ○ Connected to an electrical circuit that supplies no other outlets, switches or equipment except: A) Charging equipment for backup power and B) Alarm system for primary pump and power failure; ○ Equipped with a self-resetting thermal overload protection switch; ○ Rated for continuous duty; ○ Equipped with an audible failure alarm to notify homeowner that the primary pump has failed or the power supply has been interrupted; ○ Capable of discharging a minimum capacity of 0.90 L/s at 3.6 m head; ○ Powered by a deep-cycle lead-acid battery with a min. ampere-hour rating of 100 AH.
Sump Pit	Shall: ○ Have walls and bottoms constructed of concrete polyethylene, polypropylene, or fiberglass; ○ Be provided with a sealed cover; ○ Have a cover which must be secured in a manner acceptable to the authority having jurisdiction; ○ Be vented to the outdoors.
Discharge Pipe System from Sump Pump	Shall: ○ Be in accordance with *Appendix 9 – Standard Sump Pump Configuration in Greenfield Subdivisions with Clay Soils on Full Municipal Services*; ○ Consist of materials and be installed in conformance with the Ontario Building Code; ○ Have a minimum internal diameter of 38 mm (1-1/2”) from the sump pump to the 100 mm (4”) storm building drain; ○ Have a union, a check valve and a shut-off valve installed in that sequence in the direction of discharge outside of the sump pit; ○ Have a goose neck with a height of no more than 250 mm below the top of the foundation wall and discharge into the vertical leg of the storm building drain; ○ Have a minimum dimension of 600 mm from the vertical leg of the storm discharge pipe to the horizontal offset upstream of the backwater valve; ○ Include a CSA approved backwater valve for the stormwater discharge; ○ Include an emergency discharge pipe to the outside ground surface; ○ Be vented to the outdoors; ○ Be graded or otherwise protected to prevent the freezing of water in the system.
Connections	○ Only the perimeter foundation drainage system will be connected to the sump pit. Eaves trough, surface exterior drainage, swimming pool backwash, floor drains and any other water sources shall not be connected to the sump pit; ○ All new residences with installed sump pump systems must include: ○ Eaves troughs discharging to the surface with appropriate drainage away from the house at the time of the original sale; ○ Drainage layer as per the Ontario Building Code; ○ Clay backfill placed against the drainage layer with the clay extending a minimum 1.5 m out from the drainage layer for all sides of the foundation; ○ Impervious backfill capping at the ground surface surrounding the perimeter of the residence area and slope away from the building after settling of backfill; except in areas where window wells are required by Ontario Building Code; ○ The sump pump shall be directly connected to a storm building drain from the building to the property line.

5.6 Low Impact Development (LID)

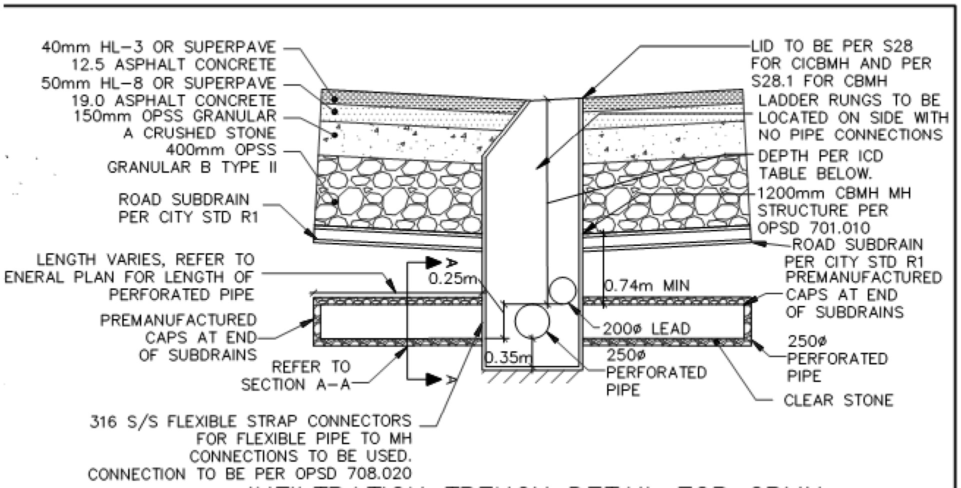
The following Low Impact Development (LID) techniques may be incorporated as part of detailed design where feasible:

- Rear-yard swales have been designed with minimum grades where possible, to promote infiltration;
- Rear-yard catchbasin leads/subdrain will be perforated (except for the last segment connecting to the storm sewer within the right-of-way), to promote infiltration;
- Where eavestroughs are provided on residential units, they are to be directed to landscaped surfaces, to promote infiltration; and,
- Etobicoke Exfiltration/Filtration Systems to assist with mitigating water balance and quality control concerns.

These LIDs are implemented as part of the general design requirements for the site.

5.6.1 Infiltration Trenches

Additional on-site retention of the first 10 mm of rainfall events (i.e. first flush) to assist with site water balance is proposed to be provided via perforated pipes connected to road catchbasins below the inverts of the lead pipes connecting to the main storm sewer. This on-site retention will be provided to the extent possible for the subject site and will be incorporated in the updated JFSA ***Water Balance Analysis*** provided as part of the ***2021 MDP Update***. The perforated pipes will be surrounded by a 50 mm clear stone infiltration trench with details similar to the following conceptual configuration (subject to further consultation with City staff).



INFILTRATION TRENCH DETAIL FOR CBMHs
SCALE: N.T.S.

5.7 Stormwater Management Conclusions

Stormwater management for the Green Lands West follows the previous rationale provided for in the ***MDP 2020 Update*** and to be carried forward in an ***MDP 2021 Update***. Stormwater flows will be directed to SWM Pond 1 and managed for quality and quantity control prior to discharge to the Arbuckle Drain.

The Green Lands East area was not considered in the original MDP, and subsequent updates, and will provide quality and quantity control within that development area via ICDs and an OGS unit prior within the ROW prior to any discharge. The lots to be provided on a new street extension will be tributary to a new outlet to the Van Gaal Drain (with the approval with the City Drainage Engineer). Sump pumps for the new units fronting onto the west side of existing Mira Court will connect to a storm sewer extension that will be installed for those ‘clean water’ connections.

The Laffin Lands servicing concept proposes to deviate from the ***MDP 2020 Update*** and remove the SWM Pond 2 requirement from that parcel and redirect flows to SWM Pond 1 for quality/quantity control to accommodate. This will require a new ***MDP 2021 Update*** with the following updates:

- ➢ Revisions to the SWM Pond 1 erosion control orifice size (300mm diameter to 260 mm diameter), water levels (maximum delta of 0.04 m), and south forebay inlet and headwall replacements will be required to accommodate the additional tributary areas. The existing forebay is sufficiently sized for the proposed tributary area.
- ➢ The realignment of the Moore Tributary will be maintained as per the ***MDP 2020 Update***. This will be subject to RVCA and the City Drainage Engineer’s approval.
- ➢ 39.2 ha and 32.6 ha of land originally proposed to drain to Ottawa Street, then to SWM Pond 2, is proposed instead to drain along Ottawa Street via a future storm trunk sewer outletting to the Jock River (Note: This is along the same alignment as was proposed for the prior Pond 2 concept). This work will require approval by the RVCA.
- ➢ In conjunction with the external flows proposed to be conveyed along Ottawa Street to the Jock River, the development lands south of Ottawa Street will be collected and then treated by proposed Etobicoke Exfiltration/Filtration systems discharge eastward to the Jock River. Local Ottawa Street drainage will be conveyed to SWM Pond 1 for quality treatment.
- ➢ Additional infiltration measures in the form of infiltration trenches at catchbasin’s within the Laffin and Mattamy Phase 3 lands to capture 10mm events.

The associated storm sewer collection system, and stormwater management facility designs have been prepared in accordance with standard City of Ottawa modeling techniques.

In circumstances where infrastructure may be required outside of an individual landowner’s development area (due to differences in development timing), there will need to be agreements in place facilitating cost sharing and access when necessary.

6.0 SITE GRADING

6.1 Grading Criteria

The following grading criteria and guidelines have been applied to the detailed design as per City of Ottawa Guidelines:

- Maximum slope in grassed areas between 2% and 5%;
- Grades in excess of 7% require terracing to a maximum of a 3:1 slope;
- Driveway grades between 2% and 6%;
- Drainage ditches and swales should have a minimum slope of 1.5%;
- Perforated pipe is required for swales less than 1.5% in slope;
- Swales are to be 0.15 m deep with 3:1 side slopes unless otherwise indicated on the drawings;

The ideal grading for the proposed 100-year ponding approach is summarized as follows:

- 0.5% longitudinal road slopes from high point to low point and from low point to high point within the ponding area;
- A 2.0% road cross-slope (although a 3.0% road cross-slope is also acceptable);
- As reasonable a freeboard as feasible between the maximum extent of surface storage on the road (i.e. the 100-year water level) and the lowest nearby building opening elevation, in order to ensure that the 100-year + 20% stress test water levels do not reach the building envelope; and
- Back-to-front drainage or well-spaced discharge points for excess rear yard flows draining to the street. Rear yard catchbasins are connected to street catchbasins, which in turn connects to the main storm sewer, allowing rear yard flows to back up into road ponding areas when the capacity of the catchbasin lead is exceeded.

6.2 Functional Grading Design

6.2.1 Green Lands West

The Green Lands West development is constrained by grade raise restrictions. The geotechnical investigation provided an assessment of permissible grade raises based on unit weights of fill of 18.0 kN/m^3 and 19.5 kN/m^3. The most restrictive grade raise is for the 19.5 kN/m^3 unit weight with restrictions of 2.0 m within the roadway and 1.3 m to 1.5 m at the house. See the ***Green Lands Geotechnical Report*** for full details. The servicing and grading have been designed as low as possible, to minimize the proposed grade raise within the subdivision and adheres to this requirement. In future, the detailed grading plans will be forwarded to the geotechnical consultant for review and recommendations. Final signoff for the detailed grading plans will be provided by the Geotechnical Engineer.

6.2.2 Green Lands East

The results of the ***Green Lands Geotechnical Report*** as summarized above for the Green Lands West is the same for the East area. Grading is kept as low as possible and ties into the adjacent existing development grading.

6.2.3 Laffin Lands

The geotechnical investigation of the area indicates that the site is generally underlain by loose to very dense native silty sand and silty sand till and therefore grade raises typical for low-rise subdivisions (assumed to be 1.5 to 2.5 m) are deemed acceptable. Based on the *Grading Plan* ***Drawing 1B*** for the property the proposed grade raise is approximately 2 m or less therefore no concerns are expected. The grading will ultimately be coordinated with the grading for the adjacent Mattamy development areas. Final signoff for the detailed grading plans will be provided by the Geotechnical Engineer.

7.0 EROSION AND SEDIMENT CONTROL

Soil erosion occurs naturally and is a function of soil type, climate and topography. The extent of erosions losses is exaggerated during construction where the vegetation has been removed and the top layer of soil is disturbed.

- Erosion and sediment controls must be in place during construction. The following recommendations to the contractor will be included in contract documents.
- Limit extent of exposed soils at any given time.
- Re-vegetate exposed areas as soon as possible.
- Minimize the area to be cleared and grubbed.
- Protect exposed slopes with plastic or synthetic mulches.
- Install silt fence to prevent sediment from entering existing ditches.
- No refueling or cleaning of equipment near existing watercourses.
- Provide sediment traps and basins during dewatering.
- Install filter cloth between catch basins and frames.
- Installation of mud mats at construction accesses.

8.0 CONCLUSION AND RECOMMENDATIONS

Richmond Village Development Corporation is proposing residential development within the Village of Richmond WDL. The subject properties are the Green Lands West (12.3 ha), Green Land East (3.62 ha) and Laffin Lands (7.62 ha). DSEL was retained to prepare a Functional Servicing Study in support of draft plan application.

- Approvals will be required from the City of Ottawa, the Ministry of the Environment, Conservation and Parks (MECP) and the RVCA as required;
- Water supply to the Green Lands West and Laffin Lands was previously contemplated in the ***MSS***. Water supply to the development areas will be via extension of watermains from the now functional Communal Well for the WDL. This water supply will also be extended to the Green Lands East development area given the minor increase in demand for those 33 units. The City is currently undertaking a review of the Communal Well to assess future upgrades for the WDL and external development areas;
- Wastewater services will be provided through a network of gravity sewers that are tributary to the recently constructed and commissioned Martin Street sanitary sewer and any ongoing and planned future upgrades to the existing Richmond Sanitary Pumping Station and downstream forcemains. The ongoing, and future, off-site upgrades required to support the development area were contemplated in the ***MSS***;
- With the implementation of the new sanitary design criteria as per Technical Bulletin ISTB-2018-01 (March 21, 2018), the proposed flows downstream of the WDL is lower than what the ***MSS*** calculated, even with the increase in population of the WDL from what the ***MSS*** originally projected;
- Foundation drainage for all units will be via sump pumps in the Green and Laffin Land development areas;
- Green Lands West storm sewers are designed in accordance with the new City of Ottawa stormwater guidelines with new 100-year ponding design criteria with a minimum 2-year minor system capture on local roads and a minimum 5-year minor system capture on collector roads. The sewers will outlet to SWM Pond 1 via Fox Run Phase 2 sewers which have considered this drainage area previously;
- Green Lands East storm sewers are designed to the same standard noted for Green Lands West. The sewers will have a new outlet to the adjacent Van Gaal Drain (with the approval with the City Drainage Engineer and RVCA). Quality and quantity control within the development area will be via ICDs and an OGS unit prior to any discharge. Sump pumps for the new units fronting onto the west side of existing Mira Court will connect to a storm sewer extension that will be installed for those ‘clean water’ connections;

- The Laffin Lands servicing concept proposes to deviate from the ***MDP 2020 Update*** and remove the SWM Pond 2 requirement from that parcel and redirect flows to an updated SWM Pond 1 for quality/quantity control to accommodate. This will require:
    - Revisions to the SWM Pond 1 erosion control orifice size (300mm diameter to 260 mm diameter), water levels (maximum delta of 0.04 m), and south forebay inlet and headwall replacements will be required to accommodate the additional tributary areas. The existing forebay is sufficiently sized for the proposed tributary area.
    - The realignment of the Moore Tributary will be maintained as per the ***MDP 2020 Update***. This will be subject to RVCA and the City Drainage Engineer's approval.
    - 39.2 ha and 32.6 ha of land originally proposed to drain to Ottawa Street, then to SWM Pond 2, is proposed instead to drain along Ottawa Street via a future storm trunk sewer outletting to the Jock River (Note: This is along the same alignment as was proposed for the prior Pond 2 concept). This work will require approval by the RVCA.
- In conjunction with the external flows proposed to be conveyed along Ottawa Street to the Jock River, the development lands south of Ottawa Street will be collected and then treated by Etobicoke Exfiltration/Filtration Systems prior to discharge eastward to the Jock River. Local Ottawa Street stormwater will be conveyed to SWM Pond 1 for quality treatment.
- The proposed stormwater management Pond 1 is designed to meet MECP Enhanced Level of suspended solid removal and will attenuate stormwater to limit impacts on water levels in the receiving Arbuckle Drain.
- The Green Lands West/East will be subject to grade raise restrictions ranging from 2.0 m in the roadways to 1.3 m to 1.5 m at the future residential units (depending on the fill used). Ultimately the grading plan will be reviewed and signed off by the geotechnical engineer or they will provide recommendations to suite.
- The Laffin Lands area is not subject to any grade raise restrictions.
- Erosion and sediment control measures will be implemented and maintained throughout construction.

Prepared by,
David Schaeffer Engineering Ltd.

K.L. MURPHY
90475369

Aug 24/21

Per: Kevin L. Murphy, P.Eng.

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APPENDIX A

PC2020-0062 – Perth and Ottawa Street Richmond: DRAFT

Friday March 13 2020

Attendance:

May Pham, Caivan

Matthew Hayley, Environmental Planner

Neeti Paudel, Transportation Engineer

Sarah McCormick, Planner

Damien Whittaker, Senior Engineer

Eric Lalande, RVCA

Reid Shepherd, Parks Planner

Cheryl McWilliams, Planner

Matthew Ippersiel, Urban Design (absent)

The proposal relates to residential subdivision development of lands known as the Green lands and the Laffin lands would see an additional approximately 600 plus units. There are a number of separate parcels at 6295, 6363, 6409 Perth Street and 6305 Ottawa Street.

General

Please note that this pre-consultation is only valid for one year. In addition, given the current sanitary servicing constraints in Richmond, capacity may not be available for the development of these sites until the completion of the final stage of the upgrades, which is the full replacement of the pump station not yet scheduled, so possibly 20 years away.

Given the timing and preliminary nature we are available to speak further on these matters and any revised plans.

Planning

- The road widths and cross-section, block depths and proposed setbacks must be demonstrated as supporting trees (one on each lot not just on average) as part of draft approval
- 16.5 m row widths will not be accepted
- The depths of the blocks must be adequate along the west lot line (Village boundary) to preserve any hedge row.
- There are some older trees on the house lot that should be preserved.
- Demonstrate consistency with the CDP and secondary plan for connections. Look at the north side potential of a MUP connecting across the drains to the east side of the van Gaal Drain to connect eventually to Cedarstone. Alternatively consider the hydro corridor. Royal York is the vehicular connection Mattamy is proposing to the village on

the south side. Burke Street connection as shown is also an option, but we would also want to see pedestrian links through to Meynell.

- Demonstrate compliance with the unit counts and density mixes per the CDP and secondary plan
- The sidewalk will need to be extended along Perth Street to the window street west of the Home Hardware.
- Servicing will need to be confirmed as available prior to supporting any draft approval.
- Consider approaching Hydro again with respect to their lands.
- The current version of the draft update to the Master Drainage Plan for the Western Development lands shows a 3rd storm pond within the hydro corridor and seems to be an in-line pond of the van Gaal. This is not acceptable.
- That same MDP is also showing much of the Laffin lands as a storm pond, which is consistent with the current approved version of the MDP but not the concept plan provided.
- An Archaeological Assessment will be needed
- The LandOwners Agreement and trustee sign-off will be required, for any works to commence.
- There is some sensitivity of the residents in Cedarstone Subdivision (north of Perth) to increases in traffic.
- There is a triangle parcel that is not owned and would limit frontage of the southern most lots on Mira.
- There is a small watercourse abutting the Laffin lands that will require some setback

Engineering

This is a follow-up to the pre-application consultation held on Friday March 13, 2020, at City Hall for regarding a proposal PC2020-0062 for development of the balance of the Western development Lands; 6363, 6409 and 6296 Perth Street in the City of Ottawa district of Rideau-Goulbourn (Ward 21) covered by Councillor Scott Moffatt. The purpose of the meeting was to identify and conduct a general overview of the key issues regarding the proposed development to ensure the application, when submitted, will be as complete as possible prior to circulation of the application and review.

Please find below City of Ottawa engineering/infrastructure information regarding an engineering design submission relevant to the proposed development. The information provided will assist the applicant for their plan of subdivision application.

Guidelines;

Please note that as this application is quite premature, the guidelines to be reviewed against will need to be the (future) amended versions, and there may even be guidelines in place then, that are not currently contemplated.

Water/Sanitary/Storm Servicing:

Water pipes:

Municipal water pipes will need to be extended to service the proposed development. The Western Development Lands developments will need to expand the well supply when appropriate and need to collectively expand the water storage at 28 l/s demand.

Sanitary Sewers:

No capacity exists in the sanitary sewer system presently and the application will not be accepted for draft approval for, probably, ten years, or more. Design parameters shall be the higher of the rates in the Sewer Design Guidelines, as amended and monitored flows. The developer shall apply I/I reduction techniques beyond that provided for the Fox Run Phase II development, that presently consists of blueskin wrap to the existing groundwater level and the use of pressure-rated pipe.

Storm Sewers:

The developer will need to extend conveyance systems in the Village of Richmond to include the development and, entirely at their cost, provide such extension.

Storm Water Management:

The consultant should determine a stormwater management regime for the application and, generally, maintain post-development flows to pre-development levels by way of providing storage to offset increased impervious areas. The existing runoff coefficient shall be taken as that from approved development; non-approved development should be ignored by the consultant in the determination of existing runoff coefficient and will not be taken into consideration by City engineering review staff.

Any existing stormwater runoff from adjacent site(s) that crosses the property must be accommodated by the proposed stormwater management design.

Stormwater quality control is required for the site. The Rideau Valley Conservation Authority (RVCA) can be contacted to determine the level of stormwater quality control required for the site.

All stormwater management determinations shall have supporting rationale.

Stormwater management solutions should be in concurrence with the content of the Western Development Lands Master Drainage Plan (MDP) that shows stormwater management ponds on both areas of proposed development; it is not clear how some of the development will proceed as the MDP plan currently shows the Laffin Lands to be entirely a SWM pond and SWM pond 1 was not designed to take more flow nor is there space for it to be expanded.

Please note that the SWM pond and upstream pipe/s and connected manholes shall be held in securities until the pond unit accepts the pond (at a date anticipated to be later than the rest of the subdivision)

A hydrogeoloogical report will be required for each, and all, stormwater management ponds

Please note that LID will be required and that the forthcoming LID policy may impact the design.

Roads:

Please refer to the City of Ottawa Private Approach By-Law 2003-447 for the entrance design.

Please note that Council has adopted a safer roads initiative called the Road Safety Action Plan that requires local residential roads be both, signed and designed to a 30 km/h limit. This means that curvilinear design is required to deny vehicles from achieving speeds accessible on long straight roads.

Please note that 16.5 m ROW will not be permitted for the development.

Please note that 18 m ROW will not be permitted where either sensitive marine clay is found (whether named or not) or a sidewalk is proposed
Please note that a 25 m, or wider, ROW will be required for any road sections with two sidewalks.

Sensitive Marine Clay:

It is understood that sensitive marine clay (or by any other name) exists in the vicinity. Enhanced investigation will be required including, but not limited to: Atterberg limits testing, sensitivity analysis (if sensitivity analysis is not included an exhaustive discussion of why will be required), consolidation testing (cyclic and non-cyclic) and plasticity chart

Discussion of vibration induced loss of strength (by any name) is required

Discussion of retrogressive landslides is required.

Peer-reviewed and published papers may be necessary for the consultant's reviews; any papers/articles/journals/textbooks used shall be sufficiently provided to the City and the reference shall show unmistakable and undeniable concurrence with the consultant's usage.

Relatively impervious clay shall not be accepted as a reason for not applying LID.

High Performance design Standard:

In due time the City will have High Performance Design Standards in place that the proposal will need to adhere to that may include, but not be limited to; enhanced insulation, electrical generation, electrical grid security, reduced energy demand, reduced environmental "footprint".

Permits and Approvals:

Please note that approval through the Ministry of the Environment, Conservation and Parks (MECP), amongst other federal and provincial departments/agencies, including the Rideau Valley Conservation Authority (RVCA), will be required to facilitate the development: responsibility rests with the developer and their consultant for determining which approvals are needed and for obtaining all external agency approvals. The address shall be in good standing with all approval agencies, for example the RVCA, prior to approval. Copies of confirmation of correspondence will be required by the City of Ottawa from all approval agencies that a form of assent is given. Please note that a stormwater program for multiple lots is understood to be the expanded transfer-of-review type of Environmental Compliance

Approval (ECA) application with the MECP; please speak with your engineering consultant to understand the impact of time and cost this has on the application. An MECP ECA is not submitted until after planning approval. No construction shall commence until after a commence work notification is given from an engineering representative from Development Review.

Ministry of the Environment, Conservation and Parks	Rideau Valley Conservation Authority
Contact Information:	Contact Information:
Christina Des Rochers	Eric Lalande
Water Inspector	eric.lalande@rvca.ca
613-521-3450 ext. 231	
Chstina.Desrochers@ontario.ca	

Plan requirements;

Grading and Drainage Plans*

Erosion and Sediment Control Plan/s*

*All identified required plans are to be submitted on standard A1 size sheets as per City of Ottawa Servicing and Grading Plan Requirements and note the survey monument used to establish datum on the plans with sufficient information to enable a layperson to locate the monument.

Report Submission Requirements[1]:

-Site Servicing Report

A plan is required that clearly shows the proposed water service layout.

-Storm Water Management Report

-Erosion and Sediment Control Measures

-Geotechnical Investigation Study

Please note that the area may contain sensitive marine clays. Please note that Atterberg limits, consolidation testing, grade raise restriction, and chemical analysis and discussion will be required in the report if sensitive marine clay is found. The geotechnical consultant will need to provide full copies of any published and peer reviewed papers relied on to determine results and conclusions

Earthquake analysis is now required to be provided in the report.

-Slope Stability Study (if topography deems necessary)

-Phase 1 Environmental Site Assessment (ESA)

The Phase 1 Environmental Site Assessment (ESA) as per O.Reg. 153/04. Phase 1 ESA documents performed to CSA standards are not acceptable.

Please find relevant City of Ottawa Links to Preparing Studies and Plans below:

Guide to preparing drawings for City of Ottawa engineering submissions

https://ottawa.ca/en/city-hall/planning-and-development/information-developers/development-application-review-process/development-application-submission/guide-preparing-studies-and-plans#servicing-and-grading-plan-requirements

Guide to preparing City of Ottawa Studies and Plans:

http://ottawa.ca/en/development-application-review-process-0/guide-preparing-studies-and-plans

Servicing Study Guidelines for Development Applications:

https://ottawa.ca/en/city-hall/planning-and-development/information-developers/development-application-review-process/development-application-submission/guide-preparing-studies-and-plans#servicing-and-grading-plan-requirements

To request City of Ottawa plan(s) or report information please contact the ISD Information Centre:

Information Centre

(613) 580-2424 ext. 44455

Please feel free to contact me if you have any questions.

Damien

Parks Planning

- Area Parks Plan (APP) is currently in place and was approved in 2019.
- The amenities and park sizes in the APP should be considered minimum requirements for any new proposals.
- If unit density is above that which is listed in the APP, park size requirements and/or Cash-in-Lieu will be larger than those required in the APP. These sizes would need to be determined once a more detailed proposal is put forward containing actual unit numbers.
- Parkland funding agreement required to be in place prior to registering any new phases of development in Western Lands.
- Parks recommends that the lotting pattern around the proposed northern parkette be adjusted to shift the park south so that it is adjacent to the hydro corridor that contains a proposed Multi-Use Pathway (MUP). The adjustment will improve connectivity from the MUP to the park, which was the intention behind the proposed location originally shown in the APP.

Reid Shepherd

Environmental Planning

- A Tree Conservation Report and an Environmental Impact Statement will be required
- A preliminary Integrated Environmental Impact Statement will be required at submission, and form part of the Planning Rationale.
- A 30 m setback is require for the watercourses to the north
- A minimum 6 m access will be needed to the watercourse buffer lands – likely best off the north end of the collector road.

Matthew Hayley

Transportation:

- Follow Traffic Impact Assessment Guidelines
  - Traffic Impact Assessment will be required. Proceed to scoping.
  - Start this process asap.
  - Applicant advised that their application will not be deemed complete until the submission of the draft step 1-4, including the functional draft RMA package (if applicable) and/or monitoring report (if applicable).
  - Request base mapping asap if RMA is required. Contact Engineering Services (https://ottawa.ca/en/city-hall/planning-and-development/engineering-services)
- ROW protection on Perth Street between Eagleson and Village Boundary is 30m even.
- Geometric Road Design (GRD) drawings will be required with the first submission of underground infrastructure and grading drawings. These drawings should include such items as, but is not limited to:
  - Road Signage and Pavement Marking for the subdivision;
  - Intersection control measure at new internal intersections; and
  - Location of depressed curbs and TWSIs;
  - More details can be provided upon request
- Include traffic calming measures on roads within the limits of their subdivision to limit vehicular speed and improve pedestrian safety. Traffic calming measures shall reference best management practices from the Canadian Guide to Neighbourhood Traffic Calming, published by the Transportation Association of Canada, and/or Ontario Traffic Manual, and/or the City of Ottawa's Draft Traffic Calming Design Guidelines. These measures may include either vertical or horizontal features (such measures shall not interfere with stormwater management and overland flow routing), including but not limited to:
  - intersection or mid block narrowings, chicanes, medians;
  - speed humps, speed tables, raised intersections, raised pedestrian crossings;
  - road surface alterations (for example, use of pavers or other alternate materials, provided these are consistent with the City's Official Plan polices related to Design Priority Areas);
  - pavement markings/signage; and
  - temporary/seasonal installations such as flexi posts or removable bollards.
- Corner triangles as per OP Annex 1 - Road Classification and Rights-of-Way at the following locations on the final plan will be required:
  - Local Road to Local Road: 3 metre x 3 metres
  - Local Road to Collector Road: 5 metre x 5 metres

    - Collector Road to Collector Road: 5 metre x 5 metres
    - Collector Road to Arterial Road: 5 metre x 5 metres
- Noise Impact Studies required (Road):
    - Feasibility before draft approval
    - Detailed before registration

-Residential streets (local and collector) are to be designed for 30 kph speed limits (posted). (Direction from Councillors and Director of Traffic Services).

Neeti Paudel, P.Eng.

Rideau Valley Conservation Authority

- Some flood plain showing on the lands. Confirm that the realignment of the Van Gaal Drain resolves that
- Looking for 80% TSS removal for water quality
- Require a 30 metre setbacks from the drain to the north side of the Green lands.

Eric Lalande

Green Lands Urban Design Comments

- Ensure lot sizes, ROWs, and setbacks are sufficiently sized to achieve the design guidelines found in Section 7.4 of the Village of Richmond CDP. Currently, there may be enough space to achieve such guidelines as having enough space to plant a tree in the front yard, having a varied building setbacks, or parking a vehicle without it overhanging onto the sidewalk or street.
- Explore opportunities to integrate large-lot, village-style detached dwellings into the development along targeted and highly visible streets. See section 7.4.8 of the Village of Richmond CDP for additional details.
- Include a greater mix of the proposed building typologies. It appears the highest densities units have been clustered south of the hydro corridor.
- Open a vehicular connection to Perth Road as a gateway into the community, as shown in the Richmond CDP Demonstration Plan.
- If a window street is created adjacent to Perth Road, re-orient as many of the properties towards Perth as possible.
- Create pedestrian pathway connections in the north-most block to break up the long block and provide a link to a potential future pedestrian pathway north of the site. The pathways should be aligned with proposed north-south streets to create view corridors.
- It would be preferable to have the park open to the public realm on at least three sides, surrounded by single-loaded streets. Configure surrounding roads to have the park terminate views and offset the street grid.

Laffin Lands Urban Design Comments

- Relocate the proposed park to a more central location in the development that is well connected.
- Include mid-block pedestrian pathways to align with adjacent proposed pathways.

Matt Ippersiel

APPENDIX B

Ministry of the Environment, Conservation and Parks
Ministère de l'Environnement, de la Protection de la nature et des Parcs

ENVIRONMENTAL COMPLIANCE APPROVAL

NUMBER 1528-BLFNVH
Issue Date: February 24, 2020

Richmond Village Development Corporation
2934 Baseline Road, Unit 302
Ottawa, Ontario
K2H 1B2

Site Location: Fox Run Subdivision - Phase 2 (North)
6335 Perth Street
City of Ottawa, Ontario

You have applied under section 20.2 of Part II.1 of the Environmental Protection Act*, R.S.O. 1990, c. E. 19 (Environmental Protection Act) for approval of:*

the establishment of wastewater infrastructure Works located in the City of Ottawa, consisting of the following:

- **storm sewers** on proposed Trammel Road (from Station 0-14.006 to Station 0-0.25, and from Station 0-0.25 to Station 0+187.215), proposed Postilion Street (from Station 0+160 to Station 0+149.62, and from Station 0+149.62 to 0-1.995), proposed Latigo Ridge (from Station 0+1.952 to Station 0+151.572), proposed Chasing Grove (from Station 0+2.05 to Station 0+151.67), proposed Brush Lane (from Station 0+85.71 to Station 0+151.63), proposed Bascule Place (from Station 0+135.562 to Station 0+197.009, from Station 0+135.562 to Station 0+71.69, from Station 0+71.69 to 0+34.591, and from Station 0+34.591 to 0+2.202), proposed Vaulting Crescent (from Station 0+7.492 to Station 0+53.326), proposed Oldenburg Avenue (from Station 0+238.745 to Station 0+223.481, and from Station 223.481 to Station 0+0.813), Perth Street (from adjacent Block 221 to Station 0+241.788, from Station 0+36.821 to 0+476.497, from Station 0+476.497 to Station 0+37.095, from southwest of Block 282 to 0+242.061, from Station 240.762 to Station 0+285.925, and from Station 285.925 to 0+335.294), proposed Griseo Way (from Station 0+36.761 to Station 0+2.021), and servicing Block 280, discharging to the existing stormwater management facility, located southeast of the intersection of Perth Street and Meynell Road; and

- **sanitary sewers** on proposed Trammel Road (from Station 0+72.432 to Station 0+133.61, from Station 0+180.711 to Station 0+133.61, from Station 0+72.432 to Station 0-0.25, and from Station -0+14.006 to Station 0+0.25), proposed Postilion Street (from Station 0+160.000 to Station 0+0.000), proposed Latigo Ridge (from Station 0+0.000 to Station 149.620), proposed Chasing Grove (from Station 0+0.000 to Station 0+149.620), proposed Bascule Place (from Station 0+194.808 to Station 0+72.432, and from Station 0+72.432 to 0-0.25), and proposed Oldenburg Avenue (from Station 0+238.745 to Station 0+75.807, and from Station 0+75.807 to Station 0-14.971), discharging to existing sanitary sewers, located on Meynell Road (southeast of Perth Street);

including erosion/sedimentation control measures during construction and all other controls and appurtenances essential for the proper operation of the aforementioned Works;

all in accordance with the submitted application and supporting documents listed in Schedule "A" forming part of this approval.

For the purpose of this environmental compliance approval, the following definitions apply:

DEFINITIONS

1. "Approval" means this entire document and any schedules attached to it, and the application;
2. "Director" means a person appointed by the Minister pursuant to section 5 of the EPA for the purposes of Part II.1 of the EPA;
3. "District Manager" means the District Manager of the appropriate local District Office of the Ministry, where the Works are geographically located;
4. "EPA" means the *Environmental Protection Act,* R.S.O. 1990, c.E.19, as amended;
5. "Ministry" means the ministry of the government of Ontario responsible for the EPA and OWRA and includes all officials, employees or other persons acting on its behalf;
6. "Owner" means Richmond Village Development Corporation, and includes its successors and assignees;
7. "OWRA" means the Ontario Water Resources Act, R.S.O. 1990, c. O.40, as amended;
8. "Works" means the sewage Works described in the Owner's application, and this Approval.

You are hereby notified that this environmental compliance approval is issued to you subject to the terms and conditions outlined below:

TERMS AND CONDITIONS

1. GENERAL CONDITIONS

1. The Owner shall ensure that any person authorized to carry out work on or operate any aspect of the Works is notified of this Approval and the conditions herein and shall take all reasonable measures to ensure any such person complies with the same.

2. Except as otherwise provided by these Conditions, the Owner shall design, build, install, operate and maintain the Works in accordance with the description given in this Approval, and the application for approval of the Works.

3. Where there is a conflict between a provision of any document in the schedule referred to in this Approval and the conditions of this Approval, the conditions in this Approval shall take precedence, and where there is a conflict between the documents in the schedule, the document bearing the most recent date shall prevail.

4. Where there is a conflict between the documents listed in Schedule "A" and the application, the application shall take precedence unless it is clear that the purpose of the document was to amend the application.

5. The conditions of this Approval are severable. If any condition of this Approval, or the application of any requirement of this Approval to any circumstance, is held invalid or unenforceable, the application of such condition to other circumstances and the remainder of this Approval shall not be affected thereby.

2. EXPIRY OF APPROVAL

1. This Approval will cease to apply to those parts of the Works which have not been constructed within five (5) years of the date of this Approval.

2. In the event that completion and commissioning of any portion of the Works is anticipated to be delayed beyond the specified expiry period, the Owner shall submit an application of extension to the expiry period, at least twelve (12) months prior to the end of the period. The application for extension shall include the reason(s) for the delay, whether there is any design change(s) and a review of whether the standards applicable at the time of Approval of the Works are still applicable at the time of request for extension, to ensure the ongoing protection of the environment.

3. CHANGE OF OWNER

1. The Owner shall notify the District Manager and the Director, in writing, of any of the following changes within thirty (30) days of the change occurring:

    a. change of Owner;

    b. change of address of the Owner;

    c. change of partners where the Owner is or at any time becomes a partnership, and a copy of the most recent declaration filed under the *Business Names Act,* R.S.O. 1990, c.B17 shall be included in the notification to the District Manager; or

    d. change of name of the corporation where the Owner is or at any time becomes a corporation, and a copy of the most current information filed under the Corporations Information Act, R.S.O. 1990, c. C39 shall be included in the notification to the District Manager.

2. In the event of any change in ownership of the Works, other than a change to a successor municipality, the Owner shall notify in writing the succeeding owner of the existence of this Approval, and a copy of such notice shall be forwarded to the District Manager and the Director.

3. The Owner shall ensure that all communications made pursuant to this condition refer to the number at the top of this Approval.

4. OPERATION AND MAINTENANCE

1. If applicable, any proposed storm sewers or other stormwater conveyance in this Approval can be constructed but not operated until the proposed stormwater management facilities in this Approval or any other Approval that are designed to service the storm sewers or other stormwater conveyance are in operation.

Schedule "A"

1. Application for Environmental Compliance Approval, dated December 12, 2019, received on January 20, 2020, submitted by Richmond Village Development Corporation;

2. Transfer of Review Letter of Recommendation, dated January 14, 2020, revised on January 31, 2020, and signed by Damien Whittaker, P. Eng., Senior Engineer - Infrastructure Applications, Planning, Infrastructure and Economic Development Department, City of Ottawa;

    a. Final Plans and Specifications prepared by David Schaeffer Engineering Ltd.

    b. Pipe Data Form - Watermain, Storm Sewer, Sanitary Sewer, and Forcemain Design Supplement to Application for Approval for Water and Sewage Works.

    c. Hydraulic Design Sheets prepared by David Schaeffer Engineering Ltd.

3. Emails dated January 30, 2020, January 31, 2020, and February 7, 2020, from Damien Whittaker, P. Eng., City of Ottawa.

4. Emails dated February 3, 2020 and February 7, 2020, from Kevin Murphy, David Schaeffer Engineering Ltd.

The reasons for the imposition of these terms and conditions are as follows:

1. Condition 1 is imposed to ensure that the Works are constructed and operated in the manner in which they were described and upon which approval was granted. This condition is also included to emphasize the precedence of conditions in the Approval and the practice that the Approval is based on the most current document, if several conflicting documents are submitted for review.

2. Condition 2 is included to ensure that, when the Works are constructed, the Works will meet the standards that apply at the time of construction to ensure the ongoing protection of the environment.

3. Condition 3 is included to ensure that the Ministry records are kept accurate and current with respect to the approved Works and to ensure that subsequent owners of the Works are made aware of the Approval and continue to operate the Works in compliance with it.

4. Condition 4 is included to prevent the operation of stormwater pipes and other conveyance until such time that their required associated stormwater management Works are also constructed.

In accordance with Section 139 of the Environmental Protection Act, you may by written Notice served upon me and the Environmental Review Tribunal within 15 days after receipt of this Notice, require a hearing by the Tribunal. Section 142 of the Environmental Protection Act provides that the Notice requiring the hearing shall state:

a. The portions of the environmental compliance approval or each term or condition in the environmental compliance approval in respect of which the hearing is required, and;
b. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

The Notice should also include:

1. The name of the appellant;
2. The address of the appellant;
3. The environmental compliance approval number;
4. The date of the environmental compliance approval;
5. The name of the Director, and;
6. The municipality or municipalities within which the project is to be engaged in.

And the Notice should be signed and dated by the appellant.

This Notice must be served upon:

The Secretary*
Environmental Review Tribunal
655 Bay Street, Suite 1500
Toronto, Ontario
M5G 1E5

AND

The Director appointed for the purposes of
Part II.1 of the Environmental Protection Act
Ministry of the Environment,
Conservation and Parks
135 St. Clair Avenue West, 1st Floor
Toronto, Ontario
M4V 1P5

* **Further information on the Environmental Review Tribunal's requirements for an appeal can be obtained directly from the Tribunal at: Tel: (416) 212-6349, Fax: (416) 326-5370 or www.ert.gov.on.ca**

The above noted activity is approved under s.20.3 of Part II.1 of the Environmental Protection Act.

DATED AT TORONTO this 24th day of February, 2020

A. Ahmed

Aziz Ahmed, P.Eng.
Director
appointed for the purposes of Part II.1 of the *Environmental Protection Act*

CA/
c: District Manager, MECP Ottawa
Clerk, City of Ottawa (File No. D07-16-19-0009)
Damien Whittaker, City of Ottawa
Kevin Murphy, David Schaeffer Engineering Ltd.

Ontario
Ministry of the Environment, Conservation and Parks
Ministère de l'Environnement, de la Protection de la nature et des Parcs

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AMENDED ENVIRONMENTAL COMPLIANCE APPROVAL

NUMBER 1608-BPHMBF
Issue Date: May 19, 2020

Richmond Village Development Corporation
2934 Baseline Road, Unit 302
Ottawa, Ontario
K2H 1B2

Site Location: Fox Run Subdivision
6350 Perth Street
City of Ottawa, Ontario

You have applied under section 20.2 of Part II.1 of the Environmental Protection Act, R.S.O. 1990, c. E. 19 (Environmental Protection Act) for approval of:

modifications to existing stormwater management Works to serve the Western Development Lands and related to the Fox Run subdivision Phase II (North), located in the City of Ottawa, for the collection, transmission, treatment and disposal of stormwater runoff from a total catchment area of 185.19 hectares, to provide Enhanced Level water quality protection and erosion control, baseflow augmentation, and to attenuate post-development peak flows to pre-development peak flows for all storm events up to and including the 100-year storm event, discharging to the Van Gaal/Arbuckle Drain, consisting of the following:

- **stormwater management facility (catchment area 185.19 hectares):** one (1) wet pond with two existing sediment forebays and the inclusion of an additional sediment forebay, located southeast of Perth Street, southwest of Queen Charlotte Street North and northeast of Meynell Road, having a permanent storage volume of 45,330 cubic metres, an extended detention volume of 43,875 cubic metres, and a total storage volume of 66,394 cubic metres including the permanent pool, at a total depth of 1.85 metres, and a new additional inlet structure consisting of a 2100 millimetre and a 975 millimetre diameter series of storm inlet pipes and a concrete headwall, an existing middle inlet of a 1200 millimetre diameter pipe and a concrete headwall, and 'south' inlet consisting of a 1350 millimetre and a 1650 millimetre diameter series of pipes; an outlet structure comprised of a 900 millimetre diameter storm outlet pipe equipped with a 300 millimetre diameter orifice, allowing a maximum extended detention discharge of 440 litres per second under the 100-year storm event to the Van Gaal/Arbuckle Drain, located to east of the pond, cool drain baseflow augmentation via a 100 millimetre diameter orifice and a 300 millimetre diameter pipe providing 28 litres per second and, for emergency events, a 45 metre wide spillway is also provided in collaboration with an 88.5 metre long quantity control weir;

including erosion/sedimentation control measures during construction and all other controls and appurtenances essential for the proper operation of the aforementioned Works;

all in accordance with the submitted application and supporting documents listed in Schedule "A" forming part of this Approval.

For the purpose of this environmental compliance approval, the following definitions apply:

1. "Approval" means this entire document and any schedules attached to it, and the application;

2. "Director" means a person appointed by the Minister pursuant to section 5 of the EPA for the purposes of Part II.1 of the EPA;

3. "District Manager" means the District Manager of the appropriate local District Office of the Ministry, where the Works are geographically located;

4. "EPA" means the *Environmental Protection Act,* R.S.O. 1990, c.E.19, as amended;

5. "Ministry" means the ministry of the government of Ontario responsible for the EPA and OWRA and includes all officials, employees or other persons acting on its behalf;

6. "Owner" means Richmond Village Development Corporation, and includes its successors and assignees;

7. "OWRA" means the *Ontario Water Resources Act, R.S.O. 1990, c. O.40* , as amended;

8. "Works" means the sewage Works described in the Owner's application, and this Approval.

You are hereby notified that this environmental compliance approval is issued to you subject to the terms and conditions outlined below:

TERMS AND CONDITIONS

1. GENERAL CONDITIONS

1. The Owner shall ensure that any person authorized to carry out work on or operate any aspect of the Works is notified of this Approval and the conditions herein and shall take all reasonable measures to ensure any such person complies with the same.

2. Except as otherwise provided by these Conditions, the Owner shall design, build, install, operate and maintain the Works in accordance with the description given in this Approval, and the

application for approval of the Works.

3. Where there is a conflict between a provision of any document in the schedule referred to in this Approval and the conditions of this Approval, the conditions in this Approval shall take precedence, and where there is a conflict between the documents in the schedule, the document bearing the most recent date shall prevail.

4. Where there is a conflict between the documents listed in Schedule "A" and the application, the application shall take precedence unless it is clear that the purpose of the document was to amend the application.

5. The conditions of this Approval are severable. If any condition of this Approval, or the application of any requirement of this Approval to any circumstance, is held invalid or unenforceable, the application of such condition to other circumstances and the remainder of this Approval shall not be affected thereby.

2. EXPIRY OF APPROVAL

1. This Approval will cease to apply to those parts of the Works which have not been constructed within five (5) years of the date of this Approval.

2. In the event that completion and commissioning of any portion of the Works is anticipated to be delayed beyond the specified expiry period, the Owner shall submit an application of extension to the expiry period, at least twelve (12) months prior to the end of the period. The application for extension shall include the reason(s) for the delay, whether there is any design change(s) and a review of whether the standards applicable at the time of Approval of the Works are still applicable at the time of request for extension, to ensure the ongoing protection of the environment.

3. CHANGE OF OWNER

1. The Owner shall notify the District Manager and the Director, in writing, of any of the following changes within thirty (30) days of the change occurring:

    a. change of Owner;

    b. change of address of the Owner;

    c. change of partners where the Owner is or at any time becomes a partnership, and a copy of the most recent declaration filed under the *Business Names Act,* R.S.O. 1990, c.B17 shall be included in the notification to the District Manager; or

   d. change of name of the corporation where the Owner is or at any time becomes a corporation, and a copy of the most current information filed under the *Corporations Information Act,* R.S.O. 1990, c. C39 shall be included in the notification to the District Manager.

2. In the event of any change in ownership of the Works, other than a change to a successor municipality, the Owner shall notify in writing the succeeding owner of the existence of this Approval, and a copy of such notice shall be forwarded to the District Manager and the Director.

3. The Owner shall ensure that all communications made pursuant to this condition refer to the number at the top of this Approval.

4. OPERATION AND MAINTENANCE

1. If applicable, any proposed storm sewers or other stormwater conveyance in this Approval can be constructed but not operated until the proposed stormwater management facilities in this Approval or any other Approval that are designed to service the storm sewers or other stormwater conveyance are in operation.

2. The Owner shall make all necessary investigations, take all necessary steps and obtain all necessary approvals so as to ensure that the physical structure, siting and operations of the Works do not constitute a safety or health hazard to the general public.

3. The Owner shall inspect and ensure that the design minimum liquid retention volume is maintained in the Works at all times, except when maintenance is required.

4. The Owner shall undertake an inspection of the condition of the Works, at least once a year, and undertake any necessary cleaning and maintenance to ensure that sediment, debris and excessive decaying vegetation are removed from the Works to prevent the excessive build-up of sediment, oil/grit, debris and/or decaying vegetation, to avoid reduction of the capacity and/or permeability of the Works, as applicable. The Owner shall also regularly inspect and clean out the inlet to and outlet from the Works to ensure that these are not obstructed.

5. The Owner shall construct, operate and maintain the Works with the objective that the effluent from the Works is essentially free of floating and settleable solids and does not contain oil or any other substance in amounts sufficient to create a visible film, sheen, foam or discoloration on the receiving waters.

6. The Owner shall maintain a logbook to record the results of these inspections and any cleaning and maintenance operations undertaken, and shall keep the logbook at the Owner's administrative office for inspection by the Ministry. The logbook shall include the following:

   a. the name of the Works; and

   b. the date and results of each inspection, maintenance and cleaning, including an estimate of the quantity of any materials removed and method of clean-out of the Works.

7. The Owner shall prepare an operations manual prior to the commencement of operation of the Works that includes, but is not necessarily limited to, the following information:

   a. operating and maintenance procedures for routine operation of the Works;

   b. inspection programs, including frequency of inspection, for the Works and the methods or tests employed to detect when maintenance is necessary;

   c. repair and maintenance programs, including the frequency of repair and maintenance for the Works;

   d. contingency plans and procedures for dealing with potential spills and any other abnormal situations and for notifying the District Manager; and

   e. procedures for receiving, responding and recording public complaints, including recording any follow-up actions taken.

8. The Owner shall maintain the operations manual current and retain a copy at the Owner's administrative office for the operational life of the Works. Upon request, the Owner shall make the manual available to Ministry staff.

5. TEMPORARY EROSION AND SEDIMENT CONTROL

1. The Owner shall install and maintain temporary sediment and erosion control measures during construction and conduct inspections once every two (2) weeks and after each significant storm event (a significant storm event is defined as a minimum of 25 mm of rain in any 24 hours period). The inspections and maintenance of the temporary sediment and erosion control measures shall continue until they are no longer required and at which time they shall be removed and all disturbed areas reinstated properly.

2. The Owner shall maintain records of inspections and maintenance which shall be made available for inspection by the Ministry, upon request. The record shall include the name of the inspector, date of inspection, and the remedial measures, if any, undertaken to maintain the temporary sediment and erosion control measures.

6. REPORTING

1. One (1) week prior to the start-up of the operation of the Works, the Owner shall notify the District Manager (in writing) of the pending start-up date.

2. The Owner shall, upon request, make all reports, manuals, plans, records, data, procedures and supporting documentation available to Ministry staff.

3. The Owner shall prepare a performance report within ninety (90) days following the end of the period being reported upon, and submit the report(s) to the District Manager when requested. The first such report shall cover the first annual period following the commencement of operation of the Works and subsequent reports shall be prepared to cover successive annual periods following thereafter. The reports shall contain, but shall not be limited to, the following information:

    a. a description of any operating problems encountered and corrective actions taken;

    b. a summary of all maintenance carried out on any major structure, equipment, apparatus, mechanism or thing forming part of the Works, including an estimate of the quantity of any materials removed from the Works;

    c. a summary of any complaints received during the reporting period and any steps taken to address the complaints;

    d. a summary of all spill or abnormal discharge events; and

    e. any other information the District Manager requires from time to time.

7. RECORD KEEPING

1. The Owner shall retain for a minimum of five (5) years from the date of their creation, all records and information related to or resulting from the operation, maintenance and monitoring activities required by this Approval.

Schedule "A"

1. Application for Environmental Compliance Approval, dated March 27, 2020, received on April 30, 2020, submitted by Richmond Village Development Corporation;

2. Transfer of Review Letter of Recommendation, dated April 30, 2020 and signed by Damien Whittaker, P.Eng., Infrastructure Applications, Development Review, City of Ottawa, including the following supporting documents:

    a. Final Plans and Specifications prepared by David Schaeffer Engineering Ltd.

    b. Stormwater Management Report prepared by David Schaeffer Engineering Ltd.

    c. Design Brief for Stormwater Management Pond 1, Western Development Lands - Richmond, Revised March 2020, prepared by J.F. Sabourin and Associates & David Schaeffer Engineering Ltd.

3. Emails received on May 7, 2020, May 8, 2020, May 12, 2020, and May 13, 2020 from Damien Whittaker, P. Eng., City of Ottawa.

The reasons for the imposition of these terms and conditions are as follows:

1. Condition 1 is imposed to ensure that the Works are constructed and operated in the manner in which they were described and upon which approval was granted. This condition is also included to emphasize the precedence of conditions in the Approval and the practice that the Approval is based on the most current document, if several conflicting documents are submitted for review.

2. Condition 2 is included to ensure that, when the Works are constructed, the Works will meet the standards that apply at the time of construction to ensure the ongoing protection of the environment.

3. Condition 3 is included to ensure that the Ministry records are kept accurate and current with respect to the approved Works and to ensure that subsequent owners of the Works are made aware of the Approval and continue to operate the Works in compliance with it.

4. Condition 4 is included as regular inspection and necessary removal of sediment and excessive decaying vegetation from the Works are required to mitigate the impact of sediment, debris and/or decaying vegetation on the treatment capacity of the Works. The Condition also ensures that adequate storage is maintained in the Works at all times as required by the design. Furthermore, this Condition is included to ensure that the Works are operated and maintained to function as designed.

5. Condition 5 is included as installation, regular inspection and maintenance of the temporary sediment and erosion control measures is required to mitigate the impact on the downstream receiving watercourse during construction until they are no longer required.

6. Condition 6 is included to provide a performance record for future references, to ensure that the Ministry is made aware of problems as they arise, and to provide a compliance record for all the terms and conditions outlined in this Approval, so that the Ministry can work with the Owner in resolving any problems in a timely manner.

7. Condition 7 is included to require that all records are retained for a sufficient time period to adequately evaluate the long-term operation and maintenance of the Works.

Upon issuance of the environmental compliance approval, I hereby revoke Approval No(s). 1060-AY8JK4 issued on May 30, 2018.

In accordance with Section 139 of the Environmental Protection Act, you may by written Notice served upon me and the Environmental Review Tribunal within 15 days after receipt of this Notice, require a hearing by the Tribunal. Section 142 of the Environmental Protection Act provides that the Notice requiring the hearing shall state:

a. The portions of the environmental compliance approval or each term or condition in the environmental compliance approval in respect of which the hearing is required, and;
b. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

Pursuant to subsection 139(3) of the Environmental Protection Act, a hearing may not be required with respect to any terms and conditions in this environmental compliance approval, if the terms and conditions are substantially the same as those contained in an approval that is amended or revoked by this environmental compliance approval.

The Notice should also include:

1. The name of the appellant;
2. The address of the appellant;
3. The environmental compliance approval number;
4. The date of the environmental compliance approval;
5. The name of the Director, and;
6. The municipality or municipalities within which the project is to be engaged in.

And the Notice should be signed and dated by the appellant.

This Notice must be served upon:

The Secretary*
Environmental Review Tribunal
655 Bay Street, Suite 1500
Toronto, Ontario
M5G 1E5

AND

The Director appointed for the purposes of Part II.1 of the Environmental Protection Act
Ministry of the Environment, Conservation and Parks
135 St. Clair Avenue West, 1st Floor
Toronto, Ontario
M4V 1P5

*** Further information on the Environmental Review Tribunal's requirements for an appeal can be obtained directly from the Tribunal at: Tel: (416) 212-6349, Fax: (416) 326-5370 or www.ert.gov.on.ca**

The above noted activity is approved under s.20.3 of Part II.1 of the Environmental Protection Act.

DATED AT TORONTO this 19th day of May, 2020

A. Ahmed

Aziz Ahmed, P.Eng.
Director
appointed for the purposes of Part II.1 of the
Environmental Protection Act

SW/

c: District Manager, MECP Ottawa District Office
City Clerk, City of Ottawa
Damien Whittaker, P. Eng., Senior Engineer, Infrastructure Applications, City of Ottawa
Kevin Murphy, David Schaeffer Engineering Ltd.

Ministry of the Environment and Climate Change
Ministère de l'Environnement et de l'Action en matière de changement climatique

ENVIRONMENTAL COMPLIANCE APPROVAL

NUMBER 9297-AV9KAL
Issue Date: January 25, 2018

Richmond Village Development Corporation
2934 Baseline Road, Unit 302
Ottawa, Ontario
K2H 1B2

Site Location: Caivan Communities - Richmond Phase 1
6350 Perth Street
City of Ottawa, Ontario

You have applied under section 20.2 of Part II.1 of the Environmental Protection Act, R.S.O. 1990, c. E. 19 (Environmental Protection Act) for approval of:

sanitary and storm sewers to be constructed in the City of Ottawa, as follows:

- sanitary sewers on Meynell Road (from Station 0+671.0 to Station 1+225.3), Cantle Crescent (from Station 0+000.0 to Station 0+267.9), Pelham Crescent (from Station 0-013.0 to Station 0+377.6), Reynard Crescent (from Station 0+000.0 to Station 0+308.6), Noriker Court (from Station 0-014.0 to Station 0+228.3), Hackamore Crescent (from Station 0+000.0 to Station 0+084.3), Equitation Circle (from Station 0+000.0 to Station 0+503.4), and Pond Inlet 3 - Storm Trunk 2 (from Station 0+080.0 to Station 0+172.6), discharging to Richmond Stormwater Management Pond 1, located in the City of Ottawa; and

- storm sewers on Meynell Road (from Station 0+687.1 to Station 1+225.7), Cantle Crescent (from Station 0+002.5 to Station 0+267.9), Pelham Crescent (from Station 0-013.5 to Station 0+380.0), Reynard Crescent (from Station 0-002.0 to Station 0+310.6), Noriker Court (from Station 0-016.0 to Station 0+238.0), Hackamore Crescent (from Station 0-002.5 to Station 0+084.3), Equitation Circle (from Station 0+002.5 to Station 0+505.8), Block 235 (from Station 0+002.5 to Station 0+070.8), Pond Inlet 2 (from Station 0+006.9 to Station 0+076.8, Pond Inlet 3 - Storm Trunk 1 (from Station 0+003.9 to Station 0+162.3), and Pond Inlet 3 - Storm Trunk 2 (from Station 0+077.7 to Station 0+206.7), discharging to Richmond Stormwater Management Pond 1, located in the City of Ottawa;

all in accordance with the submitted application and supporting documents listed in Schedule "A" forming part of this approval.

For the purpose of this environmental compliance approval, the following definitions apply:

1. "Approval" means this entire document and any schedules attached to it, and the application;
2. "Director" means a person appointed by the Minister pursuant to section 5 of the EPA for the purposes of Part II.1 of the EPA;
3. "District Manager" means the District Manager of the appropriate local District Office of the Ministry, where the Works are geographically located;
4. "EPA" means the Environmental Protection Act, R.S.O. 1990, c.E.19, as amended;
5. "Ministry" means the ministry of the government of Ontario responsible for the EPA and OWRA and includes all officials, employees or other persons acting on its behalf;
6. "Owner" means Richmond Village Development Corporation, and includes their successors and assignees;
7. "OWRA" means the Ontario Water Resources Act, R.S.O. 1990, c. O.40, as amended;
8. "Significant Threat Policy(ies)" has the same meaning as in the Clean Water Act, 2006;
9. "Source Protection Plan" means a drinking water source protection plan prepared under the Clean Water Act, 2006;
10. "Works" means the sewage works described in the Owner's application, and this Approval.

You are hereby notified that this environmental compliance approval is issued to you subject to the terms and conditions outlined below:

TERMS AND CONDITIONS

1. GENERAL CONDITIONS

1. The Owner shall ensure that any person authorized to carry out work on or operate any aspect of the Works is notified of this Approval and the conditions herein and shall take all reasonable measures to ensure any such person complies with the same.
2. Except as otherwise provided by these Conditions, the Owner shall design, build, install, operate and maintain the Works in accordance with the description given in this Approval, and the application for approval of the Works.
3. Where there is a conflict between a provision of any document in the schedule referred to in this Approval and the conditions of this Approval, the conditions in this Approval shall take precedence, and where there is a conflict between the documents in the schedule, the document bearing the most recent date shall prevail.

4. Where there is a conflict between the documents listed in Schedule "A" and the application, the application shall take precedence unless it is clear that the purpose of the document was to amend the application.

5. The conditions of this Approval are severable. If any condition of this Approval, or the application of any requirement of this Approval to any circumstance, is held invalid or unenforceable, the application of such condition to other circumstances and the remainder of this Approval shall not be affected thereby.

2. EXPIRY OF APPROVAL

1. This Approval will cease to apply to those parts of the Work which have not been constructed within five (5) years of the date of this Approval.

2. In the event that completion and commissioning of any portion of the Works is anticipated to be delayed beyond the specified expiry period, the Owner shall submit an application of extension to the expiry period, at least twelve (12) months prior to the end of the period. The application for extension shall include the reason(s) for the delay, whether there is any design change(s) and a review of whether the standards applicable at the time of Approval of the Works are still applicable at the time of request for extension, to ensure the ongoing protection of the environment.

3. CHANGE OF OWNER

1. The Owner shall notify the District Manager and the Director, in writing, of any of the following changes within thirty (30) days of the change occurring:

   a. change of Owner;

   b. change of address of the Owner;

   c. change of partners where the Owner is or at any time becomes a partnership, and a copy of the most recent declaration filed under the Business Names Act, R.S.O. 1990, c.B17 shall be included in the notification to the District Manager; or

   d. change of name of the corporation where the Owner is or at any time becomes a corporation, and a copy of the most current information filed under the Corporations Information Act, R.S.O. 1990, c. C39 shall be included in the notification to the District Manager.

2. In the event of any change in ownership of the Works, other than a change to a successor municipality, the Owner shall notify in writing the succeeding owner of the existence of this Approval, and a copy of such notice shall be forwarded to the District Manager and the Director.

3. The Owner shall ensure that all communications made pursuant to this condition refer to the number at the top of this Approval.

4. Notwithstanding any other requirements in this Approval, upon transfer of the ownership or assumption of the Works to a municipality if applicable, any reference to the District Manager shall be replaced with the Water Supervisor.

4. OPERATION AND MAINTENANCE

1. If applicable, any proposed storm sewers or other stormwater conveyance in this Approval can be constructed but not operated until the proposed stormwater management facilities in this Approval or any other Approval that are designed to service the storm sewers or other stormwater conveyance are in operation.

5. SOURCE WATER PROTECTION

1. The Owner shall ensure, if applicable, that the design, construction and operation of the Works conforms to any Significant Threat Policies in any Source Protection Plan that applies to the location of the Works.

SCHEDULE "A"

1. Application for Environmental Compliance Approval for Municipal and Private Sewage Works, dated December 19, 2017 and received on December 28, 2017, submitted by Richmond Village Development Corporation.

2. Transfer of Review Letter of Recommendation, dated December 28, 2017 and signed by Damien Whittaker, Senior Engineer, City of Ottawa.

The reasons for the imposition of these terms and conditions are as follows:

1. Condition 1 is imposed to ensure that the Works are constructed and operated in the manner in which they were described and upon which approval was granted. This condition is also included to emphasize the precedence of conditions in the Approval and the practice that the Approval is based on the most current document, if several conflicting documents are submitted for review.

2. Condition 2 is included to ensure that, when the Works are constructed, the Works will meet the standards that apply at the time of construction to ensure the ongoing protection of the environment.

3. Condition 3 is included to ensure that the Ministry records are kept accurate and current with respect to approved Works and to ensure that subsequent owners of the Works are made aware of the Approval and continue to operate the Works in compliance with it.

4. Condition 4 is included to prevent the operation of stormwater pipes and other conveyance until such time that their required associated stormwater management Works are also constructed.

5. Condition 5 is included to ensure that the Works conform to the policies of the local Source Water Protection Plan.

In accordance with Section 139 of the Environmental Protection Act, you may by written Notice served upon me and the Environmental Review Tribunal within 15 days after receipt of this Notice, require a hearing by the Tribunal. Section 142 of the Environmental Protection Act provides that the Notice requiring the hearing shall state:

a. The portions of the environmental compliance approval or each term or condition in the environmental compliance approval in respect of which the hearing is required, and;
b. The grounds on which you intend to rely at the hearing in relation to each portion appealed.

The Notice should also include:

1. The name of the appellant;
2. The address of the appellant;
3. The environmental compliance approval number;
4. The date of the environmental compliance approval;
5. The name of the Director, and;
6. The municipality or municipalities within which the project is to be engaged in.

And the Notice should be signed and dated by the appellant.

This Notice must be served upon:

The Secretary*
Environmental Review Tribunal
655 Bay Street, Suite 1500
Toronto, Ontario
M5G 1E5

AND

The Director appointed for the purposes of
Part II.1 of the Environmental Protection Act
Ministry of the Environment and
Climate Change
135 St. Clair Avenue West, 1st Floor
Toronto, Ontario
M4V 1P5

* **Further information on the Environmental Review Tribunal's requirements for an appeal can be obtained directly from the Tribunal at: Tel: (416) 212-6349, Fax: (416) 326-5370 or www.ert.gov.on.ca**

The above noted activity is approved under s.20.3 of Part II.1 of the Environmental Protection Act.

DATED AT TORONTO this 25th day of January, 2018

C. Labarge

Christina Labarge, P.Eng.
Director
appointed for the purposes of Part II.1 of the
Environmental Protection Act

RS/
c: District Manager, MOECC Ottawa
City Clerk, City of Ottawa (File No. D07-16-11-0014)
Linda Carkner, Program Mananger, Right of Way Unit (MC 26-61)
Harry R. Alvey, P.E., P.Eng., Project Manager, Rural Branch
Kevin Murphy, David Schaeffer Engineering Ltd.

APPENDIX C

Memo

To: Kevin Murphy
David Schaeffer Engineering Ltd.

From: Jasmin Sidhu / Kevin Alemany
Stantec Consulting Ltd.

File: 163401550

Date: February 26, 2021

Reference: Richmond Caivan Green & Laffin Lands – Potable Water Capacity Analysis

OVERVIEW

To support David Schaeffer Engineering Ltd. (DSEL) with their Functional Servicing Report, Stantec Consulting Ltd. (Stantec) was retained by Richmond Village Development Corporation (RVDC) to complete a potable water hydraulic analysis for Caivan's recently acquired properties within the Richmond Western Development Lands.

To date, Stantec has completed hydraulic analyses for the water distribution system internal to the Western Development Lands, including that within Caivan's Richmond Fox Run development lands (Phases 1 and 2) and under buildout conditions.

Caivan has recently acquired additional property in the Western Development Lands, including:

(1) The lands adjacent to their Fox Run Phase 2 subdivision lands on the north side of Perth Street, including Green Lands West and Fox Run Phase 3 (formerly identified as 'Other' as part of previous potable water analyses complete for the Western Development Lands), and Green Lands East (formerly not part of the Western Development Lands); and,

(2) The Laffin Lands which is within the land area owned by Mattamy.

This technical memorandum quantifies the updated unit density (and population) and documents the associated supply and distribution system capacity analyses to identify if the Green Lands West, Green Lands East and Laffin development lands can still be serviced by the communal well. This memo also identifies if the existing watermain distribution network is capable of servicing the areas in question and if required, what watermain upgrades might be required.

HYDRAULIC ASSESSMENT

PHASING

For the purpose this assessment, development within the Western Development Lands, as shown in **Figure 1**, was assumed to occur (or have occurred) in the following phasing order:

(1) Caivan Fox Run Phase 1 (servicing construction completed and home building/occupancies ongoing);

(2) Caivan Fox Run Phase 2 North and South (draft approved with Phase 2 North and South servicing construction ongoing);

(3) Caivan Fox Run Phase 3 (future; draft approved);

(4) Mattamy Phase 1 (future; not yet draft approved);

(5) Caivan Green Lands West, Green Lands East and Laffin Lands; and,

(6) Buildout of the remaining Western Development Lands, including other developments from Mattamy (draft approved landholdings with design pending).

Herein, “interim conditions” was considered to include constructed and/or anticipated development up to, and including, the Caivan Green Lands West, Green Lands East and Laffin Lands (i.e., development phases 1 to 5).

GROWTH & DEMAND PROJECTIONS

Growth Projections

The estimated residential population for the Green Lands West, Green Lands East and Laffin Lands is estimated based on projected household sizes as per the Ottawa Water Design Guidelines. **Table 1** attached shows the estimated number of units for these two development lands and their respective projected populations based on the distribution of residential unit types. In summary:

- Green Lands West is estimated to have a total of 375 residential units with a population of 1,093 persons;
- Green Lands East is estimated to have a total of 37 residential units with a population of 126 persons; and,
- Laffin Lands is estimated to have a total of 174 residential units with a population of 545 persons.

Upon buildout of the Western Development Lands, the majority of the land is proposed to be residential, with 2.63 ha proposed to be institutional (i.e., school) as a future phase of the Mattamy buildout development area. **Table 2** attached provides a breakdown of the estimated units and populations for each development phase/area within the Western Development Lands. The total number of units upon buildout is estimated to be 2,475, with a total projected population of 7,875 persons.

Demand Projections

The criteria outlined in the City of Ottawa 2013 Water Master Plan (WMP) were followed to establish water demands for the Green Lands West, Green Lands East and Laffin Lands, as well as the rest of the Western Development Lands. As per **Table 2** attached, the estimated buildout population for the Western Development Lands is 7,875 persons, therefore Zone Level demands for populations greater than 3,000 persons were used. The demand rates from the Table 3-1 of the 2013 WMP were applied to the population projections presented in **Table 2** attached based on land-use and location with respect to the Greenbelt (i.e., outside, denoted as “outside Greenbelt” or OGB). Zone level demands are generally used to assess larger service areas and are not generally used to size smaller internal watermains; however, fire flows generally govern the minimum sizing for smaller internal watermain infrastructure and therefore the use of Zone Level demands for this analysis was considered appropriate.

For residential land use, single-family and semi-detached homes were considered to have similar demands, therefore both housing types were classified as “single-family houses” (SFH) that have a unit consumption rate of 180 L/cap/d. All townhouses were classified as “multi-level townhouses” (MLT) with a unit consumption rate of 198 L/cap/d. For the institutional (INS) lands, a unit demand rate of 28,000 L/ha/d was applied to establish basic day (BSDY) demands. BSDY demands for the Green Lands West, Green Lands East and Laffin Lands and the rest of the Western Development Lands are summarized in **Table 3** attached.

To establish maximum day (MXDY) demands, an outdoor water demand (OWD) of 1,049 L/SFH/d was taken, as per the 2013 WMP, and allocated to all SFH units. This outdoor water demand was added to BSDY demands to obtain the MXDY demand (see **Table 3** attached).

Peak hour (PKHR) demands were established by applying diurnal patterns developed by the City of Ottawa to the maximum day demands. The diurnal patterns are different for each unit type and vary with time of day. The overall maximum observed demand, with patterns applied, is the PKHR demand. For example, single-family houses will typically have peak demands during 7 to 8 a.m. in the morning and 5 to 8 p.m. in the evening, whereas a school will typically experience peak demands during lunch hours and during the evenings for custodial cleaning.

DISTRIBUTION SYSTEM CAPACITY ANALYSIS

Serviceability

System Pressures

As per the Ottawa Water Design Guidelines, the desired range of pressure under BSDY, MXDY and PKHR demands is 345 to 552 kPa (50 to 80 psi) and no less than 276 kPa (40 psi) at ground elevation (i.e., at street level). The maximum pressure at any point in the water distribution system should not exceed 552 kPa (80 psi); pressure reducing measures are required to service areas where pressures greater than 552 kPa (80 psi) are anticipated.

Under emergency fire conditions, the system must be able to supply appropriate fire flow while maintaining a residual pressure of 138 kPa (20 psi).

Fire Flows

The City requires a fire flow assessment to be completed to demonstrate that local watermains can provide the objective fire flows. For this analysis, an available fire flow of 167 L/s (10,000 L/min), as previously established for the Western Development Lands (Stantec, 2020), was applied. This flow rate was calculated based on the detailed Fire Underwriters Survey (FUS) Guidelines (long method) and capped as per the City of Ottawa Technical Bulletin ISDTB-2014-02 since a minimum separation of 10 m between backs of adjacent units will be provided. The local watermains must therefore be able to provide a minimum fire flow of 167 L/s at a residual pressure of 20 psi.

Proposed Watermain Sizing & Layout

Watermain sizing and layout proposed as part of the Fox Run Phase 2 development and buildout conditions water distribution system analysis (Stantec, 2020) were used for this analysis and updated to reflect the currently proposed site plans for the Green Lands West, Green Lands East and Laffin Lands. The updated watermain sizing and layout for the Green and Laffin development areas are shown in **Figure 2** and **Figure 3**, respectively.

Within Green Lands West, the network is proposed to consist of 152 to 305 mm diameter watermains as shown in **Figure 2**. Based on the current proposed site plan and assumed phasing, the 375 proposed units would be serviced by five feeds. These include one feed across Perth St from Fox Run Phase 1, and four feeds from the

305 mm and 203 mm proposed watermains sized to accommodate buildout demand conditions to fully service both the adjacent Fox Run Phase 3 lands and Green Lands West.

Within Green Lands East, the network is proposed to consist of a looped 203 mm diameter watermain. As shown in **Figure 2**, this loop is proposed to cross the Van Gaal Drain in two locations, connecting to the Fox Run Phase 3 lands to the north and the Fox Run Phase 2 North lands to the south.

Within the Laffin Lands, the network is proposed to consist of 152 to 305 mm diameter watermains. As previously stated, it is assumed that development of the Mattamy Phase 1 lands, which are located north of the Laffin Lands, will start prior to development of the Laffin Lands. Based on the current proposed site plan, the Laffin Lands will consist of 174 residential units. As such, this development will need to be serviced by more than one feed. Therefore, it is proposed to service the Laffin Lands via two 305 mm diameter feeds through the Mattamy buildout development lands, as shown in **Figure 3** attached. The current site plan also shows 5 properties located along Ottawa Street. To service these properties, the looped 305 mm diameter feed would need to be extended south to Ottawa Street and connected to a proposed 254 mm diameter watermain along Ottawa Street, as shown in **Figure 3** attached. Alternatively, sale of these 5 lots may be frozen until development of the adjacent Mattamy lands. The proposed 305 mm diameter feeds and 254 mm watermain extension along Ottawa Street were previously identified as required upon buildout of the surrounding Mattamy lands. As such, these proposed watermains have been sized to accommodate current buildout demand projections.

Model Results

Basic Day & Peak Hour Demands

Under interim and buildout BSDY conditions, model results show that the maximum HGL in the system is 149 m and 148 m respectively, which correspond to maximum pressures of 531 kPa (77 psi) 524 kPa (76 psi). Under PKHR demands, model results show that the minimum HGL in the system is 144 m for interim conditions and 132 m for buildout conditions, which corresponds to minimum pressures of 455 kPa (66 psi) and 324 kPa (47 psi), respectively. Therefore, modelled minimum and maximum pressures are within the City's objective of 345 to 552 kPa (50 to 80 psi). Detailed modelling results are provided in the **Hydraulic Modelling Results** attachment.

Maximum Day + Fire Flow

Under both interim and buildout maximum day + fire flow (MXDY+FF) conditions, model results show that fire flows greater than 10,000 L/min with a residual pressure of 138 kPa (20 psi) are available throughout the distribution system. Detailed modelling results are provided in the **Hydraulic Modelling Results** attachment.

SUPPLY CAPACITY ANALYSIS

Maximum Day Supply

With respect to well supply capacity, the 2008 Ministry of Environment of Ontario Design Guidelines for Drinking-Water Systems require that the total developed groundwater source capacity shall equal or exceed the design maximum day demand with the largest producing well out of service (i.e., firm capacity). The two existing groundwater supply wells servicing the Richmond West Pumping Station provide 28 L/s and 40 L/s, respectively. With the largest well out of service, the available supply is **28 L/s**. The cumulative maximum day demand for interim conditions (i.e., constructed and/or anticipated development up to, and including, the Caivan Green Lands West, Green Lands East and Laffin Lands) is **23.8 L/s** (refer to **Table 4** attached). Therefore, the existing firm capacity of the well supply exceeds the supply required to service these developments.

The projected buildout maximum day demand from other developments to be serviced by the Richmond West Pumping Station is currently estimated to exceed 28 L/s. As such, as the maximum day demand of the area to be serviced approaches the firm capacity of 28 L/s, additional well supply will be required. It is recommended that the well supply be expanded prior to the system demand reaching 90% of the firm capacity, or 25 L/s.

Fire Flow Storage & Supply

With respect to storage capacity, the Richmond West Pump Station has an existing reservoir storage volume of 1,175 m^3. The reservoir is comprised of two reservoirs each capable of operating independently with a volume of 588 m^3.

The current fire flow demand of 10,000 L/min was determined following the latest City of Ottawa Water Design Guidelines recommendations for interpretation of the Fire Underwriters Survey (FUS). From an operational perspective, an analysis was carried out to assess the pumping station's ability to provide the maximum day plus fire flow demand over a design period of 2 hours. **Table 5** attached demonstrates the existing facility's ability to provide a 10,000 L/min fire flow using excess well capacity and with various levels of storage water available, ranging from 70% to 90% full. Based on this sensitivity analysis, a fire flow of 10,000 L/min for a duration of 2 hours is available for all anticipated development phases (this assumes additional well capacity is added upon Mattamy Buildout to address maximum day well supply needs).

It is noted that the overall system storage requirements will be assessed as part of a new Village of Richmond functional design report (FDR). The new FDR will be assessing system storage requirements based on the current projection of number of units in Richmond, the Ministry of Environment of Ontario Design Guidelines for new or expanded storage facilities, and the revised fire flow design requirements. This separate study will ultimately identify triggers for both well and storage expansions.

Redundant Storage Requirement

Section 3.29 (Reliability & Redundancy) of the 2008 Ministry of Environment of Ontario Design Guidelines for Drinking-Water Systems states:

> "*The design of water treatment plants should be based on the premise that failure of any single component must not prevent the drinking-water system from satisfying all applicable regulatory requirements and other site specific treated water quality and quantity criteria, while operating at design flows.*"

As such, with respect to treated storage, the failure of a single cell in the dual cell reservoir is considered a failure for reliability purposes. Furthermore, to supplement the MOE design guidelines, the City of Ottawa 2013 Water Master Plan Level of Service guidelines stated that for populations less than 10,000 persons, the minimum demands to be met by major infrastructure at all times is Basic Day demand only.

The Richmond West Pumping Station has a reservoir that is split into two independent cells. The storage capacity of each cell is 588 m^3. For operation and reliability, each cell can operate independently when the other cell is taken out of service. The cumulative basic day demand for interim conditions is 10.85 L/s.

Therefore, the well supply and remaining storage capacity meet the basic day demand with one cell out of service (refer to **Table 6** attached).

As the current Western Development Lands service area is not currently projected to exceed 10,000 persons, the current redundant storage and well supply would be capable of meeting the buildout basic day demand of 17.69 L/s for all known developments.

CONCLUSION

Supply and distribution system capacity analyses were completed for the Green Lands West, Green Lands East and Laffin Lands within Richmond's Western Development Lands. The purpose of these analyses was to identify if the additional associated properties can still be serviced by the Communal Well and if the existing watermain distribution network is capable of servicing the areas in question and if required, what watermain upgrades might be required. Based on the results of the analyses, the following conclusions were made:

- Within Green Lands West, the network is proposed to consist of 152 to 305 mm diameter watermains. Based on the current proposed site plan and assumed phasing, the 375 proposed units would be serviced by five feeds from other adjacent development lands sized to accommodate buildout demand conditions to fully service both the adjacent Fox Run Phase 3 lands and Green Lands West.
- Within Green Lands East, the network is proposed to consist of a looped 203 mm diameter watermain. This loop is proposed to cross the Van Gaal Drain in two locations, connecting to the Fox Run Phase 3 lands to the north and the Fox Run Phase 2 North lands to the south.
- Similarly, the network within the Laffin Lands is proposed to consist of 152 to 305 mm diameter watermains and also requires more than one service feed to meet City of Ottawa standards. Therefore, it is proposed to service the Laffin Lands via two 305 mm diameter feeds through the Mattamy buildout development lands. The current site plan also shows 5 properties located along Ottawa Street. To service these properties, the looped 305 mm diameter feed would need to be extended south to Ottawa Street and connected to a proposed 254 mm diameter watermain along Ottawa Street. Alternatively, sale of these 5 lots may be frozen until development of the adjacent Mattamy lands. The proposed 305 mm diameter feeds and 254 mm watermain extension along Ottawa Street were previously identified as required upon buildout of the surrounding Mattamy lands. As such, these proposed watermains have been sized to accommodate buildout demand conditions.
- With the proposed watermain sizing/configuration, system pressures and fire flow serviceability requirements are met under interim and buildout conditions for BSDY, PKHR and MXDY+FF demands.
- The current well supply capacity of the Richmond West Pumping Station meets maximum day demands for constructed and/or anticipated development up to, and including, the Caivan Green Lands West, Green Lands East and Laffin Lands (i.e., interim conditions).
- The current Richmond West Pumping Station has a total storage capacity of 1,175 m^3 . An operational assessment demonstrated that with a range of existing reservoir volume, plus excess well capacity, a fire flow of 10,000 L/min for a duration of 2 hours can be provided for all anticipated development phases (this assumes additional well capacity is added upon Mattamy Buildout to address maximum day well supply needs).
- The current Richmond West Pumping Station has a storage volume of approximately 590 m^3 when one cell is taken out of service. Under the reliability scenario of one cell out of service, the supply wells and remaining storage are capable of meeting the required basic day demand.

REFERENCES

City of Ottawa. (2010). *Ottawa Design Guidelines - Water Distribution.* Ottawa.
City of Ottawa. (2014). *Technical Bulletin ISDTB-2014-02: Revisions to Ottawa Design Guidelines - Water.* Ottawa.
Ministry of the Environment Ontario. (2008). *Design Guidelines for Drinking-Water Systems.*
Stantec Consulting Ltd. (2013). *City of Ottawa 2013 Water Master Plan.* Ottawa.
Stantec Consulting Ltd. (2020). *Fox Run Subdivision Phase 2 Water Distribution System Analysis.* Ottawa.

Stantec Consulting Ltd.

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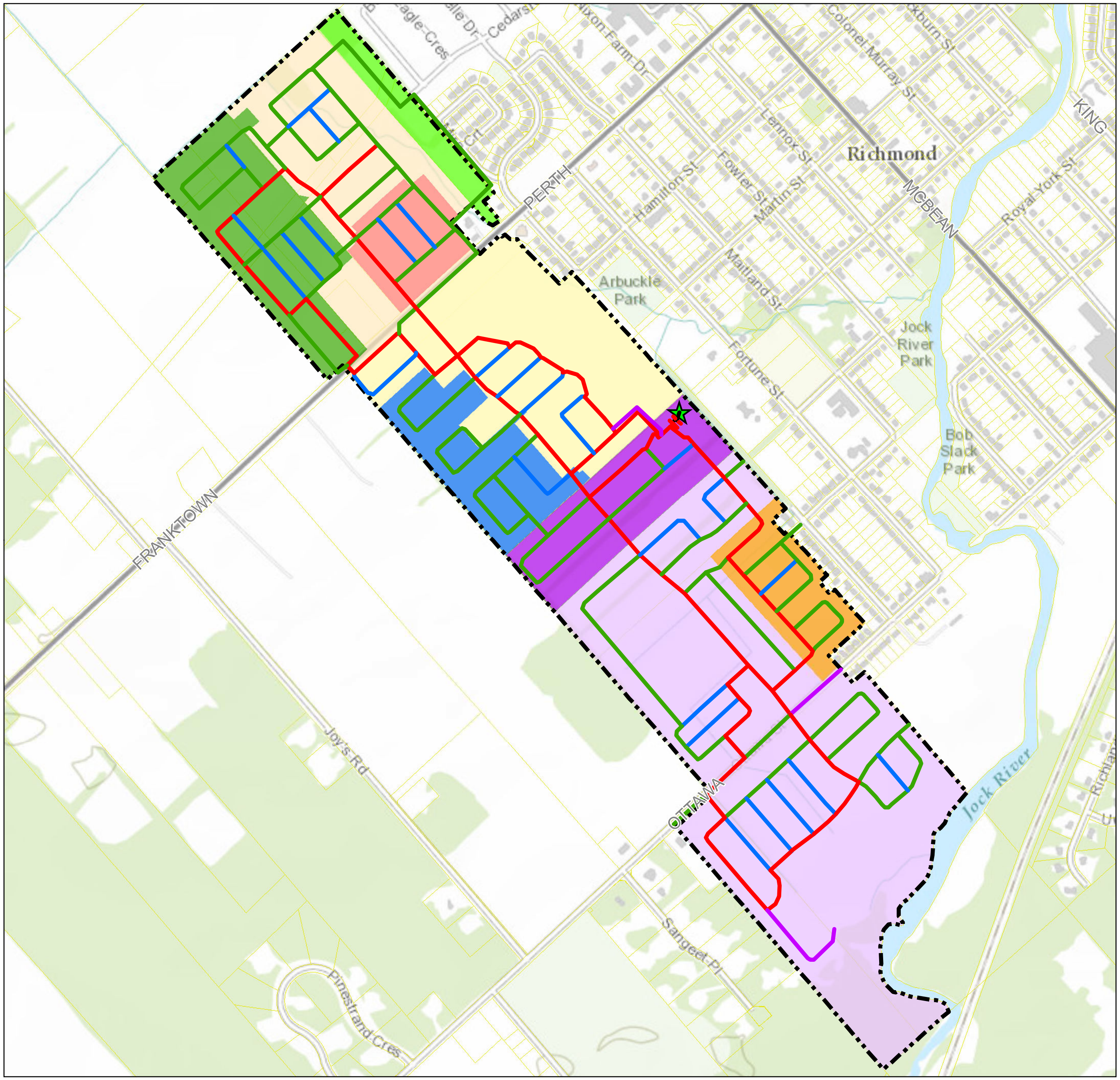
Attachments:

Figure 1: Western Development Lands
Figure 2: Proposed Watermain Sizing/Layout – Green Lands West & East
Figure 3: Proposed Watermain Sizing/Layout – Laffin Lands

Table 1: Estimated Unit Counts and Populations for Green & Laffin Lands
Table 2: Estimated Unit Counts and Populations for Buildout Conditions
Table 3: Estimated Water Demands
Table 4: Maximum Day Supply
Table 5: Sensitivity Analysis of Existing Available Storage
Table 6: Redundant Storage Requirement

Figure A1: Model System Map
Hydraulic Modelling Results



Stantec

Legend

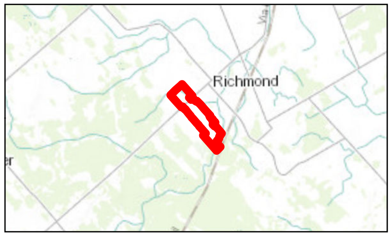
- 🟨 Caivan Fox Run Phase 1
- 🟥 Caivan Fox Run Phase 2 North
- 🟦 Caivan Fox Run Phase 2 South
- 🟧 Caivan Fox Run Phase 3 (formerly RVDC)
- 🟩 Caivan Green Lands West
- 🟩 Caivan Green Lands East
- 🟧 Caivan Laffin Lands
- 🟪 Mattamy Phase 1
- 🟪 Mattamy (Buildout)
- ▭ Western Development Lands
- ▭ Property Parcel
- ★ Richmond West Pumping Station

N

0 190 380 metres

(At original document size of 8.5x11)
1:15,000

Notes
1. Coordinate System: NAD 1983 MTM 9



Project Location
Richmond, ON

Client/Project
Richmond Village Development Corporation
Richmond Caivan Green & Laffin Lands
Potable Water Capacity Analysis

Figure No.
1

Title
Western Development Lands

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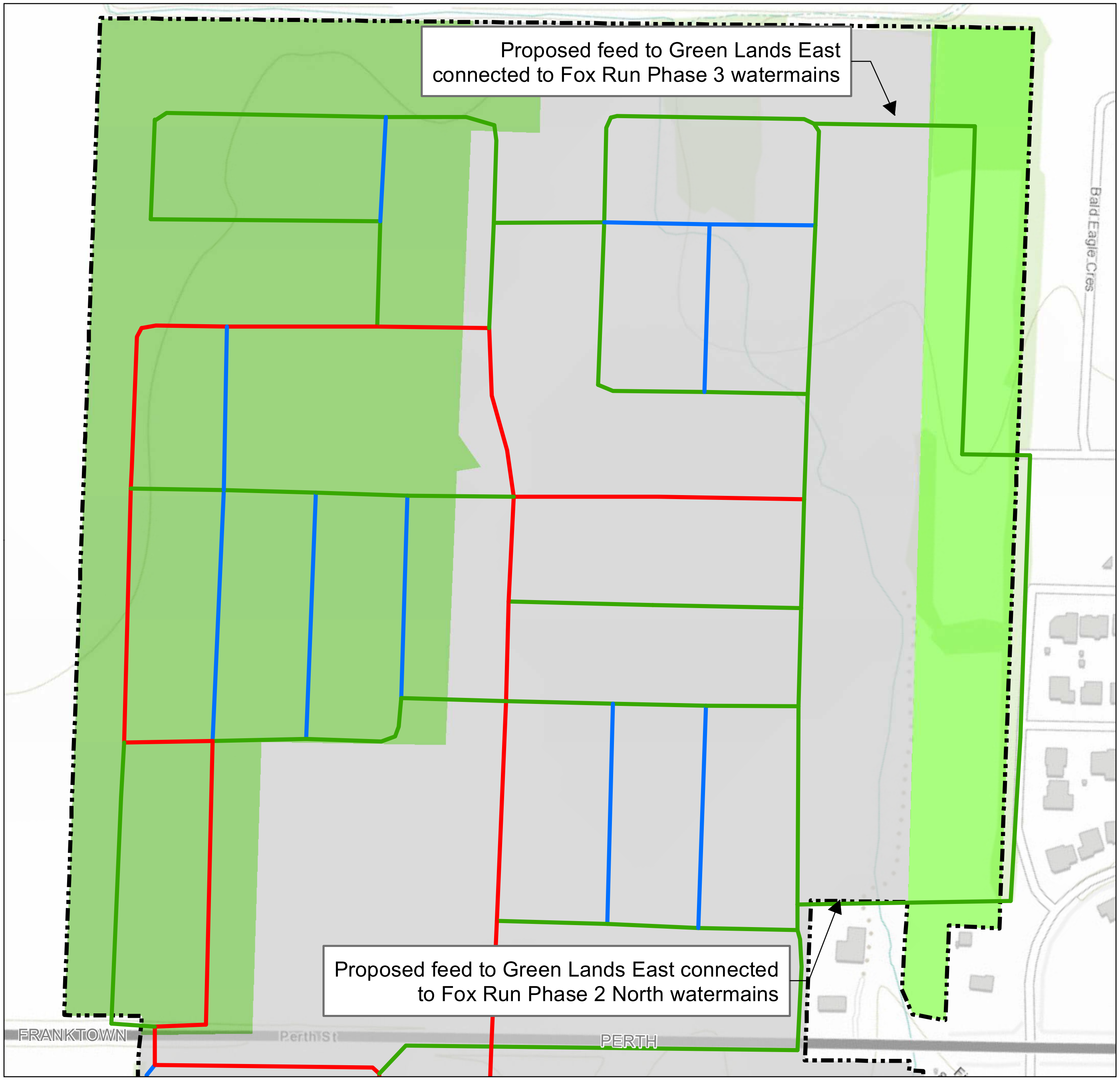


Proposed feed to Green Lands East connected to Fox Run Phase 3 watermains

Proposed feed to Green Lands East connected to Fox Run Phase 2 North watermains

Stantec

Legend

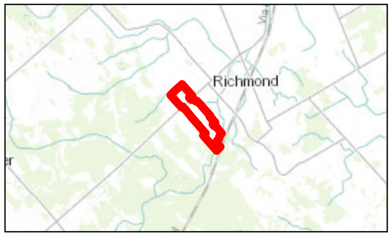
🟩 Caivan Green Lands West
🟩 Caivan Green Lands East
⬜ Other Development
⬚ Western Development Lands

Watermain Diameter (mm)

— 305
— 203
— 152

0 50 100 metres
(At original document size of 8.5x11)
1:4,000

Notes
1. Coordinate System: NAD 1983 MTM 9



Project Location
Richmond, ON

Client/Project
Richmond Village Development Corporation
Richmond Caivan Green & Laffin Lands
Potable Water Capacity Analysis

Figure No.
2

Title
Proposed Watermain Sizing/Layout - Green Lands West & East

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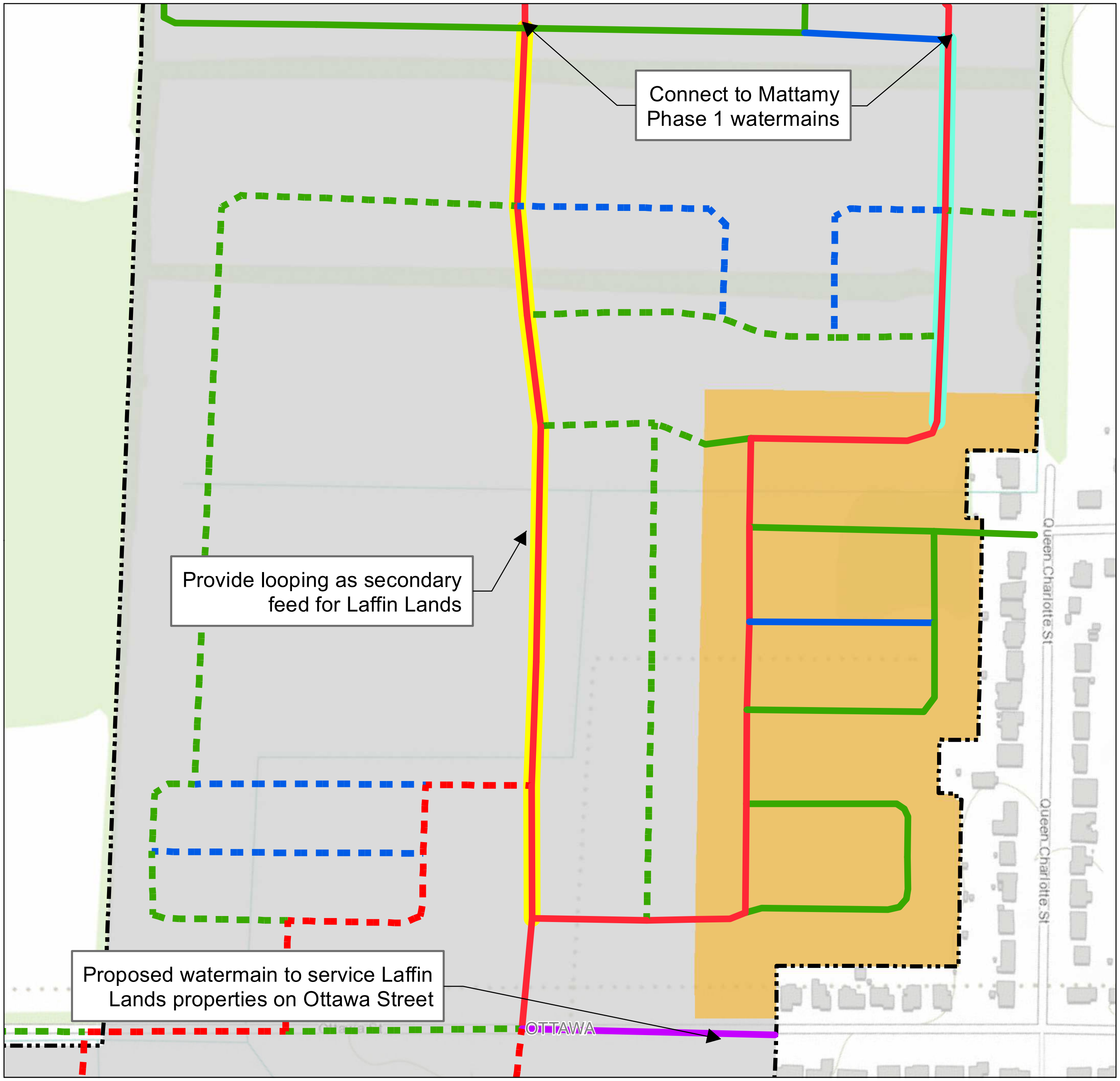


Stantec

Legend

Existing/Proposed (Interim) Watermain (mm)

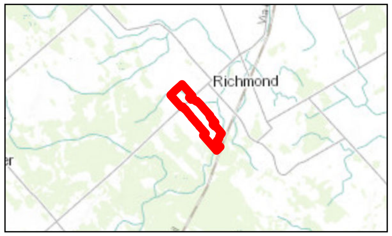
- 🟥 305
- 🟪 254
- 🟩 305
- 🟦 152

Future (Buildout) Watermain (mm)

- 🟥 305
- 🟩 203
- 🟦 152
- Proposed Primary Feed
- Proposed Secondary Feed
- Caivan Laffin Lands
- Other Development
- Western Development Lands

0 50 100 metres
(At original document size of 8.5x11)
1:4,000

Notes
1. Coordinate System: NAD 1983 MTM 9



Project Location
Richmond, ON

Client/Project
Richmond Village Development Corporation
Richmond Caivan Green & Laffin Lands
Potable Water Capacity Analysis

Figure No.
3

Title
Proposed Watermain Sizing/Layout - Laffin Lands

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Table 1: Estimated Unit Counts and Populations for Green & Laffin Lands

Development Area	Unit Type	Unit Count	PPU	Population
Caivan Green Lands West	SFH	115	3.4	391
	MLT	260	2.7	702
Caivan Green Lands East	SFH	37	3.4	126
Caivan Laffin Lands	SFH	108	3.4	367
	MLT	66	2.7	178
	Total	***586***		***1,764***

Table 2: Estimated Unit Counts and Populations for Buildout Conditions

Development Area	Unit Type	Unit Count	Area (ha)	PPU	Population
Caivan Fox Run Phase 1	SFH	220	-	3.4	748
Caivan Fox Run Phase 2 North	SFH	31	-	3.4	105
	MLT	163	-	2.7	440
Caivan Fox Run Phase 2 South	SFH	200	-	3.4	680
Caivan Fox Run Phase 3	SFH	221	-	3.4	751
Mattamy Phase 1	SFH	132	-	3.4	449
	MLT	47	-	2.7	127
Caivan Green Lands West	SFH	115	-	3.4	391
	MLT	260	-	2.7	702
Caivan Green Lands East	SFH	37	-	3.4	126
Caivan Laffin Lands	SFH	108	-	3.4	367
	MLT	66	-	2.7	178
Interim Conditions (Sub-total)		***1,600***	***0***	***-***	***5,064***
Mattamy (Buildout)	SFH	640	-	3.4	2,176
	MLT	235	-	2.7	635
	INS	-	2.63	-	-
Buildout Conditions (Total)		***2,475***	***2.63***	***-***	***7,875***

Table 3: Estimated Water Demands

Development Area	Unit Type	Population	Area (ha)	Water Demands		
				BSDY (L/s)	OWD (L/s)	MXDY (L/s)
Caivan Fox Run Phase 1	SFH	748	-	1.56	2.67	4.23
Caivan Fox Run Phase 2 North	SFH	105	-	0.22	0.38	0.60
	MLT	440	-	1.01	-	1.01
Caivan Fox Run Phase 2 South	SFH	680	-	1.42	2.43	3.85
Caivan Fox Run Phase 3	SFH	751	-	1.57	2.68	4.25
Mattamy Phase 1	SFH	449	-	0.94	1.60	2.54
	MLT	127	-	0.29	-	0.29
Caivan Green Lands West	SFH	391	-	0.81	1.40	2.21
	MLT	702	-	1.61	-	1.61
Caivan Green Lands East	SFH	126	-	0.26	0.45	0.71
Caivan Laffin Lands	SFH	367	-	0.76	1.31	2.08
	MLT	178	-	0.41	-	0.41
Interim Conditions (Sub-total)		***5,064***	***0***	***10.85***	***12.92***	***23.78***
Mattamy (Buildout)	SFH	2,176	-	4.53	7.77	12.30
	MLT	635	-	1.45	-	1.45
	INS	-	2.63	0.85	-	0.85
Buildout Conditions (Total)		***7,875***	***2.63***	***17.69***	***20.69***	***38.39***

Table 4: Maximum Day Well Supply

	(A)	(B)	(C)	(D)	(E)	(F)	(G)
						= [Sum of (C) to (E)] - [Max of (C) to (E)]	*= (F) - (B)*
			Well Capacity				
Development Area	MXDY	Cumulative MXDY	Well #1 (Existing)	Well #2 (Existing)	Well #3 (Future)	Firm Well Capacity (Largest Well Out of Service)	Additional Firm Well Capacity Available for MXDY
	(L/s)	(L/s)	(L/s)	(L/s)	(L/s)	(L/s)	(L/s)
Caivan Fox Run Phase 1	4.23	4.23	28.0	40.0		28.0	23.77
Caivan Fox Run Phase 2 (South)	3.85	8.08	28.0	40.0		28.0	19.92
Caivan Fox Run Phase 2 (North)	1.61	9.69	28.0	40.0		28.0	18.31
Caivan Fox Run Phase 3 (formerly RVDC Buildout)	4.25	13.94	28.0	40.0		28.0	14.06
Mattamy Phase 1	2.83	16.77	28.0	40.0		28.0	11.23
Caivan Green Lands West (incl. Flowing Creek Farms)	3.82	20.59	28.0	40.0		28.0	7.41
Caivan Green Lands East	0.71	21.30	28.0	40.0		28.0	6.70
Caivan Laffin Lands	2.48	23.78	28.0	40.0		28.0	4.22
Mattamy (Buildout)	14.61	38.39	28.0	40.0	40.0	68.0	29.61
Tamarack(1)	21.42	59.81	28.0	40.0	40.0	68.0	8.19

Trigger (90% of Existing Firm Capacity)(2)	-	*25.20*	*28.0*	*40.0*		*28.0*	*2.80*
Trigger (Existing Firm Capacity)(2)	-	*28.00*	*28.0*	*40.0*		*28.0*	*0*

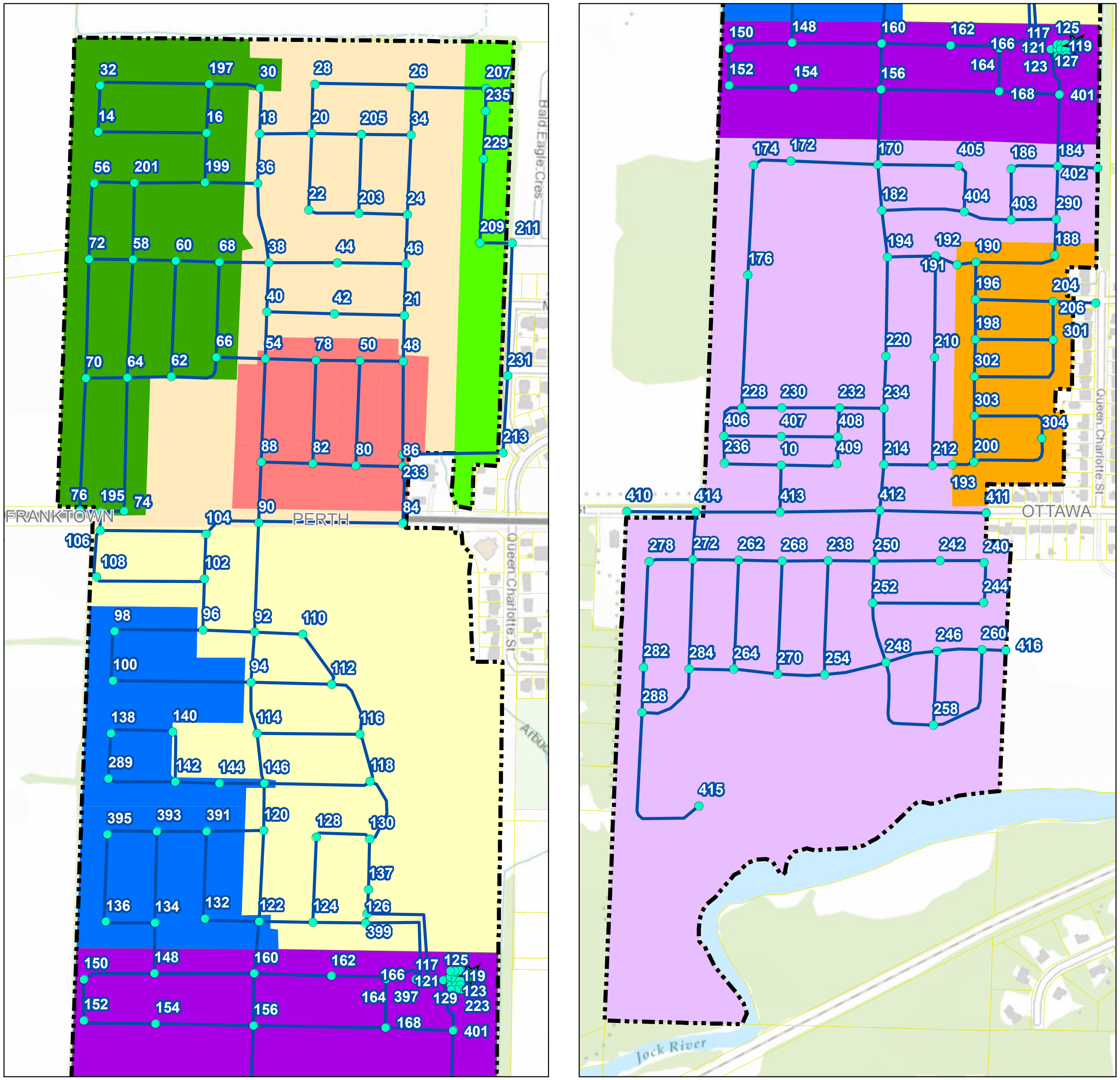
Table 5: Sensitivity Analysis of Existing Available Storage

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)
					*= (D)*0.9*1000/60/60/2.0*	*= (E) + (C)*	*= (F)*60 (rounded to nearest 1,000)*	*= *0.8*1000/60/60/2.0*	*= (H) + (C)*	*= (I)*60 (rounded to nearest 1,000)*	*= (D)*0.7*1000/60/60/2.0*	*= (K) + (C)*	*= (L)*60 (rounded to nearest 1,000)*
					Sensitivity Analysis of Existing Available Storage								
					w/ 90% Existing Available Storage			w/ 80% Existing Available Storage			w/ 70% Existing Available Storage		
Development Area	MXDY	Cumulative MXDY	Excess Total Well Capacity (Total Well Capacity - Cumulative MXDY)	Existing Storage Available	Available FF Provided by 90% of Existing Available Storage for Duration of 2 hrs	Available FF based on Existing Storage and Excess Total Well Capacity		Available FF Provided by 80% of Existing Available Storage for Duration of 2 hrs	Available FF based on Existing Storage and Excess Total Well Capacity		Available FF Provided by 70% of Existing Available Storage for Duration of 2 hrs	Available FF based on Existing Storage and Excess Total Well Capacity	
	(L/s)	(L/s)	(L/s)	(m^3)	(L/s)	(L/s)	(L/min)	(L/s)	(L/s)	(L/min)	(L/s)	(L/s)	(L/min)
Caivan Fox Run Phase 1	4.23	4.23	63.8	1,175	146.9	210.6	13,000	130.6	194.3	12,000	114.2	178.0	11,000
Caivan Fox Run Phase 2 (South)	3.85	8.08	59.9	1,175	146.9	206.8	12,000	130.6	190.5	11,000	114.2	174.2	10,000
Caivan Fox Run Phase 2 (North)	1.61	9.69	58.3	1,175	146.9	205.2	12,000	130.6	188.9	11,000	114.2	172.5	10,000
Caivan Fox Run Phase 3 (formerly RVDC Buildout)	4.25	13.94	54.1	1,175	146.9	200.9	12,000	130.6	184.6	11,000	114.2	168.3	10,000
Mattamy Phase 1	2.83	16.77	51.2	1,175	146.9	198.1	12,000	130.6	181.8	11,000	114.2	165.5	10,000
Caivan Green Lands West (incl. Flowing Creek Farms)	3.82	20.59	47.4	1,175	146.9	194.3	12,000	130.6	178.0	11,000	114.2	161.7	10,000
Caivan Green Lands East	0.71	21.30	46.7	1,175	146.9	193.6	12,000	130.6	177.3	11,000	114.2	160.9	10,000
Caivan Laffin Lands	2.48	23.78	44.2	1,175	146.9	191.1	11,000	130.6	174.8	10,000	114.2	158.5	10,000
Mattamy (Buildout)	14.61	38.39	69.6	1,175	146.9	216.5	13,000	130.6	200.2	12,000	114.2	183.8	11,000
Tamarack	21.42	59.81	48.2	1,175	146.9	195.1	12,000	130.6	178.7	11,000	114.2	162.4	10,000

Table 6: Redundant Storage Requirement

	(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)	(M)	(N)	(O)	(P)	(Q)	(R)	(S)	(T)	(U)
							= (D) or [(D) + (E)]				*= Sum of (H) to (J)*			*= (L)*	*= (N)*1000/2/3600*	*= (K) + (O)*	*= (P) - (G)*	*= (L) + (M)*	*= (R)*1000/2/3600*	*= (K) + (S)*	*= (T) - (G)*
								Well Capacity						w/ Existing Available Storage				w/ Additional Storage			
Development Area	Population	Cumulative Population	BSDY	Cumulative BSDY	FUS FF		BSDY (<10,000 persons) or BSDY + Fire Flow (>10,000 persons)	Well #1 (Existing)	Well #2 (Existing)	Well #3 (Future)	Total Well Capacity	Existing Storage with One Cell Out of Service	Additional Storage to Be Provided	Available Storage with One Cell Out of Service	Flow from Storage with One Cell Out of Service (over 2 hours)	Total Well & Storage Supply Available (over 2 hours)	Excess Well & Storage Supply Available (over 2 hours)	Available Storage with One Cell Out of Service	Flow from Storage with One Cell Out of Service (over 2 hours)	Firm Well & Storage Supply Available (over 2 hours)	Excess Well & Storage Supply Available (over 2 hours)
	(persons)	(persons)	(L/s)	(L/s)	(L/s)	(hrs)	(L/s)	(L/s)	(L/s)	(L/s)	(L/s)	(m^3)	(m^3)	(m^3)	(L/s)	(L/s)	(L/s)	(m^3)	(L/s)	(L/s)	(L/s)
Caivan Fox Run Phase 1	748	748	1.56	1.56	0	0	1.56	28.0	40.0		68.0	588	0	588	82	150	148.0	588	82	150	148.0
Caivan Fox Run Phase 2 (South)	680	1,428	1.42	2.98	0	0	2.98	28.0	40.0		68.0	588	1,300	588	82	150	146.6	1,888	262	330	327.2
Caivan Fox Run Phase 2 (North)	546	1,974	1.23	4.20	0	0	4.20	28.0	40.0		68.0	588	1,300	588	82	150	145.4	1,888	262	330	325.9
Caivan Fox Run Phase 3 (formerly RVDC Buildout)	751	2,725	1.57	5.77	0	0	5.77	28.0	40.0		68.0	588	1,300	588	82	150	143.8	1,888	262	330	324.4
Mattamy Phase 1	576	3,301	1.23	6.99	0	0	6.99	28.0	40.0		68.0	588	1,300	588	82	150	142.6	1,888	262	330	323.2
Caivan Green Lands West (incl. Flowing Creek Farms)	1,093	4,394	2.42	9.42	0	0	9.42	28.0	40.0		68.0	588	1,300	588	82	150	140.2	1,888	262	330	320.7
Caivan Green Lands East	126	4,519	0.26	9.68	0	0	9.68	28.0	40.0		68.0	588	1,300	588	82	150	139.9	1,888	262	330	320.5
Caivan Laffin Lands	545	5,065	1.17	10.85	0	0	10.85	28.0	40.0		68.0	588	1,300	588	82	150	138.7	1,888	262	330	319.3
Mattamy (Buildout)	2,811	7,875	6.84	17.69	0	0	17.69	28.0	40.0	40.0	108.0	588	1,300	588	82	190	171.9	1,888	262	370	352.5
Tamarack(1)	3,249	11,124	15.62	33.31	166.7	2	200.01	28.0	40.0	40.0	108.0	588	2,750	588	82	190	-10.4	3,338	464	572	371.5

Trigger (Population/BSDY when Redundant Storage Req. Changes)	-	*10,000*	-	*22.59*	*166.7*	*2*	*189.29*	*28.0*	*40.0*	*40.0*	*108.0*	*588*	*1,300*	*588*	*82*	*190*	*0.4*	*1,888*	*262*	*370*	*180.9*



Stantec

Legend

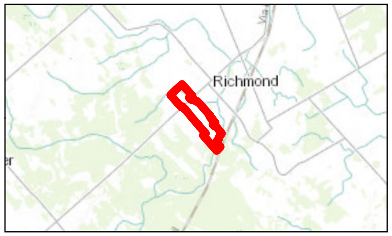
- ● Model Node
- — Model Pipe
- 🟨 Caivan Fox Run Phase 1
- 🟥 Caivan Fox Run Phase 2 North
- 🟦 Caivan Fox Run Phase 2 South
- 🟧 Caivan Fox Run Phase 3 (formerly RVDC)
- 🟩 Caivan Green Lands West
- 🟩 Caivan Green Lands East
- 🟧 Caivan Laffin Lands
- 🟪 Mattamy Phase 1
- 🟪 Mattamy (Buildout)
- ▭ Western Development Lands
- ▢ Property Parcel
- ★ Richmond West Pumping Station

0 100 200 metres

(At original document size of 8.5x11)
1:9,500

Notes

1. Coordinate System: NAD 1983 MTM 9



Project Location
Richmond, ON

Client/Project
Richmond Village Development Corporation
Richmond Caivan Green & Laffin Lands
Potable Water Capacity Analysis

Figure No.
A1

Title
Model System Map

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163401550 - Richmond Caivan Water Distribution System Analysis - Scope Change 1

Model Results - BSDY (Interim Conditions)

Head

ID	Max.Value (m)	Max.Time (hrs.)	Min.Value (m)	Min.Time (hrs.)	Average (m)	Difference (m)
Min			***147.62***			
Max	***148.59***					
100	148.59	3:00	147.63	7:00	148.18	0.97
102	148.59	3:00	147.62	7:00	148.18	0.97
104	148.59	3:00	147.62	7:00	148.18	0.97
106	148.59	3:00	147.62	7:00	148.18	0.97
108	148.59	3:00	147.62	7:00	148.18	0.97
110	148.59	3:00	147.63	7:00	148.18	0.96
112	148.59	3:00	147.63	7:00	148.18	0.96
114	148.59	3:00	147.63	7:00	148.19	0.96
116	148.59	3:00	147.63	7:00	148.19	0.96
117	148.59	3:00	147.66	7:00	148.20	0.93
118	148.59	3:00	147.64	7:00	148.19	0.96
119	148.59	3:00	147.67	7:00	148.20	0.93
120	148.59	3:00	147.64	7:00	148.19	0.95
121	148.59	3:00	147.67	7:00	148.20	0.93
122	148.59	3:00	147.64	7:00	148.19	0.95
123	148.59	3:00	147.67	7:00	148.20	0.93
124	148.59	3:00	147.65	7:00	148.19	0.95
125	148.59	3:00	147.67	7:00	148.20	0.93
126	148.59	3:00	147.65	7:00	148.19	0.95
127	97.80	3:00	97.80	7:00	97.80	0
128	148.59	3:00	147.64	7:00	148.19	0.95
129	148.59	3:00	147.67	7:00	148.20	0.93
130	148.59	3:00	147.64	7:00	148.19	0.95
131	97.80	3:00	97.80	7:00	97.80	0
132	148.59	3:00	147.64	7:00	148.19	0.95
133	148.59	3:00	147.67	7:00	148.20	0.93
134	148.59	3:00	147.64	7:00	148.19	0.95
135	97.80	3:00	97.80	7:00	97.80	0
136	148.59	3:00	147.64	7:00	148.19	0.95
137	148.59	3:00	147.64	7:00	148.19	0.95
138	148.59	3:00	147.64	7:00	148.19	0.96
14	148.59	3:00	147.62	7:00	148.18	0.98
140	148.59	3:00	147.64	7:00	148.19	0.96
142	148.59	3:00	147.64	7:00	148.19	0.96
144	148.59	3:00	147.64	7:00	148.19	0.96
146	148.59	3:00	147.64	7:00	148.19	0.96
148	148.59	3:00	147.64	7:00	148.19	0.95
150	148.59	3:00	147.64	7:00	148.19	0.95
152	148.59	3:00	147.64	7:00	148.19	0.95
154	148.59	3:00	147.65	7:00	148.19	0.95
156	148.59	3:00	147.65	7:00	148.19	0.95
16	148.59	3:00	147.62	7:00	148.18	0.98
160	148.59	3:00	147.65	7:00	148.19	0.95
162	148.59	3:00	147.65	7:00	148.19	0.94
164	148.59	3:00	147.65	7:00	148.19	0.94
166	148.59	3:00	147.66	7:00	148.19	0.94
168	148.59	3:00	147.65	7:00	148.19	0.94
170	148.59	3:00	147.65	7:00	148.19	0.95
18	148.59	3:00	147.62	7:00	148.18	0.98
182	148.59	3:00	147.65	7:00	148.19	0.95
184	148.59	3:00	147.66	7:00	148.20	0.94
188	148.59	3:00	147.66	7:00	148.19	0.94
190	148.59	3:00	147.65	7:00	148.19	0.94
191	148.59	3:00	147.65	7:00	148.19	0.94
193	148.59	3:00	147.65	7:00	148.19	0.94
194	148.59	3:00	147.65	7:00	148.19	0.95
195	148.59	3:00	147.62	7:00	148.18	0.97
196	148.59	3:00	147.65	7:00	148.19	0.94
197	148.59	3:00	147.62	7:00	148.18	0.98
198	148.59	3:00	147.65	7:00	148.19	0.94
199	148.59	3:00	147.62	7:00	148.18	0.98
20	148.59	3:00	147.62	7:00	148.18	0.98
200	148.59	3:00	147.65	7:00	148.19	0.94
201	148.59	3:00	147.62	7:00	148.18	0.98
203	148.59	3:00	147.62	7:00	148.18	0.98
204	148.59	3:00	147.65	7:00	148.19	0.94
205	148.59	3:00	147.62	7:00	148.18	0.98
206	148.59	3:00	147.65	7:00	148.19	0.94
207	148.59	3:00	147.62	7:00	148.18	0.98
209	148.59	3:00	147.62	7:00	148.18	0.98
21	148.59	3:00	147.62	7:00	148.18	0.97
211	148.59	3:00	147.62	7:00	148.18	0.98
212	148.59	3:00	147.65	7:00	148.19	0.94
213	148.59	3:00	147.62	7:00	148.18	0.97
214	148.59	3:00	147.65	7:00	148.19	0.94
217	97.80	3:00	97.80	7:00	97.80	0
219	148.59	3:00	147.67	7:00	148.20	0.93
22	148.59	3:00	147.62	7:00	148.18	0.98
220	148.59	3:00	147.65	7:00	148.19	0.94
221	148.59	3:00	147.67	7:00	148.20	0.93
223	97.80	3:00	97.80	7:00	97.80	0
225	148.59	3:00	147.67	7:00	148.20	0.93
227	148.59	3:00	147.67	7:00	148.20	0.93
229	148.59	3:00	147.62	7:00	148.18	0.98
231	148.59	3:00	147.62	7:00	148.18	0.98
233	148.59	3:00	147.62	7:00	148.18	0.97
234	148.59	3:00	147.65	7:00	148.19	0.94
235	148.59	3:00	147.62	7:00	148.18	0.98
24	148.59	3:00	147.62	7:00	148.18	0.98
26	148.59	3:00	147.62	7:00	148.18	0.98
28	148.59	3:00	147.62	7:00	148.18	0.98
289	148.59	3:00	147.64	7:00	148.19	0.96

Pressure

ID	Max.Value (psi)	Max.Time (hrs.)	Min.Value (psi)	Min.Time (hrs.)	Average (psi)	Difference (psi)
			70.89			
	76.54					
100	75.83	3:00	74.46	7:00	75.25	1.37
102	75.60	3:00	74.23	7:00	75.02	1.38
104	75.43	3:00	74.05	7:00	74.85	1.38
106	75.12	3:00	73.74	7:00	74.53	1.38
108	75.01	3:00	73.63	7:00	74.42	1.38
110	76.54	3:00	75.17	7:00	75.96	1.37
112	76.40	3:00	75.03	7:00	75.82	1.37
114	76.06	3:00	74.70	7:00	75.48	1.36
116	76.12	3:00	74.75	7:00	75.54	1.36
117	72.21	3:00	70.89	7:00	71.64	1.32
118	76.32	3:00	74.96	7:00	75.74	1.36
119	72.21	3:00	70.89	7:00	71.65	1.32
120	75.61	3:00	74.25	7:00	75.03	1.36
121	72.21	3:00	70.89	7:00	71.65	1.32
122	75.72	3:00	74.37	7:00	75.15	1.35
123	72.21	3:00	70.89	7:00	71.65	1.32
124	76.12	3:00	74.77	7:00	75.54	1.35
125	72.21	3:00	70.89	7:00	71.65	1.32
126	76.27	3:00	74.93	7:00	75.70	1.35
127	0	3:00	0	7:00	0	0
128	76.20	3:00	74.85	7:00	75.63	1.35
129	72.21	3:00	70.89	7:00	71.65	1.32
130	76.32	3:00	74.96	7:00	75.74	1.35
131	0	3:00	0	7:00	0	0
132	75.48	3:00	74.13	7:00	74.90	1.35
133	72.21	3:00	70.89	7:00	71.65	1.32
134	74.94	3:00	73.59	7:00	74.36	1.35
135	0	3:00	0	7:00	0	0
136	74.79	3:00	73.44	7:00	74.22	1.35
137	76.30	3:00	74.95	7:00	75.73	1.35
138	75.48	3:00	74.11	7:00	74.90	1.36
14	73.84	3:00	72.45	7:00	73.25	1.39
140	75.31	3:00	73.94	7:00	74.73	1.36
142	75.19	3:00	73.83	7:00	74.61	1.36
144	75.06	3:00	73.70	7:00	74.49	1.36
146	75.41	3:00	74.05	7:00	74.83	1.36
148	75.45	3:00	74.10	7:00	74.87	1.35
150	75.31	3:00	73.96	7:00	74.73	1.35
152	75.18	3:00	73.83	7:00	74.60	1.35
154	75.35	3:00	74.00	7:00	74.78	1.35
156	75.18	3:00	73.83	7:00	74.61	1.34
16	74.58	3:00	73.19	7:00	73.99	1.39
160	75.79	3:00	74.44	7:00	75.22	1.35
162	75.73	3:00	74.39	7:00	75.16	1.34
164	75.63	3:00	74.30	7:00	75.06	1.34
166	76.02	3:00	74.68	7:00	75.45	1.33
168	75.93	3:00	74.59	7:00	75.36	1.34
170	74.50	3:00	73.15	7:00	73.92	1.34
18	74.58	3:00	73.19	7:00	73.99	1.39
182	74.35	3:00	73.01	7:00	73.78	1.34
184	74.84	3:00	73.51	7:00	74.27	1.33
188	74.75	3:00	73.42	7:00	74.18	1.33
190	74.50	3:00	73.16	7:00	73.93	1.34
191	74.41	3:00	73.08	7:00	73.84	1.34
193	73.77	3:00	72.43	7:00	73.20	1.34
194	74.10	3:00	72.76	7:00	73.53	1.34
195	74.20	3:00	72.81	7:00	73.61	1.38
196	74.37	3:00	73.03	7:00	73.80	1.34
197	74.01	3:00	72.62	7:00	73.42	1.39
198	74.24	3:00	72.90	7:00	73.67	1.34
199	74.69	3:00	73.31	7:00	74.11	1.39
20	74.51	3:00	73.12	7:00	73.92	1.39
200	73.81	3:00	72.47	7:00	73.24	1.34
201	74.55	3:00	73.17	7:00	73.96	1.39
203	74.62	3:00	73.24	7:00	74.03	1.39
204	74.44	3:00	73.10	7:00	73.87	1.34
205	74.42	3:00	73.04	7:00	73.84	1.39
206	74.35	3:00	73.02	7:00	73.78	1.34
207	74.57	3:00	73.18	7:00	73.98	1.39
209	75.11	3:00	73.72	7:00	74.52	1.39
21	75.48	3:00	74.09	7:00	74.89	1.39
211	74.44	3:00	73.05	7:00	73.85	1.39
212	74.55	3:00	73.21	7:00	73.98	1.34
213	74.05	3:00	72.67	7:00	73.47	1.39
214	74.38	3:00	73.04	7:00	73.81	1.34
217	0	3:00	0	7:00	0	0
219	72.21	3:00	70.89	7:00	71.65	1.32
22	74.69	3:00	73.31	7:00	74.11	1.39
220	73.89	3:00	72.54	7:00	73.31	1.34
221	72.21	3:00	70.89	7:00	71.65	1.32
223	0	3:00	0	7:00	0	0
225	72.21	3:00	70.89	7:00	71.65	1.32
227	72.21	3:00	70.89	7:00	71.65	1.32
229	74.76	3:00	73.38	7:00	74.18	1.39
231	74.20	3:00	72.81	7:00	73.61	1.39
233	76.33	3:00	74.94	7:00	75.74	1.39
234	74.23	3:00	72.88	7:00	73.66	1.34
235	74.67	3:00	73.28	7:00	74.08	1.39
24	74.84	3:00	73.45	7:00	74.25	1.39
26	74.40	3:00	73.01	7:00	73.81	1.39
28	74.35	3:00	72.97	7:00	73.76	1.39
289	74.87	3:00	73.50	7:00	74.29	1.36

290	148.59	3:00	147.66	7:00	148.19	0.94
30	148.59	3:00	147.62	7:00	148.18	0.98
301	148.59	3:00	147.65	7:00	148.19	0.94
302	148.59	3:00	147.65	7:00	148.19	0.94
303	148.59	3:00	147.65	7:00	148.19	0.94
304	148.59	3:00	147.65	7:00	148.19	0.94
32	148.59	3:00	147.62	7:00	148.18	0.98
34	148.59	3:00	147.62	7:00	148.18	0.98
36	148.59	3:00	147.62	7:00	148.18	0.98
38	148.59	3:00	147.62	7:00	148.18	0.97
391	148.59	3:00	147.64	7:00	148.19	0.95
393	148.59	3:00	147.64	7:00	148.19	0.95
395	148.59	3:00	147.64	7:00	148.19	0.95
397	148.59	3:00	147.66	7:00	148.19	0.94
399	148.59	3:00	147.64	7:00	148.19	0.95
40	148.59	3:00	147.62	7:00	148.18	0.97
401	148.59	3:00	147.66	7:00	148.20	0.93
411	148.59	3:00	147.65	7:00	148.19	0.94
412	148.59	3:00:00	147.65	7:00	148.19	0.94
42	148.59	3:00:00	147.62	7:00	148.18	0.97
44	148.59	3:00:00	147.62	7:00	148.18	0.98
46	148.59	3:00	147.62	7:00	148.18	0.98
48	148.59	3:00:00	147.62	7:00	148.18	0.97
50	148.59	3:00	147.62	7:00	148.18	0.97
54	148.59	3:00:00	147.62	7:00	148.18	0.97
56	148.59	3:00:00	147.62	7:00	148.18	0.98
58	148.59	3:00	147.62	7:00	148.18	0.97
60	148.59	3:00:00	147.62	7:00	148.18	0.97
62	148.59	3:00:00	147.62	7:00	148.18	0.97
64	148.59	3:00	147.62	7:00	148.18	0.97
66	148.59	3:00	147.62	7:00	148.18	0.97
68	148.59	3:00	147.62	7:00	148.18	0.97
70	148.59	3:00:00	147.62	7:00	148.18	0.97
72	148.59	3:00:00	147.62	7:00	148.18	0.97
74	148.59	3:00	147.62	7:00	148.18	0.97
76	148.59	3:00	147.62	7:00	148.18	0.97
78	148.59	3:00	147.62	7:00	148.18	0.97
80	148.59	3:00	147.62	7:00	148.18	0.97
82	148.59	3:00	147.62	7:00	148.18	0.97
84	148.59	3:00:00	147.62	7:00	148.18	0.97
86	148.59	3:00	147.62	7:00	148.18	0.97
88	148.59	3:00	147.62	7:00	148.18	0.97
90	148.59	3:00	147.62	7:00	148.18	0.97
92	148.59	3:00:00	147.63	7:00	148.18	0.97
94	148.59	3:00:00	147.63	7:00	148.18	0.96
96	148.59	3:00	147.63	7:00	148.18	0.97
98	148.59	3:00:00	147.63	7:00	148.18	0.97

290	74.75	3:00	73.42	7:00	74.19	1.33
30	74.49	3:00	73.11	7:00	73.91	1.39
301	74.31	3:00	72.97	7:00	73.74	1.34
302	74.10	3:00	72.76	7:00	73.53	1.34
303	73.96	3:00	72.62	7:00	73.39	1.34
304	73.66	3:00	72.32	7:00	73.09	1.34
32	73.50	3:00	72.11	7:00	72.91	1.39
34	74.55	3:00	73.16	7:00	73.96	1.39
36	74.81	3:00	73.42	7:00	74.22	1.39
38	75.39	3:00	74.00	7:00	74.80	1.39
391	75.78	3:00	74.42	7:00	75.20	1.35
393	75.14	3:00	73.78	7:00	74.56	1.35
395	75.18	3:00	73.83	7:00	74.60	1.35
397	76.02	3:00	74.69	7:00	75.45	1.33
399	76.27	3:00	74.92	7:00	75.70	1.35
40	75.45	3:00	74.06	7:00	74.86	1.39
401	75.90	3:00	74.58	7:00	75.34	1.33
411	73.35	3:00	72.00	7:00	72.77	1.34
412	73.63	3:00:00	72.29	7:00	73.06	1.34
42	75.21	3:00:00	73.82	7:00	74.62	1.39
44	75.05	3:00:00	73.66	7:00	74.46	1.39
46	75.05	3:00	73.66	7:00	74.46	1.39
48	75.52	3:00:00	74.13	7:00	74.93	1.39
50	75.66	3:00	74.28	7:00	75.07	1.39
54	75.76	3:00:00	74.38	7:00	75.17	1.38
56	74.35	3:00:00	72.97	7:00	73.76	1.39
58	74.65	3:00	73.27	7:00	74.06	1.39
60	74.76	3:00:00	73.38	7:00	74.18	1.39
62	75.38	3:00:00	73.99	7:00	74.79	1.39
64	74.62	3:00	73.24	7:00	74.04	1.38
66	75.59	3:00	74.20	7:00	75.00	1.39
68	74.88	3:00	73.49	7:00	74.29	1.39
70	74.62	3:00:00	73.24	7:00	74.04	1.38
72	74.24	3:00:00	72.85	7:00	73.65	1.39
74	74.27	3:00	72.88	7:00	73.68	1.38
76	74.20	3:00	72.81	7:00	73.61	1.38
78	75.93	3:00	74.55	7:00	75.34	1.39
80	76.09	3:00	74.70	7:00	75.50	1.38
82	76.24	3:00	74.86	7:00	75.66	1.38
84	76.06	3:00:00	74.67	7:00	75.47	1.38
86	76.33	3:00	74.94	7:00	75.74	1.38
88	75.66	3:00	74.28	7:00	75.07	1.38
90	76.03	3:00	74.65	7:00	75.45	1.38
92	76.39	3:00:00	75.01	7:00	75.80	1.37
94	75.83	3:00:00	74.46	7:00	75.25	1.37
96	76.13	3:00	74.76	7:00	75.55	1.37
98	75.63	3:00:00	74.26	7:00	75.05	1.37

▨ Dummy PS nodes; results at these nodes not reported.

163401550 - Richmond Caivan Water Distribution System Analysis - Scope Change 1

Model Results - BSDY (Buildout Conditions)

Head

ID	Max.Value (m)	Max.Time (hrs.)	Min.Value (m)	Min.Time (hrs.)	Average (m)	Difference (m)
Min			*146.21*			
Max	*148.48*					
10	148.48	3:00	146.23	7:00	147.64	2.25
100	148.48	3:00	146.22	7:00	147.64	2.26
102	148.48	3:00	146.22	7:00	147.64	2.26
104	148.48	3:00	146.21	7:00	147.64	2.26
106	148.48	3:00	146.21	7:00	147.64	2.27
108	148.48	3:00	146.21	7:00	147.64	2.26
110	148.48	3:00	146.22	7:00	147.64	2.26
112	148.48	3:00	146.22	7:00	147.64	2.25
114	148.48	3:00	146.23	7:00	147.64	2.25
116	148.48	3:00	146.23	7:00	147.64	2.25
117	148.48	3:00	146.27	7:00	147.66	2.21
118	148.48	3:00	146.23	7:00	147.64	2.25
119	148.48	3:00	146.28	7:00	147.66	2.20
120	148.48	3:00	146.23	7:00	147.64	2.25
121	148.48	3:00	146.28	7:00	147.66	2.20
122	148.48	3:00	146.24	7:00	147.65	2.24
123	148.48	3:00	146.28	7:00	147.66	2.20
124	148.48	3:00	146.24	7:00	147.65	2.24
125	148.48	3:00	146.28	7:00	147.66	2.20
126	148.48	3:00	146.24	7:00	147.65	2.24
127	97.80	3:00	97.80	7:00	97.80	0
128	148.48	3:00	146.23	7:00	147.65	2.24
129	148.48	3:00	146.28	7:00	147.66	2.20
130	148.48	3:00	146.23	7:00	147.64	2.24
131	97.80	3:00	97.80	7:00	97.80	0
132	148.48	3:00	146.23	7:00	147.64	2.24
133	148.48	3:00	146.28	7:00	147.66	2.20
134	148.48	3:00	146.23	7:00	147.64	2.25
135	97.80	3:00	97.80	7:00	97.80	0
136	148.48	3:00	146.23	7:00	147.64	2.25
137	148.48	3:00	146.24	7:00	147.65	2.24
138	148.48	3:00	146.23	7:00	147.64	2.25
14	148.48	3:00	146.21	7:00	147.63	2.27
140	148.48	3:00	146.23	7:00	147.64	2.25
142	148.48	3:00	146.23	7:00	147.64	2.25
144	148.48	3:00	146.23	7:00	147.64	2.25
146	148.48	3:00	146.23	7:00	147.64	2.25
148	148.48	3:00	146.23	7:00	147.64	2.24
150	148.48	3:00	146.23	7:00	147.64	2.24
152	148.48	3:00	146.23	7:00	147.64	2.24
154	148.48	3:00	146.24	7:00	147.65	2.24
156	148.48	3:00	146.24	7:00	147.65	2.24
16	148.48	3:00	146.21	7:00	147.63	2.27
160	148.48	3:00	146.24	7:00	147.65	2.24
162	148.48	3:00	146.24	7:00	147.65	2.23
164	148.48	3:00	146.25	7:00	147.65	2.23
166	148.48	3:00	146.26	7:00	147.65	2.22
168	148.48	3:00	146.25	7:00	147.65	2.23
170	148.48	3:00	146.23	7:00	147.64	2.24
172	148.48	3:00	146.23	7:00	147.64	2.25
174	148.48	3:00	146.23	7:00	147.64	2.25
176	148.48	3:00	146.23	7:00	147.64	2.25
18	148.48	3:00	146.21	7:00	147.63	2.27
182	148.48	3:00	146.23	7:00	147.64	2.25
184	148.48	3:00	146.25	7:00	147.65	2.23
186	148.48	3:00	146.24	7:00	147.65	2.24
188	148.48	3:00	146.24	7:00	147.65	2.24
190	148.48	3:00	146.23	7:00	147.64	2.25
191	148.48	3:00	146.23	7:00	147.64	2.25
192	148.48	3:00	146.23	7:00	147.64	2.25
193	148.48	3:00	146.23	7:00	147.64	2.25
194	148.48	3:00	146.23	7:00	147.64	2.25
195	148.48	3:00	146.21	7:00	147.64	2.27
196	148.48	3:00	146.23	7:00	147.64	2.25
197	148.48	3:00	146.21	7:00	147.63	2.27
198	148.48	3:00	146.23	7:00	147.64	2.25
199	148.48	3:00	146.21	7:00	147.63	2.27
20	148.48	3:00	146.21	7:00	147.63	2.27
200	148.48	3:00	146.23	7:00	147.64	2.25
201	148.48	3:00	146.21	7:00	147.64	2.27
203	148.48	3:00	146.21	7:00	147.63	2.27
204	148.48	3:00	146.23	7:00	147.64	2.25
205	148.48	3:00	146.21	7:00	147.63	2.27
206	148.48	3:00	146.23	7:00	147.64	2.25
207	148.48	3:00	146.21	7:00	147.63	2.27
209	148.48	3:00	146.21	7:00	147.63	2.27
21	148.48	3:00	146.21	7:00	147.64	2.27
210	148.48	3:00	146.23	7:00	147.64	2.25
211	148.48	3:00	146.21	7:00	147.63	2.27
212	148.48	3:00	146.23	7:00	147.64	2.25
213	148.48	3:00	146.21	7:00	147.64	2.27
214	148.48	3:00	146.23	7:00	147.64	2.25
217	97.80	3:00	97.80	7:00	97.80	0
219	148.48	3:00	146.28	7:00	147.66	2.20
22	148.48	3:00	146.21	7:00	147.63	2.27
220	148.48	3:00	146.23	7:00	147.64	2.25
221	148.48	3:00	146.28	7:00	147.66	2.20
223	97.80	3:00	97.80	7:00	97.80	0
225	148.48	3:00	146.28	7:00	147.66	2.20
227	148.48	3:00	146.28	7:00	147.66	2.20
228	148.48	3:00	146.23	7:00	147.64	2.25
229	148.48	3:00	146.21	7:00	147.63	2.27

Pressure

ID	Max.Value (psi)	Max.Time (hrs.)	Min.Value (psi)	Min.Time (hrs.)	Average (psi)	Difference (psi)
			67.56			
	76.38					
10	73.88	3:00	70.68	7:00	72.69	3.20
100	75.67	3:00	72.46	7:00	74.48	3.21
102	75.44	3:00	72.23	7:00	74.25	3.22
104	75.27	3:00	72.05	7:00	74.07	3.22
106	74.96	3:00	71.74	7:00	73.76	3.22
108	74.84	3:00	71.62	7:00	73.65	3.22
110	76.38	3:00	73.17	7:00	75.19	3.21
112	76.24	3:00	73.03	7:00	75.05	3.20
114	75.90	3:00	72.69	7:00	74.71	3.20
116	75.95	3:00	72.75	7:00	74.76	3.20
117	72.05	3:00	68.91	7:00	70.88	3.14
118	76.15	3:00	72.96	7:00	74.96	3.20
119	72.05	3:00	68.92	7:00	70.88	3.13
120	75.44	3:00	72.25	7:00	74.25	3.19
121	72.05	3:00	68.92	7:00	70.89	3.13
122	75.56	3:00	72.37	7:00	74.37	3.19
123	72.05	3:00	68.92	7:00	70.88	3.13
124	75.95	3:00	72.77	7:00	74.77	3.19
125	72.05	3:00	68.92	7:00	70.89	3.13
126	76.11	3:00	72.93	7:00	74.93	3.18
127	0	3:00	-0.01	7:00	0	0.01
128	76.04	3:00	72.85	7:00	74.85	3.19
129	72.05	3:00	68.92	7:00	70.88	3.13
130	76.15	3:00	72.96	7:00	74.97	3.19
131	0	3:00	-0.01	7:00	0	0.01
132	75.31	3:00	72.12	7:00	74.13	3.19
133	72.05	3:00	68.92	7:00	70.88	3.13
134	74.77	3:00	71.58	7:00	73.59	3.19
135	0	3:00	-0.01	7:00	0	0.01
136	74.63	3:00	71.44	7:00	73.45	3.19
137	76.14	3:00	72.95	7:00	74.95	3.19
138	75.31	3:00	72.11	7:00	74.12	3.20
14	73.68	3:00	70.45	7:00	72.48	3.23
140	75.14	3:00	71.94	7:00	73.95	3.20
142	75.03	3:00	71.83	7:00	73.84	3.20
144	74.90	3:00	71.70	7:00	73.71	3.20
146	75.24	3:00	72.04	7:00	74.05	3.20
148	75.29	3:00	72.10	7:00	74.10	3.19
150	75.14	3:00	71.95	7:00	73.96	3.19
152	75.02	3:00	71.83	7:00	73.83	3.19
154	75.19	3:00	72.00	7:00	74.00	3.19
156	75.02	3:00	71.83	7:00	73.83	3.19
16	74.42	3:00	71.19	7:00	73.22	3.22
160	75.63	3:00	72.44	7:00	74.44	3.19
162	75.57	3:00	72.39	7:00	74.39	3.18
164	75.47	3:00	72.30	7:00	74.29	3.17
166	75.86	3:00	72.69	7:00	74.68	3.16
168	75.77	3:00	72.60	7:00	74.59	3.17
170	74.33	3:00	71.14	7:00	73.15	3.19
172	74.05	3:00	70.85	7:00	72.86	3.20
174	73.93	3:00	70.74	7:00	72.75	3.20
176	73.61	3:00	70.41	7:00	72.42	3.20
18	74.42	3:00	71.19	7:00	73.22	3.22
182	74.19	3:00	71.00	7:00	73.00	3.19
184	74.67	3:00	71.50	7:00	73.50	3.17
186	74.52	3:00	71.34	7:00	73.34	3.18
188	74.59	3:00	71.41	7:00	73.41	3.18
190	74.33	3:00	71.14	7:00	73.15	3.19
191	74.25	3:00	71.05	7:00	73.06	3.19
192	73.99	3:00	70.80	7:00	72.80	3.19
193	73.61	3:00	70.41	7:00	72.42	3.20
194	73.93	3:00	70.74	7:00	72.75	3.19
195	74.03	3:00	70.81	7:00	72.84	3.22
196	74.20	3:00	71.01	7:00	73.02	3.19
197	73.85	3:00	70.62	7:00	72.65	3.23
198	74.08	3:00	70.88	7:00	72.89	3.19
199	74.53	3:00	71.31	7:00	73.33	3.22
20	74.35	3:00	71.12	7:00	73.15	3.23
200	73.65	3:00	70.45	7:00	72.46	3.20
201	74.39	3:00	71.16	7:00	73.19	3.22
203	74.46	3:00	71.23	7:00	73.26	3.23
204	74.28	3:00	71.08	7:00	73.09	3.19
205	74.26	3:00	71.03	7:00	73.06	3.23
206	74.19	3:00	71.00	7:00	73.00	3.19
207	74.40	3:00	71.18	7:00	73.20	3.23
209	74.94	3:00	71.72	7:00	73.74	3.22
21	75.31	3:00	72.09	7:00	74.11	3.22
210	74.23	3:00	71.04	7:00	73.05	3.20
211	74.27	3:00	71.05	7:00	73.08	3.22
212	74.39	3:00	71.19	7:00	73.20	3.20
213	73.89	3:00	70.67	7:00	72.69	3.22
214	74.22	3:00	71.02	7:00	73.03	3.20
217	0	3:00	-0.01	7:00	0	0.01
219	72.05	3:00	68.92	7:00	70.89	3.13
22	74.53	3:00	71.30	7:00	73.33	3.23
220	73.72	3:00	70.52	7:00	72.53	3.20
221	72.05	3:00	68.92	7:00	70.89	3.13
223	0	3:00	-0.01	7:00	0	0.01
225	72.05	3:00	68.92	7:00	70.88	3.13
227	72.05	3:00	68.92	7:00	70.88	3.13
228	73.59	3:00	70.39	7:00	72.40	3.20
229	74.60	3:00	71.38	7:00	73.40	3.22

230	148.48	3:00	146.23	7:00	147.64	2.25
231	148.48	3:00	146.21	7:00	147.64	2.27
232	148.48	3:00	146.23	7:00	147.64	2.25
233	148.48	3:00	146.21	7:00	147.64	2.27
234	148.48	3:00	146.23	7:00	147.64	2.25
235	148.48	3:00	146.21	7:00	147.63	2.27
236	148.48	3:00	146.23	7:00	147.64	2.25
238	148.48	3:00	146.22	7:00	147.64	2.25
24	148.48	3:00	146.21	7:00	147.63	2.27
240	148.48	3:00	146.22	7:00	147.64	2.25
242	148.48	3:00	146.22	7:00	147.64	2.25
244	148.48	3:00	146.22	7:00	147.64	2.25
246	148.48	3:00	146.22	7:00	147.64	2.25
248	148.48	3:00	146.22	7:00	147.64	2.25
250	148.48	3:00	146.22	7:00	147.64	2.25
252	148.48	3:00	146.22	7:00	147.64	2.25
254	148.48	3:00	146.22	7:00	147.64	2.25
258	148.48	3:00	146.22	7:00	147.64	2.25
26	148.48	3:00	146.21	7:00	147.63	2.27
260	148.48	3:00	146.22	7:00	147.64	2.25
262	148.48	3:00	146.22	7:00	147.64	2.25
264	148.48	3:00	146.22	7:00	147.64	2.25
268	148.48	3:00	146.22	7:00	147.64	2.25
270	148.48	3:00	146.22	7:00	147.64	2.25
272	148.48	3:00	146.22	7:00	147.64	2.25
278	148.48	3:00	146.22	7:00	147.64	2.25
28	148.48	3:00	146.21	7:00	147.63	2.27
282	148.48	3:00	146.22	7:00	147.64	2.25
284	148.48	3:00	146.22	7:00	147.64	2.25
288	148.48	3:00	146.22	7:00	147.64	2.25
289	148.48	3:00	146.23	7:00	147.64	2.25
290	148.48	3:00	146.24	7:00	147.65	2.24
30	148.48	3:00	146.21	7:00	147.63	2.27
301	148.48	3:00	146.23	7:00	147.64	2.25
302	148.48	3:00	146.23	7:00	147.64	2.25
303	148.48	3:00	146.23	7:00	147.64	2.25
304	148.48	3:00	146.23	7:00	147.64	2.25
32	148.48	3:00	146.21	7:00	147.63	2.27
34	148.48	3:00	146.21	7:00	147.63	2.27
36	148.48	3:00	146.21	7:00	147.63	2.27
38	148.48	3:00	146.21	7:00	147.64	2.27
391	148.48	3:00	146.23	7:00	147.64	2.25
393	148.48	3:00	146.23	7:00	147.64	2.25
395	148.48	3:00	146.23	7:00	147.64	2.25
397	148.48	3:00	146.26	7:00	147.65	2.22
399	148.48	3:00	146.24	7:00	147.65	2.24
40	148.48	3:00	146.21	7:00	147.64	2.27
401	148.48	3:00	146.26	7:00	147.66	2.22
402	148.48	3:00	146.25	7:00	147.65	2.23
403	148.48	3:00	146.24	7:00	147.65	2.24
404	148.48	3:00	146.24	7:00	147.65	2.24
405	148.48	3:00	146.23	7:00	147.64	2.24
406	148.48	3:00	146.23	7:00	147.64	2.25
407	148.48	3:00	146.23	7:00	147.64	2.25
408	148.48	3:00	146.23	7:00	147.64	2.25
409	148.48	3:00	146.23	7:00	147.64	2.25
410	148.48	3:00	146.22	7:00	147.64	2.25
411	148.48	3:00	146.23	7:00	147.64	2.25
412	148.48	3:00	146.23	7:00	147.64	2.25
413	148.48	3:00	146.23	7:00	147.64	2.25
414	148.48	3:00	146.22	7:00	147.64	2.25
415	148.48	3:00	146.22	7:00	147.64	2.25
416	148.48	3:00	146.22	7:00	147.64	2.25
42	148.48	3:00	146.21	7:00	147.64	2.27
44	148.48	3:00	146.21	7:00	147.64	2.27
46	148.48	3:00	146.21	7:00	147.64	2.27
48	148.48	3:00	146.21	7:00	147.64	2.27
50	148.48	3:00	146.21	7:00	147.64	2.27
54	148.48	3:00	146.21	7:00	147.64	2.27
56	148.48	3:00	146.21	7:00	147.64	2.27
58	148.48	3:00	146.21	7:00	147.64	2.27
60	148.48	3:00	146.21	7:00	147.64	2.27
62	148.48	3:00	146.21	7:00	147.64	2.27
64	148.48	3:00	146.21	7:00	147.64	2.27
66	148.48	3:00	146.21	7:00	147.64	2.27
68	148.48	3:00	146.21	7:00	147.64	2.27
70	148.48	3:00	146.21	7:00	147.64	2.27
72	148.48	3:00	146.21	7:00	147.64	2.27
74	148.48	3:00	146.21	7:00	147.64	2.27
76	148.48	3:00	146.21	7:00	147.64	2.27
78	148.48	3:00	146.21	7:00	147.64	2.27
80	148.48	3:00	146.21	7:00	147.64	2.27
82	148.48	3:00	146.21	7:00	147.64	2.27
84	148.48	3:00	146.21	7:00	147.64	2.27
86	148.48	3:00	146.21	7:00	147.64	2.27
88	148.48	3:00	146.21	7:00	147.64	2.26
90	148.48	3:00	146.22	7:00	147.64	2.26
92	148.48	3:00	146.22	7:00	147.64	2.26
94	148.48	3:00	146.22	7:00	147.64	2.26
96	148.48	3:00	146.22	7:00	147.64	2.26
98	148.48	3:00	146.22	7:00	147.64	2.26

230	73.75	3:00	70.55	7:00	72.56	3.20
231	74.03	3:00	70.81	7:00	72.84	3.22
232	73.91	3:00	70.70	7:00	72.72	3.20
233	76.16	3:00	72.94	7:00	74.97	3.22
234	74.06	3:00	70.86	7:00	72.87	3.20
235	74.50	3:00	71.28	7:00	73.30	3.22
236	73.78	3:00	70.58	7:00	72.59	3.20
238	73.42	3:00	70.22	7:00	72.23	3.20
24	74.67	3:00	71.45	7:00	73.47	3.22
240	73.04	3:00	69.83	7:00	71.85	3.20
242	73.68	3:00	70.47	7:00	72.49	3.20
244	70.76	3:00	67.56	7:00	69.57	3.20
246	70.76	3:00	67.56	7:00	69.57	3.20
248	72.04	3:00	68.84	7:00	70.85	3.20
250	73.52	3:00	70.32	7:00	72.33	3.20
252	72.97	3:00	69.76	7:00	71.78	3.20
254	72.71	3:00	69.51	7:00	71.52	3.20
258	71.70	3:00	68.50	7:00	70.51	3.20
26	74.23	3:00	71.01	7:00	73.03	3.23
260	71.50	3:00	68.30	7:00	70.31	3.20
262	73.07	3:00	69.86	7:00	71.88	3.20
264	72.65	3:00	69.45	7:00	71.46	3.20
268	72.75	3:00	69.55	7:00	71.56	3.20
270	72.54	3:00	69.34	7:00	71.35	3.20
272	72.91	3:00	69.71	7:00	71.72	3.20
278	72.65	3:00	69.45	7:00	71.46	3.20
28	74.19	3:00	70.96	7:00	72.99	3.23
282	72.40	3:00	69.19	7:00	71.21	3.20
284	72.51	3:00	69.31	7:00	71.32	3.20
288	72.14	3:00	68.94	7:00	70.95	3.20
289	74.70	3:00	71.50	7:00	73.51	3.20
290	74.59	3:00	71.41	7:00	73.41	3.18
30	74.33	3:00	71.11	7:00	73.13	3.23
301	74.15	3:00	70.95	7:00	72.96	3.19
302	73.93	3:00	70.74	7:00	72.75	3.20
303	73.79	3:00	70.60	7:00	72.60	3.20
304	73.49	3:00	70.30	7:00	72.31	3.20
32	73.34	3:00	70.11	7:00	72.14	3.23
34	74.39	3:00	71.16	7:00	73.19	3.23
36	74.64	3:00	71.42	7:00	73.45	3.22
38	75.23	3:00	72.00	7:00	74.03	3.22
391	75.61	3:00	72.42	7:00	74.43	3.19
393	74.97	3:00	71.78	7:00	73.79	3.19
395	75.01	3:00	71.82	7:00	73.83	3.19
397	75.86	3:00	72.70	7:00	74.68	3.16
399	76.11	3:00	72.92	7:00	74.93	3.19
40	75.28	3:00	72.06	7:00	74.09	3.22
401	75.74	3:00	72.59	7:00	74.57	3.16
402	74.60	3:00	71.43	7:00	73.43	3.17
403	74.46	3:00	71.28	7:00	73.28	3.18
404	75.46	3:00	72.27	7:00	74.27	3.19
405	75.60	3:00	72.41	7:00	74.41	3.19
406	73.61	3:00	70.41	7:00	72.42	3.20
407	73.75	3:00	70.55	7:00	72.56	3.20
408	74.03	3:00	70.83	7:00	72.84	3.20
409	74.18	3:00	70.97	7:00	72.99	3.20
410	73.18	3:00	69.98	7:00	71.99	3.20
411	73.18	3:00	69.98	7:00	71.99	3.20
412	73.47	3:00	70.26	7:00	72.28	3.20
413	73.04	3:00	69.84	7:00	71.85	3.20
414	72.90	3:00	69.69	7:00	71.71	3.20
415	72.19	3:00	68.98	7:00	71.00	3.20
416	71.47	3:00	68.27	7:00	70.28	3.20
42	75.04	3:00	71.82	7:00	73.84	3.22
44	74.89	3:00	71.66	7:00	73.69	3.22
46	74.89	3:00	71.66	7:00	73.69	3.22
48	75.35	3:00	72.13	7:00	74.16	3.22
50	75.50	3:00	72.27	7:00	74.30	3.22
54	75.60	3:00	72.37	7:00	74.40	3.22
56	74.19	3:00	70.96	7:00	72.99	3.22
58	74.49	3:00	71.26	7:00	73.29	3.22
60	74.60	3:00	71.38	7:00	73.4	3.22
62	75.21	3:00	71.99	7:00	74.02	3.22
64	74.46	3:00	71.24	7:00	73.26	3.22
66	75.43	3:00	72.20	7:00	74.23	3.22
68	74.71	3:00	71.49	7:00	73.52	3.22
70	74.46	3:00	71.24	7:00	73.26	3.22
72	74.08	3:00	70.85	7:00	72.88	3.22
74	74.10	3:00	70.88	7:00	72.91	3.22
76	74.03	3:00	70.81	7:00	72.84	3.22
78	75.77	3:00	72.54	7:00	74.57	3.22
80	75.92	3:00	72.70	7:00	74.73	3.22
82	76.08	3:00	72.86	7:00	74.88	3.22
84	75.89	3:00	72.67	7:00	74.7	3.22
86	76.16	3:00	72.94	7:00	74.97	3.22
88	75.50	3:00	72.28	7:00	74.3	3.22
90	75.87	3:00	72.65	7:00	74.67	3.22
92	76.22	3:00	73.01	7:00	75.03	3.21
94	75.67	3:00	72.46	7:00	74.48	3.21
96	75.97	3:00	72.75	7:00	74.77	3.21
98	75.47	3:00	72.26	7:00	74.28	3.21

▨ Dummy PS nodes; results at these nodes not reported.

163401550 - Richmond Caivan Water Distribution System Analysis - Scope Change 1

Model Results - PKHR (Interim Conditions)

Head

ID	Max.Value (m)	Max.Time (hrs.)	Min.Value (m)	Min.Time (hrs.)	Average (m)	Difference (m)
Min			***143.93***			
Max	***148.77***					
100	148.76	3:00	143.99	20:00	147.55	4.77
102	148.76	3:00	143.97	20:00	147.54	4.79
104	148.76	3:00	143.96	20:00	147.54	4.80
106	148.76	3:00	143.95	20:00	147.54	4.81
108	148.76	3:00	143.96	20:00	147.54	4.81
110	148.76	3:00	144.00	20:00	147.55	4.76
112	148.76	3:00	144.01	20:00	147.55	4.75
114	148.76	3:00	144.02	20:00	147.56	4.74
116	148.76	3:00	144.03	20:00	147.56	4.74
117	148.77	3:00	144.22	20:00	147.61	4.55
118	148.76	3:00	144.04	20:00	147.56	4.72
119	148.77	3:00	144.25	20:00	147.62	4.52
120	148.77	3:00	144.06	20:00	147.57	4.71
121	148.77	3:00	144.25	20:00	147.62	4.52
122	148.77	3:00	144.09	20:00	147.58	4.67
123	148.77	3:00	144.25	20:00	147.62	4.52
124	148.77	3:00	144.09	20:00	147.58	4.67
125	148.77	3:00	144.25	20:00	147.62	4.52
126	148.77	3:00	144.10	20:00	147.58	4.67
127	97.80	3:00	97.79	20:00	97.80	0.01
128	148.77	3:00	144.08	20:00	147.57	4.69
129	148.77	3:00	144.25	20:00	147.62	4.52
130	148.77	3:00	144.07	20:00	147.57	4.70
131	97.80	3:00	97.79	20:00	97.80	0.01
132	148.77	3:00	144.08	20:00	147.57	4.69
133	148.77	3:00	144.25	20:00	147.62	4.52
134	148.77	3:00	144.07	20:00	147.57	4.69
135	97.80	3:00	97.79	20:00	97.80	0.01
136	148.77	3:00	144.07	20:00	147.57	4.70
137	148.77	3:00	144.08	20:00	147.57	4.68
138	148.76	3:00	144.03	20:00	147.56	4.74
14	148.76	3:00	143.93	20:00	147.53	4.83
140	148.76	3:00	144.03	20:00	147.56	4.74
142	148.76	3:00	144.03	20:00	147.56	4.74
144	148.76	3:00	144.03	20:00	147.56	4.73
146	148.76	3:00	144.04	20:00	147.56	4.73
148	148.77	3:00	144.09	20:00	147.57	4.68
150	148.77	3:00	144.09	20:00	147.58	4.68
152	148.77	3:00	144.09	20:00	147.58	4.68
154	148.77	3:00	144.10	20:00	147.58	4.67
156	148.77	3:00	144.11	20:00	147.58	4.65
16	148.76	3:00	143.93	20:00	147.53	4.83
160	148.77	3:00	144.11	20:00	147.58	4.66
162	148.77	3:00	144.13	20:00	147.59	4.64
164	148.77	3:00	144.15	20:00	147.59	4.62
166	148.77	3:00	144.17	20:00	147.60	4.60
168	148.77	3:00	144.15	20:00	147.59	4.62
170	148.77	3:00	144.12	20:00	147.58	4.65
18	148.76	3:00	143.93	20:00	147.53	4.83
182	148.77	3:00	144.12	20:00	147.58	4.65
184	148.77	3:00	144.19	20:00	147.60	4.58
188	148.77	3:00	144.17	20:00	147.60	4.60
190	148.77	3:00	144.15	20:00	147.59	4.61
191	148.77	3:00	144.15	20:00	147.59	4.61
193	148.77	3:00	144.13	20:00	147.59	4.63
194	148.77	3:00	144.12	20:00	147.58	4.65
195	148.76	3:00	143.95	20:00	147.54	4.81
196	148.77	3:00	144.15	20:00	147.59	4.62
197	148.76	3:00	143.93	20:00	147.53	4.83
198	148.77	3:00	144.14	20:00	147.59	4.62
199	148.76	3:00	143.94	20:00	147.53	4.83
20	148.76	3:00	143.93	20:00	147.53	4.83
200	148.77	3:00	144.13	20:00	147.59	4.63
201	148.76	3:00	143.94	20:00	147.53	4.83
203	148.76	3:00	143.93	20:00	147.53	4.83
204	148.77	3:00	144.14	20:00	147.59	4.62
205	148.76	3:00	143.93	20:00	147.53	4.83
206	148.77	3:00	144.14	20:00	147.59	4.62
207	148.76	3:00	143.93	20:00	147.53	4.83
209	148.76	3:00	143.93	20:00	147.53	4.83
21	148.76	3:00	143.94	20:00	147.53	4.82
211	148.76	3:00	143.93	20:00	147.53	4.83
212	148.77	3:00	144.13	20:00	147.59	4.63
213	148.76	3:00	143.94	20:00	147.53	4.83
214	148.77	3:00	144.13	20:00	147.59	4.64
217	97.80	3:00	97.79	20:00	97.80	0.01
219	148.77	3:00	144.25	20:00	147.62	4.52
22	148.76	3:00	143.93	20:00	147.53	4.83
220	148.77	3:00	144.12	20:00	147.58	4.64
221	148.77	3:00	144.25	20:00	147.62	4.52
223	97.80	3:00	97.79	20:00	97.80	0.01
225	148.77	3:00	144.25	20:00	147.62	4.52
227	148.77	3:00	144.25	20:00	147.62	4.52
229	148.76	3:00	143.93	20:00	147.53	4.83
231	148.76	3:00	143.93	20:00	147.53	4.83
233	148.76	3:00	143.94	20:00	147.54	4.82
234	148.77	3:00	144.13	20:00	147.58	4.64
235	148.76	3:00	143.93	20:00	147.53	4.83
24	148.76	3:00	143.93	20:00	147.53	4.83
26	148.76	3:00	143.93	20:00	147.53	4.83
28	148.76	3:00	143.93	20:00	147.53	4.83
289	148.76	3:00	144.03	20:00	147.56	4.74

Pressure

ID	Max.Value (psi)	Max.Time (hrs.)	Min.Value (psi)	Min.Time (hrs.)	Average (psi)	Difference (psi)
			65.99			
	76.79					
100	76.07	3:00	69.29	20:00	74.35	6.79
102	75.85	3:00	69.03	20:00	74.11	6.81
104	75.67	3:00	68.85	20:00	73.94	6.82
106	75.36	3:00	68.52	20:00	73.62	6.84
108	75.25	3:00	68.41	20:00	73.51	6.83
110	76.79	3:00	70.01	20:00	75.06	6.77
112	76.64	3:00	69.89	20:00	74.92	6.76
114	76.30	3:00	69.56	20:00	74.59	6.74
116	76.36	3:00	69.63	20:00	74.65	6.73
117	72.46	3:00	65.99	20:00	70.81	6.47
118	76.56	3:00	69.85	20:00	74.85	6.71
119	72.46	3:00	66.03	20:00	70.82	6.43
120	75.85	3:00	69.16	20:00	74.15	6.69
121	72.46	3:00	66.04	20:00	70.82	6.42
122	75.96	3:00	69.32	20:00	74.27	6.64
123	72.46	3:00	66.03	20:00	70.82	6.43
124	76.36	3:00	69.72	20:00	74.67	6.64
125	72.46	3:00	66.04	20:00	70.82	6.42
126	76.52	3:00	69.88	20:00	74.83	6.64
127	0	3:00	-0.02	20:00	-0.01	0.02
128	76.45	3:00	69.78	20:00	74.75	6.67
129	72.46	3:00	66.03	20:00	70.82	6.43
130	76.56	3:00	69.88	20:00	74.86	6.68
131	0	3:00	-0.02	20:00	0	0.02
132	75.72	3:00	69.06	20:00	74.03	6.67
133	72.46	3:00	66.03	20:00	70.82	6.43
134	75.18	3:00	68.51	20:00	73.48	6.67
135	0	3:00	-0.02	20:00	0	0.02
136	75.04	3:00	68.36	20:00	73.34	6.68
137	76.55	3:00	69.89	20:00	74.85	6.65
138	75.72	3:00	68.98	20:00	74.01	6.74
14	74.08	3:00	67.21	20:00	72.33	6.87
140	75.55	3:00	68.81	20:00	73.84	6.74
142	75.44	3:00	68.70	20:00	73.72	6.73
144	75.31	3:00	68.58	20:00	73.60	6.73
146	75.65	3:00	68.93	20:00	73.94	6.72
148	75.69	3:00	69.04	20:00	74.00	6.65
150	75.55	3:00	68.90	20:00	73.86	6.65
152	75.42	3:00	68.78	20:00	73.73	6.65
154	75.59	3:00	68.96	20:00	73.90	6.64
156	75.42	3:00	68.81	20:00	73.74	6.62
16	74.82	3:00	67.95	20:00	73.07	6.87
160	76.04	3:00	69.41	20:00	74.35	6.62
162	75.98	3:00	69.39	20:00	74.30	6.59
164	75.88	3:00	69.32	20:00	74.21	6.56
166	76.27	3:00	69.73	20:00	74.60	6.54
168	76.18	3:00	69.61	20:00	74.51	6.57
170	74.74	3:00	68.13	20:00	73.06	6.61
18	74.82	3:00	67.95	20:00	73.07	6.87
182	74.60	3:00	67.99	20:00	72.92	6.61
184	75.09	3:00	68.58	20:00	73.43	6.51
188	75.00	3:00	68.46	20:00	73.33	6.54
190	74.74	3:00	68.19	20:00	73.07	6.56
191	74.66	3:00	68.10	20:00	72.99	6.56
193	74.02	3:00	67.43	20:00	72.34	6.59
194	74.34	3:00	67.74	20:00	72.66	6.61
195	74.44	3:00	67.60	20:00	72.70	6.84
196	74.62	3:00	68.05	20:00	72.94	6.57
197	74.25	3:00	67.38	20:00	72.50	6.87
198	74.49	3:00	67.92	20:00	72.81	6.57
199	74.93	3:00	68.07	20:00	73.19	6.86
20	74.75	3:00	67.88	20:00	73.00	6.87
200	74.06	3:00	67.48	20:00	72.38	6.59
201	74.79	3:00	67.93	20:00	73.05	6.86
203	74.86	3:00	67.99	20:00	73.11	6.87
204	74.69	3:00	68.11	20:00	73.01	6.57
205	74.66	3:00	67.79	20:00	72.92	6.87
206	74.60	3:00	68.03	20:00	72.93	6.57
207	74.81	3:00	67.94	20:00	73.06	6.87
209	75.35	3:00	68.48	20:00	73.60	6.87
21	75.72	3:00	68.86	20:00	73.97	6.86
211	74.68	3:00	67.81	20:00	72.93	6.87
212	74.80	3:00	68.21	20:00	73.12	6.59
213	74.29	3:00	67.44	20:00	72.55	6.86
214	74.63	3:00	68.04	20:00	72.95	6.59
217	0	3:00	-0.02	20:00	-0.01	0.02
219	72.46	3:00	66.04	20:00	70.82	6.42
22	74.93	3:00	68.06	20:00	73.19	6.87
220	74.13	3:00	67.53	20:00	72.45	6.60
221	72.46	3:00	66.04	20:00	70.82	6.42
223	0	3:00	-0.02	20:00	0	0.02
225	72.46	3:00	66.03	20:00	70.82	6.43
227	72.46	3:00	66.03	20:00	70.82	6.43
229	75.01	3:00	68.14	20:00	73.26	6.87
231	74.44	3:00	67.57	20:00	72.69	6.86
233	76.57	3:00	69.72	20:00	74.83	6.85
234	74.47	3:00	67.88	20:00	72.79	6.60
235	74.91	3:00	68.03	20:00	73.16	6.87
24	75.08	3:00	68.21	20:00	73.33	6.87
26	74.64	3:00	67.76	20:00	72.89	6.87
28	74.59	3:00	67.72	20:00	72.84	6.87
289	75.11	3:00	68.37	20:00	73.39	6.74

290	148.77	3:00	144.18	20:00	147.60	4.59
30	148.76	3:00	143.93	20:00	147.53	4.83
301	148.77	3:00	144.14	20:00	147.59	4.62
302	148.77	3:00	144.14	20:00	147.59	4.63
303	148.77	3:00	144.14	20:00	147.59	4.63
304	148.77	3:00	144.14	20:00	147.59	4.63
32	148.76	3:00	143.93	20:00	147.53	4.83
34	148.76	3:00	143.93	20:00	147.53	4.83
36	148.76	3:00	143.94	20:00	147.53	4.83
38	148.76	3:00	143.94	20:00	147.53	4.83
391	148.77	3:00	144.07	20:00	147.57	4.70
393	148.77	3:00	144.07	20:00	147.57	4.70
395	148.77	3:00	144.07	20:00	147.57	4.70
397	148.77	3:00	144.18	20:00	147.60	4.59
399	148.77	3:00	144.09	20:00	147.58	4.67
40	148.76	3:00	143.94	20:00	147.53	4.82
401	148.77	3:00	144.20	20:00	147.60	4.57
411	148.77	3:00	144.13	20:00	147.59	4.64
412	148.77	3:00	144.13	20:00	147.59	4.64
42	148.76	3:00	143.94	20:00	147.53	4.82
44	148.76	3:00	143.94	20:00	147.53	4.83
46	148.76	3:00	143.94	20:00	147.53	4.83
48	148.76	3:00	143.94	20:00	147.53	4.82
50	148.76	3:00	143.94	20:00:00	147.53	4.82
54	148.76	3:00	143.94	20:00	147.54	4.82
56	148.76	3:00	143.94	20:00	147.53	4.83
58	148.76	3:00:00	143.94	20:00	147.53	4.82
60	148.76	3:00	143.94	20:00:00	147.53	4.82
62	148.76	3:00	143.94	20:00	147.53	4.82
64	148.76	3:00	143.94	20:00	147.54	4.82
66	148.76	3:00	143.94	20:00	147.53	4.82
68	148.76	3:00:00	143.94	20:00	147.53	4.82
70	148.76	3:00	143.94	20:00	147.54	4.82
72	148.76	3:00	143.94	20:00	147.53	4.82
74	148.76	3:00:00	143.95	20:00	147.54	4.81
76	148.76	3:00	143.95	20:00	147.54	4.81
78	148.76	3:00:00	143.94	20:00	147.54	4.82
80	148.76	3:00	143.94	20:00	147.54	4.82
82	148.76	3:00	143.95	20:00	147.54	4.82
84	148.76	3:00	143.95	20:00	147.54	4.82
86	148.76	3:00	143.94	20:00	147.54	4.82
88	148.76	3:00	143.95	20:00	147.54	4.81
90	148.76	3:00	143.97	20:00	147.54	4.8
92	148.76	3:00	143.99	20:00:00	147.55	4.77
94	148.76	3:00	144.00	20:00	147.55	4.76
96	148.76	3:00	143.98	20:00:00	147.55	4.78
98	148.76	3:00	143.98	20:00:00	147.55	4.78

290	75.00	3:00	68.47	20:00	73.34	6.53
30	74.74	3:00	67.87	20:00	72.99	6.87
301	74.56	3:00	67.98	20:00	72.88	6.57
302	74.35	3:00	67.77	20:00	72.67	6.58
303	74.20	3:00	67.62	20:00	72.53	6.58
304	73.90	3:00	67.32	20:00	72.23	6.58
32	73.74	3:00	66.87	20:00	71.99	6.87
34	74.79	3:00	67.92	20:00	73.04	6.87
36	75.05	3:00	68.19	20:00	73.30	6.86
38	75.63	3:00	68.77	20:00	73.89	6.86
391	76.02	3:00	69.34	20:00	74.32	6.68
393	75.38	3:00	68.70	20:00	73.68	6.68
395	75.42	3:00	68.75	20:00	73.72	6.68
397	76.27	3:00	69.74	20:00	74.60	6.52
399	76.52	3:00	69.88	20:00	74.83	6.64
40	75.69	3:00	68.83	20:00	73.94	6.86
401	76.15	3:00	69.66	20:00	74.50	6.49
411	73.59	3:00	67.00	20:00	71.91	6.59
412	73.88	3:00	67.28	20:00	72.2	6.59
42	75.45	3:00	68.59	20:00	73.7	6.86
44	75.29	3:00	68.43	20:00	73.54	6.86
46	75.29	3:00	68.43	20:00	73.54	6.86
48	75.76	3:00	68.90	20:00	74.01	6.85
50	75.90	3:00	69.05	20:00:00	74.16	6.85
54	76.00	3:00	69.15	20:00	74.26	6.85
56	74.59	3:00	67.73	20:00	72.85	6.86
58	74.89	3:00:00	68.03	20:00	73.15	6.86
60	75.01	3:00	68.15	20:00:00	73.26	6.86
62	75.62	3:00	68.76	20:00	73.87	6.85
64	74.86	3:00	68.01	20:00	73.12	6.85
66	75.83	3:00	68.98	20:00	74.09	6.85
68	75.12	3:00:00	68.26	20:00	73.37	6.86
70	74.86	3:00	68.01	20:00	73.12	6.85
72	74.48	3:00	67.62	20:00	72.73	6.86
74	74.51	3:00:00	67.67	20:00	72.77	6.84
76	74.44	3:00	67.59	20:00	72.70	6.84
78	76.17	3:00:00	69.32	20:00	74.43	6.85
80	76.33	3:00	69.48	20:00	74.58	6.85
82	76.48	3:00	69.64	20:00	74.74	6.85
84	76.30	3:00	69.45	20:00	74.56	6.85
86	76.57	3:00	69.72	20:00	74.83	6.85
88	75.90	3:00	69.07	20:00	74.16	6.84
90	76.27	3:00	69.45	20:00	74.54	6.82
92	76.63	3:00	69.85	20:00:00	74.90	6.78
94	76.07	3:00	69.31	20:00	74.35	6.77
96	76.37	3:00	69.58	20:00:00	74.64	6.8
98	75.87	3:00	69.08	20:00:00	74.15	6.79

▨ Dummy PS nodes; results at these nodes not reported.

163401550 - Richmond Caivan Water Distribution System Analysis - Scope Change 1

Model Results - PKHR (Buildout Conditions)

Head

Min			***131.65***			
Max	***148.53***					
ID	Max.Value (m)	Max.Time (hrs.)	Min.Value (m)	Min.Time (hrs.)	Average (m)	Difference (m)
10	148.52	3:00	131.74	20:00	145.32	16.78
100	148.51	3:00	131.71	20:00	145.31	16.80
102	148.51	3:00	131.69	20:00	145.31	16.82
104	148.51	3:00	131.69	20:00	145.30	16.83
106	148.51	3:00	131.68	20:00	145.30	16.84
108	148.51	3:00	131.68	20:00	145.30	16.84
110	148.51	3:00	131.73	20:00	145.31	16.79
112	148.52	3:00	131.74	20:00	145.32	16.78
114	148.52	3:00	131.75	20:00	145.32	16.77
116	148.52	3:00	131.76	20:00	145.32	16.76
117	148.52	3:00	132.05	20:00	145.40	16.47
118	148.52	3:00	131.77	20:00	145.33	16.74
119	148.53	3:00	132.12	20:00	145.42	16.40
120	148.52	3:00	131.78	20:00	145.33	16.73
121	148.53	3:00	132.13	20:00	145.42	16.40
122	148.52	3:00	131.81	20:00	145.34	16.70
123	148.53	3:00	132.12	20:00	145.42	16.40
124	148.52	3:00	131.82	20:00	145.34	16.70
125	148.53	3:00	132.13	20:00	145.42	16.40
126	148.52	3:00	131.83	20:00	145.34	16.69
127	97.80	3:00	97.77	20:00	97.79	0.03
128	148.52	3:00	131.81	20:00	145.34	16.71
129	148.53	3:00	132.12	20:00	145.42	16.40
130	148.52	3:00	131.80	20:00	145.33	16.72
131	97.80	3:00	97.77	20:00	97.79	0.03
132	148.52	3:00	131.80	20:00	145.33	16.72
133	148.53	3:00	132.12	20:00	145.42	16.40
134	148.52	3:00	131.79	20:00	145.33	16.73
135	97.80	3:00	97.77	20:00	97.79	0.03
136	148.52	3:00	131.79	20:00	145.33	16.73
137	148.52	3:00	131.82	20:00	145.34	16.70
138	148.52	3:00	131.75	20:00	145.32	16.77
14	148.51	3:00	131.65	20:00	145.29	16.86
140	148.52	3:00	131.75	20:00	145.32	16.77
142	148.52	3:00	131.75	20:00	145.32	16.77
144	148.52	3:00	131.75	20:00	145.32	16.76
146	148.52	3:00	131.76	20:00	145.32	16.75
148	148.52	3:00	131.80	20:00	145.33	16.72
150	148.52	3:00	131.80	20:00	145.33	16.72
152	148.52	3:00	131.80	20:00	145.33	16.72
154	148.52	3:00	131.81	20:00	145.34	16.71
156	148.52	3:00	131.82	20:00	145.34	16.70
16	148.51	3:00	131.65	20:00	145.29	16.86
160	148.52	3:00	131.82	20:00	145.34	16.70
162	148.52	3:00	131.87	20:00	145.35	16.65
164	148.52	3:00	131.91	20:00	145.36	16.61
166	148.52	3:00	131.95	20:00	145.37	16.57
168	148.52	3:00	131.90	20:00	145.36	16.62
170	148.52	3:00	131.80	20:00	145.33	16.72
172	148.52	3:00	131.78	20:00	145.33	16.74
174	148.52	3:00	131.77	20:00	145.33	16.75
176	148.52	3:00	131.75	20:00	145.32	16.76
18	148.51	3:00	131.65	20:00	145.29	16.86
182	148.52	3:00	131.79	20:00	145.33	16.72
184	148.52	3:00	131.90	20:00	145.36	16.62
186	148.52	3:00	131.87	20:00	145.35	16.65
188	148.52	3:00	131.84	20:00	145.34	16.68
190	148.52	3:00	131.79	20:00	145.33	16.72
191	148.52	3:00	131.79	20:00	145.33	16.73
192	148.52	3:00	131.78	20:00	145.33	16.73
193	148.52	3:00	131.76	20:00	145.32	16.76
194	148.52	3:00	131.78	20:00	145.33	16.74
195	148.51	3:00	131.67	20:00	145.30	16.84
196	148.52	3:00	131.79	20:00	145.33	16.73
197	148.51	3:00	131.65	20:00	145.29	16.86
198	148.52	3:00	131.78	20:00	145.33	16.74
199	148.51	3:00	131.66	20:00	145.30	16.86
20	148.51	3:00	131.65	20:00	145.29	16.86
200	148.52	3:00	131.76	20:00	145.32	16.75
201	148.51	3:00	131.66	20:00	145.30	16.85
203	148.51	3:00	131.65	20:00	145.29	16.86
204	148.52	3:00	131.78	20:00	145.33	16.74
205	148.51	3:00	131.65	20:00	145.29	16.86
206	148.52	3:00	131.78	20:00	145.33	16.74
207	148.51	3:00	131.65	20:00	145.29	16.86
209	148.51	3:00	131.65	20:00	145.29	16.86
21	148.51	3:00	131.66	20:00	145.30	16.85
210	148.52	3:00	131.77	20:00	145.33	16.75
211	148.51	3:00	131.65	20:00	145.29	16.86
212	148.52	3:00	131.76	20:00	145.32	16.76
213	148.51	3:00	131.66	20:00	145.30	16.85
214	148.52	3:00	131.75	20:00	145.32	16.77
217	97.80	3:00	97.77	20:00	97.79	0.03
219	148.53	3:00	132.13	20:00	145.42	16.40
22	148.51	3:00	131.65	20:00	145.29	16.86
220	148.52	3:00	131.76	20:00	145.32	16.76
221	148.53	3:00	132.13	20:00	145.42	16.40
223	97.80	3:00	97.77	20:00	97.79	0.03
225	148.53	3:00	132.12	20:00	145.42	16.40
227	148.53	3:00	132.12	20:00	145.42	16.40
228	148.52	3:00	131.74	20:00	145.32	16.77
229	148.51	3:00	131.65	20:00	145.29	16.86

Pressure

			46.95			
	76.43					
ID	Max.Value (psi)	Max.Time (hrs.)	Min.Value (psi)	Min.Time (hrs.)	Average (psi)	Difference (psi)
10	73.93	3:00	50.08	20:00	69.38	23.85
100	75.72	3:00	51.83	20:00	71.17	23.89
102	75.49	3:00	51.58	20:00	70.93	23.91
104	75.32	3:00	51.40	20:00	70.76	23.92
106	75.01	3:00	51.07	20:00	70.44	23.94
108	74.89	3:00	50.96	20:00	70.33	23.93
110	76.43	3:00	52.56	20:00	71.88	23.87
112	76.29	3:00	52.44	20:00	71.74	23.85
114	75.95	3:00	52.11	20:00	71.41	23.84
116	76.01	3:00	52.18	20:00	71.47	23.83
117	72.11	3:00	48.70	20:00	67.67	23.41
118	76.21	3:00	52.40	20:00	71.67	23.80
119	72.11	3:00	48.79	20:00	67.69	23.32
120	75.50	3:00	51.71	20:00	70.96	23.79
121	72.11	3:00	48.80	20:00	67.70	23.31
122	75.61	3:00	51.87	20:00	71.09	23.74
123	72.11	3:00	48.79	20:00	67.69	23.32
124	76.01	3:00	52.27	20:00	71.49	23.74
125	72.11	3:00	48.80	20:00	67.70	23.31
126	76.17	3:00	52.44	20:00	71.65	23.72
127	0	3:00	-0.05	20:00	-0.01	0.05
128	76.09	3:00	52.34	20:00	71.57	23.76
129	72.11	3:00	48.79	20:00	67.69	23.32
130	76.21	3:00	52.44	20:00	71.68	23.76
131	0	3:00	-0.04	20:00	-0.01	0.04
132	75.37	3:00	51.60	20:00	70.84	23.77
133	72.11	3:00	48.79	20:00	67.69	23.32
134	74.83	3:00	51.05	20:00	70.30	23.78
135	0	3:00	-0.04	20:00	-0.01	0.04
136	74.69	3:00	50.90	20:00	70.16	23.78
137	76.19	3:00	52.45	20:00	71.67	23.74
138	75.37	3:00	51.53	20:00	70.83	23.83
14	73.73	3:00	49.76	20:00	69.15	23.97
140	75.20	3:00	51.36	20:00	70.65	23.83
142	75.08	3:00	51.25	20:00	70.54	23.83
144	74.95	3:00	51.13	20:00	70.41	23.83
146	75.30	3:00	51.48	20:00	70.76	23.82
148	75.34	3:00	51.57	20:00	70.82	23.77
150	75.20	3:00	51.43	20:00	70.67	23.76
152	75.07	3:00	51.31	20:00	70.55	23.76
154	75.24	3:00	51.48	20:00	70.72	23.76
156	75.07	3:00	51.33	20:00	70.55	23.74
16	74.47	3:00	50.50	20:00	69.89	23.97
160	75.68	3:00	51.95	20:00	71.16	23.74
162	75.63	3:00	51.96	20:00	71.13	23.66
164	75.53	3:00	51.92	20:00	71.04	23.61
166	75.91	3:00	52.36	20:00	71.44	23.56
168	75.83	3:00	52.20	20:00	71.34	23.62
170	74.39	3:00	50.62	20:00	69.86	23.77
172	74.10	3:00	50.30	20:00	69.57	23.80
174	73.99	3:00	50.18	20:00	69.45	23.81
176	73.66	3:00	49.83	20:00	69.12	23.83
18	74.47	3:00	50.50	20:00	69.89	23.97
182	74.25	3:00	50.47	20:00	69.72	23.78
184	74.73	3:00	51.10	20:00	70.24	23.63
186	74.57	3:00	50.90	20:00	70.07	23.67
188	74.64	3:00	50.93	20:00	70.13	23.72
190	74.39	3:00	50.62	20:00	69.86	23.77
191	74.30	3:00	50.52	20:00	69.77	23.78
192	74.05	3:00	50.26	20:00	69.51	23.79
193	73.66	3:00	49.84	20:00	69.12	23.82
194	73.99	3:00	50.20	20:00	69.46	23.79
195	74.08	3:00	50.14	20:00	69.51	23.94
196	74.26	3:00	50.47	20:00	69.73	23.79
197	73.90	3:00	49.93	20:00	69.32	23.97
198	74.13	3:00	50.34	20:00	69.60	23.79
199	74.58	3:00	50.62	20:00	70.01	23.96
20	74.40	3:00	50.42	20:00	69.82	23.97
200	73.70	3:00	49.89	20:00	69.17	23.82
201	74.44	3:00	50.48	20:00	69.86	23.96
203	74.51	3:00	50.54	20:00	69.93	23.97
204	74.33	3:00	50.54	20:00	69.80	23.79
205	74.31	3:00	50.34	20:00	69.73	23.97
206	74.24	3:00	50.45	20:00	69.71	23.79
207	74.45	3:00	50.48	20:00	69.88	23.97
209	74.99	3:00	51.02	20:00	70.42	23.97
21	75.36	3:00	51.40	20:00	70.79	23.96
210	74.29	3:00	50.48	20:00	69.75	23.81
211	74.32	3:00	50.36	20:00	69.75	23.97
212	74.44	3:00	50.62	20:00	69.90	23.82
213	73.94	3:00	49.98	20:00	69.37	23.96
214	74.27	3:00	50.44	20:00	69.73	23.84
217	0	3:00	-0.05	20:00	-0.01	0.05
219	72.11	3:00	48.80	20:00	67.70	23.31
22	74.58	3:00	50.61	20:00	70.00	23.97
220	73.77	3:00	49.95	20:00	69.24	23.82
221	72.11	3:00	48.80	20:00	67.70	23.31
223	0	3:00	-0.04	20:00	-0.01	0.04
225	72.11	3:00	48.79	20:00	67.69	23.32
227	72.11	3:00	48.79	20:00	67.69	23.32
228	73.65	3:00	49.80	20:00	69.10	23.85
229	74.65	3:00	50.68	20:00	70.08	23.97

230	148.52	3:00	131.74	20:00	145.32	16.77
231	148.51	3:00	131.66	20:00	145.30	16.86
232	148.52	3:00	131.74	20:00	145.32	16.77
233	148.51	3:00	131.66	20:00	145.30	16.85
234	148.52	3:00	131.75	20:00	145.32	16.77
235	148.51	3:00	131.65	20:00	145.29	16.86
236	148.52	3:00	131.74	20:00	145.32	16.78
238	148.52	3:00	131.73	20:00	145.32	16.79
24	148.51	3:00	131.65	20:00	145.29	16.86
240	148.52	3:00	131.73	20:00	145.32	16.79
242	148.52	3:00	131.73	20:00	145.32	16.79
244	148.52	3:00	131.73	20:00	145.32	16.79
246	148.52	3:00	131.73	20:00	145.31	16.79
248	148.52	3:00	131.73	20:00	145.32	16.79
250	148.52	3:00	131.73	20:00	145.32	16.78
252	148.52	3:00	131.73	20:00	145.32	16.79
254	148.52	3:00	131.73	20:00	145.32	16.79
258	148.52	3:00	131.73	20:00	145.31	16.79
26	148.51	3:00	131.65	20:00	145.29	16.86
260	148.52	3:00	131.73	20:00	145.31	16.79
262	148.52	3:00	131.73	20:00	145.32	16.79
264	148.52	3:00	131.73	20:00	145.32	16.79
268	148.52	3:00	131.73	20:00	145.32	16.79
270	148.52	3:00	131.73	20:00	145.32	16.79
272	148.52	3:00	131.73	20:00	145.32	16.79
278	148.52	3:00	131.73	20:00	145.32	16.79
28	148.51	3:00	131.65	20:00	145.29	16.86
282	148.52	3:00	131.73	20:00	145.32	16.79
284	148.52	3:00	131.73	20:00	145.32	16.79
288	148.52	3:00	131.73	20:00	145.32	16.79
289	148.52	3:00	131.75	20:00	145.32	16.77
290	148.52	3:00	131.85	20:00	145.35	16.66
30	148.51	3:00	131.65	20:00	145.29	16.86
301	148.52	3:00	131.78	20:00	145.33	16.74
302	148.52	3:00	131.77	20:00	145.33	16.74
303	148.52	3:00	131.77	20:00	145.33	16.75
304	148.52	3:00	131.76	20:00	145.32	16.75
32	148.51	3:00	131.65	20:00	145.29	16.86
34	148.51	3:00	131.65	20:00	145.29	16.86
36	148.51	3:00	131.66	20:00	145.30	16.86
38	148.51	3:00	131.66	20:00	145.30	16.85
391	148.52	3:00	131.78	20:00	145.33	16.73
393	148.52	3:00	131.79	20:00	145.33	16.73
395	148.52	3:00	131.79	20:00	145.33	16.73
397	148.52	3:00	131.98	20:00	145.38	16.54
399	148.52	3:00	131.83	20:00	145.34	16.69
40	148.51	3:00	131.66	20:00	145.30	16.85
401	148.52	3:00	131.98	20:00	145.38	16.54
402	148.52	3:00	131.90	20:00	145.36	16.62
403	148.52	3:00	131.84	20:00	145.34	16.68
404	148.52	3:00	131.81	20:00	145.34	16.70
405	148.52	3:00	131.80	20:00	145.33	16.71
406	148.52	3:00	131.74	20:00	145.32	16.78
407	148.52	3:00	131.74	20:00	145.32	16.78
408	148.52	3:00	131.74	20:00	145.32	16.77
409	148.52	3:00	131.74	20:00	145.32	16.78
410	148.52	3:00	131.73	20:00	145.32	16.79
411	148.52	3:00	131.74	20:00	145.32	16.78
412	148.52	3:00	131.74	20:00	145.32	16.78
413	148.52	3:00	131.74	20:00	145.32	16.78
414	148.52	3:00	131.73	20:00	145.32	16.78
415	148.52	3:00	131.73	20:00	145.32	16.79
416	148.52	3:00	131.73	20:00	145.31	16.79
42	148.51	3:00	131.66	20:00	145.30	16.85
44	148.51	3:00	131.66	20:00	145.30	16.85
46	148.51	3:00	131.66	20:00	145.30	16.86
48	148.51	3:00	131.66	20:00	145.30	16.85
50	148.51	3:00	131.66	20:00	145.30	16.85
54	148.51	3:00	131.66	20:00	145.30	16.85
56	148.51	3:00	131.66	20:00	145.30	16.85
58	148.51	3:00	131.66	20:00	145.30	16.85
60	148.51	3:00	131.66	20:00:00	145.3	16.85
62	148.51	3:00	131.66	20:00:00	145.3	16.85
64	148.51	3:00:00	131.67	20:00:00	145.3	16.85
66	148.51	3:00	131.66	20:00:00	145.3	16.85
68	148.51	3:00	131.66	20:00:00	145.3	16.85
70	148.51	3:00	131.66	20:00:00	145.3	16.85
72	148.51	3:00	131.66	20:00:00	145.3	16.85
74	148.51	3:00:00	131.67	20:00:00	145.3	16.84
76	148.51	3:00	131.67	20:00:00	145.3	16.84
78	148.51	3:00	131.66	20:00:00	145.3	16.85
80	148.51	3:00	131.67	20:00:00	145.3	16.85
82	148.51	3:00	131.67	20:00:00	145.3	16.84
84	148.51	3:00	131.67	20:00:00	145.3	16.84
86	148.51	3:00:00	131.67	20:00:00	145.3	16.85
88	148.51	3:00	131.68	20:00:00	145.3	16.84
90	148.51	3:00	131.69	20:00:00	145.3	16.82
92	148.51	3:00	131.72	20:00:00	145.31	16.8
94	148.51	3:00	131.73	20:00:00	145.31	16.79
96	148.51	3:00	131.71	20:00:00	145.31	16.81
98	148.51	3:00	131.71	20:00:00	145.31	16.81

230	73.80	3:00	49.96	20:00	69.26	23.85
231	74.08	3:00	50.12	20:00	69.51	23.96
232	73.96	3:00	50.12	20:00	69.42	23.84
233	76.22	3:00	52.26	20:00	71.64	23.95
234	74.12	3:00	50.28	20:00	69.57	23.84
235	74.55	3:00	50.58	20:00	69.98	23.97
236	73.83	3:00	49.98	20:00	69.29	23.85
238	73.48	3:00	49.61	20:00	68.93	23.86
24	74.72	3:00	50.75	20:00	70.15	23.97
240	73.09	3:00	49.23	20:00	68.54	23.86
242	73.73	3:00	49.87	20:00	69.18	23.86
244	70.82	3:00	46.95	20:00	66.27	23.86
246	70.82	3:00	46.95	20:00	66.27	23.87
248	72.10	3:00	48.23	20:00	67.55	23.87
250	73.57	3:00	49.72	20:00	69.03	23.86
252	73.02	3:00	49.16	20:00	68.47	23.86
254	72.76	3:00	48.90	20:00	68.22	23.87
258	71.75	3:00	47.89	20:00	67.21	23.87
26	74.28	3:00	50.31	20:00	69.71	23.97
260	71.56	3:00	47.69	20:00	67.01	23.87
262	73.12	3:00	49.26	20:00	68.57	23.86
264	72.71	3:00	48.84	20:00	68.16	23.87
268	72.81	3:00	48.94	20:00	68.26	23.86
270	72.59	3:00	48.73	20:00	68.04	23.87
272	72.96	3:00	49.10	20:00	68.41	23.86
278	72.71	3:00	48.84	20:00	68.16	23.86
28	74.24	3:00	50.27	20:00	69.66	23.97
282	72.45	3:00	48.59	20:00	67.90	23.87
284	72.57	3:00	48.70	20:00	68.02	23.87
288	72.20	3:00	48.33	20:00	67.65	23.87
289	74.76	3:00	50.92	20:00	70.21	23.83
290	74.65	3:00	50.96	20:00	70.14	23.69
30	74.38	3:00	50.41	20:00	69.81	23.97
301	74.20	3:00	50.41	20:00	69.67	23.80
302	73.99	3:00	50.19	20:00	69.45	23.80
303	73.85	3:00	50.04	20:00	69.31	23.81
304	73.55	3:00	49.73	20:00	69.01	23.81
32	73.39	3:00	49.42	20:00	68.81	23.97
34	74.44	3:00	50.47	20:00	69.86	23.97
36	74.69	3:00	50.73	20:00	70.12	23.96
38	75.28	3:00	51.32	20:00	70.70	23.96
391	75.67	3:00	51.88	20:00	71.14	23.79
393	75.03	3:00	51.24	20:00	70.50	23.78
395	75.07	3:00	51.29	20:00	70.54	23.78
397	75.91	3:00	52.40	20:00	71.45	23.52
399	76.17	3:00	52.44	20:00	71.65	23.73
40	75.33	3:00	51.38	20:00	70.76	23.96
401	75.80	3:00	52.29	20:00	71.34	23.52
402	74.66	3:00	51.03	20:00	70.17	23.63
403	74.52	3:00	50.81	20:00	70.01	23.71
404	75.51	3:00	51.77	20:00	70.99	23.75
405	75.65	3:00	51.89	20:00	71.13	23.76
406	73.66	3:00	49.81	20:00	69.12	23.85
407	73.80	3:00	49.95	20:00	69.26	23.85
408	74.09	3:00	50.24	20:00	69.54	23.85
409	74.23	3:00	50.38	20:00	69.68	23.85
410	73.23	3:00	49.37	20:00	68.69	23.86
411	73.23	3:00	49.38	20:00	68.69	23.85
412	73.52	3:00	49.67	20:00	68.97	23.85
413	73.09	3:00	49.24	20:00	68.55	23.85
414	72.95	3:00	49.09	20:00	68.40	23.86
415	72.24	3:00	48.37	20:00	67.69	23.87
416	71.53	3:00	47.66	20:00	66.98	23.87
42	75.09	3:00	51.14	20:00	70.52	23.96
44	74.94	3:00	50.98	20:00	70.36	23.96
46	74.94	3:00	50.98	20:00	70.36	23.96
48	75.41	3:00	51.45	20:00	70.83	23.95
50	75.55	3:00	51.60	20:00	70.98	23.95
54	75.65	3:00	51.70	20:00	71.08	23.95
56	74.24	3:00	50.28	20:00	69.67	23.96
58	74.54	3:00	50.58	20:00	69.96	23.96
60	74.65	3:00	50.69	20:00:00	70.08	23.96
62	75.26	3:00	51.31	20:00:00	70.69	23.95
64	74.51	3:00:00	50.56	20:00:00	69.94	23.95
66	75.48	3:00	51.52	20:00:00	70.9	23.95
68	74.77	3:00	50.81	20:00:00	70.19	23.96
70	74.51	3:00	50.56	20:00:00	69.94	23.95
72	74.13	3:00	50.17	20:00:00	69.55	23.96
74	74.15	3:00:00	50.21	20:00:00	69.59	23.94
76	74.08	3:00	50.14	20:00:00	69.51	23.94
78	75.82	3:00	51.87	20:00:00	71.25	23.95
80	75.97	3:00	52.03	20:00:00	71.4	23.95
82	76.13	3:00	52.19	20:00:00	71.56	23.94
84	75.95	3:00	52	20:00:00	71.38	23.94
86	76.22	3:00:00	52.27	20:00:00	71.64	23.95
88	75.55	3:00	51.61	20:00:00	70.98	23.93
90	75.92	3:00	52	20:00:00	71.36	23.92
92	76.27	3:00	52.39	20:00:00	71.72	23.88
94	75.72	3:00	51.86	20:00:00	71.17	23.86
96	76.02	3:00	52.12	20:00:00	71.46	23.89
98	75.52	3:00	51.63	20:00:00	70.97	23.89

▨ Dummy PS nodes; results at these nodes not reported.

163401550 - Richmond Caivan Water Distribution System Analysis - Scope Change 1

Model Results - MXDY+FF (Interim Conditions)

ID	Static Demand (L/s)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (L/s)	Residual Pressure (psi)	Available Flow at Hydrant (L/s)	Available Flow Pressure (psi)
Min					*26.87*	*175.93*	
Max					*67.90*	*244.92*	
100	0.28	92.66	160.43	167.00	50.99	216.37	20.00
102	0.17	92.43	160.43	167.00	60.18	237.23	20.00
104	0.17	92.26	160.43	167.00	59.42	236.57	20.00
106	0.17	91.94	160.42	167.00	58.09	233.95	20.00
108	0.17	91.83	160.42	167.00	30.43	181.03	20.00
110	0.17	93.38	160.44	167.00	63.11	239.70	20.00
112	0.17	93.24	160.44	167.00	63.36	240.01	20.00
114	0.17	92.90	160.44	167.00	63.74	240.57	20.00
116	0.17	92.96	160.44	167.00	63.70	240.48	20.00
118	0.17	93.16	160.45	167.00	64.39	241.09	20.00
120	0.17	92.46	160.45	167.00	64.63	241.70	20.00
122	0.17	92.58	160.46	167.00	65.96	243.02	20.00
124	0.17	92.98	160.46	167.00	66.05	242.90	20.00
126	0.17	93.14	160.46	167.00	66.51	243.32	20.00
128	0.17	93.06	160.45	167.00	37.67	192.51	20.00
130	0.17	93.17	160.45	167.00	65.16	241.87	20.00
132	0.28	92.34	160.45	167.00	37.10	191.88	20.00
134	0.28	91.80	160.45	167.00	56.49	229.55	20.00
136	0.28	91.65	160.45	167.00	51.11	217.25	20.00
137	0.17	93.16	160.45	167.00	65.81	242.56	20.00
138	0.28	92.32	160.44	167.00	26.87	175.93	20.00
14	0.22	90.65	160.42	167.00	38.84	196.10	20.00
140	0.28	92.15	160.44	167.00	29.07	179.05	20.00
142	0.28	92.04	160.44	167.00	36.21	190.52	20.00
144	0.28	91.91	160.44	167.00	49.61	214.09	20.00
146	0.17	92.25	160.44	167.00	63.76	240.90	20.00
148	0.28	92.31	160.46	167.00	59.64	236.70	20.00
150	0.32	92.17	160.46	167.00	53.58	222.21	20.00
152	0.32	92.04	160.46	167.00	52.39	219.68	20.00
154	0.32	92.22	160.46	167.00	54.06	223.23	20.00
156	0.32	92.05	160.46	167.00	65.34	242.75	20.00
16	0.22	91.39	160.42	167.00	49.29	213.98	20.00
160	0.32	92.66	160.46	167.00	66.40	243.59	20.00
162	0.32	92.61	160.47	167.00	66.29	243.47	20.00
164	0.32	92.52	160.47	167.00	66.83	244.10	20.00
166	0.17	92.90	160.47	167.00	67.90	244.92	20.00
168	0.32	92.81	160.47	167.00	63.37	240.21	20.00
170	0	91.37	160.46	167.00	63.17	240.46	20.00
18	0.25	91.39	160.42	167.00	53.10	222.24	20.00
182	0	91.23	160.46	167.00	62.33	239.64	20.00
184	0	91.73	160.48	167.00	64.47	241.59	20.00
188	0.19	91.64	160.47	167.00	62.81	240.09	20.00
190	0.19	91.38	160.47	167.00	61.56	238.93	20.00
191	0.19	91.29	160.47	167.00	54.86	225.77	20.00
193	0.19	90.65	160.47	167.00	59.83	237.53	20.00
194	0	90.97	160.46	167.00	61.49	238.89	20.00
195	0.22	91.02	160.42	167.00	57.01	232.24	20.00
196	0.19	91.25	160.47	167.00	61.10	238.52	20.00
197	0.22	90.82	160.42	167.00	46.18	208.35	20.00
198	0.19	91.12	160.47	167.00	60.67	238.15	20.00
199	0.22	91.51	160.42	167.00	56.18	229.54	20.00
20	0.25	91.32	160.42	167.00	51.19	218.07	20.00
200	0.19	90.69	160.47	167.00	59.91	237.59	20.00
201	0.22	91.37	160.42	167.00	55.93	229.07	20.00
203	0.25	91.43	160.42	167.00	48.56	212.54	20.00
204	0.19	91.32	160.47	167.00	53.43	222.41	20.00
205	0.25	91.24	160.42	167.00	41.18	199.59	20.00
206	0.19	91.23	160.47	167.00	38.90	195.61	20.00
209	0.14	91.92	160.42	167.00	30.97	181.83	20.00
21	0.25	92.29	160.42	167.00	55.42	226.79	20.00
211	0.14	91.25	160.42	167.00	30.22	180.83	20.00
212	0	91.43	160.47	167.00	60.60	237.75	20.00
213	0.14	90.87	160.42	167.00	39.18	196.48	20.00
214	0	91.26	160.46	167.00	60.47	237.70	20.00
22	0.25	91.51	160.42	167.00	46.43	208.45	20.00
220	0	90.76	160.46	167.00	60.42	237.89	20.00
229	0	91.58	160.42	167.00	33.63	186.03	20.00
231	0	91.01	160.42	167.00	33.55	186.06	20.00
233	0	93.14	160.42	167.00	55.35	225.47	20.00
234	0	91.10	160.46	167.00	60.48	237.79	20.00
235	0	91.48	160.42	167.00	36.94	191.87	20.00
24	0.25	91.65	160.42	167.00	51.99	219.51	20.00
26	0.25	91.21	160.42	167.00	47.50	210.65	20.00
28	0.25	91.16	160.42	167.00	46.18	208.19	20.00
289	0.28	91.71	160.44	167.00	27.51	176.90	20.00
290	0	91.64	160.48	167.00	63.38	240.49	20.00
30	0.25	91.31	160.42	167.00	48.34	212.19	20.00
301	0.19	91.19	160.47	167.00	54.16	224.24	20.00
302	0.19	90.98	160.47	167.00	60.46	238.01	20.00
303	0.19	90.83	160.47	167.00	60.14	237.76	20.00
304	0.19	90.54	160.47	167.00	51.77	219.38	20.00
32	0.22	90.31	160.42	167.00	38.26	195.12	20.00
34	0.25	91.36	160.42	167.00	48.45	212.38	20.00
36	0.25	91.62	160.42	167.00	56.54	230.37	20.00
38	0.25	92.20	160.42	167.00	57.86	233.17	20.00
391	0.28	92.63	160.45	167.00	60.16	237.08	20.00
393	0.28	91.99	160.45	167.00	56.76	230.03	20.00
395	0.28	92.04	160.45	167.00	51.40	217.55	20.00
399	0.17	93.14	160.46	167.00	66.28	243.07	20.00
40	0.25	92.26	160.42	167.00	58.07	233.64	20.00
401	0.32	92.80	160.48	167.00	67.36	244.47	20.00
411	0.19	90.22	160.46	167.00	45.09	206.33	20.00
412	0	90.50	160.46	167.00	57.54	233.43	20.00
42	0.25	92.02	160.42	167.00	51.78	218.69	20.00
44	0.25	91.86	160.42	167.00	56.45	229.87	20.00
46	0.25	91.86	160.42	167.00	56.08	228.93	20.00
48	0.18	92.33	160.42	167.00	55.32	226.42	20.00
50	0.18	92.48	160.42	167.00	54.48	224.26	20.00
54	0.18	92.58	160.42	167.00	58.78	235.11	20.00
56	0.22	91.17	160.42	167.00	55.69	228.65	20.00
58	0.22	91.47	160.42	167.00	54.56	225.52	20.00
60	0.22	91.58	160.42	167.00	53.50	222.90	20.00
62	0.22	92.19	160.42	167.00	54.69	225.07	20.00
64	0.22	91.44	160.42	167.00	57.02	231.78	20.00
66	0.22	92.41	160.42	167.00	54.91	225.40	20.00
68	0.22	91.69	160.42	167.00	54.00	223.97	20.00
70	0.22	91.44	160.42	167.00	56.82	231.26	20.00
72	0.22	91.05	160.42	167.00	55.98	229.53	20.00
74	0.22	91.09	160.42	167.00	56.78	231.54	20.00
76	0.22	91.01	160.42	167.00	53.79	224.10	20.00
78	0.18	92.75	160.42	167.00	55.26	225.85	20.00
80	0.18	92.9	160.42	167.00	54.96	224.95	20.00
82	0.18	93.06	160.42	167.00	55.82	226.85	20.00
84	0.18	92.88	160.42	167.00	50.31	214.83	20.00
86	0.18	93.15	160.42	167.00	55.78	226.67	20.00
88	0.18	92.48	160.42	167.00	59.28	236.35	20.00
90	0.17	92.85	160.43	167.00	60.28	237.14	20.00
92	0.17	93.22	160.43	167.00	63.01	239.69	20.00
94	0.17	92.67	160.44	167.00	62.89	239.82	20.00
96	0.17	92.96	160.43	167.00	61.67	238.47	20.00
98	0.28	92.46	160.43	167.00	51.82	218.26	20.00

▨ No units serviced in this area under interim conditions

163401550 - Richmond Caivan Water Distribution System Analysis - Scope Change 1
Model Results - MXDY+FF (Buildout Conditions)

Min					***21.95***	***169.76***	
Max					***62.92***	***229.96***	
ID	Static Demand (L/s)	Static Pressure (psi)	Static Head (m)	Fire-Flow Demand (L/s)	Residual Pressure (psi)	Available Flow at Hydrant (L/s)	Available Flow Pressure (psi)
10	0.26	90.54	160.20	167.00	54.40	222.97	20.00
100	0.28	92.33	160.20	167.00	46.07	205.94	20.00
102	0.17	92.09	160.19	167.00	55.26	223.11	20.00
104	0.17	91.92	160.19	167.00	54.50	222.50	20.00
106	0.17	91.60	160.19	167.00	53.16	221.45	20.00
108	0.17	91.49	160.19	167.00	25.50	174.56	20.00
110	0.17	93.04	160.20	167.00	58.19	225.38	20.00
112	0.17	92.90	160.20	167.00	58.44	225.66	20.00
114	0.17	92.57	160.20	167.00	58.82	226.14	20.00
116	0.17	92.63	160.21	167.00	58.77	226.06	20.00
118	0.17	92.83	160.21	167.00	59.47	226.62	20.00
120	0.17	92.12	160.21	167.00	59.72	227.14	20.00
122	0.17	92.25	160.22	167.00	61.06	228.34	20.00
124	0.17	92.65	160.22	167.00	61.13	228.23	20.00
126	0.17	92.81	160.22	167.00	61.58	228.60	20.00
128	0.17	92.73	160.22	167.00	32.75	184.59	20.00
130	0.17	92.84	160.22	167.00	60.23	227.32	20.00
132	0.28	92.00	160.22	167.00	32.21	184.15	20.00
134	0.28	91.46	160.21	167.00	51.62	218.18	20.00
136	0.28	91.31	160.21	167.00	46.25	206.78	20.00
137	0.17	92.83	160.22	167.00	60.88	227.93	20.00
138	0.28	91.98	160.21	167.00	21.95	169.76	20.00
14	0.22	90.32	160.18	167.00	33.91	186.91	20.00
140	0.28	91.81	160.21	167.00	24.15	172.73	20.00
142	0.28	91.70	160.21	167.00	31.29	183.08	20.00
144	0.28	91.57	160.21	167.00	44.69	203.76	20.00
146	0.17	91.92	160.21	167.00	58.84	226.40	20.00
148	0.28	91.97	160.22	167.00	54.79	222.72	20.00
150	0.32	91.83	160.22	167.00	48.74	211.49	20.00
152	0.32	91.70	160.22	167.00	47.55	209.14	20.00
154	0.32	91.87	160.22	167.00	49.24	212.50	20.00
156	0.32	91.71	160.22	167.00	60.60	228.26	20.00
16	0.22	91.06	160.18	167.00	44.36	203.54	20.00
160	0.32	92.32	160.22	167.00	61.54	228.91	20.00
162	0.32	92.28	160.23	167.00	61.36	228.73	20.00
164	0.32	92.19	160.24	167.00	61.87	229.26	20.00
166	0.17	92.59	160.25	167.00	62.92	229.96	20.00
168	0.32	92.49	160.24	167.00	58.37	225.77	20.00
170	0.26	91.02	160.22	167.00	58.93	226.91	20.00
172	0.26	90.73	160.21	167.00	44.40	203.62	20.00
174	0.26	90.61	160.21	167.00	41.19	197.97	20.00
176	0.26	90.28	160.21	167.00	38.32	193.42	20.00
18	0.25	91.06	160.18	167.00	48.17	211.16	20.00
182	0.61	90.87	160.21	167.00	58.33	226.76	20.00
184	0.26	91.39	160.24	167.00	59.88	227.63	20.00
186	0.26	91.22	160.23	167.00	36.69	190.55	20.00
188	0.19	91.29	160.22	167.00	58.57	226.38	20.00
190	0.19	91.02	160.21	167.00	57.54	225.54	20.00
191	0.19	90.93	160.21	167.00	55.44	223.64	20.00
192	0.26	90.67	160.21	167.00	55.10	223.50	20.00
193	0.19	90.28	160.21	167.00	55.61	224.07	20.00
194	0.61	90.61	160.21	167.00	57.51	226.10	20.00
195	0.22	90.68	160.19	167.00	52.09	220.33	20.00
196	0.19	90.89	160.21	167.00	56.80	224.91	20.00
197	0.22	90.49	160.18	167.00	41.25	198.26	20.00
198	0.19	90.76	160.21	167.00	56.27	224.47	20.00
199	0.22	91.17	160.18	167.00	51.25	217.90	20.00
20	0.25	90.98	160.18	167.00	46.26	207.30	20.00
200	0.19	90.32	160.21	167.00	55.58	224.02	20.00
201	0.22	91.03	160.18	167.00	51.01	217.45	20.00
203	0.25	91.10	160.18	167.00	43.62	202.21	20.00
204	0.19	90.96	160.21	167.00	49.06	212.79	20.00
205	0.25	90.90	160.18	167.00	36.25	190.17	20.00
206	0.19	90.87	160.21	167.00	34.53	187.51	20.00
209	0.14	91.58	160.18	167.00	26.02	175.29	20.00
21	0.25	91.95	160.18	167.00	50.49	215.48	20.00
210	0.26	90.91	160.21	167.00	47.50	209.59	20.00
211	0.14	90.91	160.18	167.00	25.27	174.28	20.00
212	0.26	91.06	160.21	167.00	56.51	224.67	20.00
213	0.14	90.53	160.18	167.00	34.24	187.24	20.00
214	0.26	90.89	160.20	167.00	56.30	224.55	20.00
22	0.25	91.17	160.18	167.00	41.50	198.42	20.00
220	0.61	90.39	160.21	167.00	56.02	224.82	20.00
228	0.26	90.26	160.20	167.00	46.99	209.06	20.00
229	0	91.24	160.18	167.00	28.67	179.23	20.00
230	0.26	90.42	160.20	167.00	31.84	184.02	20.00
231	0	90.67	160.18	167.00	28.61	179.23	20.00
232	0.26	90.57	160.20	167.00	55.27	223.73	20.00
233	0	92.81	160.19	167.00	50.42	214.35	20.00
234	0.26	90.73	160.20	167.00	56.23	224.55	20.00
235	0.14	91.14	160.18	167.00	31.98	184.01	20.00
236	0.26	90.44	160.20	167.00	48.87	212.93	20.00
238	0.26	90.09	160.20	167.00	49.12	213.81	20.00
24	0.25	91.31	160.18	167.00	47.05	208.67	20.00
240	0.26	89.70	160.20	167.00	40.76	197.73	20.00
242	0.26	90.34	160.20	167.00	43.66	202.55	20.00
244	0.26	87.43	160.20	167.00	38.44	194.78	20.00
246	0.26	87.43	160.20	167.00	41.09	199.42	20.00
248	0.26	88.71	160.20	167.00	50.51	218.29	20.00
250	0.26	90.19	160.20	167.00	53.43	222.23	20.00
252	0.26	89.63	160.20	167.00	52.15	221.31	20.00
254	0.26	89.38	160.20	167.00	50.97	218.78	20.00
258	0.26	88.37	160.20	167.00	39.83	196.75	20.00
26	0.25	90.87	160.18	167.00	42.56	200.42	20.00
260	0.26	88.17	160.20	167.00	36.91	192.04	20.00
262	0.26	89.73	160.20	167.00	48.45	212.61	20.00
264	0.26	89.32	160.20	167.00	50.57	217.87	20.00

268	0.26	89.42	160.20	167.00	47.58	210.96	20.00
270	0.26	89.20	160.20	167.00	50.65	218.16	20.00
272	0.26	89.57	160.20	167.00	51.72	220.44	20.00
278	0.26	89.32	160.20	167.00	50.64	218.04	20.00
28	0.25	90.83	160.18	167.00	41.25	198.15	20.00
282	0.26	89.06	160.20	167.00	49.58	215.74	20.00
284	0.26	89.18	160.20	167.00	50.17	217.03	20.00
288	0.26	88.81	160.20	167.00	49.33	215.39	20.00
289	0.28	91.37	160.21	167.00	22.60	170.64	20.00
290	0.26	91.29	160.23	167.00	59.18	227.01	20.00
30	0.25	90.97	160.18	167.00	43.41	201.87	20.00
301	0.19	90.83	160.21	167.00	49.78	214.48	20.00
302	0.19	90.61	160.21	167.00	56.01	224.29	20.00
303	0.19	90.47	160.21	167.00	55.72	224.09	20.00
304	0.19	90.17	160.21	167.00	47.38	209.82	20.00
32	0.22	89.98	160.18	167.00	33.33	186.18	20.00
34	0.25	91.03	160.18	167.00	43.52	202.05	20.00
36	0.25	91.29	160.18	167.00	51.61	218.68	20.00
38	0.25	91.87	160.18	167.00	52.93	221.26	20.00
391	0.28	92.29	160.21	167.00	55.28	223.05	20.00
393	0.28	91.65	160.21	167.00	51.89	218.63	20.00
395	0.28	91.70	160.21	167.00	46.54	207.10	20.00
399	0.17	92.81	160.22	167.00	61.35	228.38	20.00
40	0.25	91.93	160.18	167.00	53.14	221.42	20.00
401	0.32	92.48	160.26	167.00	62.39	229.62	20.00
402	0.26	91.32	160.24	167.00	46.23	206.64	20.00
403	0.26	91.16	160.23	167.00	55.36	223.51	20.00
404	0.26	92.15	160.22	167.00	55.14	222.94	20.00
405	0.26	92.29	160.22	167.00	30.88	182.37	20.00
406	0.26	90.27	160.20	167.00	48.61	212.50	20.00
407	0.26	90.42	160.20	167.00	27.86	178.32	20.00
408	0.26	90.70	160.20	167.00	55.02	223.45	20.00
409	0.26	90.84	160.20	167.00	54.87	223.27	20.00
410	0.26	89.85	160.20	167.00	28.88	180.06	20.00
411	0.19	89.85	160.20	167.00	42.06	199.82	20.00
412	0.26	90.13	160.20	167.00	54.51	223.21	20.00
413	0.26	89.70	160.20	167.00	53.27	222.26	20.00
414	0.26	89.56	160.20	167.00	52.01	221.17	20.00
415	0.26	88.85	160.20	167.00	30.00	181.93	20.00
416	0.26	88.14	160.20	167.00	28.88	180.44	20.00
42	0.25	91.68	160.18	167.00	46.86	207.98	20.00
44	0.25	91.53	160.18	167.00	51.53	218.26	20.00
46	0.25	91.53	160.18	167.00	51.16	217.39	20.00
48	0.18	92.00	160.18	167.00	50.39	215.14	20.00
50	0.18	92.14	160.18	167.00	49.55	213.17	20.00
54	0.18	92.24	160.19	167.00	53.86	221.86	20.00
56	0.22	90.83	160.18	167.00	50.76	217.04	20.00
58	0.22	91.13	160.18	167.00	49.63	214.20	20.00
60	0.22	91.24	160.18	167.00	48.58	211.80	20.00
62	0.22	91.86	160.18	167.00	49.76	213.88	20.00
64	0.22	91.10	160.19	167.00	52.10	219.96	20.00
66	0.22	92.07	160.18	167.00	49.99	214.21	20.00
68	0.22	91.36	160.18	167.00	49.08	212.80	20.00
70	0.22	91.10	160.19	167.00	51.90	219.48	20.00
72	0.22	90.72	160.18	167.00	51.06	217.84	20.00
74	0.22	90.75	160.19	167.00	51.86	219.70	20.00
76	0.22	90.68	160.19	167.00	48.87	212.84	20.00
78	0.18	92.41	160.19	167.00	50.34	214.66	20.00
80	0.18	92.57	160.19	167.00	50.03	213.86	20.00
82	0.18	92.72	160.19	167.00	50.9	215.64	20.00
84	0.18	92.54	160.19	167.00	45.39	204.51	20.00
86	0.18	92.81	160.19	167.00	50.85	215.48	20.00
88	0.18	92.14	160.19	167.00	54.35	222.32	20.00
90	0.17	92.52	160.19	167.00	55.36	223.05	20.00
92	0.17	92.88	160.20	167.00	58.09	225.37	20.00
94	0.17	92.33	160.20	167.00	57.97	225.45	20.00
96	0.17	92.62	160.19	167.00	56.75	224.25	20.00
98	0.28	92.13	160.20	167.00	46.89	207.66	20.00

APPENDIX D

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
STREET 'L'																											
	436A	437A	0.52		47	0.52	47	3.7	0.56		0.00		0.00		0.00	0.00	0.52	0.52	0.17	0.73	85.0	200	0.65	26.44	0.03	0.84	0.36
	437A	439A	0.48		43	1.00	90	3.6	1.05		0.00		0.00		0.00	0.00	0.48	1.00	0.33	1.38	85.0	200	0.35	19.40	0.07	0.62	0.36
To STREET 'Q', Pipe 439A - 440A						1.00	90				0.00		0.00		0.00			1.00									
COMMERCIAL BLOCK																											
	430A	432A				0.00				1.89	1.89		0.00		0.00	0.61	1.89	1.89	0.62	1.24	30.0	200	0.65	26.44	0.05	0.84	0.43
To STREET 'I', Pipe 432A - 413A						0.00	0				1.89		0.00		0.00			1.89									
STREET 'I'																											
Contribution From COMMERCIAL BLOCK, Pipe 430A - 432A						0.00	0				1.89		0.00		0.00		1.89	1.89									
	432A	413A	0.68		61	0.68	61	3.6	0.72		1.89		0.00		0.00	0.61	0.68	2.57	0.85	2.18	97.5	250	0.25	29.73	0.07	0.61	0.35
	413A	433A	0.35		32	1.03	93	3.6	1.09		1.89		0.00		0.00	0.61	0.35	2.92	0.96	2.66	77.5	250	0.25	29.73	0.09	0.61	0.37
To STREET 'Q', Pipe 433A - 434A						1.03	93				1.89		0.00		0.00			2.92									
STREET 'Q'																											
	438A	439A	0.24		22	0.24	22	3.7	0.26		0.00		0.00		0.00	0.00	0.24	0.24	0.08	0.34	53.5	200	0.65	26.44	0.01	0.84	0.28
Contribution From STREET 'L', Pipe 437A - 439A						1.00	90				0.00		0.00		0.00		1.00	1.24									
	439A	440A	0.12		11	1.36	123	3.6	1.42		0.00		0.00		0.00	0.00	0.12	1.36	0.45	1.87	31.5	200	0.35	19.40	0.10	0.62	0.39
To STREET 'J', Pipe 440A - 442A						1.36	123				0.00		0.00		0.00			1.36									
Contribution From STREET 'O', Pipe 426A - 429A						1.11	100				0.00		0.00		0.00		1.11	1.11									
Contribution From STREET 'O', Pipe 428A - 429A						0.50	46				0.00		0.00		0.00		0.50	1.61									
	429A	433A	0.21		19	1.82	165	3.5	1.89		0.00		0.00		0.00	0.00	0.21	1.82	0.60	2.49	61.5	250	0.25	29.73	0.08	0.61	0.37
Contribution From STREET 'I', Pipe 413A - 433A						1.03	93				1.89		0.00		0.00		2.92	4.74									
	433A	434A	0.66		59	3.51	317	3.5	3.55		1.89		0.00		0.00	0.61	0.66	5.40	1.78	5.94	113.0	250	0.25	29.73	0.20	0.61	0.47
	434A	435A	0.15		14	3.66	331	3.4	3.70		1.89		0.00		0.00	0.61	0.15	5.55	1.83	6.14	11.0	250	0.25	29.73	0.21	0.61	0.47
	435A	440A	0.06		6	3.72	337	3.4	3.76		1.89		0.00		0.00	0.61	0.06	5.61	1.85	6.23	21.5	250	0.25	29.73	0.21	0.61	0.48
To STREET 'J', Pipe 440A - 442A						3.72	337				1.89		0.00		0.00			5.61									
STREET 'J'																											
Contribution From STREET 'Q', Pipe 435A - 440A						3.72	337				1.89		0.00		0.00		5.61	5.61									
Contribution From STREET 'Q', Pipe 439A - 440A						1.36	123				0.00		0.00		0.00		1.36	6.97									
	440A	261A	0.10		9	5.18	469	3.4	5.15		1.89		0.00		0.00	0.61	0.10	7.07	2.33	8.10	71.5	250	0.25	29.73	0.27	0.61	0.51
To OLDENBURG AVENUE, Pipe 261A - 262A						5.18	469				1.89		0.00		0.00			7.07									
STREET 'P'																											
	419A	414A	0.50		38	0.50	38	3.7	0.45		0.00		0.00		0.00	0.00	0.50	0.50	0.17	0.62	67.5	200	0.65	26.44	0.02	0.84	0.35
	414A	421A	0.42		32	0.92	70	3.6	0.82		0.00		0.00		0.00	0.00	0.42	0.92	0.30	1.13	67.5	200	0.35	19.40	0.06	0.62	0.33
To STREET 'H', Pipe 421A - 422A						0.92	70				0.00		0.00		0.00			0.92									
STREET 'H'																											
Contribution From STREET 'O', Pipe 412A - 420A						1.02	80				0.00		0.00		0.00		1.02	1.02									
	420A	421A	0.30		23	1.32	103	3.6	1.20		0.00		0.00		0.00	0.00	0.30	1.32	0.44	1.63	73.5	200	0.35	19.40	0.08	0.62	0.37
Contribution From STREET 'P', Pipe 414A - 421A						0.92	70				0.00		0.00		0.00		0.92	2.24									
	421A	422A	0.45		35	2.69	208	3.5	2.37		0.00		0.00		0.00	0.00	0.45	2.69	0.89	3.26	106.0	200	0.35	19.40	0.17	0.62	0.46

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da	0.10764	l/s/Ha					
Average Daily Flow =	280	l/p/day			Industrial Peak Factor = as per MOE Graph				
Comm/Inst Flow =	28000	L/ha/da	0.3241	l/s/Ha	Extraneous Flow =		0.330	L/s/ha	
Industrial Flow =	35000	L/ha/da	0.40509	l/s/Ha	Minimum Velocity =		0.600	m/s	
Max Res. Peak Factor =	4.00				Manning's n =	(Conc)	0.013	(Pvc)	0.013
Commercial/Inst./Park Peak Factor =	1.00				Townhouse coeff=		2.7		
Institutional =	0.32	l/s/Ha			Single house coeff=		3.4		

Designed:
CB

PROJECT:
Caivan (Richmond North) Ltd

Checked:
SLM

LOCATION:
City of Ottawa

Dwg. Reference:
Sanitary Drainage Plan, Dwgs. No. 2A

File Ref:
20-1183

Date:
August 2021

Sheet No. 1 of 3

GREEN LANDS WEST & EAST

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
	422A	309A	0.12		10	2.81	218	3.5	2.48		0.00		0.00		0.00	0.00	0.12	2.81	0.93	3.41	72.0	200	0.35	19.40	0.18	0.62	0.46
To OLDENBURG AVENUE, Pipe 309A - 310A						2.81	218				0.00		0.00		0.00			2.81									
STREET 'K'																											
	403A	404A	0.26		20	0.26	20	3.7	0.24		0.00		0.00		0.00	0.00	0.26	0.26	0.09	0.33	59.0	200	0.65	26.44	0.01	0.84	0.28
Contribution From STREET 'N', Pipe 411A - 404A						1.45	112				0.00		0.00		0.00		1.45	1.71									
	404A	408A	0.29		23	2.00	155	3.5	1.78		0.00		0.00		0.00	0.00	0.29	2.00	0.66	2.44	71.5	200	0.35	19.40	0.13	0.62	0.42
To STREET 'O', Pipe 408A - 304A						2.00	155				0.00		0.00		0.00			2.00									
STREET 'O'																											
	405A	412A	0.54		42	0.54	42	3.7	0.50		0.00		0.00		0.00	0.00	0.54	0.54	0.18	0.68	70.5	200	0.65	26.44	0.03	0.84	0.36
			0.05		5	0.59	47				0.00		0.00		0.00		0.05	0.59									
	412A	420A	0.43		33	1.02	80	3.6	0.94		0.00		0.00		0.00	0.00	0.43	1.02	0.34	1.27	70.5	200	0.35	19.40	0.07	0.62	0.34
To STREET 'H', Pipe 420A - 421A						1.02	80				0.00		0.00		0.00			1.02									
	425A	426A	0.61		55	0.61	55	3.6	0.65		0.00		0.00		0.00	0.00	0.61	0.61	0.20	0.85	86.5	200	0.65	26.44	0.03	0.84	0.38
	426A	429A	0.50		45	1.11	100	3.6	1.17		0.00		0.00		0.00	0.00	0.50	1.11	0.37	1.53	86.5	250	0.25	29.73	0.05	0.61	0.31
To STREET 'Q', Pipe 429A - 433A						1.11	100				0.00		0.00		0.00			1.11									
	427A	428A	0.25		23	0.25	23	3.7	0.28		0.00		0.00		0.00	0.00	0.25	0.25	0.08	0.36	57.5	200	0.65	26.44	0.01	0.84	0.29
	428A	429A	0.25		23	0.50	46	3.7	0.55		0.00		0.00		0.00	0.00	0.25	0.50	0.17	0.71	60.5	250	0.25	29.73	0.02	0.61	0.25
To STREET 'Q', Pipe 429A - 433A						0.50	46				0.00		0.00		0.00			0.50									
	405A	406A	0.12		10	0.12	10	3.7	0.12		0.00		0.00		0.00	0.00	0.12	0.12	0.04	0.16	11.0	200	0.65	26.44	0.01	0.84	0.23
	406A	407A	0.32		25	0.44	35	3.7	0.42		0.00		0.00		0.00	0.00	0.32	0.44	0.15	0.56	63.5	200	0.65	26.44	0.02	0.84	0.34
	407A	408A	0.51		39	0.95	74	3.6	0.87		0.00		0.00	1.22	1.22	0.13	1.73	2.17	0.72	1.72	84.0	200	0.35	19.40	0.09	0.62	0.38
Contribution From STREET 'K', Pipe 404A - 408A						2.00	155				0.00		0.00		0.00		2.00	4.17									
	408A	304A	0.26		20	3.21	249	3.5	2.82		0.00		0.00		1.22	0.13	0.26	4.43	1.46	4.41	73.5	200	0.35	19.40	0.23	0.62	0.50
To OLDENBURG AVENUE, Pipe 304A - 305A						3.21	249				0.00		0.00		1.22			4.43									
STREET 'N'																											
	400A	409A	0.16		13	0.16	13	3.7	0.16		0.00		0.00		0.00	0.00	0.16	0.16	0.05	0.21	11.0	200	0.65	26.44	0.01	0.84	0.24
	409A	423A	0.50		38	0.66	51	3.7	0.60		0.00		0.00		0.00	0.00	0.50	0.66	0.22	0.82	74.0	200	0.65	26.44	0.03	0.84	0.38
	423A	424A	0.49		37	1.15	88	3.6	1.03		0.00		0.00		0.00	0.00	0.49	1.15	0.38	1.41	73.5	200	0.35	19.40	0.07	0.62	0.36
	424A	301A	0.25		19	1.40	107	3.6	1.24		0.00		0.00		0.00	0.00	0.25	1.40	0.46	1.71	68.0	200	0.35	19.40	0.09	0.62	0.38
To OLDENBURG AVENUE, Pipe 301A - 302A						1.40	107				0.00		0.00		0.00			1.40									
	400A	401A	0.30		23	0.30	23	3.7	0.28		0.00		0.00		0.00	0.00	0.30	0.30	0.10	0.37	54.5	200	0.70	27.44	0.01	0.87	0.30
	401A	402A	0.15		12	0.45	35	3.7	0.42		0.00		0.00		0.00	0.00	0.15	0.45	0.15	0.57	11.5	200	0.35	19.40	0.03	0.62	0.27
	402A	411A	0.52		40	0.97	75	3.6	0.88		0.00		0.00		0.00	0.00	0.52	0.97	0.32	1.20	76.5	200	0.35	19.40	0.06	0.62	0.34
	411A	404A	0.48		37	1.45	112	3.6	1.30		0.00		0.00		0.00	0.00	0.48	1.45	0.48	1.78	71.0	200	0.35	19.40	0.09	0.62	0.38
To STREET 'K', Pipe 404A - 408A						1.45	112				0.00		0.00		0.00			1.45									
OLDENBURG AVENUE																											
Contribution From External						2.87	173				0.00		0.00		0.00		2.87	2.87									
Contribution From STREET 'N', Pipe 410A - 301A						1.40	107				0.00		0.00		0.00		1.40	1.40									
	301A	302A	0.25		18	4.52	298	3.5	3.35		0.00		0.00		0.00	0.00	0.25	4.52	1.49	4.84	13.0	200	0.35	19.40	0.25	0.62	0.51
			0.15		12	4.67	310				0.00		0.00		0.00		0.15	4.67									
	302A	303A	0.27		20	4.94	330	3.4	3.69		0.00		0.00		0.00	0.00	0.27	4.94	1.63	5.32	61.5	200	0.35	19.40	0.27	0.62	0.52

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da	0.10764	l/s/Ha					
Average Daily Flow =	280	l/p/day			Industrial Peak Factor = as per MOE Graph				
Comm/Inst Flow =	28000	L/ha/da	0.3241	l/s/Ha	Extraneous Flow =		0.330	L/s/ha	
Industrial Flow =	35000	L/ha/da	0.40509	l/s/Ha	Minimum Velocity =		0.600	m/s	
Max Res. Peak Factor =	4.00				Manning's n =	(Conc)	0.013	(Pvc)	0.013
Commercial/Inst./Park Peak Factor =	1.00				Townhouse coeff=		2.7		
Institutional =	0.32	l/s/Ha			Single house coeff=		3.4		

Designed: CB

Checked: SLM

Dwg. Reference: Sanitary Drainage Plan, Dwgs. No. 2A

PROJECT: **Caivan (Richmond North) Ltd**

LOCATION: **City of Ottawa**

File Ref: 20-1183

Date: **August 2021**

Sheet No. 2 of 3

Lower flows (37.67L/s) projected for the Green Lands West and overall development area than the flows that were previously summarized in the Fox Run Phase 1 design sheet (41.93 L/s). Therefore, no downstream impacts.
Note: This also accounts for other future external areas.

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
			0.18		14	5.12	344				0.00		0.00		0.00		0.18	4.85									
	303A	304A	2.01		145	7.13	489	3.4	5.36		0.00		0.00		0.00	0.00	2.01	6.86	2.26	7.63	71.5	200	0.35	19.40	0.39	0.62	0.58
Contribution From STREET 'O', Pipe 408A - 304A						3.21	249				0.00		0.00		1.22		4.43	11.29									
	304A	305A	0.18		13	10.52	751	3.3	8.03		0.00		0.00		1.22	0.13	0.18	11.47	3.79	11.95	45.5	250	0.25	29.73	0.40	0.61	0.57
	305A	306A	0.07		6	10.59	757	3.3	8.10		0.00		0.00		1.22	0.13	0.07	11.54	3.81	12.03	14.5	250	0.25	29.73	0.40	0.61	0.57
			0.18		13	10.77	770				0.00		0.00		1.22		0.18	11.72									
	306A	307A	0.62		45	11.39	815	3.3	8.67		0.00		0.00		1.22	0.13	0.62	12.34	4.07	12.88	40.0	250	0.25	29.73	0.43	0.61	0.58
	307A	308A	0.14		11	11.53	826	3.3	8.78		0.00		0.00		1.22	0.13	0.14	12.48	4.12	13.03	29.5	250	0.25	29.73	0.44	0.61	0.58
	308A	309A				11.53	826	3.3	8.78		0.00		0.00		1.22	0.13	0.00	12.48	4.12	13.03	22.5	250	0.25	29.73	0.44	0.61	0.58
Contribution From STREET 'H', Pipe 422A - 309A						2.81	218				0.00		0.00		0.00		2.81	15.29									
	309A	310A	0.16		14	14.50	1058	3.2	11.07		0.00		0.00		1.22	0.13	0.16	15.45	5.10	16.30	38.0	250	0.25	29.73	0.55	0.61	0.62
			0.26		23	14.76	1081				0.00		0.00		1.22		0.26	15.71									
	310A	EX 261A	0.38		28	15.14	1109	3.2	11.56		0.00		0.00		1.22	0.13	0.38	16.09	5.31	17.00	61.0	300	0.20	43.25	0.39	0.61	0.57
Contribution From STREET 'J', Pipe 442A - 261A						5.18	469				1.89		0.00		0.00		7.07	23.16									
			0.25		21	20.57	1599				1.89		0.00		1.22		0.25	23.41									
	EX 261A	EX 262A	0.50		44	21.07	1643	3.1	16.62		1.89		0.00		1.22	0.74	0.50	23.91	7.89	25.25	75.0	300	0.20	43.25	0.58	0.61	0.63
			0.26		24	21.33	1667				1.89		0.00		1.22		0.26	24.17									
	EX 262A	EX 263A	0.29		28	21.62	1695	3.1	17.10		1.89		0.00		1.22	0.74	0.29	24.46	8.07	25.91	75.0	300	0.20	43.25	0.60	0.61	0.64
			0.22		14	21.84	1709				1.89		0.00		1.22		0.22	24.68									
			4.04		360	25.88	2069				1.89		0.00		1.22		4.04	28.72									
	EX 263A	EX 267A	5.84		421	31.72	2490	3.0	24.27		1.89		0.00		1.22	0.74	5.84	34.56	11.40	36.42	69.0	375	0.15	67.91	0.54	0.61	0.62
	EX 267A	EX 150A	0.44		126	32.16	2616	3.0	25.38		1.89		0.00		1.22	0.74	0.44	35.00	11.55	37.67	22.0	375	0.15	67.91	0.55	0.61	0.63
MIRA COURT																											
	24	506A	0.48		16	0.48	16	3.7	0.19		0.00		0.00		0.00	0.00	0.48	0.48	0.16	0.35	101.5	200	0.65	26.44	0.01	0.84	0.29
To STREET 'G', Pipe 506A - 508A						0.48	16				0.00		0.00		0.00			0.48									
STREET 'G'																											
Contribution From MIRA COURT, Pipe 24 - 506A						0.48	16				0.00		0.00		0.00		0.48	0.48									
	506A	508A	0.00		0	0.48	16	3.7	0.19		0.00		0.00		0.00	0.00	0.00	0.48	0.16	0.35	30.0	200	1.55	40.83	0.01	1.30	0.40
To STREET 'G', Pipe 508A - 509A						0.48	16				0.00		0.00		0.00			0.48									
STREET 'G'																											
	502A	503A	0.71		24	0.71	24	3.7	0.29		0.00		0.00		0.00	0.00	0.71	0.71	0.23	0.52	86.5	200	0.65	26.44	0.02	0.84	0.33
	503A	504A	0.48		16	1.19	40	3.7	0.48		0.00		0.00		0.00	0.00	0.48	1.19	0.39	0.87	84.0	200	0.35	19.40	0.04	0.62	0.31
	504A	509A	0.53		17	1.72	57	3.6	0.67		0.00		0.00		0.00	0.00	0.53	1.72	0.57	1.24	83.5	200	0.35	19.40	0.06	0.62	0.34
To CEDARSTONE STREET, Pipe 509A - EX. MH						1.72	57				0.00		0.00		0.00			1.72									
Contribution From STREET 'G', Pipe 506A - 508A						0.48	16				0.00		0.00		0.00		0.48	0.48									
	508A	509A	0.69		23	1.17	39	3.7	0.46		0.00		0.00		0.00	0.00	0.69	1.17	0.39	0.85	23.0	200	1.45	39.49	0.02	1.26	0.50
To CEDARSTONE STREET, Pipe 509A - EX. MH						1.17	39				0.00		0.00		0.00			1.17									
CEDARSTONE STREET																											
Contribution From STREET 'G', Pipe 504A - 509A						1.72	57				0.00		0.00		0.00		1.72	1.72									
Contribution From STREET 'G', Pipe 508A - 509A						1.17	39				0.00		0.00		0.00		1.17	2.89									
	509A	EX. MH	0.00		0	2.89	96	3.6	1.12		0.00		0.00		0.00	0.00	0.00	2.89	0.95	2.07	9.0	200	0.35	19.40	0.11	0.62	0.40

Green Lands East sanitary flow total of 2.42 L/s projected to existing sewers.

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da	0.10764	l/s/Ha				
Average Daily Flow =	280	l/p/day			Industrial Peak Factor = as per MOE Graph			
Comm/Inst Flow =	28000	L/ha/da	0.3241	l/s/Ha	Extraneous Flow =		0.330	L/s/ha
Industrial Flow =	35000	L/ha/da	0.40509	l/s/Ha	Minimum Velocity =		0.600	m/s
Max Res. Peak Factor =	4.00				Manning's n =	(Conc)	0.013	(Pvc) 0.013
Commercial/Inst./Park Peak Factor =	1.00				Townhouse coeff=		2.7	
Institutional =	0.32	l/s/Ha			Single house coeff=		3.4	

Designed: CB

Checked: SLM

Dwg. Reference: Sanitary Drainage Plan, Dwgs. No. 2A

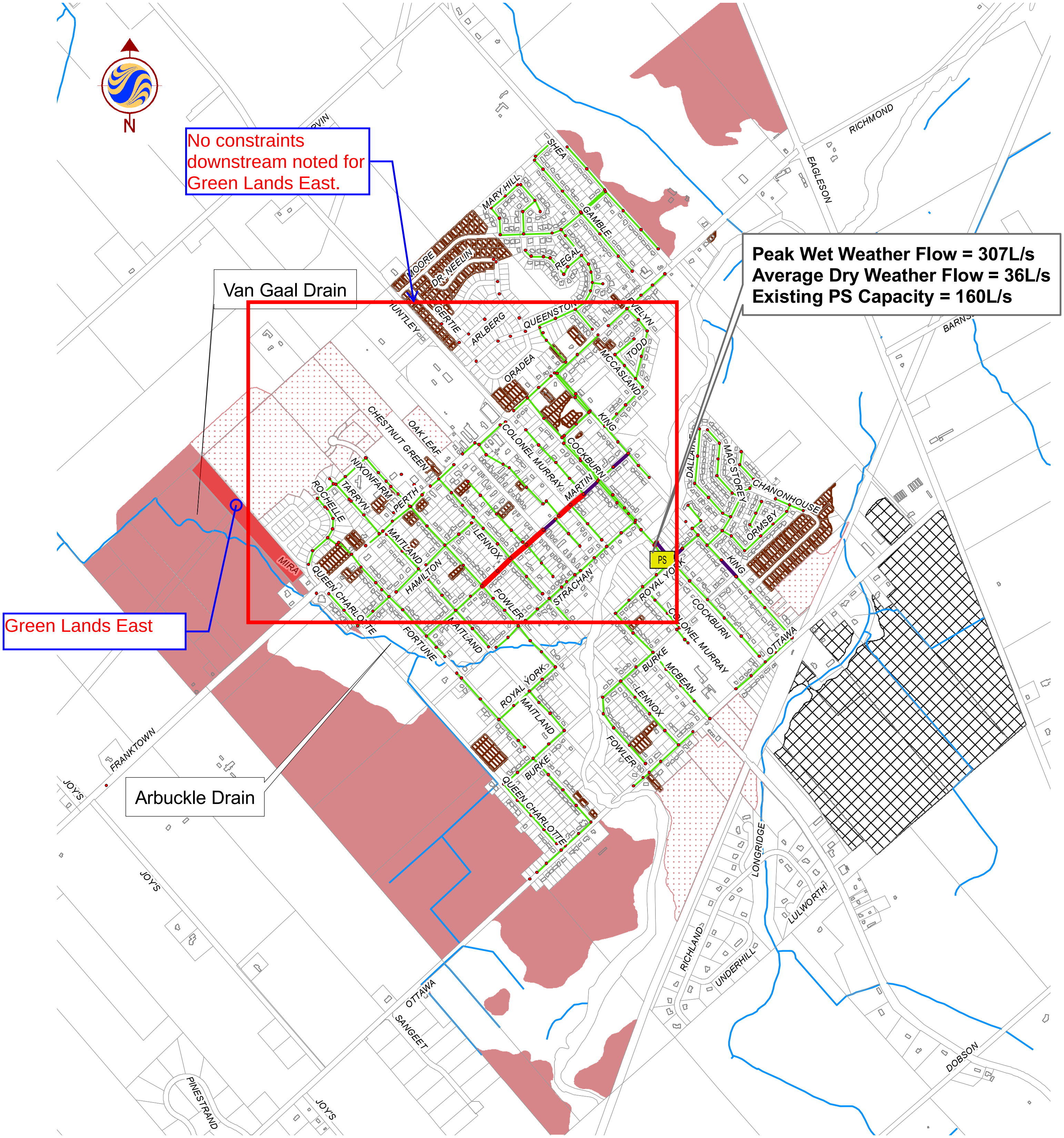
PROJECT: **Caivan (Richmond North) Ltd**

LOCATION: **City of Ottawa**

File Ref: 20-1183

Date: **August 2021**

Sheet No. 3 of 3



No constraints downstream noted for Green Lands East.

Peak Wet Weather Flow = 307L/s
Average Dry Weather Flow = 36L/s
Existing PS Capacity = 160L/s

W:\active\1634_00808_Richmond_Water_Sanitary\planning\drawing\GIS Data\Master Plan Figures\Figure 5.7-richmond_wastewater_SS_Results_PS_ECapacity_portrait_mt20090130.mxd

Legend

Flow / Pipe Capacity

- 0.00-0.90
- 0.90-1.10
- +1.10

- Serviced Future Development
- Future Development
- Future Infill
- Future Industrial

Client/Project
CITY OF OTTAWA
VILLAGE OF RICHMOND
MASTER SERVICING STUDY

Figure No.
5.7

Title
Existing, Infill & Limited Future Growth Area Gravity Collection System Bottlenecks

March 2009
1634-00808

LICENSED PROFESSIONAL ENGINEER
W. LIU
100167932
21-07-27
PROVINCE OF ONTARIO

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
STREET D																											
	518A	519A	0.67		54	0.67	54	3.6	0.64		0.00		0.00		0.00	0.00	0.67	0.67	0.22	0.86	113.0	200	0.65	26.44	0.03	0.84	0.38
To STREET C, Pipe 519A - 521A						0.67	54				0.00		0.00		0.00			0.67									
STREET C																											
	515A	516A	0.67		54	0.67	54	3.6	0.64		0.00		0.00		0.00	0.00	0.67	0.67	0.22	0.86	105.5	200	0.65	26.44	0.03	0.84	0.38
	516A	517A	0.15		12	0.82	66	3.6	0.78		0.00		0.00		0.00	0.00	0.15	0.82	0.27	1.05	11.0	200	0.35	19.40	0.05	0.62	0.33
	517A	519A	0.21		17	1.03	83	3.6	0.97		0.00		0.00		0.00	0.00	0.21	1.03	0.34	1.31	53.0	200	0.35	19.40	0.07	0.62	0.35
Contribution From STREET D, Pipe 518A - 519A						0.67	54				0.00		0.00		0.00		0.67	1.70									
	519A	521A	0.19		16	1.89	153	3.6	1.76		0.00		0.00		0.00	0.00	0.19	1.89	0.62	2.38	60.5	200	0.35	19.40	0.12	0.62	0.42
To STREET E, Pipe 521A - 522A						1.89	153				0.00		0.00		0.00			1.89									
STREET E																											
	520A	521A	0.70		56	0.70	56	3.6	0.66		0.00		0.00		0.00	0.00	0.70	0.70	0.23	0.89	113.0	200	0.65	26.44	0.03	0.84	0.39
Contribution From STREET C, Pipe 519A - 521A						1.89	153				0.00		0.00		0.00		1.89	2.59									
	521A	522A	0.07		6	2.66	215	3.5	2.45		0.00		0.00		0.00	0.00	0.07	2.66	0.88	3.32	18.0	200	0.35	19.40	0.17	0.62	0.46
To PATHWAY SERVICING BLOCK, Pipe 522A - 523A						2.66	215				0.00		0.00		0.00			2.66									
PATHWAY SERVICING BLOCK																											
Contribution From STREET E, Pipe 521A - 522A						2.66	215				0.00		0.00		0.00		2.66	2.66									
			0.02		2	2.68	217				0.00		0.00		0.00		0.02	2.68									
	522A	523A	0.09		8	2.77	225	3.5	2.55		0.00		0.00		0.00	0.00	0.09	2.77	0.91	3.47	45.0	200	0.35	19.40	0.18	0.62	0.47
	523A	524A	0.02		2	2.79	227	3.5	2.58		0.00		0.00		0.00	0.00	0.02	2.79	0.92	3.50	27.5	200	0.35	19.40	0.18	0.62	0.47
To SAN TRUNK 2, Pipe 524A - 525A						2.79	227				0.00		0.00		0.00			2.79									
STREET B																											
	506A	507A	0.14		12	0.14	12	3.7	0.14		0.00		0.00		0.00	0.00	0.14	0.14	0.05	0.19	30.5	200	0.65	26.44	0.01	0.84	0.24
To STREET A, Pipe 507A - 508A						0.14	12				0.00		0.00		0.00			0.14									
	501A	502A	0.28		23	0.28	23	3.7	0.28		0.00		0.00		0.00	0.00	0.28	0.28	0.09	0.37	55.0	200	0.65	26.44	0.01	0.84	0.29
	502A	503A	0.13		11	0.41	34	3.7	0.41		0.00		0.00		0.00	0.00	0.13	0.41	0.14	0.54	11.0	200	0.35	19.40	0.03	0.62	0.26
			0.28		23	0.69	57				0.00		0.00		0.00		0.28	0.69									
	503A	508A	0.33		27	1.02	84	3.6	0.98		0.00		0.00		0.00	0.00	0.33	1.02	0.34	1.32	101.5	200	0.35	19.40	0.07	0.62	0.35
To STREET A, Pipe 508A - 509A						1.02	84				0.00		0.00		0.00			1.02									
	501A	504A	0.17		14	0.17	14	3.7	0.17		0.00		0.00		0.00	0.00	0.17	0.17	0.06	0.22	11.0	200	0.65	26.44	0.01	0.84	0.26
	504A	505A	0.56		45	0.73	59	3.6	0.70		0.00		0.00		0.00	0.00	0.56	0.73	0.24	0.94	80.5	200	0.35	19.40	0.05	0.62	0.31
	505A	507A	0.14		12	0.87	71	3.6	0.83		0.00		0.00		0.00	0.00	0.14	0.87	0.29	1.12	21.5	200	0.40	20.74	0.05	0.66	0.35
To STREET A, Pipe 507A - 508A						0.87	71				0.00		0.00		0.00			0.87									
STREET A																											
Contribution From STREET B, Pipe 505A - 507A						0.87	71				0.00		0.00		0.00		0.87	0.87									
Contribution From STREET B, Pipe 506A - 507A						0.14	12				0.00		0.00		0.00		0.14	1.01									
	507A	508A	0.26		21	1.27	104	3.6	1.21		0.00		0.00		0.00	0.00	0.26	1.27	0.42	1.63	74.0	250	0.30	32.57	0.05	0.66	0.34
Contribution From STREET B, Pipe 503A - 508A						1.02	84				0.00		0.00		0.00		1.02	2.29									
	508A	509A	0.22		18	2.51	206	3.5	2.35		0.00		0.00		0.00	0.00	0.22	2.51	0.83	3.17	60.5	250	0.30	32.57	0.10	0.66	0.42
	509A	510A	0.22		18	2.73	224	3.5	2.54		0.00		0.00		0.00	0.00	0.22	2.73	0.90	3.44	60.5	250	0.30	32.57	0.11	0.66	0.43
	510A	511A	0.24		20	2.97	244	3.5	2.76		0.00		0.00		0.00	0.00	0.24	2.97	0.98	3.74	61.5	250	0.30	32.57	0.11	0.66	0.44

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da	0.10764	l/s/Ha
Average Daily Flow =	280	l/p/day		
Comm/Inst Flow =	28000	L/ha/da	0.3241	l/s/Ha
Industrial Flow =	35000	L/ha/da	0.40509	l/s/Ha
Max Res. Peak Factor =	4.00			
Commercial/Inst./Park Peak Factor =	1.00			
Institutional =	0.32	l/s/Ha		

Industrial Peak Factor = as per MOE Graph
Extraneous Flow = 0.330 L/s/ha
Minimum Velocity = 0.600 m/s
Manning's n = (Conc) 0.013 (Pvc) 0.013
Townhouse coeff= 2.7
Single house coeff= 3.4

Designed: A.K.
Checked: W.L.
Dwg. Reference: 2B

PROJECT: **CAIVAN RICHMOND SOUTH LAFFIN LAND**
LOCATION: **City of Ottawa**
File Ref: 20-1184
Date: **Jul 2021**
Sheet No. 1 of 2

LAFFIN LANDS

W. LIU
100167932
21-07-27

TOTAL FLOWS FROM LAFFIN ONLY

SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	POP.	CUMULATIVE		PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL.	
						AREA (ha)	POP.																			(FULL) (m/s)	(ACT.) (m/s)
	511A	513A	0.19		16	3.16	260	3.5	2.94		0.00		0.00		0.00	0.00	0.19	3.16	1.04	3.98	60.5	250	0.30	32.57	0.12	0.66	0.45
To STREET F, Pipe 513A - 514A						3.16	260				0.00		0.00		0.00			3.16									
STREET F																											
	512A	513A	0.11		9	0.11	9	3.7	0.11		0.00		0.00		0.00	0.00	0.11	0.11	0.04	0.15	30.5	200	0.65	26.44	0.01	0.84	0.22
Contribution From STREET A, Pipe 511A - 513A						3.16	260				0.00		0.00		0.00		3.16	3.27									
	513A	514A	0.71		57	3.98	326	3.5	3.65		0.00		0.00		0.00	0.00	0.71	3.98	1.31	4.96	120.0	250	0.30	32.57	0.15	0.66	0.48
	514A	524A	0.05		4	4.03	330	3.4	3.69		0.00		0.00		0.00	0.00	0.05	4.03	1.33	5.02	9.5	250	0.30	32.57	0.15	0.66	0.48
To SAN TRUNK 2, Pipe 524A - 525A						4.03	330				0.00		0.00		0.00			4.03									
SAN TRUNK 2																											
Contribution From PATHWAY SERVICING BLOCK, Pipe 523A - 524A						2.79	227				0.00		0.00		0.00		2.79	2.79									
Contribution From STREET F, Pipe 514A - 524A						4.03	330				0.00		0.00		0.00		4.03	4.03									
			0.15		12	6.97	569				0.00		0.00		0.00		0.15	6.97									
	524A	525A	0.15	3	11	7.12	580	3.4	6.30		0.00		0.00		0.00	0.00	0.15	7.12	2.35	8.65	61.0	250	0.30	32.57	0.27	0.66	0.56
	525A	526A	0.80	18	62	7.92	642	3.3	6.93		0.00		0.00		0.00	0.00	0.80	7.92	2.61	9.55	83.5	250	0.30	32.57	0.29	0.66	0.58
			0.32	2	7	8.24	649				0.00		0.00		0.00		0.32	8.24									
	526A	8A	6.30		481	14.54	1130	3.2	11.76		0.00		0.00		0.00	0.00	6.30	14.54	4.80	16.56	81.5	250	0.30	32.57	0.51	0.66	0.66
	8A	9A	0.12	3	11	14.66	1141	3.2	11.87		0.00		0.00		0.00	0.00	0.12	14.66	4.84	16.71	26.0	250	0.30	32.57	0.51	0.66	0.67
	9A	11A	0.25	4	14	14.91	1155	3.2	12.00		0.00		0.00		0.00	0.00	0.25	14.91	4.92	16.92	11.0	250	0.30	32.57	0.52	0.66	0.67
	11A	12A	0.26	6	21	15.17	1176	3.2	12.21		0.00		0.00		0.00	0.00	0.26	15.17	5.01	17.21	44.5	250	0.30	32.57	0.53	0.66	0.67
	12A	13A	0.26	6	21	15.43	1197	3.2	12.41		0.00		0.00		0.00	0.00	0.26	15.43	5.09	17.50	42.0	250	0.30	32.57	0.54	0.66	0.67
To SAN TRUNK 2, Pipe 13A - 20A						15.43	1197				0.00		0.00		0.00			15.43									
SAN TRUNK 1																											
Contribution From SAN TRUNK 2, Pipe 12A - 13A						15.43	1197				0.00		0.00		0.00		15.43	15.43									
						15.43	1197				0.00		0.00		0.00		0.00	15.43									
	13A	20A	0.25	3	11	15.68	1208	3.2	12.51		0.00		0.00		0.00	0.00	0.25	15.68	5.17	17.69	65.5	300	0.20	43.25	0.41	0.61	0.58
			38.75		2874	54.43	4082				0.00	2.84	2.84	4.21	4.21		45.80	61.48									
	20A	21A				54.43	4082	2.9	37.84		0.00		2.84		4.21	1.37	0.00	61.48	20.29	59.50	47.5	450	0.12	98.76	0.60	0.62	0.65
	21A	Ex Plug				54.43	4082	2.9	37.84		0.00		2.84		4.21	1.37	0.00	61.48	20.29	59.50	13.5	450	0.19	124.27	0.48	0.78	0.77
						54.43	4082				0.00		2.84		4.21			61.48									

DESIGN PARAMETERS

Park Flow =	9300	L/ha/da	0.10764	l/s/Ha					
Average Daily Flow =	280	l/p/day			Industrial Peak Factor = as per MOE Graph				
Comm/Inst Flow =	28000	L/ha/da	0.3241	l/s/Ha	Extraneous Flow =		0.330	L/s/ha	
Industrial Flow =	35000	L/ha/da	0.40509	l/s/Ha	Minimum Velocity =		0.600	m/s	
Max Res. Peak Factor =	4.00				Manning's n =	(Conc)	0.013	(Pvc)	0.013
Commercial/Inst./Park Peak Factor =	1.00				Townhouse coeff=		2.7		
Institutional =	0.32	l/s/Ha			Single house coeff=		3.4		

Designed: A.K.	PROJECT: CAIVAN RICHMOND SOUTH LAFFIN LAND		
Checked: W.L.	LOCATION: City of Ottawa		
Dwg. Reference: 2B	File Ref: 20-1184	Date: Jul 2021	Sheet No. 2 of 2

TOTAL FLOWS FROM ALL SOUTH LANDS TO PHASE 1 SEWER (i.e. less than the flow of 62.33L/s estimated during sanitary sewer design for Fox Run Phase 1 sewers).

SANITARY SEWER CALCULATION SHEET

Ottawa

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA Nominal (mm)	DIA Actual (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)
cercle Equitation Circle																											
	5A	6A	0.38	9	30.6	0.38	30.6	4.00	0.50								0.38	0.38	0.106	0.61	50.0	200	200	0.90	31.12	0.02	0.99
	6A	7A	0.71	20	68.0	1.09	98.6	4.00	1.60								0.71	1.09	0.305	1.91	107.5	200	200	0.40	20.74	0.09	0.66
To cercle Equitation Circle , Pipe 7A - 8A						1.09	98.6																				
	1A	2A	0.24	4	13.6	0.24	13.6	4.00	0.22								0.24	0.24	0.067	0.29	40.0	200	200	0.65	26.44	0.01	0.84
	2A	3A	0.38	8	27.2	0.62	40.8	4.00	0.66								0.38	0.62	0.174	0.83	94.0	200	200	0.40	20.74	0.04	0.66
	3A	4A	0.06	1	3.4	0.68	44.2	4.00	0.72								0.06	0.68	0.190	0.91	11.0	200	200	0.40	20.74	0.04	0.66
	4A	7A	0.29	7	23.8	0.97	68.0	4.00	1.10								0.29	0.97	0.272	1.37	62.5	200	200	0.85	30.24	0.05	0.96
Contribution From cercle Equitation Circle, Pipe 6A - 7A						1.09	98.6										1.09	2.06									
	7A	8A	0.25	5	17.0	2.31	183.6	4.00	2.98								0.25	2.31	0.647	3.63	70.5	200	200	0.40	20.74	0.18	0.66
To croissant Hackamore Crescent , Pipe 8A - 152A						2.31	183.6																				
croissant Hackamore Crescent																											
Contribution From Future Phase						0.94	72.0										0.94	0.94									
	PLUG	8A	0.04	1	3.4	0.98	75.4	4.00	1.22								0.04	0.98	0.274	1.49	11.0	200	200	0.50	23.19	0.06	0.74
Contribution From cercle Equitation Circle, Pipe 7A - 8A						2.31	183.6										2.31	3.29									
	8A	152A	0.26	5	17.0	3.55	276.0	4.00	4.47								0.26	3.55	0.994	5.46	73.5	200	200	0.40	20.74	0.26	0.66
To chemin Meynell Road, Pipe 152A - 153A						3.55	276.0																				
croissant Cantle Crescent																											
Contribution From Flushing Device (1.50 L/s)																				1.50							
	9A	152A	0.34	4	13.6	0.34	13.6	4.00	0.22								0.34	0.34	0.095	1.82	59.0	200	200	0.65	26.44	0.07	0.84
To chemin Meynell Road, Pipe 152A - 153A						0.34	13.6																				
	10A	11A	0.22	3	10.2	0.22	10.2	4.00	0.17								0.22	0.22	0.062	0.23	16.5	200	200	0.65	26.44	0.01	0.84
	11A	153A	0.65	16	54.4	0.87	64.6	4.00	1.05								0.65	0.87	0.244	1.29	103.5	200	200	0.35	19.40	0.07	0.62
To chemin Meynell Road, Pipe 153A - 155A						0.87	64.6																				
Contribution From Future Phase						1.73	130.0										1.73	1.73									
	PLUG	153A	0.00	0	0.0	1.73	130.0	4.00	2.11								0.00	1.73	0.484	2.59	15.5	200	200	0.40	20.74	0.12	0.66
To chemin Meynell Road, Pipe 153A - 155A						1.73	130.0																				
croissant Pelham Crescent																											
	12A	13A	0.36	7	23.8	0.36	23.8	4.00	0.39								0.36	0.36	0.101	0.49	38.0	200	200	0.65	26.44	0.02	0.84
	13A	155A	0.65	16	54.4	1.01	78.2	4.00	1.27								0.65	1.01	0.283	1.55	105.0	200	200	0.40	20.74	0.07	0.66
To chemin Meynell Road, Pipe 155A - 156A						1.01	78.2																				
	1500A	15A	0.11	1	3.4	0.11	3.4	4.00	0.06								0.11	0.11	0.031	0.09	10.0	200	200	0.65	26.44	0.00	0.84
	15A	16A	0.27	6	20.4	0.38	23.8	4.00	0.39								0.27	0.38	0.106	0.50	37.0	200	200	0.65	26.44	0.02	0.84
	16A	156A	0.73	19	64.6	1.11	88.4	4.00	1.43								0.73	1.11	0.311	1.74	112.0	200	200	0.40	20.74	0.08	0.66
To chemin Meynell Road, Pipe 156A - 157A						1.11	88.4																				
Contribution From Future Phase						2.25	162.0										2.25	2.25									
	PLUG	156A	0.00	0	0.0	2.25	162.0	4.00	2.63								0.00	2.25	0.630	3.26	14.5	200	200	0.40	20.74	0.16	0.66
To chemin Meynell Road, Pipe 156A - 157A						2.25	162.0																				

W. LIU
100167932
NOV 17, 2017

DESIGN PARAMETERS

Average Daily Flow =	350	l/p/day	Industrial Peak Factor = as per MOE Graph		
Commercial/Institution Flow =	50000	L/ha/da	Extraneous Flow =	0.280	L/s/ha
Industrial Flow =	35000	L/ha/da	Minimum Velocity =	0.60	m/s
Max Res. Peak Factor =	4.00		Manning's n =	0.013	
Commercial/Institution/Park Peak Factor =	1.50		Townhouse coeff=	2.7	
Park Average Flow =	9300	L/ha/da	Single house coeff=	3.4	

Designed: K.M.

Checked: W.L.

Dwg. Reference: Sanitary Drainage Plan, Dwg. No. 39 - 40

PROJECT: **Caivan Coomunities - Richmond Phase 1**

LOCATION: **City of Ottawa**

File Ref: 15-783

Date: November, 2017

Sheet No. 1 of 2

SUMMATION OF PROJECTED POPULATIONS FROM THE DEVELOPMENT AREAS NORTH OF PERTH STREET CONSIDERED IN THE FOX RUN PHASE 1 DESIGN:
TO MH150A = 1897 persons

Projected Total flow of 41.93 L/s in the original Fox Run Phase 1 design sheet.

Projected Total flow from the Phase 2 (North) and Green Lands West design sheet (including external areas) = 37.67/s < 41.93 L/s therefore OK for downstream capacities.

SANITARY SEWER CALCULATION SHEE

Manning's n=0.013

LOCATION			RESIDENTIAL AREA AND POPULATION							COMM		INSTIT		PARK		C+I+I	INFILTRATION				PIPE						
STREET	FROM M.H.	TO M.H.	AREA (ha)	UNITS	POP.	CUMULATIVE AREA (ha)	CUMULATIVE POP.	PEAK FACT.	PEAK FLOW (l/s)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (l/s)	TOTAL FLOW (l/s)	DIST (m)	DIA Nominal (mm)	DIA Actual (mm)	SLOPE (%)	CAP. (FULL) (l/s)	RATIO Q act/Q cap	VEL. (FULL) (m/s)
croissant Reynard Crescent																											
	17A	18A	0.20	2	6.8	0.20	6.8	4.00	0.11								0.20	0.20	0.056	0.17	11.0	200	200	2.00	46.38	0.00	1.48
	18A	19A	0.28	4	13.6	0.48	20.4	4.00	0.33								0.28	0.48	0.134	0.46	61.0	200	200	0.50	23.19	0.02	0.74
	19A	20A	0.09	1	3.4	0.57	23.8	4.00	0.39								0.09	0.57	0.160	0.55	11.0	200	200	0.40	20.74	0.03	0.66
	20A	160A	0.77	9	30.6	1.34	54.4	4.00	0.88								0.77	1.34	0.375	1.26	114.0	200	200	0.40	20.74	0.06	0.66
To cour Noriker Court, Pipe 160A - 161A						1.34	54.4																				
	17A	159A	0.84	13	44.2	0.84	44.2	4.00	0.72								0.84	0.84	0.235	0.96	113.5	200	200	0.65	26.44	0.04	0.84
To cour Noriker Court, Pipe 159A - 160A						0.84	44.2																				
chemin Meynell Road																											
Contribution From External						31.61	1897.0			1.12		2.75		1.13			36.61	36.61									
	150A	151A	0.45	7	23.8	32.06	1920.8	3.60	28.01		1.12		2.75		1.13	3.54	0.45	37.06	10.377	41.93	73.5	450	450	0.13	102.80	0.41	0.65
	151A	152A	0.51	11	37.4	32.57	1958.2	3.59	28.48		1.12		2.75		1.13	3.54	0.51	37.57	10.520	42.54	73.5	450	450	0.13	102.80	0.41	0.65
Contribution From croissant Cantle Crescent, Pipe 9A - 152A						0.34	13.6										0.34	37.91									
Contribution From croissant Hackamore Crescent, Pipe 8A - 152A						3.55	276.0										3.55	41.46									
	152A	153A	0.13	0	0.0	36.59	2247.8	3.55	32.33		1.12		2.75		1.13	3.54	0.13	41.59	11.645	49.02	70.5	450	450	0.13	102.80	0.48	0.65
Contribution From Future Street, Pipe Plug - 153A						1.73	130.0										1.73	43.32									
Contribution From croissant Cantle Crescent, Pipe 11A - 153A						0.87	64.6										0.87	44.19									
	153A	155A	0.14	0	0.0	39.33	2442.4	3.52	34.83		1.12		2.75		1.13	3.54	0.14	44.33	12.412	52.28	70.5	450	450	0.13	102.80	0.51	0.65
Contribution From Block 236 (Park)														0.96	0.96	0.16	0.96	0.96	0.269	0.43	13.0	200	200	1.00	32.80	0.01	1.04
Contribution From croissant Pelham Crescent, Pipe 13A - 155A						1.01	78.2										1.01	46.30									
	155A	156A	0.14	0	0.0	40.48	2520.6	3.51	35.84		1.12		2.75		2.09	3.70	0.14	46.44	13.003	54.04	71.0	450	450	0.13	102.80	0.53	0.65
Contribution From Future Street, Pipe Plug - 156A						2.25	162.0										2.25	48.69									
Contribution From croissant Pelham Crescent, Pipe 16A - 156A						1.11	88.4										1.11	49.80									
	156A	157A	0.63	12	40.8	44.47	2811.8	3.47	39.52		1.12		2.75		2.09	3.70	0.63	50.43	14.120	58.84	102.5	450	450	0.13	102.80	0.57	0.65
	157A	158A	0.68	15	51.0	45.15	2862.8	3.46	40.13		1.12		2.75		2.09	3.70	0.68	51.11	14.311	59.64	92.5	450	450	0.13	102.80	0.58	0.65
To cour Noriker Court, Pipe 158A - 159A						45.15	2862.8				1.12		2.75		2.09												
cour Noriker Court																											
Contribution From Future Phase						4.42	330.0										4.42	4.42									
	PLUG	158A	0.00	0	0.0	4.42	330.0	4.00	5.35								0.00	4.42	1.238	6.59	14.0	200	200	0.35	19.40	0.34	0.62
Contribution From chemin Meynell Road, Pipe 157A - 158A						45.15	2862.8				1.12		2.75		2.09		51.11	55.53									
	158A	159A	0.34	4	13.6	49.91	3206.4	3.42	44.42		1.12		2.75		2.09	3.70	0.34	55.87	15.644	65.26	79.5	450	450	0.13	102.80	0.63	0.65
Contribution From croissant Reynard Crescent, Pipe 17A - 159A						0.84	44.2										0.84	56.71									
	159A	160A	0.37	5	17.0	51.12	3267.6	3.41	45.14		1.12		2.75		2.09	3.70	0.37	57.08	15.982	66.32	76.5	450	450	0.13	102.80	0.65	0.65
Contribution From croissant Reynard Crescent, Pipe 20A - 160A						1.34	54.4										1.34	58.42									
	160A	161A	0.36	4	13.6	52.82	3335.6	3.40	45.94		1.12		2.75		2.09	3.70	0.36	58.78	16.458	67.60	72.5	450	450	0.13	102.80	0.66	0.65
To Block 222 (SWM Pond), Pipe 161A - 121A						52.82	3335.6				1.12		2.75		2.09												
Block 222 (SWM Pond)																											
Contribution From External						51.61	3097.0					2.65		4.10			58.36	58.36									
	PLUG	161A	0.00	0	0.0	51.61	3097.0	3.43	43.03				2.65		4.10	2.96	0.00	58.36	16.341	62.33	48.5	450	450	0.13	102.80	0.61	0.65
Contribution From cour Noriker Court, Pipe 160A - 161A						52.82	3335.6				1.12		2.75		2.09		58.78	117.14									
	161A	121A	0.00	0	0.0	104.43	6432.6	3.14	81.82		1.12		5.40		6.19	6.66	0.00	117.14	32.799	122.78	42.0	600	600	0.12	212.70	0.58	0.75
To Sanitary Trunk, Pipe 121A - 123A						104.43	6432.6				1.12		5.40		6.19												

LICENSED PROFESSIONAL ENGINEER
W. LIU
100167932
Nov 17, 2017
PROVINCE OF ONTARIO

DESIGN PARAMETERS

Average Daily Flow = 350 l/p/day
Commercial/Institution Flow = 50000 L/ha/da
Industrial Flow =
Max Res. Peak Factor =
Commercial/Institution/Park Pe
Park Average Flow =

Industrial Peak Factor = as per MOE Graph
Extraneous Flow = 0.280 L/s/ha

Designed: K.M.
Checked:
No. 39 - 40

PROJECT: **Caivan Coomunities - Richmond Phase 1**
LOCATION: **City of Ottawa**
File Ref: 15-783
Date: November, 2017
Sheet No. 2 of 2

SUMMATION OF PROJECTED POPULATIONS FROM THE AREAS SOUTH OF FOX RUN PHASE 1 DESIGN (i.e. Mattamy Lands and the Laffin Lands (RVDC):
TO MH161A

Projected Total flow of 62.33 L/s in the Phase 1 design sheet.

Projected Total flow from the Mattamy Lands and Laffin Lands design sheet = 59.50L/s < 62.33 L/s therefore OK for downstream capacities

Memo

Stantec

To:	Adam Fobert	From:	James Ricker / John Krug
	David Schaeffer Engineering Ltd. 120 Iber Road, Unit 203 Stittsville, ON		Stantec Consulting Ltd. 1505 Laperriere Ave. Ottawa, ON
File:	163401146	Date:	October 5, 2012

Reference: Richmond Pump Station – Design Level of Service

EXISTING CONDITIONS / BACKGROUND

The Richmond Pumping Station (RPS), located at 63 York Street consists of a dry well/wet well configuration equipped with emergency power, communication and control systems. The RPS moves wastewater collected from the villages of Richmond and Munster through a 13.85 km, 500 mm diameter forcemain to an outfall along the Glen Cairn trunk located on Eagleson Road across from the Hazeldean Mall. The RPS has an overflow to the Jock River and a bypass with two (2) portable connections to protect the station from flooding. Sewage can also be pumped to a lagoon cell C located off Eagleson Road during high flows or directly to the river in extreme measures. A biological odor control system is also installed in the wet well to remove hydrogen sulfide from the air.

The RPS has four (4) pumps utilizing a lead-lag configuration with a maximum firm capacity discharge flow of 160 L/s.

Typical water levels in the Jock River at the Station are 90.89m with a 100 year water level of 93.80m, which means the overflow is currently not effective to protect local residential basements should a catastrophic pump station failure occur during high water conditions.

TARGET LEVEL OF SERVICE

It is our understanding that City Staff have requested consideration for the following level of service with respect to sanitary servicing of the new development area:

- Provide a firm capacity of the station (i.e. largest pump out of service) with a 1:100 year peak flow to the station;
- Provide the ability to pump flow with primary power failure;
- Provide the ability to overflow should the secondary diesel generator backup power fail (i.e. catastrophic failure);

MINISTRY OF THE ENVIRONMENT (MOE) DESIGN GUIDELINES

The following excerpts from the 2008 MOE Design Guidelines for Sewage Works are generally considered as the minimum requirements for pump station design:

- 7.1.1 Station Capacity – "Sewage pump stations serving sanitary sewer systems should be able to pump the design peak instantaneous sewage flow."
    - *Comment: This condition is currently met and will be met with the proposed MSS upgrades.*
- 7.1.2 Flooding – "Sewage pumping stations structures and electrical and mechanical equipment should be protected from physical damage by the 100 year design event. Sewage pumping stations should remain fully operational and accessible during the 25-year flood event."
    - *Comment: This condition is currently met as floor elevation of pump station structure is at 94.0m, which is above the reported 1:100yr HWL of 93.80m thereby protecting electrical and mechanical equipment. The station is also fully operational in the 100 year event. The proposed upgrades at the station will not impact this condition.*
- 7.2.3 Pumps – "Multiple pumps should be provided. Where only two units are provided, they should be of the same size, to provide a firm capacity with one unit out-of service and at least capable of handling the 10-year design peak hourly flow."
    - *Comment: Condition currently met as there are four pumps (2 small and 2 large) to provide firm capacity. The MSS proposes to provide sufficient capacity to meet or exceed this condition.*
- 7.7 Standby Power and Emergency Operation – "Emergency pumping capability is required unless on-system overflow prevention is provided by adequate storage capacity. Emergency pumping capability should be accomplished by provision of portable or in-place internal combustion engine equipment, which will generate electrical or mechanical energy, or by the provision of portable pumping equipment. For engine driven generating equipment, an automatic transfer switch should be provided to allow for bypass of unit for service. Such emergency standby systems should have sufficient capacity to start up and maintain the design capacity of the pumping station. Regardless of the type of emergency standby system provided, a portable pump connection to the forcemain with rapid connection capabilities and appropriate valving should be provided outside the dry well and wet well."
    - *Comment: This condition is currently met with a backup diesel generator and automatic transfer switch should primary power be unavailable. The system has sufficient capacity to provide the existing station with a firm capacity of 160L/s and is proposed to be upgraded with sufficient backup power to meet future firm capacity requirements. There is also provision at the station to connect portable pumps should they be required.*

- "Emergency High Level Overflows: A controlled, high-level wet well overflow to supplement alarm systems and emergency power generation should be provided for use during possible periods of extensive power outages, mandatory power reductions, or uncontrollable emergency conditions. Where a high level overflow is utilized, consideration should also be given to the installation of storage/detention tanks, or basins, which should be made to drain to the pumping station wetwell. Where such overflows may affect public water supplies or other critical water uses, the ministry should be contacted for the necessary treatment or storage requirements and in the case of combined sewer overflow the application of the ministry Procedure F-5-5 to the site-specific conditions."
    - *Comment: The station has approval from the MOE to have an existing high level overflow to the Jock River should the station be overwhelmed to prevent basement flooding under normal water river levels.*

CITY OF OTTAWA SEWER DESIGN GUIDELINES

The City's November 2004 sewer design guidelines are consistent with the MOE's requirements as listed above. In addition, the City's guidelines for flood protection/overflow are more prescriptive giving specific design levels for the overflow elevation (i.e. 1m below basement elevation and the overflow ***should*** be above the 100 year elevation):

"7.2.1.6.8 Emergency Provision for Flood Protection

In anticipation of a potential catastrophic failure of a wastewater pumping facility and above contingency provisions, **the feasibility of providing a gravity based emergency conduit is to be evaluated** as a "last line of protection" against basement flooding. The elevation and hydraulic capacity of emergency conduit connections are to be optimized to minimize the risk of basement flooding due to sanitary system backup. **The elevation of this conduit must be maintained at least 1.0 m below the elevation of the lowest basement elevation within the service area.** This emergency connection should permit the excess flow to bypass the pumping station. If this is not possible, then a conduit from the pumping station wet well will be permitted.

Provision for an emergency conduit connection to an adjacent or downstream sanitary sewer system is preferred; however, a connection of the conduit to a storm sewer system or watercourse is often the only feasible option. Emergency conduit connections to storm sewers with downstream stormwater treatment facilities are preferred over direct connections to watercourses. **Emergency conduit connections should be above the 100-year stormwater elevation.**

Emergency conduit connections to storm sewers, storage facilities, natural water courses, or surface outfall points will be subject to approval by the Ontario Ministry of the Environment. The emergency conduits should also be identified as part of the Municipal Class Environmental Assessment Process. Emergency conduit connections see Section 4.1.1 of DSEL design brief for discussion

shall be provided with suitable protection to prevent backflow from the flow receptor into the pumping station. This may consist of backwater valves and/or shut off valving."

- *Comment: The existing overflow currently does not meet the City's guidelines of being above the 100 year stormwater elevation (i.e. 93.8m at this location), which states that this elevation "should" be met, but does not state that this condition "shall" be met. There are other pump stations in Ottawa that operate with similar high level overflows that are below the 100 year elevation (i.e. Signature Ridge PS).*

PROPOSED RPS UPGRADES

The proposed RPS upgrades within the MSS do not impact the current level of service at the station. The station currently meets, and the future upgrades will meet, the MOE and City's design guidelines. The only concern to be noted is that both the existing condition and proposed future upgrade will have an overflow elevation that is not consistent with the City's 2004 design guideline that the elevation "should" be above the 100 year stormwater elevation. Given the topography of the Richmond area this condition cannot be met.

In the event of catastrophic failure of the pump station, the City can bring additional measures to bear to prevent basement flooding and/or overflow including portable pumping or portable backup generator power. In the unlikely event of a catastrophic failure of the pump station during the 100 year storm event, the Western Development lands would likely not be affected immediately, as these lands lie a distance away from the pump station and the existing village lies between the pump station and the new development.

Given the remote possibility of each of these occurrences happening at the same time (i.e. 100yr event, primary power failure, backup generator failure) a probability cannot be accurately determined.

James Ricker, P.Eng.
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John Krug, P.Eng.
Managing Principal - Water
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APPENDIX E

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Arterial Roads Return Frequency = 10 years

Manning 0.013

	LOCATION		AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Conc.	2 Year	5 Year	10 Year	100 Year										
Location	From Node	To Node	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(min)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min	Q/Q full
LANE 'A'																																	
	445	446	0.24	0.70	0.47	0.47			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	36	300	300	PVC	0.35	88.5	57.21	0.81	1.82	0.63
To STREET 'J', Pipe 446 - 263						0.47				0.00				0.00				0.00	11.82														
STREET 'L'																																	
	440	441	0.53	0.70	1.03	1.03			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	79	450	450	CONC	0.20	86.0	127.50	0.80	1.79	0.62
	441	443	0.48	0.70	0.93	1.97			0.00	0.00			0.00	0.00			0.00	0.00	11.79	70.56	95.61	112.04	163.72	139	525	525	CONC	0.20	86.0	192.33	0.89	1.61	0.72
To STREET 'Q', Pipe 443 - 444						1.97				0.00				0.00				0.00	13.40														
COMMERCIAL OUTLET																																	
	1001	435			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	0	450	450	CONC	0.20	29.0	127.50	0.80	0.60	0.00
To STREET 'I', Pipe 435 - 436						0.00				0.00				0.00				0.00	10.60														
STREET 'I'																																	
Contribution From COMMERCIAL OUTLET, Pipe 1001 - 435						0.00				0.00				0.00				0.00	10.60														
	435	436	0.66	0.70	1.28	1.28			0.00	0.00			0.00	0.00			0.00	0.00	10.60	74.56	101.11	118.51	173.23	96	600	600	CONC	0.15	98.5	237.81	0.84	1.95	0.40
	436	437	0.36	0.70	0.70	1.98			0.00	0.00			0.00	0.00			0.00	0.00	12.55	68.21	92.39	108.25	158.15	135	600	600	CONC	0.15	73.0	237.81	0.84	1.45	0.57
To STREET 'Q', Pipe 437 - 438						1.98				0.00				0.00				0.00	14.00														
STREET 'Q'																																	
	442	443	0.16	0.70	0.31	0.31			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	24	300	300	PVC	0.35	51.5	57.21	0.81	1.06	0.42
Contribution From STREET 'L', Pipe 441 - 443						1.97				0.00				0.00				0.00	13.40														
	443	444	0.08	0.70	0.16	2.43			0.00	0.00			0.00	0.00			0.00	0.00	13.40	65.82	89.11	104.38	152.47	160	525	525	CONC	0.25	35.5	215.03	0.99	0.60	0.74
To STREET 'J', Pipe 444 - 446						2.43				0.00				0.00				0.00	14.00														
Contribution From STREET 'O', Pipe 429 - 432						2.08				0.00				0.00				0.00	13.38														
Contribution From STREET 'O', Pipe 431 - 432						1.03				0.00				0.00				0.00	12.38														
	432	437	0.21	0.70	0.41	3.52			0.00	0.00			0.00	0.00			0.00	0.00	13.38	65.87	89.18	104.47	152.60	232	825	825	CONC	0.10	61.5	453.92	0.85	1.21	0.51
Contribution From STREET 'I', Pipe 436 - 437						1.98				0.00				0.00				0.00	14.00														
	437	438	0.66	0.70	1.28	6.79			0.00	0.00			0.00	0.00			0.00	0.00	14.59	62.76	84.91	99.44	145.23	426	825	825	CONC	0.15	112.0	555.94	1.04	1.79	0.77
	438	439	0.15	0.70	0.29	7.08			0.00	0.00			0.00	0.00			0.00	0.00	16.38	58.68	79.34	92.89	135.62	416	825	825	CONC	0.15	12.5	555.94	1.04	0.20	0.75
	439	444	0.06	0.70	0.12	7.20			0.00	0.00			0.00	0.00			0.00	0.00	16.58	58.27	78.77	92.22	134.63	420	900	900	CONC	0.10	20.0	572.47	0.90	0.37	0.73
To STREET 'J', Pipe 444 - 446						7.20				0.00				0.00				0.00	16.95														
STREET 'J'																																	
Contribution From STREET 'Q', Pipe 439 - 444						7.20				0.00				0.00				0.00	16.95														
Contribution From STREET 'Q', Pipe 443 - 444						2.43				0.00				0.00				0.00	14.00														
	444	446	0.04	0.70	0.08	9.71			0.00	0.00			0.00	0.00			0.00	0.00	16.95	57.51	77.73	91.00	132.85	558	975	975	CONC	0.10	34.5	708.68	0.95	0.61	0.79
Contribution From LANE 'A', Pipe 445 - 446						0.47				0.00				0.00				0.00	11.82														
	446	263			0.00	10.18	0.06	0.65	0.11	0.11			0.00	0.00			0.00	0.00	17.56	56.32	76.11	89.09	130.04	581	1050	1050	CONC	0.25	37.5	1365.36	1.58	0.40	0.43
To OLDENBURG AVENUE, Pipe 263 - 264						10.18				0.11				0.00				0.00	17.96														
STREET 'P'																																	
	422	423	0.49	0.65	0.89	0.89			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	68	375	375	PVC	0.30	66.5	96.03	0.87	1.27	0.71
	423	424	0.42	0.65	0.76	1.64			0.00	0.00			0.00	0.00			0.00	0.00	11.27	72.23	97.91	114.74	167.69	119	450	450	CONC	0.30	66.5	156.16	0.98	1.13	0.76
To STREET 'H', Pipe 424 - 425						1.64				0.00				0.00				0.00	12.40														
STREET 'H'																																	
Contribution From STREET 'O', Pipe 420 - 421						1.79				0.00				0.00				0.00	12.54														
	421	424	0.30	0.65	0.54	2.34			0.00	0.00			0.00	0.00			0.00	0.00	12.54	68.25	92.45	108.31	158.25	159	600	600	CONC	0.15	72.0	237.81	0.84	1.43	0.67
Contribution From STREET 'P', Pipe 423 - 424						1.64				0.00				0.00				0.00	12.40														
	424	425	0.45	0.65	0.81	4.79			0.00	0.00			0.00	0.00			0.00	0.00	13.97	64.32	87.05	101.96	148.92	308	750	750	CONC	0.15	106.0	431.17	0.98	1.81	0.71
					0.00	4.79	1.28	0.40	1.42	1.42			0.00	0.00			0.00	0.00															
	425	309	0.12	0.65	0.22	5.01			0.00	1.42			0.00	0.00			0.00	0.00	15.78	59.99	81.12	94.99	138.70	416	750	750	CONC	0.15	72.0	431.17	0.98	1.23	0.96
To OLDENBURG AVENUE, Pipe 309 - 310						5.01				1.42				0.00				0.00	17.01														
STREET 'K'																																	
	404	405	0.25	0.65	0.45	0.45			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	35	300	300	PVC	0.35	61.0	57.21	0.81	1.26	0.61

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Green Lands

Designed: CPB
Checked: SLM
Dwg. Reference: 3A

PROJECT: **Caivan (Richmond North) Ltd**
LOCATION: **City of Ottawa**
File Ref: 20-1183
Date: August 2021
Sheet No. SHEET 1 OF 3

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Arterial Roads Return Frequency = 10 years

Manning 0.013

	LOCATION		AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)	DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF LOW (min	RATIO Q/Q full
Location	From Node	To Node	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC															
Contribution From STREET 'N', Pipe 403 - 405						2.64				0.00				0.00				0.00	12.58														
	405	409	0.29	0.65	0.52	3.61			0.00	0.00			0.00	0.00			0.00	0.00	12.58	68.13	92.27	108.11	157.94	246	675	675	CONC	0.15	71.5	325.56	0.91	1.31	0.76
To STREET 'O', Pipe 409 - 304						3.61				0.00				0.00				0.00	13.89														
STREET 'O'																																	
	406	420	0.54	0.65	0.98	0.98			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	75	375	375	PVC	0.30	67.0	96.03	0.87	1.28	0.78
			0.03	0.70	0.06	1.03			0.00	0.00			0.00	0.00			0.00	0.00															
	420	421	0.42	0.65	0.76	1.79			0.00	0.00			0.00	0.00			0.00	0.00	11.28	72.20	97.87	114.69	167.61	129	525	525	CONC	0.20	67.0	192.33	0.89	1.26	0.67
To STREET 'H', Pipe 421 - 424						1.79				0.00				0.00				0.00	12.54														
	428	429	0.57	0.70	1.11	1.11			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	85	450	450	CONC	0.20	85.5	127.50	0.80	1.78	0.67
	429	432	0.50	0.70	0.97	2.08			0.00	0.00			0.00	0.00			0.00	0.00	11.78	70.59	95.66	112.09	163.79	147	525	525	CONC	0.20	85.5	192.33	0.89	1.60	0.76
To STREET 'Q', Pipe 432 - 437						2.08				0.00				0.00				0.00	13.38														
	430	431	0.27	0.70	0.53	0.53			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	40	300	300	PVC	0.35	55.5	57.21	0.81	1.14	0.71
	431	432	0.26	0.70	0.51	1.03			0.00	0.00			0.00	0.00			0.00	0.00	11.14	72.68	98.52	115.46	168.75	75	375	375	PVC	0.30	64.5	96.03	0.87	1.24	0.78
To STREET 'Q', Pipe 432 - 437						1.03				0.00				0.00				0.00	12.38														
	406	407	0.12	0.65	0.22	0.22			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	17	300	300	PVC	0.35	10.5	57.21	0.81	0.22	0.29
	407	408	0.33	0.65	0.60	0.81			0.00	0.00			0.00	0.00			0.00	0.00	10.22	75.98	103.06	120.81	176.61	62	375	375	PVC	0.30	64.5	96.03	0.87	1.24	0.64
	408	409	0.51	0.65	0.92	1.73			0.00	0.00			0.00	0.00			0.00	0.00	11.45	71.64	97.10	113.79	166.29	124	675	675	CONC	0.15	84.0	325.56	0.91	1.54	0.38
Contribution From STREET 'K', Pipe 405 - 409						3.61				0.00				0.00				0.00	13.89														
	409	304	0.26	0.65	0.47	5.82			0.00	0.00			0.00	0.00			0.00	0.00	13.89	64.51	87.31	102.27	149.37	375	750	750	CONC	0.25	73.5	556.64	1.26	0.97	0.67
To OLDENBURG AVENUE, Pipe 304 - 305						5.82				0.00				0.00				0.00	14.87														
STREET 'N'																																	
	400	410	0.16	0.65	0.29	0.29			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	22	300	300	PVC	0.55	12.5	71.72	1.01	0.21	0.31
	410	447	0.54	0.65	0.98	1.26			0.00	0.00			0.00	0.00			0.00	0.00	10.21	76.03	103.12	120.88	176.70	96	450	450	CONC	0.20	75.5	127.50	0.80	1.57	0.75
	447	448	0.45	0.65	0.81	2.08			0.00	0.00			0.00	0.00			0.00	0.00	11.77	70.60	95.67	112.10	163.81	147	525	525	CONC	0.20	75.0	192.33	0.89	1.41	0.76
	448	301	0.25	0.65	0.45	2.53			0.00	0.00			0.00	0.00			0.00	0.00	13.18	66.42	89.93	105.35	153.90	168	600	600	CONC	0.15	66.5	237.81	0.84	1.32	0.71
To OLDENBURG AVENUE, Pipe 301 - 302						2.53				0.00				0.00				0.00	14.50														
	400	401	0.30	0.65	0.54	0.54			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	42	300	300	PVC	0.55	56.5	71.72	1.01	0.93	0.58
	401	402	0.15	0.65	0.27	0.81			0.00	0.00			0.00	0.00			0.00	0.00	10.93	73.42	99.53	116.65	170.50	60	375	375	PVC	0.30	13.0	96.03	0.87	0.25	0.62
	402	403	0.52	0.65	0.94	1.75			0.00	0.00			0.00	0.00			0.00	0.00	11.18	72.56	98.36	115.27	168.47	127	525	525	CONC	0.20	75.0	192.33	0.89	1.41	0.66
	403	405	0.49	0.65	0.89	2.64			0.00	0.00			0.00	0.00			0.00	0.00	12.58	68.13	92.27	108.11	157.94	180	600	600	CONC	0.15	75.0	237.81	0.84	1.49	0.76
To STREET 'K', Pipe 405 - 409						2.64				0.00				0.00				0.00	14.07														
OLDENBURG AVENUE																																	
Contribution From STREET 'N', Pipe 411 - 301						2.53				0.00				0.00				0.00	14.50														
	301	302			0.00	2.53			0.00	0.00			0.00	0.00			0.00	0.00	14.50	62.97	85.21	99.80	145.75	159	600	600	CONC	0.15	14.5	237.81	0.84	0.29	0.67
					0.00	2.53	0.15	0.65	0.27	0.27			0.00	0.00			0.00	0.00															
	302	303			0.00	2.53	0.52	0.65	0.94	1.21			0.00	0.00			0.00	0.00	14.79	62.27	84.25	98.67	144.09	260	675	675	CONC	0.20	64.0	375.92	1.05	1.02	0.69
			1.81	0.65	3.27	5.80			0.00	1.21			0.00	0.00			0.00	0.00	15.50														
					0.00	5.80	0.18	0.65	0.33	1.54			0.00	0.00			0.00	0.00															
	303	304			0.00	5.80	0.33	0.65	0.60	2.13			0.00	0.00			0.00	0.00	15.80	59.94	81.05	94.91	138.57	520	750	750	CONC	0.35	71.5	658.62	1.49	0.80	0.79
Contribution From STREET 'O', Pipe 409 - 304						5.82				0.00				0.00				0.00	14.87														
					0.00	11.62	0.06	0.65	0.11	2.24			0.00	0.00			0.00	0.00															
	304	305			0.00	11.62	0.12	0.65	0.22	2.46			0.00	0.00			0.00	0.00	16.60	58.23	78.72	92.16	134.54	870	1050	1050	CONC	0.20	43.0	1221.22	1.41	0.51	0.71
	305	306			0.00	11.62	0.06	0.65	0.11	2.57			0.00	0.00			0.00	0.00	17.11	57.20	77.31	90.50	132.11	863	1050	1050	CONC	0.20	16.0	1221.22	1.41	0.19	0.71
					0.00	11.62	0.17	0.65	0.31	2.87			0.00	0.00			0.00	0.00															
	306	307	0.62	0.65	1.12	12.74			0.00	2.87			0.00	0.00			0.00	0.00	17.30	56.83	76.80	89.90	131.23	945	1200	1200	CONC	0.15	38.0	1509.97	1.34	0.47	0.63
	307	308			0.00	12.74	0.16	0.65	0.29	3.16			0.00	0.00			0.00	0.00	17.77	55.91	75.55	88.44	129.08	951	1200	1200	CONC	0.15	31.0	1509.97	1.34	0.39	0.63
	308	309			0.00	12.74			0.00	3.16			0.00	0.00			0.00	0.00	18.16	55.19	74.57	87.28	127.39	939	1200	1200	CONC	0.15	19.0	1509.97	1.34	0.24	0.62
Contribution From STREET 'H', Pipe 425 - 309						5.01				1.42				0.00				0.00	0.00														
	309	310			0.00	17.75	0.11	0.70	0.21	4.80			0.00	0.00			0.00	0.00	18.40	54.76	73.98	86.59	126.37	1327	1350	1350	CONC	0.10	41.5	1687.83	1.18	0.59	0.79

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: CPB
Checked: SLM
Dwg. Reference: 3A

PROJECT: **Caivan (Richmond North) Ltd**
LOCATION: **City of Ottawa**
File Ref: 20-1183
Date: August 2021
Sheet No. SHEET 1 OF 3

Projected storm flows as compared to the Fox Run Phase 2 (North) design sheet flow of 2,201 L/s

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Arterial Roads Return Frequency = 10 years

Manning 0.013

	LOCATION		AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR																		
Location	From Node	To Node	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)	DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF LOW (min	RATIO Q/Q full
					0.00	17.75	0.17	0.70	0.33	5.13			0.00	0.00			0.00	0.00															
	310	EX 263	0.38	0.70	0.74	18.49			0.00	5.13			0.00	0.00			0.00	0.00	18.98	53.73	72.56	84.93	123.93	1366	1350	1350	CONC	0.10	61.5	1687.83	1.18	0.87	0.81
Contribution From STREET 'J', Pipe 446 - 263						10.18				0.11				0.00				0.00	17.96														
			0.34	0.67	0.63	29.30			0.00	5.24			0.00	0.00			0.00	0.00	11.30														
					0.00	29.30	0.12	0.71	0.24	5.48			0.00	0.00			0.00	0.00															
	EX 263	EX 264			0.00	29.30	0.12	0.75	0.25	5.73			0.00	0.00			0.00	0.00	19.85	52.27	70.57	82.59	120.51	1936	1500	1500	CONC	0.15	75.0	2737.76	1.55	0.81	0.71
					0.00	29.30	0.19	0.75	0.40	6.12			0.00	0.00			0.00	0.00															
			0.21	0.54	0.32	29.61			0.00	6.12			0.00	0.00			0.00	0.00															
	EX 264	EX 265			0.00	29.61	0.25	0.71	0.49	6.62			0.00	0.00			0.00	0.00	20.66	50.99	68.83	80.55	117.51	1966	1500	1500	CONC	0.15	75.0	2737.76	1.55	0.81	0.72
			4.04	0.69	7.75	37.36			0.00	6.62			0.00	0.00			0.00	0.00	16.70														
					0.00	37.36	0.11	0.75	0.23	6.84			0.00	0.00			0.00	0.00															
	EX 265	EX 266			0.00	37.36	0.12	0.71	0.24	7.08			0.00	0.00			0.00	0.00	21.47	49.79	67.19	78.61	114.67	2336	1500	1500	CONC	0.20	75.0	3161.29	1.79	0.70	0.74
To PERTH STREET, Pipe EX 266 - 267TEE						37.36				7.08				0.00				0.00	22.17														
PERTH ST DTICH																																	
					0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00			0.00	0.00						2430									
	DICB	2802			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	2430	1050	1050	CONC	0.90	11.5	2590.59	2.99	0.06	0.94
To PERTH STREET, Pipe 2802 - 280						0.00				0.00				0.00				0.00	10.06					2430									
PERTH STREET																																	
Contribution From PERTH ST DTICH, Pipe DICB - 2802						0.00				0.00				0.00				0.00	10.06					2430									
					0.00	0.00	0.00	0.00	0.00	0.00			0.00	0.00			0.00	0.00						875									
					0.00	0.00			0.00	0.00	0.67	0.85	1.58	1.58			0.00	0.00															
	2802	EX 280			0.00	0.00	1.88	0.80	4.18	4.18			0.00	1.58			0.00	0.00	10.06	76.56	103.86	121.74	177.98	3932	1650	1650	CONC	0.15	68.5	3530.01	1.65	0.69	1.11
			0.07	0.54	0.11	0.11			0.00	4.18			0.00	1.58			0.00	0.00															
	EX 280	EX 266			0.00	0.11			0.00	4.18	0.10	0.85	0.24	1.82			0.00	0.00	10.76	74.02	100.36	117.63	171.93	3946	1650	1650	CONC	0.15	44.5	3530.01	1.65	0.45	1.12
Contribution From OLDENBURG AVENUE, Pipe 265 - 266						37.36				7.08				0.00				0.00	22.17														
	EX 266	EX 267TEE			0.00	37.47			0.00	11.26	0.23	0.85	0.54	2.36			0.00	0.00	22.17	48.79	65.83	77.02	112.34	6057	2100	2100	CONC	0.15	70.5	6715.38	1.94	0.61	0.90
To STM OUTLET, Pipe EX 267TEE - 26701						37.47				11.26				2.36				0.00	22.77					3305									
STM OUTLET																																	
Contribution From PERTH STREET, Pipe 266 - 267TEE						37.47				11.26				2.36				0.00	22.77					3305									
	EX267TEE	EX 26701			0.00	37.47			0.00	11.26			0.00	2.36			0.00	0.00	22.77	47.96	64.70	75.69	110.39	6010	2100	2100	CONC	0.15	19.0	6715.38	1.94	0.16	0.89
	EX 26701	EX HW			0.00	37.47			0.00	11.26			0.00	2.36			0.00	0.00	22.94	47.74	64.40	75.34	109.88	5997	2100	2100	CONC	0.15	18.0	6715.38	1.94	0.15	0.89
STREET 'G'																																	
	505	506 (OGS)	0.13	0.65	0.23	0.23			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	18	300	300	PVC	0.35	16.0	57.21	0.81	0.33	0.32
To BLOCK 28, Pipe 506 (OGS) - 2804						0.23				0.00				0.00				0.00	10.33														
	501	502	0.15	0.65	0.27	0.27			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	21	300	300	PVC	0.35	18.0	57.21	0.81	0.37	0.36
	502	503	0.43	0.65	0.78	1.05			0.00	0.00			0.00	0.00			0.00	0.00	10.37	75.41	102.27	119.88	175.24	79	450	450	CONC	0.20	107.5	127.50	0.80	2.23	0.62
	503	504	0.46	0.65	0.83	1.88			0.00	0.00			0.00	0.00			0.00	0.00	12.61	68.06	92.19	108.00	157.80	128	525	525	CONC	0.20	106.5	192.33	0.89	2.00	0.67
	504	505	0.17	0.65	0.31	2.19			0.00	0.00			0.00	0.00			0.00	0.00	14.60	62.72	84.86	99.39	145.14	137	525	525	CONC	0.20	39.0	192.33	0.89	0.73	0.71
	505	506 (OGS)	0.34	0.65	0.61	2.80			0.00	0.00			0.00	0.00			0.00	0.00	15.33	60.99	82.49	96.60	141.05	171	525	525	CONC	0.25	84.5	215.03	0.99	1.42	0.79
To BLOCK 28, Pipe 506 (OGS) - 2804						2.80				0.00				0.00				0.00	16.75														
BLOCK 28																																	
Contribution From STREET 'G', Pipe 504 - 506 (OGS)						2.80				0.00				0.00				0.00	16.75														
Contribution From STREET 'G', Pipe 505 - 506 (OGS)						0.23				0.00				0.00				0.00	10.33														
	506 (OGS)	HW	0.09	0.65	0.16	3.20			0.00	0.00			0.00	0.00			0.00	0.00	16.75	57.92	78.29	91.66	133.81	185	525	525	CONC	0.80	71.0	384.66	1.78	0.67	0.48
MIRA COURT																																	
	22	23			0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	0	1050	1050	CONC	0.15	46.8	1057.61	1.22	0.64	0.00
To MIRA COURT, Pipe 23 - 24						0.00				0.00				0.00				0.00	10.64														

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: CPB
Checked: SLM
Dwg. Reference: 3A
PROJECT: **Caivan (Richmond North) Ltd**
LOCATION: **City of Ottawa**
File Ref: 20-1183
Date: August 2021
Sheet No. SHEET 3 OF 3

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Ottawa

Manning 0.013

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Arterial Roads Return Frequency = 10 years

	LOCATION		AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Conc.	2 Year	5 Year	10 Year	100 Year										
Location	From Node	To Node	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(min)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min	Q/Q full
BRUSH LANE																																	
	258	261	0.33	0.75	0.69	0.69			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	53	300	300	PVC	0.40	66.0	61	0.87	1.27	0.86
To BASCULE PLACE, Pipe 261 - 265						0.69				0.00				0.00				0.00	11.27														
CHASING GROVE																																	
			0.03	0.75	0.06	0.06			0.00	0.00			0.00	0.00			0.00	0.00															
			0.25	0.72	0.50	0.56			0.00	0.00			0.00	0.00			0.00	0.00															
	251	256	0.27	0.75	0.56	1.13			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	86	457	450	CONC	0.20	149.5	133	0.81	3.08	0.65
To BASCULE PLACE, Pipe 256 - 261						1.13				0.00				0.00				0.00	13.08														
TRAMMEL ROAD																																	
			0.12	0.54	0.18	0.18			0.00	0.00			0.00	0.00			0.00	0.00															
	250	252	0.13	0.72	0.26	0.44			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	34	300	300	PVC	0.35	51.5	57	0.81	1.06	0.59
To LATIGO RIDGE, Pipe 252 - 254						0.44				0.00				0.00				0.00	11.06														
			0.19	0.72	0.38	0.38			0.00	0.00			0.00	0.00			0.00	0.00															
	251	252	0.21	0.54	0.32	0.70			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	53	300	300	PVC	0.45	65.0	65	0.92	1.18	0.82
To LATIGO RIDGE, Pipe 252 - 254						0.70				0.00				0.00				0.00	11.18														
			0.03	0.75	0.06	0.06			0.00	0.00			0.00	0.00			0.00	0.00															
			0.13	0.54	0.20	0.26			0.00	0.00			0.00	0.00			0.00	0.00															
			0.07	0.75	0.15	0.40			0.00	0.00			0.00	0.00			0.00	0.00															
	251	263	0.14	0.72	0.28	0.68			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	53	300	300	PVC	0.40	68.0	61	0.87	1.31	0.86
To OLDENBURG AVENUE, Pipe 263 - 264						0.68				0.00				0.00				0.00	11.31														
LATIGO RIDGE																																	
Contribution From TRAMMEL ROAD, Pipe 250 - 252						0.44				0.00				0.00				0.00	11.06														
Contribution From TRAMMEL ROAD, Pipe 251 - 252						0.70				0.00				0.00				0.00	11.18														
			0.14	0.54	0.21	1.35			0.00	0.00			0.00	0.00			0.00	0.00															
	252	254	0.51	0.72	1.02	2.37			0.00	0.00			0.00	0.00			0.00	0.00	11.18	72.55	98.35	115.25	168.44	172	610	600	CONC	0.15	149.5	249	0.85	2.93	0.69
To BASCULE PLACE, Pipe 254 - 256						2.37				0.00				0.00				0.00	14.11														
GRISEO WAY																																	
			0.18	0.75	0.38	0.38			0.00	0.00			0.00	0.00			0.00	0.00															
	259	257	0.10	0.75	0.21	0.58			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	45	300	300	PVC	0.50	35.0	68	0.97	0.60	0.66
To BASCULE PLACE, Pipe 257 - 256						0.58				0.00				0.00				0.00	10.60														
BASCULE PLACE																																	
			0.06	0.72	0.12	0.12			0.00	0.00			0.00	0.00			0.00	0.00															
			0.15	0.54	0.23	0.35			0.00	0.00			0.00	0.00			0.00	0.00															
	254	273	0.16	0.75	0.33	0.68			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	52	300	300	PVC	0.45	61.0	65	0.92	1.11	0.80
To VAULTING CRESCENT, Pipe 273 - 275						0.68				0.00				0.00				0.00	11.11														
Contribution From LATIGO RIDGE, Pipe 252 - 254						2.37				0.00				0.00				0.00	14.11														
			0.16	0.54	0.24	0.24			0.00	0.00			0.00	0.00			0.00	0.00															
	254	257	0.04	0.72	0.08	2.69			0.00	0.00			0.00	0.00			0.00	0.00	14.11	63.95	86.55	101.37	148.05	172	610	600	CONC	0.15	35.5	249	0.85	0.70	0.69
Contribution From GRISEO WAY, Pipe 259 - 257						0.58				0.00				0.00				0.00	10.60														
	257	256			0.00	3.27			0.00	0.00			0.00	0.00			0.00	0.00	14.81	62.23	84.19	98.59	143.98	204	610	600	CONC	0.15	30.0	249	0.85	0.59	0.82
Contribution From CHASING GROVE, Pipe 255 - 256						1.13				0.00				0.00				0.00	13.08														
	256	261	0.11	0.75	0.23	4.63			0.00	0.00			0.00	0.00			0.00	0.00	15.39	60.85	82.30	96.38	140.73	282	686	675	CONC	0.15	33.0	340	0.92	0.60	0.83
Contribution From BRUSH LANE, Pipe 258 - 261						0.69				0.00				0.00				0.00	11.27														
Contribution From VAULTING CRESCENT, Pipe 260 - 261						0.40				0.00				0.00				0.00	10.72														
	261	265			0.00	5.71			0.00	0.00			0.00	0.00			0.00	0.00	15.99	59.52	80.48	94.24	137.59	340	838	825	CONC	0.10	35.0	473	0.86	0.68	0.72
To OLDENBURG AVENUE, Pipe 265 - 266						5.71				0.00				0.00				0.00	16.67														

A. D. FOBERT

2020-03-09

JOB# 19-1083

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: SLM	PROJECT:	FOX RUN SUBDIVISION PHASE 2 NORTH		
Checked: ADF	LOCATION:	City of Ottawa		
Dwg. Reference: Storm Drainage Plan Dwg. No. 30	File Ref: 19-1083	Date: 9-Mar-19	Sheet No. SHEET 1 OF 3	

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

	LOCATION		AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Conc.	2 Year	5 Year	10 Year	100 Year										
Location	From Node	To Node	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(min)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min	Q/Q full
POSTILION STREET																																	
Contribution From Future Phase, Pipe 318 - 270						9.49				0.00				0.00				0.00	17.25														
			0.13	0.72	0.26	9.75			0.00	0.00			0.00	0.00			0.00	0.00															
			0.16	0.54	0.24	9.99			0.00	0.00			0.00	0.00			0.00	0.00															
	270	271	0.21	0.71	0.41	10.40			0.00	0.00			0.00	0.00			0.00	0.00	17.25	56.92	76.93	90.06	131.46	592	914	900	CONC	0.20	74.5	844	1.29	0.97	0.70
			0.11	0.72	0.22	10.62			0.00	0.00			0.00	0.00			0.00	0.00															
	271	273	0.14	0.71	0.28	10.90			0.00	0.00			0.00	0.00			0.00	0.00	18.22	55.09	74.43	87.12	127.15	600	914	900	CONC	0.30	75.5	1033	1.57	0.80	0.58
To VAULTING CRESCENT, Pipe 273 - 275						10.90				0.00				0.00				0.00	19.01														
VAULTING CRESCENT																																	
	260	261	0.19	0.75	0.40	0.40			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	122.14	178.56	30	300	300	PVC	0.30	32.5	53	0.75	0.72	0.57
To BASCULE PLACE, Pipe 261 - 265						0.40				0.00				0.00				0.00	10.72														
Contribution From BASCULE PLACE, Pipe 254 - 273						0.68				0.00				0.00				0.00	11.11														
Contribution From POSTILION STREET, Pipe 271 - 273						10.90				0.00				0.00				0.00	19.01														
	273	275	0.21	0.75	0.44	12.01			0.00	0.00			0.00	0.00			0.00	0.00	19.01	53.67	72.49	84.84	123.81	645	914	900	CONC	0.20	33.0	844	1.29	0.43	0.76
To Servicing & Walkway Block, Pipe 275 - 276						12.01				0.00				0.00				0.00	19.44														
Servicing & Walkway Block																																	
Contribution From VAULTING CRESCENT, Pipe 273 - 275						12.01				0.00				0.00				0.00	19.44														
	275	276			0.00	12.01			0.00	0.00			0.00	0.00			0.00	0.00	19.44	52.95	71.50	83.68	122.10	636	914	900	CONC	0.20	29.5	844	1.29	0.38	0.75
	276	277			0.00	12.01			0.00	0.00			0.00	0.00			0.00	0.00	19.82	52.32	70.64	82.67	120.62	629	914	900	CONC	0.20	17.0	844	1.29	0.22	0.75
To PERTH STREET, Pipe 277 - 278						12.01				0.00				0.00				0.00	20.04														
OLDENBURG AVENUE																																	
Contribution From TRAMMEL ROAD, Pipe 251 - 263						0.68				0.00				0.00				0.00	11.31														
Contribution From Future External, Pipe 329 - PLUG						15.44				0.00				0.00				0.00	13.39														
	PLUG	263	0.07	0.85	0.17	15.61			0.00	0.00			0.00	0.00			0.00	0.00	13.39	65.85	89.15	104.43	152.55	1028	1067	1050	CONC	0.25	13.0	1425	1.59	0.14	0.72
Contribution From Future External, Pipe 328 - PLUG						20.44				2.11				0.00				0.00	18.25														
	PLUG	263			0.00	20.44			0.00	2.11			0.00	0.00			0.00	0.00	18.25	55.03	74.34	87.02	127.00	1282	1372	1350	CONC	0.10	13.0	1762	1.19	0.18	0.73
					0.00	36.73	0.12	0.71	0.24	2.35			0.00	0.00			0.00	0.00															
	263	264			0.00	36.73	0.12	0.75	0.25	2.60			0.00	0.00			0.00	0.00	18.43	54.70	73.89	86.49	126.23	2201	1524	1500	CONC	0.15	75.0	2856	1.57	0.80	0.77
					0.00	36.73	0.19	0.75	0.40	3.00			0.00	0.00			0.00	0.00															
					0.00	36.73	0.25	0.71	0.49	3.49			0.00	0.00			0.00	0.00															
	264	265	0.43	0.54	0.65	37.37			0.00	3.49			0.00	0.00			0.00	0.00	19.23	53.30	71.99	84.25	122.95	2243	1524	1500	CONC	0.15	75.0	2856	1.57	0.80	0.79
Contribution From BASCULE PLACE, Pipe 261 - 265						5.71				0.00				0.00				0.00	16.67														
					0.00	43.08	0.11	0.75	0.23	3.72			0.00	0.00			0.00	0.00															
	265	266			0.00	43.08	0.12	0.71	0.24	3.96			0.00	0.00			0.00	0.00	20.03	51.99	70.19	82.14	119.85	2517	1524	1500	CONC	0.20	75.0	3298	1.81	0.69	0.76
To PERTH STREET, Pipe 266 - 267TEE						43.08				3.96				0.00				0.00	20.72														
PERTH STREET																																	
Contribution From Servicing & Walkway Block, Pipe 276 - 277						12.01				0.00				0.00				0.00	20.04														
					0.00	12.01			0.00	0.00	0.32	0.85	0.76	0.76			0.00	0.00															
	277	278			0.00	12.01			0.00	0.00	0.55	0.85	1.30	2.06			0.00	0.00	20.04	51.96	70.15	82.10	119.78	793	991	975	CONC	0.20	107.5	1047	1.36	1.32	0.76
	278	279			0.00	12.01			0.00	0.00			0.00	2.06			0.00	0.00	21.37	49.93	67.39	78.85	115.02	762	991	975	CONC	0.20	15.5	1047	1.36	0.19	0.73

LICENSED PROFESSIONAL ENGINEER
A. D. FOBERT
2020-03-09
PROVINCE OF ONTARIO

Job #19-1083

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Projected storm flows as compared to the Green Lands West design sheet flow of 1,936L/s

Designed: SLM
Checked: ADF
Dwg. Reference: Storm Drainage Plan Dwg. No. 30
PROJECT: FOX RUN SUBDIVISION PHASE 2 NORTH
LOCATION: City of Ottawa
File Ref: 19-1083
Date: 9-Mar-19
Sheet No. SHEET 2 OF 3

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

	LOCATION		AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Conc.	2 Year	5 Year	10 Year	100 Year										
Location	From Node	To Node	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(min)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	FLOW (min	Q/Q full
To Pond Block, Pipe 279 - HW						12.01				0.00				2.06				0.00	21.56														
					0.00	0.00			0.00	0.00			0.00	0.00			0.00	0.00						3240	(DICB 100 Yr Intake)								
	280	266	0.13	0.54	0.20	0.20			0.00	0.00	0.80	0.85	1.89	1.89			0.00	0.00	10.00	76.81	104.19	122.14	178.56	3486	1676	1650	CONC	0.15	44.5	3680	1.67	0.44	0.95
Contribution From OLDENBURG AVENUE, Pipe 265 - 266						43.08				3.96				0.00				0.00	20.72														
					0.00	43.28					0.08	0.85	0.19	2.08			0.00	0.00															
	266	267TEE			0.00	43.28			0.00	3.96	0.14	0.85	0.33	2.41			0.00	0.00	20.72	50.90	68.71	80.40	117.30	5909	2134	2100	CONC	0.15	70.5	7009	1.96	0.60	0.84
	267TEE	26701			0.00	43.28			0.00	3.96			0.00	2.41			0.00	0.00	21.32	50.00	67.48	78.96	115.18	5861	2134	2100	CONC	0.15	19.0	7009	1.96	0.16	0.84
To Pond Block, Pipe 267TEE - HW						43.28				3.96				2.41				0.00	21.48														
Pond Block																																	
Contribution From PERTH STREET, Pipe 278 - 279						12.01				0.00				2.06				0.00	21.56														
	279	HW			0.00	12.01			0.00	0.00			0.00	2.06			0.00	0.00	21.56	49.66	67.01	78.41	114.37	758	991	975	CONC	0.20	16.5	1047	1.36	0.20	0.72
Contribution From PERTH STREET, Pipe 266 - 267TEE						43.28				3.96				2.41				0.00	21.48														
	26701	HW			0.00	43.28			0.00	3.96			0.00	2.41			0.00	0.00	21.48	49.77	67.16	78.58	114.63	5849	2134	2100	CONC	0.15	18.0	7009	1.96	0.15	0.83
Note:																																	
Contributions to MH 280 per JFSA analysis Table C-1D																																	
100-year 3-hour Chicago 2.60m3/s																																	
100-year 24-Hour SCS Type II 3.24m3/s																																	

A. D. FOBERT
[illegible]
2020-03-09

JOB# 19-1083

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: SLM
Checked: ADF
Dwg. Reference: Storm Drainage Plan Dwg. No. 30

PROJECT: **FOX RUN SUBDIVISION PHASE 2 NORTH**
LOCATION: **City of Ottawa**
File Ref: 19-1083
Date: 9-Mar-19
Sheet No. SHEET 3 OF 3

1083_STM_v5.xlsx

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

	LOCATION		AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
Location	From Node	To Node	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	Conc. (min)	2 Year (mm/h)	5 Year (mm/h)	10 Year (mm/h)	100 Year (mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min	Q/Q full
Street C																																	
	515	516	0.65	0.70	1.26	1.26			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	0.00	178.56	97	450	450	PVC	0.25	109.0	142.5531	0.8963	2.0268	0.682
	516	517	0.15	0.70	0.29	1.56			0.00	0.00			0.00	0.00			0.00	0.00	12.03	69.81	94.58	0.00	161.94	109	450	450	PVC	0.25	10.5	142.5531	0.8963	0.1952	0.762
	517	519	0.21	0.70	0.41	1.97			0.00	0.00			0.00	0.00			0.00	0.00	12.22	69.21	93.76	0.00	160.51	136	525	525	PVC	0.20	51.0	192.3297	0.8885	0.9567	0.707
			0.23	0.70	0.45	2.41			0.00	0.00			0.00	0.00			0.00	0.00															
	519	521	0.64	0.70	1.25	3.66			0.00	0.00			0.00	0.00			0.00	0.00	13.18	66.43	89.94	0.00	153.92	243	600	600	PVC	0.25	60.5	307.0058	1.0858	0.9286	0.792
			0.05	0.70	0.10	3.76			0.00	0.00			0.00	0.00			0.00	0.00															
	521	522	0.70	0.70	1.36	5.12			0.00	0.00			0.00	0.00			0.00	0.00	14.11	63.96	86.56	0.00	148.07	327	675	675	CONC	0.24	17.5	411.8024	1.1508	0.2535	0.795
To Service Block, Pipe 522 - 523						5.12				0.00				0.00				0.00	14.36														
Service Block						5.12				0.00				0.00				0.00	14.36														
			0.02	0.70	0.04	5.16			0.00	0.00			0.00	0.00			0.00	0.00															
	522	523	0.10	0.70	0.19	5.35			0.00	0.00			0.00	0.00			0.00	0.00	14.36	63.32	85.68	0.00	146.56	339	750	750	CONC	0.15	46.0	431.1703	0.9760	0.7855	0.786
	523	524	0.02	0.70	0.04	5.39			0.00	0.00			0.00	0.00			0.00	0.00	15.15	61.42	83.09	0.00	142.08	331	750	750	CONC	0.14	30.5	416.5501	0.9429	0.5391	0.795
To Street F, Pipe 524 - 525						5.39				0.00				0.00				0.00	15.69														
Street B																																	
	501	504	0.18	0.70	0.35	0.35			0.00	0.00			0.00	0.00			0.00	0.00	10.00	76.81	104.19	0.00	178.56	27	300	300	PVC	0.40	13.5	61.1589	0.8652	0.2600	0.440
	504	505	0.58	0.70	1.13	1.48			0.00	0.00			0.00	0.00			0.00	0.00	10.26	75.82	102.84	0.00	176.22	112	450	450	PVC	0.25	82.0	142.5531	0.8963	1.5248	0.787
	505	507	0.34	0.70	0.66	2.14			0.00	0.00			0.00	0.00			0.00	0.00	11.78	70.57	95.62	0.00	163.74	151	900	900	CONC	0.73	24.5	1546.7305	2.4313	0.1679	0.098
STREET A, Pipe 507 - 508						2.14				0.00				0.00				0.00	11.95														
Street A																																	
Contribution From STREET B, Pipe 507 - 508						2.14				0.00				0.00				0.00	11.95														
	507	508	0.27	0.70	0.53	2.67			0.00	0.00			0.00	0.00			0.00	0.00	11.95	70.04	94.90	0.00	162.48	187	975	975	CONC	0.19	80.0	976.8525	1.3084	1.0191	0.191
			0.21	0.70	0.41	3.07			0.00	0.00			0.00	0.00			0.00	0.00															
	508	509	1.01	0.70	1.97	5.04			0.00	0.00			0.00	0.00			0.00	0.00	12.97	67.01	90.74	0.00	155.30	338	1200	1200	CONC	0.25	55.0	1949.3651	1.7236	0.5318	0.173
	509	510	0.23	0.70	0.45	5.49			0.00	0.00			0.00	0.00			0.00	0.00	13.50	65.54	88.73	0.00	151.82	360	1200	1200	CONC	0.25	60.5	1949.3651	1.7236	0.5850	0.185
	510	511	0.23	0.70	0.45	5.94			0.00	0.00			0.00	0.00			0.00	0.00	14.09	64.01	86.62	0.00	148.18	380	1200	1200	CONC	0.25	61.5	1949.3651	1.7236	0.5947	0.195
	511	513	0.35	0.70	0.68	6.62			0.00	0.00			0.00	0.00			0.00	0.00	14.68	62.52	84.59	0.00	144.68	414	1350	1350	CONC	0.26	67.0	2721.5517	1.9013	0.5873	0.152
To STREET F, Pipe 513 - 514						6.62				0.00				0.00				0.00	15.27														
Street F																																	
Contribution From STREET A, Pipe 511 - 513						6.62				0.00				0.00				0.00	15.27														
	513	514	0.68	0.70	1.32	7.94			0.00	0.00			0.00	0.00			0.00	0.00	15.27	61.14	82.69	0.00	141.40	485	1350	1350	CONC	0.18	121.5	2264.4679	1.5820	1.2800	0.214
	514	524	0.05	0.70	0.10	8.04			0.00	0.00			0.00	0.00			0.00	0.00	16.55	58.33	78.86	0.00	134.79	469	1350	1350	CONC	0.17	6.0	2200.6672	1.5374	0.0650	0.213
Contribution From Service Block, Pipe 523 - 524						5.39				0.00				0.00				0.00	15.69														
			0.15	0.70	0.29	13.72			0.00	0.00			0.00	0.00			0.00	0.00															
			0.12	0.70	0.23	13.95			0.00	0.00			0.00	0.00			0.00	0.00															
	524	525	0.25	0.70	0.49	14.44			0.00	0.00			0.00	0.00			0.00	0.00	16.62	58.20	78.68	0.00	134.47	840	1350	1350	CONC	0.14	57.0	1997.0730	1.3952	0.6809	0.421
	525	526	0.64	0.70	1.25	15.68			0.00	0.00			0.00	0.00			0.00	0.00	17.30	56.83	76.80	0.00	131.24	891	1650	1650	CONC	0.10	89.5	2882.2416	1.3479	1.1066	0.309
To STM TRUNK 2, Pipe 526 - 8						15.68				0.00				0.00				0.00	18.40														
STM TRUNK 2																																	
Contribution From Street F, Pipe 525 - 526						15.68				0.00				0.00				0.00	18.40														
			6.32	0.70	12.30	27.98			0.00	0.00			0.00	0.00			0.00	0.00	19.07														
	526	8	0.21	0.70	0.41	28.39			0.00	0.00			0.00	0.00			0.00	0.00	19.07	53.58	72.36	0.00	123.59	1521	1650	1650	CONC	0.10	77.0	2882.2416	1.3479	0.9521	0.528
	8	9	0.11	0.70	0.21	28.61			0.00	0.00			0.00	0.00			0.00	0.00	20.02	52.00	70.20	0.00	119.87	1487	1650	1650	CONC	0.10	25.5	2882.2416	1.3479	0.3153	0.516
	9	11	0.26	0.70	0.51	29.11			0.00	0.00			0.00	0.00			0.00	0.00	20.34	51.49	69.52	0.00	118.69	1499	1650	1650	CONC	0.10	10.5	2882.2416	1.3479	0.1298	0.520
	11	12	0.25	0.70	0.49	29.60			0.00	0.00			0.00	0.00			0.00	0.00	20.47	51.29	69.24	0.00	118.21	1518	1650	1650	CONC	0.10	41.0	2882.2416	1.3479	0.5069	0.527
	12	13	0.27	0.70	0.53	30.12			0.00	0.00			0.00	0.00			0.00	0.00	20.97	50.52	68.18	0.00	116.39	1522	1800	1800	CONC	0.10	40.0	3634.9621	1.4284	0.4667	0.419
	13	47	0.25	0.70	0.49	30.61			0.00	0.00			0.00	0.00			0.00	0.00	21.44	49.82	67.24	0.00	114.76	1525	1800	1800	CONC	0.10	61.0	3634.9621	1.4284	0.7117	0.420
	47	470			0.00	30.61			0.00	0.00			0.00	0.00			0.00	0.00	22.15	48.81	65.86	0.00	112.38	1494	1800	1800	CONC	0.10	17.0	3634.9621	1.4284	0.1984	0.411
STM TRUNK 1, Pipe 470 - 21						30.61				0.00				0.00				0.00	22.35														

Definitions:
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A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Laffin Lands

LICENSED PROFESSIONAL ENGINEER
W. LIU
100167932
21-07-27
PROVINCE OF ONTARIO

Designed: RA	PROJECT: CAIVAN RICHMOND SOUTH LAFFIN LAND	
Checked: WL	LOCATION: City of Ottawa	
Dwg. Reference: 3B	File Ref: 20-1184	Date: Jul 2021	Sheet No. SHEET 1 OF 2

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Ottawa

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

	LOCATION		AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of Conc. (min)	Intensity 2 Year (mm/h)	Intensity 5 Year (mm/h)	Intensity 10 Year (mm/h)	Intensity 100 Year (mm/h)	Peak Flow Q (l/s)	DIA. (mm) (actual)	DIA. (mm) (nominal)	TYPE	SLOPE (%)	LENGTH (m)	CAPACITY (l/s)	VELOCITY (m/s)	TIME OF FLOW (min	RATIO Q/Q full
Location	From Node	To Node	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC	AREA (Ha)	R	Indiv. 2.78 AC	Accum. 2.78 AC															
STM Trunk 1																																	
Contribution From STM Trunk 2, Pipe 12 - 13						30.61				0.00				0.00				0.00	22.35														
					0.00	30.61			0.00	0.00			0.00	0.00	0.97	0.70	1.89	1.89															
					0.00	30.61	2.84	0.75	5.92	5.92			0.00	0.00			0.00	1.89															
					0.00	30.61	3.36	0.40	3.74	9.66			0.00	0.00			0.00	1.89															
					0.00	30.61	2.66	0.72	5.32	14.98			0.00	0.00			0.00	1.89															
			6.35	0.72	12.71	43.32			0.00	14.98			0.00	0.00			0.00	1.89															
			2.62	0.59	4.30	47.62			0.00	14.98			0.00	0.00			0.00	1.89	22.35														
			2.77	0.70	5.39	53.01			0.00	14.98			0.00	0.00			0.00	1.89															
			1.57	0.76	3.32	56.33			0.00	14.98			0.00	0.00			0.00	1.89															
	470	21	1.58	0.74	3.25	59.58			0.00	14.98			0.00	0.00			0.00	1.89	22.35	48.53	65.48	0.00	111.74	4083	2250	2250	CONC	0.10	33.5	6590.6247	1.6576	0.3368	0.620
	21	49	0.84	0.70	1.63	61.21			0.00	14.98			0.00	0.00			0.00	1.89	22.69	48.07	64.86	0.00	110.66	4123	2250	2250	CONC	0.10	57.0	6590.6247	1.6576	0.5731	0.626
	49	50	0.27	0.65	0.49	61.70			0.00	14.98			0.00	0.00			0.00	1.89	23.26	47.31	63.82	0.00	108.88	4081	2250	2250	CONC	0.10	41.5	6590.6247	1.6576	0.4173	0.619
	50	HW			0.00	61.70			0.00	14.98			0.00	0.00			0.00	1.89	23.68	46.78	63.09	0.00	107.62	4035	2250	2250	CONC	0.10	38.0	6590.6247	1.6576	0.3821	0.612

LICENSED PROFESSIONAL ENGINEER
W. LIU
100167932
21-07-21
PROVINCE OF ONTARIO

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: RA
Checked: WL
Dwg. Reference: 3B
PROJECT: **CAIVAN RICHMOND SOUTH LAFFIN LAND**
LOCATION: **City of Ottawa**
File Ref: 20-1184
Date: Jul 2021
Sheet No. SHEET 2 OF 2

ANY DISTURBED AREA DURING CONSTRUCTION TO BE RESTORED TO THE ORIGINAL CONDITION OR BETTER TO THE SATISFACTION OF THE AUTHORITIES HAVING JURISDICTION

CONTRACTOR TO VERIFY THE PRECISE LOCATIONS AND INVERT ELEVATIONS OF Ex. UNDERGROUND SERVICES AND Ex. UTILITIES PRIOR TO STARTING CONSTRUCTION

PERMISSION REQUIRED FOR WORK ON ADJACENT LANDS

NOTE:

FOR CROSS SECTION 2–2 AND 3–3, REFER TO DRAWING No. 37

NOTE RE: TEST PIT/BOREHOLE EXCAVATIONS

ANY DISTURBED MATERIAL ENCOUNTERED BELOW THE SUBGRADE LEVEL WITHIN A BUILDING FOOTPRINT TO BE SUB–EXCAVATED AND BACKFILLED WITH COMPACTED ENGINEERED FILL AS PER GEOTECHNICAL ENGINEERS RECOMMENDATION.

NOTE

FOR WATERMAIN CROSSING BELOW AND ABOVE SEWERS, REFER TO CITY STD. W25 AND W25.2, RESPECTIVELY, WHERE APPLICABLE

NOTE

FOR WATERMAIN STUBS, 2.4m MIN. COVER TO BE PROVIDED

NOTE: ICD

FOR ICD APPLICATION, REFER TO DRAWINGS No. 6 TO 7B & 45 TO 46 FOR DETAIL.

NOTE RE: CLAY SEALS

CLAY SEALS SHALL BE CONSTRUCTED IN THE SERVICE TRENCH FOR SANITARY MAIN PIPE, WATERMAIN AND ALL TYPES OF HOUSE CONNECTIONS. CLAY SEALS SHALL NOT BE CONSTRUCTED IN THE SERVICE TRENCH FOR STORM MAIN PIPE, AS PER GEOTECHNICAL CONSULTANT'S RECOMMENDATION.

NOTE RE: WATERMAIN / WATER SERVICE

1. INSULATION REQUIRED FOR WATERMAIN / WATER SERVICE WHERE THE SEPARATION BETWEEN WATERMAIN / WATER SERVICE AND OTHER SERVICES AND STRUCTURES IS LESS THAN 1.2m AND THE COVER IS LESS THAN 2.4m. REFER TO CITY STD. W23 FOR DETAIL.
2. FOR SERVICE INSTALLATION AT SEWER CROSSING, REFER TO CITY STD. W38 FOR DETAIL

NOTE RE: CATCHBASIN LEAD CROSSING DATA

FOR STREET CATCHBASIN LEAD CROSSING STORM, SANITARY, AND WATERMAIN DATA, REFER TO DWG. 6.

VILLAGE OF RICHMOND
SWM POND 1
REFER TO
DAVID SCHAEFFER ENGINEERING LTD.
PROJECT No. 15-764 BB
CITY OF OTTAWA FILE No. D07-16-11-0014

VILLAGE OF RICHMOND
SANITARY TRUNK
REFER TO
DAVID SCHAEFFER ENGINEERING LTD.
PROJECT No. 15-764 BA
CITY OF OTTAWA FILE No. D07-16-11-0014

NOTE RE: MH 111

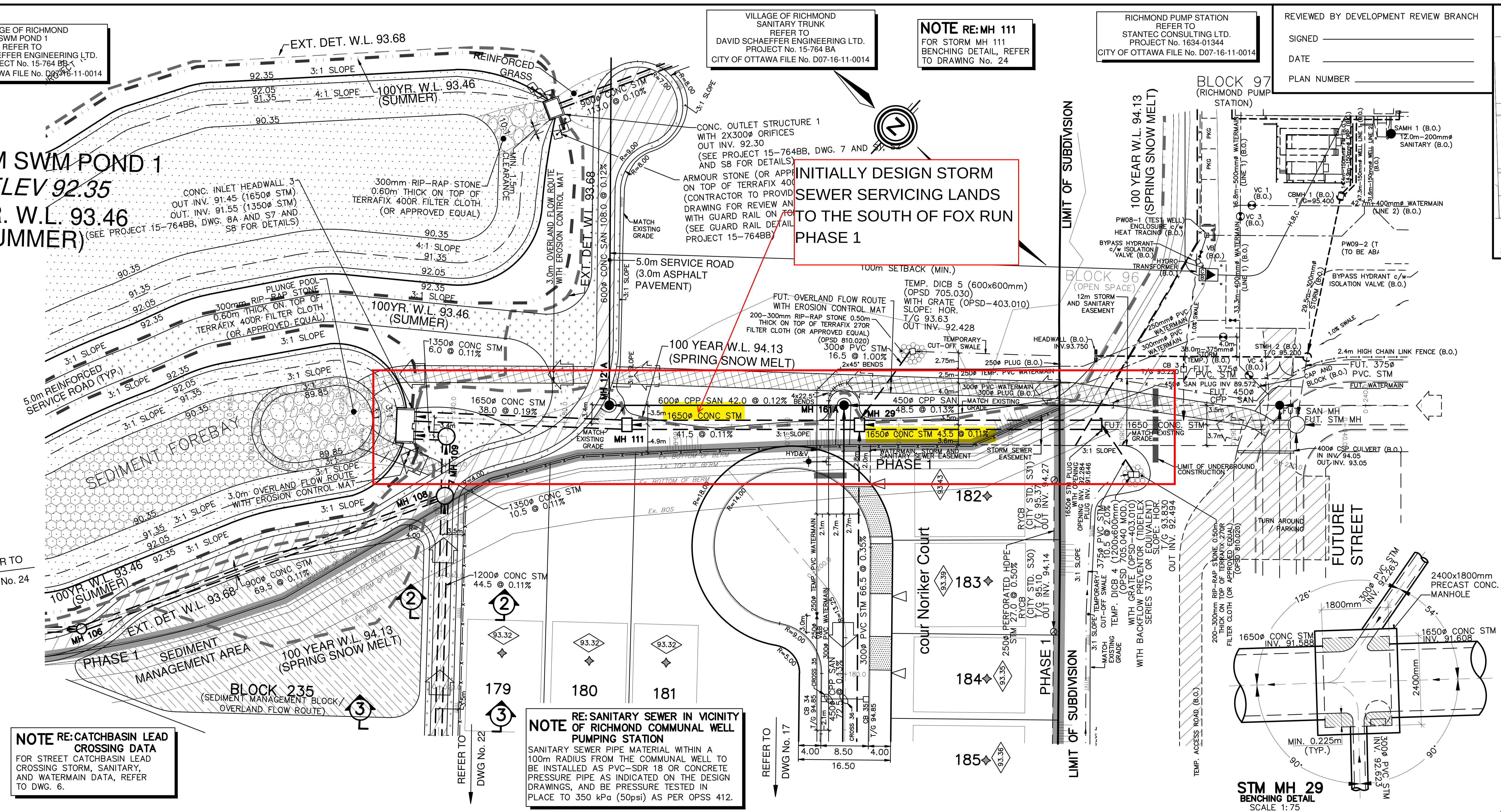
FOR STORM MH 111 BENCHING DETAIL, REFER TO DRAWING No. 24

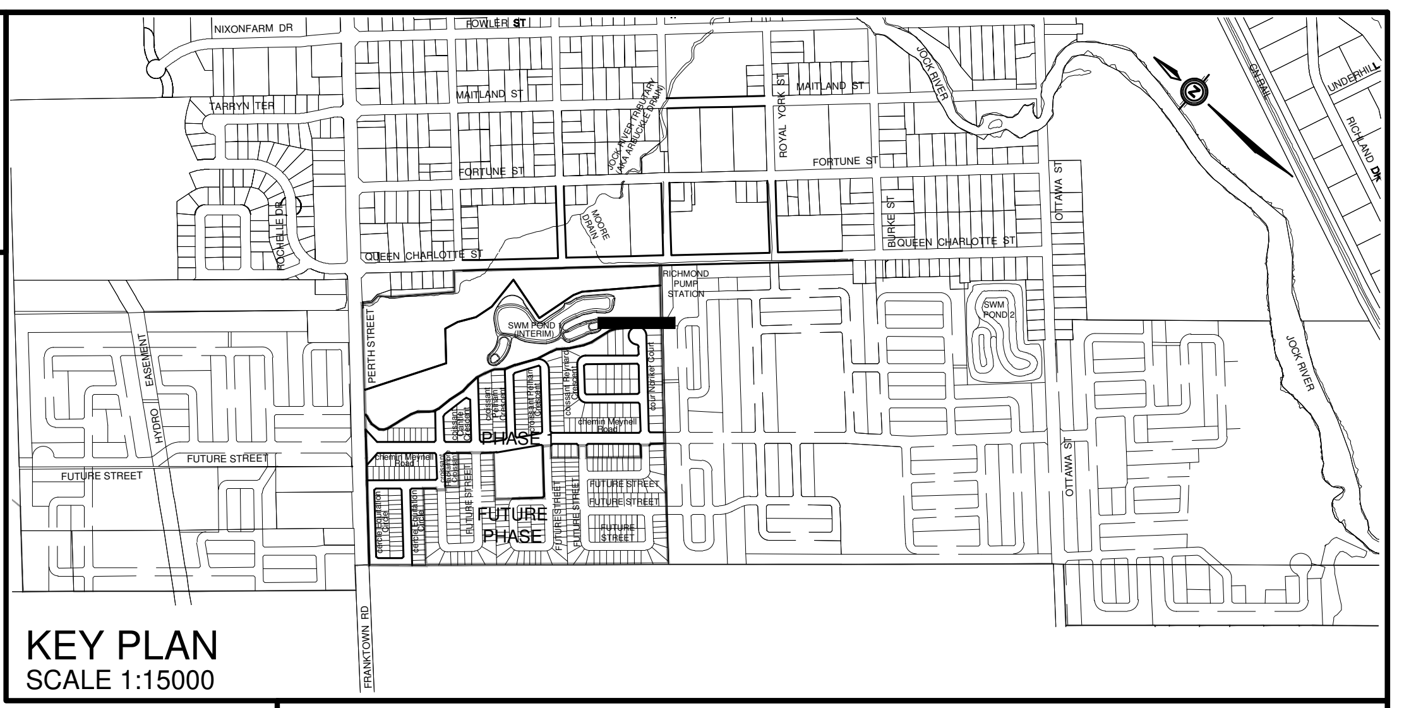
RICHMOND PUMP STATION
REFER TO
STANTEC CONSULTING LTD.
PROJECT No. 1634-01344
CITY OF OTTAWA FILE No. D07-16-11-0014

INITIALLY DESIGN STORM SEWER SERVICING LANDS TO THE SOUTH OF FOX RUN PHASE 1

NOTE RE: SANITARY SEWER IN VICINITY OF RICHMOND COMMUNAL WELL PUMPING STATION

SANITARY SEWER PIPE MATERIAL WITHIN A 100m RADIUS FROM THE COMMUNAL WELL TO BE INSTALLED AS PVC–SDR 18 OR CONCRETE PRESSURE PIPE AS INDICATED ON THE DESIGN DRAWINGS, AND BE PRESSURE TESTED IN PLACE TO 350 kPa (50psi) AS PER OPSS 412.





KEY PLAN
SCALE 1:15000

REVIEWED BY DEVELOPMENT REVIEW BRANCH

SIGNED ______________________

DATE ______________________

PLAN NUMBER ______________________

ALL DWELLINGS ARE TO BE PROVIDED WITH SUMP PUMPS UNLESS OTHERWISE NOTED. SEE DETAIL ON DWG. 3.

LEGEND

CROSS
45° BEND
LATERAL
HYDRANT, VALVE & VB
TEE
VALVE & VC
VALVE & VB
22.5° BEND
11.25° BEND
REDUCER
CAP
SANITARY MAINTENANCE HOLE
CAP
STREET CATCHBASIN & LEAD
STORM MAINTENANCE HOLE
CURB INLET CATCHBASIN & LEAD
CATCHBASIN/ MAINTENANCE HOLE
INTERCONNECTED CATCH BASIN & LEADS
CAP
SINGLE SERVICE LOCATION (ST, SAN & WM)
EXISTING SINGLE SERVICE LOCATION (ST, SAN & WM)
SINGLE SERVICE LOCATION (ST, SAN & WM)
TEE CATCHBASIN
PERFORATED PIPE
ELBOW CATCHBASIN
CABLE PEDESTAL
BELL PEDESTAL
HYDRO TRANSFORMER

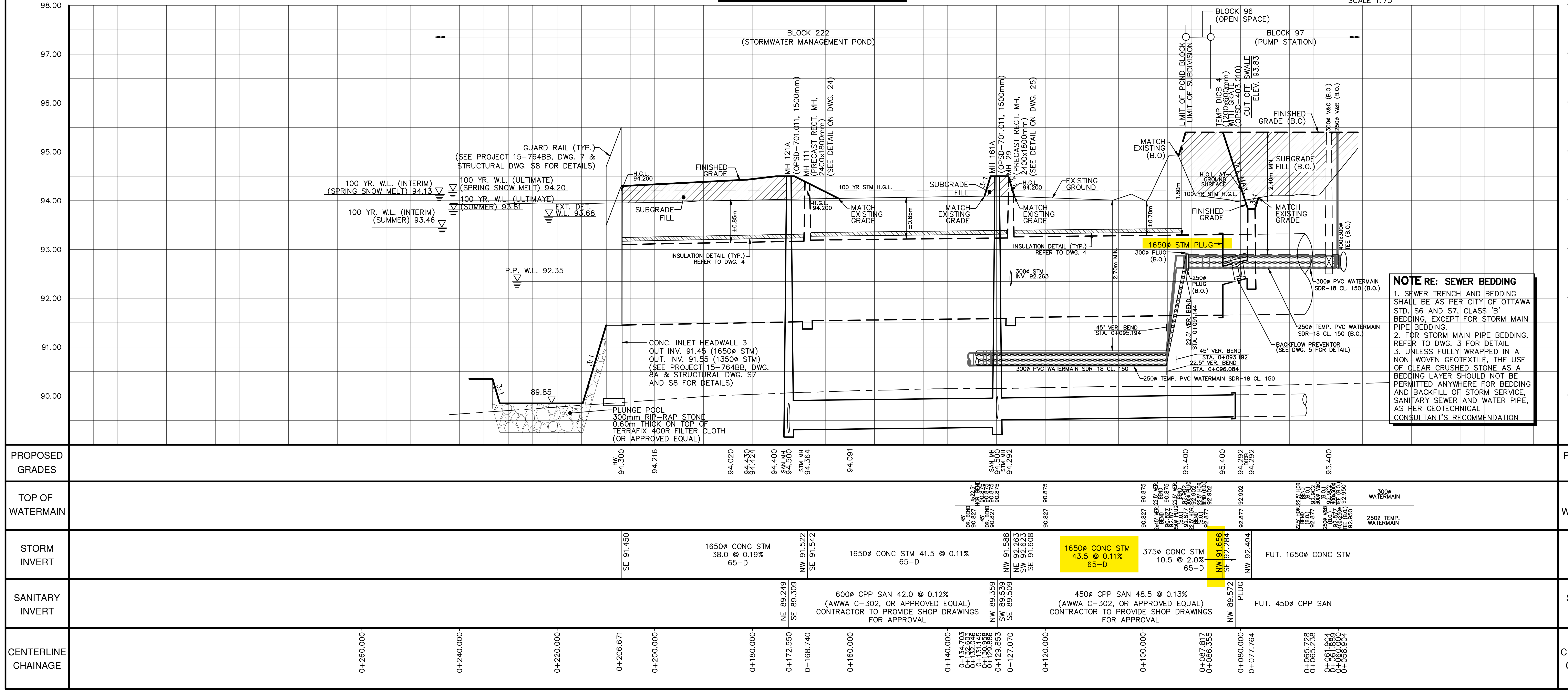
CURB & DEPRESSED CURB
ASPHALT SIDEWALK
1.8m CHAIN LINK FENCE (UNLESS OTHERWISE NOTED)
NOISE BARRIER (3.0m UNLESS OTHERWISE NOTED)
WOOD PRIVACY BARRIER
POST AND RAIL FENCE
PHASING LIMITS
PROPERTY BOUNDARY
BOREHOLE (BH)
TEST PIT (TP)
AUGER HOLE (AH)
MONITORING WELL LOCATION
CONCEPTUAL WELL LOCATION
AS PER GEOTECHNICAL REPORT
TOP OF FOUNDATION ELEVATION
FINISHED FLOOR ELEVATION
UNDERSIDE OF FOOTING ELEVATION
NUMBER OF RISERS
LOTS EQUIPPED WITH SUMP PUMP
WALKOUT UNITS — W.O.
SLAB ON GRADE — SOG
UNITS REQUIRING PRESSURE REDUCING VALVES — PRV
OVERLAND FLOW DIRECTION
EXTERNAL OVERLAND FLOW DIRECTION
TACTILE WALKING SURFACE INDICATOR (AS PER CITY OF OTTAWA STD. SC6, SC7, SC7.1, SC7.2, SC7.3)
CLAY SEAL (REFER TO GENERAL NOTES. No.18. ON DWG. No. 1, AND GEOTECHNICAL CONSULTANT'S SPECIFICATIONS)
DITCH AND CULVERT
CONCRETE SIDEWALK
INFERRED TOP OF BEDROCK ELEVATION PROVIDED BY GOLDER ASSOCIATES AUGUST 2013
NATURAL GAS LINE
JOINT UTILITY TRENCH (HYDRO, BELL, CABLE)

TOPOGRAPHIC INFORMATION

TOPOGRAPHIC INFORMATION PROVIDED BY J.D. BARNES LIMITED, PROJECT No. 10–10–314–00. DRAWING DATED SEPTEMBER 26, 2012. CITY OF OTTAWA 1K MAPPING, RECEIVED ON MARCH 27, 2013. GIS MAP, RECEIVED ON JANUARY 20, 2009.

LEGAL INFORMATION

M–PLAN PROVIDED BY J.D. BARNES LIMITED, PROJECT No. 10–10–314–00, SURVEY DATED MAY 12, 2017



NOTE RE: SEWER BEDDING

1. SEWER TRENCH AND BEDDING SHALL BE AS PER CITY OF OTTAWA STD. S6 AND S7, CLASS 'B' BEDDING, EXCEPT FOR STORM MAIN PIPE BEDDING.
2. FOR STORM MAIN PIPE BEDDING, REFER TO DWG. 3 FOR DETAIL
3. UNLESS FULLY WRAPPED IN A NON–WOVEN GEOTEXTILE, THE USE OF CLEAR CRUSHED STONE AS A BEDDING LAYER SHOULD NOT BE PERMITTED ANYWHERE FOR BEDDING AND BACKFILL OF STORM SERVICE, SANITARY SEWER AND WATER PIPE, AS PER GEOTECHNICAL CONSULTANT'S RECOMMENDATION

BENCH MARK No. 0011968U124 ELEVATION = 95.186 m

ELEVATIONS SHOWN ARE GEODETIC AND ARE REFERRED TO BENCHMARK No. 0011968U124 HAVING A PUBLISHED ELEVATION OF 95.186m. LOCATION: BRIDGE OVER JOCK RIVER IN RICHMOND, 0.8 KM SOUTH OF RICHMOND ROAD, BARSS CAP IN TOP OF EAST WALL, 2.7M FROM NORTH END.

7.	18–06–13	W.L.	MYLARS FOR STORM SEWER COMMENCE WORK
6.	18–03–23	W.L.	COMMUNAL WELL SITE INFORMATION UPDATED
5.	18–01–25	W.L.	ISSUED FOR FINAL APPROVAL
4.	17–11–17	W.L.	4th SUBMISSION
3.	17–10–13	W.L.	3rd SUBMISSION
2.	17–05–19	W.L./Z.L.	2nd SUBMISSION
1.	16–12–23	W.L./Z.L.	1st SUBMISSION
No.	DATE	BY	DESCRIPTION

CITY OF OTTAWA

PROJECT No. 15–783

W. LIU
100167932
18-06-13

PLAN AND PROFILE OF
POND INLET 3 - STORM TRUNK 2
(STA. 0+060.000 TO STA. 0+260.000)

RICHMOND VILLAGE DEVELOPMENT CORPORATION

CAIVAN COMMUNITIES
RICHMOND PHASE 1

david schaeffer engineering ltd
120 Iber Road, Unit 203
Stittsville, ON K2S 1E9
Tel. (613) 836-0856
Fax. (613) 836-7183
www.DSEL.ca

DRAWN BY: A.B.	CHECKED BY: W.L/C.M	DRAWING NO.	SHEET NO.
DESIGNED BY: W.L/P.P.	CHECKED BY: K.M.		25
SCALE: H=1:500/V=1:50	DATE: DECEMBER 2016		

CITY PLAN No. ______

CITY FILE No. D07-16-11-0014

JFSA
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS

Ottawa. ON
Paris. ON
Gatineau. QC
Montréal. QC
Québec. QC

August 12, 2020

Project Number: P922

David Schaeffer Engineering Limited
120 Iber Road, Unit 103
Ottawa, Ontario
K2S 1E9

Attention: **Mr. Adam Fobert, P.Eng.**

Subject: **Richmond Village Development / Proposed Realignment of the Van Gaal Drain Adjacent to the Green Lands**

As requested by your office, we have evaluated the channel dimensions required to contain the 100-year design water levels within the proposed realignment of the Van Gaal Drain adjacent to the Green Lands based on the information provided. This assessment builds on the *Richmond Village Development / Proposed Realignment of the Van Gaal Drain* by JFSA (April 20, 2017). The requested changes to the HEC-RAS models were to adjust cross sections 2478 – 2258 along the Van Gaal Drain Reach 2 as labelled in Figure 1. This section of the channel is immediately downstream of the realignment proposed in the April 2017 *Realignment* memo.

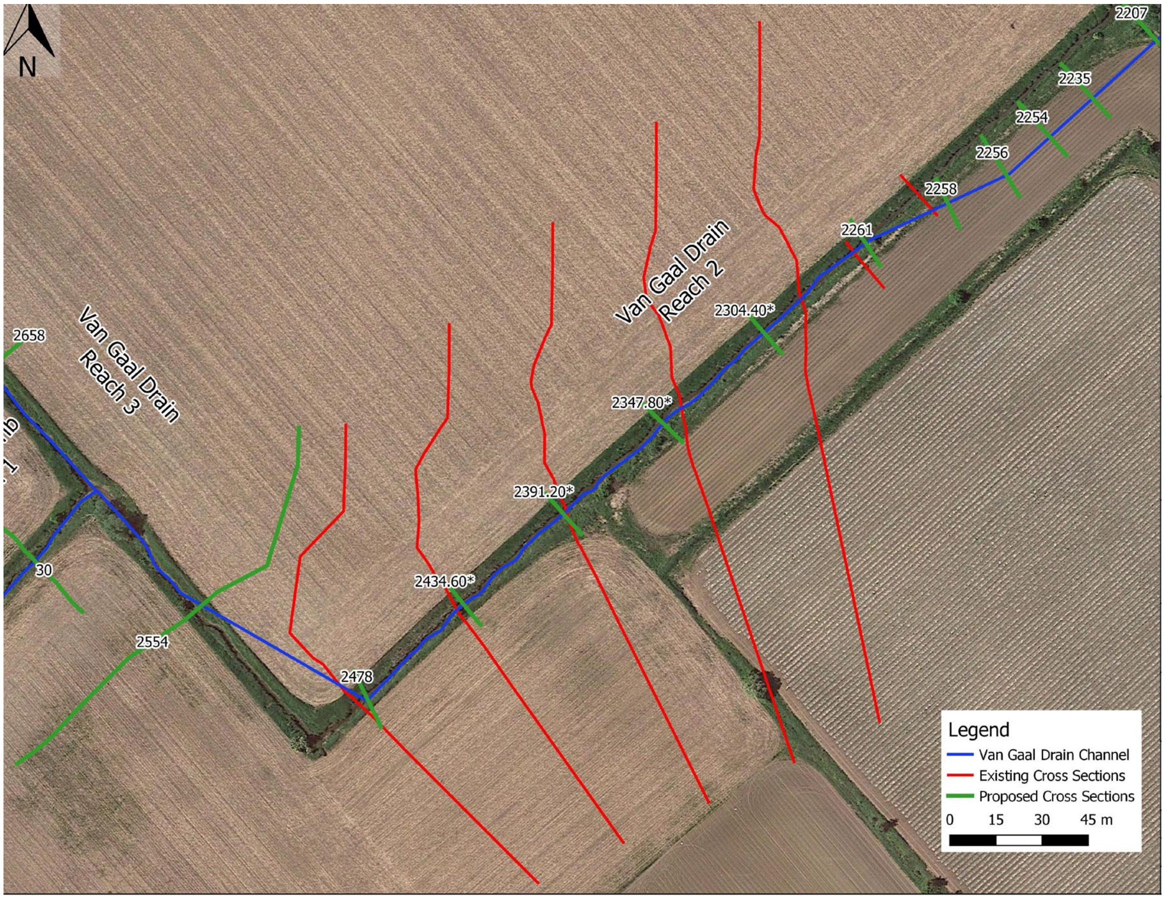


Figure 1: Van Gaal Drain Reach 2 Cross Section Labels

In undertaking this work, the following information was considered;

1) HEC-RAS models of Van Gaal Drain under existing conditions (spring and summer) were obtained from the *Floodplain Mapping Report for the Van Gaal Drain and Arbuckle Municipal Drains in the Village of Richmond* (JFSA, November 2009). The November 2009 report defined the maximum flood levels in the Van Gaal Drain based on three scenarios: (1) the Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River; (2) The Van Gaal 100-year spring snowmelt plus rainfall peak flow reaches the Jock River; and (4) The Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain.

2) The HEC-RAS models were modified as described in the April 2017 *Realignment* memo to evaluate the proposed realignment of approximately 900 m of the existing Van Gaal Drain to follow the boundary of the Richmond Village subdivision downstream of the Green Lands and upstream of Perth Street. Please refer to the April 2017 *Realignment* memo for further details of the existing (pre-realignment) and proposed (post-realignment) conditions modelling. Figure 1 of Attachment F in the current memo shows the proposed April 2017 channel realignment and cross-section extents.

3) The proposed conditions HEC-RAS models from the April 2017 *Realignment* memo were modified to reflect the current proposed channel realignment adjacent to the Green Lands based on information provided by DSEL. Going forward, this will be referred to as the proposed conditions model.

4) The typical proposed conditions channel dimension for updated cross-sections 2478 to 2258 include a 10 m wide floodplain with a cross-slope of 0.5%. The realigned channel is bounded by side slopes at 3H:1V and has a longitudinal slope of 0.4%. The low flow channel is 0.5 m deep with a bottom width of 1.0 m and a top width of 3.0 m. To match existing conditions, Manning's roughness coefficients for the proposed channel were set as 0.035 for the low flow channel, 0.05 for the banks under spring conditions and 0.08 for the banks under summer conditions. However, consistent with the April 2017 Realignment memo, we understand that trees and shrubs are to be planted on the banks about the 25 mm water level, and as such the Manning's roughness coefficients for this area of the proposed channel have been set to 0.08 under spring conditions and 0.10 under summer conditions.

5) Note that the proposed channel realignment will not significantly impact flows in the Van Gaal Drain. As such, existing conditions flows provided in the April 2017 *Realignment* memo models were also used to model proposed conditions. Consistent with the April 2017 *Realignment* memo, the 2-, 5-, 10-, 25- and 100-year return periods were assessed, as per the flows provided in the *March 26, 2010 P709(02) Richmond 2, 5, 10, 25 Year WSEL Results* email from JFSA to the City of Ottawa (forwarded to RVCA on March 30, 2012). The 25 mm 3-hour Chicago storm flows, as simulated using the March 26, 2010 SWMHYMO models, were also evaluated.

6) For the purpose of calculating floodplain elevations, all channel infrastructure was included in the existing and proposed conditions models. Conversely, for the purpose of calculating riparian storage volumes, all channel infrastructure was removed from the models. The existing flow profiles for the 25 mm and 2- to 100-year events were used to compare existing and proposed riparian storage volumes.

7) The proposed channel dimensions were set to contain the 100-year flood levels within the channel for all three spring and summer scenarios, and to set the 100-year proposed conditions water levels at comparable cross sections (for the Green lands realignment, cross-sections 2544 and 2478 in the Van Gaal Drain Reach 2) equal to or less than the maximum existing conditions flood levels defined in the November 2009 *Floodplain Mapping Report*. See Table 1 for details.

Based on the above information, 25 mm and 2- to 100-year design water levels and velocities were determined using HEC-RAS under the three spring and summer scenarios and are presented in Attachments A for existing conditions and Attachments C for proposed conditions. The 100-year design water levels for the proposed channel realignment of the Van Gaal Drain are presented in Table 1 and are contained within the proposed channel for all scenarios.

Table 1: Water Levels on Van Gaal Drain Reach 2 to Perth Street Under Proposed Conditions (1)

River Station	Scenario / Water Level (m)			
	1	*2*	*4*	*Max. Allowable (2)*
2554	95.90	95.89	95.54	96.28
2478	95.58	95.55	95.20	96.16
2434.60*	95.41	95.39	95.03	N/A
2391.20*	95.27	95.23	94.85	N/A
2347.80*	95.16	95.11	94.68	N/A
2304.40*	95.08	95.03	94.56	N/A
2261	95.03	94.98	94.50	N/A
2258	94.99	94.94	94.46	N/A
2256	94.98	94.92	94.44	N/A
2254	94.96	94.91	94.42	N/A
2235	94.95	94.89	94.40	N/A
2207	94.92	94.87	94.38	95.48
2188	94.88	94.83	94.36	N/A
2163	94.85	94.8	94.33	N/A
2141	94.82	94.77	94.31	N/A
2121	94.80	94.74	94.30	N/A
2101	94.77	94.72	94.28	N/A
2080	94.74	94.69	94.26	N/A
2059	94.71	94.66	94.25	N/A
2038	94.68	94.63	94.23	N/A
2017	94.67	94.62	94.23	N/A
2003	94.66	94.61	94.22	N/A
1982	94.63	94.58	94.21	N/A
1961	94.61	94.56	94.20	N/A
1940	94.58	94.54	94.19	N/A
1919	94.56	94.51	94.18	N/A
1898	94.54	94.49	94.18	N/A
1877	94.52	94.47	94.17	N/A
1857	94.50	94.45	94.17	N/A
1837	94.48	94.44	94.16	N/A
1817	94.46	94.42	94.16	N/A
1797	94.45	94.41	94.16	N/A
1777	94.43	94.39	94.15	N/A
1757	94.42	94.38	94.15	N/A
1736	94.40	94.37	94.15	N/A
1715	94.39	94.36	94.15	N/A
1694	94.38	94.35	94.15	N/A
1673	94.37	94.34	94.14	N/A
1653	94.36	94.33	94.14	N/A
1632	94.35	94.33	94.14	N/A
1615	94.35	94.32	94.14	94.61
1555	94.33	94.31	94.14	94.55
1488	94.31	94.29	94.14	94.45
1416	94.29	94.28	94.13	94.41
1400	94.28	94.27	94.13	94.36
1364	94.28	94.27	94.13	94.31
1340	94.24	94.22	94.13	94.21

(1) Scenario Descriptions:
1. The Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River.
2. The Van Gaal Drain 100-year spring snowmelt plus rainfall peak flow reaches the Jock River.
4. The Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain.

(2) Maximum water level at existing cross-sections as per "*Floodplain Mapping Report for the Van Gaal and Arbuckle Municipal Drains in the Village of Richmond*" (JFSA, November 2009)

As seen in Table 1, the proposed conditions 100-year water levels at comparable cross sections 2554 and 2478 are equal to or less than the flood levels defined in *November 2009 Floodplain Mapping Report*.

An analysis of riparian storage in the channel under existing and proposed conditions was performed using the 25 mm and 2-, 5-, 10-, 25-, and 100-year flows for the three scenarios. All drainage infrastructure was removed from the models for the purpose of this analysis. Refer to Attachments B and D for detailed results under existing and proposed conditions, respectively. Table 2 presents a summary of the riparian storage analysis results.

Table 2: Riparian Storage on Van Gaal Drain Reach 2 (1)

Event	Existing Volume (m^3)			Proposed Volume (m^3)		
	Scenario 1	Scenario 2	Scenario 4	Scenario 1	Scenario 2	Scenario 4
25 mm	3570	N/A	N/A	6800	N/A	N/A
2-Year	7640	12550	11550	14550	19630	18390
5-Year	11950	16610	5890	20230	23500	11060
10-Year	15650	20280	5250	24360	26120	9070
25-Year	22190	26230	9590	29890	30210	15300
100-Year	38090	39190	36830	40630	39360	44560

(1) No channel infrastructure included in Van Gaal Drain for riparian storage analysis.

Scenario Descriptions:
1. The Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River.
2. The Van Gaal Drain 100-year spring snowmelt plus rainfall peak flow reaches the Jock River.
4. The Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain.

As is seen in Table 2, riparian storage volumes under proposed conditions are equal to or greater than existing riparian storage volumes for all scenarios and return periods, and will not adversely impact downstream flooding.

Yours truly,
J.F Sabourin and Associates Inc.

DRAFT FOR REVIEW

Tamarra Lewis, B.Eng., EIT
Water Resources Engineer-in-Training

DRAFT FOR REVIEW

Laura Pipkins, P.Eng.
Water Resources Engineer

cc: J.F Sabourin, M.Eng, P.Eng
Director of Water Resources Projects

Figures

Tables

Attachments

Project Ref #:P922
Client: David Schaeffer Engineering

Ottawa. ON
Paris. ON
Gatineau. QB
Montréal. QB
Québec. QB

Attachment A

HEC-RAS Results for Van Gaal Drain Reach 2
Existing Conditions (Floodplain Analysis)

Table A-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2554	(1) 25 mm	0.72	94.75	95.41	0.41	0.85
2554	(1) 2-Year	1.95	94.75	95.72	0.56	0.70
2554	(1) 5-Year	3.20	94.75	95.93	0.65	0.61
2554	(1) 10-Year	4.11	94.75	96.04	0.71	0.57
2554	(1) 25-Year	5.28	94.75	96.14	0.78	0.55
2554	(1) 100-Year	7.27	94.75	96.26	0.84	0.58
2478	(1) 25 mm	0.72	94.75	95.35	0.42	0.80
2478	(1) 2-Year	1.95	94.75	95.65	0.59	0.66
2478	(1) 5-Year	3.20	94.75	95.85	0.72	0.58
2478	(1) 10-Year	4.11	94.75	95.94	0.82	0.54
2478	(1) 25-Year	5.28	94.75	96.03	0.93	0.53
2478	(1) 100-Year	7.27	94.75	96.12	1.10	0.56
2427.58*	(1) 25 mm	0.72	94.68	95.30	0.43	0.76
2427.58*	(1) 2-Year	1.95	94.68	95.60	0.61	0.64
2427.58*	(1) 5-Year	3.20	94.68	95.79	0.74	0.56
2427.58*	(1) 10-Year	4.11	94.68	95.87	0.84	0.53
2427.58*	(1) 25-Year	5.28	94.68	95.95	0.95	0.52
2427.58*	(1) 100-Year	7.27	94.68	96.04	1.11	0.54
2377.17*	(1) 25 mm	0.72	94.61	95.25	0.44	0.73
2377.17*	(1) 2-Year	1.95	94.61	95.54	0.62	0.61
2377.17*	(1) 5-Year	3.20	94.61	95.72	0.76	0.55
2377.17*	(1) 10-Year	4.11	94.61	95.80	0.86	0.51
2377.17*	(1) 25-Year	5.28	94.61	95.87	0.97	0.50
2377.17*	(1) 100-Year	7.27	94.61	95.95	1.09	0.53
2326.76*	(1) 25 mm	0.72	94.54	95.19	0.46	0.70
2326.76*	(1) 2-Year	1.95	94.54	95.48	0.64	0.59
2326.76*	(1) 5-Year	3.20	94.54	95.65	0.78	0.53
2326.76*	(1) 10-Year	4.11	94.54	95.72	0.88	0.50
2326.76*	(1) 25-Year	5.28	94.54	95.78	0.97	0.49
2326.76*	(1) 100-Year	7.27	94.54	95.85	1.07	0.52
2276.35*	(1) 25 mm	0.72	94.48	95.13	0.49	0.67
2276.35*	(1) 2-Year	1.95	94.48	95.41	0.68	0.57
2276.35*	(1) 5-Year	3.20	94.48	95.57	0.80	0.51
2276.35*	(1) 10-Year	4.11	94.48	95.63	0.89	0.48
2276.35*	(1) 25-Year	5.28	94.48	95.69	0.96	0.47
2276.35*	(1) 100-Year	7.27	94.48	95.77	0.98	0.50
2225.94*	(1) 25 mm	0.72	94.41	95.05	0.54	0.65
2225.94*	(1) 2-Year	1.95	94.41	95.33	0.74	0.55
2225.94*	(1) 5-Year	3.20	94.41	95.48	0.84	0.49
2225.94*	(1) 10-Year	4.11	94.41	95.54	0.88	0.46
2225.94*	(1) 25-Year	5.28	94.41	95.59	0.95	0.46
2225.94*	(1) 100-Year	7.27	94.41	95.66	1.05	0.49
2175.53*	(1) 25 mm	0.72	94.34	94.93	0.68	0.62
2175.53*	(1) 2-Year	1.95	94.34	95.18	0.92	0.53
2175.53*	(1) 5-Year	3.20	94.34	95.33	1.04	0.48

Table A-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2175.53*	(1) 10-Year	4.11	94.34	95.42	0.95	0.45
2175.53*	(1) 25-Year	5.28	94.34	95.47	1.01	0.44
2175.53*	(1) 100-Year	7.27	94.34	95.54	1.07	0.48
2157	(1) 25 mm	0.72	94.31	94.72	1.45	0.62
2157	(1) 2-Year	1.95	94.31	94.93	1.76	0.53
2157	(1) 5-Year	3.20	94.31	95.13	1.64	0.47
2157	(1) 10-Year	4.11	94.31	95.25	1.54	0.44
2157	(1) 25-Year	5.28	94.31	95.37	1.28	0.44
2157	(1) 100-Year	7.27	94.31	95.48	1.13	0.47
2076	(1) 25 mm	1.16	93.86	94.39	0.64	0.60
2076	(1) 2-Year	2.80	93.86	94.74	0.76	0.51
2076	(1) 5-Year	4.41	93.86	94.99	0.82	0.46
2076	(1) 10-Year	5.53	93.86	95.10	0.90	0.43
2076	(1) 25-Year	6.96	93.86	95.20	0.96	0.42
2076	(1) 100-Year	9.54	93.86	95.33	0.99	0.45
1974	(1) 25 mm	1.16	93.68	94.22	0.62	0.55
1974	(1) 2-Year	2.80	93.68	94.61	0.70	0.48
1974	(1) 5-Year	4.41	93.68	94.87	0.75	0.42
1974	(1) 10-Year	5.53	93.68	94.96	0.84	0.39
1974	(1) 25-Year	6.96	93.68	95.05	0.93	0.39
1974	(1) 100-Year	9.54	93.68	95.17	1.02	0.42
1922	(1) 25 mm	1.16	93.59	94.14	0.61	0.53
1922	(1) 2-Year	2.80	93.59	94.56	0.67	0.46
1922	(1) 5-Year	4.41	93.59	94.82	0.74	0.40
1922	(1) 10-Year	5.53	93.59	94.90	0.84	0.38
1922	(1) 25-Year	6.96	93.59	94.97	0.96	0.38
1922	(1) 100-Year	9.54	93.59	95.06	1.11	0.41
1833	(1) 25 mm	1.16	93.44	94.02	0.56	0.49
1833	(1) 2-Year	2.80	93.44	94.48	0.59	0.42
1833	(1) 5-Year	4.41	93.44	94.74	0.61	0.37
1833	(1) 10-Year	5.53	93.44	94.80	0.69	0.35
1833	(1) 25-Year	6.96	93.44	94.86	0.76	0.35
1833	(1) 100-Year	9.54	93.44	94.95	0.85	0.39
1796	(1) 25 mm	1.16	93.37	93.97	0.54	0.47
1796	(1) 2-Year	2.80	93.37	94.45	0.57	0.40
1796	(1) 5-Year	4.41	93.37	94.71	0.64	0.35
1796	(1) 10-Year	5.53	93.37	94.76	0.76	0.33
1796	(1) 25-Year	6.96	93.37	94.80	0.90	0.33
1796	(1) 100-Year	9.54	93.37	94.86	1.13	0.38
1735	(1) 25 mm	1.16	93.26	93.93	0.47	0.44
1735	(1) 2-Year	2.80	93.26	94.42	0.48	0.37
1735	(1) 5-Year	4.41	93.26	94.68	0.51	0.32
1735	(1) 10-Year	5.53	93.26	94.73	0.58	0.31
1735	(1) 25-Year	6.96	93.26	94.77	0.66	0.31
1735	(1) 100-Year	9.54	93.26	94.82	0.79	0.36

Table A-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1728	(1) 25 mm	1.16	93.25	93.91	0.56	0.44
1728	(1) 2-Year	2.80	93.25	94.41	0.60	0.37
1728	(1) 5-Year	4.41	93.25	94.67	0.68	0.32
1728	(1) 10-Year	5.53	93.25	94.71	0.80	0.31
1728	(1) 25-Year	6.96	93.25	94.73	0.96	0.31
1728	(1) 100-Year	9.54	93.25	94.75	1.25	0.36
1727		Culvert				
1717	(1) 25 mm	1.16	93.24	93.79	0.70	0.43
1717	(1) 2-Year	2.80	93.24	94.17	0.85	0.36
1717	(1) 5-Year	4.41	93.24	94.39	0.97	0.32
1717	(1) 10-Year	5.53	93.24	94.51	1.03	0.30
1717	(1) 25-Year	6.96	93.24	94.62	1.13	0.31
1717	(1) 100-Year	9.54	93.24	94.74	1.28	0.35
1615	(1) 25 mm	1.16	93.05	93.64	0.56	0.39
1615	(1) 2-Year	2.80	93.05	94.04	0.64	0.32
1615	(1) 5-Year	4.41	93.05	94.24	0.77	0.28
1615	(1) 10-Year	5.53	93.05	94.36	0.84	0.27
1615	(1) 25-Year	6.96	93.05	94.47	0.87	0.28
1615	(1) 100-Year	9.54	93.05	94.61	0.87	0.33
1555	(1) 25 mm	1.16	92.94	93.58	0.50	0.35
1555	(1) 2-Year	2.80	92.94	93.99	0.59	0.30
1555	(1) 5-Year	4.41	92.94	94.19	0.72	0.26
1555	(1) 10-Year	5.53	92.94	94.29	0.80	0.25
1555	(1) 25-Year	6.96	92.94	94.40	0.86	0.26
1555	(1) 100-Year	9.54	92.94	94.53	0.94	0.31
1488	(1) 25 mm	1.16	92.82	93.53	0.43	0.31
1488	(1) 2-Year	2.80	92.82	93.96	0.53	0.26
1488	(1) 5-Year	4.41	92.82	94.13	0.66	0.23
1488	(1) 10-Year	5.53	92.82	94.23	0.73	0.23
1488	(1) 25-Year	6.96	92.82	94.33	0.82	0.24
1488	(1) 100-Year	9.54	92.82	94.46	0.92	0.29
1416	(1) 25 mm	1.16	92.71	93.48	0.54	0.28
1416	(1) 2-Year	2.80	92.71	93.89	0.73	0.23
1416	(1) 5-Year	4.41	92.71	94.03	0.96	0.21
1416	(1) 10-Year	5.53	92.71	94.10	1.07	0.21
1416	(1) 25-Year	6.96	92.71	94.20	1.13	0.22
1416	(1) 100-Year	9.54	92.71	94.38	0.94	0.27
1400	(1) 25 mm	1.16	92.68	93.47	0.39	0.27
1400	(1) 2-Year	2.80	92.68	93.89	0.47	0.23
1400	(1) 5-Year	4.41	92.68	94.03	0.60	0.20
1400	(1) 10-Year	5.53	92.68	94.11	0.67	0.20
1400	(1) 25-Year	6.96	92.68	94.20	0.75	0.22
1400	(1) 100-Year	9.54	92.68	94.36	0.86	0.27

Table A-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1364	(1) 25 mm	1.16	92.62	93.46	0.34	0.24
1364	(1) 2-Year	2.80	92.62	93.87	0.46	0.20
1364	(1) 5-Year	4.41	92.62	94.00	0.61	0.19
1364	(1) 10-Year	5.53	92.62	94.07	0.71	0.19
1364	(1) 25-Year	6.96	92.62	94.16	0.81	0.20
1364	(1) 100-Year	9.54	92.62	94.31	0.92	0.25
1340	(1) 25 mm	1.53	92.61	93.45	0.37	0.22
1340	(1) 2-Year	3.64	92.61	93.85	0.60	0.19
1340	(1) 5-Year	5.57	92.61	93.97	0.84	0.18
1340	(1) 10-Year	6.92	92.61	94.03	1.00	0.18
1340	(1) 25-Year	8.58	92.61	94.09	1.18	0.20
1340	(1) 100-Year	11.43	92.61	94.21	1.46	0.25
1339		Culvert				
1312	(1) 25 mm	1.53	92.47	93.45	0.32	0.20
1312	(1) 2-Year	3.87	92.47	93.84	0.57	0.18
1312	(1) 5-Year	5.93	92.47	93.95	0.82	0.17
1312	(1) 10-Year	7.38	92.47	94.00	0.99	0.17
1312	(1) 25-Year	9.17	92.47	94.05	1.19	0.19
1312	(1) 100-Year	12.20	92.47	94.14	1.50	0.24
1302	(1) 25 mm	1.53	92.57	93.41	0.83	0.19
1302	(1) 2-Year	3.87	92.57	93.81	0.88	0.17
1302	(1) 5-Year	5.93	92.57	93.92	1.05	0.17
1302	(1) 10-Year	7.38	92.57	93.98	1.15	0.17
1302	(1) 25-Year	9.17	92.57	94.04	1.26	0.19
1302	(1) 100-Year	12.20	92.57	94.15	1.23	0.24
1268	(1) 25 mm	1.53	92.47	93.33	0.79	0.18
1268	(1) 2-Year	3.87	92.47	93.75	0.56	0.16
1268	(1) 5-Year	5.93	92.47	93.88	0.57	0.16
1268	(1) 10-Year	7.38	92.47	93.94	0.60	0.16
1268	(1) 25-Year	9.17	92.47	94.01	0.61	0.18
1268	(1) 100-Year	12.20	92.47	94.14	0.52	0.23
1212	(1) 25 mm	1.53	92.36	93.18	0.86	0.16
1212	(1) 2-Year	3.87	92.36	93.61	0.89	0.14
1212	(1) 5-Year	5.93	92.36	93.78	0.91	0.13
1212	(1) 10-Year	7.38	92.36	93.85	0.93	0.14
1212	(1) 25-Year	9.17	92.36	93.93	0.91	0.16
1212	(1) 100-Year	12.20	92.36	94.10	0.76	0.21
1169	(1) 25 mm	1.53	92.30	93.10	0.69	0.15
1169	(1) 2-Year	3.87	92.30	93.53	0.77	0.13
1169	(1) 5-Year	5.93	92.30	93.70	0.86	0.12
1169	(1) 10-Year	7.38	92.30	93.77	0.91	0.12
1169	(1) 25-Year	9.17	92.30	93.85	0.95	0.14
1169	(1) 100-Year	12.20	92.30	94.04	0.88	0.19
1091	(1) 25 mm	1.53	92.15	92.98	0.65	0.11

Table A-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1091	(1) 2-Year	3.87	92.15	93.40	0.75	0.10
1091	(1) 5-Year	5.93	92.15	93.57	0.82	0.09
1091	(1) 10-Year	7.38	92.15	93.65	0.85	0.10
1091	(1) 25-Year	9.17	92.15	93.75	0.85	0.12
1091	(1) 100-Year	12.20	92.15	93.97	0.83	0.17
1002	(1) 25 mm	1.53	92.06	92.81	0.76	0.08
1002	(1) 2-Year	3.87	92.06	93.21	0.90	0.07
1002	(1) 5-Year	5.93	92.06	93.39	0.98	0.07
1002	(1) 10-Year	7.38	92.06	93.50	0.93	0.07
1002	(1) 25-Year	9.17	92.06	93.65	0.83	0.09
1002	(1) 100-Year	12.20	92.06	93.93	0.65	0.13
961	(1) 25 mm	1.53	91.96	92.77	0.54	0.06
961	(1) 2-Year	3.87	91.96	93.14	0.71	0.05
961	(1) 5-Year	5.93	91.96	93.31	0.76	0.05
961	(1) 10-Year	7.38	91.96	93.44	0.71	0.06
961	(1) 25-Year	9.17	91.96	93.61	0.52	0.07
961	(1) 100-Year	12.20	91.96	93.92	0.35	0.11
910	(1) 25 mm	1.53	91.93	92.72	0.57	0.04
910	(1) 2-Year	3.87	91.93	93.07	0.72	0.03
910	(1) 5-Year	5.93	91.93	93.25	0.73	0.04
910	(1) 10-Year	7.38	91.93	93.40	0.69	0.04
910	(1) 25-Year	9.17	91.93	93.59	0.53	0.05
910	(1) 100-Year	12.20	91.93	93.91	0.33	0.07
840	(1) 25 mm	1.53	91.86	92.64	0.50	0.00
840	(1) 2-Year	3.87	91.86	93.00	0.44	0.00
840	(1) 5-Year	5.93	91.86	93.22	0.37	0.00
840	(1) 10-Year	7.38	91.86	93.38	0.33	0.00
840	(1) 25-Year	9.17	91.86	93.58	0.30	0.00
840	(1) 100-Year	12.20	91.86	93.91	0.25	0.00

(1) All channel infrastructure included in the HEC-RAS model for floodplain analysis.

For Scenario 1 (the Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River).

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) [(1)]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2554	(2) 2-Year	4.13	94.75	96.03	0.71	0.58
2554	(2) 5-Year	5.24	94.75	96.13	0.78	0.55
2554	(2) 10-Year	6.01	94.75	96.18	0.81	0.54
2554	(2) 25-Year	6.94	94.75	96.23	0.83	0.57
2554	(2) 100-Year	8.32	94.75	96.28	0.82	0.68
2554	(4) 2-Year	3.97	94.75	96.02	0.70	0.58
2554	(4) 5-Year	2.02	94.75	95.74	0.56	0.71
2554	(4) 10-Year	1.57	94.75	95.64	0.52	0.82
2554	(4) 25-Year	2.25	94.75	95.78	0.58	0.93
2554	(4) 100-Year	2.86	94.75	95.88	0.63	2.01
2478	(2) 2-Year	4.13	94.75	95.93	0.83	0.55
2478	(2) 5-Year	5.24	94.75	96.02	0.93	0.52
2478	(2) 10-Year	6.01	94.75	96.06	1.00	0.52
2478	(2) 25-Year	6.94	94.75	96.10	1.09	0.55
2478	(2) 100-Year	8.32	94.75	96.14	1.17	0.66
2478	(4) 2-Year	3.97	94.75	95.92	0.81	0.56
2478	(4) 5-Year	2.02	94.75	95.67	0.60	0.67
2478	(4) 10-Year	1.57	94.75	95.57	0.55	0.78
2478	(4) 25-Year	2.25	94.75	95.71	0.63	0.89
2478	(4) 100-Year	2.86	94.75	95.80	0.69	1.98
2427.58*	(2) 2-Year	4.13	94.68	95.86	0.85	0.53
2427.58*	(2) 5-Year	5.24	94.68	95.94	0.95	0.51
2427.58*	(2) 10-Year	6.01	94.68	95.97	1.04	0.51
2427.58*	(2) 25-Year	6.94	94.68	96.01	1.09	0.53
2427.58*	(2) 100-Year	8.32	94.68	96.05	1.16	0.65
2427.58*	(4) 2-Year	3.97	94.68	95.85	0.83	0.54
2427.58*	(4) 5-Year	2.02	94.68	95.61	0.61	0.65
2427.58*	(4) 10-Year	1.57	94.68	95.52	0.56	0.75
2427.58*	(4) 25-Year	2.25	94.68	95.65	0.64	0.87
2427.58*	(4) 100-Year	2.86	94.68	95.74	0.70	1.96
2377.17*	(2) 2-Year	4.13	94.61	95.79	0.87	0.52
2377.17*	(2) 5-Year	5.24	94.61	95.85	0.97	0.49
2377.17*	(2) 10-Year	6.01	94.61	95.88	1.03	0.49
2377.17*	(2) 25-Year	6.94	94.61	95.91	1.08	0.52
2377.17*	(2) 100-Year	8.32	94.61	95.95	1.13	0.63
2377.17*	(4) 2-Year	3.97	94.61	95.78	0.85	0.52
2377.17*	(4) 5-Year	2.02	94.61	95.56	0.63	0.63
2377.17*	(4) 10-Year	1.57	94.61	95.47	0.58	0.73
2377.17*	(4) 25-Year	2.25	94.61	95.60	0.65	0.85
2377.17*	(4) 100-Year	2.86	94.61	95.68	0.72	1.94
2326.76*	(2) 2-Year	4.13	94.54	95.71	0.88	0.50
2326.76*	(2) 5-Year	5.24	94.54	95.76	0.98	0.48
2326.76*	(2) 10-Year	6.01	94.54	95.79	1.02	0.48
2326.76*	(2) 25-Year	6.94	94.54	95.82	1.06	0.51
2326.76*	(2) 100-Year	8.32	94.54	95.85	1.11	0.62
2326.76*	(4) 2-Year	3.97	94.54	95.70	0.87	0.51
2326.76*	(4) 5-Year	2.02	94.54	95.50	0.65	0.61
2326.76*	(4) 10-Year	1.57	94.54	95.41	0.60	0.70

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2326.76*	(4) 25-Year	2.25	94.54	95.54	0.68	0.83
2326.76*	(4) 100-Year	2.86	94.54	95.61	0.75	1.92
2276.35*	(2) 2-Year	4.13	94.48	95.62	0.90	0.49
2276.35*	(2) 5-Year	5.24	94.48	95.66	0.98	0.46
2276.35*	(2) 10-Year	6.01	94.48	95.69	1.00	0.47
2276.35*	(2) 25-Year	6.94	94.48	95.72	1.00	0.50
2276.35*	(2) 100-Year	8.32	94.48	95.76	0.99	0.61
2276.35*	(4) 2-Year	3.97	94.48	95.61	0.89	0.49
2276.35*	(4) 5-Year	2.02	94.48	95.43	0.69	0.58
2276.35*	(4) 10-Year	1.57	94.48	95.34	0.63	0.68
2276.35*	(4) 25-Year	2.25	94.48	95.46	0.71	0.81
2276.35*	(4) 100-Year	2.86	94.48	95.53	0.77	1.91
2225.94*	(2) 2-Year	4.13	94.41	95.52	0.87	0.47
2225.94*	(2) 5-Year	5.24	94.41	95.56	0.93	0.45
2225.94*	(2) 10-Year	6.01	94.41	95.59	0.97	0.45
2225.94*	(2) 25-Year	6.94	94.41	95.62	1.01	0.48
2225.94*	(2) 100-Year	8.32	94.41	95.65	1.06	0.59
2225.94*	(4) 2-Year	3.97	94.41	95.52	0.86	0.47
2225.94*	(4) 5-Year	2.02	94.41	95.34	0.75	0.57
2225.94*	(4) 10-Year	1.57	94.41	95.26	0.69	0.66
2225.94*	(4) 25-Year	2.25	94.41	95.37	0.77	0.79
2225.94*	(4) 100-Year	2.86	94.41	95.44	0.81	1.89
2175.53*	(2) 2-Year	4.13	94.34	95.43	0.83	0.45
2175.53*	(2) 5-Year	5.24	94.34	95.46	0.92	0.44
2175.53*	(2) 10-Year	6.01	94.34	95.47	0.99	0.44
2175.53*	(2) 25-Year	6.94	94.34	95.49	1.02	0.47
2175.53*	(2) 100-Year	8.32	94.34	95.54	1.02	0.58
2175.53*	(4) 2-Year	3.97	94.34	95.41	0.85	0.46
2175.53*	(4) 5-Year	2.02	94.34	95.19	0.93	0.55
2175.53*	(4) 10-Year	1.57	94.34	95.12	0.86	0.64
2175.53*	(4) 25-Year	2.25	94.34	95.23	0.96	0.77
2175.53*	(4) 100-Year	2.86	94.34	95.30	0.98	1.87
2157	(2) 2-Year	4.13	94.31	95.20	1.80	0.45
2157	(2) 5-Year	5.24	94.31	95.34	1.36	0.43
2157	(2) 10-Year	6.01	94.31	95.38	1.22	0.43
2157	(2) 25-Year	6.94	94.31	95.43	1.14	0.46
2157	(2) 100-Year	8.32	94.31	95.49	1.02	0.58
2157	(4) 2-Year	3.97	94.31	95.17	1.85	0.45
2157	(4) 5-Year	2.02	94.31	94.94	1.78	0.54
2157	(4) 10-Year	1.57	94.31	94.88	1.70	0.64
2157	(4) 25-Year	2.25	94.31	94.97	1.81	0.77
2157	(4) 100-Year	2.86	94.31	95.03	1.89	1.87
2076	(2) 2-Year	5.00	93.86	95.05	0.86	0.43
2076	(2) 5-Year	6.32	93.86	95.16	0.93	0.41
2076	(2) 10-Year	7.24	93.86	95.21	0.95	0.41
2076	(2) 25-Year	8.38	93.86	95.27	0.95	0.44
2076	(2) 100-Year	10.81	93.86	95.35	0.96	0.55

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2076	(4) 2-Year	4.78	93.86	95.03	0.85	0.44
2076	(4) 5-Year	2.34	93.86	94.65	0.75	0.53
2076	(4) 10-Year	1.78	93.86	94.53	0.71	0.62
2076	(4) 25-Year	2.60	93.86	94.70	0.76	0.75
2076	(4) 100-Year	3.29	93.86	94.85	0.76	1.85
1974	(2) 2-Year	5.00	93.68	94.92	0.80	0.40
1974	(2) 5-Year	6.32	93.68	95.01	0.90	0.38
1974	(2) 10-Year	7.24	93.68	95.06	0.94	0.38
1974	(2) 25-Year	8.38	93.68	95.11	0.98	0.41
1974	(2) 100-Year	10.81	93.68	95.20	1.01	0.53
1974	(4) 2-Year	4.78	93.68	94.90	0.78	0.40
1974	(4) 5-Year	2.34	93.68	94.51	0.70	0.49
1974	(4) 10-Year	1.78	93.68	94.37	0.67	0.58
1974	(4) 25-Year	2.60	93.68	94.57	0.70	0.71
1974	(4) 100-Year	3.29	93.68	94.74	0.68	1.81
1922	(2) 2-Year	5.00	93.59	94.86	0.79	0.38
1922	(2) 5-Year	6.32	93.59	94.93	0.91	0.37
1922	(2) 10-Year	7.24	93.59	94.97	0.99	0.37
1922	(2) 25-Year	8.38	93.59	95.01	1.07	0.40
1922	(2) 100-Year	10.81	93.59	95.08	1.18	0.51
1922	(4) 2-Year	4.78	93.59	94.84	0.77	0.39
1922	(4) 5-Year	2.34	93.59	94.44	0.67	0.47
1922	(4) 10-Year	1.78	93.59	94.30	0.66	0.56
1922	(4) 25-Year	2.60	93.59	94.51	0.67	0.69
1922	(4) 100-Year	3.29	93.59	94.69	0.65	1.79
1833	(2) 2-Year	5.00	93.44	94.78	0.65	0.35
1833	(2) 5-Year	6.32	93.44	94.84	0.71	0.34
1833	(2) 10-Year	7.24	93.44	94.87	0.75	0.34
1833	(2) 25-Year	8.38	93.44	94.90	0.78	0.37
1833	(2) 100-Year	10.81	93.44	94.97	0.82	0.49
1833	(4) 2-Year	4.78	93.44	94.76	0.64	0.35
1833	(4) 5-Year	2.34	93.44	94.35	0.60	0.43
1833	(4) 10-Year	1.78	93.44	94.20	0.59	0.52
1833	(4) 25-Year	2.60	93.44	94.42	0.60	0.65
1833	(4) 100-Year	3.29	93.44	94.63	0.55	1.75
1796	(2) 2-Year	5.00	93.37	94.74	0.70	0.33
1796	(2) 5-Year	6.32	93.37	94.79	0.83	0.32
1796	(2) 10-Year	7.24	93.37	94.80	0.93	0.33
1796	(2) 25-Year	8.38	93.37	94.83	1.04	0.36
1796	(2) 100-Year	10.81	93.37	94.87	1.23	0.48
1796	(4) 2-Year	4.78	93.37	94.73	0.68	0.34
1796	(4) 5-Year	2.34	93.37	94.33	0.57	0.41
1796	(4) 10-Year	1.78	93.37	94.17	0.56	0.50
1796	(4) 25-Year	2.60	93.37	94.40	0.57	0.64
1796	(4) 100-Year	3.29	93.37	94.60	0.55	1.73
1735	(2) 2-Year	5.00	93.26	94.71	0.53	0.31
1735	(2) 5-Year	6.32	93.26	94.76	0.57	0.30

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1735	(2) 10-Year	7.24	93.26	94.77	0.63	0.31
1735	(2) 25-Year	8.38	93.26	94.79	0.68	0.34
1735	(2) 100-Year	10.81	93.26	94.84	0.74	0.46
1735	(4) 2-Year	4.78	93.26	94.70	0.53	0.31
1735	(4) 5-Year	2.34	93.26	94.29	0.49	0.38
1735	(4) 10-Year	1.78	93.26	94.13	0.49	0.47
1735	(4) 25-Year	2.60	93.26	94.36	0.49	0.61
1735	(4) 100-Year	3.29	93.26	94.58	0.45	1.70
1728	(2) 2-Year	5.00	93.25	94.69	0.73	0.31
1728	(2) 5-Year	6.32	93.25	94.74	0.84	0.30
1728	(2) 10-Year	7.24	93.25	94.74	0.95	0.31
1728	(2) 25-Year	8.38	93.25	94.75	1.07	0.34
1728	(2) 100-Year	10.81	93.25	94.76	1.32	0.46
1728	(4) 2-Year	4.78	93.25	94.68	0.72	0.31
1728	(4) 5-Year	2.34	93.25	94.28	0.61	0.38
1728	(4) 10-Year	1.78	93.25	94.11	0.60	0.47
1728	(4) 25-Year	2.60	93.25	94.35	0.61	0.60
1728	(4) 100-Year	3.29	93.25	94.57	0.58	1.70
1727		Culvert				
1717	(2) 2-Year	5.00	93.24	94.45	1.02	0.30
1717	(2) 5-Year	6.32	93.24	94.57	1.10	0.29
1717	(2) 10-Year	7.24	93.24	94.62	1.17	0.30
1717	(2) 25-Year	8.38	93.24	94.67	1.26	0.34
1717	(2) 100-Year	10.81	93.24	94.74	1.39	0.46
1717	(4) 2-Year	4.78	93.24	94.42	1.01	0.30
1717	(4) 5-Year	2.34	93.24	94.06	0.84	0.37
1717	(4) 10-Year	1.78	93.24	93.94	0.80	0.46
1717	(4) 25-Year	2.60	93.24	94.12	0.86	0.60
1717	(4) 100-Year	3.29	93.24	94.32	0.79	1.69
1615	(2) 2-Year	5.00	93.05	94.29	0.83	0.27
1615	(2) 5-Year	6.32	93.05	94.40	0.88	0.26
1615	(2) 10-Year	7.24	93.05	94.47	0.87	0.28
1615	(2) 25-Year	8.38	93.05	94.53	0.87	0.31
1615	(2) 100-Year	10.81	93.05	94.62	0.82	0.43
1615	(4) 2-Year	4.78	93.05	94.26	0.82	0.27
1615	(4) 5-Year	2.34	93.05	93.92	0.65	0.34
1615	(4) 10-Year	1.78	93.05	93.78	0.63	0.42
1615	(4) 25-Year	2.60	93.05	93.98	0.66	0.56
1615	(4) 100-Year	3.29	93.05	94.24	0.58	1.65
1555	(2) 2-Year	5.00	92.94	94.22	0.79	0.25
1555	(2) 5-Year	6.32	92.94	94.33	0.85	0.25
1555	(2) 10-Year	7.24	92.94	94.39	0.88	0.26
1555	(2) 25-Year	8.38	92.94	94.45	0.91	0.29
1555	(2) 100-Year	10.81	92.94	94.55	0.96	0.41
1555	(4) 2-Year	4.78	92.94	94.19	0.78	0.25
1555	(4) 5-Year	2.34	92.94	93.87	0.59	0.31
1555	(4) 10-Year	1.78	92.94	93.72	0.58	0.40

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1555	(4) 25-Year	2.60	92.94	93.93	0.60	0.54
1555	(4) 100-Year	3.29	92.94	94.21	0.53	1.62
1488	(2) 2-Year	5.00	92.82	94.16	0.72	0.23
1488	(2) 5-Year	6.32	92.82	94.26	0.81	0.22
1488	(2) 10-Year	7.24	92.82	94.31	0.86	0.24
1488	(2) 25-Year	8.38	92.82	94.37	0.91	0.27
1488	(2) 100-Year	10.81	92.82	94.46	1.00	0.40
1488	(4) 2-Year	4.78	92.82	94.13	0.72	0.23
1488	(4) 5-Year	2.34	92.82	93.82	0.53	0.28
1488	(4) 10-Year	1.78	92.82	93.66	0.51	0.36
1488	(4) 25-Year	2.60	92.82	93.88	0.54	0.50
1488	(4) 100-Year	3.29	92.82	94.18	0.46	1.59
1416	(2) 2-Year	5.00	92.71	94.02	1.09	0.21
1416	(2) 5-Year	6.32	92.71	94.10	1.21	0.20
1416	(2) 10-Year	7.24	92.71	94.17	1.21	0.22
1416	(2) 25-Year	8.38	92.71	94.25	1.12	0.25
1416	(2) 100-Year	10.81	92.71	94.40	0.82	0.37
1416	(4) 2-Year	4.78	92.71	93.99	1.08	0.21
1416	(4) 5-Year	2.34	92.71	93.74	0.74	0.25
1416	(4) 10-Year	1.78	92.71	93.58	0.71	0.33
1416	(4) 25-Year	2.60	92.71	93.81	0.76	0.47
1416	(4) 100-Year	3.29	92.71	94.14	0.58	1.55
1400	(2) 2-Year	5.00	92.68	94.02	0.68	0.20
1400	(2) 5-Year	6.32	92.68	94.11	0.77	0.20
1400	(2) 10-Year	7.24	92.68	94.16	0.82	0.21
1400	(2) 25-Year	8.38	92.68	94.23	0.87	0.25
1400	(2) 100-Year	10.81	92.68	94.36	0.96	0.37
1400	(4) 2-Year	4.78	92.68	93.99	0.68	0.20
1400	(4) 5-Year	2.34	92.68	93.74	0.50	0.24
1400	(4) 10-Year	1.78	92.68	93.58	0.50	0.32
1400	(4) 25-Year	2.60	92.68	93.80	0.50	0.47
1400	(4) 100-Year	3.29	92.68	94.14	0.38	1.54
1364	(2) 2-Year	5.00	92.62	93.99	0.71	0.19
1364	(2) 5-Year	6.32	92.62	94.06	0.82	0.19
1364	(2) 10-Year	7.24	92.62	94.11	0.88	0.20
1364	(2) 25-Year	8.38	92.62	94.18	0.95	0.24
1364	(2) 100-Year	10.81	92.62	94.29	1.06	0.36
1364	(4) 2-Year	4.78	92.62	93.96	0.70	0.19
1364	(4) 5-Year	2.34	92.62	93.72	0.46	0.22
1364	(4) 10-Year	1.78	92.62	93.56	0.44	0.30
1364	(4) 25-Year	2.60	92.62	93.79	0.47	0.45
1364	(4) 100-Year	3.29	92.62	94.13	0.39	1.51
1340	(2) 2-Year	5.79	92.61	93.96	0.88	0.18
1340	(2) 5-Year	7.32	92.61	94.01	1.06	0.18
1340	(2) 10-Year	8.34	92.61	94.05	1.18	0.19
1340	(2) 25-Year	9.65	92.61	94.10	1.33	0.23
1340	(2) 100-Year	11.62	92.61	94.19	1.50	0.35

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1340	(4) 2-Year	5.26	92.61	93.93	0.81	0.18
1340	(4) 5-Year	2.44	92.61	93.71	0.45	0.21
1340	(4) 10-Year	1.86	92.61	93.55	0.40	0.29
1340	(4) 25-Year	2.71	92.61	93.78	0.47	0.43
1340	(4) 100-Year	3.43	92.61	94.13	0.46	1.50
1339		Culvert				
1312	(2) 2-Year	6.08	92.47	93.94	0.85	0.17
1312	(2) 5-Year	7.69	92.47	93.98	1.04	0.17
1312	(2) 10-Year	8.76	92.47	94.01	1.16	0.19
1312	(2) 25-Year	10.15	92.47	94.04	1.32	0.23
1312	(2) 100-Year	12.20	92.47	94.12	1.51	0.35
1312	(4) 2-Year	5.46	92.47	93.91	0.77	0.17
1312	(4) 5-Year	2.47	92.47	93.71	0.41	0.19
1312	(4) 10-Year	1.87	92.47	93.55	0.35	0.27
1312	(4) 25-Year	2.73	92.47	93.77	0.43	0.41
1312	(4) 100-Year	3.44	92.47	94.12	0.43	1.48
1302	(2) 2-Year	6.08	92.57	93.91	1.03	0.17
1302	(2) 5-Year	7.69	92.57	93.97	1.12	0.17
1302	(2) 10-Year	8.76	92.57	94.00	1.18	0.19
1302	(2) 25-Year	10.15	92.57	94.04	1.26	0.23
1302	(2) 100-Year	12.20	92.57	94.14	1.07	0.35
1302	(4) 2-Year	5.46	92.57	93.89	0.98	0.17
1302	(4) 5-Year	2.47	92.57	93.68	0.77	0.18
1302	(4) 10-Year	1.87	92.57	93.51	0.84	0.26
1302	(4) 25-Year	2.73	92.57	93.75	0.72	0.41
1302	(4) 100-Year	3.44	92.57	94.12	0.33	1.47
1268	(2) 2-Year	6.08	92.47	93.87	0.59	0.15
1268	(2) 5-Year	7.69	92.47	93.93	0.62	0.16
1268	(2) 10-Year	8.76	92.47	93.96	0.64	0.18
1268	(2) 25-Year	10.15	92.47	94.00	0.65	0.22
1268	(2) 100-Year	12.20	92.47	94.14	0.45	0.34
1268	(4) 2-Year	5.46	92.47	93.84	0.57	0.15
1268	(4) 5-Year	2.47	92.47	93.59	0.68	0.17
1268	(4) 10-Year	1.87	92.47	93.44	0.79	0.25
1268	(4) 25-Year	2.73	92.47	93.69	0.51	0.39
1268	(4) 100-Year	3.44	92.47	94.12	0.14	1.43
1212	(2) 2-Year	6.08	92.36	93.78	0.84	0.13
1212	(2) 5-Year	7.69	92.36	93.85	0.85	0.14
1212	(2) 10-Year	8.76	92.36	93.89	0.85	0.15
1212	(2) 25-Year	10.15	92.36	93.94	0.80	0.19
1212	(2) 100-Year	12.20	92.36	94.11	0.56	0.30
1212	(4) 2-Year	5.46	92.36	93.74	0.83	0.13
1212	(4) 5-Year	2.47	92.36	93.41	0.89	0.15
1212	(4) 10-Year	1.87	92.36	93.32	0.81	0.23
1212	(4) 25-Year	2.73	92.36	93.58	0.66	0.37
1212	(4) 100-Year	3.44	92.36	94.12	0.15	1.32

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1169	(2) 2-Year	6.08	92.30	93.70	0.85	0.12
1169	(2) 5-Year	7.69	92.30	93.76	0.91	0.13
1169	(2) 10-Year	8.76	92.30	93.80	0.94	0.14
1169	(2) 25-Year	10.15	92.30	93.87	0.94	0.18
1169	(2) 100-Year	12.20	92.30	94.08	0.73	0.29
1169	(4) 2-Year	5.46	92.30	93.67	0.83	0.12
1169	(4) 5-Year	2.47	92.30	93.32	0.73	0.13
1169	(4) 10-Year	1.87	92.30	93.26	0.62	0.21
1169	(4) 25-Year	2.73	92.30	93.54	0.53	0.35
1169	(4) 100-Year	3.44	92.30	94.12	0.17	1.25
1091	(2) 2-Year	6.08	92.15	93.57	0.82	0.09
1091	(2) 5-Year	7.69	92.15	93.64	0.85	0.10
1091	(2) 10-Year	8.76	92.15	93.69	0.84	0.12
1091	(2) 25-Year	10.15	92.15	93.78	0.78	0.15
1091	(2) 100-Year	12.20	92.15	94.04	0.57	0.25
1091	(4) 2-Year	5.46	92.15	93.54	0.82	0.09
1091	(4) 5-Year	2.47	92.15	93.19	0.70	0.10
1091	(4) 10-Year	1.87	92.15	93.17	0.55	0.18
1091	(4) 25-Year	2.73	92.15	93.50	0.45	0.30
1091	(4) 100-Year	3.44	92.15	94.12	0.13	1.10
1002	(2) 2-Year	6.08	92.06	93.38	1.02	0.07
1002	(2) 5-Year	7.69	92.06	93.49	0.94	0.07
1002	(2) 10-Year	8.76	92.06	93.59	0.82	0.09
1002	(2) 25-Year	10.15	92.06	93.71	0.70	0.12
1002	(2) 100-Year	12.20	92.06	94.02	0.41	0.20
1002	(4) 2-Year	5.46	92.06	93.33	1.01	0.06
1002	(4) 5-Year	2.47	92.06	93.01	0.83	0.07
1002	(4) 10-Year	1.87	92.06	93.09	0.55	0.13
1002	(4) 25-Year	2.73	92.06	93.47	0.36	0.24
1002	(4) 100-Year	3.44	92.06	94.12	0.09	0.88
961	(2) 2-Year	6.08	91.96	93.28	0.83	0.05
961	(2) 5-Year	7.69	91.96	93.41	0.78	0.06
961	(2) 10-Year	8.76	91.96	93.52	0.65	0.07
961	(2) 25-Year	10.15	91.96	93.69	0.43	0.10
961	(2) 100-Year	12.20	91.96	94.02	0.24	0.17
961	(4) 2-Year	5.46	91.96	93.23	0.82	0.05
961	(4) 5-Year	2.47	91.96	92.97	0.62	0.06
961	(4) 10-Year	1.87	91.96	93.06	0.40	0.11
961	(4) 25-Year	2.73	91.96	93.46	0.25	0.21
961	(4) 100-Year	3.44	91.96	94.12	0.05	0.72
910	(2) 2-Year	6.08	91.93	93.22	0.70	0.03
910	(2) 5-Year	7.69	91.93	93.38	0.63	0.04
910	(2) 10-Year	8.76	91.93	93.49	0.52	0.05
910	(2) 25-Year	10.15	91.93	93.68	0.34	0.06
910	(2) 100-Year	12.20	91.93	94.02	0.20	0.10
910	(4) 2-Year	5.46	91.93	93.17	0.73	0.03
910	(4) 5-Year	2.47	91.93	92.91	0.64	0.03
910	(4) 10-Year	1.87	91.93	93.05	0.35	0.07

Table A-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
910	(4) 25-Year	2.73	91.93	93.46	0.18	0.14
910	(4) 100-Year	3.44	91.93	94.12	0.05	0.44
840	(2) 2-Year	6.08	91.86	93.18	0.41	0.00
840	(2) 5-Year	7.69	91.86	93.35	0.34	0.00
840	(2) 10-Year	8.76	91.86	93.48	0.30	0.00
840	(2) 25-Year	10.15	91.86	93.67	0.26	0.00
840	(2) 100-Year	12.20	91.86	94.02	0.18	0.00
840	(4) 2-Year	5.46	91.86	93.11	0.44	0.00
840	(4) 5-Year	2.47	91.86	92.83	0.47	0.00
840	(4) 10-Year	1.87	91.86	93.03	0.19	0.00
840	(4) 25-Year	2.73	91.86	93.45	0.10	0.00
840	(4) 100-Year	3.44	91.86	94.12	0.04	0.00

(1) All channel infrastructure included in the HEC-RAS model for floodplain analysis.

For Scenario 2 (the Van Gaal Drain 100-year spring snowmelt plus rainfall peak flow reaches the Jock River) and Scenario 4 (the Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain).

Ottawa. ON
Paris. ON
Gatineau. QB
Montréal. QB
Québec. QB

Attachment B

HEC-RAS Results for Van Gaal Drain Reach 2
Existing Conditions (Riparian Storage Analysis)

Table B-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2554	(1) 25 mm	0.72	94.75	95.41	0.41	3.57
2554	(1) 2-Year	1.95	94.75	95.72	0.56	7.64
2554	(1) 5-Year	3.20	94.75	95.93	0.65	11.95
2554	(1) 10-Year	4.11	94.75	96.04	0.71	15.65
2554	(1) 25-Year	5.28	94.75	96.14	0.78	22.19
2554	(1) 100-Year	7.27	94.75	96.26	0.84	38.09
2478	(1) 25 mm	0.72	94.75	95.35	0.42	3.44
2478	(1) 2-Year	1.95	94.75	95.65	0.59	7.39
2478	(1) 5-Year	3.20	94.75	95.85	0.72	11.60
2478	(1) 10-Year	4.11	94.75	95.94	0.82	15.23
2478	(1) 25-Year	5.28	94.75	96.03	0.93	21.64
2478	(1) 100-Year	7.27	94.75	96.12	1.10	37.03
2427.58*	(1) 25 mm	0.72	94.68	95.30	0.43	3.36
2427.58*	(1) 2-Year	1.95	94.68	95.60	0.61	7.23
2427.58*	(1) 5-Year	3.20	94.68	95.79	0.74	11.38
2427.58*	(1) 10-Year	4.11	94.68	95.87	0.84	14.96
2427.58*	(1) 25-Year	5.28	94.68	95.95	0.95	21.30
2427.58*	(1) 100-Year	7.27	94.68	96.04	1.11	36.45
2377.17*	(1) 25 mm	0.72	94.61	95.25	0.44	3.28
2377.17*	(1) 2-Year	1.95	94.61	95.54	0.62	7.07
2377.17*	(1) 5-Year	3.20	94.61	95.72	0.76	11.16
2377.17*	(1) 10-Year	4.11	94.61	95.80	0.86	14.68
2377.17*	(1) 25-Year	5.28	94.61	95.87	0.97	20.90
2377.17*	(1) 100-Year	7.27	94.61	95.95	1.09	35.75
2326.76*	(1) 25 mm	0.72	94.54	95.19	0.46	3.20
2326.76*	(1) 2-Year	1.95	94.54	95.48	0.64	6.91
2326.76*	(1) 5-Year	3.20	94.54	95.65	0.78	10.93
2326.76*	(1) 10-Year	4.11	94.54	95.72	0.88	14.37
2326.76*	(1) 25-Year	5.28	94.54	95.78	0.97	20.42
2326.76*	(1) 100-Year	7.27	94.54	95.85	1.07	34.92
2276.35*	(1) 25 mm	0.72	94.48	95.13	0.49	3.12
2276.35*	(1) 2-Year	1.95	94.48	95.41	0.68	6.77
2276.35*	(1) 5-Year	3.20	94.48	95.57	0.80	10.67
2276.35*	(1) 10-Year	4.11	94.48	95.63	0.89	14.00
2276.35*	(1) 25-Year	5.28	94.48	95.69	0.96	19.84
2276.35*	(1) 100-Year	7.27	94.48	95.77	0.98	33.90
2225.94*	(1) 25 mm	0.72	94.41	95.05	0.54	3.05
2225.94*	(1) 2-Year	1.95	94.41	95.33	0.74	6.63
2225.94*	(1) 5-Year	3.20	94.41	95.48	0.84	10.38
2225.94*	(1) 10-Year	4.11	94.41	95.54	0.88	13.58
2225.94*	(1) 25-Year	5.28	94.41	95.59	0.95	19.24
2225.94*	(1) 100-Year	7.27	94.41	95.66	1.05	32.94
2175.53*	(1) 25 mm	0.72	94.34	94.93	0.68	2.99
2175.53*	(1) 2-Year	1.95	94.34	95.18	0.92	6.51
2175.53*	(1) 5-Year	3.20	94.34	95.33	1.03	10.12

Table B-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2175.53*	(1) 10-Year	4.11	94.34	95.42	0.94	13.14
2175.53*	(1) 25-Year	5.28	94.34	95.47	1.01	18.68
2175.53*	(1) 100-Year	7.27	94.34	95.54	1.07	32.14
2157	(1) 25 mm	0.72	94.31	94.72	1.45	2.98
2157	(1) 2-Year	1.95	94.31	94.93	1.77	6.48
2157	(1) 5-Year	3.20	94.31	95.12	1.71	10.06
2157	(1) 10-Year	4.11	94.31	95.24	1.59	13.03
2157	(1) 25-Year	5.28	94.31	95.37	1.29	18.50
2157	(1) 100-Year	7.27	94.31	95.48	1.13	31.84
2076	(1) 25 mm	1.16	93.86	94.39	0.64	2.89
2076	(1) 2-Year	2.80	93.86	94.71	0.81	6.30
2076	(1) 5-Year	4.41	93.86	94.94	0.89	9.79
2076	(1) 10-Year	5.53	93.86	95.07	0.93	12.67
2076	(1) 25-Year	6.96	93.86	95.19	0.97	17.86
2076	(1) 100-Year	9.54	93.86	95.33	0.99	30.64
1974	(1) 25 mm	1.16	93.68	94.21	0.63	2.71
1974	(1) 2-Year	2.80	93.68	94.54	0.78	5.95
1974	(1) 5-Year	4.41	93.68	94.77	0.86	9.29
1974	(1) 10-Year	5.53	93.68	94.92	0.89	12.06
1974	(1) 25-Year	6.96	93.68	95.04	0.95	16.97
1974	(1) 100-Year	9.54	93.68	95.17	1.02	28.90
1922	(1) 25 mm	1.16	93.59	94.12	0.63	2.62
1922	(1) 2-Year	2.80	93.59	94.46	0.78	5.77
1922	(1) 5-Year	4.41	93.59	94.70	0.87	9.04
1922	(1) 10-Year	5.53	93.59	94.84	0.91	11.76
1922	(1) 25-Year	6.96	93.59	94.95	0.98	16.58
1922	(1) 100-Year	9.54	93.59	95.07	1.10	28.19
1833	(1) 25 mm	1.16	93.44	93.97	0.62	2.45
1833	(1) 2-Year	2.80	93.44	94.33	0.75	5.45
1833	(1) 5-Year	4.41	93.44	94.56	0.81	8.57
1833	(1) 10-Year	5.53	93.44	94.70	0.82	11.18
1833	(1) 25-Year	6.96	93.44	94.82	0.83	15.73
1833	(1) 100-Year	9.54	93.44	94.95	0.84	26.54
1796	(1) 25 mm	1.16	93.37	93.91	0.62	2.38
1796	(1) 2-Year	2.80	93.37	94.28	0.73	5.31
1796	(1) 5-Year	4.41	93.37	94.51	0.83	8.38
1796	(1) 10-Year	5.53	93.37	94.64	0.88	10.95
1796	(1) 25-Year	6.96	93.37	94.75	0.96	15.39
1796	(1) 100-Year	9.54	93.37	94.87	1.11	25.93
1735	(1) 25 mm	1.16	93.26	93.83	0.58	2.27
1735	(1) 2-Year	2.80	93.26	94.21	0.67	5.08
1735	(1) 5-Year	4.41	93.26	94.44	0.74	8.05
1735	(1) 10-Year	5.53	93.26	94.57	0.77	10.56
1735	(1) 25-Year	6.96	93.26	94.69	0.80	14.83
1735	(1) 100-Year	9.54	93.26	94.83	0.76	24.60

Table B-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1728	(1) 25 mm	1.16	93.25	93.81	0.68	2.26
1728	(1) 2-Year	2.80	93.25	94.19	0.84	5.05
1728	(1) 5-Year	4.41	93.25	94.41	0.95	8.01
1728	(1) 10-Year	5.53	93.25	94.53	1.01	10.51
1728	(1) 25-Year	6.96	93.25	94.64	1.11	14.76
1728	(1) 100-Year	9.54	93.25	94.78	1.17	24.43
1717	(1) 25 mm	1.16	93.24	93.79	0.71	2.24
1717	(1) 2-Year	2.80	93.24	94.16	0.86	5.01
1717	(1) 5-Year	4.41	93.24	94.38	0.98	7.96
1717	(1) 10-Year	5.53	93.24	94.50	1.04	10.45
1717	(1) 25-Year	6.96	93.24	94.61	1.14	14.69
1717	(1) 100-Year	9.54	93.24	94.73	1.32	24.28
1615	(1) 25 mm	1.16	93.05	93.63	0.56	2.05
1615	(1) 2-Year	2.80	93.05	94.03	0.65	4.63
1615	(1) 5-Year	4.41	93.05	94.24	0.78	7.45
1615	(1) 10-Year	5.53	93.05	94.35	0.85	9.83
1615	(1) 25-Year	6.96	93.05	94.46	0.89	13.75
1615	(1) 100-Year	9.54	93.05	94.59	0.90	22.47
1555	(1) 25 mm	1.16	92.94	93.57	0.50	1.92
1555	(1) 2-Year	2.80	92.94	93.99	0.60	4.36
1555	(1) 5-Year	4.41	92.94	94.18	0.73	7.10
1555	(1) 10-Year	5.53	92.94	94.28	0.81	9.41
1555	(1) 25-Year	6.96	92.94	94.39	0.88	13.09
1555	(1) 100-Year	9.54	92.94	94.51	0.97	21.28
1488	(1) 25 mm	1.16	92.82	93.53	0.43	1.76
1488	(1) 2-Year	2.80	92.82	93.95	0.53	4.04
1488	(1) 5-Year	4.41	92.82	94.12	0.67	6.69
1488	(1) 10-Year	5.53	92.82	94.22	0.75	8.93
1488	(1) 25-Year	6.96	92.82	94.31	0.83	12.45
1488	(1) 100-Year	9.54	92.82	94.43	0.97	20.32
1416	(1) 25 mm	1.16	92.71	93.47	0.55	1.59
1416	(1) 2-Year	2.80	92.71	93.88	0.74	3.73
1416	(1) 5-Year	4.41	92.71	94.01	0.98	6.31
1416	(1) 10-Year	5.53	92.71	94.08	1.11	8.48
1416	(1) 25-Year	6.96	92.71	94.16	1.22	11.83
1416	(1) 100-Year	9.54	92.71	94.28	1.29	19.29
1400	(1) 25 mm	1.16	92.68	93.46	0.39	1.55
1400	(1) 2-Year	2.80	92.68	93.87	0.48	3.65
1400	(1) 5-Year	4.41	92.68	94.01	0.61	6.21
1400	(1) 10-Year	5.53	92.68	94.08	0.69	8.37
1400	(1) 25-Year	6.96	92.68	94.16	0.79	11.69
1400	(1) 100-Year	9.54	92.68	94.27	0.95	19.07
1364	(1) 25 mm	1.16	92.62	93.45	0.35	1.44
1364	(1) 2-Year	2.80	92.62	93.86	0.46	3.44

Table B-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1364	(1) 5-Year	4.41	92.62	93.98	0.63	5.96
1364	(1) 10-Year	5.53	92.62	94.04	0.73	8.09
1364	(1) 25-Year	6.96	92.62	94.11	0.85	11.37
1364	(1) 100-Year	9.54	92.62	94.20	1.05	18.72
1340	(1) 25 mm	1.53	92.61	93.45	0.19	1.30
1340	(1) 2-Year	3.64	92.61	93.86	0.29	3.22
1340	(1) 5-Year	5.57	92.61	93.98	0.41	5.71
1340	(1) 10-Year	6.92	92.61	94.05	0.48	7.82
1340	(1) 25-Year	8.58	92.61	94.12	0.57	11.09
1340	(1) 100-Year	11.43	92.61	94.21	0.71	18.39
1312	(1) 25 mm	1.53	92.47	93.45	0.29	1.10
1312	(1) 2-Year	3.87	92.47	93.84	0.51	2.91
1312	(1) 5-Year	5.93	92.47	93.96	0.71	5.36
1312	(1) 10-Year	7.38	92.47	94.01	0.84	7.45
1312	(1) 25-Year	9.17	92.47	94.07	1.01	10.69
1312	(1) 100-Year	12.20	92.47	94.13	1.29	17.96
1302	(1) 25 mm	1.53	92.57	93.41	0.83	1.07
1302	(1) 2-Year	3.87	92.57	93.81	0.88	2.84
1302	(1) 5-Year	5.93	92.57	93.92	1.05	5.28
1302	(1) 10-Year	7.38	92.57	93.98	1.15	7.35
1302	(1) 25-Year	9.17	92.57	94.03	1.27	10.58
1302	(1) 100-Year	12.20	92.57	94.11	1.41	17.81
1268	(1) 25 mm	1.53	92.47	93.33	0.79	1.00
1268	(1) 2-Year	3.87	92.47	93.75	0.56	2.62
1268	(1) 5-Year	5.93	92.47	93.88	0.57	4.91
1268	(1) 10-Year	7.38	92.47	93.94	0.60	6.88
1268	(1) 25-Year	9.17	92.47	94.01	0.62	9.89
1268	(1) 100-Year	12.20	92.47	94.10	0.60	16.63
1212	(1) 25 mm	1.53	92.36	93.18	0.86	0.90
1212	(1) 2-Year	3.87	92.36	93.61	0.89	2.25
1212	(1) 5-Year	5.93	92.36	93.77	0.91	4.21
1212	(1) 10-Year	7.38	92.36	93.85	0.93	5.90
1212	(1) 25-Year	9.17	92.36	93.92	0.94	8.43
1212	(1) 100-Year	12.20	92.36	94.04	0.90	14.29
1169	(1) 25 mm	1.53	92.30	93.10	0.69	0.81
1169	(1) 2-Year	3.87	92.30	93.53	0.78	2.01
1169	(1) 5-Year	5.93	92.30	93.70	0.86	3.67
1169	(1) 10-Year	7.38	92.30	93.77	0.92	5.11
1169	(1) 25-Year	9.17	92.30	93.84	0.98	7.33
1169	(1) 100-Year	12.20	92.30	93.94	1.09	12.63
1091	(1) 25 mm	1.53	92.15	92.98	0.65	0.63
1091	(1) 2-Year	3.87	92.15	93.40	0.75	1.62
1091	(1) 5-Year	5.93	92.15	93.57	0.83	2.89
1091	(1) 10-Year	7.38	92.15	93.64	0.87	4.03
1091	(1) 25-Year	9.17	92.15	93.71	0.92	5.91

Table B-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1091	(1) 100-Year	12.20	92.15	93.82	0.97	10.61
1002	(1) 25 mm	1.53	92.06	92.81	0.76	0.44
1002	(1) 2-Year	3.87	92.06	93.21	0.91	1.21
1002	(1) 5-Year	5.93	92.06	93.37	1.02	2.15
1002	(1) 10-Year	7.38	92.06	93.46	1.04	2.97
1002	(1) 25-Year	9.17	92.06	93.55	1.03	4.45
1002	(1) 100-Year	12.20	92.06	93.69	1.02	8.49
961	(1) 25 mm	1.53	91.96	92.77	0.54	0.34
961	(1) 2-Year	3.87	91.96	93.13	0.72	1.01
961	(1) 5-Year	5.93	91.96	93.28	0.80	1.85
961	(1) 10-Year	7.38	91.96	93.37	0.83	2.56
961	(1) 25-Year	9.17	91.96	93.47	0.82	3.85
961	(1) 100-Year	12.20	91.96	93.64	0.64	7.42
910	(1) 25 mm	1.53	91.93	92.72	0.57	0.20
910	(1) 2-Year	3.87	91.93	93.06	0.74	0.62
910	(1) 5-Year	5.93	91.93	93.20	0.81	1.16
910	(1) 10-Year	7.38	91.93	93.30	0.82	1.62
910	(1) 25-Year	9.17	91.93	93.41	0.83	2.38
910	(1) 100-Year	12.20	91.93	93.60	0.68	4.32
840	(1) 25 mm	1.53	91.86	92.65	0.50	0.00
840	(1) 2-Year	3.87	91.86	92.98	0.47	0.00
840	(1) 5-Year	5.93	91.86	93.16	0.43	0.00
840	(1) 10-Year	7.38	91.86	93.26	0.41	0.00
840	(1) 25-Year	9.17	91.86	93.38	0.41	0.00
840	(1) 100-Year	12.20	91.86	93.58	0.39	0.00

(1) All channel infrastructure removed from the HEC-RAS model for riparian storage analysis.
For Scenario 1 (the Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River).

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2554	(2) 2-Year	4.13	94.75	96.03	0.71	12.55
2554	(2) 5-Year	5.24	94.75	96.13	0.78	16.61
2554	(2) 10-Year	6.01	94.75	96.18	0.81	20.28
2554	(2) 25-Year	6.94	94.75	96.23	0.83	26.23
2554	(2) 100-Year	8.32	94.75	96.28	0.82	39.19
2554	(4) 2-Year	3.97	94.75	96.02	0.70	11.55
2554	(4) 5-Year	2.02	94.75	95.74	0.56	5.89
2554	(4) 10-Year	1.57	94.75	95.64	0.52	5.25
2554	(4) 25-Year	2.25	94.75	95.78	0.58	9.59
2554	(4) 100-Year	2.86	94.75	95.88	0.63	36.83
2478	(2) 2-Year	4.13	94.75	95.93	0.83	12.14
2478	(2) 5-Year	5.24	94.75	96.02	0.93	16.08
2478	(2) 10-Year	6.01	94.75	96.06	1.00	19.63
2478	(2) 25-Year	6.94	94.75	96.10	1.09	25.37
2478	(2) 100-Year	8.32	94.75	96.14	1.17	37.97
2478	(4) 2-Year	3.97	94.75	95.92	0.81	11.15
2478	(4) 5-Year	2.02	94.75	95.67	0.60	5.63
2478	(4) 10-Year	1.57	94.75	95.57	0.55	5.03
2478	(4) 25-Year	2.25	94.75	95.71	0.63	9.31
2478	(4) 100-Year	2.86	94.75	95.80	0.69	36.50
2427.58*	(2) 2-Year	4.13	94.68	95.86	0.85	11.88
2427.58*	(2) 5-Year	5.24	94.68	95.94	0.95	15.75
2427.58*	(2) 10-Year	6.01	94.68	95.97	1.04	19.25
2427.58*	(2) 25-Year	6.94	94.68	96.01	1.09	24.89
2427.58*	(2) 100-Year	8.32	94.68	96.05	1.16	37.34
2427.58*	(4) 2-Year	3.97	94.68	95.85	0.83	10.90
2427.58*	(4) 5-Year	2.02	94.68	95.61	0.61	5.47
2427.58*	(4) 10-Year	1.57	94.68	95.52	0.56	4.88
2427.58*	(4) 25-Year	2.25	94.68	95.65	0.64	9.13
2427.58*	(4) 100-Year	2.86	94.68	95.74	0.70	36.30
2377.17*	(2) 2-Year	4.13	94.61	95.79	0.87	11.60
2377.17*	(2) 5-Year	5.24	94.61	95.85	0.97	15.39
2377.17*	(2) 10-Year	6.01	94.61	95.88	1.03	18.81
2377.17*	(2) 25-Year	6.94	94.61	95.91	1.08	24.33
2377.17*	(2) 100-Year	8.32	94.61	95.95	1.13	36.61
2377.17*	(4) 2-Year	3.97	94.61	95.78	0.85	10.63
2377.17*	(4) 5-Year	2.02	94.61	95.56	0.63	5.30
2377.17*	(4) 10-Year	1.57	94.61	95.47	0.58	4.75
2377.17*	(4) 25-Year	2.25	94.61	95.60	0.65	8.96
2377.17*	(4) 100-Year	2.86	94.61	95.68	0.72	36.10
2326.76*	(2) 2-Year	4.13	94.54	95.71	0.88	11.31
2326.76*	(2) 5-Year	5.24	94.54	95.76	0.98	14.98
2326.76*	(2) 10-Year	6.01	94.54	95.79	1.02	18.30
2326.76*	(2) 25-Year	6.94	94.54	95.82	1.06	23.69
2326.76*	(2) 100-Year	8.32	94.54	95.85	1.11	35.80
2326.76*	(4) 2-Year	3.97	94.54	95.70	0.87	10.35
2326.76*	(4) 5-Year	2.02	94.54	95.50	0.65	5.14
2326.76*	(4) 10-Year	1.57	94.54	95.41	0.60	4.61

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2326.76*	(4) 25-Year	2.25	94.54	95.54	0.68	8.79
2326.76*	(4) 100-Year	2.86	94.54	95.61	0.75	35.90
2276.35*	(2) 2-Year	4.13	94.48	95.62	0.90	10.97
2276.35*	(2) 5-Year	5.24	94.48	95.66	0.98	14.50
2276.35*	(2) 10-Year	6.01	94.48	95.69	1.00	17.70
2276.35*	(2) 25-Year	6.94	94.48	95.72	1.00	22.95
2276.35*	(2) 100-Year	8.32	94.48	95.76	0.99	34.83
2276.35*	(4) 2-Year	3.97	94.48	95.61	0.89	10.03
2276.35*	(4) 5-Year	2.02	94.48	95.43	0.69	4.99
2276.35*	(4) 10-Year	1.57	94.48	95.34	0.63	4.48
2276.35*	(4) 25-Year	2.25	94.48	95.46	0.71	8.62
2276.35*	(4) 100-Year	2.86	94.48	95.53	0.77	35.68
2225.94*	(2) 2-Year	4.13	94.41	95.52	0.87	10.59
2225.94*	(2) 5-Year	5.24	94.41	95.56	0.93	14.00
2225.94*	(2) 10-Year	6.01	94.41	95.59	0.97	17.11
2225.94*	(2) 25-Year	6.94	94.41	95.62	1.01	22.24
2225.94*	(2) 100-Year	8.32	94.41	95.65	1.06	33.93
2225.94*	(4) 2-Year	3.97	94.41	95.52	0.86	9.67
2225.94*	(4) 5-Year	2.02	94.41	95.34	0.75	4.85
2225.94*	(4) 10-Year	1.57	94.41	95.26	0.69	4.36
2225.94*	(4) 25-Year	2.25	94.41	95.37	0.77	8.46
2225.94*	(4) 100-Year	2.86	94.41	95.44	0.81	35.46
2175.53*	(2) 2-Year	4.13	94.34	95.43	0.83	10.17
2175.53*	(2) 5-Year	5.24	94.34	95.46	0.92	13.49
2175.53*	(2) 10-Year	6.01	94.34	95.47	0.99	16.55
2175.53*	(2) 25-Year	6.94	94.34	95.49	1.02	21.61
2175.53*	(2) 100-Year	8.32	94.34	95.54	1.02	33.17
2175.53*	(4) 2-Year	3.97	94.34	95.42	0.85	9.27
2175.53*	(4) 5-Year	2.02	94.34	95.19	0.93	4.73
2175.53*	(4) 10-Year	1.57	94.34	95.12	0.86	4.26
2175.53*	(4) 25-Year	2.25	94.34	95.23	0.96	8.33
2175.53*	(4) 100-Year	2.86	94.34	95.30	0.98	35.25
2157	(2) 2-Year	4.13	94.31	95.18	1.86	10.06
2157	(2) 5-Year	5.24	94.31	95.34	1.37	13.33
2157	(2) 10-Year	6.01	94.31	95.38	1.22	16.37
2157	(2) 25-Year	6.94	94.31	95.43	1.14	21.39
2157	(2) 100-Year	8.32	94.31	95.49	1.02	32.87
2157	(4) 2-Year	3.97	94.31	95.16	1.91	9.17
2157	(4) 5-Year	2.02	94.31	94.94	1.78	4.70
2157	(4) 10-Year	1.57	94.31	94.88	1.70	4.24
2157	(4) 25-Year	2.25	94.31	94.97	1.81	8.29
2157	(4) 100-Year	2.86	94.31	95.03	1.90	35.20
2076	(2) 2-Year	5.00	93.86	95.01	0.91	9.75
2076	(2) 5-Year	6.32	93.86	95.14	0.95	12.81
2076	(2) 10-Year	7.24	93.86	95.21	0.96	15.68
2076	(2) 25-Year	8.38	93.86	95.27	0.95	20.49
2076	(2) 100-Year	10.81	93.86	95.35	0.96	31.59

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume $(1000\ m^3)$
2076	(4) 2-Year	4.78	93.86	94.98	0.91	8.88
2076	(4) 5-Year	2.34	93.86	94.63	0.77	4.53
2076	(4) 10-Year	1.78	93.86	94.52	0.72	4.10
2076	(4) 25-Year	2.60	93.86	94.67	0.79	8.11
2076	(4) 100-Year	3.29	93.86	94.79	0.83	34.98
1974	(2) 2-Year	5.00	93.68	94.85	0.88	9.20
1974	(2) 5-Year	6.32	93.68	94.99	0.93	12.10
1974	(2) 10-Year	7.24	93.68	95.05	0.96	14.73
1974	(2) 25-Year	8.38	93.68	95.11	0.98	19.20
1974	(2) 100-Year	10.81	93.68	95.20	1.00	29.64
1974	(4) 2-Year	4.78	93.68	94.82	0.88	8.35
1974	(4) 5-Year	2.34	93.68	94.46	0.76	4.23
1974	(4) 10-Year	1.78	93.68	94.35	0.71	3.86
1974	(4) 25-Year	2.60	93.68	94.51	0.78	7.79
1974	(4) 100-Year	3.29	93.68	94.62	0.80	34.59
1922	(2) 2-Year	5.00	93.59	94.77	0.89	8.92
1922	(2) 5-Year	6.32	93.59	94.90	0.94	11.76
1922	(2) 10-Year	7.24	93.59	94.96	1.00	14.32
1922	(2) 25-Year	8.38	93.59	95.01	1.07	18.67
1922	(2) 100-Year	10.81	93.59	95.08	1.18	28.85
1922	(4) 2-Year	4.78	93.59	94.74	0.89	8.08
1922	(4) 5-Year	2.34	93.59	94.37	0.76	4.08
1922	(4) 10-Year	1.78	93.59	94.26	0.71	3.73
1922	(4) 25-Year	2.60	93.59	94.42	0.77	7.62
1922	(4) 100-Year	3.29	93.59	94.55	0.80	34.38
1833	(2) 2-Year	5.00	93.44	94.63	0.82	8.40
1833	(2) 5-Year	6.32	93.44	94.77	0.84	11.10
1833	(2) 10-Year	7.24	93.44	94.83	0.82	13.41
1833	(2) 25-Year	8.38	93.44	94.89	0.80	17.44
1833	(2) 100-Year	10.81	93.44	94.98	0.81	27.04
1833	(4) 2-Year	4.78	93.44	94.60	0.82	7.58
1833	(4) 5-Year	2.34	93.44	94.24	0.73	3.80
1833	(4) 10-Year	1.78	93.44	94.12	0.69	3.51
1833	(4) 25-Year	2.60	93.44	94.29	0.74	7.31
1833	(4) 100-Year	3.29	93.44	94.42	0.76	34.01
1796	(2) 2-Year	5.00	93.37	94.57	0.87	8.19
1796	(2) 5-Year	6.32	93.37	94.70	0.93	10.83
1796	(2) 10-Year	7.24	93.37	94.76	0.99	13.05
1796	(2) 25-Year	8.38	93.37	94.81	1.06	16.97
1796	(2) 100-Year	10.81	93.37	94.88	1.20	26.38
1796	(4) 2-Year	4.78	93.37	94.54	0.86	7.38
1796	(4) 5-Year	2.34	93.37	94.19	0.71	3.68
1796	(4) 10-Year	1.78	93.37	94.06	0.68	3.41
1796	(4) 25-Year	2.60	93.37	94.24	0.73	7.19
1796	(4) 100-Year	3.29	93.37	94.37	0.75	33.85
1735	(2) 2-Year	5.00	93.26	94.50	0.77	7.83
1735	(2) 5-Year	6.32	93.26	94.63	0.80	10.38

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1735	(2) 10-Year	7.24	93.26	94.70	0.80	12.45
1735	(2) 25-Year	8.38	93.26	94.77	0.74	16.06
1735	(2) 100-Year	10.81	93.26	94.85	0.69	24.90
1735	(4) 2-Year	4.78	93.26	94.47	0.76	7.04
1735	(4) 5-Year	2.34	93.26	94.11	0.66	3.49
1735	(4) 10-Year	1.78	93.26	93.98	0.64	3.26
1735	(4) 25-Year	2.60	93.26	94.17	0.67	6.97
1735	(4) 100-Year	3.29	93.26	94.31	0.67	33.58
1728	(2) 2-Year	5.00	93.25	94.47	1.00	7.79
1728	(2) 5-Year	6.32	93.25	94.59	1.07	10.33
1728	(2) 10-Year	7.24	93.25	94.65	1.14	12.38
1728	(2) 25-Year	8.38	93.25	94.71	1.19	15.95
1728	(2) 100-Year	10.81	93.25	94.81	1.12	24.69
1728	(4) 2-Year	4.78	93.25	94.44	0.99	7.00
1728	(4) 5-Year	2.34	93.25	94.09	0.82	3.46
1728	(4) 10-Year	1.78	93.25	93.96	0.78	3.24
1728	(4) 25-Year	2.60	93.25	94.14	0.84	6.94
1728	(4) 100-Year	3.29	93.25	94.29	0.85	33.55
1717	(2) 2-Year	5.00	93.24	94.44	1.03	7.74
1717	(2) 5-Year	6.32	93.24	94.56	1.11	10.26
1717	(2) 10-Year	7.24	93.24	94.61	1.18	12.30
1717	(2) 25-Year	8.38	93.24	94.66	1.28	15.86
1717	(2) 100-Year	10.81	93.24	94.73	1.45	24.52
1717	(4) 2-Year	4.78	93.24	94.41	1.02	6.94
1717	(4) 5-Year	2.34	93.24	94.06	0.85	3.43
1717	(4) 10-Year	1.78	93.24	93.93	0.81	3.21
1717	(4) 25-Year	2.60	93.24	94.11	0.87	6.91
1717	(4) 100-Year	3.29	93.24	94.26	0.87	33.51
1615	(2) 2-Year	5.00	93.05	94.28	0.84	7.18
1615	(2) 5-Year	6.32	93.05	94.40	0.89	9.52
1615	(2) 10-Year	7.24	93.05	94.46	0.88	11.35
1615	(2) 25-Year	8.38	93.05	94.52	0.88	14.62
1615	(2) 100-Year	10.81	93.05	94.62	0.84	22.57
1615	(4) 2-Year	4.78	93.05	94.25	0.83	6.41
1615	(4) 5-Year	2.34	93.05	93.92	0.65	3.11
1615	(4) 10-Year	1.78	93.05	93.77	0.64	2.96
1615	(4) 25-Year	2.60	93.05	93.97	0.66	6.56
1615	(4) 100-Year	3.29	93.05	94.15	0.65	33.06
1555	(2) 2-Year	5.00	92.94	94.21	0.79	6.82
1555	(2) 5-Year	6.32	92.94	94.33	0.86	9.01
1555	(2) 10-Year	7.24	92.94	94.39	0.89	10.68
1555	(2) 25-Year	8.38	92.94	94.45	0.92	13.73
1555	(2) 100-Year	10.81	92.94	94.54	0.98	21.28
1555	(4) 2-Year	4.78	92.94	94.19	0.79	6.06
1555	(4) 5-Year	2.34	92.94	93.86	0.60	2.89
1555	(4) 10-Year	1.78	92.94	93.71	0.59	2.79
1555	(4) 25-Year	2.60	92.94	93.92	0.61	6.32
1555	(4) 100-Year	3.29	92.94	94.11	0.59	32.74

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1488	(2) 2-Year	5.00	92.82	94.15	0.73	6.39
1488	(2) 5-Year	6.32	92.82	94.25	0.82	8.47
1488	(2) 10-Year	7.24	92.82	94.31	0.87	10.04
1488	(2) 25-Year	8.38	92.82	94.36	0.93	12.96
1488	(2) 100-Year	10.81	92.82	94.43	1.06	20.28
1488	(4) 2-Year	4.78	92.82	94.12	0.73	5.64
1488	(4) 5-Year	2.34	92.82	93.81	0.54	2.62
1488	(4) 10-Year	1.78	92.82	93.65	0.52	2.58
1488	(4) 25-Year	2.60	92.82	93.88	0.55	6.02
1488	(4) 100-Year	3.29	92.82	94.07	0.53	32.36
1416	(2) 2-Year	5.00	92.71	94.00	1.11	6.00
1416	(2) 5-Year	6.32	92.71	94.08	1.27	8.01
1416	(2) 10-Year	7.24	92.71	94.12	1.34	9.48
1416	(2) 25-Year	8.38	92.71	94.18	1.35	12.25
1416	(2) 100-Year	10.81	92.71	94.28	1.32	19.24
1416	(4) 2-Year	4.78	92.71	93.98	1.11	5.27
1416	(4) 5-Year	2.34	92.71	93.73	0.75	2.36
1416	(4) 10-Year	1.78	92.71	93.57	0.73	2.38
1416	(4) 25-Year	2.60	92.71	93.80	0.77	5.74
1416	(4) 100-Year	3.29	92.71	94.01	0.73	31.99
1400	(2) 2-Year	5.00	92.68	94.00	0.70	5.91
1400	(2) 5-Year	6.32	92.68	94.08	0.80	7.90
1400	(2) 10-Year	7.24	92.68	94.12	0.86	9.35
1400	(2) 25-Year	8.38	92.68	94.17	0.93	12.10
1400	(2) 100-Year	10.81	92.68	94.25	1.10	19.02
1400	(4) 2-Year	4.78	92.68	93.97	0.70	5.18
1400	(4) 5-Year	2.34	92.68	93.73	0.51	2.30
1400	(4) 10-Year	1.78	92.68	93.56	0.51	2.33
1400	(4) 25-Year	2.60	92.68	93.79	0.51	5.67
1400	(4) 100-Year	3.29	92.68	94.01	0.46	31.90
1364	(2) 2-Year	5.00	92.62	93.97	0.73	5.66
1364	(2) 5-Year	6.32	92.62	94.03	0.85	7.62
1364	(2) 10-Year	7.24	92.62	94.06	0.93	9.06
1364	(2) 25-Year	8.38	92.62	94.10	1.03	11.79
1364	(2) 100-Year	10.81	92.62	94.15	1.27	18.68
1364	(4) 2-Year	4.78	92.62	93.94	0.72	4.94
1364	(4) 5-Year	2.34	92.62	93.71	0.47	2.13
1364	(4) 10-Year	1.78	92.62	93.54	0.46	2.20
1364	(4) 25-Year	2.60	92.62	93.77	0.48	5.48
1364	(4) 100-Year	3.29	92.62	93.99	0.46	31.64
1340	(2) 2-Year	5.79	92.61	93.97	0.42	5.41
1340	(2) 5-Year	7.32	92.61	94.04	0.51	7.36
1340	(2) 10-Year	8.34	92.61	94.07	0.57	8.79
1340	(2) 25-Year	9.65	92.61	94.11	0.64	11.50
1340	(2) 100-Year	11.62	92.61	94.16	0.74	18.38
1340	(4) 2-Year	5.26	92.61	93.94	0.40	4.70
1340	(4) 5-Year	2.44	92.61	93.71	0.22	1.94

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1340	(4) 10-Year	1.86	92.61	93.54	0.20	2.05
1340	(4) 25-Year	2.71	92.61	93.78	0.23	5.28
1340	(4) 100-Year	3.43	92.61	93.99	0.25	31.39
1312	(2) 2-Year	6.08	92.47	93.95	0.71	5.07
1312	(2) 5-Year	7.69	92.47	94.00	0.85	7.00
1312	(2) 10-Year	8.76	92.47	94.03	0.95	8.41
1312	(2) 25-Year	10.15	92.47	94.06	1.08	11.11
1312	(2) 100-Year	12.20	92.47	94.09	1.27	17.96
1312	(4) 2-Year	5.46	92.47	93.92	0.65	4.37
1312	(4) 5-Year	2.47	92.47	93.71	0.36	1.67
1312	(4) 10-Year	1.87	92.47	93.54	0.32	1.82
1312	(4) 25-Year	2.73	92.47	93.77	0.37	4.99
1312	(4) 100-Year	3.44	92.47	93.99	0.39	31.03
1302	(2) 2-Year	6.08	92.57	93.91	1.03	4.98
1302	(2) 5-Year	7.69	92.57	93.97	1.13	6.90
1302	(2) 10-Year	8.76	92.57	94.00	1.18	8.31
1302	(2) 25-Year	10.15	92.57	94.04	1.26	11.00
1302	(2) 100-Year	12.20	92.57	94.07	1.39	17.84
1302	(4) 2-Year	5.46	92.57	93.89	0.98	4.28
1302	(4) 5-Year	2.47	92.57	93.68	0.77	1.62
1302	(4) 10-Year	1.87	92.57	93.50	0.85	1.79
1302	(4) 25-Year	2.73	92.57	93.74	0.73	4.94
1302	(4) 100-Year	3.44	92.57	93.98	0.49	30.93
1268	(2) 2-Year	6.08	92.47	93.87	0.59	4.63
1268	(2) 5-Year	7.69	92.47	93.93	0.62	6.46
1268	(2) 10-Year	8.76	92.47	93.96	0.64	7.77
1268	(2) 25-Year	10.15	92.47	94.00	0.67	10.34
1268	(2) 100-Year	12.20	92.47	94.05	0.64	16.97
1268	(4) 2-Year	5.46	92.47	93.84	0.57	3.96
1268	(4) 5-Year	2.47	92.47	93.59	0.68	1.50
1268	(4) 10-Year	1.87	92.47	93.43	0.81	1.71
1268	(4) 25-Year	2.73	92.47	93.67	0.53	4.78
1268	(4) 100-Year	3.44	92.47	93.98	0.24	30.37
1212	(2) 2-Year	6.08	92.36	93.78	0.84	3.93
1212	(2) 5-Year	7.69	92.36	93.85	0.85	5.52
1212	(2) 10-Year	8.76	92.36	93.88	0.86	6.62
1212	(2) 25-Year	10.15	92.36	93.93	0.84	8.90
1212	(2) 100-Year	12.20	92.36	94.00	0.80	15.05
1212	(4) 2-Year	5.46	92.36	93.74	0.83	3.36
1212	(4) 5-Year	2.47	92.36	93.41	0.89	1.32
1212	(4) 10-Year	1.87	92.36	93.30	0.83	1.58
1212	(4) 25-Year	2.73	92.36	93.54	0.74	4.52
1212	(4) 100-Year	3.44	92.36	93.97	0.24	28.89
1169	(2) 2-Year	6.08	92.30	93.70	0.86	3.39
1169	(2) 5-Year	7.69	92.30	93.76	0.91	4.74
1169	(2) 10-Year	8.76	92.30	93.80	0.95	5.69
1169	(2) 25-Year	10.15	92.30	93.84	0.99	7.77

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1169	(2) 100-Year	12.20	92.30	93.91	1.04	13.62
1169	(4) 2-Year	5.46	92.30	93.67	0.83	2.90
1169	(4) 5-Year	2.47	92.30	93.32	0.73	1.19
1169	(4) 10-Year	1.87	92.30	93.24	0.65	1.47
1169	(4) 25-Year	2.73	92.30	93.49	0.59	4.33
1169	(4) 100-Year	3.44	92.30	93.97	0.28	27.39
1091	(2) 2-Year	6.08	92.15	93.57	0.83	2.61
1091	(2) 5-Year	7.69	92.15	93.64	0.85	3.66
1091	(2) 10-Year	8.76	92.15	93.68	0.88	4.46
1091	(2) 25-Year	10.15	92.15	93.72	0.91	6.34
1091	(2) 100-Year	12.20	92.15	93.80	0.88	11.79
1091	(4) 2-Year	5.46	92.15	93.53	0.82	2.26
1091	(4) 5-Year	2.47	92.15	93.18	0.71	0.93
1091	(4) 10-Year	1.87	92.15	93.14	0.58	1.23
1091	(4) 25-Year	2.73	92.15	93.42	0.51	3.94
1091	(4) 100-Year	3.44	92.15	93.96	0.19	24.73
1002	(2) 2-Year	6.08	92.06	93.36	1.05	1.89
1002	(2) 5-Year	7.69	92.06	93.45	1.07	2.63
1002	(2) 10-Year	8.76	92.06	93.50	1.06	3.23
1002	(2) 25-Year	10.15	92.06	93.57	0.99	4.82
1002	(2) 100-Year	12.20	92.06	93.70	0.86	9.70
1002	(4) 2-Year	5.46	92.06	93.32	1.03	1.66
1002	(4) 5-Year	2.47	92.06	93.00	0.85	0.65
1002	(4) 10-Year	1.87	92.06	93.04	0.60	0.95
1002	(4) 25-Year	2.73	92.06	93.37	0.47	3.41
1002	(4) 100-Year	3.44	92.06	93.96	0.14	20.76
961	(2) 2-Year	6.08	91.96	93.25	0.88	1.61
961	(2) 5-Year	7.69	91.96	93.33	0.93	2.25
961	(2) 10-Year	8.76	91.96	93.39	0.95	2.77
961	(2) 25-Year	10.15	91.96	93.48	0.88	4.19
961	(2) 100-Year	12.20	91.96	93.67	0.55	8.56
961	(4) 2-Year	5.46	91.96	93.22	0.85	1.41
961	(4) 5-Year	2.47	91.96	92.95	0.64	0.51
961	(4) 10-Year	1.87	91.96	93.02	0.43	0.80
961	(4) 25-Year	2.73	91.96	93.35	0.32	3.09
961	(4) 100-Year	3.44	91.96	93.96	0.08	18.01
910	(2) 2-Year	6.08	91.93	93.17	0.79	0.99
910	(2) 5-Year	7.69	91.93	93.26	0.80	1.41
910	(2) 10-Year	8.76	91.93	93.32	0.77	1.75
910	(2) 25-Year	10.15	91.93	93.43	0.70	2.59
910	(2) 100-Year	12.20	91.93	93.65	0.44	4.99
910	(4) 2-Year	5.46	91.93	93.14	0.78	0.86
910	(4) 5-Year	2.47	91.93	92.89	0.67	0.31
910	(4) 10-Year	1.87	91.93	93.00	0.40	0.51
910	(4) 25-Year	2.73	91.93	93.35	0.24	2.01
910	(4) 100-Year	3.44	91.93	93.96	0.06	10.36
840	(2) 2-Year	6.08	91.86	93.10	0.50	0.00

Table B-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Existing Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
840	(2) 5-Year	7.69	91.86	93.21	0.48	0.00
840	(2) 10-Year	8.76	91.86	93.28	0.46	0.00
840	(2) 25-Year	10.15	91.86	93.41	0.41	0.00
840	(2) 100-Year	12.20	91.86	93.64	0.34	0.00
840	(4) 2-Year	5.46	91.86	93.06	0.51	0.00
840	(4) 5-Year	2.47	91.86	92.80	0.52	0.00
840	(4) 10-Year	1.87	91.86	92.97	0.23	0.00
840	(4) 25-Year	2.73	91.86	93.34	0.12	0.00
840	(4) 100-Year	3.44	91.86	93.96	0.05	0.00

(1) All channel infrastructure removed from the HEC-RAS model for riparian storage analysis.
For Scenario 2 (the Van Gaal Drain 100-year spring snowmelt plus rainfall peak flow reaches the Jock River) and
Scenario 4 (the Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain).

JFSA
WATER RESOURCES AND
ENVIRONMENTAL CONSULTANTS

Project Ref #:P922
Client: David Schaeffer Engineering

Ottawa. ON
Paris. ON
Gatineau. QB
Montréal. QB
Québec. QB

Attachment C

HEC-RAS Results for Van Gaal Drain Reach 2

Proposed Conditions (Floodplain Analysis)

Richmond Village Development / Proposed Green Lands Channel Extension of the Van Gaal Drain
August 2020

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2554	(1) 25 mm	0.72	94.75	95.24	0.73	1.06
2554	(1) 2-Year	1.95	94.75	95.45	0.99	0.82
2554	(1) 5-Year	3.20	94.75	95.59	1.18	0.68
2554	(1) 10-Year	4.11	94.75	95.67	1.29	0.62
2554	(1) 25-Year	5.28	94.75	95.76	1.40	0.59
2554	(1) 100-Year	7.27	94.75	95.90	1.55	0.59
2478	(1) 25 mm	0.72	94.46	94.93	0.79	1.03
2478	(1) 2-Year	1.95	94.46	95.14	1.09	0.80
2478	(1) 5-Year	3.20	94.46	95.26	1.27	0.66
2478	(1) 10-Year	4.11	94.46	95.34	1.37	0.61
2478	(1) 25-Year	5.28	94.46	95.44	1.48	0.58
2478	(1) 100-Year	7.27	94.46	95.58	1.63	0.58
2434.60*	(1) 25 mm	0.72	94.28	94.75	0.80	1.01
2434.60*	(1) 2-Year	1.95	94.28	94.96	1.09	0.79
2434.60*	(1) 5-Year	3.20	94.28	95.09	1.27	0.65
2434.60*	(1) 10-Year	4.11	94.28	95.17	1.36	0.60
2434.60*	(1) 25-Year	5.28	94.28	95.26	1.46	0.57
2434.60*	(1) 100-Year	7.27	94.28	95.41	1.59	0.57
2434.60*						
2434.60*	(1) 25 mm	0.72	94.10	94.57	0.79	1.00
2434.60*	(1) 2-Year	1.95	94.10	94.78	1.09	0.78
2434.60*	(1) 5-Year	3.20	94.10	94.92	1.25	0.64
	(1) 10-Year	4.11	94.10	95.00	1.33	0.59
2391.20*	(1) 25-Year	5.28	94.10	95.11	1.41	0.56
2391.20*	(1) 100-Year	7.27	94.10	95.27	1.52	0.56
2391.20*						
2391.20*	(1) 25 mm	0.72	93.93	94.40	0.79	0.98
2391.20*	(1) 2-Year	1.95	93.93	94.61	1.06	0.77
2391.20*	(1) 5-Year	3.20	93.93	94.77	1.16	0.63
2391.20*	(1) 10-Year	4.11	93.93	94.87	1.22	0.58
2391.20*	(1) 25-Year	5.28	93.93	94.98	1.29	0.55
2391.20*	(1) 100-Year	7.27	93.93	95.16	1.39	0.56
2391.20*						
	(1) 25 mm	0.72	93.75	94.24	0.73	0.97
2347.80*	(1) 2-Year	1.95	93.75	94.49	0.89	0.76
2347.80*	(1) 5-Year	3.20	93.75	94.68	0.97	0.62
2347.80*	(1) 10-Year	4.11	93.75	94.78	1.04	0.57
2347.80*	(1) 25-Year	5.28	93.75	94.90	1.12	0.54
2347.80*	(1) 100-Year	7.27	93.75	95.08	1.23	0.55
2347.80*						
2347.80*	(1) 25 mm	0.72	93.57	94.18	0.49	0.95
2347.80*	(1) 2-Year	1.95	93.57	94.44	0.66	0.74
2347.80*	(1) 5-Year	3.20	93.57	94.63	0.78	0.60
2347.80*	(1) 10-Year	4.11	93.57	94.73	0.86	0.55
	(1) 25-Year	5.28	93.57	94.85	0.95	0.53
2304.40*	(1) 100-Year	7.27	93.57	95.03	1.07	0.54
2304.40*						
2304.40*	(1) 25 mm	0.72	93.57	94.14	0.56	0.93
2304.40*	(1) 2-Year	1.95	93.57	94.41	0.72	0.73
2304.40*	(1) 5-Year	3.20	93.57	94.60	0.82	0.59

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2304.40*	(1) 10-Year	4.11	93.57	94.70	0.90	0.55
2304.40*	(1) 25-Year	5.28	93.57	94.81	0.99	0.52
2304.40*	(1) 100-Year	7.27	93.57	94.99	1.11	0.53
2304.40*						
2304.40*	(1) 25 mm	0.72	93.49	94.12	0.46	0.92
2256	(1) 2-Year	1.95	93.49	94.39	0.63	0.72
2256	(1) 5-Year	3.20	93.49	94.58	0.75	0.59
2256	(1) 10-Year	4.11	93.49	94.68	0.81	0.54
2256	(1) 25-Year	5.28	93.49	94.80	0.88	0.51
2256	(1) 100-Year	7.27	93.49	94.98	0.96	0.52
2254	(1) 25 mm	0.72	93.46	94.11	0.44	0.91
2254	(1) 2-Year	1.95	93.46	94.38	0.62	0.71
2254	(1) 5-Year	3.20	93.46	94.56	0.73	0.58
2254	(1) 10-Year	4.11	93.46	94.67	0.80	0.53
2254	(1) 25-Year	5.28	93.46	94.78	0.87	0.51
2254	(1) 100-Year	7.27	93.46	94.96	0.95	0.52
2235	(1) 25 mm	0.72	93.44	94.10	0.43	0.90
2235	(1) 2-Year	1.95	93.44	94.36	0.60	0.70
2235	(1) 5-Year	3.20	93.44	94.55	0.72	0.57
2235	(1) 10-Year	4.11	93.44	94.65	0.78	0.53
2235	(1) 25-Year	5.28	93.44	94.77	0.85	0.50
2235	(1) 100-Year	7.27	93.44	94.95	0.94	0.51
2207	(1) 25 mm	0.72	93.40	94.08	0.40	0.88
2207	(1) 2-Year	1.95	93.40	94.35	0.59	0.69
2207	(1) 5-Year	3.20	93.40	94.53	0.71	0.56
2207	(1) 10-Year	4.11	93.40	94.63	0.78	0.52
2207	(1) 25-Year	5.28	93.40	94.74	0.85	0.49
2207	(1) 100-Year	7.27	93.40	94.92	0.94	0.50
2188	(1) 25 mm	1.16	93.37	94.05	0.65	0.87
2188	(1) 2-Year	2.80	93.37	94.31	0.84	0.68
2188	(1) 5-Year	4.41	93.37	94.49	0.98	0.56
2188	(1) 10-Year	5.53	93.37	94.59	1.05	0.51
2188	(1) 25-Year	6.96	93.37	94.71	1.12	0.49
2188	(1) 100-Year	9.54	93.37	94.88	1.23	0.50
2163	(1) 25 mm	1.16	93.34	94.02	0.65	0.86
2163	(1) 2-Year	2.80	93.34	94.28	0.84	0.67
2163	(1) 5-Year	4.41	93.34	94.46	0.97	0.55
2163	(1) 10-Year	5.53	93.34	94.56	1.04	0.50
2163	(1) 25-Year	6.96	93.34	94.67	1.11	0.48
2163	(1) 100-Year	9.54	93.34	94.85	1.22	0.49
2141	(1) 25 mm	1.16	93.31	93.99	0.65	0.85
2141	(1) 2-Year	2.80	93.31	94.25	0.83	0.67
2141	(1) 5-Year	4.41	93.31	94.43	0.97	0.54
2141	(1) 10-Year	5.53	93.31	94.53	1.04	0.50
2141	(1) 25-Year	6.96	93.31	94.65	1.11	0.48
2141	(1) 100-Year	9.54	93.31	94.82	1.22	0.49

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2121	(1) 25 mm	1.16	93.28	93.96	0.64	0.84
2121	(1) 2-Year	2.80	93.28	94.23	0.83	0.66
2121	(1) 5-Year	4.41	93.28	94.41	0.96	0.54
2121	(1) 10-Year	5.53	93.28	94.51	1.03	0.49
2121	(1) 25-Year	6.96	93.28	94.62	1.11	0.47
2121	(1) 100-Year	9.54	93.28	94.80	1.22	0.48
2101	(1) 25 mm	1.16	93.26	93.94	0.66	0.83
2101	(1) 2-Year	2.80	93.26	94.20	0.84	0.65
2101	(1) 5-Year	4.41	93.26	94.38	0.97	0.53
2101	(1) 10-Year	5.53	93.26	94.48	1.04	0.49
2101	(1) 25-Year	6.96	93.26	94.59	1.12	0.47
2101	(1) 100-Year	9.54	93.26	94.77	1.23	0.48
2080	(1) 25 mm	1.16	93.24	93.90	0.68	0.82
2080	(1) 2-Year	2.80	93.24	94.17	0.85	0.65
2080	(1) 5-Year	4.41	93.24	94.35	0.99	0.52
2080	(1) 10-Year	5.53	93.24	94.45	1.06	0.48
2080	(1) 25-Year	6.96	93.24	94.56	1.14	0.46
2080	(1) 100-Year	9.54	93.24	94.74	1.24	0.47
2059	(1) 25 mm	1.16	93.21	93.87	0.69	0.81
2059	(1) 2-Year	2.80	93.21	94.14	0.85	0.64
2059	(1) 5-Year	4.41	93.21	94.32	0.99	0.52
2059	(1) 10-Year	5.53	93.21	94.42	1.06	0.48
2059	(1) 25-Year	6.96	93.21	94.53	1.14	0.46
2059	(1) 100-Year	9.54	93.21	94.71	1.24	0.47
2038	(1) 25 mm	1.16	93.18	93.84	0.70	0.81
2038	(1) 2-Year	2.80	93.18	94.12	0.84	0.63
2038	(1) 5-Year	4.41	93.18	94.30	0.98	0.51
2038	(1) 10-Year	5.53	93.18	94.40	1.05	0.47
2038	(1) 25-Year	6.96	93.18	94.51	1.12	0.45
2038	(1) 100-Year	9.54	93.18	94.68	1.23	0.46
2017	(1) 25 mm	1.16	93.17	93.82	0.71	0.80
2017	(1) 2-Year	2.80	93.17	94.11	0.85	0.63
2017	(1) 5-Year	4.41	93.17	94.28	1.00	0.51
2017	(1) 10-Year	5.53	93.17	94.38	1.07	0.47
2017	(1) 25-Year	6.96	93.17	94.49	1.14	0.45
2017	(1) 100-Year	9.54	93.17	94.67	1.25	0.46
2003	(1) 25 mm	1.16	93.16	93.81	0.73	0.80
2003	(1) 2-Year	2.80	93.16	94.10	0.86	0.63
2003	(1) 5-Year	4.41	93.16	94.27	1.00	0.51
2003	(1) 10-Year	5.53	93.16	94.37	1.07	0.47
2003	(1) 25-Year	6.96	93.16	94.48	1.15	0.45
2003	(1) 100-Year	9.54	93.16	94.66	1.26	0.46
1982	(1) 25 mm	1.16	93.12	93.77	0.71	0.79
1982	(1) 2-Year	2.80	93.12	94.07	0.82	0.62

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1982	(1) 5-Year	4.41	93.12	94.25	0.97	0.50
1982	(1) 10-Year	5.53	93.12	94.34	1.04	0.46
1982	(1) 25-Year	6.96	93.12	94.46	1.11	0.44
1982	(1) 100-Year	9.54	93.12	94.63	1.22	0.46
1961	(1) 25 mm	1.16	93.08	93.74	0.70	0.78
1961	(1) 2-Year	2.80	93.08	94.05	0.80	0.62
1961	(1) 5-Year	4.41	93.08	94.22	0.94	0.50
1961	(1) 10-Year	5.53	93.08	94.32	1.01	0.46
1961	(1) 25-Year	6.96	93.08	94.43	1.09	0.44
1961	(1) 100-Year	9.54	93.08	94.61	1.20	0.45
1940	(1) 25 mm	1.16	93.04	93.70	0.68	0.78
1940	(1) 2-Year	2.80	93.04	94.03	0.77	0.61
1940	(1) 5-Year	4.41	93.04	94.20	0.92	0.49
1940	(1) 10-Year	5.53	93.04	94.30	0.99	0.45
1940	(1) 25-Year	6.96	93.04	94.41	1.07	0.43
1940	(1) 100-Year	9.54	93.04	94.58	1.18	0.45
1919	(1) 25 mm	1.16	93.01	93.67	0.68	0.77
1919	(1) 2-Year	2.80	93.01	94.01	0.75	0.60
1919	(1) 5-Year	4.41	93.01	94.18	0.90	0.49
1919	(1) 10-Year	5.53	93.01	94.27	0.97	0.45
1919	(1) 25-Year	6.96	93.01	94.38	1.05	0.43
1919	(1) 100-Year	9.54	93.01	94.56	1.16	0.44
1898	(1) 25 mm	1.16	92.97	93.64	0.66	0.76
1898	(1) 2-Year	2.80	92.97	93.99	0.72	0.59
1898	(1) 5-Year	4.41	92.97	94.16	0.87	0.48
1898	(1) 10-Year	5.53	92.97	94.25	0.94	0.44
1898	(1) 25-Year	6.96	92.97	94.36	1.03	0.42
1898	(1) 100-Year	9.54	92.97	94.54	1.14	0.44
1877	(1) 25 mm	1.16	92.93	93.61	0.64	0.75
1877	(1) 2-Year	2.80	92.93	93.97	0.70	0.59
1877	(1) 5-Year	4.41	92.93	94.14	0.84	0.47
1877	(1) 10-Year	5.53	92.93	94.24	0.91	0.43
1877	(1) 25-Year	6.96	92.93	94.34	1.00	0.42
1877	(1) 100-Year	9.54	92.93	94.52	1.12	0.43
1857	(1) 25 mm	1.16	92.89	93.59	0.62	0.74
1857	(1) 2-Year	2.80	92.89	93.96	0.67	0.58
1857	(1) 5-Year	4.41	92.89	94.12	0.81	0.47
1857	(1) 10-Year	5.53	92.89	94.22	0.89	0.43
1857	(1) 25-Year	6.96	92.89	94.32	0.98	0.41
1857	(1) 100-Year	9.54	92.89	94.50	1.10	0.43
1837	(1) 25 mm	1.16	92.86	93.57	0.60	0.73
1837	(1) 2-Year	2.80	92.86	93.95	0.65	0.57
1837	(1) 5-Year	4.41	92.86	94.11	0.79	0.46
1837	(1) 10-Year	5.53	92.86	94.20	0.87	0.42
1837	(1) 25-Year	6.96	92.86	94.31	0.96	0.40

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1837	(1) 100-Year	9.54	92.86	94.48	1.08	0.42
1817	(1) 25 mm	1.16	92.81	93.55	0.56	0.72
1817	(1) 2-Year	2.80	92.81	93.94	0.62	0.56
1817	(1) 5-Year	4.41	92.81	94.10	0.76	0.45
1817	(1) 10-Year	5.53	92.81	94.19	0.84	0.41
1817	(1) 25-Year	6.96	92.81	94.29	0.93	0.40
1817	(1) 100-Year	9.54	92.81	94.46	1.05	0.42
1797	(1) 25 mm	1.16	92.77	93.53	0.52	0.71
1797	(1) 2-Year	2.80	92.77	93.93	0.58	0.55
1797	(1) 5-Year	4.41	92.77	94.08	0.73	0.44
1797	(1) 10-Year	5.53	92.77	94.17	0.81	0.41
1797	(1) 25-Year	6.96	92.77	94.27	0.90	0.39
1797	(1) 100-Year	9.54	92.77	94.45	1.03	0.41
1777	(1) 25 mm	1.16	92.73	93.52	0.48	0.70
1777	(1) 2-Year	2.80	92.73	93.92	0.55	0.54
1777	(1) 5-Year	4.41	92.73	94.07	0.69	0.44
1777	(1) 10-Year	5.53	92.73	94.16	0.78	0.40
1777	(1) 25-Year	6.96	92.73	94.26	0.87	0.39
1777	(1) 100-Year	9.54	92.73	94.43	0.99	0.41
1757	(1) 25 mm	1.16	92.69	93.51	0.46	0.69
1757	(1) 2-Year	2.80	92.69	93.91	0.53	0.53
1757	(1) 5-Year	4.41	92.69	94.06	0.67	0.43
1757	(1) 10-Year	5.53	92.69	94.15	0.75	0.39
1757	(1) 25-Year	6.96	92.69	94.25	0.85	0.38
1757	(1) 100-Year	9.54	92.69	94.42	0.98	0.40
1736	(1) 25 mm	1.16	92.66	93.50	0.43	0.68
1736	(1) 2-Year	2.80	92.66	93.91	0.50	0.52
1736	(1) 5-Year	4.41	92.66	94.06	0.65	0.42
1736	(1) 10-Year	5.53	92.66	94.14	0.73	0.39
1736	(1) 25-Year	6.96	92.66	94.24	0.82	0.37
1736	(1) 100-Year	9.54	92.66	94.40	0.95	0.40
1715	(1) 25 mm	1.16	92.62	93.50	0.40	0.66
1715	(1) 2-Year	2.80	92.62	93.90	0.48	0.51
1715	(1) 5-Year	4.41	92.62	94.05	0.61	0.41
1715	(1) 10-Year	5.53	92.62	94.13	0.70	0.38
1715	(1) 25-Year	6.96	92.62	94.23	0.79	0.37
1715	(1) 100-Year	9.54	92.62	94.39	0.92	0.39
1694	(1) 25 mm	1.16	92.58	93.49	0.38	0.65
1694	(1) 2-Year	2.80	92.58	93.90	0.46	0.50
1694	(1) 5-Year	4.41	92.58	94.04	0.59	0.40
1694	(1) 10-Year	5.53	92.58	94.13	0.68	0.37
1694	(1) 25-Year	6.96	92.58	94.22	0.77	0.36
1694	(1) 100-Year	9.54	92.58	94.38	0.90	0.38
1673	(1) 25 mm	1.16	92.53	93.49	0.35	0.63

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1673	(1) 2-Year	2.80	92.53	93.89	0.43	0.48
1673	(1) 5-Year	4.41	92.53	94.04	0.57	0.39
1673	(1) 10-Year	5.53	92.53	94.12	0.65	0.36
1673	(1) 25-Year	6.96	92.53	94.21	0.74	0.35
1673	(1) 100-Year	9.54	92.53	94.37	0.87	0.38
1653	(1) 25 mm	1.16	92.50	93.48	0.33	0.62
1653	(1) 2-Year	2.80	92.50	93.89	0.41	0.47
1653	(1) 5-Year	4.41	92.50	94.03	0.55	0.38
1653	(1) 10-Year	5.53	92.50	94.11	0.63	0.35
1653	(1) 25-Year	6.96	92.50	94.20	0.72	0.34
1653	(1) 100-Year	9.54	92.50	94.36	0.85	0.37
1632	(1) 25 mm	1.16	92.46	93.48	0.31	0.60
1632	(1) 2-Year	2.80	92.46	93.89	0.40	0.46
1632	(1) 5-Year	4.41	92.46	94.03	0.53	0.37
1632	(1) 10-Year	5.53	92.46	94.11	0.61	0.34
1632	(1) 25-Year	6.96	92.46	94.20	0.71	0.34
1632	(1) 100-Year	9.54	92.46	94.35	0.84	0.36
1615	(1) 25 mm	1.16	92.43	93.48	0.31	0.58
1615	(1) 2-Year	2.80	92.43	93.88	0.38	0.45
1615	(1) 5-Year	4.41	92.43	94.02	0.51	0.36
1615	(1) 10-Year	5.53	92.43	94.10	0.59	0.34
1615	(1) 25-Year	6.96	92.43	94.19	0.68	0.33
1615	(1) 100-Year	9.54	92.43	94.35	0.81	0.36
1555	(1) 25 mm	1.16	92.35	93.47	0.28	0.53
1555	(1) 2-Year	2.80	92.35	93.88	0.35	0.40
1555	(1) 5-Year	4.41	92.35	94.01	0.47	0.33
1555	(1) 10-Year	5.53	92.35	94.09	0.55	0.31
1555	(1) 25-Year	6.96	92.35	94.17	0.64	0.30
1555	(1) 100-Year	9.54	92.35	94.33	0.76	0.34
1488	(1) 25 mm	1.16	92.28	93.46	0.24	0.46
1488	(1) 2-Year	2.80	92.28	93.87	0.32	0.35
1488	(1) 5-Year	4.41	92.28	94.00	0.44	0.29
1488	(1) 10-Year	5.53	92.28	94.08	0.51	0.27
1488	(1) 25-Year	6.96	92.28	94.16	0.60	0.27
1488	(1) 100-Year	9.54	92.28	94.31	0.72	0.31
1416	(1) 25 mm	1.16	92.20	93.46	0.21	0.38
1416	(1) 2-Year	2.80	92.20	93.87	0.30	0.29
1416	(1) 5-Year	4.41	92.20	94.00	0.41	0.25
1416	(1) 10-Year	5.53	92.20	94.07	0.48	0.24
1416	(1) 25-Year	6.96	92.20	94.15	0.57	0.25
1416	(1) 100-Year	9.54	92.20	94.29	0.70	0.29
1400	(1) 25 mm	1.16	92.17	93.46	0.20	0.35
1400	(1) 2-Year	2.80	92.17	93.87	0.29	0.27
1400	(1) 5-Year	4.41	92.17	93.99	0.40	0.23
1400	(1) 10-Year	5.53	92.17	94.06	0.47	0.22

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1400	(1) 25-Year	6.96	92.17	94.14	0.55	0.23
1400	(1) 100-Year	9.54	92.17	94.28	0.68	0.28
1364	(1) 25 mm	1.16	91.63	93.46	0.08	0.28
1364	(1) 2-Year	2.80	91.63	93.87	0.15	0.22
1364	(1) 5-Year	4.41	91.63	93.99	0.22	0.20
1364	(1) 10-Year	5.53	91.63	94.06	0.26	0.20
1364	(1) 25-Year	6.96	91.63	94.14	0.31	0.21
1364	(1) 100-Year	9.54	91.63	94.28	0.39	0.26
1340	(1) 25 mm	1.53	91.60	93.46	0.18	0.23
1340	(1) 2-Year	3.64	91.60	93.86	0.35	0.20
1340	(1) 5-Year	5.57	91.60	93.98	0.50	0.18
1340	(1) 10-Year	6.92	91.60	94.04	0.61	0.18
1340	(1) 25-Year	8.58	91.60	94.11	0.73	0.20
1340	(1) 100-Year	11.43	91.60	94.24	0.93	0.25
1339		Culvert				
1312	(1) 25 mm	1.53	92.47	93.45	0.32	0.20
1312	(1) 2-Year	3.87	92.47	93.84	0.57	0.18
1312	(1) 5-Year	5.93	92.47	93.95	0.82	0.17
1312	(1) 10-Year	7.38	92.47	94.00	0.99	0.17
1312	(1) 25-Year	9.17	92.47	94.05	1.19	0.19
1312	(1) 100-Year	12.20	92.47	94.13	1.50	0.24
1302	(1) 25 mm	1.53	92.57	93.41	0.83	0.19
1302	(1) 2-Year	3.87	92.57	93.81	0.88	0.17
1302	(1) 5-Year	5.93	92.57	93.92	1.05	0.17
1302	(1) 10-Year	7.38	92.57	93.98	1.15	0.17
1302	(1) 25-Year	9.17	92.57	94.03	1.26	0.19
1302	(1) 100-Year	12.20	92.57	94.15	1.23	0.24
1268	(1) 25 mm	1.53	92.47	93.33	0.79	0.18
1268	(1) 2-Year	3.87	92.47	93.75	0.56	0.16
1268	(1) 5-Year	5.93	92.47	93.88	0.57	0.16
1268	(1) 10-Year	7.38	92.47	93.94	0.60	0.16
1268	(1) 25-Year	9.17	92.47	94.01	0.61	0.18
1268	(1) 100-Year	12.20	92.47	94.14	0.52	0.23
1212	(1) 25 mm	1.53	92.36	93.18	0.86	0.16
1212	(1) 2-Year	3.87	92.36	93.61	0.89	0.14
1212	(1) 5-Year	5.93	92.36	93.77	0.91	0.13
1212	(1) 10-Year	7.38	92.36	93.85	0.93	0.14
1212	(1) 25-Year	9.17	92.36	93.93	0.91	0.16
1212	(1) 100-Year	12.20	92.36	94.10	0.76	0.21
1169	(1) 25 mm	1.53	92.30	93.10	0.69	0.15
1169	(1) 2-Year	3.87	92.30	93.53	0.77	0.13
1169	(1) 5-Year	5.93	92.30	93.70	0.86	0.12
1169	(1) 10-Year	7.38	92.30	93.77	0.91	0.12
1169	(1) 25-Year	9.17	92.30	93.85	0.95	0.14

Table C-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1169	(1) 100-Year	12.20	92.30	94.04	0.88	0.19
1091	(1) 25 mm	1.53	92.15	92.98	0.65	0.11
1091	(1) 2-Year	3.87	92.15	93.40	0.75	0.10
1091	(1) 5-Year	5.93	92.15	93.57	0.82	0.09
1091	(1) 10-Year	7.38	92.15	93.65	0.85	0.10
1091	(1) 25-Year	9.17	92.15	93.75	0.85	0.12
1091	(1) 100-Year	12.20	92.15	93.97	0.82	0.17
1002	(1) 25 mm	1.53	92.06	92.81	0.76	0.08
1002	(1) 2-Year	3.87	92.06	93.21	0.90	0.07
1002	(1) 5-Year	5.93	92.06	93.39	0.98	0.07
1002	(1) 10-Year	7.38	92.06	93.50	0.93	0.07
1002	(1) 25-Year	9.17	92.06	93.65	0.83	0.09
1002	(1) 100-Year	12.20	92.06	93.93	0.64	0.13
961	(1) 25 mm	1.53	91.96	92.77	0.54	0.06
961	(1) 2-Year	3.87	91.96	93.14	0.71	0.05
961	(1) 5-Year	5.93	91.96	93.31	0.76	0.05
961	(1) 10-Year	7.38	91.96	93.44	0.71	0.06
961	(1) 25-Year	9.17	91.96	93.61	0.52	0.07
961	(1) 100-Year	12.20	91.96	93.92	0.35	0.11
910	(1) 25 mm	1.53	91.93	92.72	0.57	0.04
910	(1) 2-Year	3.87	91.93	93.07	0.72	0.03
910	(1) 5-Year	5.93	91.93	93.25	0.73	0.04
910	(1) 10-Year	7.38	91.93	93.40	0.69	0.04
910	(1) 25-Year	9.17	91.93	93.59	0.53	0.05
910	(1) 100-Year	12.20	91.93	93.91	0.33	0.07
840	(1) 25 mm	1.53	91.86	92.64	0.50	0.00
840	(1) 2-Year	3.87	91.86	93.00	0.44	0.00
840	(1) 5-Year	5.93	91.86	93.22	0.36	0.00
840	(1) 10-Year	7.38	91.86	93.38	0.33	0.00
840	(1) 25-Year	9.17	91.86	93.58	0.30	0.00
840	(1) 100-Year	12.20	91.86	93.91	0.25	0.00

(1) All channel infrastructure included in the HEC-RAS model for floodplain analysis.
For Scenario 1 (the Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River).

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2554	(2) 2-Year	4.13	94.75	95.68	1.28	0.69
2554	(2) 5-Year	5.24	94.75	95.77	1.38	0.64
2554	(2) 10-Year	6.00	94.75	95.82	1.44	0.62
2554	(2) 25-Year	6.94	94.75	95.89	1.51	0.63
2554	(2) 100-Year	8.32	94.75	95.98	1.56	0.72
2554	(4) 2-Year	3.97	94.75	95.67	1.26	0.70
2554	(4) 5-Year	2.02	94.75	95.47	1.00	0.92
2554	(4) 10-Year	1.57	94.75	95.40	0.91	1.03
2554	(4) 25-Year	2.25	94.75	95.49	1.04	1.14
2554	(4) 100-Year	2.86	94.75	95.56	1.13	2.31
2478	(2) 2-Year	4.13	94.46	95.34	1.42	0.67
2478	(2) 5-Year	5.24	94.46	95.42	1.54	0.62
2478	(2) 10-Year	6.00	94.46	95.47	1.61	0.61
2478	(2) 25-Year	6.94	94.46	95.53	1.69	0.62
2478	(2) 100-Year	8.32	94.46	95.62	1.79	0.70
2478	(4) 2-Year	3.97	94.46	95.32	1.40	0.68
2478	(4) 5-Year	2.02	94.46	95.14	1.12	0.90
2478	(4) 10-Year	1.57	94.46	95.09	1.03	1.01
2478	(4) 25-Year	2.25	94.46	95.17	1.16	1.12
2478	(4) 100-Year	2.86	94.46	95.23	1.26	2.29
2434.60*	(2) 2-Year	4.13	94.28	95.16	1.35	0.67
2434.60*	(2) 5-Year	5.24	94.28	95.24	1.44	0.61
2434.60*	(2) 10-Year	6.00	94.28	95.30	1.50	0.60
2434.60*	(2) 25-Year	6.94	94.28	95.36	1.56	0.61
2434.60*	(2) 100-Year	8.32	94.28	95.45	1.63	0.70
2434.60*	(4) 2-Year	3.97	94.28	95.15	1.33	0.67
2434.60*	(4) 5-Year	2.02	94.28	94.96	1.10	0.89
2434.60*	(4) 10-Year	1.57	94.28	94.91	1.02	1.00
2434.60*	(4) 25-Year	2.25	94.28	94.99	1.13	1.11
2434.60*	(4) 100-Year	2.86	94.28	95.05	1.21	2.28
2391.20*	(2) 2-Year	4.13	94.10	94.99	1.34	0.66
2391.20*	(2) 5-Year	5.24	94.10	95.08	1.43	0.60
2391.20*	(2) 10-Year	6.00	94.10	95.14	1.48	0.59
2391.20*	(2) 25-Year	6.94	94.10	95.20	1.54	0.60
2391.20*	(2) 100-Year	8.32	94.10	95.30	1.60	0.69
2391.20*	(4) 2-Year	3.97	94.10	94.98	1.32	0.66
2391.20*	(4) 5-Year	2.02	94.10	94.79	1.10	0.88
2391.20*	(4) 10-Year	1.57	94.10	94.73	1.02	0.98
2391.20*	(4) 25-Year	2.25	94.10	94.81	1.13	1.10
2391.20*	(4) 100-Year	2.86	94.10	94.87	1.21	2.27
2347.80*	(2) 2-Year	4.13	93.93	94.84	1.29	0.65
2347.80*	(2) 5-Year	5.24	93.93	94.93	1.37	0.60
2347.80*	(2) 10-Year	6.00	93.93	94.99	1.42	0.58
2347.80*	(2) 25-Year	6.94	93.93	95.06	1.47	0.60
2347.80*	(2) 100-Year	8.32	93.93	95.17	1.52	0.68
2347.80*	(4) 2-Year	3.97	93.93	94.82	1.28	0.65
2347.80*	(4) 5-Year	2.02	93.93	94.61	1.09	0.87
2347.80*	(4) 10-Year	1.57	93.93	94.55	1.02	0.97

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2347.80*	(4) 25-Year	2.25	93.93	94.64	1.12	1.09
2347.80*	(4) 100-Year	2.86	93.93	94.71	1.18	2.26
2304.40*	(2) 2-Year	4.13	93.75	94.72	1.17	0.64
2304.40*	(2) 5-Year	5.24	93.75	94.82	1.25	0.59
2304.40*	(2) 10-Year	6.00	93.75	94.88	1.30	0.57
2304.40*	(2) 25-Year	6.94	93.75	94.95	1.36	0.59
2304.40*	(2) 100-Year	8.32	93.75	95.06	1.41	0.67
2304.40*	(4) 2-Year	3.97	93.75	94.70	1.16	0.64
2304.40*	(4) 5-Year	2.02	93.75	94.47	1.00	0.86
2304.40*	(4) 10-Year	1.57	93.75	94.40	0.95	0.96
2304.40*	(4) 25-Year	2.25	93.75	94.50	1.02	1.07
2304.40*	(4) 100-Year	2.86	93.75	94.58	1.05	2.25
2261	(2) 2-Year	4.13	93.57	94.64	0.99	0.63
2261	(2) 5-Year	5.24	93.57	94.74	1.09	0.58
2261	(2) 10-Year	6.00	93.57	94.80	1.15	0.56
2261	(2) 25-Year	6.94	93.57	94.87	1.22	0.58
2261	(2) 100-Year	8.32	93.57	94.99	1.27	0.66
2261	(4) 2-Year	3.97	93.57	94.62	0.98	0.63
2261	(4) 5-Year	2.02	93.57	94.39	0.78	0.84
2261	(4) 10-Year	1.57	93.57	94.32	0.71	0.94
2261	(4) 25-Year	2.25	93.57	94.42	0.81	1.06
2261	(4) 100-Year	2.86	93.57	94.51	0.85	2.24
2258	(2) 2-Year	4.13	93.57	94.58	1.09	0.62
2258	(2) 5-Year	5.24	93.57	94.67	1.19	0.57
2258	(2) 10-Year	6.00	93.57	94.73	1.26	0.56
2258	(2) 25-Year	6.94	93.57	94.80	1.33	0.57
2258	(2) 100-Year	8.32	93.57	94.92	1.36	0.66
2258	(4) 2-Year	3.97	93.57	94.56	1.08	0.62
2258	(4) 5-Year	2.02	93.57	94.33	0.91	0.83
2258	(4) 10-Year	1.57	93.57	94.26	0.85	0.93
2258	(4) 25-Year	2.25	93.57	94.36	0.93	1.05
2258	(4) 100-Year	2.86	93.57	94.45	0.96	2.23
2256	(2) 2-Year	4.13	93.49	94.56	0.83	0.61
2256	(2) 5-Year	5.24	93.49	94.66	0.88	0.56
2256	(2) 10-Year	6.00	93.49	94.72	0.91	0.55
2256	(2) 25-Year	6.94	93.49	94.79	0.95	0.57
2256	(2) 100-Year	8.32	93.49	94.92	0.95	0.65
2256	(4) 2-Year	3.97	93.49	94.54	0.82	0.62
2256	(4) 5-Year	2.02	93.49	94.30	0.69	0.83
2256	(4) 10-Year	1.57	93.49	94.23	0.66	0.93
2256	(4) 25-Year	2.25	93.49	94.34	0.71	1.04
2256	(4) 100-Year	2.86	93.49	94.44	0.72	2.22
2254	(2) 2-Year	4.13	93.46	94.54	0.81	0.60
2254	(2) 5-Year	5.24	93.46	94.64	0.87	0.56
2254	(2) 10-Year	6.00	93.46	94.70	0.90	0.55
2254	(2) 25-Year	6.94	93.46	94.77	0.94	0.56
2254	(2) 100-Year	8.32	93.46	94.91	0.94	0.65

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2254	(4) 2-Year	3.97	93.46	94.53	0.81	0.61
2254	(4) 5-Year	2.02	93.46	94.28	0.68	0.82
2254	(4) 10-Year	1.57	93.46	94.21	0.65	0.92
2254	(4) 25-Year	2.25	93.46	94.31	0.70	1.04
2254	(4) 100-Year	2.86	93.46	94.42	0.71	2.22
2235	(2) 2-Year	4.13	93.44	94.53	0.80	0.60
2235	(2) 5-Year	5.24	93.44	94.62	0.86	0.55
2235	(2) 10-Year	6.00	93.44	94.68	0.89	0.54
2235	(2) 25-Year	6.94	93.44	94.76	0.92	0.55
2235	(2) 100-Year	8.32	93.44	94.89	0.92	0.64
2235	(4) 2-Year	3.97	93.44	94.51	0.80	0.60
2235	(4) 5-Year	2.02	93.44	94.26	0.68	0.81
2235	(4) 10-Year	1.57	93.44	94.19	0.64	0.91
2235	(4) 25-Year	2.25	93.44	94.29	0.70	1.03
2235	(4) 100-Year	2.86	93.44	94.40	0.69	2.21
2207	(2) 2-Year	4.13	93.40	94.50	0.80	0.59
2207	(2) 5-Year	5.24	93.40	94.60	0.86	0.54
2207	(2) 10-Year	6.00	93.40	94.66	0.89	0.53
2207	(2) 25-Year	6.94	93.40	94.73	0.93	0.55
2207	(2) 100-Year	8.32	93.40	94.87	0.92	0.63
2207	(4) 2-Year	3.97	93.40	94.48	0.80	0.59
2207	(4) 5-Year	2.02	93.40	94.23	0.68	0.80
2207	(4) 10-Year	1.57	93.40	94.16	0.65	0.90
2207	(4) 25-Year	2.25	93.40	94.26	0.70	1.02
2207	(4) 100-Year	2.86	93.40	94.38	0.69	2.20
2188	(2) 2-Year	5.00	93.37	94.47	0.96	0.58
2188	(2) 5-Year	6.32	93.37	94.56	1.03	0.54
2188	(2) 10-Year	7.24	93.37	94.62	1.07	0.53
2188	(2) 25-Year	8.38	93.37	94.69	1.11	0.54
2188	(2) 100-Year	10.81	93.37	94.83	1.20	0.63
2188	(4) 2-Year	4.78	93.37	94.45	0.95	0.59
2188	(4) 5-Year	2.33	93.37	94.20	0.77	0.79
2188	(4) 10-Year	1.78	93.37	94.13	0.71	0.89
2188	(4) 25-Year	2.60	93.37	94.24	0.79	1.01
2188	(4) 100-Year	3.29	93.37	94.36	0.77	2.19
2163	(2) 2-Year	5.00	93.34	94.44	0.95	0.58
2163	(2) 5-Year	6.32	93.34	94.53	1.02	0.53
2163	(2) 10-Year	7.24	93.34	94.59	1.06	0.52
2163	(2) 25-Year	8.38	93.34	94.66	1.10	0.53
2163	(2) 100-Year	10.81	93.34	94.80	1.18	0.62
2163	(4) 2-Year	4.78	93.34	94.42	0.94	0.58
2163	(4) 5-Year	2.33	93.34	94.17	0.77	0.78
2163	(4) 10-Year	1.78	93.34	94.10	0.71	0.88
2163	(4) 25-Year	2.60	93.34	94.20	0.79	1.00
2163	(4) 100-Year	3.29	93.34	94.33	0.75	2.18
2141	(2) 2-Year	5.00	93.31	94.41	0.95	0.57
2141	(2) 5-Year	6.32	93.31	94.50	1.01	0.52

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2141	(2) 10-Year	7.24	93.31	94.56	1.05	0.51
2141	(2) 25-Year	8.38	93.31	94.63	1.10	0.53
2141	(2) 100-Year	10.81	93.31	94.77	1.18	0.62
2141	(4) 2-Year	4.78	93.31	94.39	0.94	0.57
2141	(4) 5-Year	2.33	93.31	94.14	0.76	0.78
2141	(4) 10-Year	1.78	93.31	94.07	0.71	0.87
2141	(4) 25-Year	2.60	93.31	94.17	0.78	0.99
2141	(4) 100-Year	3.29	93.31	94.31	0.74	2.17
2121	(2) 2-Year	5.00	93.28	94.38	0.94	0.56
2121	(2) 5-Year	6.32	93.28	94.48	1.01	0.52
2121	(2) 10-Year	7.24	93.28	94.54	1.05	0.51
2121	(2) 25-Year	8.38	93.28	94.61	1.09	0.52
2121	(2) 100-Year	10.81	93.28	94.74	1.18	0.61
2121	(4) 2-Year	4.78	93.28	94.36	0.93	0.57
2121	(4) 5-Year	2.33	93.28	94.11	0.76	0.77
2121	(4) 10-Year	1.78	93.28	94.04	0.70	0.86
2121	(4) 25-Year	2.60	93.28	94.15	0.78	0.99
2121	(4) 100-Year	3.29	93.28	94.30	0.72	2.17
2101	(2) 2-Year	5.00	93.26	94.35	0.95	0.56
2101	(2) 5-Year	6.32	93.26	94.45	1.02	0.51
2101	(2) 10-Year	7.24	93.26	94.51	1.06	0.50
2101	(2) 25-Year	8.38	93.26	94.58	1.10	0.52
2101	(2) 100-Year	10.81	93.26	94.72	1.19	0.61
2101	(4) 2-Year	4.78	93.26	94.33	0.95	0.56
2101	(4) 5-Year	2.33	93.26	94.09	0.77	0.76
2101	(4) 10-Year	1.78	93.26	94.01	0.72	0.86
2101	(4) 25-Year	2.60	93.26	94.12	0.79	0.98
2101	(4) 100-Year	3.29	93.26	94.28	0.71	2.16
2080	(2) 2-Year	5.00	93.24	94.32	0.97	0.55
2080	(2) 5-Year	6.32	93.24	94.42	1.04	0.51
2080	(2) 10-Year	7.24	93.24	94.48	1.08	0.50
2080	(2) 25-Year	8.38	93.24	94.55	1.12	0.51
2080	(2) 100-Year	10.81	93.24	94.69	1.20	0.60
2080	(4) 2-Year	4.78	93.24	94.30	0.97	0.56
2080	(4) 5-Year	2.33	93.24	94.05	0.80	0.75
2080	(4) 10-Year	1.78	93.24	93.98	0.75	0.85
2080	(4) 25-Year	2.60	93.24	94.09	0.81	0.97
2080	(4) 100-Year	3.29	93.24	94.26	0.71	2.15
2059	(2) 2-Year	5.00	93.21	94.29	0.98	0.55
2059	(2) 5-Year	6.32	93.21	94.39	1.04	0.50
2059	(2) 10-Year	7.24	93.21	94.45	1.08	0.49
2059	(2) 25-Year	8.38	93.21	94.52	1.12	0.51
2059	(2) 100-Year	10.81	93.21	94.66	1.20	0.60
2059	(4) 2-Year	4.78	93.21	94.27	0.97	0.55
2059	(4) 5-Year	2.33	93.21	94.02	0.80	0.75
2059	(4) 10-Year	1.78	93.21	93.94	0.76	0.84
2059	(4) 25-Year	2.60	93.21	94.06	0.81	0.97
2059	(4) 100-Year	3.29	93.21	94.25	0.70	2.14

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
2038	(2) 2-Year	5.00	93.18	94.27	0.96	0.54
2038	(2) 5-Year	6.32	93.18	94.36	1.03	0.50
2038	(2) 10-Year	7.24	93.18	94.43	1.07	0.49
2038	(2) 25-Year	8.38	93.18	94.50	1.11	0.50
2038	(2) 100-Year	10.81	93.18	94.63	1.19	0.59
2038	(4) 2-Year	4.78	93.18	94.25	0.96	0.55
2038	(4) 5-Year	2.33	93.18	93.99	0.80	0.74
2038	(4) 10-Year	1.78	93.18	93.91	0.76	0.83
2038	(4) 25-Year	2.60	93.18	94.03	0.80	0.96
2038	(4) 100-Year	3.29	93.18	94.23	0.67	2.13
2017	(2) 2-Year	5.00	93.17	94.26	0.98	0.54
2017	(2) 5-Year	6.32	93.17	94.35	1.05	0.49
2017	(2) 10-Year	7.24	93.17	94.41	1.09	0.49
2017	(2) 25-Year	8.38	93.17	94.48	1.13	0.50
2017	(2) 100-Year	10.81	93.17	94.62	1.21	0.59
2017	(4) 2-Year	4.78	93.17	94.23	0.98	0.54
2017	(4) 5-Year	2.33	93.17	93.98	0.81	0.74
2017	(4) 10-Year	1.78	93.17	93.90	0.78	0.83
2017	(4) 25-Year	2.60	93.17	94.02	0.82	0.96
2017	(4) 100-Year	3.29	93.17	94.23	0.68	2.13
2003	(2) 2-Year	5.00	93.16	94.24	0.99	0.54
2003	(2) 5-Year	6.32	93.16	94.34	1.06	0.49
2003	(2) 10-Year	7.24	93.16	94.40	1.10	0.48
2003	(2) 25-Year	8.38	93.16	94.47	1.14	0.50
2003	(2) 100-Year	10.81	93.16	94.61	1.22	0.59
2003	(4) 2-Year	4.78	93.16	94.22	0.98	0.54
2003	(4) 5-Year	2.33	93.16	93.97	0.83	0.74
2003	(4) 10-Year	1.78	93.16	93.88	0.81	0.83
2003	(4) 25-Year	2.60	93.16	94.01	0.83	0.95
2003	(4) 100-Year	3.29	93.16	94.22	0.68	2.13
1982	(2) 2-Year	5.00	93.12	94.22	0.95	0.53
1982	(2) 5-Year	6.32	93.12	94.31	1.02	0.49
1982	(2) 10-Year	7.24	93.12	94.38	1.06	0.48
1982	(2) 25-Year	8.38	93.12	94.45	1.10	0.50
1982	(2) 100-Year	10.81	93.12	94.58	1.18	0.59
1982	(4) 2-Year	4.78	93.12	94.20	0.95	0.54
1982	(4) 5-Year	2.33	93.12	93.94	0.79	0.73
1982	(4) 10-Year	1.78	93.12	93.85	0.78	0.82
1982	(4) 25-Year	2.60	93.12	93.98	0.79	0.95
1982	(4) 100-Year	3.29	93.12	94.21	0.63	2.12
1961	(2) 2-Year	5.00	93.08	94.19	0.92	0.52
1961	(2) 5-Year	6.32	93.08	94.29	0.99	0.48
1961	(2) 10-Year	7.24	93.08	94.35	1.03	0.47
1961	(2) 25-Year	8.38	93.08	94.42	1.08	0.49
1961	(2) 100-Year	10.81	93.08	94.56	1.16	0.58
1961	(4) 2-Year	4.78	93.08	94.17	0.92	0.53
1961	(4) 5-Year	2.33	93.08	93.91	0.77	0.72

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1961	(4) 10-Year	1.78	93.08	93.82	0.76	0.81
1961	(4) 25-Year	2.60	93.08	93.96	0.76	0.94
1961	(4) 100-Year	3.29	93.08	94.20	0.60	2.11
1940	(2) 2-Year	5.00	93.04	94.17	0.90	0.52
1940	(2) 5-Year	6.32	93.04	94.27	0.97	0.48
1940	(2) 10-Year	7.24	93.04	94.33	1.01	0.47
1940	(2) 25-Year	8.38	93.04	94.40	1.05	0.48
1940	(2) 100-Year	10.81	93.04	94.54	1.13	0.58
1940	(4) 2-Year	4.78	93.04	94.15	0.89	0.52
1940	(4) 5-Year	2.33	93.04	93.89	0.74	0.71
1940	(4) 10-Year	1.78	93.04	93.78	0.74	0.81
1940	(4) 25-Year	2.60	93.04	93.93	0.73	0.93
1940	(4) 100-Year	3.29	93.04	94.19	0.57	2.10
1919	(2) 2-Year	5.00	93.01	94.15	0.87	0.51
1919	(2) 5-Year	6.32	93.01	94.24	0.94	0.47
1919	(2) 10-Year	7.24	93.01	94.30	0.98	0.46
1919	(2) 25-Year	8.38	93.01	94.38	1.03	0.48
1919	(2) 100-Year	10.81	93.01	94.51	1.11	0.57
1919	(4) 2-Year	4.78	93.01	94.12	0.87	0.52
1919	(4) 5-Year	2.33	93.01	93.86	0.72	0.71
1919	(4) 10-Year	1.78	93.01	93.75	0.73	0.80
1919	(4) 25-Year	2.60	93.01	93.91	0.71	0.93
1919	(4) 100-Year	3.29	93.01	94.18	0.54	2.09
1898	(2) 2-Year	5.00	92.97	94.13	0.84	0.51
1898	(2) 5-Year	6.32	92.97	94.22	0.91	0.46
1898	(2) 10-Year	7.24	92.97	94.28	0.95	0.46
1898	(2) 25-Year	8.38	92.97	94.36	1.00	0.47
1898	(2) 100-Year	10.81	92.97	94.49	1.09	0.57
1898	(4) 2-Year	4.78	92.97	94.11	0.84	0.51
1898	(4) 5-Year	2.33	92.97	93.84	0.69	0.70
1898	(4) 10-Year	1.78	92.97	93.73	0.71	0.79
1898	(4) 25-Year	2.60	92.97	93.90	0.68	0.92
1898	(4) 100-Year	3.29	92.97	94.18	0.51	2.08
1877	(2) 2-Year	5.00	92.93	94.11	0.81	0.50
1877	(2) 5-Year	6.32	92.93	94.21	0.88	0.46
1877	(2) 10-Year	7.24	92.93	94.27	0.92	0.45
1877	(2) 25-Year	8.38	92.93	94.34	0.97	0.47
1877	(2) 100-Year	10.81	92.93	94.47	1.06	0.56
1877	(4) 2-Year	4.78	92.93	94.09	0.81	0.50
1877	(4) 5-Year	2.33	92.93	93.82	0.65	0.69
1877	(4) 10-Year	1.78	92.93	93.70	0.68	0.78
1877	(4) 25-Year	2.60	92.93	93.88	0.64	0.91
1877	(4) 100-Year	3.29	92.93	94.17	0.48	2.07
1857	(2) 2-Year	5.00	92.89	94.10	0.78	0.49
1857	(2) 5-Year	6.32	92.89	94.19	0.86	0.45
1857	(2) 10-Year	7.24	92.89	94.25	0.90	0.44
1857	(2) 25-Year	8.38	92.89	94.32	0.95	0.46

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) [1]

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1857	(2) 100-Year	10.81	92.89	94.45	1.04	0.55
1857	(4) 2-Year	4.78	92.89	94.07	0.78	0.50
1857	(4) 5-Year	2.33	92.89	93.81	0.62	0.68
1857	(4) 10-Year	1.78	92.89	93.68	0.65	0.78
1857	(4) 25-Year	2.60	92.89	93.87	0.62	0.90
1857	(4) 100-Year	3.29	92.89	94.17	0.46	2.06
1837	(2) 2-Year	5.00	92.86	94.08	0.75	0.48
1837	(2) 5-Year	6.32	92.86	94.17	0.83	0.44
1837	(2) 10-Year	7.24	92.86	94.23	0.87	0.44
1837	(2) 25-Year	8.38	92.86	94.30	0.92	0.46
1837	(2) 100-Year	10.81	92.86	94.44	1.01	0.55
1837	(4) 2-Year	4.78	92.86	94.06	0.75	0.49
1837	(4) 5-Year	2.33	92.86	93.79	0.59	0.67
1837	(4) 10-Year	1.78	92.86	93.66	0.63	0.77
1837	(4) 25-Year	2.60	92.86	93.85	0.59	0.89
1837	(4) 100-Year	3.29	92.86	94.16	0.44	2.04
1817	(2) 2-Year	5.00	92.81	94.07	0.72	0.48
1817	(2) 5-Year	6.32	92.81	94.16	0.80	0.44
1817	(2) 10-Year	7.24	92.81	94.22	0.85	0.43
1817	(2) 25-Year	8.38	92.81	94.29	0.90	0.45
1817	(2) 100-Year	10.81	92.81	94.42	0.99	0.54
1817	(4) 2-Year	4.78	92.81	94.04	0.72	0.48
1817	(4) 5-Year	2.33	92.81	93.78	0.56	0.66
1817	(4) 10-Year	1.78	92.81	93.64	0.59	0.76
1817	(4) 25-Year	2.60	92.81	93.84	0.56	0.88
1817	(4) 100-Year	3.29	92.81	94.16	0.42	2.03
1797	(2) 2-Year	5.00	92.77	94.06	0.69	0.47
1797	(2) 5-Year	6.32	92.77	94.15	0.77	0.43
1797	(2) 10-Year	7.24	92.77	94.21	0.82	0.42
1797	(2) 25-Year	8.38	92.77	94.27	0.87	0.44
1797	(2) 100-Year	10.81	92.77	94.41	0.96	0.54
1797	(4) 2-Year	4.78	92.77	94.03	0.69	0.47
1797	(4) 5-Year	2.33	92.77	93.77	0.53	0.65
1797	(4) 10-Year	1.78	92.77	93.63	0.55	0.75
1797	(4) 25-Year	2.60	92.77	93.84	0.53	0.87
1797	(4) 100-Year	3.29	92.77	94.16	0.40	2.02
1777	(2) 2-Year	5.00	92.73	94.05	0.65	0.46
1777	(2) 5-Year	6.32	92.73	94.14	0.73	0.42
1777	(2) 10-Year	7.24	92.73	94.19	0.78	0.42
1777	(2) 25-Year	8.38	92.73	94.26	0.83	0.44
1777	(2) 100-Year	10.81	92.73	94.39	0.93	0.53
1777	(4) 2-Year	4.78	92.73	94.02	0.65	0.47
1777	(4) 5-Year	2.33	92.73	93.77	0.49	0.64
1777	(4) 10-Year	1.78	92.73	93.62	0.51	0.74
1777	(4) 25-Year	2.60	92.73	93.83	0.49	0.86
1777	(4) 100-Year	3.29	92.73	94.15	0.37	2.00
1757	(2) 2-Year	5.00	92.69	94.04	0.63	0.45

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1757	(2) 5-Year	6.32	92.69	94.13	0.71	0.42
1757	(2) 10-Year	7.24	92.69	94.18	0.76	0.41
1757	(2) 25-Year	8.38	92.69	94.25	0.81	0.43
1757	(2) 100-Year	10.81	92.69	94.38	0.90	0.53
1757	(4) 2-Year	4.78	92.69	94.01	0.63	0.46
1757	(4) 5-Year	2.33	92.69	93.76	0.47	0.63
1757	(4) 10-Year	1.78	92.69	93.61	0.48	0.73
1757	(4) 25-Year	2.60	92.69	93.82	0.47	0.85
1757	(4) 100-Year	3.29	92.69	94.15	0.36	1.99
1736	(2) 2-Year	5.00	92.66	94.04	0.60	0.44
1736	(2) 5-Year	6.32	92.66	94.12	0.68	0.41
1736	(2) 10-Year	7.24	92.66	94.18	0.73	0.40
1736	(2) 25-Year	8.38	92.66	94.24	0.78	0.42
1736	(2) 100-Year	10.81	92.66	94.37	0.88	0.52
1736	(4) 2-Year	4.78	92.66	94.01	0.60	0.45
1736	(4) 5-Year	2.33	92.66	93.75	0.44	0.62
1736	(4) 10-Year	1.78	92.66	93.60	0.45	0.71
1736	(4) 25-Year	2.60	92.66	93.82	0.44	0.84
1736	(4) 100-Year	3.29	92.66	94.15	0.34	1.97
1715	(2) 2-Year	5.00	92.62	94.03	0.57	0.43
1715	(2) 5-Year	6.32	92.62	94.11	0.65	0.40
1715	(2) 10-Year	7.24	92.62	94.17	0.69	0.39
1715	(2) 25-Year	8.38	92.62	94.23	0.75	0.42
1715	(2) 100-Year	10.81	92.62	94.36	0.84	0.51
1715	(4) 2-Year	4.78	92.62	94.00	0.57	0.44
1715	(4) 5-Year	2.33	92.62	93.75	0.41	0.60
1715	(4) 10-Year	1.78	92.62	93.59	0.42	0.70
1715	(4) 25-Year	2.60	92.62	93.81	0.41	0.82
1715	(4) 100-Year	3.29	92.62	94.15	0.32	1.95
1694	(2) 2-Year	5.00	92.58	94.02	0.55	0.42
1694	(2) 5-Year	6.32	92.58	94.11	0.63	0.39
1694	(2) 10-Year	7.24	92.58	94.16	0.67	0.39
1694	(2) 25-Year	8.38	92.58	94.22	0.73	0.41
1694	(2) 100-Year	10.81	92.58	94.35	0.82	0.51
1694	(4) 2-Year	4.78	92.58	94.00	0.55	0.43
1694	(4) 5-Year	2.33	92.58	93.74	0.39	0.59
1694	(4) 10-Year	1.78	92.58	93.59	0.40	0.69
1694	(4) 25-Year	2.60	92.58	93.81	0.39	0.81
1694	(4) 100-Year	3.29	92.58	94.15	0.31	1.94
1673	(2) 2-Year	5.00	92.53	94.02	0.52	0.41
1673	(2) 5-Year	6.32	92.53	94.10	0.60	0.38
1673	(2) 10-Year	7.24	92.53	94.15	0.65	0.38
1673	(2) 25-Year	8.38	92.53	94.22	0.70	0.40
1673	(2) 100-Year	10.81	92.53	94.34	0.80	0.50
1673	(4) 2-Year	4.78	92.53	93.99	0.52	0.42
1673	(4) 5-Year	2.33	92.53	93.74	0.37	0.57
1673	(4) 10-Year	1.78	92.53	93.58	0.37	0.67
1673	(4) 25-Year	2.60	92.53	93.81	0.37	0.79

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1673	(4) 100-Year	3.29	92.53	94.14	0.30	1.92
1653	(2) 2-Year	5.00	92.50	94.02	0.50	0.40
1653	(2) 5-Year	6.32	92.50	94.09	0.58	0.37
1653	(2) 10-Year	7.24	92.50	94.15	0.62	0.37
1653	(2) 25-Year	8.38	92.50	94.21	0.68	0.39
1653	(2) 100-Year	10.81	92.50	94.33	0.77	0.49
1653	(4) 2-Year	4.78	92.50	93.99	0.50	0.41
1653	(4) 5-Year	2.33	92.50	93.74	0.35	0.56
1653	(4) 10-Year	1.78	92.50	93.58	0.35	0.66
1653	(4) 25-Year	2.60	92.50	93.80	0.35	0.78
1653	(4) 100-Year	3.29	92.50	94.14	0.28	1.90
1632	(2) 2-Year	5.00	92.46	94.01	0.49	0.39
1632	(2) 5-Year	6.32	92.46	94.09	0.56	0.36
1632	(2) 10-Year	7.24	92.46	94.14	0.61	0.36
1632	(2) 25-Year	8.38	92.46	94.20	0.66	0.38
1632	(2) 100-Year	10.81	92.46	94.33	0.76	0.49
1632	(4) 2-Year	4.78	92.46	93.98	0.48	0.39
1632	(4) 5-Year	2.33	92.46	93.74	0.33	0.54
1632	(4) 10-Year	1.78	92.46	93.58	0.33	0.64
1632	(4) 25-Year	2.60	92.46	93.80	0.33	0.76
1632	(4) 100-Year	3.29	92.46	94.14	0.28	1.88
1615	(2) 2-Year	5.00	92.43	94.01	0.46	0.38
1615	(2) 5-Year	6.32	92.43	94.09	0.53	0.35
1615	(2) 10-Year	7.24	92.43	94.14	0.57	0.35
1615	(2) 25-Year	8.38	92.43	94.20	0.62	0.38
1615	(2) 100-Year	10.81	92.43	94.32	0.71	0.48
1615	(4) 2-Year	4.78	92.43	93.98	0.46	0.38
1615	(4) 5-Year	2.33	92.43	93.73	0.32	0.53
1615	(4) 10-Year	1.78	92.43	93.57	0.32	0.63
1615	(4) 25-Year	2.60	92.43	93.80	0.32	0.75
1615	(4) 100-Year	3.29	92.43	94.14	0.26	1.86
1555	(2) 2-Year	5.00	92.35	94.00	0.42	0.34
1555	(2) 5-Year	6.32	92.35	94.07	0.48	0.32
1555	(2) 10-Year	7.24	92.35	94.13	0.53	0.32
1555	(2) 25-Year	8.38	92.35	94.19	0.57	0.35
1555	(2) 100-Year	10.81	92.35	94.31	0.66	0.45
1555	(4) 2-Year	4.78	92.35	93.97	0.41	0.35
1555	(4) 5-Year	2.33	92.35	93.73	0.28	0.47
1555	(4) 10-Year	1.78	92.35	93.57	0.29	0.57
1555	(4) 25-Year	2.60	92.35	93.79	0.29	0.69
1555	(4) 100-Year	3.29	92.35	94.14	0.24	1.80
1488	(2) 2-Year	5.00	92.28	93.99	0.38	0.30
1488	(2) 5-Year	6.32	92.28	94.07	0.45	0.28
1488	(2) 10-Year	7.24	92.28	94.11	0.49	0.29
1488	(2) 25-Year	8.38	92.28	94.17	0.53	0.32
1488	(2) 100-Year	10.81	92.28	94.29	0.62	0.43
1488	(4) 2-Year	4.78	92.28	93.96	0.38	0.30

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1488	(4) 5-Year	2.33	92.28	93.72	0.25	0.41
1488	(4) 10-Year	1.78	92.28	93.56	0.25	0.50
1488	(4) 25-Year	2.60	92.28	93.79	0.26	0.63
1488	(4) 100-Year	3.29	92.28	94.14	0.22	1.71
1416	(2) 2-Year	5.00	92.20	93.99	0.36	0.25
1416	(2) 5-Year	6.32	92.20	94.06	0.42	0.24
1416	(2) 10-Year	7.24	92.20	94.11	0.46	0.25
1416	(2) 25-Year	8.38	92.20	94.16	0.51	0.28
1416	(2) 100-Year	10.81	92.20	94.28	0.59	0.40
1416	(4) 2-Year	4.78	92.20	93.96	0.35	0.25
1416	(4) 5-Year	2.33	92.20	93.72	0.22	0.33
1416	(4) 10-Year	1.78	92.20	93.56	0.22	0.43
1416	(4) 25-Year	2.60	92.20	93.79	0.23	0.55
1416	(4) 100-Year	3.29	92.20	94.13	0.20	1.63
1400	(2) 2-Year	5.00	92.17	93.98	0.34	0.23
1400	(2) 5-Year	6.32	92.17	94.05	0.41	0.23
1400	(2) 10-Year	7.24	92.17	94.10	0.45	0.23
1400	(2) 25-Year	8.38	92.17	94.16	0.49	0.27
1400	(2) 100-Year	10.81	92.17	94.27	0.58	0.39
1400	(4) 2-Year	4.78	92.17	93.95	0.34	0.23
1400	(4) 5-Year	2.33	92.17	93.72	0.21	0.30
1400	(4) 10-Year	1.78	92.17	93.56	0.20	0.40
1400	(4) 25-Year	2.60	92.17	93.79	0.22	0.52
1400	(4) 100-Year	3.29	92.17	94.13	0.20	1.60
1364	(2) 2-Year	5.00	91.63	93.98	0.23	0.20
1364	(2) 5-Year	6.32	91.63	94.05	0.28	0.20
1364	(2) 10-Year	7.24	91.63	94.10	0.31	0.21
1364	(2) 25-Year	8.38	91.63	94.16	0.35	0.25
1364	(2) 100-Year	10.81	91.63	94.27	0.42	0.37
1364	(4) 2-Year	4.78	91.63	93.95	0.23	0.20
1364	(4) 5-Year	2.33	91.63	93.72	0.13	0.25
1364	(4) 10-Year	1.78	91.63	93.56	0.12	0.34
1364	(4) 25-Year	2.60	91.63	93.79	0.14	0.47
1364	(4) 100-Year	3.29	91.63	94.13	0.14	1.54
1340	(2) 2-Year	5.79	91.60	93.97	0.53	0.18
1340	(2) 5-Year	7.32	91.60	94.03	0.65	0.18
1340	(2) 10-Year	8.33	91.60	94.07	0.72	0.20
1340	(2) 25-Year	9.65	91.60	94.12	0.82	0.23
1340	(2) 100-Year	11.62	91.60	94.22	0.95	0.36
1340	(4) 2-Year	5.26	91.60	93.94	0.48	0.18
1340	(4) 5-Year	2.44	91.60	93.72	0.25	0.21
1340	(4) 10-Year	1.86	91.60	93.56	0.21	0.30
1340	(4) 25-Year	2.71	91.60	93.78	0.27	0.44
1340	(4) 100-Year	3.43	91.60	94.13	0.29	1.51
1339		Culvert				
1312	(2) 2-Year	6.08	92.47	93.94	0.85	0.17

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1312	(2) 5-Year	7.69	92.47	93.98	1.04	0.17
1312	(2) 10-Year	8.76	92.47	94.01	1.16	0.19
1312	(2) 25-Year	10.15	92.47	94.04	1.32	0.23
1312	(2) 100-Year	12.20	92.47	94.12	1.51	0.35
1312	(4) 2-Year	5.46	92.47	93.91	0.77	0.17
1312	(4) 5-Year	2.47	92.47	93.71	0.41	0.19
1312	(4) 10-Year	1.87	92.47	93.55	0.35	0.27
1312	(4) 25-Year	2.73	92.47	93.77	0.43	0.42
1312	(4) 100-Year	3.44	92.47	94.12	0.42	1.49
1302	(2) 2-Year	6.08	92.57	93.91	1.03	0.17
1302	(2) 5-Year	7.69	92.57	93.97	1.12	0.17
1302	(2) 10-Year	8.76	92.57	94.00	1.18	0.19
1302	(2) 25-Year	10.15	92.57	94.04	1.26	0.23
1302	(2) 100-Year	12.20	92.57	94.14	1.07	0.35
1302	(4) 2-Year	5.46	92.57	93.89	0.98	0.17
1302	(4) 5-Year	2.47	92.57	93.68	0.77	0.18
1302	(4) 10-Year	1.87	92.57	93.51	0.84	0.26
1302	(4) 25-Year	2.73	92.57	93.75	0.72	0.41
1302	(4) 100-Year	3.44	92.57	94.12	0.33	1.48
1268	(2) 2-Year	6.08	92.47	93.87	0.59	0.15
1268	(2) 5-Year	7.69	92.47	93.93	0.62	0.16
1268	(2) 10-Year	8.76	92.47	93.96	0.64	0.18
1268	(2) 25-Year	10.15	92.47	94.00	0.65	0.22
1268	(2) 100-Year	12.20	92.47	94.14	0.45	0.34
1268	(4) 2-Year	5.46	92.47	93.84	0.57	0.15
1268	(4) 5-Year	2.47	92.47	93.59	0.68	0.17
1268	(4) 10-Year	1.87	92.47	93.44	0.79	0.25
1268	(4) 25-Year	2.73	92.47	93.69	0.51	0.40
1268	(4) 100-Year	3.44	92.47	94.12	0.13	1.44
1212	(2) 2-Year	6.08	92.36	93.78	0.84	0.13
1212	(2) 5-Year	7.69	92.36	93.85	0.85	0.14
1212	(2) 10-Year	8.76	92.36	93.89	0.85	0.15
1212	(2) 25-Year	10.15	92.36	93.94	0.80	0.19
1212	(2) 100-Year	12.20	92.36	94.11	0.56	0.30
1212	(4) 2-Year	5.46	92.36	93.74	0.83	0.13
1212	(4) 5-Year	2.47	92.36	93.41	0.89	0.15
1212	(4) 10-Year	1.87	92.36	93.32	0.81	0.23
1212	(4) 25-Year	2.73	92.36	93.58	0.66	0.37
1212	(4) 100-Year	3.44	92.36	94.12	0.15	1.33
1169	(2) 2-Year	6.08	92.30	93.70	0.85	0.12
1169	(2) 5-Year	7.69	92.30	93.76	0.91	0.13
1169	(2) 10-Year	8.76	92.30	93.80	0.94	0.14
1169	(2) 25-Year	10.15	92.30	93.87	0.94	0.18
1169	(2) 100-Year	12.20	92.30	94.08	0.72	0.29
1169	(4) 2-Year	5.46	92.30	93.67	0.83	0.12
1169	(4) 5-Year	2.47	92.30	93.32	0.73	0.13
1169	(4) 10-Year	1.87	92.30	93.26	0.62	0.22
1169	(4) 25-Year	2.73	92.30	93.54	0.53	0.35

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
1169	(4) 100-Year	3.44	92.30	94.12	0.17	1.26
1091	(2) 2-Year	6.08	92.15	93.57	0.82	0.09
1091	(2) 5-Year	7.69	92.15	93.64	0.85	0.10
1091	(2) 10-Year	8.76	92.15	93.69	0.84	0.12
1091	(2) 25-Year	10.15	92.15	93.78	0.78	0.15
1091	(2) 100-Year	12.20	92.15	94.04	0.57	0.25
1091	(4) 2-Year	5.46	92.15	93.54	0.82	0.09
1091	(4) 5-Year	2.47	92.15	93.19	0.70	0.10
1091	(4) 10-Year	1.87	92.15	93.17	0.55	0.18
1091	(4) 25-Year	2.73	92.15	93.50	0.45	0.30
1091	(4) 100-Year	3.44	92.15	94.12	0.13	1.11
1002	(2) 2-Year	6.08	92.06	93.38	1.02	0.07
1002	(2) 5-Year	7.69	92.06	93.49	0.94	0.07
1002	(2) 10-Year	8.76	92.06	93.58	0.82	0.09
1002	(2) 25-Year	10.15	92.06	93.71	0.70	0.12
1002	(2) 100-Year	12.20	92.06	94.02	0.41	0.20
1002	(4) 2-Year	5.46	92.06	93.33	1.01	0.06
1002	(4) 5-Year	2.47	92.06	93.01	0.83	0.07
1002	(4) 10-Year	1.87	92.06	93.09	0.55	0.13
1002	(4) 25-Year	2.73	92.06	93.47	0.36	0.24
1002	(4) 100-Year	3.44	92.06	94.12	0.09	0.88
961	(2) 2-Year	6.08	91.96	93.28	0.83	0.05
961	(2) 5-Year	7.69	91.96	93.41	0.78	0.06
961	(2) 10-Year	8.76	91.96	93.52	0.65	0.07
961	(2) 25-Year	10.15	91.96	93.69	0.43	0.10
961	(2) 100-Year	12.20	91.96	94.02	0.24	0.17
961	(4) 2-Year	5.46	91.96	93.23	0.82	0.05
961	(4) 5-Year	2.47	91.96	92.96	0.62	0.06
961	(4) 10-Year	1.87	91.96	93.06	0.40	0.11
961	(4) 25-Year	2.73	91.96	93.46	0.25	0.21
961	(4) 100-Year	3.44	91.96	94.12	0.05	0.72
910	(2) 2-Year	6.08	91.93	93.22	0.70	0.04
910	(2) 5-Year	7.69	91.93	93.38	0.63	0.04
910	(2) 10-Year	8.76	91.93	93.49	0.52	0.05
910	(2) 25-Year	10.15	91.93	93.68	0.34	0.06
910	(2) 100-Year	12.20	91.93	94.02	0.20	0.10
910	(4) 2-Year	5.46	91.93	93.16	0.73	0.03
910	(4) 5-Year	2.47	91.93	92.91	0.64	0.03
910	(4) 10-Year	1.87	91.93	93.05	0.35	0.07
910	(4) 25-Year	2.73	91.93	93.46	0.18	0.14
910	(4) 100-Year	3.44	91.93	94.12	0.05	0.44
840	(2) 2-Year	6.08	91.86	93.18	0.41	0.00
840	(2) 5-Year	7.69	91.86	93.35	0.34	0.00
840	(2) 10-Year	8.76	91.86	93.48	0.30	0.00
840	(2) 25-Year	10.15	91.86	93.67	0.26	0.00
840	(2) 100-Year	12.20	91.86	94.02	0.18	0.00
840	(4) 2-Year	5.46	91.86	93.11	0.44	0.00

Table C-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Floodplain) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Channel Travel Time (h)
840	(4) 5-Year	2.47	91.86	92.83	0.47	0.00
840	(4) 10-Year	1.87	91.86	93.03	0.19	0.00
840	(4) 25-Year	2.73	91.86	93.45	0.10	0.00
840	(4) 100-Year	3.44	91.86	94.12	0.04	0.00

(1) All channel infrastructure included in the HEC-RAS model for floodplain analysis.
For Scenario 2 (the Van Gaal Drain 100-year spring snowmelt plus rainfall peak flow reaches the Jock River) and
Scenario 4 (the Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain).

Ottawa. ON
Paris. ON
Gatineau. QB
Montréal. QB
Québec. QB

Attachment D

HEC-RAS Results for Van Gaal Drain Reach 2

Proposed Conditions (Riparian Storage Analysis)

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2554	(1) 25 mm	0.72	94.75	95.24	0.73	6.80
2554	(1) 2-Year	1.95	94.75	95.45	0.99	14.55
2554	(1) 5-Year	3.20	94.75	95.59	1.18	20.23
2554	(1) 10-Year	4.11	94.75	95.67	1.29	24.36
2554	(1) 25-Year	5.28	94.75	95.76	1.40	29.89
2554	(1) 100-Year	7.27	94.75	95.90	1.55	40.63
2478	(1) 25 mm	0.72	94.46	94.93	0.79	6.72
2478	(1) 2-Year	1.95	94.46	95.14	1.09	14.37
2478	(1) 5-Year	3.20	94.46	95.26	1.27	19.97
2478	(1) 10-Year	4.11	94.46	95.34	1.37	24.04
2478	(1) 25-Year	5.28	94.46	95.44	1.48	29.52
2478	(1) 100-Year	7.27	94.46	95.58	1.63	40.15
2434.60*	(1) 25 mm	0.72	94.28	94.75	0.80	6.68
2434.60*	(1) 2-Year	1.95	94.28	94.96	1.09	14.25
2434.60*	(1) 5-Year	3.20	94.28	95.09	1.27	19.78
2434.60*	(1) 10-Year	4.11	94.28	95.17	1.36	23.81
2434.60*	(1) 25-Year	5.28	94.28	95.26	1.46	29.23
2434.60*	(1) 100-Year	7.27	94.28	95.41	1.59	39.79
2391.20*	(1) 25 mm	0.72	94.10	94.57	0.79	6.64
2391.20*	(1) 2-Year	1.95	94.10	94.78	1.09	14.13
2391.20*	(1) 5-Year	3.20	94.10	94.92	1.25	19.59
2391.20*	(1) 10-Year	4.11	94.10	95.00	1.33	23.58
2391.20*	(1) 25-Year	5.28	94.10	95.11	1.41	28.95
2391.20*	(1) 100-Year	7.27	94.10	95.27	1.52	39.42
2347.80*	(1) 25 mm	0.72	93.93	94.40	0.79	6.60
2347.80*	(1) 2-Year	1.95	93.93	94.61	1.06	14.00
2347.80*	(1) 5-Year	3.20	93.93	94.77	1.16	19.39
2347.80*	(1) 10-Year	4.11	93.93	94.87	1.22	23.33
2347.80*	(1) 25-Year	5.28	93.93	94.98	1.29	28.64
2347.80*	(1) 100-Year	7.27	93.93	95.15	1.39	39.01
2304.40*	(1) 25 mm	0.72	93.75	94.24	0.73	6.56
2304.40*	(1) 2-Year	1.95	93.75	94.49	0.89	13.86
2304.40*	(1) 5-Year	3.20	93.75	94.68	0.98	19.16
2304.40*	(1) 10-Year	4.11	93.75	94.78	1.04	23.05
2304.40*	(1) 25-Year	5.28	93.75	94.90	1.12	28.29
2304.40*	(1) 100-Year	7.27	93.75	95.08	1.23	38.55
2261	(1) 25 mm	0.72	93.57	94.18	0.49	6.49
2261	(1) 2-Year	1.95	93.57	94.44	0.66	13.67
2261	(1) 5-Year	3.20	93.57	94.63	0.78	18.87
2261	(1) 10-Year	4.11	93.57	94.73	0.86	22.70
2261	(1) 25-Year	5.28	93.57	94.85	0.95	27.87
2261	(1) 100-Year	7.27	93.57	95.02	1.07	38.03
2258	(1) 25 mm	0.72	93.57	94.14	0.56	6.44
2258	(1) 2-Year	1.95	93.57	94.41	0.72	13.53
2258	(1) 5-Year	3.20	93.57	94.60	0.82	18.66

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2258	(1) 10-Year	4.11	93.57	94.70	0.90	22.45
2258	(1) 25-Year	5.28	93.57	94.81	0.99	27.57
2258	(1) 100-Year	7.27	93.57	94.98	1.12	37.66
2256	(1) 25 mm	0.72	93.49	94.12	0.46	6.40
2256	(1) 2-Year	1.95	93.49	94.39	0.63	13.42
2256	(1) 5-Year	3.20	93.49	94.58	0.75	18.50
2256	(1) 10-Year	4.11	93.49	94.68	0.81	22.25
2256	(1) 25-Year	5.28	93.49	94.80	0.88	27.34
2256	(1) 100-Year	7.27	93.49	94.97	0.97	37.35
2254	(1) 25 mm	0.72	93.46	94.11	0.44	6.35
2254	(1) 2-Year	1.95	93.46	94.38	0.62	13.32
2254	(1) 5-Year	3.20	93.46	94.56	0.73	18.35
2254	(1) 10-Year	4.11	93.46	94.67	0.80	22.06
2254	(1) 25-Year	5.28	93.46	94.78	0.87	27.10
2254	(1) 100-Year	7.27	93.46	94.95	0.96	37.05
2235	(1) 25 mm	0.72	93.44	94.10	0.43	6.30
2235	(1) 2-Year	1.95	93.44	94.36	0.60	13.21
2235	(1) 5-Year	3.20	93.44	94.55	0.72	18.20
2235	(1) 10-Year	4.11	93.44	94.65	0.79	21.87
2235	(1) 25-Year	5.28	93.44	94.76	0.86	26.87
2235	(1) 100-Year	7.27	93.44	94.94	0.95	36.74
2207	(1) 25 mm	0.72	93.40	94.08	0.40	6.23
2207	(1) 2-Year	1.95	93.40	94.35	0.59	13.06
2207	(1) 5-Year	3.20	93.40	94.53	0.71	17.96
2207	(1) 10-Year	4.11	93.40	94.63	0.78	21.58
2207	(1) 25-Year	5.28	93.40	94.74	0.85	26.51
2207	(1) 100-Year	7.27	93.40	94.92	0.94	36.28
2188	(1) 25 mm	1.16	93.37	94.05	0.65	6.18
2188	(1) 2-Year	2.80	93.37	94.31	0.84	12.95
2188	(1) 5-Year	4.41	93.37	94.49	0.98	17.80
2188	(1) 10-Year	5.53	93.37	94.59	1.05	21.38
2188	(1) 25-Year	6.96	93.37	94.70	1.13	26.27
2188	(1) 100-Year	9.54	93.37	94.88	1.25	35.98
2163	(1) 25 mm	1.16	93.34	94.02	0.65	6.12
2163	(1) 2-Year	2.80	93.34	94.28	0.84	12.81
2163	(1) 5-Year	4.41	93.34	94.46	0.97	17.60
2163	(1) 10-Year	5.53	93.34	94.56	1.04	21.13
2163	(1) 25-Year	6.96	93.34	94.67	1.12	25.97
2163	(1) 100-Year	9.54	93.34	94.84	1.23	35.59
2141	(1) 25 mm	1.16	93.31	93.99	0.65	6.06
2141	(1) 2-Year	2.80	93.31	94.25	0.84	12.69
2141	(1) 5-Year	4.41	93.31	94.43	0.97	17.42
2141	(1) 10-Year	5.53	93.31	94.53	1.04	20.91
2141	(1) 25-Year	6.96	93.31	94.64	1.11	25.69
2141	(1) 100-Year	9.54	93.31	94.81	1.23	35.23

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2121	(1) 25 mm	1.16	93.28	93.96	0.64	6.00
2121	(1) 2-Year	2.80	93.28	94.23	0.83	12.58
2121	(1) 5-Year	4.41	93.28	94.41	0.96	17.25
2121	(1) 10-Year	5.53	93.28	94.51	1.03	20.70
2121	(1) 25-Year	6.96	93.28	94.62	1.11	25.44
2121	(1) 100-Year	9.54	93.28	94.79	1.23	34.91
2101	(1) 25 mm	1.16	93.26	93.94	0.66	5.95
2101	(1) 2-Year	2.80	93.26	94.20	0.84	12.46
2101	(1) 5-Year	4.41	93.26	94.38	0.98	17.08
2101	(1) 10-Year	5.53	93.26	94.48	1.05	20.49
2101	(1) 25-Year	6.96	93.26	94.59	1.12	25.18
2101	(1) 100-Year	9.54	93.26	94.76	1.24	34.58
2080	(1) 25 mm	1.16	93.24	93.90	0.68	5.89
2080	(1) 2-Year	2.80	93.24	94.17	0.86	12.34
2080	(1) 5-Year	4.41	93.24	94.35	0.99	16.91
2080	(1) 10-Year	5.53	93.24	94.45	1.06	20.28
2080	(1) 25-Year	6.96	93.24	94.56	1.14	24.93
2080	(1) 100-Year	9.54	93.24	94.72	1.26	34.25
2059	(1) 25 mm	1.16	93.21	93.87	0.70	5.84
2059	(1) 2-Year	2.80	93.21	94.14	0.86	12.23
2059	(1) 5-Year	4.41	93.21	94.32	0.99	16.73
2059	(1) 10-Year	5.53	93.21	94.42	1.06	20.06
2059	(1) 25-Year	6.96	93.21	94.53	1.14	24.66
2059	(1) 100-Year	9.54	93.21	94.69	1.27	33.91
2038	(1) 25 mm	1.16	93.18	93.84	0.70	5.80
2038	(1) 2-Year	2.80	93.18	94.12	0.84	12.12
2038	(1) 5-Year	4.41	93.18	94.29	0.98	16.58
2038	(1) 10-Year	5.53	93.18	94.39	1.05	19.87
2038	(1) 25-Year	6.96	93.18	94.50	1.13	24.44
2038	(1) 100-Year	9.54	93.18	94.67	1.25	33.62
2017	(1) 25 mm	1.16	93.17	93.82	0.71	5.78
2017	(1) 2-Year	2.80	93.17	94.10	0.86	12.08
2017	(1) 5-Year	4.41	93.17	94.28	1.00	16.52
2017	(1) 10-Year	5.53	93.17	94.38	1.07	19.79
2017	(1) 25-Year	6.96	93.17	94.49	1.15	24.33
2017	(1) 100-Year	9.54	93.17	94.65	1.28	33.49
2003	(1) 25 mm	1.16	93.16	93.81	0.73	5.76
2003	(1) 2-Year	2.80	93.16	94.09	0.86	12.04
2003	(1) 5-Year	4.41	93.16	94.27	1.01	16.46
2003	(1) 10-Year	5.53	93.16	94.37	1.08	19.72
2003	(1) 25-Year	6.96	93.16	94.48	1.16	24.24
2003	(1) 100-Year	9.54	93.16	94.64	1.28	33.37
1982	(1) 25 mm	1.16	93.12	93.77	0.71	5.71
1982	(1) 2-Year	2.80	93.12	94.07	0.83	11.93

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1982	(1) 5-Year	4.41	93.12	94.24	0.97	16.29
1982	(1) 10-Year	5.53	93.12	94.34	1.04	19.51
1982	(1) 25-Year	6.96	93.12	94.45	1.12	23.99
1982	(1) 100-Year	9.54	93.12	94.61	1.25	33.04
1961	(1) 25 mm	1.16	93.08	93.73	0.70	5.66
1961	(1) 2-Year	2.80	93.08	94.04	0.80	11.81
1961	(1) 5-Year	4.41	93.08	94.22	0.95	16.11
1961	(1) 10-Year	5.53	93.08	94.32	1.02	19.29
1961	(1) 25-Year	6.96	93.08	94.42	1.10	23.73
1961	(1) 100-Year	9.54	93.08	94.59	1.24	32.71
1940	(1) 25 mm	1.16	93.04	93.70	0.68	5.61
1940	(1) 2-Year	2.80	93.04	94.02	0.78	11.68
1940	(1) 5-Year	4.41	93.04	94.19	0.92	15.93
1940	(1) 10-Year	5.53	93.04	94.29	1.00	19.07
1940	(1) 25-Year	6.96	93.04	94.40	1.08	23.46
1940	(1) 100-Year	9.54	93.04	94.56	1.22	32.38
1919	(1) 25 mm	1.16	93.01	93.67	0.69	5.56
1919	(1) 2-Year	2.80	93.01	94.00	0.76	11.55
1919	(1) 5-Year	4.41	93.01	94.17	0.90	15.74
1919	(1) 10-Year	5.53	93.01	94.27	0.98	18.84
1919	(1) 25-Year	6.96	93.01	94.37	1.06	23.19
1919	(1) 100-Year	9.54	93.01	94.53	1.20	32.04
1898	(1) 25 mm	1.16	92.97	93.64	0.67	5.51
1898	(1) 2-Year	2.80	92.97	93.98	0.73	11.42
1898	(1) 5-Year	4.41	92.97	94.15	0.87	15.55
1898	(1) 10-Year	5.53	92.97	94.25	0.95	18.61
1898	(1) 25-Year	6.96	92.97	94.35	1.04	22.91
1898	(1) 100-Year	9.54	92.97	94.51	1.18	31.69
1877	(1) 25 mm	1.16	92.93	93.61	0.64	5.45
1877	(1) 2-Year	2.80	92.93	93.97	0.70	11.28
1877	(1) 5-Year	4.41	92.93	94.13	0.84	15.34
1877	(1) 10-Year	5.53	92.93	94.23	0.92	18.36
1877	(1) 25-Year	6.96	92.93	94.33	1.01	22.62
1877	(1) 100-Year	9.54	92.93	94.49	1.16	31.33
1857	(1) 25 mm	1.16	92.89	93.59	0.62	5.39
1857	(1) 2-Year	2.80	92.89	93.95	0.68	11.13
1857	(1) 5-Year	4.41	92.89	94.12	0.82	15.13
1857	(1) 10-Year	5.53	92.89	94.21	0.90	18.11
1857	(1) 25-Year	6.96	92.89	94.31	0.99	22.33
1857	(1) 100-Year	9.54	92.89	94.46	1.14	30.97
1837	(1) 25 mm	1.16	92.86	93.56	0.60	5.33
1837	(1) 2-Year	2.80	92.86	93.94	0.65	10.98
1837	(1) 5-Year	4.41	92.86	94.10	0.80	14.91
1837	(1) 10-Year	5.53	92.86	94.19	0.88	17.86
1837	(1) 25-Year	6.96	92.86	94.29	0.97	22.02

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1837	(1) 100-Year	9.54	92.86	94.44	1.12	30.60
1817	(1) 25 mm	1.16	92.81	93.54	0.56	5.27
1817	(1) 2-Year	2.80	92.81	93.93	0.62	10.81
1817	(1) 5-Year	4.41	92.81	94.09	0.77	14.68
1817	(1) 10-Year	5.53	92.81	94.18	0.85	17.59
1817	(1) 25-Year	6.96	92.81	94.28	0.94	21.71
1817	(1) 100-Year	9.54	92.81	94.42	1.10	30.23
1797	(1) 25 mm	1.16	92.77	93.53	0.53	5.20
1797	(1) 2-Year	2.80	92.77	93.92	0.59	10.64
1797	(1) 5-Year	4.41	92.77	94.08	0.74	14.44
1797	(1) 10-Year	5.53	92.77	94.17	0.82	17.31
1797	(1) 25-Year	6.96	92.77	94.26	0.92	21.39
1797	(1) 100-Year	9.54	92.77	94.40	1.07	29.85
1777	(1) 25 mm	1.16	92.73	93.52	0.49	5.13
1777	(1) 2-Year	2.80	92.73	93.91	0.56	10.45
1777	(1) 5-Year	4.41	92.73	94.07	0.70	14.19
1777	(1) 10-Year	5.53	92.73	94.15	0.78	17.02
1777	(1) 25-Year	6.96	92.73	94.25	0.88	21.06
1777	(1) 100-Year	9.54	92.73	94.39	1.04	29.45
1757	(1) 25 mm	1.16	92.69	93.51	0.46	5.04
1757	(1) 2-Year	2.80	92.69	93.91	0.53	10.24
1757	(1) 5-Year	4.41	92.69	94.06	0.68	13.92
1757	(1) 10-Year	5.53	92.69	94.14	0.76	16.72
1757	(1) 25-Year	6.96	92.69	94.24	0.86	20.72
1757	(1) 100-Year	9.54	92.69	94.37	1.02	29.05
1736	(1) 25 mm	1.16	92.66	93.50	0.44	4.96
1736	(1) 2-Year	2.80	92.66	93.90	0.51	10.03
1736	(1) 5-Year	4.41	92.66	94.05	0.65	13.65
1736	(1) 10-Year	5.53	92.66	94.13	0.74	16.40
1736	(1) 25-Year	6.96	92.66	94.23	0.83	20.36
1736	(1) 100-Year	9.54	92.66	94.36	1.00	28.63
1715	(1) 25 mm	1.16	92.62	93.49	0.40	4.86
1715	(1) 2-Year	2.80	92.62	93.90	0.48	9.80
1715	(1) 5-Year	4.41	92.62	94.04	0.62	13.35
1715	(1) 10-Year	5.53	92.62	94.12	0.70	16.07
1715	(1) 25-Year	6.96	92.62	94.21	0.80	20.00
1715	(1) 100-Year	9.54	92.62	94.34	0.96	28.20
1694	(1) 25 mm	1.16	92.58	93.48	0.38	4.76
1694	(1) 2-Year	2.80	92.58	93.89	0.46	9.56
1694	(1) 5-Year	4.41	92.58	94.03	0.60	13.05
1694	(1) 10-Year	5.53	92.58	94.12	0.68	15.73
1694	(1) 25-Year	6.96	92.58	94.21	0.78	19.61
1694	(1) 100-Year	9.54	92.58	94.33	0.94	27.76
1673	(1) 25 mm	1.16	92.53	93.48	0.35	4.64

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1673	(1) 2-Year	2.80	92.53	93.89	0.44	9.30
1673	(1) 5-Year	4.41	92.53	94.03	0.57	12.73
1673	(1) 10-Year	5.53	92.53	94.11	0.66	15.38
1673	(1) 25-Year	6.96	92.53	94.20	0.75	19.22
1673	(1) 100-Year	9.54	92.53	94.32	0.92	27.31
1653	(1) 25 mm	1.16	92.50	93.47	0.33	4.52
1653	(1) 2-Year	2.80	92.50	93.88	0.42	9.02
1653	(1) 5-Year	4.41	92.50	94.02	0.55	12.39
1653	(1) 10-Year	5.53	92.50	94.10	0.64	15.01
1653	(1) 25-Year	6.96	92.50	94.19	0.73	18.81
1653	(1) 100-Year	9.54	92.50	94.31	0.89	26.85
1632	(1) 25 mm	1.16	92.46	93.47	0.31	4.39
1632	(1) 2-Year	2.80	92.46	93.88	0.40	8.74
1632	(1) 5-Year	4.41	92.46	94.02	0.54	12.05
1632	(1) 10-Year	5.53	92.46	94.10	0.62	14.63
1632	(1) 25-Year	6.96	92.46	94.18	0.72	18.39
1632	(1) 100-Year	9.54	92.46	94.30	0.88	26.37
1615	(1) 25 mm	1.16	92.43	93.47	0.31	4.28
1615	(1) 2-Year	2.80	92.43	93.88	0.39	8.49
1615	(1) 5-Year	4.41	92.43	94.01	0.52	11.75
1615	(1) 10-Year	5.53	92.43	94.09	0.60	14.30
1615	(1) 25-Year	6.96	92.43	94.18	0.69	18.04
1615	(1) 100-Year	9.54	92.43	94.29	0.85	25.97
1555	(1) 25 mm	1.16	92.35	93.46	0.28	3.83
1555	(1) 2-Year	2.80	92.35	93.87	0.36	7.55
1555	(1) 5-Year	4.41	92.35	94.00	0.48	10.64
1555	(1) 10-Year	5.53	92.35	94.08	0.56	13.09
1555	(1) 25-Year	6.96	92.35	94.16	0.64	16.71
1555	(1) 100-Year	9.54	92.35	94.27	0.80	24.49
1488	(1) 25 mm	1.16	92.28	93.46	0.25	3.24
1488	(1) 2-Year	2.80	92.28	93.86	0.33	6.40
1488	(1) 5-Year	4.41	92.28	93.99	0.44	9.30
1488	(1) 10-Year	5.53	92.28	94.07	0.52	11.64
1488	(1) 25-Year	6.96	92.28	94.14	0.61	15.14
1488	(1) 100-Year	9.54	92.28	94.24	0.76	22.76
1416	(1) 25 mm	1.16	92.20	93.45	0.21	2.59
1416	(1) 2-Year	2.80	92.20	93.86	0.30	5.23
1416	(1) 5-Year	4.41	92.20	93.99	0.42	7.96
1416	(1) 10-Year	5.53	92.20	94.06	0.49	10.20
1416	(1) 25-Year	6.96	92.20	94.13	0.58	13.61
1416	(1) 100-Year	9.54	92.20	94.22	0.73	21.09
1400	(1) 25 mm	1.16	92.17	93.45	0.20	2.31
1400	(1) 2-Year	2.80	92.17	93.86	0.29	4.76
1400	(1) 5-Year	4.41	92.17	93.98	0.40	7.42
1400	(1) 10-Year	5.53	92.17	94.05	0.48	9.63

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1400	(1) 25-Year	6.96	92.17	94.12	0.56	12.99
1400	(1) 100-Year	9.54	92.17	94.22	0.72	20.42
1364	(1) 25 mm	1.16	91.63	93.45	0.09	1.80
1364	(1) 2-Year	2.80	91.63	93.86	0.15	3.97
1364	(1) 5-Year	4.41	91.63	93.98	0.22	6.53
1364	(1) 10-Year	5.53	91.63	94.05	0.27	8.69
1364	(1) 25-Year	6.96	91.63	94.12	0.32	12.00
1364	(1) 100-Year	9.54	91.63	94.22	0.41	19.35
1340	(1) 25 mm	1.53	91.60	93.45	0.11	1.42
1340	(1) 2-Year	3.64	91.60	93.86	0.20	3.39
1340	(1) 5-Year	5.57	91.60	93.98	0.28	5.90
1340	(1) 10-Year	6.92	91.60	94.05	0.33	8.02
1340	(1) 25-Year	8.58	91.60	94.12	0.39	11.29
1340	(1) 100-Year	11.43	91.60	94.21	0.50	18.60
1312	(1) 25 mm	1.53	92.47	93.45	0.29	1.10
1312	(1) 2-Year	3.87	92.47	93.84	0.51	2.91
1312	(1) 5-Year	5.93	92.47	93.96	0.71	5.36
1312	(1) 10-Year	7.38	92.47	94.01	0.84	7.45
1312	(1) 25-Year	9.17	92.47	94.07	1.01	10.69
1312	(1) 100-Year	12.20	92.47	94.13	1.29	17.96
1302	(1) 25 mm	1.53	92.57	93.41	0.83	1.07
1302	(1) 2-Year	3.87	92.57	93.81	0.88	2.84
1302	(1) 5-Year	5.93	92.57	93.92	1.05	5.28
1302	(1) 10-Year	7.38	92.57	93.98	1.15	7.35
1302	(1) 25-Year	9.17	92.57	94.03	1.27	10.58
1302	(1) 100-Year	12.20	92.57	94.11	1.41	17.81
1268	(1) 25 mm	1.53	92.47	93.33	0.79	1.00
1268	(1) 2-Year	3.87	92.47	93.75	0.56	2.62
1268	(1) 5-Year	5.93	92.47	93.88	0.57	4.91
1268	(1) 10-Year	7.38	92.47	93.94	0.60	6.88
1268	(1) 25-Year	9.17	92.47	94.01	0.62	9.89
1268	(1) 100-Year	12.20	92.47	94.10	0.60	16.64
1212	(1) 25 mm	1.53	92.36	93.18	0.86	0.90
1212	(1) 2-Year	3.87	92.36	93.61	0.89	2.25
1212	(1) 5-Year	5.93	92.36	93.77	0.91	4.21
1212	(1) 10-Year	7.38	92.36	93.85	0.93	5.90
1212	(1) 25-Year	9.17	92.36	93.92	0.94	8.43
1212	(1) 100-Year	12.20	92.36	94.04	0.90	14.29
1169	(1) 25 mm	1.53	92.30	93.10	0.69	0.81
1169	(1) 2-Year	3.87	92.30	93.53	0.78	2.02
1169	(1) 5-Year	5.93	92.30	93.70	0.86	3.67
1169	(1) 10-Year	7.38	92.30	93.77	0.92	5.11
1169	(1) 25-Year	9.17	92.30	93.84	0.98	7.33
1169	(1) 100-Year	12.20	92.30	93.94	1.09	12.64

Table D-1: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1091	(1) 25 mm	1.53	92.15	92.98	0.65	0.63
1091	(1) 2-Year	3.87	92.15	93.40	0.75	1.62
1091	(1) 5-Year	5.93	92.15	93.57	0.83	2.89
1091	(1) 10-Year	7.38	92.15	93.64	0.87	4.03
1091	(1) 25-Year	9.17	92.15	93.71	0.92	5.91
1091	(1) 100-Year	12.20	92.15	93.82	0.97	10.62
1002	(1) 25 mm	1.53	92.06	92.81	0.76	0.44
1002	(1) 2-Year	3.87	92.06	93.21	0.91	1.21
1002	(1) 5-Year	5.93	92.06	93.37	1.02	2.15
1002	(1) 10-Year	7.38	92.06	93.46	1.04	2.97
1002	(1) 25-Year	9.17	92.06	93.55	1.03	4.45
1002	(1) 100-Year	12.20	92.06	93.69	1.02	8.49
961	(1) 25 mm	1.53	91.96	92.77	0.54	0.34
961	(1) 2-Year	3.87	91.96	93.13	0.72	1.01
961	(1) 5-Year	5.93	91.96	93.28	0.80	1.86
961	(1) 10-Year	7.38	91.96	93.37	0.83	2.56
961	(1) 25-Year	9.17	91.96	93.47	0.82	3.85
961	(1) 100-Year	12.20	91.96	93.64	0.64	7.42
910	(1) 25 mm	1.53	91.93	92.72	0.57	0.20
910	(1) 2-Year	3.87	91.93	93.06	0.74	0.62
910	(1) 5-Year	5.93	91.93	93.20	0.81	1.16
910	(1) 10-Year	7.38	91.93	93.30	0.82	1.62
910	(1) 25-Year	9.17	91.93	93.41	0.83	2.38
910	(1) 100-Year	12.20	91.93	93.60	0.68	4.32
840	(1) 25 mm	1.53	91.86	92.65	0.50	0.00
840	(1) 2-Year	3.87	91.86	92.98	0.47	0.00
840	(1) 5-Year	5.93	91.86	93.16	0.42	0.00
840	(1) 10-Year	7.38	91.86	93.26	0.41	0.00
840	(1) 25-Year	9.17	91.86	93.38	0.41	0.00
840	(1) 100-Year	12.20	91.86	93.58	0.39	0.00

(1) All channel infrastructure removed from the HEC-RAS model for riparian storage analysis.
For Scenario 1 (the Van Gaal Drain 100-year 24-hour SCS peak flow reaches the Jock River).

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2554	(2) 2-Year	4.13	94.75	95.64	1.37	19.63
2554	(2) 5-Year	5.24	94.75	95.72	1.50	23.50
2554	(2) 10-Year	6.00	94.75	95.77	1.58	26.12
2554	(2) 25-Year	6.94	94.75	95.82	1.67	30.21
2554	(2) 100-Year	8.32	94.75	95.89	1.79	39.36
2554	(4) 2-Year	3.97	94.75	95.63	1.35	18.39
2554	(4) 5-Year	2.02	94.75	95.45	1.03	11.06
2554	(4) 10-Year	1.57	94.75	95.40	0.94	9.07
2554	(4) 25-Year	2.25	94.75	95.48	1.08	15.30
2554	(4) 100-Year	2.86	94.75	95.54	1.18	44.56
2478	(2) 2-Year	4.13	94.46	95.30	1.32	19.34
2478	(2) 5-Year	5.24	94.46	95.38	1.41	23.16
2478	(2) 10-Year	6.00	94.46	95.42	1.47	25.75
2478	(2) 25-Year	6.94	94.46	95.48	1.53	29.80
2478	(2) 100-Year	8.32	94.46	95.55	1.61	38.89
2478	(4) 2-Year	3.97	94.46	95.29	1.30	18.11
2478	(4) 5-Year	2.02	94.46	95.13	1.08	10.89
2478	(4) 10-Year	1.57	94.46	95.08	1.00	8.93
2478	(4) 25-Year	2.25	94.46	95.15	1.11	15.11
2478	(4) 100-Year	2.86	94.46	95.20	1.19	44.34
2434.60*	(2) 2-Year	4.13	94.28	95.12	1.32	19.14
2434.60*	(2) 5-Year	5.24	94.28	95.20	1.41	22.92
2434.60*	(2) 10-Year	6.00	94.28	95.25	1.46	25.48
2434.60*	(2) 25-Year	6.94	94.28	95.30	1.52	29.50
2434.60*	(2) 100-Year	8.32	94.28	95.38	1.59	38.54
2434.60*	(4) 2-Year	3.97	94.28	95.11	1.30	17.91
2434.60*	(4) 5-Year	2.02	94.28	94.95	1.08	10.77
2434.60*	(4) 10-Year	1.57	94.28	94.90	1.01	8.83
2434.60*	(4) 25-Year	2.25	94.28	94.97	1.11	14.98
2434.60*	(4) 100-Year	2.86	94.28	95.03	1.19	44.18
2391.20*	(2) 2-Year	4.13	94.10	94.95	1.31	18.93
2391.20*	(2) 5-Year	5.24	94.10	95.03	1.38	22.67
2391.20*	(2) 10-Year	6.00	94.10	95.08	1.43	25.20
2391.20*	(2) 25-Year	6.94	94.10	95.14	1.48	29.19
2391.20*	(2) 100-Year	8.32	94.10	95.23	1.53	38.18
2391.20*	(4) 2-Year	3.97	94.10	94.94	1.30	17.70
2391.20*	(4) 5-Year	2.02	94.10	94.77	1.08	10.65
2391.20*	(4) 10-Year	1.57	94.10	94.72	1.00	8.74
2391.20*	(4) 25-Year	2.25	94.10	94.79	1.11	14.85
2391.20*	(4) 100-Year	2.86	94.10	94.85	1.19	44.02
2347.80*	(2) 2-Year	4.13	93.93	94.79	1.24	18.72
2347.80*	(2) 5-Year	5.24	93.93	94.88	1.30	22.41
2347.80*	(2) 10-Year	6.00	93.93	94.94	1.33	24.91
2347.80*	(2) 25-Year	6.94	93.93	95.01	1.37	28.87
2347.80*	(2) 100-Year	8.32	93.93	95.11	1.40	37.80
2347.80*	(4) 2-Year	3.97	93.93	94.78	1.23	17.50
2347.80*	(4) 5-Year	2.02	93.93	94.59	1.08	10.53
2347.80*	(4) 10-Year	1.57	93.93	94.54	1.01	8.64

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2347.80*	(4) 25-Year	2.25	93.93	94.61	1.11	14.72
2347.80*	(4) 100-Year	2.86	93.93	94.68	1.16	43.87
2304.40*	(2) 2-Year	4.13	93.75	94.69	1.06	18.48
2304.40*	(2) 5-Year	5.24	93.75	94.78	1.12	22.12
2304.40*	(2) 10-Year	6.00	93.75	94.84	1.16	24.59
2304.40*	(2) 25-Year	6.94	93.75	94.91	1.21	28.50
2304.40*	(2) 100-Year	8.32	93.75	95.02	1.24	37.38
2304.40*	(4) 2-Year	3.97	93.75	94.67	1.06	17.27
2304.40*	(4) 5-Year	2.02	93.75	94.44	0.97	10.41
2304.40*	(4) 10-Year	1.57	93.75	94.38	0.94	8.55
2304.40*	(4) 25-Year	2.25	93.75	94.47	0.98	14.58
2304.40*	(4) 100-Year	2.86	93.75	94.55	1.01	43.69
2261	(2) 2-Year	4.13	93.57	94.63	0.85	18.19
2261	(2) 5-Year	5.24	93.57	94.72	0.93	21.77
2261	(2) 10-Year	6.00	93.57	94.78	0.97	24.21
2261	(2) 25-Year	6.94	93.57	94.85	1.02	28.08
2261	(2) 100-Year	8.32	93.57	94.97	1.06	36.88
2261	(4) 2-Year	3.97	93.57	94.61	0.84	16.99
2261	(4) 5-Year	2.02	93.57	94.38	0.70	10.25
2261	(4) 10-Year	1.57	93.57	94.31	0.65	8.42
2261	(4) 25-Year	2.25	93.57	94.41	0.72	14.41
2261	(4) 100-Year	2.86	93.57	94.49	0.77	43.48
2258	(2) 2-Year	4.13	93.57	94.58	0.92	17.98
2258	(2) 5-Year	5.24	93.57	94.68	0.99	21.53
2258	(2) 10-Year	6.00	93.57	94.74	1.03	23.94
2258	(2) 25-Year	6.94	93.57	94.81	1.09	27.79
2258	(2) 100-Year	8.32	93.57	94.93	1.12	36.54
2258	(4) 2-Year	3.97	93.57	94.57	0.91	16.79
2258	(4) 5-Year	2.02	93.57	94.33	0.80	10.13
2258	(4) 10-Year	1.57	93.57	94.26	0.77	8.32
2258	(4) 25-Year	2.25	93.57	94.36	0.82	14.28
2258	(4) 100-Year	2.86	93.57	94.44	0.85	43.32
2256	(2) 2-Year	4.13	93.49	94.56	0.83	17.83
2256	(2) 5-Year	5.24	93.49	94.66	0.88	21.34
2256	(2) 10-Year	6.00	93.49	94.72	0.92	23.73
2256	(2) 25-Year	6.94	93.49	94.79	0.95	27.55
2256	(2) 100-Year	8.32	93.49	94.91	0.96	36.26
2256	(4) 2-Year	3.97	93.49	94.54	0.82	16.64
2256	(4) 5-Year	2.02	93.49	94.30	0.69	10.04
2256	(4) 10-Year	1.57	93.49	94.23	0.66	8.25
2256	(4) 25-Year	2.25	93.49	94.33	0.71	14.19
2256	(4) 100-Year	2.86	93.49	94.42	0.75	43.21
2254	(2) 2-Year	4.13	93.46	94.54	0.82	17.68
2254	(2) 5-Year	5.24	93.46	94.64	0.87	21.16
2254	(2) 10-Year	6.00	93.46	94.70	0.91	23.53
2254	(2) 25-Year	6.94	93.46	94.77	0.94	27.32
2254	(2) 100-Year	8.32	93.46	94.90	0.95	35.98

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2254	(4) 2-Year	3.97	93.46	94.53	0.81	16.50
2254	(4) 5-Year	2.02	93.46	94.28	0.69	9.96
2254	(4) 10-Year	1.57	93.46	94.21	0.65	8.19
2254	(4) 25-Year	2.25	93.46	94.31	0.70	14.10
2254	(4) 100-Year	2.86	93.46	94.40	0.74	43.10
2235	(2) 2-Year	4.13	93.44	94.53	0.80	17.54
2235	(2) 5-Year	5.24	93.44	94.62	0.86	20.98
2235	(2) 10-Year	6.00	93.44	94.68	0.89	23.32
2235	(2) 25-Year	6.94	93.44	94.75	0.93	27.09
2235	(2) 100-Year	8.32	93.44	94.88	0.93	35.69
2235	(4) 2-Year	3.97	93.44	94.51	0.80	16.36
2235	(4) 5-Year	2.02	93.44	94.26	0.68	9.88
2235	(4) 10-Year	1.57	93.44	94.19	0.64	8.12
2235	(4) 25-Year	2.25	93.44	94.29	0.70	14.01
2235	(4) 100-Year	2.86	93.44	94.38	0.73	42.99
2207	(2) 2-Year	4.13	93.40	94.50	0.80	17.32
2207	(2) 5-Year	5.24	93.40	94.59	0.86	20.70
2207	(2) 10-Year	6.00	93.40	94.66	0.89	23.01
2207	(2) 25-Year	6.94	93.40	94.72	0.93	26.74
2207	(2) 100-Year	8.32	93.40	94.86	0.93	35.27
2207	(4) 2-Year	3.97	93.40	94.48	0.80	16.15
2207	(4) 5-Year	2.02	93.40	94.23	0.68	9.76
2207	(4) 10-Year	1.57	93.40	94.16	0.65	8.02
2207	(4) 25-Year	2.25	93.40	94.26	0.70	13.88
2207	(4) 100-Year	2.86	93.40	94.35	0.73	42.83
2188	(2) 2-Year	5.00	93.37	94.47	0.96	17.17
2188	(2) 5-Year	6.32	93.37	94.56	1.03	20.52
2188	(2) 10-Year	7.24	93.37	94.62	1.07	22.81
2188	(2) 25-Year	8.38	93.37	94.69	1.12	26.51
2188	(2) 100-Year	10.81	93.37	94.82	1.21	34.99
2188	(4) 2-Year	4.78	93.37	94.45	0.95	16.01
2188	(4) 5-Year	2.33	93.37	94.20	0.77	9.68
2188	(4) 10-Year	1.78	93.37	94.13	0.71	7.96
2188	(4) 25-Year	2.60	93.37	94.23	0.79	13.79
2188	(4) 100-Year	3.29	93.37	94.32	0.82	42.72
2163	(2) 2-Year	5.00	93.34	94.43	0.95	16.98
2163	(2) 5-Year	6.32	93.34	94.53	1.02	20.29
2163	(2) 10-Year	7.24	93.34	94.59	1.06	22.54
2163	(2) 25-Year	8.38	93.34	94.66	1.11	26.21
2163	(2) 100-Year	10.81	93.34	94.79	1.20	34.62
2163	(4) 2-Year	4.78	93.34	94.42	0.94	15.83
2163	(4) 5-Year	2.33	93.34	94.17	0.77	9.57
2163	(4) 10-Year	1.78	93.34	94.10	0.71	7.87
2163	(4) 25-Year	2.60	93.34	94.20	0.79	13.67
2163	(4) 100-Year	3.29	93.34	94.30	0.81	42.58
2141	(2) 2-Year	5.00	93.31	94.41	0.95	16.81
2141	(2) 5-Year	6.32	93.31	94.50	1.02	20.07

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2141	(2) 10-Year	7.24	93.31	94.56	1.06	22.30
2141	(2) 25-Year	8.38	93.31	94.63	1.11	25.94
2141	(2) 100-Year	10.81	93.31	94.76	1.20	34.30
2141	(4) 2-Year	4.78	93.31	94.39	0.94	15.66
2141	(4) 5-Year	2.33	93.31	94.14	0.77	9.48
2141	(4) 10-Year	1.78	93.31	94.07	0.71	7.79
2141	(4) 25-Year	2.60	93.31	94.17	0.79	13.57
2141	(4) 100-Year	3.29	93.31	94.27	0.80	42.45
2121	(2) 2-Year	5.00	93.28	94.38	0.94	16.65
2121	(2) 5-Year	6.32	93.28	94.48	1.01	19.88
2121	(2) 10-Year	7.24	93.28	94.53	1.05	22.08
2121	(2) 25-Year	8.38	93.28	94.60	1.10	25.70
2121	(2) 100-Year	10.81	93.28	94.73	1.20	34.00
2121	(4) 2-Year	4.78	93.28	94.36	0.94	15.51
2121	(4) 5-Year	2.33	93.28	94.11	0.76	9.39
2121	(4) 10-Year	1.78	93.28	94.04	0.70	7.72
2121	(4) 25-Year	2.60	93.28	94.15	0.78	13.48
2121	(4) 100-Year	3.29	93.28	94.25	0.79	42.34
2101	(2) 2-Year	5.00	93.26	94.35	0.96	16.49
2101	(2) 5-Year	6.32	93.26	94.45	1.03	19.68
2101	(2) 10-Year	7.24	93.26	94.51	1.07	21.86
2101	(2) 25-Year	8.38	93.26	94.57	1.12	25.45
2101	(2) 100-Year	10.81	93.26	94.70	1.21	33.69
2101	(4) 2-Year	4.78	93.26	94.33	0.95	15.36
2101	(4) 5-Year	2.33	93.26	94.09	0.77	9.30
2101	(4) 10-Year	1.78	93.26	94.01	0.72	7.65
2101	(4) 25-Year	2.60	93.26	94.12	0.79	13.38
2101	(4) 100-Year	3.29	93.26	94.23	0.79	42.22
2080	(2) 2-Year	5.00	93.24	94.32	0.98	16.33
2080	(2) 5-Year	6.32	93.24	94.42	1.05	19.48
2080	(2) 10-Year	7.24	93.24	94.48	1.09	21.64
2080	(2) 25-Year	8.38	93.24	94.54	1.14	25.20
2080	(2) 100-Year	10.81	93.24	94.67	1.23	33.39
2080	(4) 2-Year	4.78	93.24	94.30	0.97	15.21
2080	(4) 5-Year	2.33	93.24	94.05	0.80	9.21
2080	(4) 10-Year	1.78	93.24	93.98	0.75	7.58
2080	(4) 25-Year	2.60	93.24	94.09	0.81	13.28
2080	(4) 100-Year	3.29	93.24	94.20	0.80	42.09
2059	(2) 2-Year	5.00	93.21	94.29	0.98	16.17
2059	(2) 5-Year	6.32	93.21	94.39	1.05	19.28
2059	(2) 10-Year	7.24	93.21	94.45	1.09	21.41
2059	(2) 25-Year	8.38	93.21	94.51	1.14	24.94
2059	(2) 100-Year	10.81	93.21	94.63	1.24	33.08
2059	(4) 2-Year	4.78	93.21	94.27	0.97	15.05
2059	(4) 5-Year	2.33	93.21	94.02	0.81	9.13
2059	(4) 10-Year	1.78	93.21	93.94	0.76	7.51
2059	(4) 25-Year	2.60	93.21	94.06	0.82	13.19
2059	(4) 100-Year	3.29	93.21	94.18	0.79	41.96

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
2038	(2) 2-Year	5.00	93.18	94.27	0.97	16.03
2038	(2) 5-Year	6.32	93.18	94.36	1.03	19.10
2038	(2) 10-Year	7.24	93.18	94.42	1.08	21.22
2038	(2) 25-Year	8.38	93.18	94.49	1.13	24.72
2038	(2) 100-Year	10.81	93.18	94.61	1.23	32.81
2038	(4) 2-Year	4.78	93.18	94.24	0.96	14.92
2038	(4) 5-Year	2.33	93.18	93.99	0.80	9.05
2038	(4) 10-Year	1.78	93.18	93.91	0.76	7.45
2038	(4) 25-Year	2.60	93.18	94.03	0.81	13.10
2038	(4) 100-Year	3.29	93.18	94.16	0.77	41.85
2017	(2) 2-Year	5.00	93.17	94.25	0.99	15.96
2017	(2) 5-Year	6.32	93.17	94.35	1.06	19.03
2017	(2) 10-Year	7.24	93.17	94.41	1.10	21.13
2017	(2) 25-Year	8.38	93.17	94.47	1.15	24.62
2017	(2) 100-Year	10.81	93.17	94.59	1.25	32.69
2017	(4) 2-Year	4.78	93.17	94.23	0.98	14.87
2017	(4) 5-Year	2.33	93.17	93.98	0.82	9.02
2017	(4) 10-Year	1.78	93.17	93.90	0.79	7.42
2017	(4) 25-Year	2.60	93.17	94.02	0.82	13.07
2017	(4) 100-Year	3.29	93.17	94.15	0.78	41.81
2003	(2) 2-Year	5.00	93.16	94.24	1.00	15.91
2003	(2) 5-Year	6.32	93.16	94.34	1.07	18.96
2003	(2) 10-Year	7.24	93.16	94.39	1.11	21.05
2003	(2) 25-Year	8.38	93.16	94.46	1.16	24.53
2003	(2) 100-Year	10.81	93.16	94.58	1.26	32.58
2003	(4) 2-Year	4.78	93.16	94.22	0.99	14.81
2003	(4) 5-Year	2.33	93.16	93.97	0.83	8.99
2003	(4) 10-Year	1.78	93.16	93.88	0.81	7.40
2003	(4) 25-Year	2.60	93.16	94.01	0.84	13.03
2003	(4) 100-Year	3.29	93.16	94.14	0.78	41.76
1982	(2) 2-Year	5.00	93.12	94.22	0.96	15.75
1982	(2) 5-Year	6.32	93.12	94.31	1.03	18.76
1982	(2) 10-Year	7.24	93.12	94.37	1.07	20.83
1982	(2) 25-Year	8.38	93.12	94.43	1.12	24.28
1982	(2) 100-Year	10.81	93.12	94.55	1.23	32.28
1982	(4) 2-Year	4.78	93.12	94.19	0.95	14.67
1982	(4) 5-Year	2.33	93.12	93.94	0.79	8.90
1982	(4) 10-Year	1.78	93.12	93.85	0.78	7.34
1982	(4) 25-Year	2.60	93.12	93.98	0.80	12.94
1982	(4) 100-Year	3.29	93.12	94.12	0.74	41.63
1961	(2) 2-Year	5.00	93.08	94.19	0.93	15.59
1961	(2) 5-Year	6.32	93.08	94.28	1.00	18.56
1961	(2) 10-Year	7.24	93.08	94.34	1.05	20.60
1961	(2) 25-Year	8.38	93.08	94.41	1.10	24.03
1961	(2) 100-Year	10.81	93.08	94.52	1.21	31.98
1961	(4) 2-Year	4.78	93.08	94.17	0.93	14.51
1961	(4) 5-Year	2.33	93.08	93.91	0.77	8.82

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1961	(4) 10-Year	1.78	93.08	93.81	0.77	7.27
1961	(4) 25-Year	2.60	93.08	93.95	0.77	12.84
1961	(4) 100-Year	3.29	93.08	94.11	0.71	41.50
1940	(2) 2-Year	5.00	93.04	94.17	0.90	15.42
1940	(2) 5-Year	6.32	93.04	94.26	0.97	18.35
1940	(2) 10-Year	7.24	93.04	94.32	1.02	20.37
1940	(2) 25-Year	8.38	93.04	94.38	1.07	23.77
1940	(2) 100-Year	10.81	93.04	94.50	1.19	31.67
1940	(4) 2-Year	4.78	93.04	94.14	0.90	14.35
1940	(4) 5-Year	2.33	93.04	93.88	0.74	8.72
1940	(4) 10-Year	1.78	93.04	93.78	0.75	7.20
1940	(4) 25-Year	2.60	93.04	93.93	0.74	12.74
1940	(4) 100-Year	3.29	93.04	94.09	0.68	41.36
1919	(2) 2-Year	5.00	93.01	94.15	0.88	15.24
1919	(2) 5-Year	6.32	93.01	94.24	0.95	18.14
1919	(2) 10-Year	7.24	93.01	94.29	1.00	20.13
1919	(2) 25-Year	8.38	93.01	94.36	1.05	23.50
1919	(2) 100-Year	10.81	93.01	94.47	1.17	31.35
1919	(4) 2-Year	4.78	93.01	94.12	0.88	14.18
1919	(4) 5-Year	2.33	93.01	93.86	0.72	8.63
1919	(4) 10-Year	1.78	93.01	93.75	0.74	7.13
1919	(4) 25-Year	2.60	93.01	93.91	0.72	12.63
1919	(4) 100-Year	3.29	93.01	94.08	0.65	41.21
1898	(2) 2-Year	5.00	92.97	94.13	0.85	15.06
1898	(2) 5-Year	6.32	92.97	94.22	0.92	17.91
1898	(2) 10-Year	7.24	92.97	94.27	0.97	19.89
1898	(2) 25-Year	8.38	92.97	94.34	1.03	23.23
1898	(2) 100-Year	10.81	92.97	94.45	1.15	31.03
1898	(4) 2-Year	4.78	92.97	94.10	0.85	14.01
1898	(4) 5-Year	2.33	92.97	93.84	0.69	8.53
1898	(4) 10-Year	1.78	92.97	93.72	0.72	7.06
1898	(4) 25-Year	2.60	92.97	93.89	0.68	12.52
1898	(4) 100-Year	3.29	92.97	94.07	0.62	41.05
1877	(2) 2-Year	5.00	92.93	94.11	0.82	14.86
1877	(2) 5-Year	6.32	92.93	94.20	0.89	17.68
1877	(2) 10-Year	7.24	92.93	94.25	0.94	19.63
1877	(2) 25-Year	8.38	92.93	94.32	1.00	22.95
1877	(2) 100-Year	10.81	92.93	94.42	1.12	30.70
1877	(4) 2-Year	4.78	92.93	94.08	0.81	13.82
1877	(4) 5-Year	2.33	92.93	93.82	0.66	8.43
1877	(4) 10-Year	1.78	92.93	93.69	0.69	6.99
1877	(4) 25-Year	2.60	92.93	93.87	0.65	12.41
1877	(4) 100-Year	3.29	92.93	94.06	0.58	40.88
1857	(2) 2-Year	5.00	92.89	94.09	0.79	14.66
1857	(2) 5-Year	6.32	92.89	94.18	0.87	17.44
1857	(2) 10-Year	7.24	92.89	94.24	0.92	19.37
1857	(2) 25-Year	8.38	92.89	94.30	0.98	22.66

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1857	(2) 100-Year	10.81	92.89	94.40	1.10	30.37
1857	(4) 2-Year	4.78	92.89	94.07	0.79	13.63
1857	(4) 5-Year	2.33	92.89	93.80	0.63	8.32
1857	(4) 10-Year	1.78	92.89	93.67	0.67	6.91
1857	(4) 25-Year	2.60	92.89	93.86	0.62	12.29
1857	(4) 100-Year	3.29	92.89	94.05	0.56	40.69
1837	(2) 2-Year	5.00	92.86	94.08	0.76	14.45
1837	(2) 5-Year	6.32	92.86	94.17	0.84	17.20
1837	(2) 10-Year	7.24	92.86	94.22	0.89	19.10
1837	(2) 25-Year	8.38	92.86	94.28	0.95	22.36
1837	(2) 100-Year	10.81	92.86	94.38	1.08	30.03
1837	(4) 2-Year	4.78	92.86	94.05	0.76	13.43
1837	(4) 5-Year	2.33	92.86	93.79	0.60	8.21
1837	(4) 10-Year	1.78	92.86	93.65	0.64	6.83
1837	(4) 25-Year	2.60	92.86	93.85	0.60	12.16
1837	(4) 100-Year	3.29	92.86	94.04	0.53	40.50
1817	(2) 2-Year	5.00	92.81	94.06	0.73	14.23
1817	(2) 5-Year	6.32	92.81	94.15	0.81	16.94
1817	(2) 10-Year	7.24	92.81	94.20	0.87	18.82
1817	(2) 25-Year	8.38	92.81	94.26	0.93	22.06
1817	(2) 100-Year	10.81	92.81	94.36	1.06	29.68
1817	(4) 2-Year	4.78	92.81	94.04	0.73	13.23
1817	(4) 5-Year	2.33	92.81	93.78	0.57	8.09
1817	(4) 10-Year	1.78	92.81	93.63	0.60	6.75
1817	(4) 25-Year	2.60	92.81	93.84	0.56	12.03
1817	(4) 100-Year	3.29	92.81	94.04	0.50	40.30
1797	(2) 2-Year	5.00	92.77	94.05	0.70	14.00
1797	(2) 5-Year	6.32	92.77	94.14	0.78	16.68
1797	(2) 10-Year	7.24	92.77	94.19	0.83	18.54
1797	(2) 25-Year	8.38	92.77	94.25	0.90	21.74
1797	(2) 100-Year	10.81	92.77	94.34	1.03	29.32
1797	(4) 2-Year	4.78	92.77	94.03	0.70	13.01
1797	(4) 5-Year	2.33	92.77	93.77	0.53	7.97
1797	(4) 10-Year	1.78	92.77	93.62	0.56	6.66
1797	(4) 25-Year	2.60	92.77	93.83	0.53	11.89
1797	(4) 100-Year	3.29	92.77	94.03	0.48	40.08
1777	(2) 2-Year	5.00	92.73	94.04	0.66	13.76
1777	(2) 5-Year	6.32	92.73	94.13	0.74	16.40
1777	(2) 10-Year	7.24	92.73	94.18	0.79	18.23
1777	(2) 25-Year	8.38	92.73	94.24	0.86	21.42
1777	(2) 100-Year	10.81	92.73	94.33	0.99	28.96
1777	(4) 2-Year	4.78	92.73	94.02	0.66	12.77
1777	(4) 5-Year	2.33	92.73	93.76	0.50	7.83
1777	(4) 10-Year	1.78	92.73	93.61	0.52	6.56
1777	(4) 25-Year	2.60	92.73	93.82	0.50	11.73
1777	(4) 100-Year	3.29	92.73	94.03	0.45	39.84
1757	(2) 2-Year	5.00	92.69	94.04	0.64	13.50

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1757	(2) 5-Year	6.32	92.69	94.12	0.72	16.10
1757	(2) 10-Year	7.24	92.69	94.17	0.77	17.92
1757	(2) 25-Year	8.38	92.69	94.22	0.83	21.08
1757	(2) 100-Year	10.81	92.69	94.31	0.97	28.58
1757	(4) 2-Year	4.78	92.69	94.01	0.63	12.53
1757	(4) 5-Year	2.33	92.69	93.75	0.47	7.69
1757	(4) 10-Year	1.78	92.69	93.60	0.49	6.46
1757	(4) 25-Year	2.60	92.69	93.81	0.47	11.57
1757	(4) 100-Year	3.29	92.69	94.02	0.43	39.59
1736	(2) 2-Year	5.00	92.66	94.03	0.61	13.23
1736	(2) 5-Year	6.32	92.66	94.11	0.69	15.80
1736	(2) 10-Year	7.24	92.66	94.16	0.74	17.60
1736	(2) 25-Year	8.38	92.66	94.21	0.81	20.73
1736	(2) 100-Year	10.81	92.66	94.30	0.94	28.19
1736	(4) 2-Year	4.78	92.66	94.00	0.61	12.27
1736	(4) 5-Year	2.33	92.66	93.75	0.45	7.54
1736	(4) 10-Year	1.78	92.66	93.59	0.47	6.35
1736	(4) 25-Year	2.60	92.66	93.81	0.45	11.39
1736	(4) 100-Year	3.29	92.66	94.02	0.41	39.33
1715	(2) 2-Year	5.00	92.62	94.02	0.58	12.95
1715	(2) 5-Year	6.32	92.62	94.10	0.66	15.48
1715	(2) 10-Year	7.24	92.62	94.15	0.71	17.26
1715	(2) 25-Year	8.38	92.62	94.20	0.77	20.37
1715	(2) 100-Year	10.81	92.62	94.29	0.91	27.79
1715	(4) 2-Year	4.78	92.62	93.99	0.57	12.00
1715	(4) 5-Year	2.33	92.62	93.74	0.42	7.37
1715	(4) 10-Year	1.78	92.62	93.58	0.43	6.23
1715	(4) 25-Year	2.60	92.62	93.80	0.42	11.20
1715	(4) 100-Year	3.29	92.62	94.02	0.38	39.05
1694	(2) 2-Year	5.00	92.58	94.02	0.56	12.65
1694	(2) 5-Year	6.32	92.58	94.09	0.64	15.15
1694	(2) 10-Year	7.24	92.58	94.14	0.69	16.91
1694	(2) 25-Year	8.38	92.58	94.19	0.75	19.99
1694	(2) 100-Year	10.81	92.58	94.28	0.89	27.37
1694	(4) 2-Year	4.78	92.58	93.99	0.55	11.72
1694	(4) 5-Year	2.33	92.58	93.74	0.39	7.19
1694	(4) 10-Year	1.78	92.58	93.58	0.41	6.10
1694	(4) 25-Year	2.60	92.58	93.80	0.40	10.99
1694	(4) 100-Year	3.29	92.58	94.01	0.37	38.75
1673	(2) 2-Year	5.00	92.53	94.01	0.53	12.34
1673	(2) 5-Year	6.32	92.53	94.09	0.61	14.81
1673	(2) 10-Year	7.24	92.53	94.13	0.66	16.54
1673	(2) 25-Year	8.38	92.53	94.19	0.72	19.60
1673	(2) 100-Year	10.81	92.53	94.26	0.86	26.95
1673	(4) 2-Year	4.78	92.53	93.98	0.52	11.42
1673	(4) 5-Year	2.33	92.53	93.74	0.37	6.99
1673	(4) 10-Year	1.78	92.53	93.57	0.38	5.97
1673	(4) 25-Year	2.60	92.53	93.80	0.37	10.77

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1673	(4) 100-Year	3.29	92.53	94.01	0.35	38.44
1653	(2) 2-Year	5.00	92.50	94.01	0.51	12.01
1653	(2) 5-Year	6.32	92.50	94.08	0.59	14.45
1653	(2) 10-Year	7.24	92.50	94.13	0.64	16.16
1653	(2) 25-Year	8.38	92.50	94.18	0.70	19.20
1653	(2) 100-Year	10.81	92.50	94.26	0.83	26.51
1653	(4) 2-Year	4.78	92.50	93.98	0.50	11.10
1653	(4) 5-Year	2.33	92.50	93.73	0.35	6.78
1653	(4) 10-Year	1.78	92.50	93.57	0.36	5.82
1653	(4) 25-Year	2.60	92.50	93.79	0.35	10.53
1653	(4) 100-Year	3.29	92.50	94.01	0.33	38.11
1632	(2) 2-Year	5.00	92.46	94.00	0.49	11.68
1632	(2) 5-Year	6.32	92.46	94.08	0.57	14.08
1632	(2) 10-Year	7.24	92.46	94.12	0.62	15.77
1632	(2) 25-Year	8.38	92.46	94.17	0.68	18.78
1632	(2) 100-Year	10.81	92.46	94.25	0.82	26.06
1632	(4) 2-Year	4.78	92.46	93.97	0.49	10.78
1632	(4) 5-Year	2.33	92.46	93.73	0.33	6.56
1632	(4) 10-Year	1.78	92.46	93.56	0.34	5.66
1632	(4) 25-Year	2.60	92.46	93.79	0.34	10.29
1632	(4) 100-Year	3.29	92.46	94.01	0.32	37.77
1615	(2) 2-Year	5.00	92.43	94.00	0.47	11.39
1615	(2) 5-Year	6.32	92.43	94.07	0.55	13.76
1615	(2) 10-Year	7.24	92.43	94.12	0.60	15.44
1615	(2) 25-Year	8.38	92.43	94.17	0.66	18.43
1615	(2) 100-Year	10.81	92.43	94.24	0.79	25.68
1615	(4) 2-Year	4.78	92.43	93.97	0.47	10.50
1615	(4) 5-Year	2.33	92.43	93.73	0.32	6.36
1615	(4) 10-Year	1.78	92.43	93.56	0.32	5.52
1615	(4) 25-Year	2.60	92.43	93.79	0.32	10.07
1615	(4) 100-Year	3.29	92.43	94.01	0.31	37.48
1555	(2) 2-Year	5.00	92.35	93.99	0.42	10.29
1555	(2) 5-Year	6.32	92.35	94.06	0.49	12.57
1555	(2) 10-Year	7.24	92.35	94.10	0.54	14.19
1555	(2) 25-Year	8.38	92.35	94.15	0.59	17.12
1555	(2) 100-Year	10.81	92.35	94.22	0.71	24.27
1555	(4) 2-Year	4.78	92.35	93.96	0.42	9.44
1555	(4) 5-Year	2.33	92.35	93.72	0.29	5.61
1555	(4) 10-Year	1.78	92.35	93.55	0.30	4.97
1555	(4) 25-Year	2.60	92.35	93.79	0.29	9.24
1555	(4) 100-Year	3.29	92.35	94.00	0.27	36.37
1488	(2) 2-Year	5.00	92.28	93.98	0.39	8.97
1488	(2) 5-Year	6.32	92.28	94.05	0.45	11.14
1488	(2) 10-Year	7.24	92.28	94.09	0.50	12.70
1488	(2) 25-Year	8.38	92.28	94.14	0.55	15.56
1488	(2) 100-Year	10.81	92.28	94.20	0.67	22.62
1488	(4) 2-Year	4.78	92.28	93.95	0.38	8.16

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1488	(4) 5-Year	2.33	92.28	93.72	0.26	4.66
1488	(4) 10-Year	1.78	92.28	93.55	0.26	4.26
1488	(4) 25-Year	2.60	92.28	93.78	0.26	8.20
1488	(4) 100-Year	3.29	92.28	94.00	0.25	35.03
1416	(2) 2-Year	5.00	92.20	93.98	0.36	7.64
1416	(2) 5-Year	6.32	92.20	94.04	0.43	9.72
1416	(2) 10-Year	7.24	92.20	94.08	0.47	11.22
1416	(2) 25-Year	8.38	92.20	94.13	0.52	14.02
1416	(2) 100-Year	10.81	92.20	94.18	0.64	21.00
1416	(4) 2-Year	4.78	92.20	93.95	0.35	6.88
1416	(4) 5-Year	2.33	92.20	93.71	0.23	3.69
1416	(4) 10-Year	1.78	92.20	93.54	0.22	3.49
1416	(4) 25-Year	2.60	92.20	93.78	0.23	7.15
1416	(4) 100-Year	3.29	92.20	94.00	0.23	33.68
1400	(2) 2-Year	5.00	92.17	93.97	0.35	7.11
1400	(2) 5-Year	6.32	92.17	94.04	0.41	9.15
1400	(2) 10-Year	7.24	92.17	94.08	0.46	10.63
1400	(2) 25-Year	8.38	92.17	94.12	0.51	13.41
1400	(2) 100-Year	10.81	92.17	94.18	0.62	20.36
1400	(4) 2-Year	4.78	92.17	93.95	0.34	6.36
1400	(4) 5-Year	2.33	92.17	93.71	0.22	3.28
1400	(4) 10-Year	1.78	92.17	93.54	0.21	3.17
1400	(4) 25-Year	2.60	92.17	93.78	0.22	6.71
1400	(4) 100-Year	3.29	92.17	94.00	0.22	33.13
1364	(2) 2-Year	5.00	91.63	93.97	0.24	6.23
1364	(2) 5-Year	6.32	91.63	94.04	0.28	8.22
1364	(2) 10-Year	7.24	91.63	94.08	0.32	9.67
1364	(2) 25-Year	8.38	91.63	94.12	0.36	12.41
1364	(2) 100-Year	10.81	91.63	94.17	0.45	19.32
1364	(4) 2-Year	4.78	91.63	93.94	0.23	5.50
1364	(4) 5-Year	2.33	91.63	93.71	0.13	2.60
1364	(4) 10-Year	1.78	91.63	93.54	0.12	2.60
1364	(4) 25-Year	2.60	91.63	93.78	0.14	5.98
1364	(4) 100-Year	3.29	91.63	94.00	0.15	32.24
1340	(2) 2-Year	5.79	91.60	93.97	0.27	5.60
1340	(2) 5-Year	7.32	91.60	94.04	0.33	7.56
1340	(2) 10-Year	8.33	91.60	94.08	0.37	8.99
1340	(2) 25-Year	9.65	91.60	94.12	0.41	11.71
1340	(2) 100-Year	11.62	91.60	94.17	0.48	18.58
1340	(4) 2-Year	5.26	91.60	93.94	0.25	4.88
1340	(4) 5-Year	2.44	91.60	93.71	0.14	2.09
1340	(4) 10-Year	1.86	91.60	93.54	0.12	2.18
1340	(4) 25-Year	2.71	91.60	93.78	0.15	5.44
1340	(4) 100-Year	3.43	91.60	94.00	0.16	31.59
1312	(2) 2-Year	6.08	92.47	93.95	0.71	5.07
1312	(2) 5-Year	7.69	92.47	94.00	0.85	7.00
1312	(2) 10-Year	8.76	92.47	94.03	0.95	8.41

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1312	(2) 25-Year	10.15	92.47	94.06	1.08	11.11
1312	(2) 100-Year	12.20	92.47	94.09	1.27	17.97
1312	(4) 2-Year	5.46	92.47	93.92	0.65	4.37
1312	(4) 5-Year	2.47	92.47	93.71	0.36	1.67
1312	(4) 10-Year	1.87	92.47	93.54	0.32	1.82
1312	(4) 25-Year	2.73	92.47	93.77	0.37	5.00
1312	(4) 100-Year	3.44	92.47	93.99	0.39	31.05
1302	(2) 2-Year	6.08	92.57	93.91	1.03	4.98
1302	(2) 5-Year	7.69	92.57	93.97	1.13	6.90
1302	(2) 10-Year	8.76	92.57	94.00	1.18	8.31
1302	(2) 25-Year	10.15	92.57	94.04	1.26	11.00
1302	(2) 100-Year	12.20	92.57	94.07	1.39	17.85
1302	(4) 2-Year	5.46	92.57	93.89	0.98	4.29
1302	(4) 5-Year	2.47	92.57	93.68	0.77	1.62
1302	(4) 10-Year	1.87	92.57	93.50	0.85	1.79
1302	(4) 25-Year	2.73	92.57	93.74	0.73	4.94
1302	(4) 100-Year	3.44	92.57	93.98	0.49	30.95
1268	(2) 2-Year	6.08	92.47	93.87	0.59	4.63
1268	(2) 5-Year	7.69	92.47	93.93	0.62	6.46
1268	(2) 10-Year	8.76	92.47	93.96	0.64	7.77
1268	(2) 25-Year	10.15	92.47	94.00	0.67	10.34
1268	(2) 100-Year	12.20	92.47	94.05	0.64	16.97
1268	(4) 2-Year	5.46	92.47	93.84	0.57	3.96
1268	(4) 5-Year	2.47	92.47	93.59	0.68	1.50
1268	(4) 10-Year	1.87	92.47	93.42	0.81	1.71
1268	(4) 25-Year	2.73	92.47	93.67	0.53	4.78
1268	(4) 100-Year	3.44	92.47	93.98	0.24	30.39
1212	(2) 2-Year	6.08	92.36	93.78	0.84	3.93
1212	(2) 5-Year	7.69	92.36	93.85	0.85	5.52
1212	(2) 10-Year	8.76	92.36	93.88	0.86	6.62
1212	(2) 25-Year	10.15	92.36	93.93	0.84	8.90
1212	(2) 100-Year	12.20	92.36	94.00	0.80	15.06
1212	(4) 2-Year	5.46	92.36	93.74	0.83	3.36
1212	(4) 5-Year	2.47	92.36	93.40	0.89	1.32
1212	(4) 10-Year	1.87	92.36	93.30	0.83	1.58
1212	(4) 25-Year	2.73	92.36	93.54	0.74	4.52
1212	(4) 100-Year	3.44	92.36	93.97	0.24	28.91
1169	(2) 2-Year	6.08	92.30	93.70	0.86	3.39
1169	(2) 5-Year	7.69	92.30	93.76	0.91	4.74
1169	(2) 10-Year	8.76	92.30	93.80	0.95	5.69
1169	(2) 25-Year	10.15	92.30	93.84	0.99	7.78
1169	(2) 100-Year	12.20	92.30	93.91	1.04	13.62
1169	(4) 2-Year	5.46	92.30	93.67	0.83	2.90
1169	(4) 5-Year	2.47	92.30	93.32	0.73	1.19
1169	(4) 10-Year	1.87	92.30	93.24	0.65	1.47
1169	(4) 25-Year	2.73	92.30	93.49	0.59	4.34
1169	(4) 100-Year	3.44	92.30	93.97	0.28	27.40

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
1091	(2) 2-Year	6.08	92.15	93.57	0.83	2.61
1091	(2) 5-Year	7.69	92.15	93.64	0.85	3.66
1091	(2) 10-Year	8.76	92.15	93.68	0.88	4.46
1091	(2) 25-Year	10.15	92.15	93.72	0.91	6.34
1091	(2) 100-Year	12.20	92.15	93.80	0.88	11.79
1091	(4) 2-Year	5.46	92.15	93.53	0.82	2.26
1091	(4) 5-Year	2.47	92.15	93.18	0.71	0.93
1091	(4) 10-Year	1.87	92.15	93.14	0.58	1.23
1091	(4) 25-Year	2.73	92.15	93.42	0.51	3.95
1091	(4) 100-Year	3.44	92.15	93.96	0.19	24.74
1002	(2) 2-Year	6.08	92.06	93.36	1.06	1.89
1002	(2) 5-Year	7.69	92.06	93.45	1.07	2.63
1002	(2) 10-Year	8.76	92.06	93.50	1.06	3.23
1002	(2) 25-Year	10.15	92.06	93.57	0.99	4.83
1002	(2) 100-Year	12.20	92.06	93.70	0.86	9.70
1002	(4) 2-Year	5.46	92.06	93.32	1.03	1.66
1002	(4) 5-Year	2.47	92.06	93.00	0.85	0.65
1002	(4) 10-Year	1.87	92.06	93.04	0.60	0.95
1002	(4) 25-Year	2.73	92.06	93.37	0.47	3.42
1002	(4) 100-Year	3.44	92.06	93.96	0.14	20.77
961	(2) 2-Year	6.08	91.96	93.25	0.88	1.61
961	(2) 5-Year	7.69	91.96	93.33	0.93	2.25
961	(2) 10-Year	8.76	91.96	93.38	0.95	2.77
961	(2) 25-Year	10.15	91.96	93.48	0.88	4.20
961	(2) 100-Year	12.20	91.96	93.67	0.55	8.56
961	(4) 2-Year	5.46	91.96	93.22	0.85	1.41
961	(4) 5-Year	2.47	91.96	92.95	0.64	0.51
961	(4) 10-Year	1.87	91.96	93.02	0.43	0.80
961	(4) 25-Year	2.73	91.96	93.35	0.32	3.09
961	(4) 100-Year	3.44	91.96	93.96	0.08	18.02
910	(2) 2-Year	6.08	91.93	93.17	0.79	0.99
910	(2) 5-Year	7.69	91.93	93.26	0.80	1.41
910	(2) 10-Year	8.76	91.93	93.32	0.77	1.75
910	(2) 25-Year	10.15	91.93	93.43	0.70	2.59
910	(2) 100-Year	12.20	91.93	93.65	0.44	5.00
910	(4) 2-Year	5.46	91.93	93.14	0.78	0.86
910	(4) 5-Year	2.47	91.93	92.89	0.67	0.31
910	(4) 10-Year	1.87	91.93	93.00	0.40	0.51
910	(4) 25-Year	2.73	91.93	93.35	0.24	2.01
910	(4) 100-Year	3.44	91.93	93.96	0.06	10.36
840	(2) 2-Year	6.08	91.86	93.10	0.50	
840	(2) 5-Year	7.69	91.86	93.21	0.48	
840	(2) 10-Year	8.76	91.86	93.28	0.46	
840	(2) 25-Year	10.15	91.86	93.41	0.41	
840	(2) 100-Year	12.20	91.86	93.64	0.34	
840	(4) 2-Year	5.46	91.86	93.06	0.51	
840	(4) 5-Year	2.47	91.86	92.80	0.52	
840	(4) 10-Year	1.87	91.86	92.97	0.23	

Table D-2: HEC-RAS Results for Van Gaal Drain Reach 2 Under Proposed Conditions (Riparian) (1)

HEC-RAS River Station	Profile	Flow (m^3/s)	Minimum Channel Elevation (m)	Water Surface Elevation (m)	Channel Velocity (m/s)	Cumulative Volume (1000 m^3)
840	(4) 25-Year	2.73	91.86	93.34	0.12	
840	(4) 100-Year	3.44	91.86	93.96	0.05	

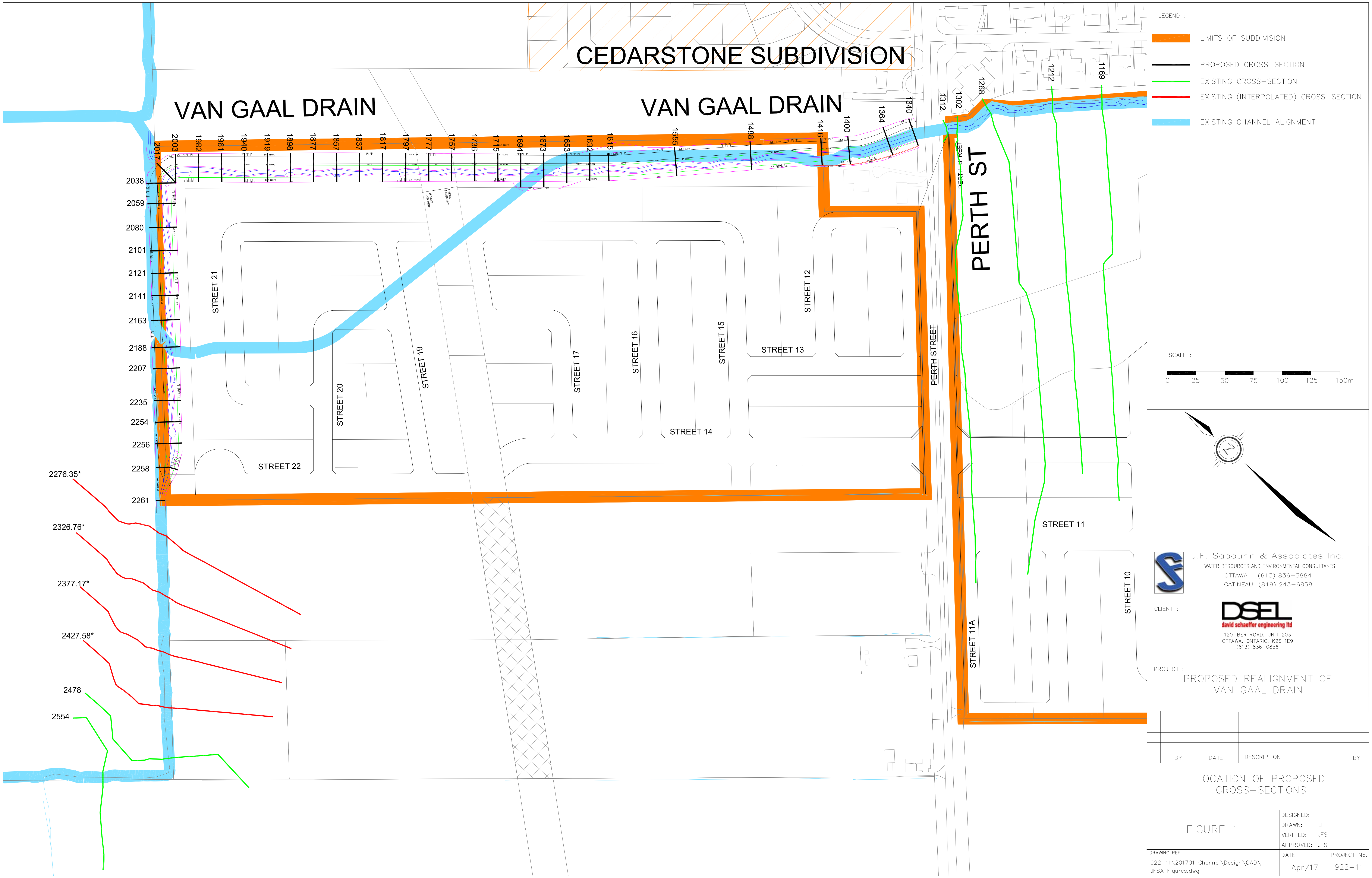
(1) All channel infrastructure removed from the HEC-RAS model for riparian storage analysis.
For Scenario 2 (the Van Gaal Drain 100-year spring snowmelt plus rainfall peak flow reaches the Jock River) and
Scenario 4 (the Jock River 100-year spring snowmelt plus rainfall peak flow reaches the outlet of the Van Gaal Drain).

Ottawa. ON
Paris. ON
Gatineau. QB
Montréal. QB
Québec. QB

Attachment E

Figure 1

Richmond Village Development / Proposed Realignment of the Van Gaal Drain by JFSA (April 20, 2017).



J.F. Sabourin & Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
OTTAWA (613) 836–3884
GATINEAU (819) 243–6858

CLIENT :
DSEL
david schaeffer engineering ltd
120 IBER ROAD, UNIT 203
OTTAWA, ONTARIO, K2S 1E9
(613) 836–0856

PROJECT :
PROPOSED REALIGNMENT OF
VAN GAAL DRAIN

	BY	DATE	DESCRIPTION	BY

LOCATION OF PROPOSED
CROSS–SECTIONS

FIGURE 1

DESIGNED:
DRAWN: LP
VERIFIED: JFS
APPROVED: JFS

DRAWING REF.
922–11\201701 Channel\Design\CAD\
JFSA Figures.dwg

DATE	PROJECT No.
Apr/17	922–11

DSEL

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Fax. (613) 836-7183
www.DSEL.ca

WESTERN DEVELOPMENT LANDS

STORM SERVICING PLAN

CITY OF OTTAWA

LEGEND

▬	STUDY LIMIT
◄	EXISTING DITCH
▨	STORM TRIBUTARY AREA
▬	STORM TRUNK
▬	LOCAL STORM SEWER
◄	EXISTING STORM TRUNK
▬	STORM TRUNK BY OTHERS
▬	1:100 YEAR REGULATORY FLOOD LINE PER JFSA NOVEMBER 2009 (BACKWATER FROM JOCK RIVER)
8.26Ha 0.62	DRAINAGE AREA IMPERVIOUSNESS
⌂	EXTERNAL DRAINAGE
▨	100 YEAR INTAKE AREA

PROJECT No.:	20-1184
DATE:	AUGUST 2021
SCALE:	1:3000
DRAWING:	3

The subject lands sloped generally from west to east under pre-development conditions. As described in ***Section 3.4***, there are significant areas west of the subject land that drain through the development property under pre-development conditions. As illustrated on ***Drawing 3***, the external areas are summarized below:

- 63.1 ha Perth Street road side ditch north;
- 34.4 ha Perth Street road side ditch south;
- 94.2 ha approximately midpoint between Perth and Ottawa Streets;
- 39.2 ha Ottawa Street road side ditch north and;
- 32.6 ha Ottawa Street road side ditch south.

The above external areas will be serviced by the two SWM ponds as they were included in the design of Pond 1 and Pond 2.

Due to anticipated urbanization of Perth Street and Ottawa Street as well as the site at large, these external areas will be collected and conveyed within storm sewers. These areas will be directed through the stormwater management facilities.

6.2.1 Deviations from Design Guidelines

The design of the sewer outfall from SWM Facility #1 (see ***Section 7.1*** of this report for Facility #1 details) results in a circumstance where it has to cross underneath the existing Moore tributary as noted in the ***Ultimate Pond 1 Design Brief***. Due to site constraints (i.e. grading and both conveyances outletting to the same tributary) there is minimum cover between the ditch invert and the obvert of the sewer outfall (0.10 m). In the detailed design of SWM Facility #1, twin 525 mm storm pipes were proposed and installed, crossing under the Moore tributary to mitigate the depth of cover. As a result, some of the storm sewers in the RVDC lands use spring line to spring line connections, deviating from obvert to obvert connections per *Section 6.2.10* of the ***Sewer Design Guidelines***. Justification for spring line to spring line connections is provided in ***Deviations from Guidelines and Standards Report (Springline Connections) Fox Run Subdivision Richmond – Phase 2 (South)*** prepared by DSEL, dated May 31, 2019 for the RVDC lands. If necessary, justification for spring line connections will be provided in the detailed design of the other land holdings within the Western Development Lands.

6.3 Sump Pump Service

The majority of the Village of Richmond is reliant on sump pumps for foundation drainage as discussed in ***Section 5.2.4***. The use of sump pumps for the subject lands remains consistent with the existing level of service within the Village of Richmond.

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WESTERN DEVELOPMENT LANDS

GRADING PLAN

CITY OF OTTAWA

LEGEND

🟧	STUDY LIMIT
—	EXISTING DITCH
95.00	EXISTING ELEVATION CONTOUR
⬆	MAJOR OVERLAND FLOW
⇧	EXTERNAL DRAINAGE
⌒	1:100 YEAR REGULATORY FLOOD LINE PER JFSA NOVEMBER 2009 (BACKWATER FROM JOCK RIVER)
⬅	EMERGENCY OVERLAND FLOW
▮▮▮	STORM MAJOR TRIBUTARY AREA
30.8Ha POND 1	DRAINAGE AREA

CUT-FILL DEPTH ALONG CENTER LINE:

CUT DEPTH (m)		FILL DEPTH (m)	
0 - 1	☐	0 - 1	☐
1 - 2	🟨	1 - 2	🟦
2 - 3	🟫	2 - 3	🟦

PROJECT No.:	20-1184
DATE:	AUGUST 2021
SCALE:	1:3000
DRAWING:	2

Excerpt from JF Sabourin & Associates'
"Stormwater Management Report for Fox Run Subdivision, Phase 2B"
Appendix D
JFSA Reference No. 922-11 (February 2020)

CALCULATION SHEET 2E: REQUIRED CAPACITY OF PHASE 2B OVERLAND FLOW ROUTE

OVERLAND FLOW ROUTE FROM POSTILION STREET TO THE VAN GAAL DRAIN - CURB CUT WEIR

Approaching flow = 0.064 m^3/s for 100-yr storm (with 100% blockage of grates)
0.186 m^3/s for 100-yr + 20% stress test (with 100% blockage of grates)

Curb cut width = 3 m as per DSEL grading plan
Spill height = 0.110 m as per DSEL
Maximum flow depth at gutter = 0.350 m
Average head of water over spill point = 0.240 m
Curb cut weir coefficient = 1.84
Maximum flow through cub cut = 0.649 m^3/s for 100-yr event

Therefore the capacity of the curb cut (0.649 m^3/s) is higher than the computed overland flow (0.064 m^3/s)

OVERLAND FLOW ROUTE DOWNSTREAM OF CURB CUT (ASSUMED SLOPES)

$Q = 1/n \times AR^{2/3}S^{1/2}$

100-Year Storm	**Max Slope**		**Min Slope**
normal depth =	**0.017**	m	**0.060**
n =	0.03		0.03
Channel width =	3	m	3
A (area of flow) =	0.051	m^2	0.181
wetted perimeter =	3.034	m	3.121
R (hydraulic radius) =	0.017	m	0.058
S (slope) =	0.333	m/m	0.005
Q (flow) =	0.064	m^3/s	0.064
velocity =	1.26	m/s	0.35

100-Year + 20% Stress Test	**Max Slope**		**Min Slope**
normal depth =	***0.032***	*m*	***0.116***
n =	*0.03*		*0.03*
Channel width =	*3*	*m*	*3*
A (area of flow) =	*0.097*	*m^2*	*0.348*
wetted perimeter =	*3.064*	*m*	*3.232*
R (hydraulic radius) =	*0.032*	*m*	*0.108*
S (slope) =	*0.333*	*m/m*	*0.005*
Q (flow) =	*0.186*	*m^3/s*	*0.186*
velocity =	*1.92*	*m/s*	*0.53*

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD
BASED ON A FINE PARTICLE SIZE DISTRIBUTION

Project Name:	Green Property - Richmond	**Engineer:**	**DSEL**
Location:	Richmond, ON	**Contact:**	S. Merrick, P.Eng
OGS #:	OGS	**Report Date:**	8-Jul-20

Area	2.16	ha	**Rainfall Station #**	215	
Weighted C	0.66		**Particle Size Distribution**	FINE	
CDS Model	3020		**CDS Treatment Capacity**	57	l/s

Rainfall Intensity[1] (mm/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (l/s)	Treated Flowrate (l/s)	Operating Rate (%)	Removal Efficiency (%)	Incremental Removal (%)
0.5	9.2%	9.2%	2.0	2.0	3.5	97.9	9.0
1.0	10.6%	19.8%	4.0	4.0	7.0	96.9	10.3
1.5	9.9%	29.7%	5.9	5.9	10.5	95.8	9.5
2.0	8.4%	38.1%	7.9	7.9	14.0	94.8	7.9
2.5	7.7%	45.8%	9.9	9.9	17.5	93.8	7.2
3.0	5.9%	51.7%	11.9	11.9	21.0	92.8	5.5
3.5	4.4%	56.1%	13.9	13.9	24.5	91.8	4.0
4.0	4.7%	60.7%	15.9	15.9	28.0	90.8	4.2
4.5	3.3%	64.0%	17.8	17.8	31.5	89.8	3.0
5.0	3.0%	67.1%	19.8	19.8	35.0	88.8	2.7
6.0	5.4%	72.4%	23.8	23.8	42.0	86.8	4.7
7.0	4.4%	76.8%	27.7	27.7	49.0	84.8	3.7
8.0	3.5%	80.3%	31.7	31.7	56.0	82.8	2.9
9.0	2.8%	83.2%	35.7	35.7	63.0	80.8	2.3
10.0	2.2%	85.3%	39.6	39.6	70.0	78.8	1.7
15.0	7.0%	92.3%	59.4	56.6	100.0	66.9	4.7
20.0	4.5%	96.9%	79.3	56.6	100.0	50.2	2.3
25.0	1.4%	98.3%	99.1	56.6	100.0	40.1	0.6
30.0	0.7%	99.0%	118.9	56.6	100.0	33.4	0.2
35.0	0.5%	99.5%	138.7	56.6	100.0	28.7	0.1
40.0	0.5%	100.0%	158.5	56.6	100.0	25.1	0.1
							86.7

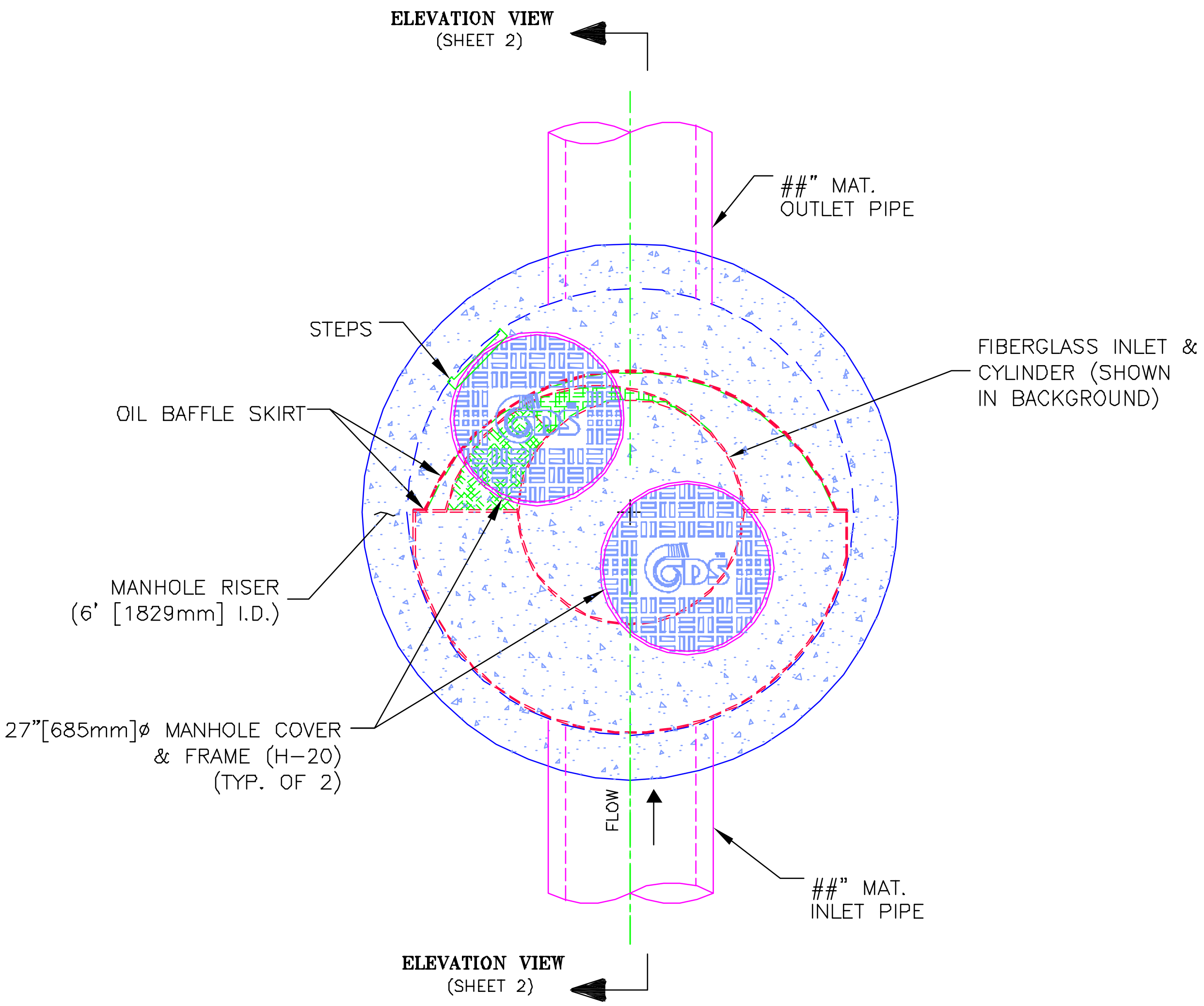
Removal Efficiency Adjustment[2] = 6.5%

Predicted Net Annual Load Removal Efficiency = 80.2%

Predicted % Annual Rainfall Treated = 96.8%

1 - Based on 42 years of hourly rainfall data from Canadian Station 6105976, Ottawa ON
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.
3 - CDS Efficiency based on testing conducted at the University of Central Florida
4 - CDS design flowrate and scaling based on standard manufacturer model & product specifications

PLAN VIEW



CDS MODEL PMSU30_20m, 2 CFS TREATMENT CAPACITY STORM WATER TREATMENT UNIT

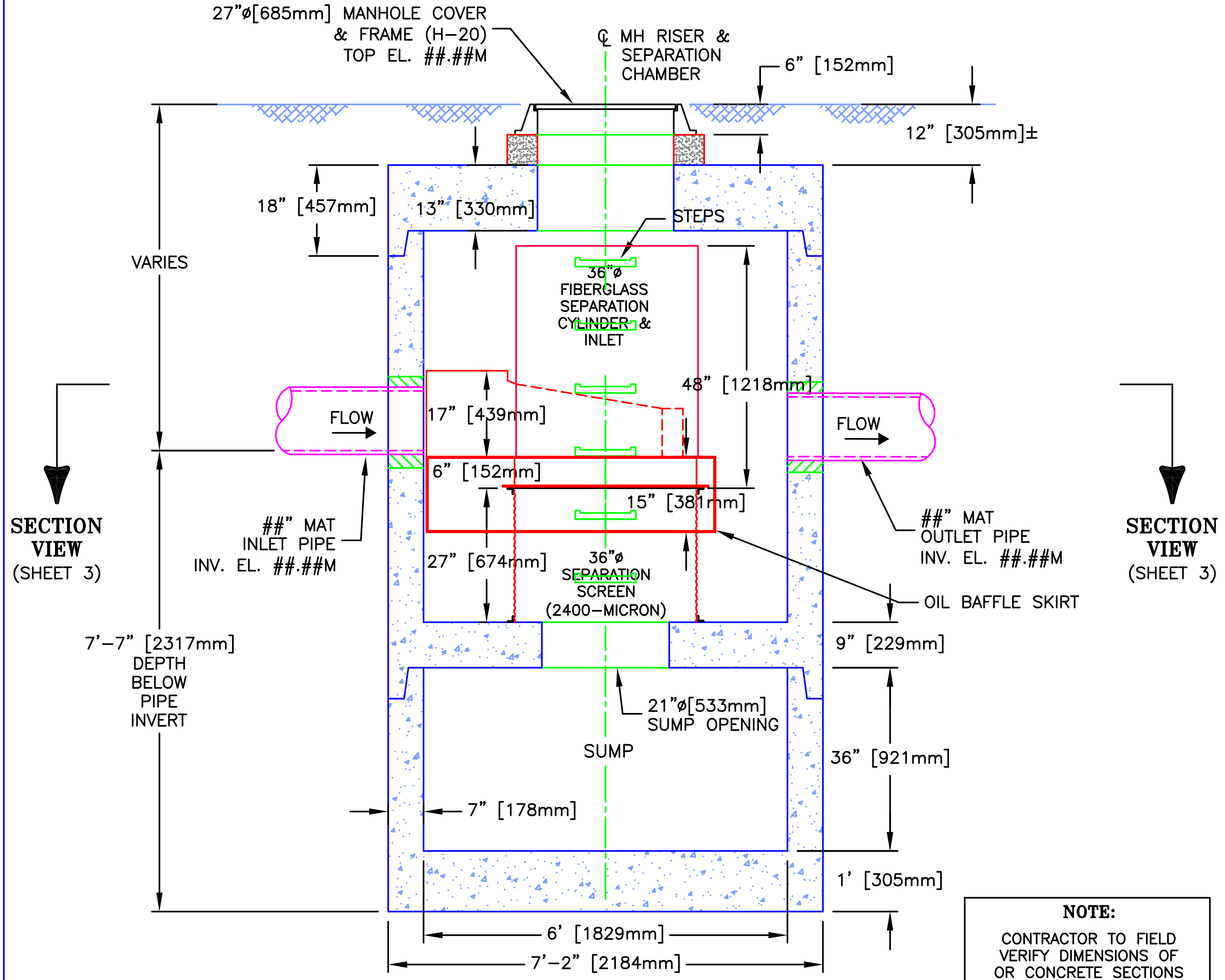
PROJECT NAME
CITY, STATE

JOB# CAN-##-###
DATE ##/##/##
DRAWN INITIALS
APPROV.

SCALE
1" = 2.5'

SHEET
1

ELEVATION VIEW



NOTE:
CONTRACTOR TO FIELD
VERIFY DIMENSIONS OF
OR CONCRETE SECTIONS

CDS MODEL PMSU30_20m, 2 CFS TREATMENT CAPACITY STORM WATER TREATMENT UNIT

CONTECH®
STORMWATER SOLUTIONS INC.

PROJECT NAME
CITY, STATE

JOB#	CAN-##-###	SCALE 1" = 3'
DATE	##/##/##	SHEET
DRAWN	INITIALS	2
APPROV.		

CALCULATION SHEET B-2: FOREBAY SIZING FOR SWM FACILITY

WESTERN DEVELOPMENT LANDS - RICHMOND
SWM Pond 1
City of Ottawa
Calculation of Forebay Size
South Forebay

© DSEL

Settling Criteria

From the SWMP Manual, the required length for settling is as follows:

$$L_{min} = \left(\frac{r\,Q_p}{V_s}\right)^{0.5}$$

where:
r = length to width ratio, at the invert of the inlet pipe.
Q_p = peak outflow during design quality storm
V_s = settling velocity

Input:
r = 3.07 (83 m / 27 m)
Q_p = 0.341 m^3/s (at elevation 93.68 m)
V_s = 0.0003 m/s

L_{min} = 59.11 m

The peak flow rate from the pond during the quality storm is taken as the flow that would occur just below the quantity controls (Refer to Table B-5 of Appendix B)

Dispersion Criteria

From the SWMP Manual, the required length for dispersion is as follows:

$$L_{min} = \frac{8Q}{d\,V_f}$$

where:
Q = Inlet flowrate (10-Year, 24-Hour SCS Storm)
d = depth of permanent pool (forebay)
V_f = desired final velocity

Input:
Q = 9.223 m^3/s
d = 2.0 m
Vf = 0.5 m/s

L_{min} = 73.78 m

The minimum forebay length is determined by the larger of the settling or dispersion criteria.

Minimum Length of Forebay Required 73.78 m
Length of Forebay Provided 83.00 m (at elevation 92.35 m)

Average Forebay Velocity

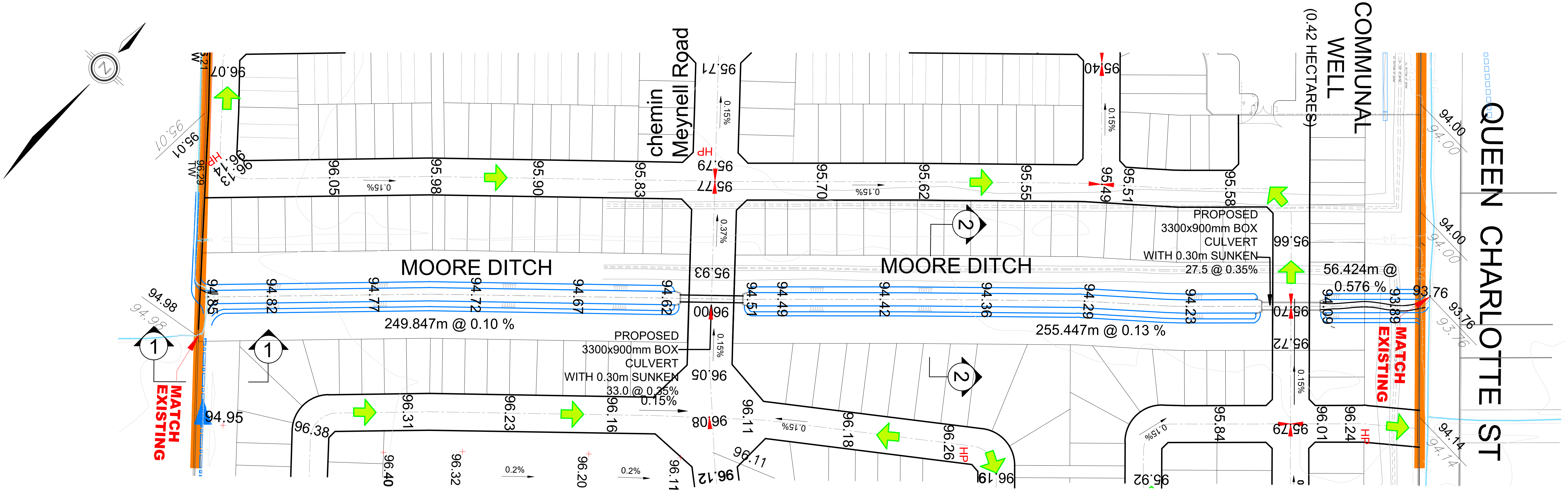
From the SWMP Manual, the maximum allowable average velocity is 0.15 m/s:

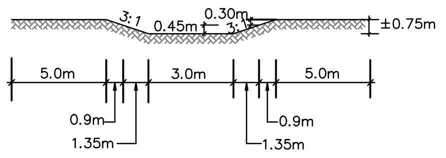
$$V_{avg} = \frac{Q}{d\,W_{avg}}$$

where:
Q = Inlet flowrate (10-Year, 24-Hour SCS Storm)
d = depth of pond during peak 10-year inflow (12h:00min)
W_{avg} = average width of forebay

Input:
Q = 9.223 m^3/s
d = 2.65 m
W_{avg} = 21 m (15 m bottom, 27 m permanent pool)

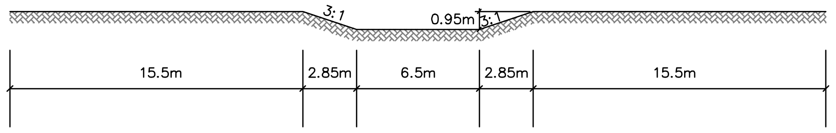
V = 0.17 m/s > 0.15 m/s





TYPICAL CHANNEL CROSS SECTION 1-1

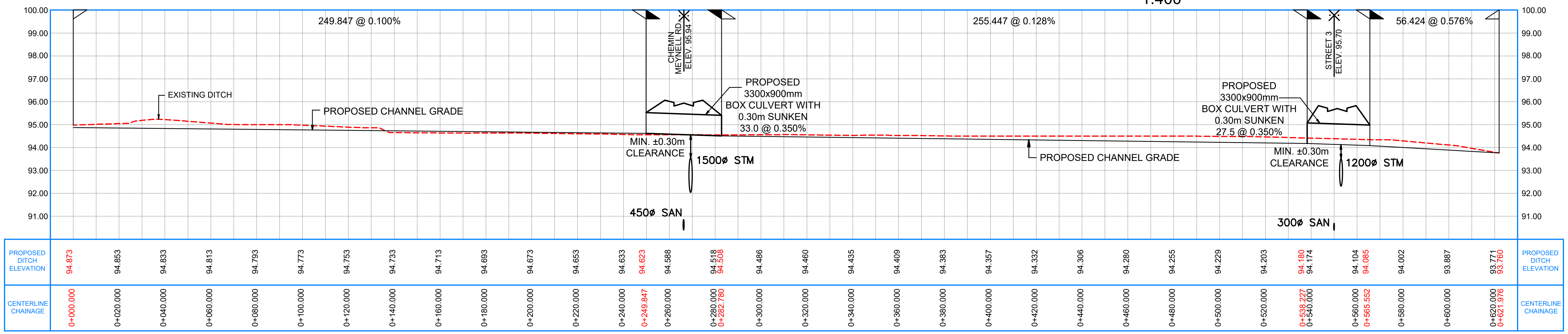
1:400



TYPICAL CHANNEL CROSS SECTION 2-2

1:400

DRAFT



DSEL
david schaeffer engineering ltd

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Fax. (613) 836-7183
www.DSEL.ca

WESTERN DEVELOPMENT LANDS
MOORE TRIBUTARY - PLAN PROFILE
CITY OF OTTAWA

LEGEND

🟧	STUDY LIMIT	—	EXISTING DITCH
- - -	REGULATORY FLOOD LINE	95.00	EXISTING ELEVATION CONTOUR
➡	OVERLAND FLOW DIRECTION		

PROJECT No.: 20-1184
DATE: February 2021
SCALE: 1:2000
FIGURE: 22

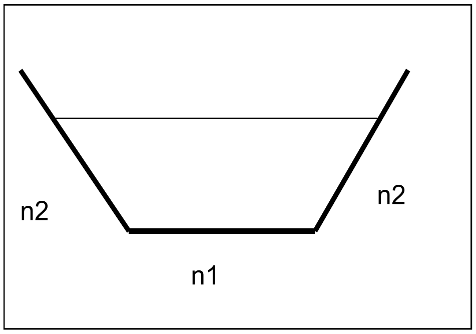
Date: January, 2019
DSEL File: 17-977

Moore Ditch

Channel Conveyance Calculations

Input:

Bottom Width	6.500	m	
Bottom "n1"	0.035		grass
Side Slope	3	:1	
Side "n2"	0.035		grass
Depth	0.650	m	
Freeboard	0.300	m	
Slope	0.10%		



Output:

Flow	**3.387**	**m^3/s**	
>	**2.793**	**m^3/s**	Outflow per JFSA: VG-6 and VG7 - 100 yr 24Hr SCS design flow. Nov 18, 2016
	OK		\\dse-fsm1.dse.ads\design$\Design\11468\Others\JF\54_Nov1816_External_Predeve
Velocity	**0.62**	**m/s**	
Total Width	**12.2**	**m**	

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

	LOCATION		AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Conc.	2 Year	5 Year	10 Year	100 Year										
Location	From Node	To Node	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(min)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min	Q/Q full
External VG-6 to Moore Trib															94.20									1885									
External VG-7 to Pond 2															39.20									908									
Total Flow															133.40									2793	1800		CONC	0.16		4598	1.81	0.00	0.61
																								2793	2400x1200		CONC	0.16		4811	1.67	0.00	0.58
Note: Please see link below for flowrate information (100-yr 24hr SCS for area VG-6 and VG-7)																																	
Z:\Projects\17-977_Mattamy_Richmond\B_Design\B1_Analysis\B1-3_Storm\2018-11-28_markham_moore_calcs																																	
																								2793	1800x900		CONC	0.35		3304	2.04	0.00	0.85
Ottawa St. Ditch 100 YR							0.00								32.60									1154	1050		CONC	0.18		1159	1.34	0.00	1.00
Ottawa St. Ditch 5 YR							32.60																	681	900		CONC	0.18		768	1.21	0.00	0.89
Note: flows calculated from Upland Method																																	
Ottawa St. Ditch 100 YR							0.00								32.60									1259	1050		CONC	0.18		1159	1.34	0.00	1.09
Ottawa St. Ditch 5 YR							32.60																	585	900		CONC	0.18		768	1.21	0.00	0.76
Note: flows per JFSA email, Nov 18, 2016																																	
Z:\Projects\17-977_Mattamy_Richmond\B_Design\B1_Analysis\B1-3_Storm\2018-11-28_markham_moore_calcs																																	

to Moore Ditch

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: A.S.	PROJECT:		
Checked: V.C.	LOCATION: City of Ottawa		
Dwg. Reference:	File Ref: 14-733	Date: May, 2018	Sheet No. 1

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

	LOCATION		AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACITY	VELOCITY	TIME OF	RATIO
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Conc.	2 Year	5 Year	10 Year	100 Year										
Location	From Node	To Node	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(min)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	FLOW (min	Q/Q full

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: A.S.	PROJECT:		
Checked: V.C.	LOCATION: **City of Ottawa**		
Dwg. Reference:	File Ref: 14-733	Date: May, 2018	Sheet No. 2

STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

Local Roads Return Frequency = 2 years
Collector Roads Return Frequency = 5 years
Manning 0.013 Arterial Roads Return Frequency = 10 years

LOCATION			AREA (Ha)																FLOW						SEWER DATA								
			2 YEAR				5 YEAR				10 YEAR				100 YEAR				Time of	Intensity	Intensity	Intensity	Intensity	Peak Flow	DIA. (mm)	DIA. (mm)	TYPE	SLOPE	LENGTH	CAPACIT	VELOCITY	TIME OF	RATIO
			AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	AREA	R	Indiv.	Accum.	Conc.	2 Year	5 Year	10 Year	100 Year										
Location	From Node	To Node	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(Ha)		2.78 AC	2.78 AC	(min)	(mm/h)	(mm/h)	(mm/h)	(mm/h)	Q (l/s)	(actual)	(nominal)		(%)	(m)	(l/s)	(m/s)	LOW (min	Q/Q full

Definitions:
Q = 2.78 AIR, where
Q = Peak Flow in Litres per second (L/s)
A = Areas in hectares (ha)
I = Rainfall Intensity (mm/h)
R = Runoff Coefficient

Notes:
1) Ottawa Rainfall-Intensity Curve
2) Min. Velocity = 0.80 m/s

Designed: A.S.
Checked: V.C.
Dwg. Reference:

PROJECT:
LOCATION: **City of Ottawa**

File Ref:	Date:	Sheet No.
14-733	May, 2018	3

J.F. Sabourin and Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
52 Springbrook Drive
Ottawa (Stittsville), ON K2S 1B9
TEL: (613) 836-3884
FAX: (613) 836-0332
WEB: www.jfsa.com

August 24, 2021

David Schaeffer Engineering Limited
120 Iber Road, Unit 103
Ottawa, Ontario K2S 1E9

Attention: **Mr. Kevin Murphy, P.Eng.**

Subject: **Western Development Lands - Richmond / Expansion of Drainage Area to SWM Facility 1** *our file: 922-11*

As requested by your office and based on the available information as described below, we have evaluated the impact of increasing the ultimate conditions drainage area to Stormwater Management (SWM) Facility 1.

PROPOSED CHANGES TO THE SWM DESIGN

SWM Facility 1 is located within the Western Development Lands, within the City of Ottawa, and was designed to service a drainage area of 33.11 ha under interim conditions and 185.19 ha under ultimate conditions (including 99.36 ha external pre-development area), as per the March 2018 *Design Brief for Interim Stormwater Management Pond 1 Western Development Lands - Richmond* and the March 2020 *Design Brief for Stormwater Management Pond 1 Western Development Lands - Richmond*, respectively. SWM Facility 1 provides quality, erosion and quantity control and discharges to the Van Gaal / Arbuckle Drain, and ultimately to the Jock River. The remainder of the proposed development (to the southeast) and 71.80 ha of external pre-development area was designed to be serviced by SWM Facility 2, in accordance with the January 2014 *Richmond Village (South) Limited Subdivision / Preliminary Stormwater Management Plan* memo. Pond 2 was designed to discharge to the Jock River, for which only quality control is required. SWM Facility 2 was to be located in the Laffin Lands within the larger Master Drainage Plan.

We understand from your office that you wish to consider a scenario wherein SWM Facility 2 is removed from the design, and additional development lands are serviced by ultimate SWM Facility 1, which would have an expanded drainage area of 202.40 ha at 35% imperviousness (including 99.36 ha external pre-development area) under ultimate conditions. Refer to Figure 1 for the proposed expanded drainage area. Note that Pond 1 is currently constructed to the ultimate conditions requirements of the March 2020 *Design Brief* and is operational.

The remaining 19.51 ha of the development (at 70% imperviousness) is located in the southwestern portion of the Western Development Lands south of Ottawa Street, and is proposed to be serviced by oil-and-grit separators or Low Impact Development (LID) measures for quality control, and to discharge directly to the Jock River at two locations (MH 5007 in the south corner and MH 1008 on Ottawa Street). No erosion or quantity control is required for this area. A clean water pipe servicing 71.80 ha of external pre-development area will connect to the Ottawa Street trunk sewer downstream of the oil-and-grit separator or LID measures. A second clean water pipe through the southwest area of the development and discharging to the Jock River at MH 306 will provide backup conveyance of flows from 32.6 ha of the external pre-development area. To evaluate the sizing of the clean water pipes, the 32.6 ha was double-counted; once to each clean water pipe.

HYDROLOGIC / HYDRAULIC MODELLING

The ultimate conditions development and ultimate Pond 1 were modelled in DDSWMM / SWMHYMO / XPSWMM for the March 2020 *Design Brief for Stormwater Management Pond 1 Western Development Lands - Richmond*, and the more recent April 2021 *Stormwater Management Report for Richmond Meadows Subdivision Phases 1 and 2*. The April 2021 models were updated in May 2021 (prior to later updates to the Richmond Meadows Phase 1 and 2 design) to reflect the information provided by DSEL as presented in Figure 1. Separate SWMHYMO / XPSWMM models of the drainage areas to the Jock River outfalls were also created based on the information shown in Figure 1.

Note that, as the DDSWMM program is most appropriate for use in modelling small urban drainage areas, the larger undetailed drainage areas in the expanded portion of the drainage area to Pond 1 and to the Jock River outfalls were instead modelled using SWMYHMO, and the generated minor system hydrographs then input to XPSWMM. This is also true of other large undetailed drainage areas to Pond 1, including future development north of Perth Street and external pre-development drainage areas to the south of the subject site.

100-year capture to the trunk storm sewers on Perth Street and Ottawa Street (and the backup clean water pipe) is required for the 171.16 ha external pre-development areas (99.36 ha + 71.80 ha).

The proposed subdivision tributary to Pond 1 is to be serviced by sump pumps, and as such a 100-year hydraulic gradeline in the main storm sewer up to ground level is permitted in accordance with the June 2018 *City of Ottawa Technical Bulletin ISTB-2018-04*. This elevated hydraulic gradeline reduces the differential head acting on an inlet control device (ICD) and / or catchbasin lead pipe, effectively reducing capture through these inlets. As such, no ICDs are proposed within the subdivision, and minor system inflows are controlled by the catchbasin grate capacity, lead pipe capacity, and surface storage above the catchbasin. In undetailed future development areas, where catchbasin details are not available for detailed incorporation in the XPSWMM model, 100-year capture has been modelled with surface storage available above the top of manholes to estimate surface storage above catchbasins.

The proposed subdivision tributary to the Jock River outfalls is to be serviced by gravity drain connections to basements, and as such a 100-year hydraulic gradeline at least 0.3 m below the underside of footing elevations is required. For the purposes of the present analysis, the underside of footing elevations were estimated as 1.8 m below the upstream manhole cover elevations.

POND 1 OPERATION

A summary of drainage areas to ultimate Pond 1 is presented in Attachment A, along with target 2- to 100-year release rates for the pond. Note that the erosion and quantity control target release rates for Pond 1 are based on pre-development drainage to the Van Gaal / Arkbuckle Drain from the subject site, and are unchanged by the proposed increase in post-development drainage area to Pond 1.

The outlet controls for the pond are proposed to be modified in order to meet the target release rates for an expanded drainage area with the same pond stage-storage-area relationship. Namely, erosion control 1 has been revised from a 300 mm diameter circular orifice at an invert of 92.65 m to a 260 mm diameter circular orifice at an invert of 92.65 m. The baseflow control 1 orifice, and quality control 1 orifice, and quantity control 1 weir are unchanged from the March 2020 *Design Brief*. Refer to Calculation Sheet B-1 of Attachment B for the proposed pond outlet controls.

The operation of the SWM facility was analysed using the updated DDSWMM / SWMHYMO / XPSWMM models for the 2- to 100-year 24-hour SCS Type II design storms and the 1979, 1988 and 1996 historical events in accordance with the March 2020 *Design Brief*. Also in accordance with the March 2020 Design Brief, the operation of the SWM facility was analysed using a lumped SWMHYMO model for the 100-year 10-day spring snowmelt + rainfall event. The operating characteristics of the SWM facility are summarized below in Table 1A for free outfall conditions, and Table 1B for restrictive downstream conditions. Restrictive downstream conditions were modelled based on the following 100-year flood levels:

- 93.64 m 100-year summer flood level at the outlet from Pond 1 to the Van Gaal Drain, at cross-section

961 per the February 2016 *Richmond Village (South) Limited Subdivision / Fortune Street Culvert Improvements* memo.

- 94.11 m 100-year spring flood level at the outlet from Pond 1 to the Van Gaal Drain, at cross-section 961 per the February 2016 *Richmond Village (South) Limited Subdivision / Fortune Street Culvert Improvements* memo.

Table 1A: Summary of SWM Pond 1 Operating Characteristics (Free Outfall Conditions)

Pond Component	Pond Level (m)	Allowable Release Rate (2) (m^3/s)	Pond Release Rate (m^3/s)	Volume Used (3) (m^3)
Permanent Pool	92.350	N/A	N/A	45330
Quality Control	92.622	N/A	0.084	8096
Extended Detention	93.680	N/A	0.376	43875
2yr/24hr SCS	93.331	0.330	0.309	31250
5yr/24hr SCS				
10yr/24hr SCS	93.739	5.348	1.987	46211
25yr/24hr SCS				
50yr/24hr SCS				
100yr/24hr SCS	93.819	8.894	5.949	49470
July 1st, 1979				
August 4th, 1988				
August 8th, 1996				
100yr/10day Spring	93.763	N/A	3.032	47150

(1) 2-year erosion control release rate of 330 L/s, and 5- to 100-yr pre-development flows (refer to Table A-3 of Appendix A)
(2) Volumes are active storage only for all pond components except the permanent pool.

Table 1B: Summary of SWM Pond 1 Operating Characteristics (Restrictive Downstream Conditions)

Pond Component	Pond Level (m)	Allowable Release Rate (2) (m^3/s)	Pond Release Rate (m^3/s)	Volume Used (3) (m^3)
Permanent Pool	92.350	N/A	N/A	45330
Quality Control	92.622	N/A	0.084	8096
Extended Detention	93.680	N/A	0.376	43875
2yr/24hr SCS	93.657	0.330	0.009	42995
5yr/24hr SCS				
10yr/24hr SCS	93.753	5.348	2.182	46779
25yr/24hr SCS				
50yr/24hr SCS				
100yr/24hr SCS	93.831	8.894	6.384	49975
July 1st, 1979				
August 4th, 1988				
August 8th, 1996				
100yr/10day Spring	94.202	N/A	3.030	66588

(1) 2-year erosion control release rate of 330 L/s, and 5- to 100-yr pre-development flows (refer to Table A-3 of Appendix A)
(2) Volumes are active storage only for all pond components except the permanent pool.

The above results show that the actual provided release rates do not exceed the allowable release rates for SWM

Pond 1. Note that the maximum 100-year pond levels are 93.831 m for the 100-year SCS event and 94.202 m for the 100-year spring event; above the previously simulated 100-year water levels of 93.791 m and 94.198 m, respectively, from the March 2020 *Design Brief*. A 0.3 m freeboard is provided between these 100-year pond levels and the surrounding residential lots in the subdivision. The berm between the pond and the Van Gaal / Arbuckle Drain is to be raised to provide a 0.3 m freeboard above the 100-year SCS pond level, in accordance with the February 2014 *Richmond Village (South) Limited Subdivision / Hydraulic Analysis of Stormwater Management Pond 1 Berm* memo, without negatively impacting the performance of the pond or water levels on the drain.

Pond 1 has been equipped with three sediment forebays. Calculations for the minimum dispersion length, settling length and the average velocity in the forebays under these expanded conditions are presented in Calculation Sheets B-2, B-3 and B-4 of Attachment B. The forebay dimensions are sufficient to satisfy these MECP standards under the expanded drainage area conditions.

Sediment drying area calculations are also provided in Attachment B; note that the combined sediment drying area volume provided of 1960 m^3 is 404 m^3 short of the 2364 m^3 volume required to provide 10 years of sediment accumulation, but is sufficient to accommodate 8 years of sediment accumulation.

SWM Pond 1 has a permanent pool volume of 45,330 m^3, which is more than the minimum permanent pool volume the *SWMP Design Manual* requires for enhanced protection for a wet pond for the 202.396 ha drainage area at 35% imperviousness, as calculated below.

$$(140.00 - 40)\ m^3/ha \times 202.396\ ha = 20{,}240\ m^3$$

The required quality control volume of 8,096 m^3 (40 m^3/ha) for the 202.396 ha drainage area is contained within the extended detention volume at an elevation of 92.622 m.

Under 100% blockage of the outlet control structure, the 100-year pond level will be 93.833 m based on the updated modelling. The broad-crested quantity control weir set in the berm of the pond at an elevation of 93.68 m will also function as an emergency overflow weir under these conditions, and the downstream spillway will convey the 100-year outflow of 6.301 m^3/s at a velocity of 0.76 m/s and a flow depth of 18.4 cm at a slope of 0.5%, or a velocity of 2.68 m/s and a flow depth of 5.2 cm at a slope of 33.3%.

It may therefore be concluded that the operation of SWM Pond 1, with the expanded drainage area to the southeast, is in conformance with the requirements presented in the March 2020 *Design Brief for Stormwater Management Pond 1 Western Development Lands - Richmond*, with the exception of sediment drying areas, to be re-sized for a minimum of 10 years of sediment accummulation, and the 100-year SCS pond level, for which the berm between the pond and the Van Gaal / Arbuckle Drain is to be raised to provide a 0.3 m freeboard.

HYDRAULIC GRADELINE ANALYSIS

The impact of the proposed Pond 1 drainage area expansion on the 100-year hydraulic gradeline elevations within the development was also evaluated using updated DDSWMM / SWMHYMO / XPSWMM models for the 100-year 3-hour Chicago storm and the 100-year 24-hour SCS Type II storm. Table 3 presents the composite hydraulic gradeline results for the 100-year 3-hour Chicago and 100-year 24-hour SCS Type II design storms.

Similarly, the composite 100-year hydraulic gradeline results for the proposed areas to the Jock River outfalls are presented in Table 2. The minor system performance was analyzed for both free outfall and restrictive downstream conditions. Restrictive downstream conditions are set by the 2- and 100-year flood levels on the Jock River per the November 2004 *Jock River Flood Risk Mapping (within the City of Ottawa) Hydraulics Report*:

> - At the MH 1008 Ottawa Street outfall, the 2- and 100-year flood levels are 93.04 m and 94.18 m, respectively, at Jock River Reach 2 cross-section 19353.

- At the MH 5007 south outfall, the 2- and 100-year flood levels are 95.75 m and 96.36 m, respectively, at Jock River Reach 2 cross-section 21097.

- At the MH 306 backup clean water pipe outfall, the 2- and 100-year flood levels are 95.84 m and 96.38 m, respectively, at Jock River Reach 2 cross-section 21178.

Taking a similar approach to that documented for tributaries of the Jock River in the November 2004 Jock River Flood Risk Mapping (within the City of Ottawa) Hydraulics Report, the 2-year and 100-year flows on the subdivision were modelled with 100-year and 2-year flood levels on the Jock River, respectively; each combination having a combined probability of a 100-year return period. The purpose of this approach is to account for the differences in timing between a small subdivision and the much larger Jock River watershed. Both scenarios are considered to have a 1:100 year return period; assuming that 100-year rainfall on the subdivision and a 100-year flood level on the Jock River are occurring at the same time would be much more than a 100-year return period, statistically.

Table 2: Composite Hydraulic Gradeline Results for the 2- and 100-Year Design Storms (2)

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and USF (1) (m)
f1	f2	97.154	96.979	0.136
f2	f3	96.979	96.776	0.291
f3	f4	96.776	96.744	0.414
f4	f5	96.744	96.583	0.426
f5	f5007	96.583	96.380	N/A
f70	f303	96.409	96.391	0.521
f76	f125	94.353	94.328	0.867
f80	f90	95.146	95.118	1.214
f90	f100	95.118	95.037	1.222
f100	f110	95.037	94.832	1.213
f110	f1200	94.783	94.689	1.357
f120	f121	94.479	94.441	0.801
f121	f122	94.441	94.417	0.999
f122	f123	94.417	94.382	0.963
f123	f76	94.382	94.353	0.918
f124	f1002	94.305	94.273	0.655
f125	f124	94.328	94.305	0.892
f130	f210	94.558	94.388	1.372
f200	f210	94.509	94.388	1.451
f210	f211	94.388	94.362	1.452
f211	f212	94.362	94.331	1.588
f212	f218	94.331	94.325	1.739
f218	f124	94.325	94.305	0.745
f300	f70	96.414	96.409	0.516
f303	f304	96.391	96.382	0.479
f304	f305	96.382	96.366	0.358
f305	f306	96.366	96.360	N/A
f600	f5	96.848	96.583	0.012
f700	f80	95.269	95.146	1.311
f701	f700	95.900	95.694	0.770
f1002	f1003	94.273	94.241	0.687
f1003	f1007	94.241	94.271	0.719
f1007	f1008	94.271	94.180	0.689
f1200	f130	94.689	94.558	1.351
f1800	f1804	95.067	94.970	1.153
f1801	f1800	95.406	95.179	0.914
f1802	f1801	95.701	95.406	0.769
f1803	f1802	95.890	95.701	0.680
f1804	f1900	94.913	94.705	1.257
f1900	f200	94.674	94.509	1.386
f4000	f212	94.653	94.583	1.447
f4001	f4000	94.807	94.653	1.413
f4002	f4001	95.153	94.807	0.837
f4003	f1804	95.261	94.993	1.029
f4004	f4003	95.477	95.261	0.913
f4005	f4004	95.694	95.477	0.906
f4006	f4003	95.616	95.261	0.834
f5000	f130	95.344	94.995	0.966
f5001	f1200	95.486	95.092	0.994
f5002	f110	95.594	95.206	1.026
f5003	f100	95.689	95.313	1.221
f5004	f600	96.936	96.848	-0.036
f5005	f5004	97.123	96.936	-0.153
f5006	f5005	97.207	97.123	-0.237

Table 2: Composite Hydraulic Gradeline Results for the 2- and 100-Year Design Storms (2)

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	Freeboard U/S HGL and USF (1) (m)
f5008	f600	96.955	96.848	-0.275
f5010	f1804	95.317	95.131	0.923
f5011	f5010	95.472	95.317	0.938
f5012	f5011	95.729	95.516	0.791

Note:

(1) Freeboard between upstream HGL elevation and underside of footing elevation, where. the USF is estimated as 1.8 m below the upstream manhole cover elevation.

(2) 2-year rainfall in the proposed subdivision + 100-year boundary conditions in the Jock River, or 100-year rainfall in the proposed subdivision + 2-year boundary conditions in the Jock River.

Table 3: Composite Hydraulic Gradeline Results for 100-Year Design Storms (Restr. Downstream Conditions)

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	U/S MH Cover Elev. (m)	D/S MH Cover Elev. (m)	Freeboard (1) (m)
1	2	94.621	94.598	95.566	95.449	0.945
2	2a	94.598	94.579	95.449	95.449	0.851
2a	3	94.580	94.489	95.449	95.220	N/A
3	4	94.489	94.431	95.220	95.300	0.731
4	7	94.431	94.223	95.300	95.174	0.869
5	5a	94.515	94.514	95.298	95.378	0.783
5a	6	94.514	94.327	95.378	95.378	N/A
6	6a	94.327	94.320	95.378	95.378	1.051
6a	7	94.320	94.223	95.378	95.174	N/A
7	7a	94.223	94.153	95.174	95.174	0.951
7a	8	94.153	94.041	95.174	95.040	N/A
8	8a	94.041	94.028	95.040	95.199	0.999
8a	11	94.028	93.951	95.199	95.199	N/A
9	10	94.235	94.184	95.652	94.963	1.417
10	10a	94.184	94.184	94.963	95.199	0.779
10a	11	94.184	93.951	95.199	95.199	N/A
11	11a	93.951	93.865	95.199	95.199	1.248
11a	12	93.865	93.842	95.199	94.782	N/A
12	12a	93.842	93.840	94.782	94.964	0.940
12a	15	93.840	93.836	94.964	94.964	N/A
13	13a	93.842	93.842	95.250	95.201	1.408
13a	13b	93.842	93.839	95.201	95.201	N/A
13b	14	93.839	93.837	95.201	94.902	N/A
14	15	93.837	93.836	94.902	94.964	1.065
15	104i	93.836	93.833	94.964	94.500	1.128
16	17	94.664	94.525	94.979	95.298	0.315
17	17a	94.525	94.456	95.298	95.298	0.773
17a	18	94.456	94.421	95.298	95.030	N/A
18	19	94.421	94.387	95.030	95.094	0.609
19	23	94.387	94.254	95.094	95.383	0.707
20	20a	94.610	94.588	95.562	95.562	0.952
20	20b	94.610	94.607	95.562	95.562	0.952
20a	21	94.588	94.432	95.562	95.128	N/A
20b	24	94.607	94.421	95.562	95.243	N/A
21	21a	94.432	94.412	95.128	95.198	0.696
21a	22	94.412	94.322	95.198	95.198	N/A
22	23	94.322	94.254	95.198	95.383	0.876
23	105i	94.254	94.106	95.383	94.500	1.129
24	24a	94.421	94.419	95.243	95.320	0.822
24a	25	94.419	94.292	95.320	95.330	N/A
25	25a	94.292	94.287	95.330	95.320	1.038
25a	26	94.287	94.175	95.320	95.212	N/A
26	26a	94.175	94.136	95.212	95.352	1.037
26a	26b	94.136	94.113	95.352	95.352	N/A
26b	27	94.113	93.994	95.352	95.352	N/A
27	27a	93.994	93.989	95.352	95.352	1.358
27	27b	93.994	93.973	95.352	95.352	1.358
27a	B49	93.989	93.840	95.352	95.440	N/A
27b	107i	93.973	93.844	95.352	95.232	N/A
B49	B50	93.840	93.835	95.440	95.440	1.600
30	30a	94.232	94.276	95.372	95.372	1.140
30	31	94.232	94.154	95.372	95.212	1.140
30a	26	94.276	94.175	95.372	95.212	N/A

Table 3: Composite Hydraulic Gradeline Results for 100-Year Design Storms (Restr. Downstream Conditions)

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	U/S MH Cover Elev. (m)	D/S MH Cover Elev. (m)	Freeboard (1) (m)
31	31a	94.154	94.140	95.212	95.212	1.058
31a	32	94.140	94.067	95.212	94.974	N/A
32	33	94.067	93.996	94.974	95.049	0.907
33	330	93.996	93.875	95.049	95.230	1.053
104i	Pond1	93.833	93.831	94.500	95.500	0.667
105i	106i	94.106	93.958	94.500	94.500	0.394
106i	108i	93.958	93.840	94.500	94.500	0.542
107i	1070	93.844	93.844	95.232	95.055	1.388
108i	109i	93.840	93.832	94.500	94.500	0.660
109i	Pond1	93.832	93.831	94.500	95.500	0.668
B50	Pond1	93.835	93.831	95.440	95.500	1.605
200	201	94.161	94.165	95.389	95.314	1.228
200	202	94.161	94.157	95.389	95.259	1.228
201	201a	94.165	94.164	95.314	95.314	1.149
201a	8	94.164	94.041	95.314	95.040	N/A
202	202a	94.157	94.157	95.259	95.296	1.102
202a	203	94.157	94.047	95.296	95.296	N/A
203	204	94.047	93.972	95.296	95.120	1.249
204	204a	93.972	93.969	95.120	95.250	1.148
204a	204b	93.969	93.846	95.250	95.250	N/A
204b	13	93.846	93.842	95.250	95.250	N/A
205	210	95.064	95.001	95.499	95.671	0.435
206	206a	95.101	95.100	95.476	95.499	0.375
206a	205	95.100	95.064	95.499	95.499	N/A
207	206	95.083	95.101	95.923	95.476	0.840
208	207	95.078	95.083	95.851	95.923	0.773
208	208a	95.078	95.073	95.851	95.851	0.773
208a	209	95.072	94.878	95.851	95.614	N/A
209	212	94.878	94.751	95.614	95.238	0.736
210	211	95.001	94.986	95.671	95.601	0.670
211	211a	94.986	94.974	95.601	95.614	0.615
211a	209	94.974	94.878	95.614	95.614	N/A
212	212a	94.751	94.740	95.238	95.550	0.487
212a	20	94.740	94.610	95.550	95.562	N/A
213	214	95.315	95.241	96.071	95.908	0.756
214	214a	95.241	95.240	95.908	95.918	0.667
214a	215	95.240	95.209	95.918	95.849	N/A
215	215a	95.209	95.159	95.849	95.849	0.640
215a	220	95.159	95.075	95.849	95.723	N/A
216	216a	95.270	95.279	95.972	95.972	0.702
216	217	95.270	95.269	95.972	95.900	0.702
216a	214	95.279	95.241	95.972	95.908	N/A
217	217a	95.269	95.274	95.900	95.900	0.631
217a	218	95.274	95.184	95.900	95.677	N/A
218	219	95.184	95.164	95.677	95.594	0.493
219	219a	95.164	95.157	95.594	95.733	0.430
219a	220	95.157	95.075	95.733	95.723	N/A
220	220a	95.075	94.898	95.723	95.733	0.648
220a	221	94.898	94.783	95.733	95.466	N/A
221	221a	94.783	94.719	95.466	95.515	0.683
221a	222	94.719	94.431	95.515	95.515	N/A
222	223	94.431	94.384	95.515	95.409	1.084
223	223a	94.384	94.351	95.409	95.409	1.025

Table 3: Composite Hydraulic Gradeline Results for 100-Year Design Storms (Restr. Downstream Conditions)

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	U/S MH Cover Elev. (m)	D/S MH Cover Elev. (m)	Freeboard (1) (m)
223a	223b	94.351	94.308	95.409	95.409	N/A
223b	25	94.308	94.292	95.409	95.330	N/A
224	221	94.884	94.783	95.273	95.466	0.389
330	1070	93.874	93.844	95.230	95.055	1.356
1070	108i	93.844	93.840	95.055	94.500	1.211
1600	1600a	94.697	94.680	95.090	95.090	0.393
1600a	16	94.680	94.664	95.090	94.979	N/A
Pond1	Out	93.831	92.350	95.500	94.500	1.669
265a	266	94.273	93.883	95.555	95.544	N/A
266	266a	93.883	93.875	95.544	95.550	1.661
266a	267	93.875	93.864	95.550	95.502	N/A
267	26701	93.864	93.837	95.502	95.532	1.638
277	277a	94.468	94.308	95.512	95.512	1.044
277a	277b	94.308	94.159	95.512	95.512	N/A
277b	278	94.159	93.934	95.512	95.630	N/A
278	279	93.934	93.863	95.630	95.442	1.696
279	Pond1	93.863	93.831	95.442	95.500	1.579
280	266	93.924	93.883	95.452	95.544	1.528
26701	Pond1	93.837	93.831	95.532	95.500	1.695
B1	B1a	96.763	96.761	97.350	97.350	0.587
B1	B1b	96.763	96.761	97.350	97.350	0.587
B1a	B2	96.761	96.716	97.350	97.250	0.589
B1b	B16	96.761	96.684	97.350	97.070	0.589
B2	B3	96.716	96.702	97.250	97.180	0.534
B3	B5	96.702	96.690	97.180	97.050	0.478
B4	B4a	96.701	96.711	97.320	97.320	0.619
B4	B4b	96.701	96.675	97.320	97.320	0.619
B4a	B5	96.711	96.690	97.320	97.050	0.609
B4b	B18	96.675	96.607	97.320	96.860	0.645
B5	B5a	96.690	96.675	97.050	97.120	0.360
B5a	B6	96.675	96.618	97.120	97.120	0.445
B6	B7	96.618	96.589	97.120	97.050	0.502
B7	B9	96.589	96.500	97.050	96.880	0.461
B8	B8a	96.545	96.533	97.140	97.140	0.595
B8	B8b	96.545	96.523	97.140	97.140	0.595
B8a	B9	96.533	96.500	97.140	96.880	0.607
B8b	B19	96.523	96.490	97.140	96.820	0.617
B9	B9a	96.500	96.486	96.880	96.910	0.380
B9a	B10	96.486	96.349	96.910	96.910	0.424
B10	B10a	96.349	96.334	96.910	96.910	0.561
B10a	B10b	96.334	96.285	96.910	96.910	0.576
B10b	B11	96.285	96.241	96.910	96.790	0.625
B11	B12	96.241	96.154	96.790	96.480	0.549
B12	B13	96.154	96.008	96.480	96.430	0.326
B13	B14	96.008	95.971	96.430	96.330	0.422
B14	B14a	95.971	95.932	96.330	96.330	0.359
B14a	B14b	95.932	95.884	96.330	96.330	0.398
B14b	B15	95.884	95.810	96.330	96.290	0.446
B15	B15a	95.810	95.778	96.290	96.370	0.480
B15a	B15b	95.778	95.711	96.370	96.370	0.592
B15b	B27	95.711	95.587	96.370	96.330	0.659
B16	B17	96.684	96.659	97.070	97.030	0.386
B17	B18	96.659	96.607	97.030	96.860	0.371

Table 3: Composite Hydraulic Gradeline Results for 100-Year Design Storms (Restr. Downstream Conditions)

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	U/S MH Cover Elev. (m)	D/S MH Cover Elev. (m)	Freeboard (1) (m)
B18	B18a	96.607	96.565	96.860	96.860	0.253
B18a	B19	96.565	96.490	96.860	96.820	0.295
B19	B19a	96.490	96.465	96.820	96.820	0.330
B19a	B19b	96.465	96.440	96.820	96.820	0.355
B19b	B21	96.440	96.385	96.820	96.740	0.380
B20	B210	96.509	96.453	96.870	96.850	0.361
B21	B21a	96.385	96.361	96.740	96.740	0.355
B21a	B21b	96.361	96.355	96.740	96.740	0.379
B21b	B21c	96.355	96.341	96.740	96.740	0.385
B21c	B23	96.341	96.330	96.740	96.530	0.399
B22	B23	96.791	96.330	96.790	96.530	-0.001
B23	B23a	96.330	96.118	96.530	96.530	0.200
B23a	B24	96.118	96.089	96.530	96.400	0.412
B24	B24a	96.089	96.001	96.400	96.400	0.311
B24a	B24b	96.001	95.974	96.400	96.400	0.399
B24b	B26	95.974	95.924	96.400	96.100	0.426
B26	B26a	95.924	95.736	96.100	96.330	0.176
B26a	B27	95.736	95.587	96.330	96.330	0.594
B27	B27a	95.587	95.549	96.330	96.330	0.743
B27a	B27b	95.549	95.432	96.330	96.330	0.781
B27b	B33	95.432	95.403	96.330	96.000	0.898
B28	B28a	95.546	95.573	96.460	96.460	0.914
B28	B34	95.546	95.519	96.460	96.380	0.914
B28a	B29	95.573	95.619	96.460	96.230	0.887
B29	B30	95.619	95.640	96.230	96.200	0.611
B30	B31	95.640	95.583	96.200	96.140	0.560
B31	B31a	95.583	95.564	96.140	96.150	0.557
B31a	B32	95.564	95.450	96.150	96.150	0.586
B32	B32a	95.450	95.432	96.150	96.150	0.700
B32a	B33	95.432	95.403	96.150	96.000	0.718
B33	B33a	95.403	95.360	96.000	96.000	0.597
B33a	B33b	95.360	95.278	96.000	96.000	0.640
B33b	B37	95.278	95.008	96.000	95.840	0.722
B34	B34a	95.519	95.504	96.380	96.380	0.861
B34a	B34b	95.504	95.465	96.380	96.380	0.876
B34b	B35	95.465	95.346	96.380	96.120	0.915
B35	B36	95.346	95.188	96.120	95.970	0.774
B36	B36a	95.188	95.159	95.970	95.970	0.782
B36a	B36b	95.159	95.095	95.970	95.970	0.811
B36b	B37	95.095	95.008	95.970	95.840	0.875
B37	B37a	95.008	94.971	95.840	95.840	0.832
B37a	B38	94.971	94.758	95.840	95.660	0.869
B38	B38a	94.758	94.719	95.660	95.660	0.902
B38a	B38b	94.719	94.683	95.660	95.660	0.941
B38b	B39	94.683	94.414	95.660	95.470	0.977
B39	B47	94.414	94.002	95.470	95.440	1.056
B40	B41	95.014	94.839	95.750	95.860	0.736
B41	B43	94.839	94.721	95.860	95.940	1.021
B42	B42a	94.781	94.780	95.650	95.740	0.869
B42a	B43	94.780	94.721	95.740	95.940	0.960
B43	B44	94.721	94.579	95.940	95.690	1.219
B44	B44a	94.579	94.538	95.690	95.690	1.111
B44a	B46	94.538	94.304	95.690	95.640	1.152

Table 3: Composite Hydraulic Gradeline Results for 100-Year Design Storms (Restr. Downstream Conditions)

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	U/S MH Cover Elev. (m)	D/S MH Cover Elev. (m)	Freeboard (1) (m)
B45	B45a	94.671	94.650	95.740	95.740	1.069
B45a	B46	94.650	94.304	95.740	95.640	1.090
B46	B46a	94.304	94.224	95.640	95.640	1.336
B46a	B47	94.225	94.002	95.640	95.440	1.415
B47	B48	94.002	93.950	95.440	95.440	1.438
B48	B49	93.950	93.840	95.440	95.440	1.490
B210	B210a	96.453	96.423	96.850	96.850	0.397
B210a	B21	96.423	96.385	96.850	96.740	0.427
B260	B26	96.338	95.924	96.360	96.100	0.022
B330	B45	94.719	94.671	95.870	95.740	1.151
f32	f33	96.793	96.646	96.760	96.630	-0.033
f33	f34	96.646	96.477	96.630	96.470	-0.016
f34	f35	96.477	96.179	96.470	96.300	-0.007
f35	f36	96.180	96.003	96.300	96.190	0.120
f36	f38	96.003	95.842	96.190	96.120	0.187
f38	f40	95.842	95.638	96.120	96.020	0.278
f40	f41	95.638	95.434	96.020	95.890	0.382
f41	f42	95.434	95.387	95.890	95.880	0.456
f42	f526	95.387	95.215	95.880	95.780	0.493
f213	f214	97.250	97.304	97.200	97.240	-0.050
f214	f215	97.315	97.179	97.240	97.150	-0.075
f215	f216	97.185	97.084	97.150	97.070	-0.035
f216	f21801	97.084	97.031	97.070	97.020	-0.014
f217	f21800	96.992	96.780	96.980	96.760	-0.012
f501	f502	96.823	96.735	96.800	96.730	-0.023
f501	f504	96.823	96.833	96.800	96.820	-0.023
f502	f503	96.736	96.713	96.730	96.710	-0.006
f503	f508	96.714	96.245	96.710	96.550	-0.004
f504	f505	96.830	96.624	96.820	96.700	-0.010
f505	f507	96.624	96.425	96.700	96.670	0.076
f507	f508	96.425	96.245	96.670	96.550	0.245
f508	f509	96.245	96.169	96.550	96.470	0.305
f509	f510	96.169	96.047	96.470	96.380	0.301
f510	f511	96.047	95.910	96.380	96.280	0.333
f511	f513	95.910	95.745	96.280	96.190	0.370
f513	f514	95.745	95.575	96.190	96.010	0.445
f514	f524	95.575	95.520	96.010	96.010	0.435
f515	f516	96.579	96.425	96.560	96.420	-0.019
f516	f517	96.425	96.402	96.420	96.400	-0.005
f517	f519	96.402	96.322	96.400	96.320	-0.002
f518	f519	96.501	96.322	96.490	96.320	-0.011
f519	f521	96.323	96.035	96.320	96.230	-0.003
f520	f521	96.416	96.035	96.400	96.230	-0.016
f521	f522	96.035	95.791	96.230	96.210	0.195
f522	f523	95.791	95.630	96.210	96.090	0.419
f523	f524	95.630	95.520	96.090	96.010	0.460
f524	f525	95.520	95.382	96.010	95.910	0.490
f525	f526	95.382	95.215	95.910	95.780	0.528
f526	B40	95.215	95.014	95.780	95.750	0.565
f2002	f36	96.258	96.003	96.240	96.190	-0.018
f2003	f38	96.058	95.842	96.210	96.120	0.152
f2004	f2003	96.212	96.057	96.170	96.210	-0.042
f21800	f505	96.780	96.624	96.760	96.700	-0.020

Table 3: Composite Hydraulic Gradeline Results for 100-Year Design Storms (Restr. Downstream Conditions)

U/S MH	D/S MH	Max. U/S HGL (m)	Max. D/S HGL (m)	U/S MH Cover Elev. (m)	D/S MH Cover Elev. (m)	Freeboard (1) (m)
f21801	f217	97.031	96.992	97.020	96.980	-0.011

Note: (1) Freeboard between upstream hydraulic gradeline elevation and upstream manhole cover elevation.

(3) Ponding allowed above manholes in undetailed future development areas to represent road surface storage above catchbasins.

As shown in Table 3, a minimum freeboard of 0 m between the 100-year hydraulic gradeline and the top of manhole elevations has been provided throughout the detailed areas of the subdivision tributary to Pond 1, including the Fox Run Phase 1 and Phase 2 subdivision, and the Mattamy Jock River Phase 1 and Phase 2 subdivision.

As noted above, surface ponding was allowed in XPSWMM above manholes in future areas tributary to Pond 1 where the details of surface storage, catchbasins, etc. were not available for detailed incorporation into the XPSWMM model. The allowed surface ponding is intended to approximate road surface storage above catchbasins, to be confirmed at the detailed design stage. Less than 0 m freeboards were simulated at some future manholes as a result; however, storage used above the future manholes is within a reasonable range of what could feasibly be provided (typically less than what would be required to contain the 100-year flows in a conventional design where minor system capture is limited by inlet control devices), so it is feasible that future areas will perform well if designed similarly to Fox Run Phase 1 and Phase 2 or Mattamy Jock River Phase 1 and Phase 2. That is, the 100-year water level would be above the surface at catchbasins, but not at manholes. For scale, a maximum 100-year unit surface storage volume of 110 m^3/ha was simulated for the 18.59 ha undetailed future development area.

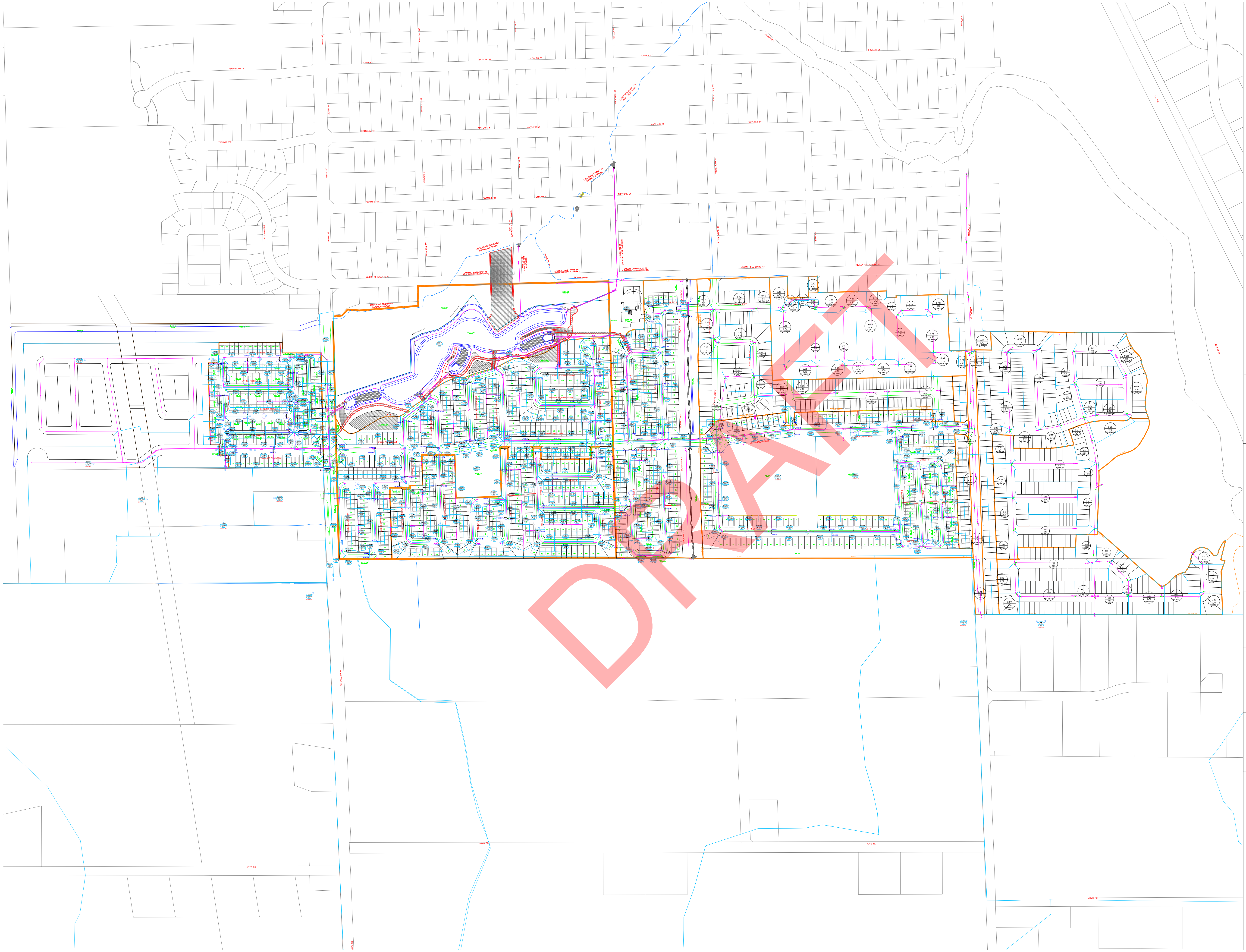
As shown in Table 2, a freeboard of less than 0.3 m between the 100-year hydraulic gradeline and the estimated underside of footing elevations has been simulated at some locations in the development discharging to the Jock River outfalls. We understand from DSEL that the grading of the site will be raised as needed to ensure a 0.3 m minimum freeboard at gravity drain basement connections.

Yours truly,
J.F. Sabourin and Associates Inc.

Laura Pipkins, P.Eng.

cc: J.F. Sabourin, M.Eng, P.Eng.
Director of Water Resources Projects

Attachment A:	Drainage Areas and Target Release Rates
Attachment B:	Pond Controls - Quality, Extended Detention and Quantity



LEGEND :

▬	LIMITS OF SUBDIVISION
▬	MAJOR SYSTEM SUBCATCHMENT BOUNDARY TO LOW POINTS AND OTHER AREAS
⇦	MAJOR SYSTEM FLOW DIRECTION
↶	FIRST DIRECTION OF EXCESS MAJOR SYSTEM FLOW AT LOW POINT
LP009SW	LOW POINT
A009SW	SUB-CATCHMENT ID
0.063 ha	SUB-CATCHMENT AREA
43%	TOTAL IMPERVIOUSNESS
0.18	FUTURE SUB-CATCHMENT AREA
0.70	FUTURE SUB-CATCHMENT RUNOFF COEFF.
MH501H504	TRIBUTARY TO MANHOLE ID (U/S, D/S)

SCALE :

0 100 200 300 400 500m

J.F. Sabourin & Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
OTTAWA (613) 836-3884
GATINEAU (819) 243-6858

CLIENT :

DSEL
david schaeffer engineering ltd
120 IBER ROAD, UNIT 103
STITTSVILLE, ONTARIO., K2S 1E9
(613) 836-0856

PROJECT :

WESTERN DEVELOPMENT LANDS
RICHMOND

BY	DATE	DESCRIPTION	BY

PROPOSED DRAINAGE AREA
TO SWM FACILITY AND JOCK RIVER
OUTFALLS

FIGURE 1

DESIGNED:
DRAWN: LP
VERIFIED: JFS
APPROVED: JFS

DRAWING REF.
922-11\202103 FSR\Design\CAD\
JFSA Figures.dwg

DATE	PROJECT No.
Aug/21	922-11

ATTACHMENT

A

Drainage Areas and Target Release Rates

JFSA Water Resources and Environmental Consultants

Table A-1 : Drainage Area to SWM Facility

Segment ID (1)	Area (ha)	Imperviousness (%)	Area x Imp.
A002NE	0.072	61	4.392
A002NW	0.108	72	7.776
A002SE	0.198	72	14.256
A002SW	0.056	73	4.088
A005NE	0.050	74	3.700
A005NW	0.105	54	5.670
A005SE	0.090	69	6.210
A005SW	0.059	68	4.012
A006N1	0.035	43	1.505
A006NE	0.044	77	3.388
A006NW	0.046	76	3.496
A006R1	0.121	27	3.267
A006R2	0.113	26	2.938
A006R3	0.117	26	3.042
A006R4	0.087	18	1.566
A006R5	0.118	25	2.950
A006R6	0.106	24	2.544
A006R7	0.114	25	2.850
A006R8	0.042	25	1.050
A006SE	0.192	71	13.632
A006SW	0.192	69	13.248
A007NW	0.199	73	14.527
A007SE	0.094	72	6.768
A007SW	0.065	43	2.795
A008NE	0.103	74	7.622
A008NW	0.058	41	2.378
A008R1	0.113	27	3.051
A008R2	0.064	27	1.728
A008SE	0.138	70	9.660
A008SW	0.013	54	0.702
A009NW	0.047	79	3.713
A009SW	0.073	66	4.818
A010NE	0.125	74	9.250
A010NW	0.123	76	9.348
A010R1	0.135	24	3.240
A010R2	0.083	25	2.075
A010R3	0.154	21	3.234
A010SE	0.132	77	10.164
A010SW	0.147	74	10.878
A011NE	0.053	30	1.590
A011NW	0.053	53	2.809
A011SE	0.116	76	8.816
A011SW	0.053	53	2.809
A012NE	0.028	36	1.008
A012R1	0.040	19	0.760

Table A-1 : Drainage Area to SWM Facility

Segment ID (1)	Area (ha)	Imperviousness (%)	Area x Imp.
A012R2	0.138	26	3.588
A013N1	0.154	76	11.704
A013N2	0.045	38	1.710
A013NE	0.027	52	1.404
A013NW	0.052	40	2.080
A013R1	0.106	25	2.650
A013R2	0.128	24	3.072
A013R3	0.116	24	2.784
A013S1	0.155	78	12.090
A013S2	0.153	75	11.475
A013SE	0.027	48	1.296
A013SW	0.051	41	2.091
A016NE	0.087	76	6.612
A016NW	0.096	76	7.296
A017NE	0.073	36	2.628
A017NW	0.060	72	4.320
A017SE	0.172	73	12.556
A017SW	0.171	73	12.483
A020N1	0.039	72	2.808
A020N2	0.025	76	1.900
A020NE	0.049	78	3.822
A020NW	0.083	65	5.395
A020SW	0.109	78	8.502
A021NE	0.151	76	11.476
A021NW	0.087	70	6.090
A021R1	0.087	25	2.175
A021R2	0.147	24	3.528
A021R3	0.070	24	1.680
A021R4	0.052	24	1.248
A021SE	0.166	77	12.782
A021SW	0.168	71	11.928
A024NE	0.135	77	10.395
A024NW	0.122	74	9.028
A024R1	0.109	27	2.943
A024R2	0.114	28	3.192
A024R3	0.067	26	1.742
A024SE	0.127	75	9.525
A024SW	0.102	74	7.548
A025NE	0.078	71	5.538
A025NW	0.035	43	1.505
A025R1	0.154	26	4.004
A025R2	0.125	26	3.250
A025S1	0.088	52	4.576
A025SE	0.075	75	5.625
A025SW	0.066	50	3.300

Table A-1 : Drainage Area to SWM Facility

Segment ID (1)	Area (ha)	Imperviousness (%)	Area x Imp.
A026NE	0.031	74	2.294
A026R1	0.174	26	4.524
A026R2	0.197	17	3.349
A026R3	0.069	28	1.932
A026R4	0.123	28	3.444
A026R5	0.120	27	3.240
A026S1	0.041	41	1.681
A026SE	0.130	75	9.750
A026SW	0.036	42	1.512
A026WK1	0.027	59	1.593
A027N1	0.081	49	3.969
A027N2	0.140	74	10.360
A027NE	0.015	47	0.705
A027NW	0.122	64	7.808
A027S1	0.015	53	0.795
A027S2	0.042	69	2.898
A027SE	0.017	65	1.105
A027SW	0.133	74	9.842
A030NE	0.067	78	5.226
A030NW	0.142	76	10.792
A030R1	0.049	27	1.323
A030R2	0.124	27	3.348
A030R3	0.135	25	3.375
A030R4	0.087	27	2.349
A030SE	0.069	77	5.313
A030SW	0.144	70	10.080
A031NE	0.093	74	6.882
A031NW	0.105	64	6.720
A031R1	0.157	22	3.454
A031R2	0.146	26	3.796
A031R3	0.197	15	2.955
A031SE	0.082	35	2.870
A031SW	0.213	67	14.271
A1600N1	0.015	60	0.900
A1600N2	0.076	43	3.268
A1600NE	0.033	45	1.485
A1600NW	0.058	45	2.610
A1600PK1	0.963	29	27.927
A1600S1	0.018	56	1.008
A1600S2	0.054	59	3.186
A1600SE	0.028	54	1.512
A1600SW	0.055	49	2.695
A201NE	0.079	75	5.925
A201NW	0.079	75	5.925
A201R1	0.085	26	2.210

Table A-1 : Drainage Area to SWM Facility

Segment ID [(1)]	Area (ha)	Imperviousness (%)	Area x Imp.
A201R2	0.093	29	2.697
A201R3	0.118	26	3.068
A201R4	0.024	30	0.720
A201SE	0.082	64	5.248
A201SW	0.169	72	12.168
A202NE	0.053	76	4.028
A202NW	0.042	41	1.722
A202SE	0.109	70	7.630
A202SW	0.090	73	6.570
A204N1	0.053	80	4.240
A204N2	0.055	76	4.180
A204NE	0.088	74	6.512
A204NW	0.080	72	5.760
A204R1	0.036	28	1.008
A204R2	0.044	27	1.188
A204R3	0.017	26	0.442
A204R4	0.129	28	3.612
A204R5	0.091	26	2.366
A204R6	0.161	20	3.220
A204SE	0.180	75	13.500
A204SW	0.180	72	12.960
A206NE	0.062	40	2.480
A206NW	0.116	73	8.468
A206SE	0.134	73	9.782
A206SW	0.166	74	12.284
A208NE	0.078	73	5.694
A208NW	0.056	73	4.088
A208R1	0.106	27	2.862
A208R2	0.071	28	1.988
A208SE	0.160	72	11.520
A208SW	0.094	77	7.238
A211NE	0.024	77	1.848
A211NW	0.097	69	6.693
A211R1	0.079	28	2.212
A211R2	0.111	28	3.108
A211SE	0.033	43	1.419
A211SW	0.061	56	3.416
A212NE	0.097	63	6.111
A212NW	0.046	59	2.714
A212R1	0.134	28	3.752
A212R2	0.100	27	2.700
A212R3	0.021	28	0.588
A212SE	0.147	70	10.290
A212SW	0.052	60	3.120
A213R1	0.079	25	1.975

Table A-1 : Drainage Area to SWM Facility

Segment ID (1)	Area (ha)	Imperviousness (%)	Area x Imp.
A213R2	0.131	23	3.013
A214NE	0.154	77	11.858
A214NW	0.070	77	5.390
A214R1	0.077	27	2.079
A214R2	0.082	28	2.296
A214R3	0.111	27	2.997
A214R4	0.032	28	0.896
A214SE	0.056	75	4.200
A214SW	0.070	74	5.180
A215NW	0.108	80	8.640
A215SE	0.102	73	7.446
A216NE	0.046	39	1.794
A216NW	0.059	40	2.360
A216SE	0.096	77	7.392
A217NE	0.088	71	6.248
A217NW	0.099	74	7.326
A217SE	0.168	71	11.928
A217SW	0.099	74	7.326
A219NE	0.046	42	1.932
A219NW	0.113	74	8.362
A219R1	0.158	22	3.476
A219SE	0.070	67	4.690
A219SW	0.154	72	11.088
A220NE	0.127	74	9.398
A221N1	0.045	77	3.465
A221NE	0.119	73	8.687
A221NW	0.043	78	3.354
A221R1	0.130	27	3.510
A221R2	0.119	27	3.213
A221R3	0.125	24	3.000
A221SE	0.119	72	8.568
A221SW	0.065	40	2.600
A223N1	0.023	70	1.610
A223N2	0.091	54	4.914
A223NE	0.047	79	3.713
A223NW	0.031	44	1.364
A223R1	0.088	24	2.112
A223R2	0.120	22	2.640
A223R3	0.174	18	3.132
A223SE	0.203	70	14.210
A223SW	0.096	59	5.664
A224NE	0.018	54	0.972
A224NW	0.017	47	0.799
A224R1	0.024	26	0.624
A224SE	0.054	42	2.268

Table A-1 : Drainage Area to SWM Facility

Segment ID (1)	Area (ha)	Imperviousness (%)	Area x Imp.
A224SW	0.101	65	6.565
A250N1	0.066	76	5.016
A250NE	0.048	39	1.872
A250NW	0.018	38	0.684
A250R1	0.073	21	1.533
A250R2	0.051	21	1.071
A251E1	0.105	73	7.665
A251E2	0.114	58	6.612
A251N1	0.029	75	2.175
A251N2	0.031	44	1.364
A251N3	0.063	73	4.599
A251N4	0.046	70	3.220
A251NE	0.064	73	4.672
A251NW	0.084	75	6.300
A251R1	0.120	24	2.880
A251R2	0.088	28	2.464
A251R3	0.086	23	1.978
A251R4	0.047	19	0.893
A251S1	0.011	41	0.451
A251S3	0.062	36	2.232
A251S4	0.033	48	1.584
A251S5	0.066	70	4.620
A251S6	0.055	76	4.180
A251SE	0.075	60	4.500
A251SW	0.085	60	5.100
A251W1	0.038	88	3.344
A251W2	0.037	86	3.182
A252E1	0.014	47	0.658
A252NE	0.078	74	5.772
A252NW	0.102	68	6.936
A252R1	0.142	24	3.408
A252SE	0.078	73	5.694
A252SW	0.084	74	6.216
A252W1	0.078	76	5.928
A252W2	0.079	76	6.004
A254N2	0.016	34	0.544
A254NE	0.054	62	3.348
A254NW	0.030	40	1.200
A254R1	0.062	24	1.488
A254R2	0.049	24	1.176
A254R3	0.065	24	1.560
A254R4	0.040	23	0.920
A254S2	0.029	37	1.073
A254SE	0.103	58	5.974
A254SW	0.035	41	1.435

Table A-1 : Drainage Area to SWM Facility

Segment ID (1)	Area (ha)	Imperviousness (%)	Area x Imp.
A256NE	0.049	57	2.793
A256SE	0.031	63	1.953
A256SW	0.031	46	1.426
A258E1	0.034	47	1.598
A258NE	0.073	88	6.424
A258NW	0.074	91	6.734
A258SE	0.074	88	6.512
A258SW	0.074	91	6.734
A259N1	0.022	63	1.386
A259NE	0.058	94	5.452
A259NW	0.046	94	4.324
A259S1	0.026	63	1.638
A259SE	0.047	89	4.183
A259SW	0.039	93	3.627
A259W1	0.023	44	1.012
A259W2	0.024	43	1.032
A260NE	0.042	86	3.612
A260NW	0.049	72	3.528
A260SE	0.046	92	4.232
A260SW	0.051	57	2.907
A263NE	0.086	58	4.988
A263NW	0.038	64	2.432
A263SE	0.085	72	6.120
A263SW	0.038	69	2.622
A264NE	0.077	60	4.620
A264NW	0.110	60	6.600
A264R1	0.124	24	2.976
A264R2	0.098	24	2.352
A264R3	0.130	24	3.120
A264R4	0.080	23	1.840
A264SE	0.143	72	10.296
A264SW	0.106	66	6.996
A265NE	0.110	69	7.590
A265SW	0.117	75	8.775
A266NE	0.043	79	3.397
A266NW	0.077	63	4.851
A266SE	0.052	85	4.420
A266SW	0.060	51	3.060
A270E1	0.046	75	3.450
A270NE	0.134	73	9.782
A270NW	0.033	73	2.409
A270R1	0.158	24	3.792
A270SE	0.045	76	3.420
A270SW	0.084	74	6.216
A271NE	0.049	51	2.499

Table A-1 : Drainage Area to SWM Facility

Segment ID [(1)]	Area (ha)	Imperviousness (%)	Area x Imp.
A271NW	0.092	70	6.440
A271S2	0.082	73	5.986
A271SW	0.031	78	2.418
A273NE	0.112	70	7.840
A273NW	0.016	47	0.752
A273SE	0.071	91	6.461
A273SW	0.013	35	0.455
A277N1	0.323	69	22.287
A277N2	0.071	63	4.473
A277N3	0.129	61	7.869
A277NE	0.036	67	2.412
A277NW	0.066	68	4.488
A277S1	0.039	69	2.691
A277S2	0.072	66	4.752
A277SE	0.047	70	3.290
A277SW	0.086	64	5.504
A280N1	0.047	51	2.397
A280NW	0.046	80	3.680
A280R1	0.050	23	1.150
A280R2	0.016	7	0.112
A280S1	0.265	62	16.430
A280S2	0.087	61	5.307
A280SE	0.268	62	16.616
A280SW	0.086	81	6.966
A329NE	0.037	76	2.812
A329NW	0.038	76	2.888
APOND1	6.472	56	362.432
APONDR1	0.138	24	3.312
APONDR2	0.043	19	0.817
APONDR3	0.167	23	3.841
APONDR4	0.022	7	0.154
B001N1	0.075	77	5.775
B001N2	0.070	69	4.830
B001NE	0.086	76	6.536
B001NW	0.082	77	6.314
B001R1	0.158	29	4.582
B001R2	0.098	26	2.548
B001R3	0.156	17	2.652
B001R4	0.189	28	5.292
B001R5	0.092	26	2.392
B001S1	0.099	79	7.821
B001S2	0.091	75	6.825
B001SE	0.069	70	4.830
B001SW	0.080	81	6.480
B001WK1	0.024	31	0.744

Table A-1 : Drainage Area to SWM Facility

Segment ID (1)	Area (ha)	Imperviousness (%)	Area x Imp.
B003NW	0.048	47	2.256
B003SE	0.077	67	5.159
B004N1	0.171	78	13.338
B004NE	0.033	52	1.716
B004NW	0.172	79	13.588
B004S1	0.184	74	13.616
B004SE	0.193	75	14.475
B004SW	0.031	48	1.488
B005NE	0.016	63	1.008
B007NE	0.047	40	1.880
B008N1	0.173	78	13.494
B008NE	0.101	75	7.575
B008NW	0.028	61	1.708
B008S1	0.073	61	4.453
B008SE	0.091	75	6.825
B008SW	0.065	51	3.315
B009NE	0.110	76	8.360
B009SW	0.115	74	8.510
B010NE	0.088	74	6.512
B010NW	0.114	75	8.550
B010R1	0.074	28	2.072
B010R2	0.086	27	2.322
B010R3	0.082	29	2.378
B010SE	0.180	71	12.780
B010SW	0.105	72	7.560
B010W1	0.072	73	5.256
B011NE	0.150	73	10.950
B011NW	0.111	77	8.547
B011R1	0.129	28	3.612
B011SE	0.166	72	11.952
B011SW	0.107	76	8.132
B013NE	0.130	71	9.230
B014N1	0.017	61	1.037
B014NE	0.024	61	1.464
B014NW	0.090	72	6.480
B014R1	0.048	28	1.344
B014R2	0.062	27	1.674
B014SE	0.149	71	10.579
B014SW	0.101	66	6.666
B015NE	0.070	67	4.690
B015NW	0.099	78	7.722
B015SE	0.047	61	2.867
B015SW	0.103	73	7.519
B018NE	0.215	72	15.480
B018NW	0.014	50	0.700

Table A-1 : Drainage Area to SWM Facility

Segment ID (1)	Area (ha)	Imperviousness (%)	Area x Imp.
B018SW	0.037	46	1.702
B019NE	0.040	41	1.640
B019NW	0.018	60	1.080
B019R1	0.147	29	4.263
B019R2	0.107	27	2.889
B019SE	0.018	40	0.720
B019SW	0.050	62	3.100
B020NE	0.056	71	3.976
B020NW	0.059	74	4.366
B020SE	0.101	54	5.454
B020SW	0.032	56	1.792
B021NE	0.097	76	7.372
B021NW	0.104	73	7.592
B021SE	0.081	66	5.346
B021SW	0.022	60	1.320
B021W1	0.127	77	9.779
B021W2	0.065	66	4.290
B023NE	0.172	79	13.588
B023NW	0.055	53	2.915
B023SE	0.091	66	6.006
B023SW	0.038	61	2.318
B023W1	0.083	33	2.739
B023W2	0.034	82	2.788
B024NE	0.130	78	10.140
B024SE	0.047	66	3.102
B024SW	0.052	66	3.432
B026N1	0.076	50	3.800
B026NE	0.172	78	13.416
B026SE	0.076	63	4.788
B026W1	0.061	77	4.697
B027NE	0.070	49	3.430
B027NW	0.098	50	4.900
B027SE	0.081	44	3.564
B028NE	0.013	67	0.871
B029NE	0.092	74	6.808
B029NW	0.063	54	3.402
B029SE	0.049	64	3.136
B029SW	0.094	76	7.144
B030NE	0.130	71	9.230
B031NE	0.095	75	7.125
B031NW	0.091	72	6.552
B031SE	0.056	64	3.584
B031SW	0.179	70	12.530
B032NE	0.108	54	5.832
B032NW	0.041	79	3.239

Table A-1 : Drainage Area to SWM Facility

Segment ID (1)	Area (ha)	Imperviousness (%)	Area x Imp.
B032SE	0.119	71	8.449
B032SW	0.107	60	6.420
B033NW	0.036	87	3.132
B033SW	0.083	80	6.640
B034N1	0.056	74	4.144
B034N2	0.021	57	1.197
B034NE	0.083	77	6.391
B034NW	0.025	40	1.000
B034R2	0.155	28	4.340
B034R3	0.085	30	2.550
B034S1	0.052	41	2.132
B034S2	0.089	67	5.963
B034SE	0.101	77	7.777
B034SW	0.133	72	9.576
B034WK1	0.024	50	1.200
B036N1	0.090	80	7.200
B036NE	0.052	45	2.340
B036NW	0.104	71	7.384
B036R1	0.097	27	2.619
B036R2	0.163	28	4.564
B036R3	0.064	29	1.856
B036SE	0.138	74	10.212
B036SW	0.118	72	8.496
B037NE	0.057	41	2.337
B037NW	0.075	79	5.925
B038N1	0.045	77	3.465
B038NE	0.050	82	4.100
B038NW	0.029	61	1.769
B038R2	0.108	28	3.024
B038R3	0.146	29	4.234
B038R4	0.111	29	3.219
B038SE	0.139	76	10.564
B038SW	0.134	75	10.050
B040NE	0.026	49	1.274
B040NW	0.070	74	5.180
B040SE	0.024	44	1.056
B040SW	0.036	40	1.440
B042NE	0.045	45	2.025
B042NW	0.063	35	2.205
B042SE	0.031	79	2.449
B042SW	0.043	43	1.849
B044S1	0.031	61	1.891
B044SE	0.154	73	11.242
B044SW	0.113	72	8.136
B045N1	0.064	73	4.672

Table A-1 : Drainage Area to SWM Facility

Segment ID (1)	Area (ha)	Imperviousness (%)	Area x Imp.
B045NE	0.070	74	5.180
B045NW	0.072	75	5.400
B045S1	0.152	69	10.488
B045SE	0.016	49	0.784
B045SW	0.167	73	12.191
B046NE	0.049	52	2.548
B046NW	0.189	70	13.230
B046R1	0.093	31	2.883
B046S1	0.053	70	3.710
B046SE	0.044	43	1.892
B046SW	0.111	66	7.326
B047R1	0.158	20	3.160
B047R2	0.027	7	0.189
B047WK1	0.043	50	2.150
B048PS1	0.838	64	53.632
B210E1	0.086	75	6.450
B210E2	0.007	84	0.588
B210NE	0.042	52	2.184
B210NW	0.113	76	8.588
B210SE	0.119	78	9.282
B210SW	0.052	79	4.108
B210W1	0.128	80	10.240
B330NE	0.062	47	2.914
B330SE	0.084	72	6.048
B022PK1	2.840	60	170.400
B260SC1	3.364	88	296.032
Undeveloped Areas			
VG-2	64.366	7	450.562
VG-5	34.992	7	244.944
Future Development Areas			
A270RE1	7.813	64	500.032
A328RE1	7.421	64	474.944
A329CM1	1.861	86	160.046
A329PK1	1.078	29	31.262
A329RE1	7.865	64	503.360
f32	1.300	71	92.300
f33	0.940	71	66.740
f34	0.750	71	53.250
f35	0.320	71	22.720
f36	0.210	71	14.910
f38	0.320	71	22.720
f40	0.700	71	49.700
f41	0.150	71	10.650
f42	0.260	71	18.460
f213	0.480	71	34.080

Table A-1 : Drainage Area to SWM Facility

Segment ID [1]	Area (ha)	Imperviousness (%)	Area x Imp.
f214	0.550	71	39.050
f215	0.580	71	41.180
f216	0.540	71	38.340
f217a	0.530	71	37.630
f217b	0.070	71	4.970
f501a	0.250	71	17.750
f501b	0.180	71	12.780
f502	0.140	71	9.940
f503	0.620	71	44.020
f504	0.580	71	41.180
f505	0.340	71	24.140
f507	0.270	71	19.170
f508	0.210	71	14.910
f509	0.230	71	16.330
f510	0.230	71	16.330
f511	0.350	71	24.850
f513	0.680	71	48.280
f514	0.050	71	3.550
f515	0.650	71	46.150
f516	0.150	71	10.650
f517	0.210	71	14.910
f518	0.640	71	45.440
f519	0.230	71	16.330
f520	0.700	71	49.700
f521	0.050	71	3.550
f522a	0.020	71	1.420
f522b	0.100	71	7.100
f523	0.020	71	1.420
f524a	0.150	71	10.650
f524b	0.250	71	17.750
f525	0.640	71	45.440
f526	0.170	71	12.070
f2002	0.440	71	31.240
f2003	0.430	71	30.530
f2004	0.940	71	66.740
f21800	0.970	71	68.870
Total	**202.396**	**35**	**7097.190**

(1) Refer to Figure 2

Weighted Average Imperviousness = S(Area x Imp) / Total Area = 7097.19 / 202.396 = 35 %

Table A-2 : Summary of Total Drainage Area

Land Use [1]	Area (ha)	Imperviousness (%)	Area x Imp.
to Pond 1	202.396	35	7097.190

[1] Refer to Figure 1.

Weighted Average Imperviousness = S(Area x Imp) / Total Area = 7097.19 / 202.396 = 35 %

Table A-3: Target Release Rates for SWM Facility

Event	Pre-Development Release Rate [1] (m^3/s/ha)	Target Release Rate (m^3/s)
2-Year, 24-Hour SCS [2]	2.767	0.330
5-Year, 24-Hour SCS	4.290	4.290
10-Year, 24-Hour SCS	5.348	5.348
25-Year, 24-Hour SCS	6.694	6.694
50-Year, 24-Hour SCS	7.749	7.749
100-Year, 24-Hour SCS	8.894	8.894

[1] As per pre-development flows modelled in the January 2014 "*Richmond Village (South) Limited Subdivision / Preliminary Stormwater Management Plan*" memo.

[2] Target release rate based on erosion control of 2-year release rate to 330 L/s (per Parish Geomorphic erosion threshold; refer to January 2014 memo).

ATTACHMENT

B

Pond Controls – Quality, Extended Detention and Quantity

Sediment Drying Area Calculations

JFSA Water Resources and Environmental Consultants

Table B-1: Criteria for Required Storage Volumes

Pond	Area (1) (ha)	Imperviousness (%)	Storage Volume for Impervious Level (2) (m^3/ha)
N/A	N/A	35	140
Pond 1	202.396	35	140.00
N/A	N/A	55	190

(1) Refer to Appendix C for drainage areas to SWM Facility.

(2) Protection Level for Wet Pond: Enhanced 80% long-term S.S. removal. SWM Planning & Design Manual, Table 3.2, p.3-10 (March 2003).

Table B-2: Required Storage Volumes for SWM Facility

Pond Component	Required Volume (m^3)	Provided Volume (4) (m^3)	Volume Ratio	Provided Area (5) (m^2)	Provided Elevation (m)
Permanent Pool (PP) (1)	20240	45330	2.24	28938	92.350
Quality Control (2)	8096	8096	1.00	N/A	92.622
Extended Detention (3)	N/A	43875	N/A	N/A	93.680
Forebay (20% PP)	4048	N/A	N/A	6199	92.350
PP - Forebay	16192	N/A	N/A	22739	92.350
			Area Ratio (%) (6) =	21	

(1) Required PP volume based on Table B-1 (140.00 - 40 = 100.00 m^3/ha).

(2) Required quality control volume based on 40 m^3/ha.

(3) Extended detention based on 100-year summer flood level at the pond outfall.

(4) Provided volume based on stage-storage curve and extended detention (refer to Tables B-8 and B-9 of Appendix B).

(5) Based on grading plan provided by DSEL (refer to Figure 2).

(6) As per MOE, Maximum Forebay Area: 33% of Total Permanent Pool.

Table B-3: Extended Detention Parameters for SWM Facility

Permanent Pool Parameters			Baseflow Orifice Parameters			Quality Orifice Parameters		
Area (C3)	28938.05	m^2	Diameter	0.100	m	Diameter	0.300	m
Volume	45330.01	m^3						
PP Elev	92.350	m	Area	0.008	m^2	Area	0.071	m^2
QC Elev	92.622	m	Invert	92.100	m	Invert	92.350	m
h (m)	0.272	m	C_o	0.62		C_o	0.62	

Notes:
- C3 is the intercept from the area-depth linear regression.
- PP Elev indicates the elevation of the permanent pool.
- QC Elev indicates the elevation of the storage volume required by MOE for quality control.
- h is the maximum water elevation above the orifice (m).

Table B-4: Extended Detention Drawdown Time for SWM Facility

Elev.	Active Storage			C2	Drawdown Time	Drawdown Time	Flow	Demarkation
(m)	V (m^3)	A (m^2)	depth (m)	(m²/m)	(h)	(days)	(m^3/s)	Point
92.35	**0.00**	**28938.05**	**0.00**				**0.011**	**PP Elev**
92.40	1447.42	28966.93	0.05	578	16.65	0.69	0.024	
92.45	2921.35	29497.69	0.10	5596	23.69	0.99	0.038	
92.50	4404.39	29790.67	0.15	5684	29.11	1.21	0.051	
92.55	5905.87	30117.00	0.20	5895	33.74	1.41	0.065	
92.60	7419.40	30403.23	0.25	5861	37.84	1.58	0.078	
92.622	**8096.00**	**30531.76**	**0.27**	**5856**	**39.54**	**1.65**	**0.084**	**QC Elev**
92.65	**8946.63**	**30693.36**	**0.30**	**5851**	**41.59**	**1.73**	**0.091**	
92.70	10489.71	30979.41	0.35	5832	45.06	1.88	0.114	
92.75	12047.14	31272.39	0.40	5836	48.33	2.01	0.135	
92.80	13618.54	31567.55	0.45	5843	51.43	2.14	0.155	
92.85	15204.56	31862.53	0.50	5849	54.39	2.27	0.174	
92.90	16806.83	32161.21	0.55	5860	57.23	2.38	0.193	
92.95	18424.87	32459.98	0.60	5870	59.97	2.50	0.210	
93.00	20054.22	32758.57	0.65	5878	62.63	2.61	0.226	
93.05	21698.57	33052.02	0.70	5877	65.20	2.72	0.241	
93.10	23361.36	33349.09	0.75	5881	67.70	2.82	0.254	
93.15	25037.25	33654.51	0.80	5896	70.16	2.92	0.267	
93.20	26728.92	33957.94	0.85	5906	72.55	3.02	0.280	
93.25	28425.62	34260.52	0.90	5914	74.90	3.12	0.291	
93.30	30162.12	34566.80	0.95	5925	77.21	3.22	0.302	
93.35	31900.53	34869.18	1.00	5931	79.47	3.31	0.313	
93.40	33804.14	35199.40	1.05	5963	81.72	3.40	0.324	
93.45	35591.37	35493.24	1.10	5959	83.90	3.50	0.334	
93.50	37203.33	35906.87	1.15	6060	86.17	3.59	0.343	
93.55	39003.77	36110.83	1.20	5977	88.21	3.68	0.353	
93.60	40793.68	38015.11	1.25	7262	91.83	3.83	0.362	
93.640	***42324.77***	***38434.78***	***1.29***	***7362***	***93.70***	***3.90***	***0.369***	***Summer FL***
93.65	42707.55	38539.70	1.30	7386	94.16	3.92	0.371	
93.680	**43874.50**	**38970.27**	**1.33**	**7543**	**95.66**	**3.99**	**0.376**	**Ext. Det.**
93.70	44652.47	39257.33	1.35	7644	96.66	4.03	0.679	
93.75	46640.54	40265.56	1.40	8091	99.45	4.14	2.348	
93.80	48678.10	41236.84	1.45	8482	102.20	4.26	4.796	
93.85	50750.08	41642.21	1.50	8469	104.37	4.35	7.821	
93.90	52847.68	42261.61	1.55	8596	106.75	4.45	11.329	
93.95	54989.42	43408.35	1.60	9044	109.69	4.57	15.261	
94.00	57180.79	44246.16	1.65	9278	112.30	4.68	19.573	

Notes:
- C2 is the slope coefficient from the area-depth linear regression.
- PP Elev indicates the elevation of the permanent pool.
- QC Elev indicates the elevation of the storage volume required by MOE for quality control, with a 24 to 48 hour drawdown time.

Table B-4: Extended Detention Drawdown Time for SWM Facility

Elev.	Active Storage			C2	Drawdown Time	Drawdown Time	Flow	Demarkation
(m)	V (m^3)	A (m^2)	depth (m)	(m^2/m)	(h)	(days)	(m^3/s)	Point

- Ext. Det. indicates the elevation of extended detention provided above the 100-year summer flood level at the pond outfall.
- Summer FL indicates the elevation of the 100-year summer flood level at the pond outfall.

Table B-5: Stage-Storage-Outflow Curve for Ultimate SWM Facility (Free Outfall Conditions)

			Baseflow Control 1		Quality Control 1		Erosion Control 1		Quantity Control 1			
			Vertical Orifice		Vertical Orifice		Vertical Orifice		Rectangular Weir			
			Dia (m)	0.100	Dia (m)	0.300	Dia (m)	0.260	L (m)	67.000		
									88.5 with 90° angle			
			Area (m^2)	0.008	Area (m^2)	0.071	Area (m^2)	0.053	C_w	1.58		
			Invert (m)	92.10	Invert (m)	92.35	Invert (m)	92.65	Invert (m)	93.68		
			C_o	0.62	C_o	0.62	C_o	0.62	n contr.	2		
			Q @ D	0.005	Q @ D	0.075	Q @ D	0.053				
Elevation	Active Sto.	Notes	Head	Outflow	Head	Outflow	Head	Outflow	Head	Outflow	Outflow	Storage
(m)	(m^3)		(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m^3/s)	(ha·m)
92.35	**0**	**PP Elev**	**0.250**	**0.011**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.011**	**0.000**
92.40	1447		0.300	0.012	0.050	0.013	0.000	0.000	0.000	0.000	0.024	0.145
92.45	2921		0.350	0.013	0.100	0.025	0.000	0.000	0.000	0.000	0.038	0.292
92.50	4404		0.400	0.014	0.150	0.038	0.000	0.000	0.000	0.000	0.051	0.440
92.55	5906		0.450	0.014	0.200	0.050	0.000	0.000	0.000	0.000	0.065	0.591
92.60	7419		0.500	0.015	0.250	0.063	0.000	0.000	0.000	0.000	0.078	0.742
92.622	**8096**	**QC Elev**	**0.522**	**0.016**	**0.272**	**0.068**	**0.000**	**0.000**	**0.000**	**0.000**	**0.084**	**0.810**
92.65	**8947**		**0.550**	**0.016**	**0.300**	**0.075**	**0.000**	**0.000**	**0.000**	**0.000**	**0.091**	**0.895**
92.70	10490		0.600	0.017	0.350	0.087	0.050	0.010	0.000	0.000	0.114	1.049
92.75	12047		0.650	0.017	0.400	0.097	0.100	0.020	0.000	0.000	0.135	1.205
92.80	13619		0.700	0.018	0.450	0.106	0.150	0.030	0.000	0.000	0.155	1.362
92.85	15205		0.750	0.019	0.500	0.115	0.200	0.040	0.000	0.000	0.174	1.520
92.90	16807		0.800	0.019	0.550	0.123	0.250	0.051	0.000	0.000	0.193	1.681
92.95	18425		0.850	0.020	0.600	0.130	0.300	0.060	0.000	0.000	0.210	1.842
93.00	20054		0.900	0.020	0.650	0.137	0.350	0.068	0.000	0.000	0.226	2.005
93.05	21699		0.950	0.021	0.700	0.144	0.400	0.076	0.000	0.000	0.241	2.170
93.10	23361		1.000	0.022	0.750	0.150	0.450	0.082	0.000	0.000	0.254	2.336
93.15	25037		1.050	0.022	0.800	0.157	0.500	0.089	0.000	0.000	0.267	2.504
93.20	26729		1.100	0.023	0.850	0.162	0.550	0.094	0.000	0.000	0.280	2.673
93.25	28426		1.150	0.023	0.900	0.168	0.600	0.100	0.000	0.000	0.291	2.843
93.30	30162		1.200	0.024	0.950	0.174	0.650	0.105	0.000	0.000	0.302	3.016
93.35	31901		1.250	0.024	1.000	0.179	0.700	0.110	0.000	0.000	0.313	3.190
93.40	33804		1.300	0.025	1.050	0.184	0.750	0.115	0.000	0.000	0.324	3.380
93.45	35591		1.350	0.025	1.100	0.189	0.800	0.119	0.000	0.000	0.334	3.559
93.50	37203		1.400	0.026	1.150	0.194	0.850	0.124	0.000	0.000	0.343	3.720
93.55	39004		1.450	0.026	1.200	0.199	0.900	0.128	0.000	0.000	0.353	3.900
93.60	40794		1.500	0.026	1.250	0.204	0.950	0.132	0.000	0.000	0.362	4.079
93.64	***42325***	***Summer FL***	***1.540***	***0.027***	***1.290***	***0.207***	***0.990***	***0.135***	***0.000***	***0.000***	***0.369***	***4.232***
93.65	42708		1.550	0.027	1.300	0.208	1.000	0.136	0.000	0.000	0.371	4.271
93.68	**43875**	**Ext. Det.**	**1.580**	**0.027**	**1.330**	**0.211**	**1.030**	**0.138**	**0.000**	**0.000**	**0.376**	**4.387**
93.70	44652		1.600	0.027	1.350	0.213	1.050	0.140	0.020	0.299	0.679	4.465
93.75	46641		1.650	0.028	1.400	0.217	1.100	0.144	0.070	1.960	2.348	4.664
93.80	48678		1.700	0.028	1.450	0.221	1.150	0.147	0.120	4.399	4.796	4.868
93.85	50750		1.750	0.029	1.500	0.226	1.200	0.151	0.170	7.416	7.821	5.075
93.90	52848		1.800	0.029	1.550	0.230	1.250	0.154	0.220	10.916	11.329	5.285
93.95	54989		1.850	0.029	1.600	0.234	1.300	0.158	0.270	14.840	15.261	5.499
94.00	57181		1.900	0.030	1.650	0.238	1.350	0.161	0.320	19.144	19.573	5.718
94.05	59423		1.950	0.030	1.700	0.242	1.400	0.164	0.370	23.799	24.235	5.942
94.10	61714		2.000	0.031	1.750	0.246	1.450	0.168	0.420	28.778	29.222	6.171
94.11	***62185***	***Spring FL***	***2.010***	***0.031***	***1.760***	***0.246***	***1.460***	***0.168***	***0.430***	***29.811***	***30.256***	***6.218***
94.15	64066		2.050	0.031	1.800	0.249	1.500	0.171	0.470	34.062	34.513	6.407
94.20	66471		2.100	0.031	1.850	0.253	1.550	0.174	0.520	39.633	40.092	6.647
94.25	68904		2.150	0.032	1.900	0.257	1.600	0.177	0.570	45.478	45.944	6.890
94.30	71364		2.200	0.032	1.950	0.260	1.650	0.180	0.620	51.584	52.056	7.136
94.35	73853		2.250	0.032	2.000	0.264	1.700	0.183	0.670	57.939	58.419	7.385
94.40	76369		2.300	0.033	2.050	0.268	1.750	0.186	0.720	64.535	65.021	7.637
94.45	78916		2.350	0.033	2.100	0.271	1.800	0.188	0.770	71.362	71.855	7.892
94.50	81485		2.400	0.033	2.150	0.275	1.850	0.191	0.820	78.413	78.912	8.148

Notes :
- PP Elev indicates the elevation of the permanent pool.
- QC Elev indicates the elevation of the storage volume required by MOE for quality control.
- Ext. Det. indicates the elevation of extended detention provided above the 100-year summer flood level at the pond outfall.

Table B-5: Stage-Storage-Outflow Curve for Ultimate SWM Facility (Free Outfall Conditions)

			Baseflow Control 1		Quality Control 1		Erosion Control 1		Quantity Control 1			
			Vertical Orifice		Vertical Orifice		Vertical Orifice		Rectangular Weir			
			Dia (m)	0.100	Dia (m)	0.300	Dia (m)	0.260	L (m)	67.000		
									88.5 with 90^o angle			
			Area (m^2)	0.008	Area (m^2)	0.071	Area (m^2)	0.053	C_w	1.58		
			Invert (m)	92.10	Invert (m)	92.35	Invert (m)	92.65	Invert (m)	93.68		
			C_o	0.62	C_o	0.62	C_o	0.62	n contr.	2		
			Q @ D	0.005	Q @ D	0.075	Q @ D	0.053				
Elevation	Active Sto.	Notes	Head	Outflow	Head	Outflow	Head	Outflow	Head	Outflow	Outflow	Storage
(m)	(m^3)		(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m^3/s)	(ha·m)

- Summer and Spring FL indicate the elevations of the 100-year summer and spring flood levels, respectively, at the pond outfall.

Table B-6: Stage-Storage-Outflow Curve for SWM Facility (Restrictive D/S Conditions; Summer Flood Level = 93.64 m)

			Baseflow Control 1		Quality Control 1		Erosion Control 1		Quantity Control 1			
			Vertical Orifice		Vertical Orifice		Vertical Orifice		Rectangular Weir			
			Dia (m)	0.100	Dia (m)	0.300	Dia (m)	0.260	L (m)	67.000		
									88.5 with 90° angle			
			Area (m^2)	0.008	Area (m^2)	0.071	Area (m^2)	0.053	C_w	1.58		
			Invert (m)	93.64	Invert (m)	93.64	Invert (m)	93.64	Invert (m)	93.68		
			C_o	0.62	C_o	0.62	C_o	0.62	n contr.	2		
			Q @ D	0.005	Q @ D	0.075	Q @ D	0.053				
Elevation	Active Sto.	Notes	Head	Outflow	Head	Outflow	Head	Outflow	Head	Outflow	Outflow	Storage
(m)	(m^3)		(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m^3/s)	(ha·m)
92.35	**0**	**PP Elev**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
92.40	1447		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.145
92.45	2921		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.292
92.50	4404		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.440
92.55	5906		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.591
92.60	7419		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.742
92.622	**8096**	**QC Elev**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.810**
92.65	**8947**		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.895**
92.70	10490		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.049
92.75	12047		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.205
92.80	13619		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.362
92.85	15205		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.520
92.90	16807		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.681
92.95	18425		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.842
93.00	20054		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.005
93.05	21699		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.170
93.10	23361		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.336
93.15	25037		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.504
93.20	26729		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.673
93.25	28426		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2.843
93.30	30162		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.016
93.35	31901		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.190
93.40	33804		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.380
93.45	35591		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.559
93.50	37203		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.720
93.55	39004		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	3.900
93.60	40794		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	4.079
93.64	***42325***	***Summer FL***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***4.232***
93.65	42708		0.010	0.000	0.010	0.003	0.010	0.002	0.000	0.000	0.005	4.271
93.68	**43875**	**Ext. Det.**	**0.040**	**0.002**	**0.040**	**0.010**	**0.040**	**0.008**	**0.000**	**0.000**	**0.020**	**4.387**
93.70	44652		0.060	0.003	0.060	0.015	0.060	0.012	0.020	0.299	0.329	4.465
93.75	46641		0.110	0.005	0.110	0.028	0.110	0.022	0.070	1.960	2.015	4.664
93.80	48678		0.160	0.007	0.160	0.040	0.160	0.032	0.120	4.399	4.479	4.868
93.85	50750		0.210	0.009	0.210	0.053	0.210	0.042	0.170	7.416	7.520	5.075
93.90	52848		0.260	0.010	0.260	0.065	0.260	0.053	0.220	10.916	11.044	5.285
93.95	54989		0.310	0.011	0.310	0.078	0.310	0.062	0.270	14.840	14.990	5.499
94.00	57181		0.360	0.012	0.360	0.089	0.360	0.070	0.320	19.144	19.315	5.718
94.05	59423		0.410	0.013	0.410	0.099	0.410	0.077	0.370	23.799	23.988	5.942
94.10	61714		0.460	0.014	0.460	0.108	0.460	0.084	0.420	28.778	28.984	6.171
94.11	***62185***	***Spring FL***	***0.470***	***0.014***	***0.470***	***0.110***	***0.470***	***0.085***	***0.430***	***29.811***	***30.020***	***6.218***
94.15	64066		0.510	0.015	0.510	0.116	0.510	0.090	0.470	34.062	34.283	6.407
94.20	66471		0.560	0.015	0.560	0.124	0.560	0.096	0.520	39.633	39.869	6.647
94.25	68904		0.610	0.016	0.610	0.132	0.610	0.101	0.570	45.478	45.727	6.890
94.30	71364		0.660	0.017	0.660	0.139	0.660	0.106	0.620	51.584	51.846	7.136
94.35	73853		0.710	0.018	0.710	0.145	0.710	0.111	0.670	57.939	58.213	7.385
94.40	76369		0.760	0.018	0.760	0.152	0.760	0.116	0.720	64.535	64.821	7.637
94.45	78916		0.810	0.019	0.810	0.158	0.810	0.120	0.770	71.362	71.659	7.892
94.50	81485		0.860	0.019	0.860	0.164	0.860	0.125	0.820	78.413	78.721	8.148

Notes :
- PP Elev indicates the elevation of the permanent pool.
- QC Elev indicates the elevation of the storage volume required by MOE for quality control.
- Ext. Det. indicates the elevation of extended detention provided above the 100-year summer flood level at the pond outfall.

Table B-6: Stage-Storage-Outflow Curve for SWM Facility (Restrictive D/S Conditions; Summer Flood Level = 93.64 m)

			Baseflow Control 1		Quality Control 1		Erosion Control 1		Quantity Control 1			
			Vertical Orifice		Vertical Orifice		Vertical Orifice		Rectangular Weir			
			Dia (m)	0.100	Dia (m)	0.300	Dia (m)	0.260	L (m)	67.000		
									88.5 with 90° angle			
			Area (m^2)	0.008	Area (m^2)	0.071	Area (m^2)	0.053	C_w	1.58		
			Invert (m)	93.64	Invert (m)	93.64	Invert (m)	93.64	Invert (m)	93.68		
			C_o	0.62	C_o	0.62	C_o	0.62	n contr.	2		
			Q @ D	0.005	Q @ D	0.075	Q @ D	0.053				
Elevation	Active Sto.	Notes	Head	Outflow	Head	Outflow	Head	Outflow	Head	Outflow	Outflow	Storage
(m)	(m^3)		(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m^3/s)	(ha·m)

- Summer and Spring FL indicate the elevations of the 100-year summer and spring flood levels, respectively, at the pond outfall.

Table B-7: Stage-Storage-Outflow Curve for SWM Facility (Restrictive D/S Conditions; Spring Flood Level = 94.11 m)

			Baseflow Control 1		Quality Control 1		Erosion Control 1		Quantity Control 1			
			Vertical Orifice		Vertical Orifice		Vertical Orifice		Rectangular Weir			
			Dia (m)	0.100	Dia (m)	0.300	Dia (m)	0.260	L (m)	67.000		
									88.5 with 90° angle			
			Area (m^2)	0.008	Area (m^2)	0.071	Area (m^2)	0.053	C_w	1.58		
			Invert (m)	94.11	Invert (m)	94.11	Invert (m)	94.11	Invert (m)	94.11		
			C_o	0.62	C_o	0.62	C_o	0.62	n contr.	2		
			Q @ D	0.005	Q @ D	0.075	Q @ D	0.053				
Elevation	Active Sto.	Notes	Head	Outflow	Head	Outflow	Head	Outflow	Head	Outflow	Outflow	Storage
(m)	(m^3)		(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m^3/s)	(ha·m)
92.35	**0**	**PP Elev**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
92.40	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
92.45	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
92.50	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
92.55	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
92.60	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
92.622	**0**	**QC Elev**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
92.65	**0**		**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
92.70	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
92.75	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
92.80	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
92.85	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
92.90	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
92.95	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.00	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.05	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.10	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.15	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.20	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.25	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.30	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.35	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.40	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.45	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.50	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.55	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.60	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.64	***0***	***Summer FL***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***
93.65	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.68	**0**	**Ext. Det.**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**	**0.000**
93.70	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.75	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.80	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.85	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.90	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
93.95	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
94.00	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
94.05	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
94.10	0		0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
94.11	***0***	***Spring FL***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***	***0.000***
94.15	1881		0.040	0.002	0.040	0.010	0.040	0.008	0.040	0.847	0.867	0.188
94.20	4286		0.090	0.004	0.090	0.023	0.090	0.018	0.090	2.857	2.903	0.429
94.25	6719		0.140	0.006	0.140	0.035	0.140	0.028	0.140	5.543	5.613	0.672
94.30	9180		0.190	0.008	0.190	0.048	0.190	0.038	0.190	8.762	8.856	0.918
94.35	11668		0.240	0.009	0.240	0.060	0.240	0.049	0.240	12.438	12.556	1.167
94.40	14184		0.290	0.011	0.290	0.073	0.290	0.058	0.290	16.518	16.659	1.418
94.45	16731		0.340	0.012	0.340	0.085	0.340	0.067	0.340	20.966	21.129	1.673
94.50	19300		0.390	0.013	0.390	0.095	0.390	0.074	0.390	25.753	25.935	1.930

Notes :
- PP Elev indicates the elevation of the permanent pool. Volume below the elevation of the 100-year spring flood level treated as dead storage.
- QC Elev indicates the elevation of the storage volume required by MOE for quality control.
- Ext. Det. indicates the elevation of extended detention provided above the 100-year summer flood level at the pond outfall.

Table B-7: Stage-Storage-Outflow Curve for SWM Facility (Restrictive D/S Conditions; Spring Flood Level = 94.11 m)

			Baseflow Control 1		Quality Control 1		Erosion Control 1		Quantity Control 1			
			Vertical Orifice		Vertical Orifice		Vertical Orifice		Rectangular Weir			
			Dia (m)	0.100	Dia (m)	0.300	Dia (m)	0.260	L (m)	67.000		
									88.5 with 90° angle			
			Area (m^2)	0.008	Area (m^2)	0.071	Area (m^2)	0.053	C_w	1.58		
			Invert (m)	94.11	Invert (m)	94.11	Invert (m)	94.11	Invert (m)	94.11		
			C_o	0.62	C_o	0.62	C_o	0.62	n contr.	2		
			Q @ D	0.005	Q @ D	0.075	Q @ D	0.053				
Elevation	Active Sto.	Notes	Head	Outflow	Head	Outflow	Head	Outflow	Head	Outflow	Outflow	Storage
(m)	(m^3)		(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m)	(m^3/s)	(m^3/s)	(ha·m)

- Summer and Spring FL indicate the elevations of the 100-year summer and spring flood levels, respectively, at the pond outfall.

CALCULATION SHEET B-1: CONTROLS

Baseflow Control 1		
Vertical Circular Orifice		
Diameter	(m)	0.100
A_o	(m^2)	0.008
invert	(m)	92.10
C_o		0.62
100yr Water Level	(m)	93.831
Head of Water	(m)	1.731
Q_o	(m^3/s)	0.028

Orifice Equation:

$Q_o = C_o A_o (2gh)^{0.5}$

Not including reverse pipe losses

Q_o is the orifice flow

C_o is the orifice coefficient

A_o is the orifice flow area

g is the gravitational constant

h is the head of water

Quality Control 1		
Vertical Circular Orifice		
Diameter	(m)	0.300
A_o	(m^2)	0.071
invert	(m)	92.35
C_o		0.62
100yr Water Level	(m)	93.831
Head of Water	(m)	1.481
Q_o	(m^3/s)	0.224

Orifice Equation:

$Q_o = C_o A_o (2gh)^{0.5}$

Not including reverse pipe losses

Q_o is the orifice flow

C_o is the orifice coefficient

A_o is the orifice flow area

g is the gravitational constant

h is the head of water

Erosion Control 1		
Vertical Circular Orifice		
Diameter	(m)	0.260
A_o	(m^2)	0.053
Invert	(m)	92.65
C_o		0.62
100yr Water Level	(m)	93.831
Head of Water	(m)	1.181
Q_o	(m^3/s)	0.149

Orifice Equation:

$Q_o = C_o A_o (2gh)^{0.5}$

Q_o is the orifice flow

C_o is the orifice coefficient

A_o is the orifice flow area

g is the gravitational constant

h is the head of water

Quantity Control 1		
Rectangular Weir		
L	(m)	67.000
C_w		1.58
Invert	(m)	93.680
n		2
Max Water Level	(m)	93.833
Head of Water	(m)	0.152
Q_w *(100% Blockage)*	(m^3/s)	6.301

Note: Sloping Sides of weir are not considered in weir capacity (underestimated capacity)

Weir Equation:

$Qw = C_w (L-0.1nh)h^{1.5}$

Qw is the weir flow

Cw is the weir coefficient

L is the weir length

h is the weir height

n is the # of side contractions

Spillway Velocity - Minimum Slope		
Restangular Channel Equation:		
$Q = 1/n \times AR^{2/3}S^{1/2}$		
normal depth	(m)	0.184
n (roughness coef.)		0.03
W (width)	(m)	45.000
A (area of flow)	(m^2)	8.297
p (wetted perimeter)	(m)	45.369
R (hydraulic radius)	(m)	0.183
S (assumed slope)	(m/m)	0.005
Q (flow)	(m^3/s)	6.301
v (velocity)	(m/s)	0.76

Spillway Velocity - Maximum Slope		
Restangular Channel Equation:		
$Q = 1/n \times AR^{2/3}S^{1/2}$		
normal depth	(m)	0.052
n (roughness coef.)		0.03
W (width)	(m)	45.000
A (area of flow)	(m^2)	2.348
p (wetted perimeter)	(m)	45.104
R (hydraulic radius)	(m)	0.052
S (assumed slope)	(m/m)	0.333
Q (flow)	(m^3/s)	6.301
v (velocity)	(m/s)	2.68

CALCULATION SHEET B-2: FOREBAY SIZING FOR SWM FACILITY

WESTERN DEVELOPMENT LANDS - RICHMOND
SWM Pond 1
City of Ottawa
Calculation of Forebay Size
South Forebay

Settling Criteria

From the SWMP Manual, the required length for settling is as follows:

$$L_{min} = \left(\frac{r\,Q_p}{V_s}\right)^{0.5}$$

where:
r = length to width ratio, at the invert of the inlet pipe.
Q_p = peak outflow during design quality storm
V_s = settling velocity

Input:
r = 3.07 (83 m / 27 m)
Q_p = 0.376 m^3/s (at elevation 93.68 m)
V_s = 0.0003 m/s

L_{min} = 62.10 m

The peak flow rate from the pond during the quality storm is taken as the flow that would occur just below the quantity controls (Refer to Table B-5 of Appendix B)

Dispersion Criteria

From the SWMP Manual, the required length for dispersion is as follows:

$$L_{min} = \frac{8\,Q}{d\,V_f}$$

where:
Q = Inlet flowrate (10-Year, 24-Hour SCS Storm)
d = depth of permanent pool (forebay)
V_f = desired final velocity

Input:
Q = 7.527 m^3/s
d = 2.0 m
Vf = 0.5 m/s

L_{min} = 60.22 m

The minimum forebay length is determined by the larger of the settling or dispersion criteria.

Minimum Length of Forebay Required 62.10 m
Length of Forebay Provided 83.00 m (at elevation 92.35 m)

Average Forebay Velocity

From the SWMP Manual, the maximum allowable average velocity is 0.15 m/s:

$$V_{avg} = \frac{Q}{d\,W_{avg}}$$

where:
Q = Inlet flowrate (10-Year, 24-Hour SCS Storm)
d = depth of pond during peak 10-year inflow (12h:00min)
W_{avg} = average width of forebay

Input:
Q = 7.527 m^3/s
d = 2.56 m
W_{avg} = 21 m (15 m bottom, 27 m permanent pool)

V = 0.14 m/s < 0.15 m/s

CALCULATION SHEET B-3: FOREBAY SIZING FOR SWM FACILITY

WESTERN DEVELOPMENT LANDS - RICHMOND
SWM Pond 1
City of Ottawa
Calculation of Forebay Size
West Forebay

Settling Criteria

From the SWMP Manual, the required length for settling is as follows:

$$L_{min} = \left(\frac{r\,Q_p}{V_s}\right)^{0.5}$$

where:
r = length to width ratio, at the invert of the inlet pipe.
Q_p = peak outflow during design quality storm
V_s = settling velocity

Input:
r = 2.39 (67 m / 28 m)
Q_p = 0.376 m^3/s (at elevation 93.68 m)
V_s = 0.0003 m/s

L_{min} = 54.79 m

The peak flow rate from the pond during the quality storm is taken as the flow that would occur just below the quantity controls (Refer to Table B-5 of Appendix B)

Dispersion Criteria

From the SWMP Manual, the required length for dispersion is as follows:

$$L_{min} = \frac{8\,Q}{d\,V_f}$$

where:
Q = Inlet flowrate (10-Year, 24-Hour SCS Storm)
d = depth of permanent pool (forebay)
V_f = desired final velocity

Input:
Q = 1.088 m^3/s
d = 2.0 m
Vf = 0.5 m/s

L_{min} = 8.71 m

The minimum forebay length is determined by the larger of the settling or dispersion criteria.

Minimum Length of Forebay Required 54.79 m
Length of Forebay Provided **67.00 m** (at elevation 92.35 m)

Average Forebay Velocity

From the SWMP Manual, the maximum allowable average velocity is 0.15 m/s:

$$V_{avg} = \frac{Q}{d\,W_{avg}}$$

where:
Q = Inlet flowrate (10-Year, 24-Hour SCS Storm)
d = depth of pond during peak 10-year inflow (12h:00min)
W_{avg} = average width of forebay

Input:
Q = 1.088 m^3/s
d = 2.56 m
W_{avg} = 22 m (16 m bottom, 28 m permanent pool)

V = 0.02 m/s < 0.15 m/s

CALCULATION SHEET B-4: FOREBAY SIZING FOR SWM FACILITY

WESTERN DEVELOPMENT LANDS - RICHMOND
SWM Pond 1
City of Ottawa
Calculation of Forebay Size
North Forebay

Settling Criteria

From the SWMP Manual, the required length for settling is as follows:

$$L_{min} = \left(\frac{r\,Q_p}{V_s}\right)^{0.5}$$

where:
r = length to width ratio, at the invert of the inlet pipe.
Q_p = peak outflow during design quality storm
V_s = settling velocity

Input:
r = 3.04 (85 m / 28 m)
Q_p = 0.376 m^3/s (at elevation 93.68 m)
V_s = 0.0003 m/s

L_{min} = 61.71 m

The peak flow rate from the pond during the quality storm is taken as the flow that would occur just below the quantity controls (Refer to Table B-5 of Appendix B)

Dispersion Criteria

From the SWMP Manual, the required length for dispersion is as follows:

$$L_{min} = \frac{8\,Q}{d\,V_f}$$

where:
Q = Inlet flowrate (10-Year, 24-Hour SCS Storm)
d = depth of permanent pool (forebay)
V_f = desired final velocity

Input:
Q = 5.304 m^3/s
d = 2.0 m
Vf = 0.5 m/s

L_{min} = 42.43 m

The minimum forebay length is determined by the larger of the settling or dispersion criteria.

Minimum Length of Forebay Required 61.71 m
Length of Forebay Provided 85.00 m (at elevation 92.35 m)

Average Forebay Velocity

From the SWMP Manual, the maximum allowable average velocity is 0.15 m/s:

$$V_{avg} = \frac{Q}{d\,W_{avg}}$$

where:
Q = Inlet flowrate (10-Year, 24-Hour SCS Storm)
d = depth of pond during peak 10-year inflow (12h:00min)
W_{avg} = average width of forebay

Input:
Q = 5.304 m^3/s
d = 2.56 m
W_{avg} = 22 m (16 m bottom, 28 m permanent pool)

V = 0.09 m/s < 0.15 m/s

Date: August 2021
File: 15-764BB

WESTERN DEVELOPMENT LANDS - RICHMOND
City of Ottawa
SWM Pond 1
North Sediment Drying Area

As per Table 6.3 in the MOE SWMP Manual, the annual sediment loading for this catchments will be 0.60 m^3/ha

Table 6.3 Annual Sediment Loadings

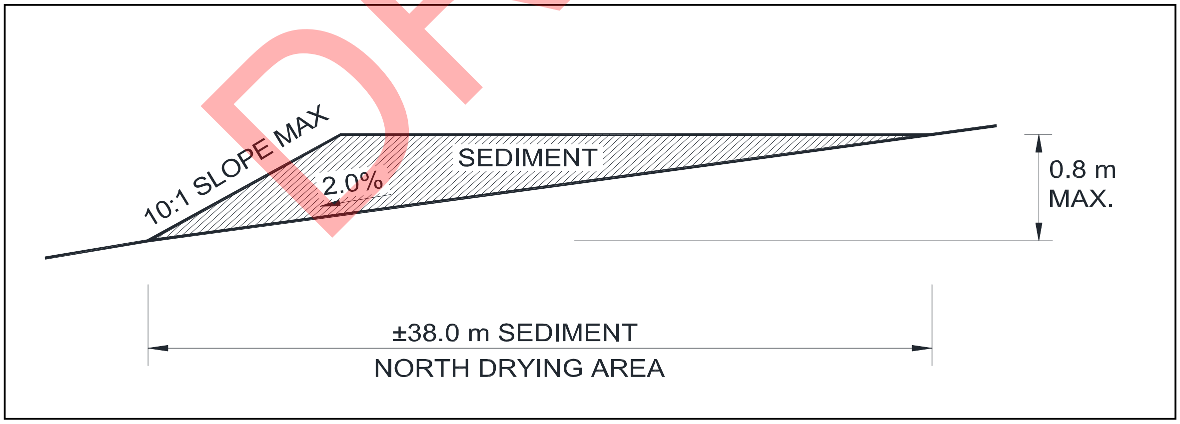
Catchement Imperviousness	Annual Loading (kg/ha)	Wet Density (kg/m^3)	Annual Loading (m^3/ha)
35%	770	1230	0.6
55%	2300	1230	1.9
70%	3495	1230	2.8
85%	4680	1230	3.8

Interpolate for Catchment Imperviousness of 22% - Annual Loading = 0.60 m^3/ha
Total Drainage Area = 140.386 ha

Sediment Drying Volume = min 10 yrs accumulation x annual loading x drainage area

Sediment Drying Volume = (10)*(0.6)*(140.386)

= 842 m^3



Provided Sediment Drying Area Capacity = 1155 m^3

BaseArea= 3800 m^2

Date: August 2021
File: 15-764BB

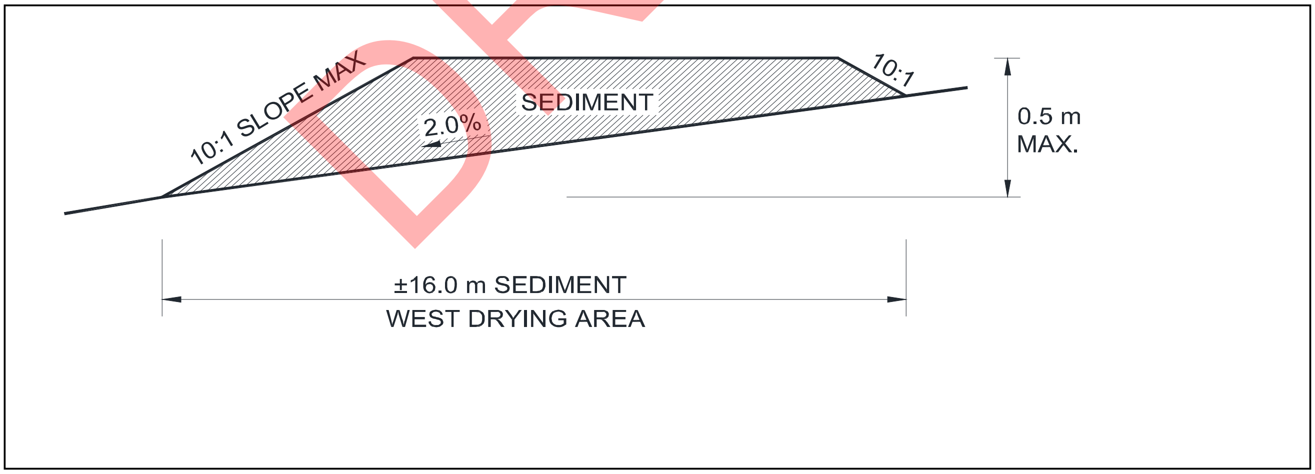
WESTERN DEVELOPMENT LANDS - RICHMOND
City of Ottawa
SWM Pond 1
West Sediment Drying Area

As per Table 6.3 in the MOE SWMP Manual, the annual sediment loading for this catchments will be 1.71 m^3/ha

Table 6.3 Annual Sediment Loadings			
Catchement Imperviousness	Annual Loading (kg/ha)	Wet Density (kg/m^3)	Annual Loading (m^3/ha)
35%	770	1230	0.6
55%	2300	1230	1.9
70%	3495	1230	2.8
85%	4680	1230	3.8

Interpolate for Catchment Imperviousness of 52% - Annual Loading = 1.71 m^3/ha
Total Drainage Area = 7.701 ha

Sediment Drying Volume = min10 yrs accumulation x annual loading x drainage area
Sediment Drying Volume = (10)*(1.71)*(7.701)
= 132 m^3



Provided Sediment Drying Area Capacity = 177 m^3

BaseArea= 704 m^2

Date: August 2021
File: 15-764BB

WESTERN DEVELOPMENT LANDS - RICHMOND
City of Ottawa
SWM Pond 1
South Sediment Drying Area

As per Table 6.3 in the MOE SWMP Manual, the annual sediment loading for this catchments will be 2.56 m^3/ha

Table 6.3 Annual Sediment Loadings

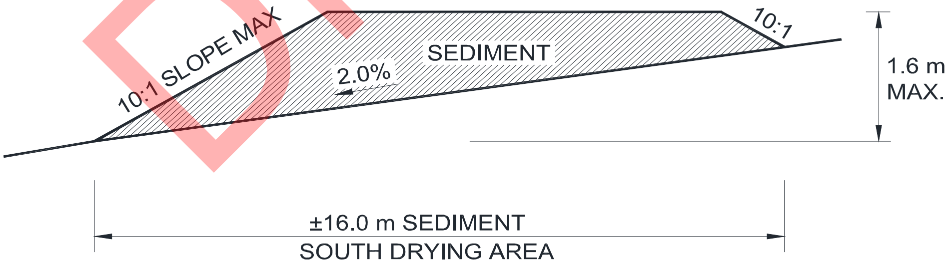
Catchement Imperviousness	Annual Loading (kg/ha)	Wet Density (kg/m^3)	Annual Loading (m^3/ha)
35%	770	1230	0.6
55%	2300	1230	1.9
70%	3495	1230	2.8
85%	4680	1230	3.8

Interpolate for Catchment Imperviousness of 66% - Annual Loading =	2.56 m^3/ha
Total Drainage Area =	54.309 ha

Sediment Drying Volume = min 10 yrs accumulation x annual loading x drainage area

Sediment Drying Volume = (10)*(2.56)*(54.309)

= 1390 m^3



Provided Sediment Drying Area Capacity = 628 m^3

BaseArea= 960 m^2

Chapter 25

City of Etobicoke Exfiltration and Filtration Systems Pilot/Demonstration Project

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The timely development of the Etobicoke Exfiltration System (EES) occurred at a period when engineers, biologists and scientists were actively investigating infiltration as a technique to manage stormwater.

In most areas which can be significantly impacted by urbanization, infiltration is a major component of the hydrologic cycle. Consequently, the reduction in pervious land cover due to urbanization has a direct and detrimental impact on fluvial geomorphology, erosion, water temperature, chemistry, aquatic environment (fisheries) and adjacent terrestrial environments.

Candaras, A.M., L. Carvalho and M-K. Koo. 1995. "City of Etobicoke Exfiltration and Filtration Systems Pilot/ Demonstration Project." *Journal of Water Management Modeling* R183-25. doi: 10.14796/JWMM.R183-25.
www.chijournal.org ISSN: 2292-6062 (Formerly in Modern Methods for Modeling the Management of Stormwater Impacts. ISBN: 0-9697422-4-X)

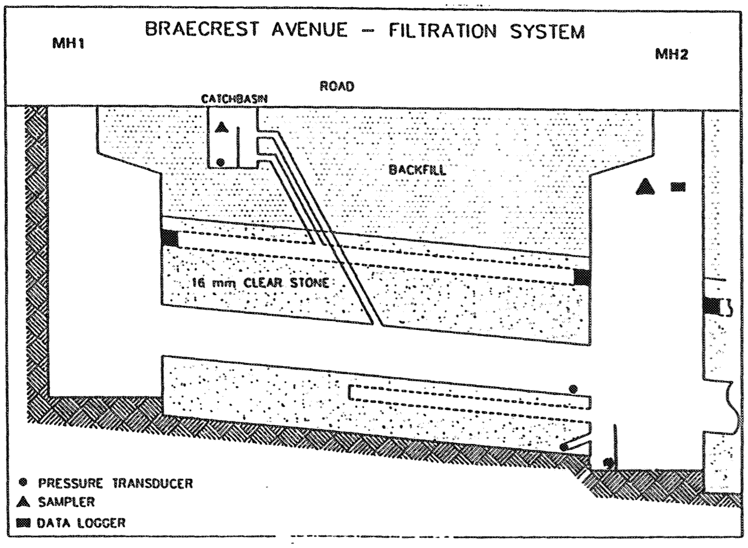


Figure 25.3
Braecrest Avenue filtration system - longitudinal section.

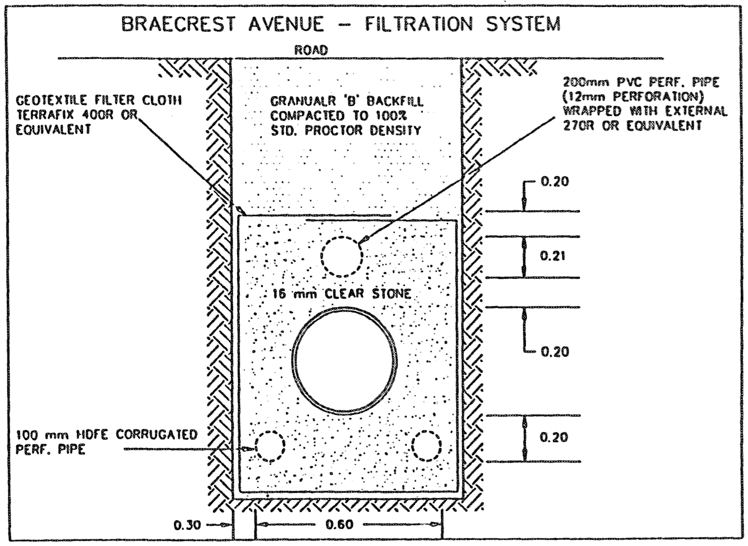


Figure 25.4
Braecrest Avenue filtration system - cross section.

geotechnical investigation was carried out in which seven boreholes were dug between January 18 to 20 1993. The borehole locations were chosen based on proximity to storm sewer and sanitary sewer crossings. The investigation confirmed that the subsurface soils were dominated by silty clay to clayey silt till underlain by silty sand till.

The underlying soils were observed to be very dense due to the geomorphological processes which created them. Thus the hydraulic conductivity of these soils were lower than would normally be expected for these soil types. Quantification of this characteristic was accomplished by carrying out falling-head tests on all of the boreholes. The hydraulic conductivity for the silty sand to sandy silt till ranged from $6x10^{-6}$ m/s to $1x10^{-7}$ m/s.

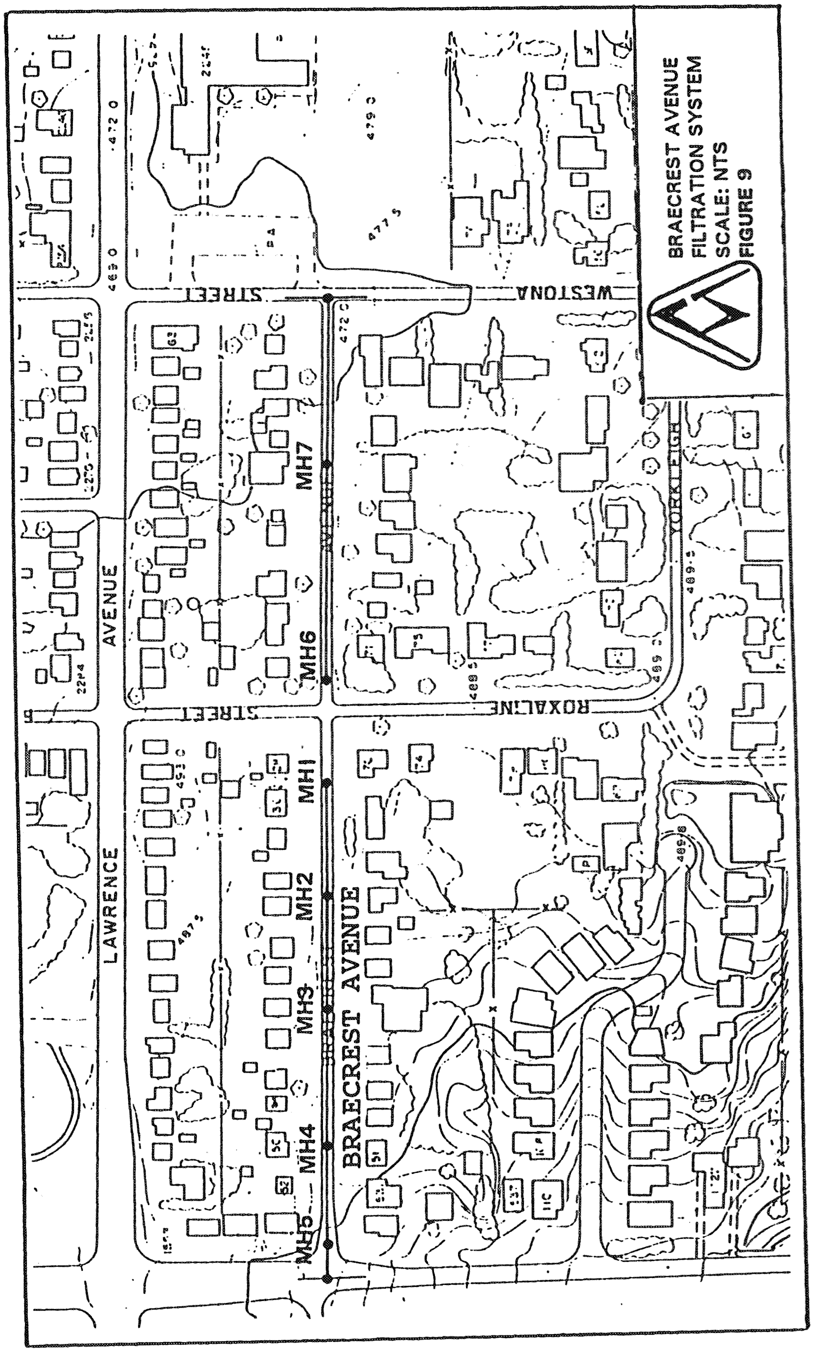
All boreholes were dry on completion of drilling. Depth of drilling ranged from approximately 4.5 m to 14.0 m below ground surface.

25.3.3 Braecrest Road - Filtration System

The Braecrest Road (Fig 25.7) study area has a tributary area of 2.38 ha of low-density residential housing. The site drains to the west, at approximately 2% to Royal York Road. The high point of Braecrest Road in this area is approximately at the intersection of Braecrest Avenue and Roxaline Street. East of this high point Braecrest drains to Westona Street. The similarity of the east and west draining areas is further discussed below in the monitoring section. The roadway is presently ditched, but will be "upgraded" to curb and gutter.

A geotechnical investigation was carried out during which two boreholes were drilled on Royal York Road. Study results suggested that the controlling soil types are brown silty clay and dark grey organic sand loam with organic matter. Additional soils records from the City of Etobicoke show that on Braecrest Avenue the dominant soils are clay loam. Local well records indicate that the upper soils in the area (up to 7 m deep) are brown clays. These studies corroborate the dominance of relatively impervious soils in the area of the proposed system.

Records of water table locations are not available for this site. However, this lack of information is not of significance since the filtration system will be used and the site is relatively high in relation to the adjacent lands. Exfiltration to the surrounding soil will not be a feasible method of transporting the stormwater due to the relatively impervious local soils.



25.7 Braecrest Avenue filtration system plan.

connect directly to the storm sewer between MH1 and MH2 at the upstream end of the local drainage system. The four catchbasins connecting to the storm sewer between MH2 and MH4 will be temporarily sealed to prevent runoff entering the monitored section. Only one runoff input source to the monitored section (at MH2) will be allowed, in order to simplify monitoring and increase equipment cost-effectiveness. Road grading will convey this surface runoff downstream of MH3 to the catchbasins between MH3 and MH4. Similar to the Queens Marys Drive site, the exfiltration system upstream of MH2 will be temporarily put off-line by plugging the perforated PVC pipes between MH1 and MH2. System monitoring within the section will be essentially identical to that in the Queens Marys Drive site.

The major difference in monitoring between the two exfiltration sites is that piezometers will not be installed on Princess Margaret Boulevard. A geotechnical investigation suggests that groundwater in the area is located at depths exceeding 15 m below the ground surface. The exfiltration rate from this EES will therefore not be affected by local ground water conditions.

As in the Queen Marys Drive site, monitoring will also be carried out to ascertain the effectiveness of this system on a larger scale. Total flows and water quality will be monitored near the end of the EES at MH7 on Princess Anne Crescent.

25.4.3 The Etobicoke Filtration System

The exfiltration system is not appropriate for the Braecrest Avenue site due to the local low permeability soils. This condition will not permit the exfiltration of the first flush in less than 48 hours. Therefore, the Braecrest site will use the filtration system.

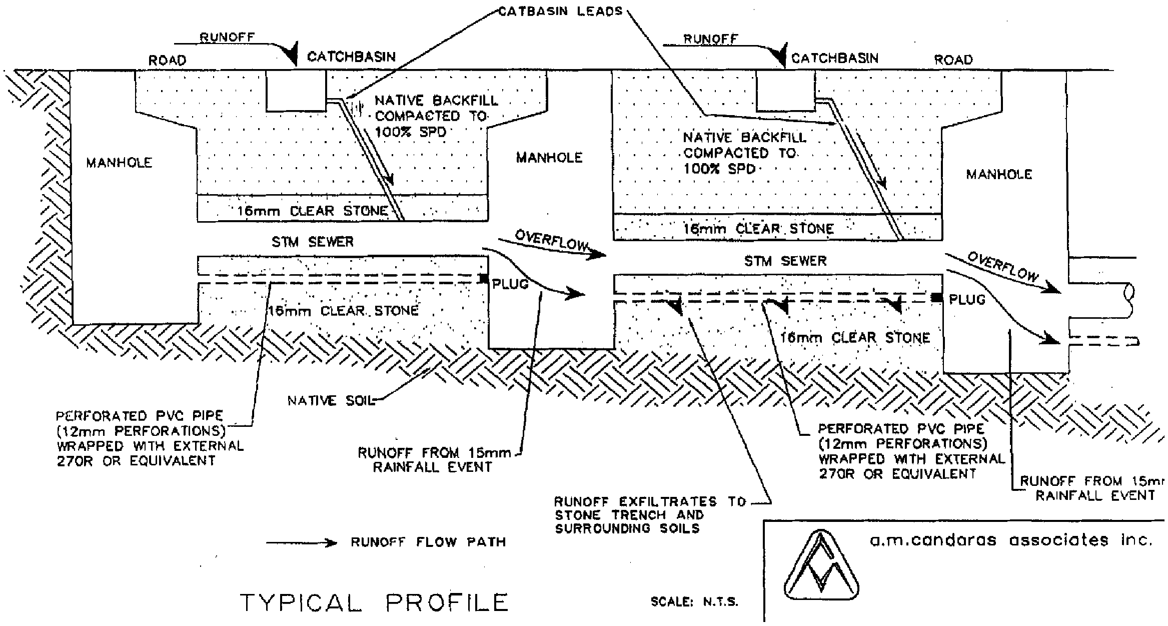
Braecrest Avenue

Monitoring of the EFS will be conducted at the upstream end of the drainage basin. A single catchbasin drains directly into the upstream maintenance hatch (MH1) and two others connect directly into the storm sewer between MH1 and MH2. The catchbasin connected to MH1 and the catchbasin north of the storm sewer between MH1 and MH2 will be temporarily plugged. This will ensure that the only input to the EFS at this section is the single catchbasin. The catchbasin south of the sewer was chosen over the one to the north as it drains a much greater area.

basis in areas of existing development which are undergoing storm sewer rehabilitation or upgrading.

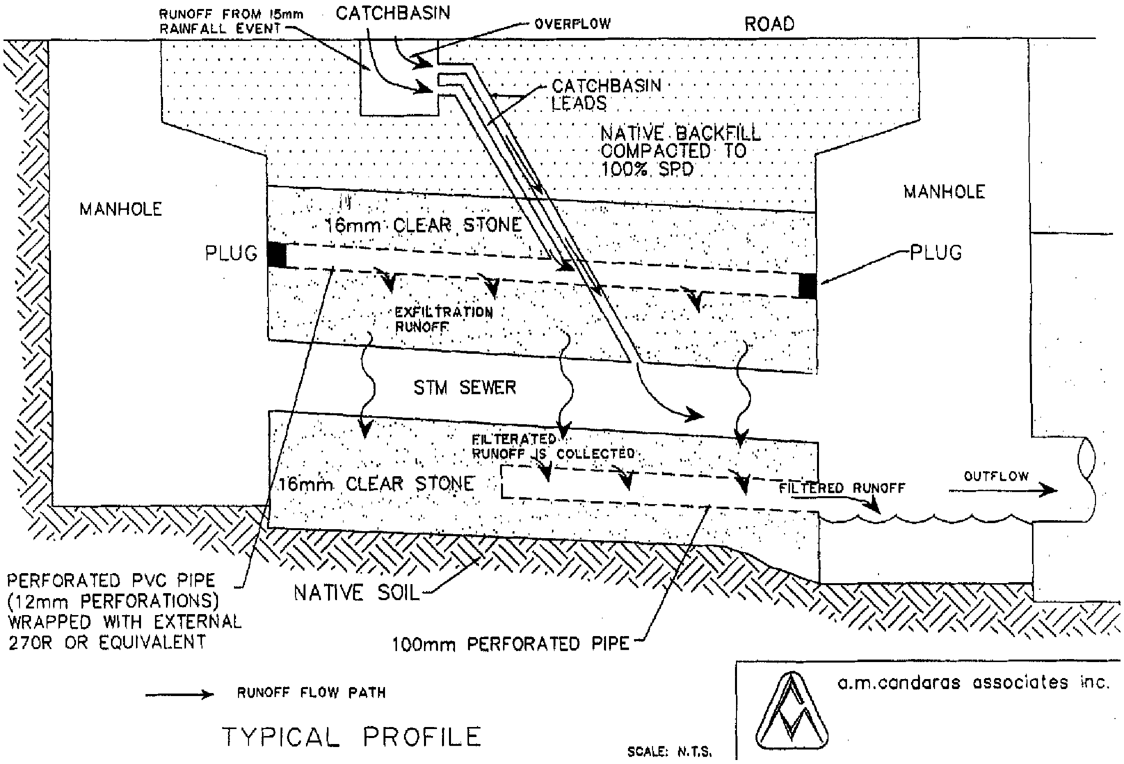
In the Etobicoke system, road runoff is captured in catchbasins and fed into the conventional storm sewer pipe. At the next downstream manhole, flow drops down into a perforated pipe which is plugged at its downstream end. Runoff either exfiltrates, or if the capacity is exceeded, backs up into the conventional storm sewer which conveys it to the next manhole, and eventually to its outlet. The two pipe system provides a contingency conveyance system if the perforated pipe becomes clogged. A double pipe system also allows the perforated pipe to be plugged during the construction phase until the site has stabilized, thereby preventing it from becoming clogged prematurely. The exfiltration system is illustrated in Figure 4.13.

Figure 4.13: Exfiltration System



The exfiltration system is best implemented in areas with pervious soils. A variation on the system uses filtration rather than exfiltration and is applicable to areas with tighter soils. In this variation, flow from the catchbasin is discharged to a length of perforated pipe within a gravel-filled trench (in which the conventional storm sewer is also bedded). The runoff filters down through the trench and is collected by a second perforated pipe at the bottom of the trench. The second pipe conveys flow to the next downstream manhole and into the conventional sewer system. If the trench volume or catchbasin capacity is exceeded, a second, higher level outlet in the catchbasin allows flow to be conveyed to the conventional storm sewer. This configuration is illustrated in Figure 4.14.

Figure 4.14: Filtration System

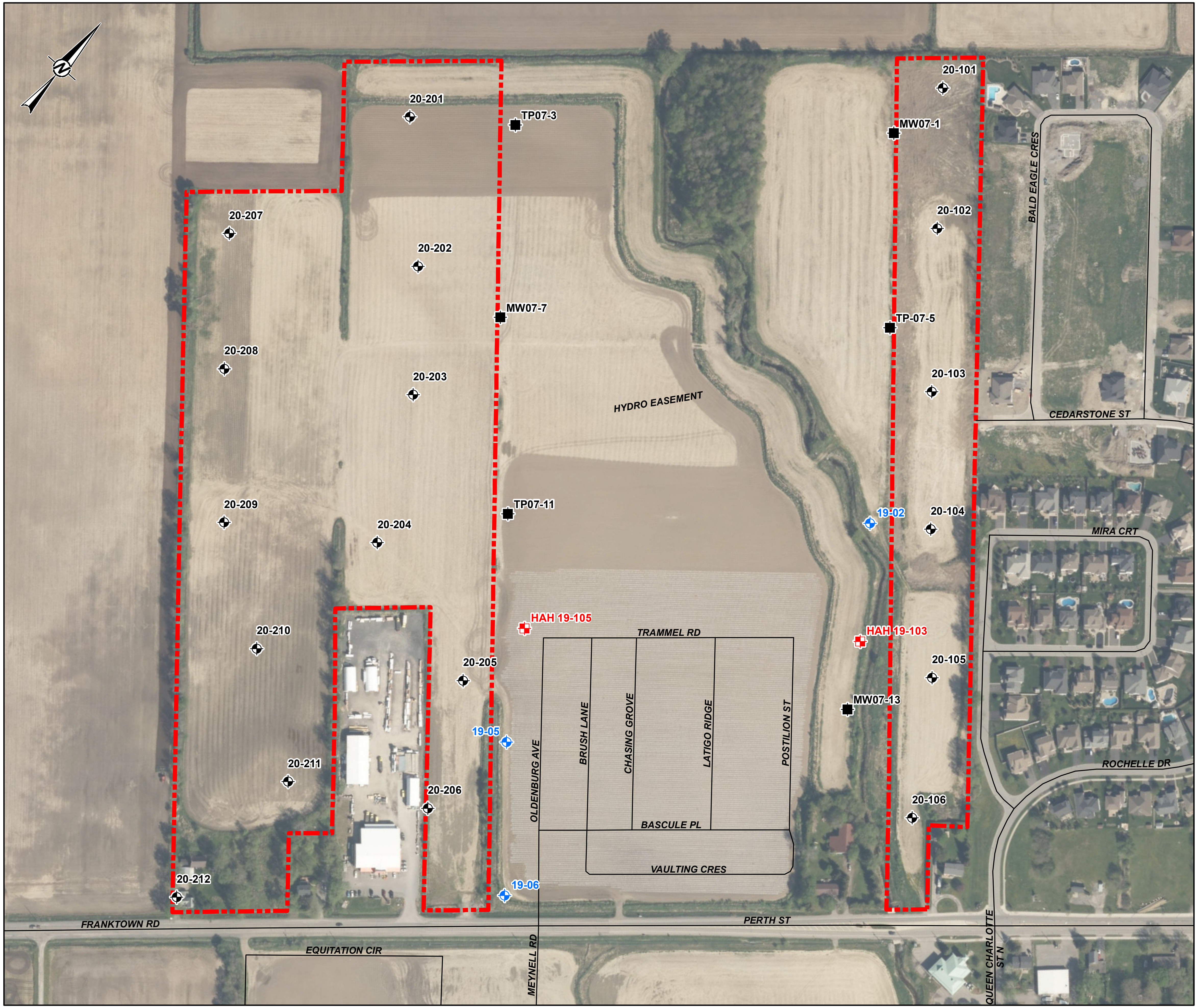


A monitoring program for the Etobicoke systems has been completed (A.M. Candaras Associates Inc., 1997). The study was sponsored by the City of Etobicoke, MOE and the Great Lakes Clean-up Fund (now referred to as the Government of Canada's Great Lakes Sustainability Fund). Two exfiltration systems (serving areas of about 13 and 30 hectares) and a filtration system (serving 2.4 hectares) were monitored. The systems each work very well and may in fact be overdesigned. The design basis for the systems was the runoff from a 15 mm Atmospheric Environment Service (AES) storm and exfiltration to saturated media. There have been no reported overflows of the perforated pipe system and it has been hypothesized that much higher rates of exfiltration are occurring because the media is not saturated. Since there were no outflows from the system, contaminant discharge was eliminated over the period of monitoring.

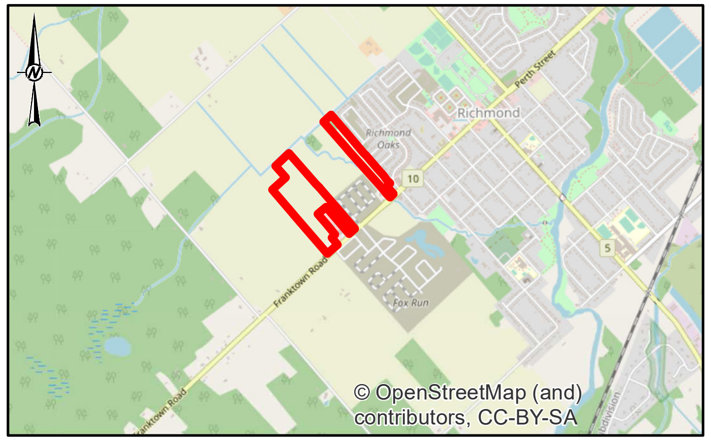
4.5.11 Pervious Catchbasins

Pervious catchbasins are simply normal catchbasins with a larger sump which are physically connected to an exfiltration storage medium. In some designs, the storage medium is connected

APPENDIX F



KEY MAP



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SCALE 1:50,000

LEGEND

⊕	PROPOSED BOREHOLE LOCATION
⊕	APPROXIMATE HAND AUGERHOLE LOCATION, PREVIOUS INVESTIGATION
⊕	APPROXIMATE BOREHOLE LOCATION, PREVIOUS INVESTIGATION
■	APPROXIMATE TESTHOLE LOCATION, PREVIOUS INVESTIGATION BY JACQUES WHITFORD, JUNE 2007
—	ROADWAY
▭	APPROXIMATE SITE BOUNDARY

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: MTM ZONE 9, VERTICAL DATUM: CGVD28

0 30 60 120
1:3,000 METRES

CLIENT
CAIVAN (RICHMOND NORTH) LIMITED

PROJECT
PRELIMINARY GEOTECHNICAL REPORT
GREEN LANDS EAST AND GREEN LANDS WEST

TITLE
SITE PLAN

CONSULTANT
GOLDER

YYYY-MM-DD	2020-06-29
DESIGNED	----
PREPARED	JEM
REVIEWED	KCP
APPROVED	WC

PROJECT NO.	CONTROL	REV.	FIGURE
20144864	0005	0	1

Path: N:\Active\Spatial_IM\Caivan\RichmondProposedSWMP\99_PROJ\20144864_Caivan_Enviro\0005_Geotech_Memo_GreenEW\20144864-0005-BG-0001.mxd

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:
25mm
0

APPENDIX A

Record of Previous Investigations

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of rock material weathering.

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)
The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)
The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)
The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index
A count of the number of naturally occuring discontinuities (physical separations) in the rock core. Mechanically induced breaks caused by drilling are not included.

Dip with Respect to Core Axis
The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^{o} angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

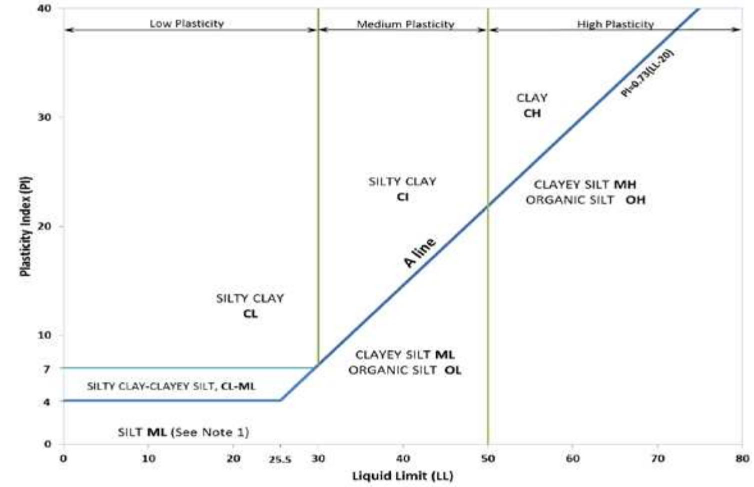
JN	Joint
FLT	Fault
SH	Shear
VN	Vein
FR	Fracture
SY	Stylolite
BD	Bedding
FO	Foliation
CO	Contact
AXJ	Axial Joint
KV	Karstic Void
MB	Mechanical Break
PL	Planar
CU	Curved
UN	Undulating
IR	Irregular
K	Slickensided
PO	Polished
SM	Smooth
SR	Slightly Rough
RO	Rough
VR	Very Rough

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% **(see Note 2)**	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH:	Sampler advanced by hydraulic pressure
PM:	Sampler advanced by manual pressure
WH:	Sampler advanced by static weight of hammer
WR:	Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
$\ln x$	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\,\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l – w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w – w_p) / I_p$
I_C	consistency index = $(w_l – w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} – e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = $\tan \delta$
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes:
1 $\tau = c' + \sigma' \tan \phi'$
2 shear strength = (compressive strength)/2

---

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

PROJECT: 1522173

RECORD OF BOREHOLE: 19-02

SHEET 1 OF 1

LOCATION: N 5005908.9 ;E 355900.6

BORING DATE: April 23, 2019

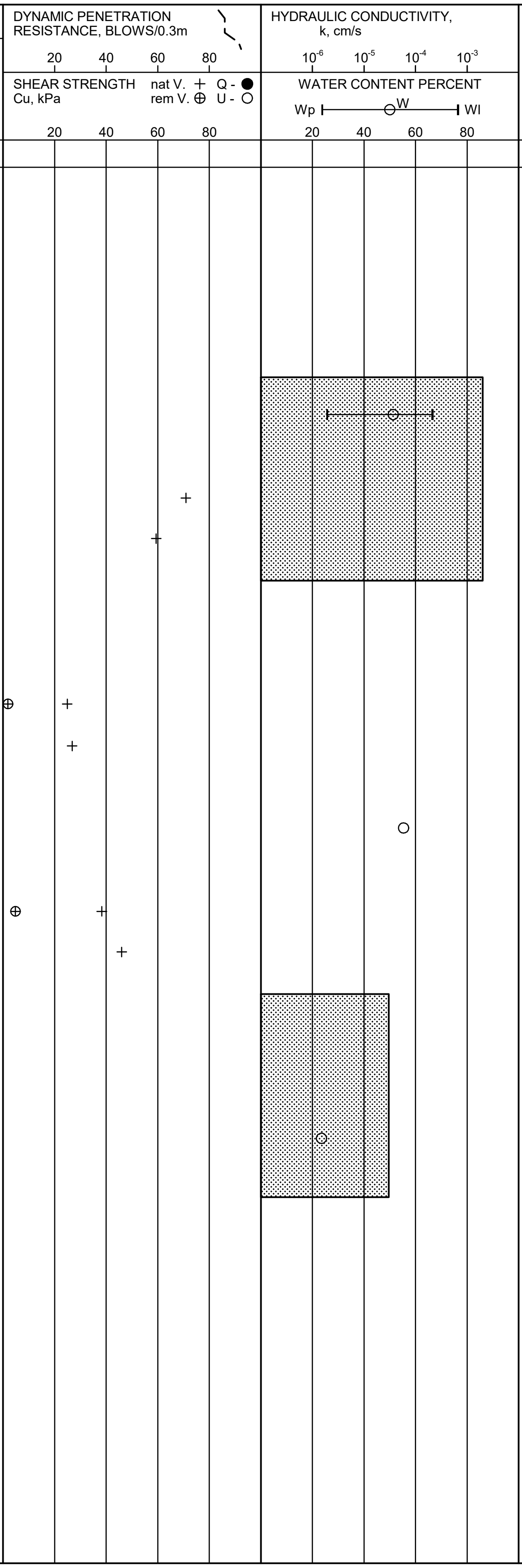
DATUM: Geodetic

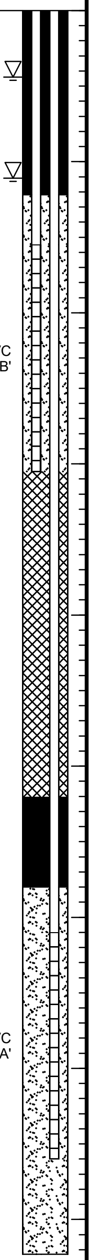
SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

BORING METHOD: Power Auger
200 mm Diam. (Hollow Stem)

SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m
GROUND SURFACE	94.75			
TOPSOIL- (ML) sandy SILT; dark brown	0.00	1	GRAB	-
(CL-ML) CLAYEY SILT to SILTY CLAY; grey brown, fissured, contains silty sand seams (WEATHERED CRUST); cohesive, w<PL, very stiff	94.50 0.25	2	SS	6
(CI/CH) SILTY CLAY to CLAY; grey brown (WEATHERED CRUST); cohesive, w>PL, stiff	93.38 1.37	3	SS	2
(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, firm	91.70 3.05	4 5	TP SS	PH WH
(CI/CH-ML) SILTY CLAY to CLAYEY SILT; grey; cohesive, w>PL	88.65 6.10			
(ML) sandy SILT; grey; non-cohesive, wet, loose to very loose	88.35 6.40	6 7 8	SS SS SS	4 7 2
End of Borehole	86.52 8.23			





WL in screen 'A' at Elev. 94.31 m on May 6, 2019

WL in screen 'B' at Elev. 93.64 m on May 6, 2019

DEPTH SCALE
1 : 50

GOLDER

LOGGED: PAH
CHECKED: WAM

PROJECT: 1522173

RECORD OF BOREHOLE: 19-06

SHEET 1 OF 1

LOCATION: N 5005503.4 ;E 355883.6

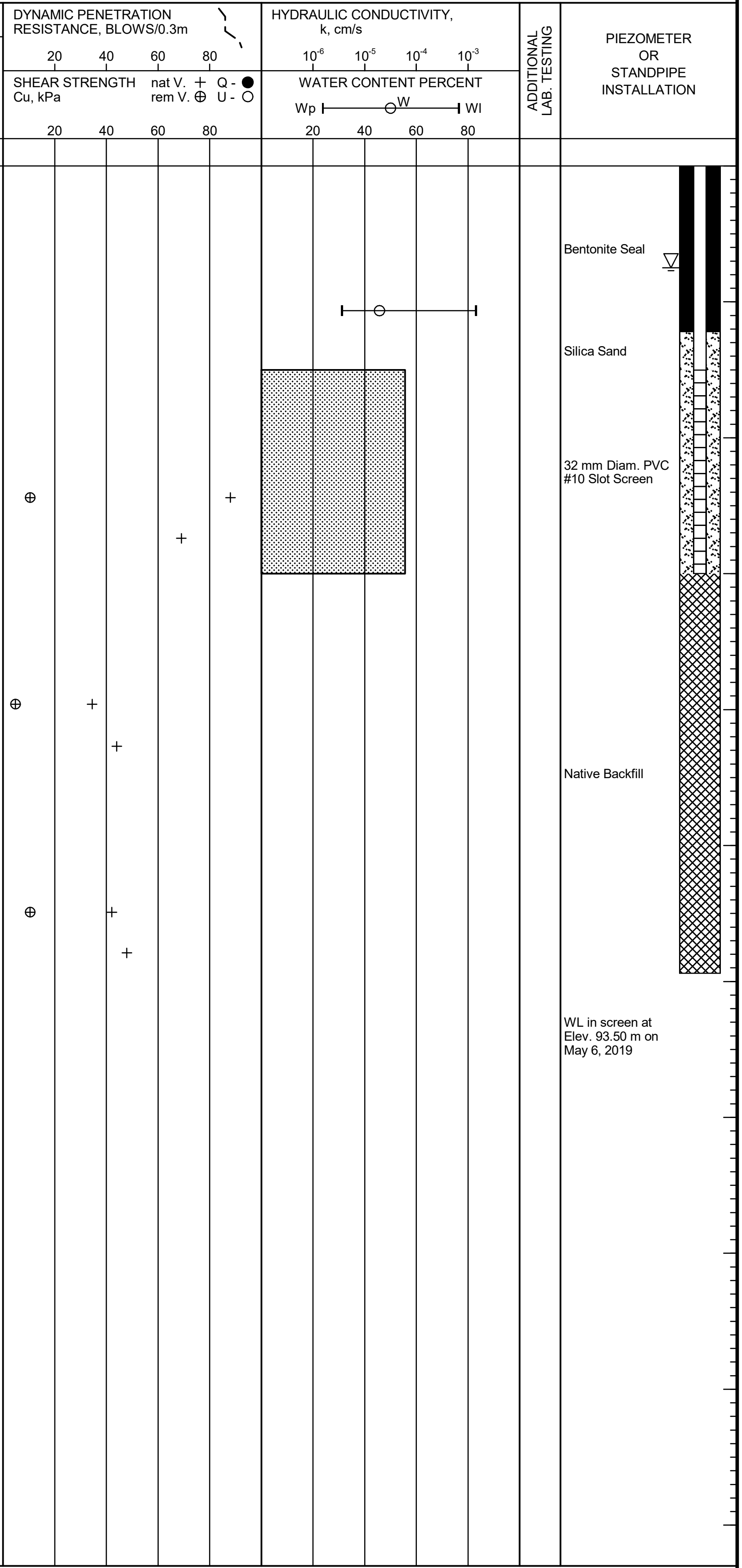
BORING DATE: April 25, 2019

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.30m
		GROUND SURFACE		94.25			
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (CL) SILTY CLAY; dark brown		0.00	1	AS	-
		(CI/CH) SILTY CLAY to CLAY; grey brown, contains silty sand seams (WEATHERED CRUST); cohesive, w>PL very stiff to stiff		94.03 0.22			
1					2	SS	7
2					3	SS	5
3		(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL, firm		91.20 3.05	4	SS	1
4							
5		(CI/CH-ML) SILTY CLAY, CLAYEY SILT and sandy SILT; grey, laminated; cohesive, w>PL, firm		89.68 4.57	5	TP	PH
6		End of Borehole Auger Refusal		88.31 5.94			
7							
8							
9							
10							



DEPTH SCALE

1 : 50

GOLDER

LOGGED: PAH

CHECKED: WAM

TABLE 1

RECORD OF HAND AUGERHOLES

Hand Augerhole Number	Depth (metres)	Description
19-103	0.0 – 0.3	TOPSOIL – (ML) CLAYEY SILT some sand; brown; non-cohesive, moist
	0.3 – 0.5	(ML) CLAYEY SILT, some sand; brown (WEATHERED CRUST); cohesive, w>PL
	0.5 – 1.9	(ML-CI/CH) CLAYEY SILT to SILTY CLAY, trace to some sand; grey brown (WEATHERED CRUST); cohesive, w>PL
	1.9 – 2.5	(CI/CH) SILTY CLAY to CLAY trace sand; grey; cohesive, w>PL
	2.50	END OF AUGERHOLE

Note: water seepage at 1.1 m depth upon completion

Sample	Depth (m)	Lab Testing
1	1.1 – 1.5	w_n = 51%, PI=35%, LL=56%
2	1.5 – 1.9	
3	1.9 – 2.3	
4	2.3 – 2.5	

19-105	0.00 – 0.20	TOPSOIL – (ML) CLAYEY SILT some sand; brown; non-cohesive, moist
	0.20 – 1.60	(CI/CH-ML) SILTY CLAY to CLAYEY SILT, some sand; grey brown (WEATHERED CRUST); cohesive, w>PL
	1.60 – 2.00	(CI/CH) SILTY CLAY to CLAY; grey brown (WEATHERED CRUST); cohesive, w>PL
	2.00 – 2.50	(CI/CH) SILTY CLAY to CLAY; grey; cohesive, w>PL
	2.50	END OF AUGERHOLE

Note: water seepage at 1.1 m depth upon completion

Sample	Depth (m)	Lab Testing
1	0.7 – 1.1	w_n = 43%, PI=27%, LL=52%
2	1.1 – 1.6	
3	1.6 – 2.0	
4	2.0 – 2.5	

Jacques Whitford

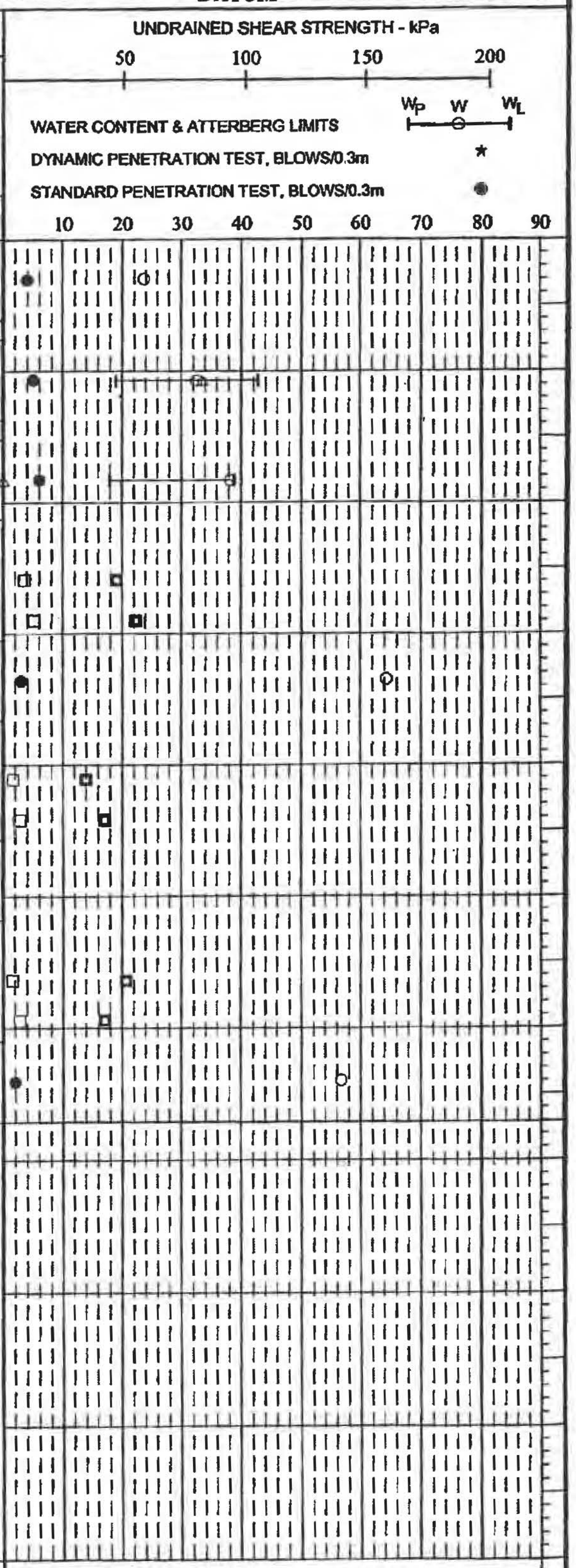
MONITORING WELL RECORD

MW07-1

1 of 1

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 18, 2007 WATER LEVEL June 20, 2007
BOREHOLE No. MW07-1
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	100.32							
	100.2	150 mm TOPSOIL						
		Firm to stiff, greyish brown lean CLAY (CL)			SS	1	300	4
1				▼	SS	2	610	5
2				▽	SS	3	610	6
3	97.3	Firm to stiff, grey lean CLAY			SS	4	610	3
4								
5					ST	5	610	
6	93.8				SS	6	610	2
	93.6	Very loose, grey SANDY SILT (ML)						
7		End of Borehole Monitoring Well Installed						
8								
9								
10								



▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

▣ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

Jacques Whitford

1 of 1

MONITORING WELL RECORD

MW07-7

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

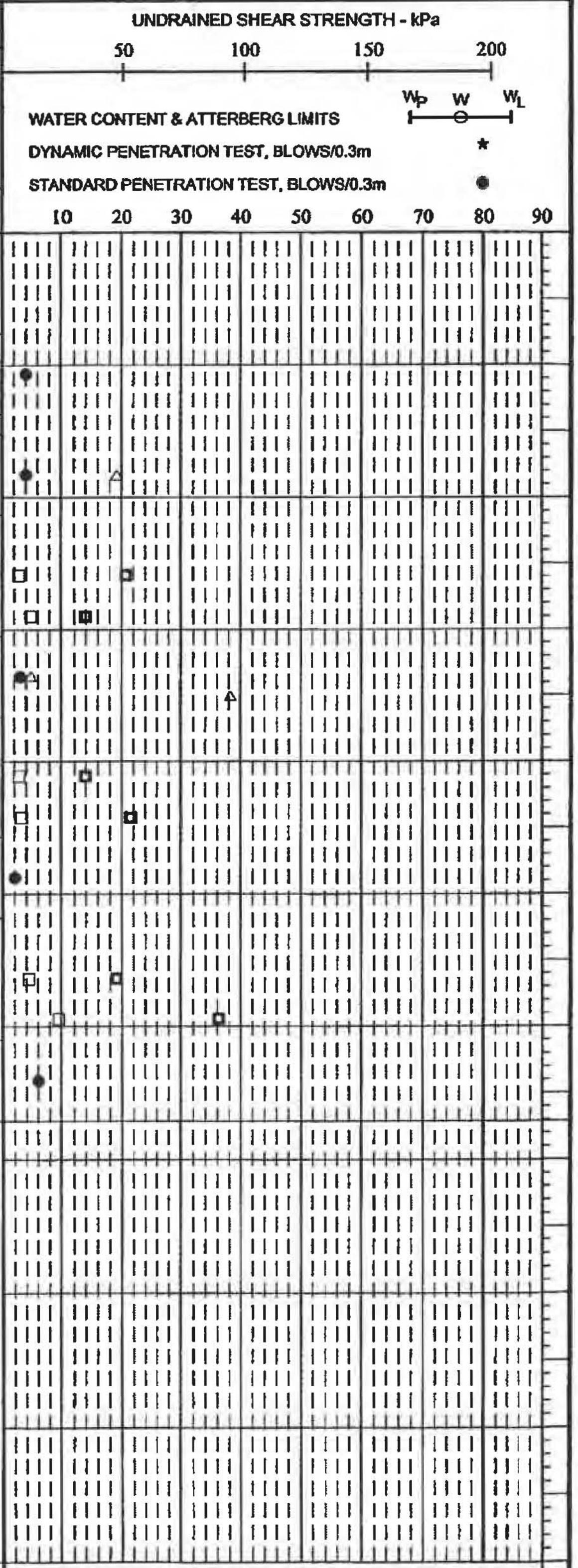
DATES: BORING June 18, 2007 WATER LEVEL June 20, 2007

BOREHOLE No. MW07-7

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.21	Firm to stiff, greyish brown lean CLAY (CL)	▨					
1			▨		SS	1	610	4
			▨	▼				
			▨		SS	2	610	4
2			▨					
3	97.2	Firm to stiff, grey lean CLAY	▨	▽	SS	3	610	3
4			▨					
5			▨		SS	4	610	2
6			▨					
	93.8	Loose, grey SANDY SILT (ML)			SS	5	150	6
	93.5	End of Borehole Monitoring Well Installed						
7								
8								
9								
10								



▽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

◘ Field Vane Test, kPa

☐ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd ______

Date ______

JWL-OLD 1026929.GPJ SMART.GDT 07/06/22

Jacques Whitford

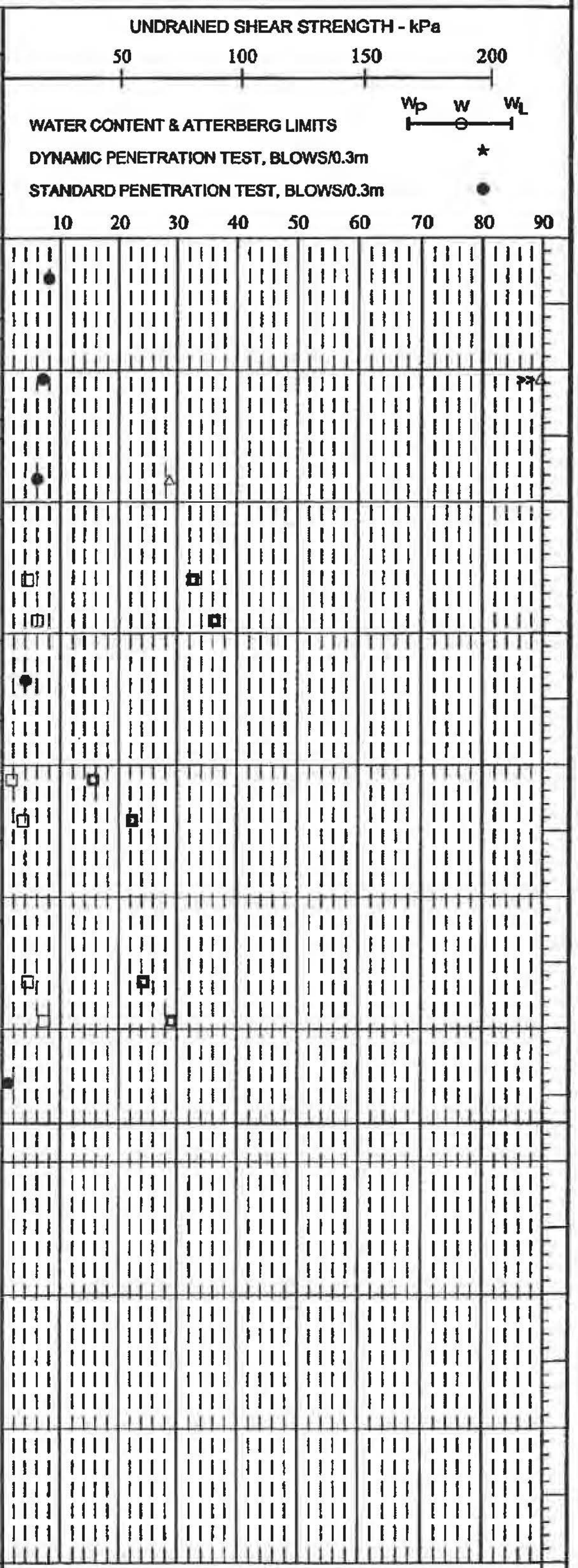
MONITORING WELL RECORD

MW07-13

1 of 1

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 18, 2007 WATER LEVEL June 20, 2007
BOREHOLE No. MW07-13
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	NUMBER	RECOVERY (mm)	N-VALUE OR RQD
0	99.30	Stiff, greyish brown lean CLAY (CL)			SS	1	120	8
1				▼	SS	2	75	7
2					SS	3	610	6
3	96.3	Firm to stiff, grey lean CLAY		▽	SS	4	40	4
5					ST	5	610	
6	93.2	Very loose, grey SANDY SILT (ML)			SS	6	300	1
	92.6	End of Borehole Monitoring Well Installed						



▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

▣ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd ____
Date ____

Jacques Whitford

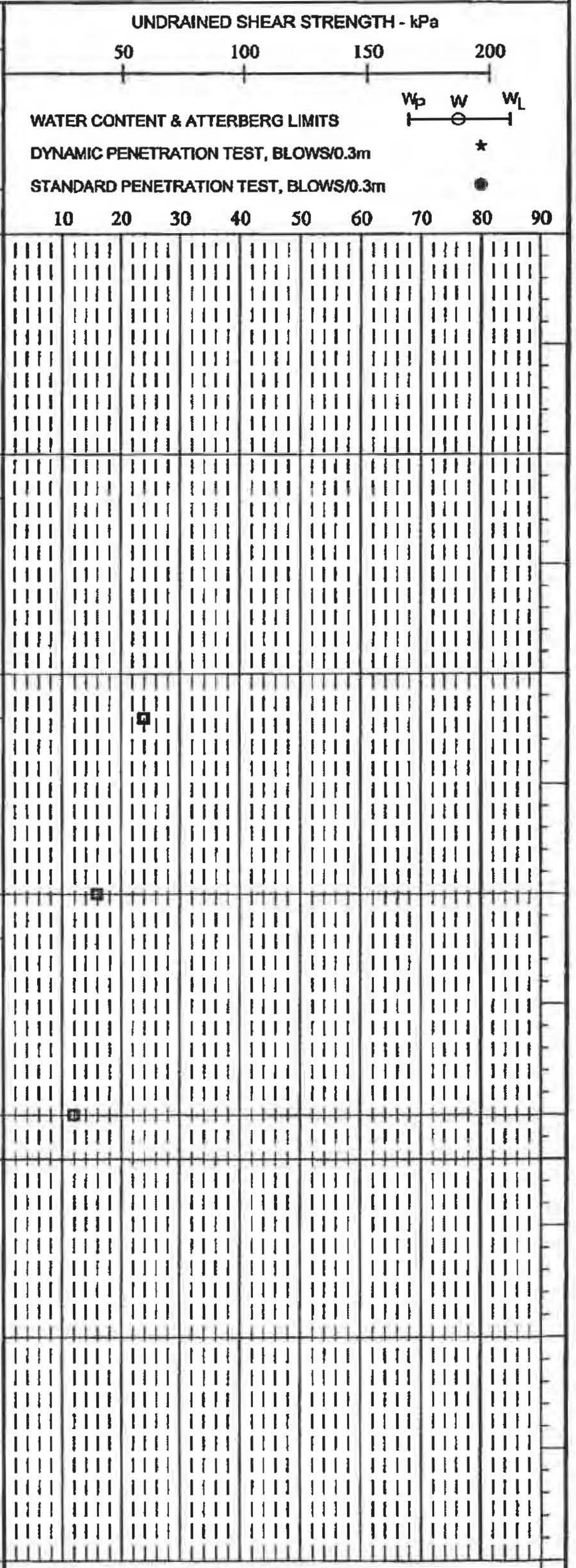
TEST PIT RECORD

TP07-3

1 of 1

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 16, 2007 WATER LEVEL
BOREHOLE No. TP07-3
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.27	230 mm TOPSOIL						
	100.0	Stiff, greyish brown lean CLAY (CL)		▽				
1					BS	1		
2					BS	2		
	97.7	Firm, grey lean CLAY (CL)						
3					BS	3		
4					BS	4		
	96.1	End of Borehole						
5								
6								



▽ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

◘ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd ______
Date ______

JWL-OLD 1026929.GPJ SMART.GDT 07/06/21

Jacques Whitford

TEST PIT RECORD

TP07-5

1 of 1

CLIENT Mattamy Homes

LOCATION Proposed Subdivision, Richmond, ON

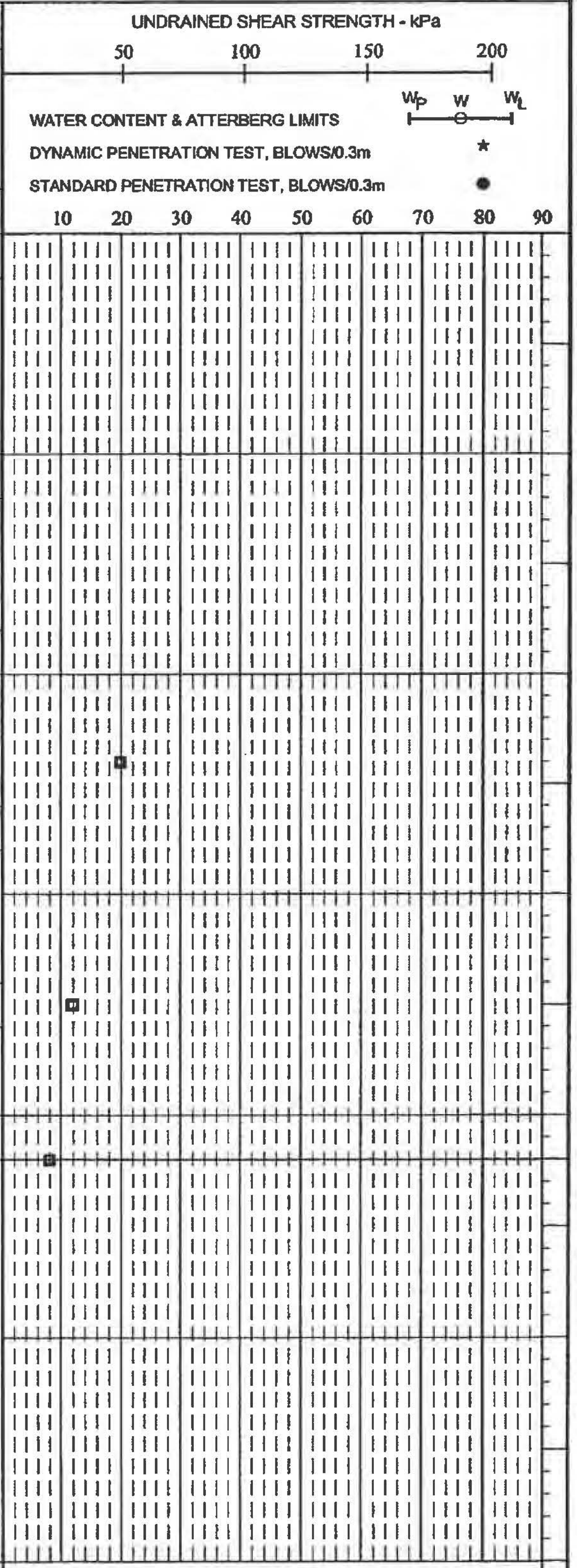
DATES: BORING June 16, 2007 WATER LEVEL

BOREHOLE No. TP07-5

PROJECT No. 1026929

DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	100.11	250 mm TOPSOIL			BS	1		
	99.9	Stiff, greyish brown lean CLAY (CL)	▨	⊽				
1					BS	2		
					BS	3		
2	98.1	Firm, grey lean CLAY (CL)	▨					
					BS	4		
3								
					BS	5		
4					BS	6		
	95.9	End of Borehole						
5								
6								



⊽ Inferred Groundwater Level

▼ Groundwater Level Measured in Standpipe

◘ Field Vane Test, kPa

□ Remoulded Vane Test, kPa

△ Pocket Penetrometer Test, kPa

App'd

Date

JWL-OLD 1026929.GPJ SMART.GDT 07/06/21

Jacques Whitford

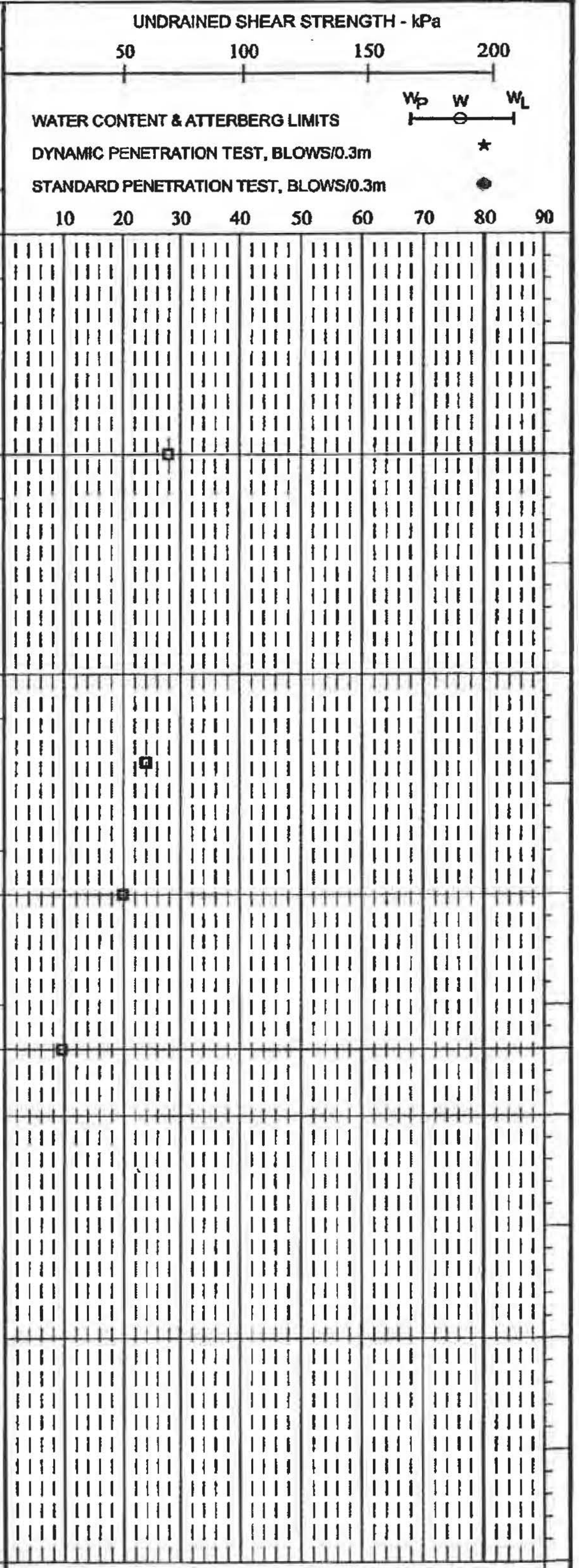
TEST PIT RECORD

TP07-11

1 of 1

CLIENT Mattamy Homes
LOCATION Proposed Subdivision, Richmond, ON
DATES: BORING June 16, 2007 WATER LEVEL
BOREHOLE No. TP07-11
PROJECT No. 1026929
DATUM Local

DEPTH (m)	ELEVATION (m)	SOIL DESCRIPTION	STRATA PLOT	WATER LEVEL	SAMPLES TYPE	SAMPLES NUMBER	SAMPLES RECOVERY (mm)	SAMPLES N-VALUE OR RQD
0	99.89	250 mm TOPSOIL						
	99.6	Stiff, brown and grey lean CLAY (CL)			BS	1		
				∇				
1					BS	2		
2					BS	3		
					BS	4		
3	96.9	Firm, grey lean CLAY (CL)						
	96.2				BS	5		
		End of Borehole						
4								
5								
6								



∇ Inferred Groundwater Level
▼ Groundwater Level Measured in Standpipe

▣ Field Vane Test, kPa
□ Remoulded Vane Test, kPa
△ Pocket Penetrometer Test, kPa

App'd
Date

LEGEND

⌖ PROPOSED BOREHOLE LOCATION

● EXISTING BOREHOLE LOCATION

— ROADWAY

▭ APPROXIMATE SITE BOUNDARY

NOTE(S)

1. ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83,
COORDINATE SYSTEM: MTM ZONE 9, VERTICAL DATUM: CGVD28

DRAFT

0 20 40 80

1:2,000 METRES

CLIENT
CAIVAN (RICHMOND NORTH) LIMITED

PROJECT
PRELIMINARY GEOTECHNICAL REPORT
LAFFIN PARCEL

TITLE
SITE PLAN, PREVIOUS AND PROPOSED TESTHOLE LOCATIONS

CONSULTANT

GOLDER

YYYY-MM-DD	2020-07-01
DESIGNED	----
PREPARED	JEM
REVIEWED	KM
APPROVED	CH

PROJECT NO.	CONTROL	REV.	FIGURE
20144864	0006	A	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM:

25mm

0

Path: N:\Active\Spatial_IM\Caivan\RichmondProposedSWMP\99_PROJ\20144864_Caivan_Enviro\0006_Geotech_Prelim_Report_LaffinParcel\20144864-0006-BG-0001.mxd

APPENDIX A

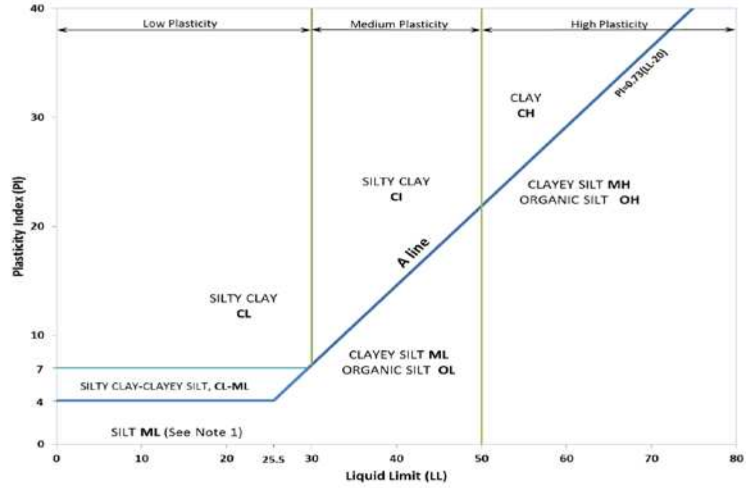
Record of Previous Investigations

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10}xD_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% **(see Note 2)**	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.

Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.

For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.

For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.

A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH:	Sampler advanced by hydraulic pressure
PM:	Sampler advanced by manual pressure
WH:	Sampler advanced by static weight of hammer
WR:	Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\,\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma$ - u)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation
w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c'	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of rock material weathering.

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)

The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)

The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)

The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index

A count of the number of naturally occuring discontinuities (physical separations) in the rock core. Mechanically induced breaks caused by drilling are not included.

Dip with Respect to Core Axis

The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^o angle is horizontal.

Description and Notes

An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint
FLT	Fault
SH	Shear
VN	Vein
FR	Fracture
SY	Stylolite
BD	Bedding
FO	Foliation
CO	Contact
AXJ	Axial Joint
KV	Karstic Void
MB	Mechanical Break
PL	Planar
CU	Curved
UN	Undulating
IR	Irregular
K	Slickensided
PO	Polished
SM	Smooth
SR	Slightly Rough
RO	Rough
VR	Very Rough

PROJECT: 08-1122-0078

RECORD OF BOREHOLE: 10-5

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: Apr. 30, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
0	Power Auger 200mm Diam. (Hollow Stem)	GROUND SURFACE	94.82				
		TOPSOIL	0.00				
		Compact grey brown SILTY fine SAND	0.10				Bentonite Seal
							Silica Sand
1				1	50 DO	15	
							32mm Diam. PVC #10 Slot Screen 'B'
				2	50 DO	5	Silica Sand
2		Compact to very dense grey SANDY SILT, some gravel, trace clay (GLACIAL TILL)	92.84 1.98				Bentonite Seal
							Silica Sand
				3	50 DO	15	
3							
				4	50 DO	>100	32mm Diam. PVC #10 Slot Screen 'A'
4		End of Borehole	90.86 3.96				
5							
6							
7							
8							
9							
10							

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: J.D.
CHECKED: BB

PROJECT: 08-1122-0078

RECORD OF BOREHOLE: 10-6

SHEET 1 OF 2

LOCATION: See Site Plan

BORING DATE: Apr. 30, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ — 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl — 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	ELEV. DEPTH (m)	SAMPLES: NUMBER	TYPE	BLOWS/0.3m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE	95.67				
0	Power Auger 200mm Diam. (Hollow Stem)	TOPSOIL	0.00				
		Loose to compact grey brown SANDY SILT to SILTY SAND, trace clay	95.42 0.25				Bentonite Seal Silica Sand
1				1	50 DO	6	32mm Diam. PVC #10 Slot Screen 'B'
2		Dense to very dense grey brown SANDY SILT, some gravel, cobbles and boulders (GLACIAL TILL)	93.84 1.83	2	50 DO	27	Silica Sand
				3	50 DO	68	Bentonite Seal
3	Rotary Drill NQ Core	Thinly to medium bedded light grey intebedded SANDSTONE and DOLOSTONE BEDROCK	92.60 3.07	4	50 DO	>100	Silica Sand
4				C1	NQ RC	DD	32mm Diam. PVC #10 Slot Screen 'A'
5				C2	NQ RC	DD	
		End of Borehole	90.49 5.18				
6							
7							
8							
9							
10							

MIS-BHS 001 0811220078-9500.GPJ GAL-MIS.GDT 5/19/10 JM

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: J.D.
CHECKED: bb

PROJECT: 08-1122-0078

RECORD OF DRILLHOLE: 10-6

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: Apr. 30, 2010

DATUM:

DRILL RIG: CME 55

INCLINATION: -90° AZIMUTH: ---

DRILLING CONTRACTOR: Marathon Drilling

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR % RETURN	FLUSH	RECOVERY TOTAL CORE % 80 60 40 20	RECOVERY SOLID CORE % 80 60 40 20	R.Q.D. % 80 60 40 20	FRACT. INDEX PER 0.3 5 10 15 20	DISCONTINUITY DATA DIP w.r.t. CORE AXIS 0 30 60 90	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec 10^{-6} 10^{-5} 10^{-4} 10^{-3}	DIAMETRAL POINT LOAD INDEX (MPa) 2 4 6	NOTES WATER LEVELS INSTRUMENTATION
		BEDROCK SURFACE		92.60													
4 5	Rotary Drill NQ Core	Thinly to medium bedded light grey intebedded SANDSTONE and DOLOSTONE BEDROCK		3.07	1												Bentonite Seal Silica Sand 32mm Diam. PVC #10 Slot Screen 'A'
				90.49 5.18													
6 7 8 9 10 11 12 13		End of Borehole															

DEPTH SCALE
1 : 50

Golder Associates

LOGGED: J.D.
CHECKED:

PROJECT: 08-1122-0078

RECORD OF BOREHOLE: 10-7

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: Apr. 29, 2010

DATUM: Geodetic

SAMPLER HAMMER, 64kg; DROP, 760mm

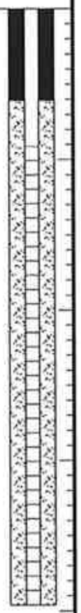
PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES | BORING METHOD | SOIL PROFILE | SAMPLES | DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 | SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80 | HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} | WATER CONTENT PERCENT Wp ⊢——○W——⊣ Wl 20 40 60 80 | ADDITIONAL LAB. TESTING | PIEZOMETER OR STANDPIPE INSTALLATION

Boring method: Power Auger 200mm Diam. (Hollow Stem)

Description	Elev. Depth (m)
GROUND SURFACE	95.36
TOPSOIL	0.00
Stiff grey to brown SILT, trace to some clay, trace fine sand	0.08
Loose grey brown SILTY fine SAND	93.07 2.29
End of Borehole	91.40 3.96

Number	Type	Blows/0.3m
1	50 DO	5
2	50 DO	9
3	50 DO	8
4	50 DO	9



MIS-BHS 001 0811220078-9500.GPJ GAL-MIS.GDT 5/19/10 JM

DEPTH SCALE

1 : 50

Golder Associates

LOGGED: J.D.

CHECKED:

APPENDIX B

Current Investigation - Record of Boreholes

PROJECT: 20144864

RECORD OF BOREHOLE: 20-301

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 23, 2020

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND; dark brown, contains organic matter; moist		0.00							
		(SM) SILTY SAND; grey brown; non-cohesive, moist, very loose to compact		0.11	1	SS	5				
1					2	SS	8				
2					3	SS	24				
		(SM) gravelly SILTY SAND; grey (GLACIAL TILL); non-cohesive, moist, compact		2.13							
		End of Borehole Auger Refusal		2.28							Open borehole dry upon completion of drilling
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE
1 : 50

GOLDER

LOGGED: KM
CHECKED:

PROJECT: 20144864

RECORD OF BOREHOLE: 20-302

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 23, 2020

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE			SAMPLES			DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ├──○W──┤ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	NUMBER	TYPE	BLOWS/0.30m				
		GROUND SURFACE									
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND; dark brown; moist		0.00							
		FILL - (SM) SILTY SAND; red brown; non-cohesive, moist, loose		0.11	1	SS	7				
1		(SM) SILTY SAND; grey brown; non-cohesive, moist, compact		0.76	2	SS	23				
					3	SS	30				
2		(SM) gravelly SILTY SAND; grey (GLACIAL TILL); non-cohesive, moist, compact to dense		2.29	4	SS	35				
		End of Borehole Auger Refusal		2.77							
3											Open borehole dry upon completion of drilling
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: KM

CHECKED:

PROJECT: 20144864

RECORD OF BOREHOLE: 20-303

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 23, 2020

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 / SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} / WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND; dark brown, contains organic matter; moist		0.00							
		FILL - (SM) SILTY SAND; grey brown, mottled, contains organic matter; non-cohesive, moist, loose		0.11	1	SS	5				
1		(SM) SILTY SAND; grey brown; non-cohesive, moist, compact to very dense		0.61	2	SS	16				
					3	SS	57/ 0.28				
2		End of Borehole Auger Refusal		1.96							Open borehole dry upon completion of drilling
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: KM

CHECKED:

PROJECT: 20144864

RECORD OF BOREHOLE: 20-304

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 24, 2020

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 20 40 60 80

ADDITIONAL LAB. TESTING

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE					
0	Power Auger 200 mm Diam. (Hollow Stem)	FILL - (SM) SILTY SAND; grey brown; non-cohesive, moist, loose	0.00	1	SS	7	Bentonite Seal
1		(SM) SILTY SAND; grey brown; non-cohesive, moist to wet, compact	0.61	2	SS	10	Silica Sand
				3	SS	20	
2		(SM/ML) gravelly SAND and SILT; grey, with cobbles and boulders (GLACIAL TILL); non-cohesive, wet, loose to compact	2.13	4	SS	4	38 mm Diam. PVC #10 Slot Screen
3				5	SS	16	∇
4				6	SS	17	
5				7	SS	16	
		End of Borehole	5.18				WL in open borehole at 3.57 m depth below ground surface upon completion of drilling
6							
7							
8							
9							
10							

DEPTH SCALE
1 : 50

GOLDER

LOGGED: DG
CHECKED:

PROJECT: 20144864

RECORD OF BOREHOLE: 20-305

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 23, 2020

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) WATER CONTENT PERCENT Wp ├──○W──┤ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND; dark brown, contains organic; moist		0.00							
		FILL - (SM) SILTY SAND; brown, mottled, contains organic matter; non-cohesive, moist, loose		0.10	1	SS	6				
1		(SM) SILTY SAND; grey brown; non-cohesive, moist, compact to loose		0.76	2	SS	10				
2					3	SS	9				
		(SM) gravelly SILTY SAND; grey (GLACIAL TILL); non-cohesive, moist, loose		2.29	4	SS	6				
3					5	SS	50/ 0.03				
		End of Borehole Auger Refusal		3.07							Open borehole dry upon completion
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: KM

CHECKED:

PROJECT: 20144864

RECORD OF BOREHOLE: 20-306

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 24, 2020

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.3m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80); SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}); WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE								
0	Power Auger 200 mm Diam. (Hollow Stem)	FILL - (SM) SILTY SAND; grey brown; non-cohesive, moist, loose	0.00	1	SS	6				
		(ML) sandy CLAYEY SILT; grey brown, contains silty sand layers; cohesive, w~PL, stiff	0.61	2	SS	3				
				3	SS	10				
				4	SS	7				
3		(SM/ML) SAND and SILT; grey brown; non-cohesive, wet, compact	2.90	5	SS	14				∇
		(SM/ML) gravelly SAND and SILT; grey, with cobbles and boulders (GLACIAL TILL); non-cohesive, wet	3.66	6	SS	51				
		End of Borehole Auger Refusal	4.26							WL in open borehole at 3.55 m depth below ground surface upon completion of drilling

DEPTH SCALE

1 : 50

GOLDER

LOGGED: DG

CHECKED:

PROJECT: 20144864

RECORD OF BOREHOLE: 20-307

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 24, 2020

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl 20 40 60 80

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE							
0	Power Auger 200 mm Diam. (Hollow Stem)	FILL - (SM) SILTY SAND; grey brown; non-cohesive, moist, loose		0.00	1	SS	5		
1		(ML) sandy CLAYEY SILT; grey brown, contains silty sand layers; cohesive, w~PL, very stiff		0.76	2	SS	4		
2					3	SS	12		
					4	SS	55/ 0.23		
3	Rotary Drill NQ Core	Fresh, medium bedded, grey, medium to strong LIMESTONE BEDROCK		2.66	5	RC	DD		
4		End of Borehole		4.31					
5									
6									
7									
8									
9									
10									

DEPTH SCALE

1 : 50

GOLDER

LOGGED: DG

CHECKED:

PROJECT: 20144864

RECORD OF BOREHOLE: 20-308

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 23, 2020

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa: nat V. + Q - ● rem V. ⊕ U - ○ : 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT: Wp ⊢—○W—⊣ Wl : 20 40 60 80

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE						
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL/FILL - (SM) SILTY SAND; dark brown, contains organic matter; non-cohesive, moist	0.00	1	SS	6		
		(SM) SILTY SAND; grey; non-cohesive, moist, loose to compact	0.30	2	SS	4		
				3	SS	16		
2		(SM) gravelly SILTY SAND; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, moist, very dense	2.13	4	SS	50/ 0.25		
		End of Borehole Auger Refusal	2.51					WL in open borehole dry upon completion of drilling

DEPTH SCALE

1 : 50

GOLDER

LOGGED: KM

CHECKED:

PROJECT: 20144864

RECORD OF BOREHOLE: 20-309

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 24, 2020

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ├──○W──┤ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL - (SM) SILTY SAND; dark brown, with rootlets; non-cohesive, moist		0.00	1	SS	8				
1		(SM) SILTY SAND; grey brown; non-cohesive, moist to wet, loose to compact		0.61	2	SS	3				
2					3	SS	12				
					4	SS	10				∇
3					5	SS	50/ 0.05				
	Rotary Drill NQ Core	Slightly weathered to fresh, medium bedded, grey, medium to strong LIMESTONE BEDROCK		3.09	6	RC	DD				
4					7	RC	DD				
5					8	RC	DD				
6											
		End of Borehole		6.32							WL in open borehole at 2.50 m depth below ground surface upon completion of drilling
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: DG

CHECKED:

PROJECT: 20144864

RECORD OF BOREHOLE: 20-310

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 24, 2020

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE					
0	Power Auger 200 mm Diam. (Hollow Stem)	FILL - (SM) SILTY SAND; brown; non-cohesive, moist, loose	0.00	1	SS	6	Bentonite Seal
1		(SM) SILTY SAND, fine; grey brown, contains silt layers; non-cohesive, moist to wet, compact	0.76	2	SS	15	Silica Sand
2				3	SS	15	
		(SM/ML) gravelly SAND and SILT; grey, with cobbles and boulders (GLACIAL TILL); non-cohesive, wet, loose to very dense	2.29	4	SS	9	38 mm Diam. PVC #10 Slot Screen
3				5	SS	15	
4				6	SS	21	
5				7	SS	92	
				8	SS	58	
6		End of Borehole	6.09				Water level in open borehole at 1.52 m depth below ground surface upon completion
7							
8							
9							
10							

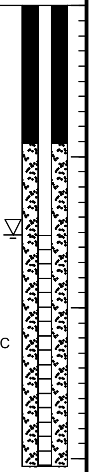
DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m: 20 40 60 80

SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○: 20 40 60 80

HYDRAULIC CONDUCTIVITY, k, cm/s: 10^{-6} 10^{-5} 10^{-4} 10^{-3}

WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl: 20 40 60 80

ADDITIONAL LAB. TESTING



DEPTH SCALE

1 : 50

GOLDER

LOGGED: DG

CHECKED:

PROJECT: 20144864

RECORD OF BOREHOLE: 20-311

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 23, 2020

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	TYPE	BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢ ○W ⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL/FILL - (SM) SILTY SAND; dark brown, contains organic matter; moist		0.00	1	SS	3				
1		(SM) SILTY SAND; grey brown to grey, contains layers of clayey silt; non-cohesive, moist, very loose to loose		0.30	2	SS	5				
2		(SM) gravelly SILTY SAND; grey, contains cobbles and boulders (GLACIAL TILL); non-cohesive, moist, compact to very dense		1.52	3 4	SS SS	26 50/ 0.03				
3		End of Borehole Auger Refusal		2.46							Open borehole dry upon completion of drilling
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: KM

CHECKED:

PROJECT: 20144864

RECORD OF BOREHOLE: 20-312

SHEET 1 OF 1

LOCATION: See Site Plan

BORING DATE: June 23, 2020

DATUM:

SAMPLER HAMMER, 64kg; DROP, 760mm

PENETRATION TEST HAMMER, 64kg; DROP, 760mm

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE DESCRIPTION	STRATA PLOT	ELEV. DEPTH (m)	SAMPLES NUMBER	SAMPLES TYPE	SAMPLES BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m 20 40 60 80 SHEAR STRENGTH Cu, kPa nat V. + Q - ● rem V. ⊕ U - ○ 20 40 60 80	HYDRAULIC CONDUCTIVITY, k, cm/s 10^{-6} 10^{-5} 10^{-4} 10^{-3} WATER CONTENT PERCENT Wp ⊢—○W—⊣ Wl 20 40 60 80	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE									
0	Power Auger 200 mm Diam. (Hollow Stem)	TOPSOIL/FILL - (SM) SILTY SAND; dark brown, contains organic matter; non-cohesive, moist, very loose	▨	0.00	1	SS	4				
1		(SM) gravelly SILTY SAND; grey brown, contains cobbles and boulders (GLACIAL TILL); non-cohesive, moist, compact to very dense	▨	0.61	2	SS	19				
					3	SS	50/ 0.10				
2		End of Borehole Auger Refusal		1.78							Open borehole dry upon completion of drilling
3											
4											
5											
6											
7											
8											
9											
10											

DEPTH SCALE

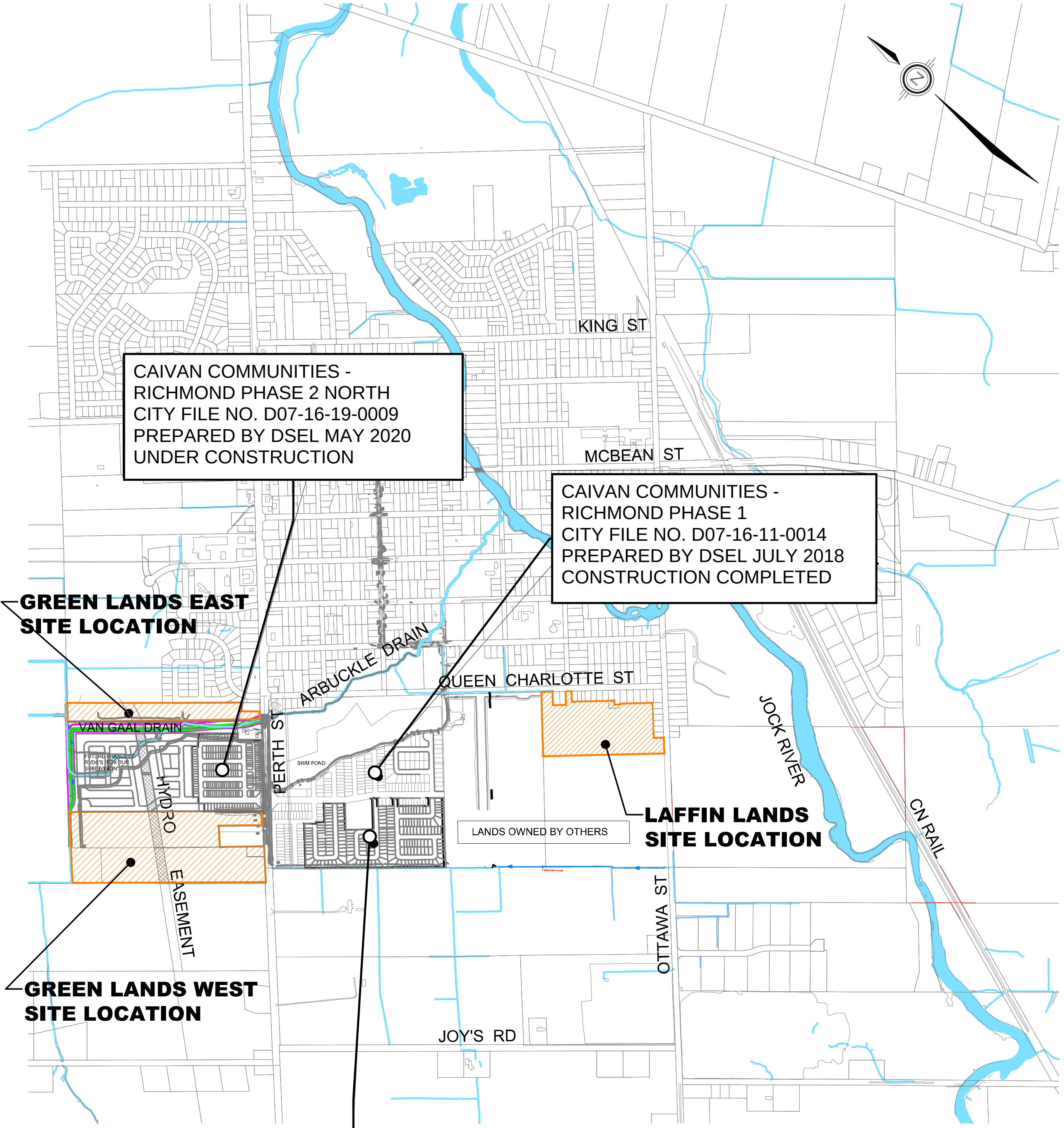
1 : 50

GOLDER

LOGGED: KM

CHECKED:

FIGURES



CAIVAN COMMUNITIES -
RICHMOND PHASE 2 NORTH
CITY FILE NO. D07-16-19-0009
PREPARED BY DSEL MAY 2020
UNDER CONSTRUCTION

CAIVAN COMMUNITIES -
RICHMOND PHASE 1
CITY FILE NO. D07-16-11-0014
PREPARED BY DSEL JULY 2018
CONSTRUCTION COMPLETED

GREEN LANDS EAST
SITE LOCATION

LAFFIN LANDS
SITE LOCATION

GREEN LANDS WEST
SITE LOCATION

CAIVAN COMMUNITIES -
RICHMOND PHASE 2 SOUTH
CITY FILE NO. D07-16-19-0009
PREPARED BY DSEL JUNE 2020
UNDER CONSTRUCTION

LEGEND

▨ SITE BOUNDARY

RICHMOND VILLAGE
DEVELOPMENT CORPORATION

SITE LOCATION

SCALE:	1:20,000
DATE:	JULY 2021
PROJECT No.:	20-1184
FIGURE:	1

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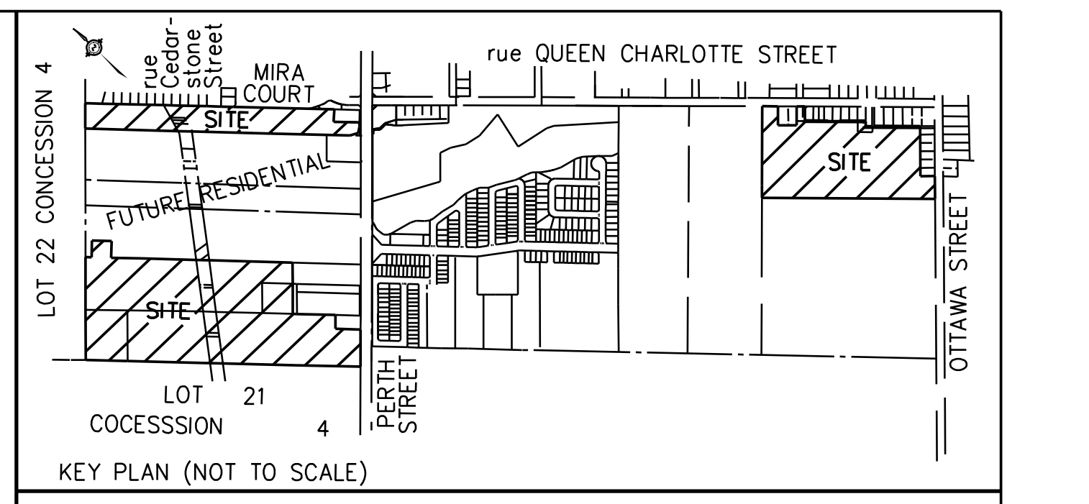
FIGURE 2

Schedule of Land Use

Land Use	Block(s)	AREA (sq. m)
RESIDENTIAL SINGLES	1 TO 13, (BOTH INCLUSIVE), 22, 23, 24, 25, AND 45 TO 56, (BOTH INCLUSIVE)	104,616.0
RESIDENTIAL TOWN HOUSE	14 TO 17, (BOTH INCLUSIVE), 36 TO 40, (BOTH INCLUSIVE) AND 42 TO 44, (BOTH INCLUSIVE)	44,955.5
RESIDENTIAL BACK-TO-BACK TOWN HOUSE	41	1,761.4
PARKS	57	10,758.5
WALKWAY/VISTA	19, 20, 26 TO 34, (BOTH INCLUSIVE, 59, 60 AND 61	3,562.9
NATURAL HERITAGE SYSTEM	18, 35 AND 58	20,459.7
STREETS	'A' TO 'Q', (BOTH INCLUSIVE)	68,985.8
LANES	'A'	288.4
STREET WIDENING	21 AND 62	388.0
Total		255,776.1



KEY PLAN (NOT TO SCALE)

DRAFT PLAN OF SUBDIVISION OF
ALL OF UNITS 1, 2, 3, 4, 5, 6, 9, 10, 11, 24, 25, 26, 27 AND 28 INDEX PLAN D-21
AND
PART OF UNITS 8, 12 AND 13 INDEX PLAN D-21
AND
PART OF UNITS 9 AND 10 INDEX PLAN 4D-25
(GEOGRAPHIC TOWNSHIP OF GOULBOURN)
NOW IN THE
CITY OF OTTAWA
J. D. BARNES LIMITED

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

SCALE 1:2000
50 0 50 100 150 metres

ELEVATION NOTE

1. ELEVATIONS SHOWN ON THIS PLAN ARE RELATED TO GEODETIC DATUM AND ARE DERIVED FROM THE MUNICIPALITY BENCHMARK No. 0011968U124 HAVING A PUBLISHED ELEVATION OF 95.185 METERS.
2. IT IS THE RESPONSIBILITY OF THE USER OF THIS INFORMATION TO VERIFY THAT THE SITE BENCHMARK HAS NOT BEEN ALTERED OR DISTRUBED AND THAT ITS' RELATIVE ELEVATION AND DESCRIPTION AGREES WITH THE INFORMATION SHOWN ON THIS DRAWING.

NOTES

DISTANCES ARE GROUND.

ALL DISTANCES ON CURVES ARE ARC DISTANCES UNLESS OTHERWISE SPECIFIED

ADDITIONAL INFORMATION
As required under section 51(17) of the Planning Act R.S.O. 2001

(a)(b)(e)(f)(g)(j) and (l) - As shown on this Plan.
(c) - As shown on this Draft and Key Plan
(d) - Land to be used in accordance with the Schedule of Land Use.
(h)(k) - Full Municipal Services
(i) - Offshore Marine Deposits of clay, silty clay and silt, Bedrock Ottawa Formation, limestone

SUBJECT TO THE CONDITIONS, IF ANY, SET FORTH IN OUR LETTER DATED......................,THIS DRAFT PLAN IS APPROVED BY THE CITY OF OTTAWA UNDER SECTION 51 OF THE PLANNING ACT THIS .... DAY OF ...., 2021.

LILY XU, MCIP, RPP, MANAGER
DEVELOPMENT REVIEW SOUTH
PLANNING, INFRASTRUCTURE AND ECONOMIC DEVELOPMENT DEPARTMENT,
CITY OF OTTAWA

OWNER'S CERTIFICATE

RICHMOND VILLAGE DEVELOPMENT CORPORATION, BEING THE REGISTERED OWNER OF THE SUBJECT LANDS HEREBY AUTHORIZES J. D. BARNES LIMITED TO PREPARE AND SUBMIT THIS DRAFT PLAN OF SUBDIVISION FOR APPROVAL.

DATE

FRANK CAIRO
PRESIDENT
(I HAVE THE AUTHORITY TO BIND THE CORPORATION)

RICHMOND VILLAGE DEVELOPMENT CORPORATION

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE LAND TO BE SUBDIVIDED ARE CORRECTLY SHOWN.

FOR REVIEW

DATE

C.M. FOX
ONTARIO LAND SURVEYOR

J.D.BARNES LIMITED
LAND INFORMATION SPECIALISTS
SURVEYING
MAPPING
GIS
62 STEACIE DRIVE, SUITE 103, KANATA, ON K2K 2A9
T: (613) 731-7244 F: (613) 254-8659 www.jdbarnes.com

DRAWN BY: NS	CHECKED BY: CF	REFERENCE NO.: 10-10-314-00 DRAFT
PLOTTED: 8/20/2021		DATED: 01/15/21

FILE: G:\19-10-122\00\Drawing\Draft Plan 2020\19-10-122-00_DraftPlan(Grid).dgn

LEGEND

SUBJECT LANDS
PROPOSED LOCAL WATERMAIN
EXISTING WATERMAIN
PROPOSED 300Ø WATERMAIN
PLUG
FUTURE 300Ø WATERMAIN
FUTURE LOCAL WATERMAIN

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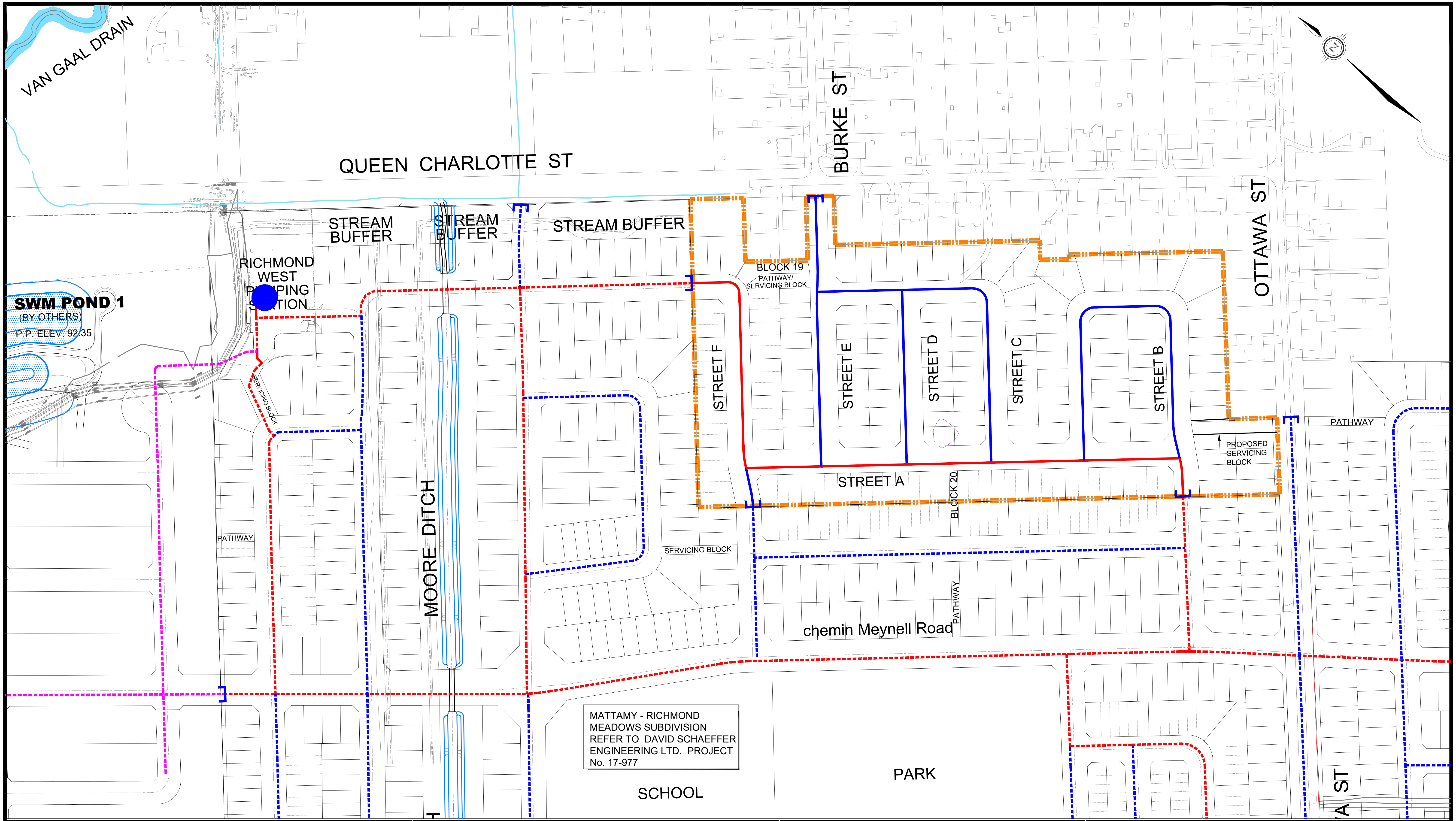
CAIVAN (RICHMOND NORTH) LTD.

CITY OF OTTAWA

WATERMAIN SERVICING PLAN
GREEN LANDS WEST AND EAST

SCALE:	1:1500_XREF	PROJECT No.:	1183
DATE:	AUGUST 2021	FIGURE:	3A



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LEGEND

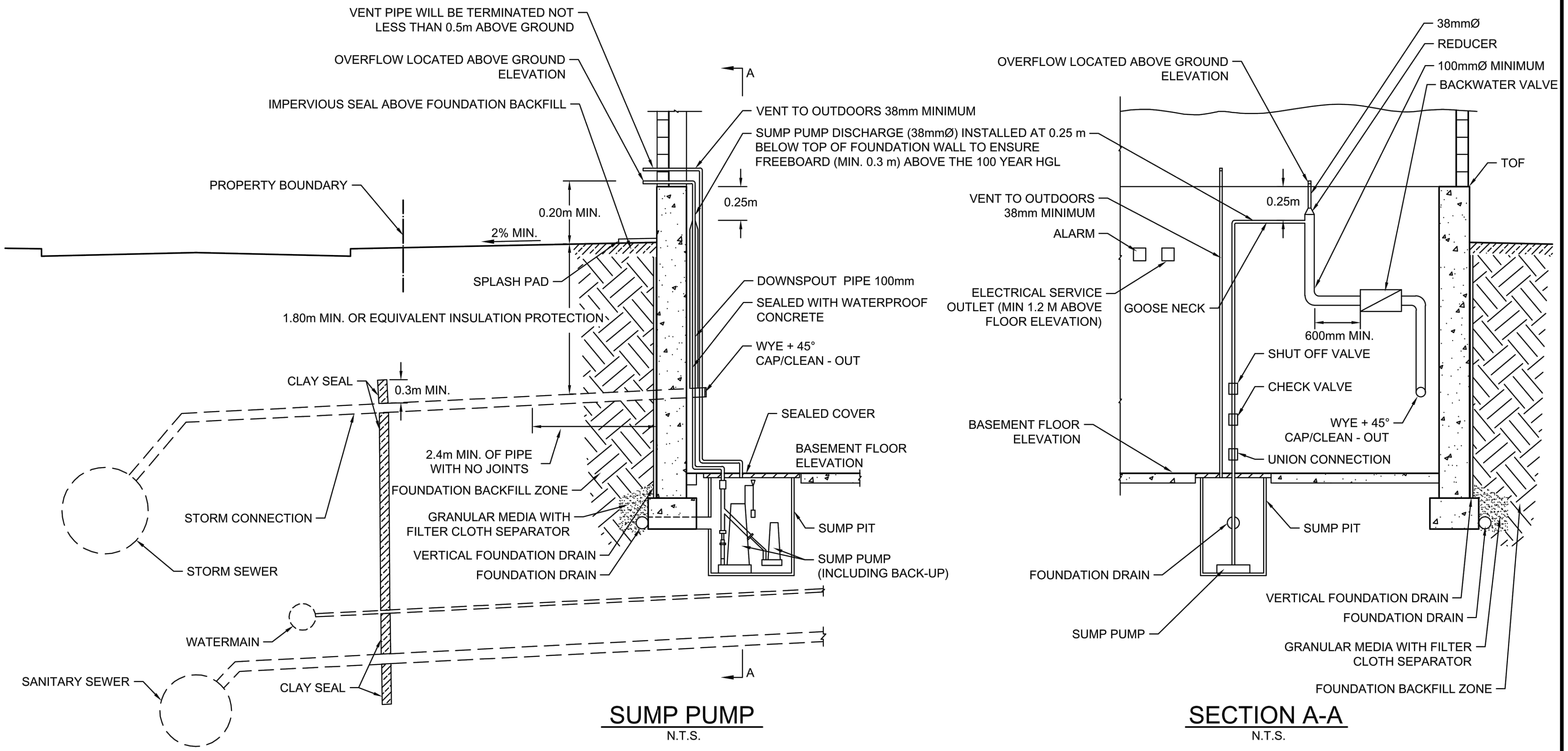
- ▬ ▬ SUBJECT LANDS
- ▬ PROP 300Ø WATERMAIN
- ▬ PROP LOCAL WATERMAIN
- ┄ LOCAL WATERMAIN (BY OTHERS)
- ┄ 300Ø WATERMAIN (BY OTHERS)
- ┄ EXISTING WATERMAIN
-] PLUG
- ● COMMUNAL WELL

CAIVAN (RICHMOND SOUTH) LTD.

CONCEPTUAL WATERMAIN
CITY OF OTTAWA

LAFFIN LANDS

PROJECT No.: 20-1184
DATE: AUGUST 2021
SCALE: 1:2500
FIGURE: 3B



SUMP PUMP
N.T.S.

SECTION A-A
N.T.S.

NOTES:

1. WORKS TO BE COMPLETED IN ACCORDANCE WITH CITY OF OTTAWA STANDARDS, POLICIES AND GUIDELINES.
2. PRIMARY DISCHARGE TO STORM SEWER WITH OVERFLOW TO GRADE, AS INDICATED.
3. SERVICE TRENCH WILL HAVE CLAY SEAL TO PREVENT GROUNDWATER FLOW THROUGH SERVICE TRENCH TO FOUNDATION.
4. INSULATION DETAIL MUST BE PROVIDED BY PROFESSIONAL ENGINEER.
5. BACKWATER VALVE TO BE CSA APPROVED COMPLETE WITH ADEQUATE SUPPORT FOR PIPING.
6. REFER TO GUIDELINES FOR SUMP PIT LOCATION.
7. IMPERVIOUS SEAL TO EXTEND BEYOND THE LINE OF EXCAVATION, SLOPED AWAY FROM BUILDING A MINIMUM OF 2% AFTER SETTLING OF BACKFILL. SEAL CAN BE CLAY, OR A MEMBRANE OR LOW-PERMEABILITY INSULATION BOARD PLACED JUST BELOW GROUND.
8. FILL PLACED IN SERVICE TRENCH MUST BE COMPACTED TO AT LEAST 98% OF ITS STANDARD PROCTOR MAXIMUM DRY DENSITY.
9. FOUNDATION BACKFILL ZONE WILL CONSIST OF CLAY WITH A MINIMUM HORIZONTAL WIDTH OF 1.5m.
10. VERTICAL FOUNDATION DRAINS ARE REQUIRED ON THE PERIMETER OF THE FOUNDATION.
11. EVERY SERVICE TRENCH REQUIRES CLAY SEAL AS PER CITY STANDARD S8. CLAY SEAL TO EXTEND A MINIMUM 0.3m ABOVE THE OBVERT OF THE STORM SERVICE PIPE.

Ottawa

STANDARD SUMP PUMP CONFIGURATION
GREENFIELD SUBDIVISIONS WITH CLAY SOILS
AND FULL MUNICIPAL SERVICES

DATE:	JUNE 2018
REV. DATE:	JUNE 2018
DWG. No.:	P 01

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CAIVAN (RICHMOND SOUTH) LTD.

SUMP PUMP DETAIL
CITY OF OTTAWA

LAFFIN LANDS

PROJECT No.:	20-1184
DATE:	AUGUST 2021
SCALE:	N.T.S.
FIGURE:	4

DRAWINGS

LEGEND

▬	SUBJECT LANDS
➜	STORM OVERLAND FLOW ARROW
192.851	PROPOSED CENTERLINE ELEVATION
[192.85]	FUTURE GRADES (BY OTHERS)
- - -	100 YEAR FLOODPLAIN
[192.85]	EX. GRADES
193.50 193.50	PROPOSED ELEVATION EXISTING ELEVATION
96	EXISTING CONTOUR ELEVATION
←1.00m→	GRADE CHANGE

CUT-FILL DEPTH ALONG CENTER LINE:

CUT DEPTH (m)

0 - 0.5	⬜
0.5 - 1.0	🟨
1.0 - 1.5	🟧
1.5 - 2.0	🟧
2.0- 2.5	🟥
> 2.5	🟫

FILL DEPTH (m)

0 - 0.5	⬜
0.5 - 1.0	🟦
1.0 - 1.5	🟦
1.5 - 2.0	🟦
2.0- 2.5	🟦
> 2.5	🟦

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CAIVAN (RICHMOND NORTH) LTD.

CITY OF OTTAWA

GRADING PLAN
GREEN LANDS WEST AND EAST

SCALE:	1:1500_XREF	PROJECT No.:	1183
DATE:	AUGUST 2021	DRAWING:	1A

LEGEND

▬ ▮ ▬	SUBJECT LANDS
← · — ·	EXISTING DITCH
95.00	EXISTING ELEVATION CONTOUR
⇧	MAJOR OVERLAND FLOW
⇧	EXTERNAL DRAINAGE
96.73	PROPOSED ELEVATION
96.73	EXISTING ELEVATION
[96.73]	FUTURE ELEVATION BY OTHERS

CUT-FILL DEPTH ALONG CENTER LINE:

CUT DEPTH (m)		FILL DEPTH (m)	
0.00~0.50:	☐	0.00~0.50:	☐
0.50~1.00:	🟨	0.50~1.00:	🟦
1.00~1.50:	🟧	1.00~1.50:	🟦
1.50~2.00:	🟥	1.50~2.00:	🟦
>2.00	🟥	>2.00	🟦

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CAIVAN (RICHMOND SOUTH) LTD.

CITY OF OTTAWA

GRADING PLAN
LAFFIN LANDS

SCALE:	1:1000	PROJECT No.:	20-1184
DATE:	AUGUST 2021	DRAWING:	1B

LEGEND

▬ ▪ ▪ ▬ SUBJECT LANDS

← PROPOSED SANITARY SEWER

← - - - EXISTING SANITARY SEWER

▬ ▬ ▬ SANITARY DRAINAGE BOUNDARY

▬ ▬ ▬ EXTERNAL SANITARY DRAINAGE BOUNDARY

3.4	POPULATION PER UNIT
0.77	SANITARY DRAINAGE AREA
82.07	NUMBER OF UNITS
63	TOTAL POPULATION
MH 513A MH 514A	UPSTREAM/DOWNSTREAM MANHOLE

3.4	POPULATION PER UNIT
0.30	EXTERNAL DRAINAGE AREA IN HECTARES
60	POPULATION PER HA
18	POPULATION

● SANITARY MANHOLE

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CAIVAN (RICHMOND NORTH) LTD.

CITY OF OTTAWA

SANITARY SERVICING PLAN
GREEN LANDS EAST & WEST

SCALE:	1:1500_XREF	PROJECT No.:	1183
DATE:	AUGUST 2021	DRAWING:	2A

LEGEND

🟧	SUBJECT LANDS
🟦	SANITARY DRAINAGE BOUNDARY
▨	EXTERNAL SANITARY DRAINAGE BOUNDARY
←	PROPOSED SANITARY SEWER
←	SAN TRUNK BY OTHERS

3.4 — POPULATION PER UNIT
1.63Ha — SANITARY DRAINAGE AREA
60 — NUMBER OF UNITS
98 — TOTAL POPULATION
MH 7A / MH 13A — UPSTREAM/DOWNSTREAM MANHOLE

3.4 — POPULATION PER UNIT
1.63Ha — SANITARY DRAINAGE AREA
60 — NUMBER OF UNITS
98 — TOTAL POPULATION
MH 7A / MH 13A — UPSTREAM/DOWNSTREAM MANHOLE

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CITY OF OTTAWA

SANITARY SERVICING PLAN
LAFFIN LANDS

SCALE:	1:1000	PROJECT No.:	20-1184
DATE:	AUGUST 2021	DRAWING:	2B

LEGEND

- SUBJECT LANDS
- STORM TRUNK
- LOCAL STORM SEWER
- EXISTING STORM SEWER
- STORM DRAINAGE AREA
- FUTURE STORM DRAINAGE AREA
- 0.45Ha / 0.66 / 523 / 524 / 2-Year — DRAINAGE AREA IMPERVIOUSNESS UPSTREAM/DOWNSTREAM MANHOLE
- EXTERNAL DRAINAGE
- 100 YEAR FLOODPLAIN
- PROPOSED CUTOFF SWALE
- STORM MANHOLE
- 0.45Ha / 0.66 / 523 / 524 / 2-Year — EXTERNAL DRAINAGE AREA IMPERVIOUSNESS UPSTREAM/DOWNSTREAM MANHOLE STORM FREQUENCY

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CAIVAN (RICHMOND NORTH) LTD.

CITY OF OTTAWA

STORM SERVICING PLAN
GREEN LANDS WEST AND EAST

SCALE:	1:1500_XREF	PROJECT No.:	1183
DATE:	AUGUST 2021	DRAWING:	3A

LEGEND

- 🟧 SUBJECT LANDS
- ← EXISTING DITCH
- 🟪 STORM TRIBUTARY AREA
- ▨ EXTERNAL STORM TRIBUTARY AREA
- ← STORM TRUNK
- 🟩 STORM TRUNK BY OTHERS
- LOCAL STORM SEWER BY OTHERS
- EXTERNAL DRAINAGE
- PLUG
- 0.13Ha / 0.70 / MH 512 / MH 513 — STORM FREQUENCY DRAINAGE AREA, RUN-OFF COEFFICIENT, UPSTREAM/DOWNSTREAM MANHOLE
- 0.96Ha / 0.7 / MH 13 / MH 20 — STORM FREQUENCY EXTERNAL DRAINAGE AREA, RUN-OFF COEFFICIENT, UPSTREAM/DOWNSTREAM MANHOLE

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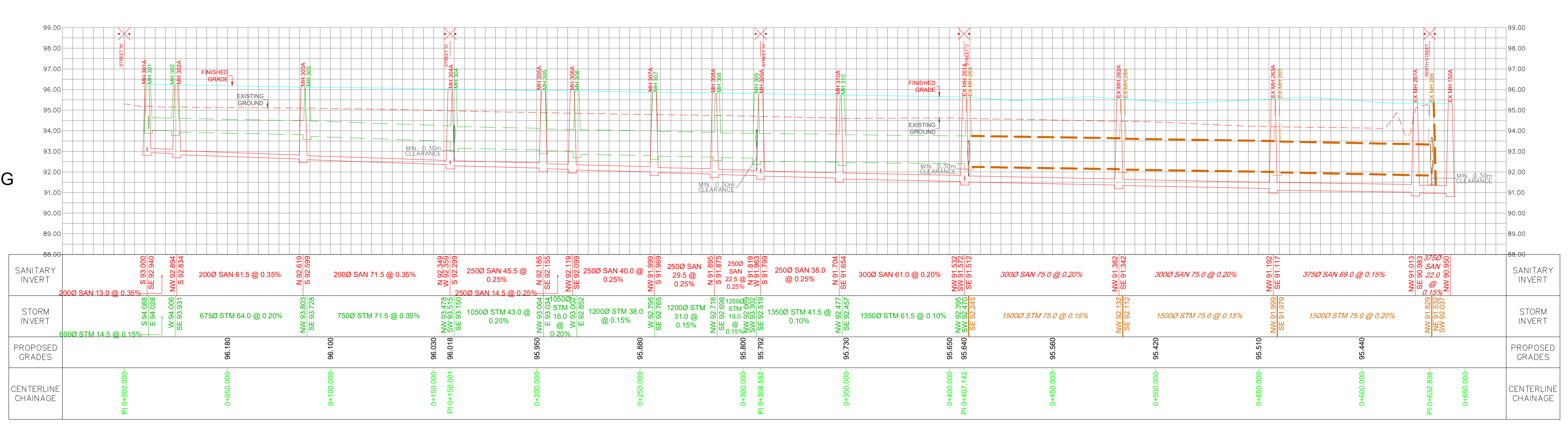
CAIVAN (RICHMOND SOUTH) LTD.

CITY OF OTTAWA

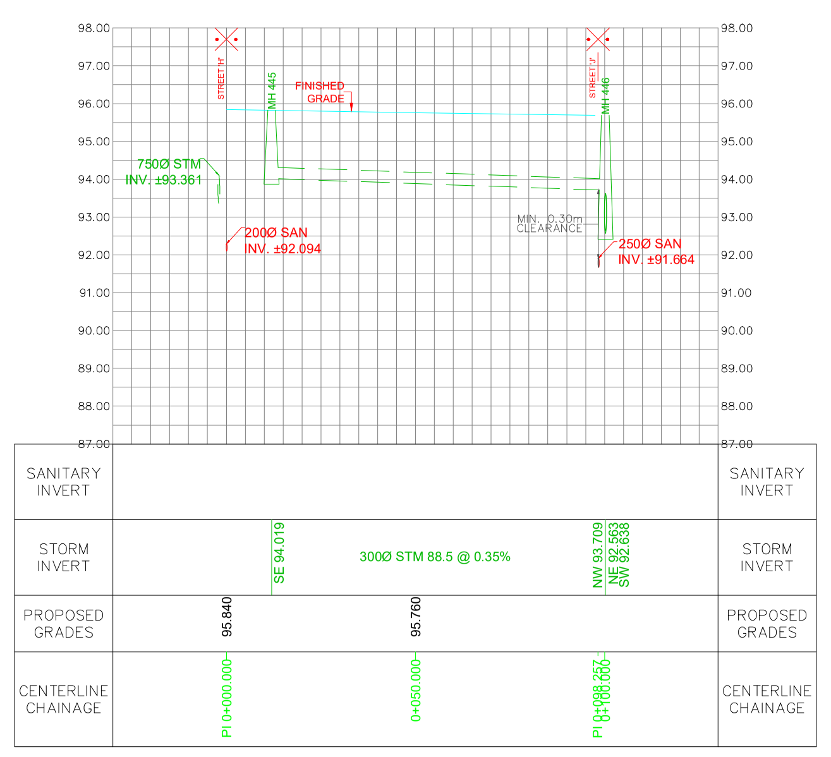
STORM SERVICING PLAN
LAFFIN LANDS

SCALE:	1:1000	PROJECT No.:	20-1184
DATE:	AUGUST 2021	DRAWING:	3B

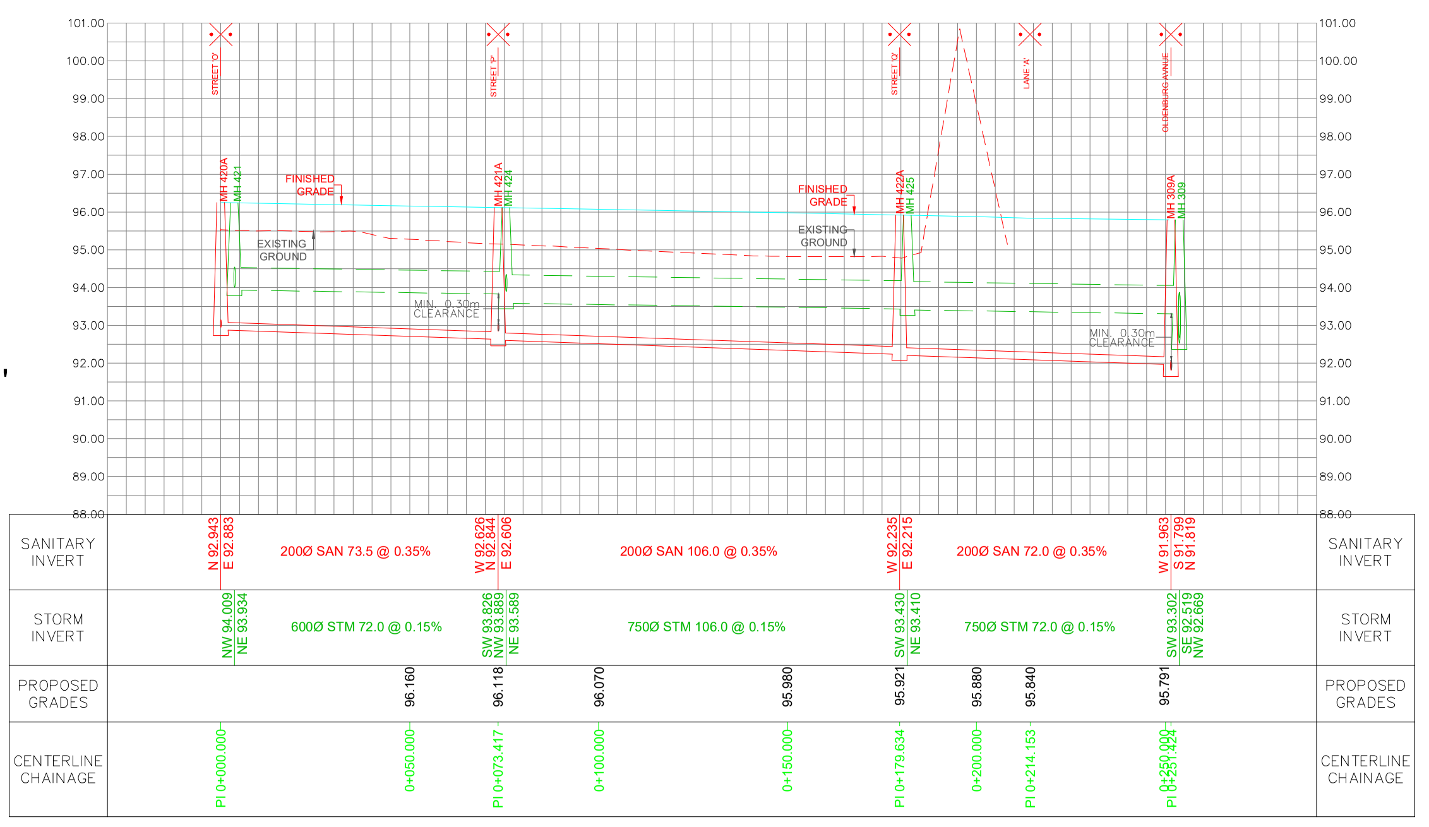
OLDENBURG AVENUE



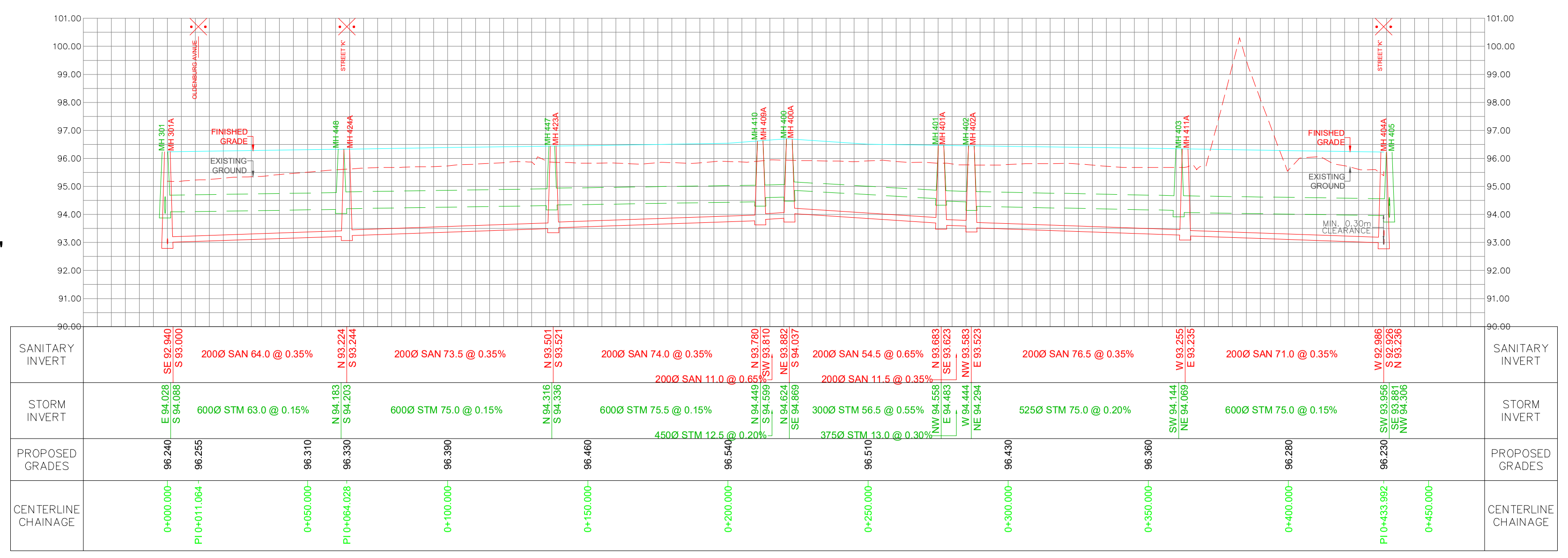
LANE 'A'



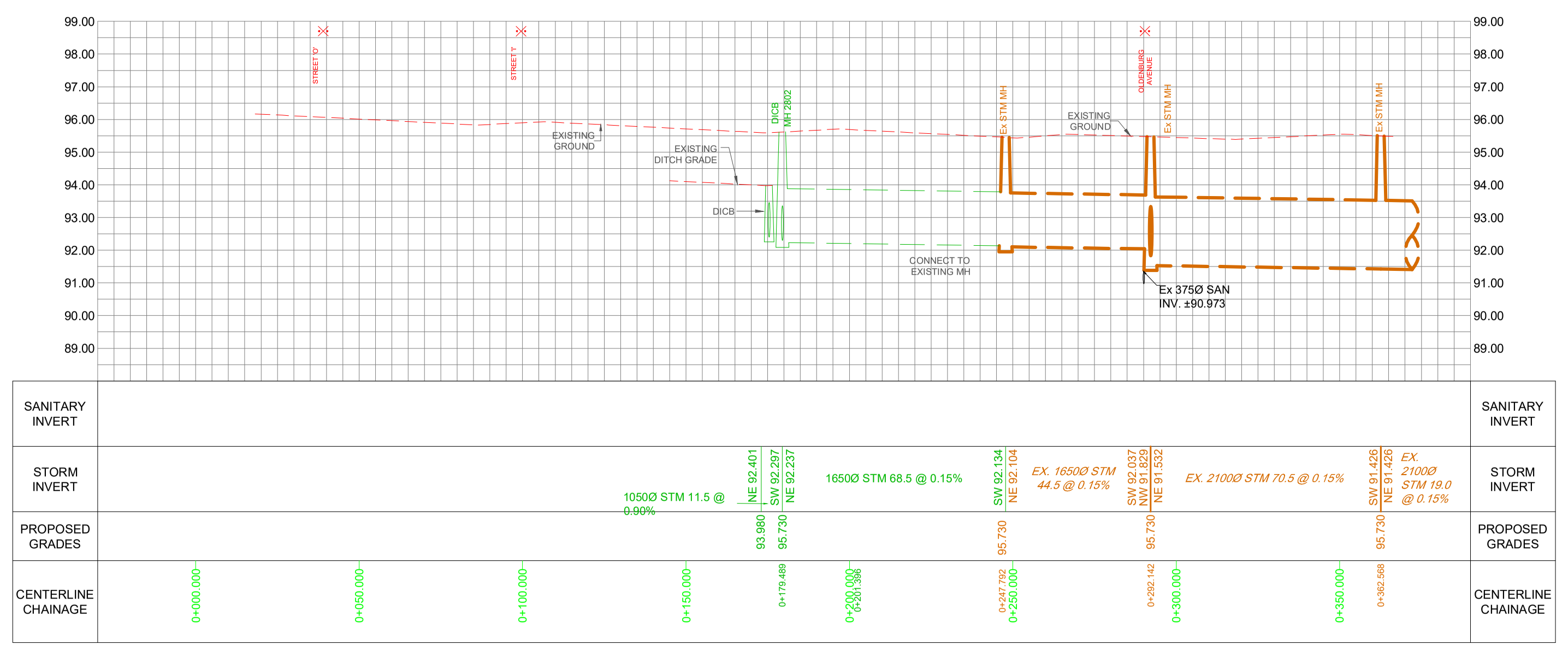
STREET 'H'



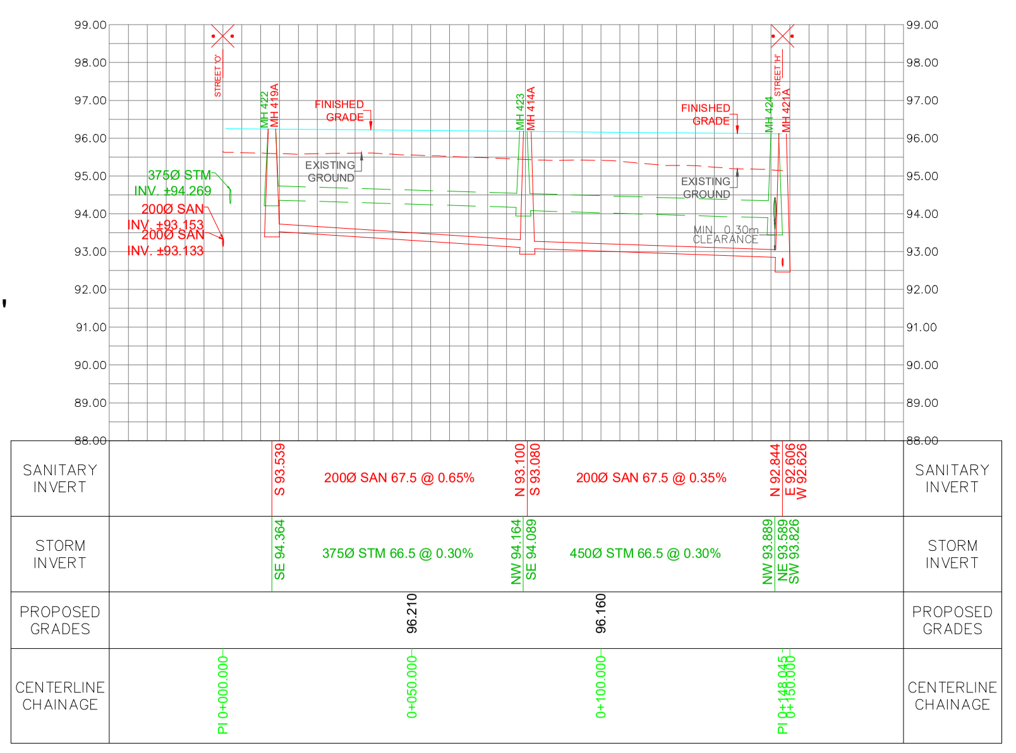
STREET 'N'



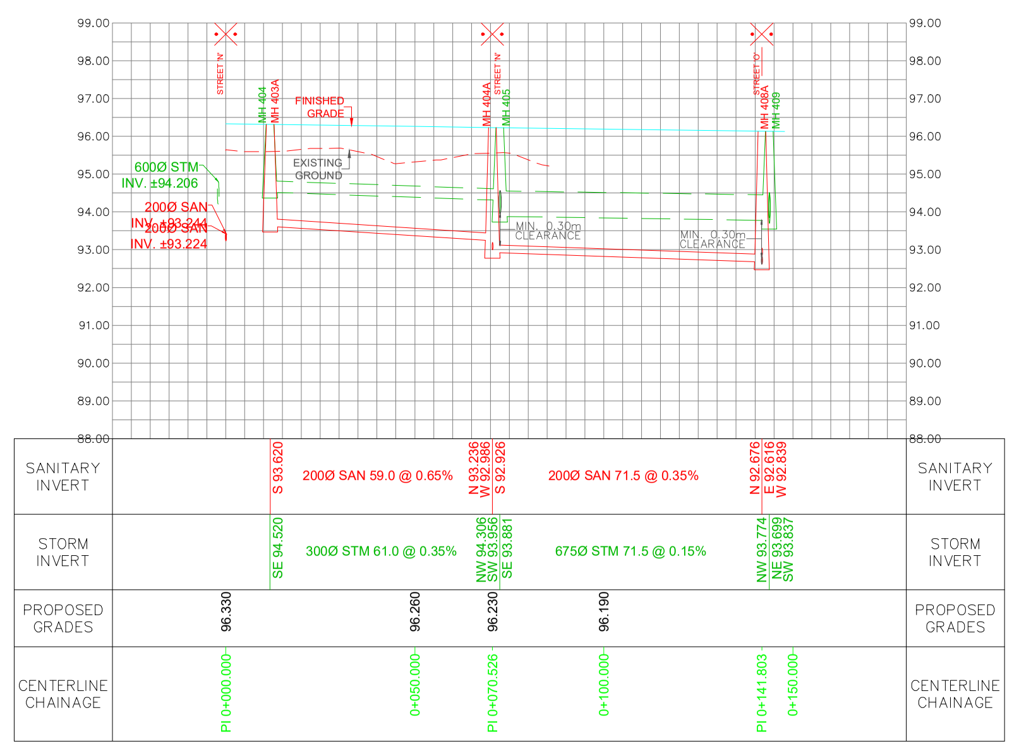
PERTH STREET



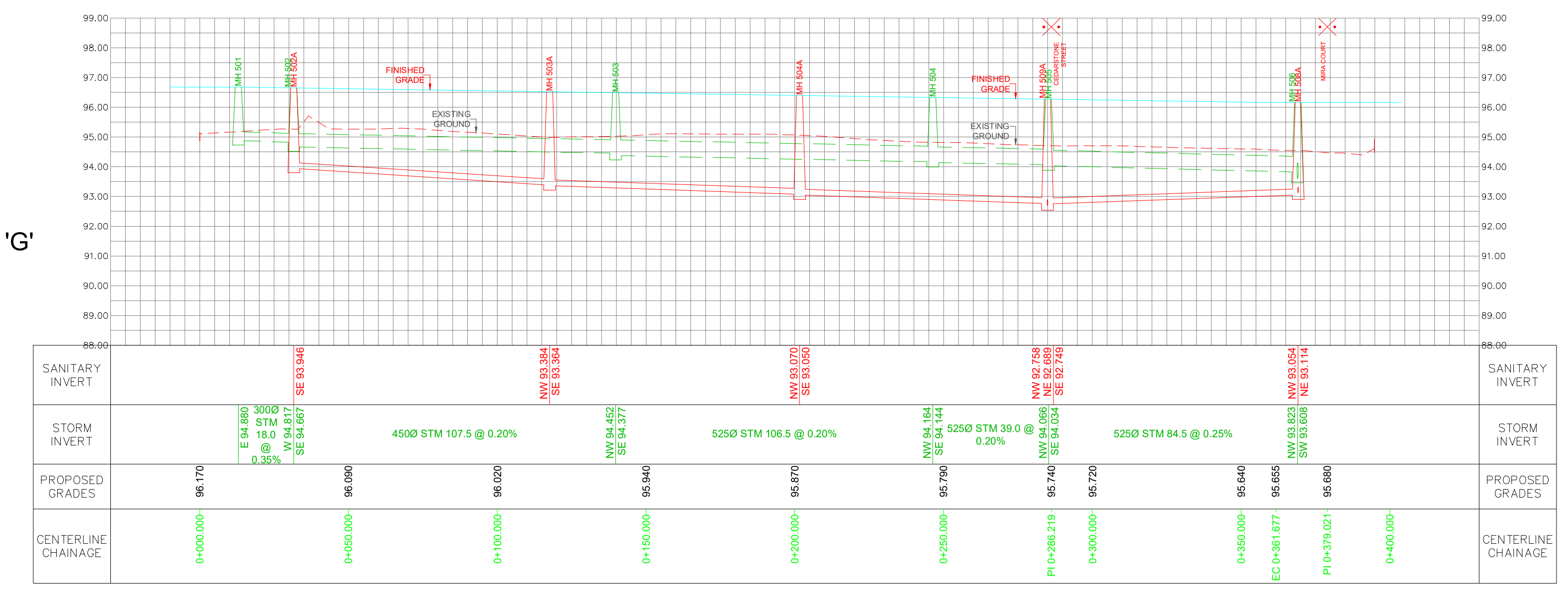
STREET 'P'



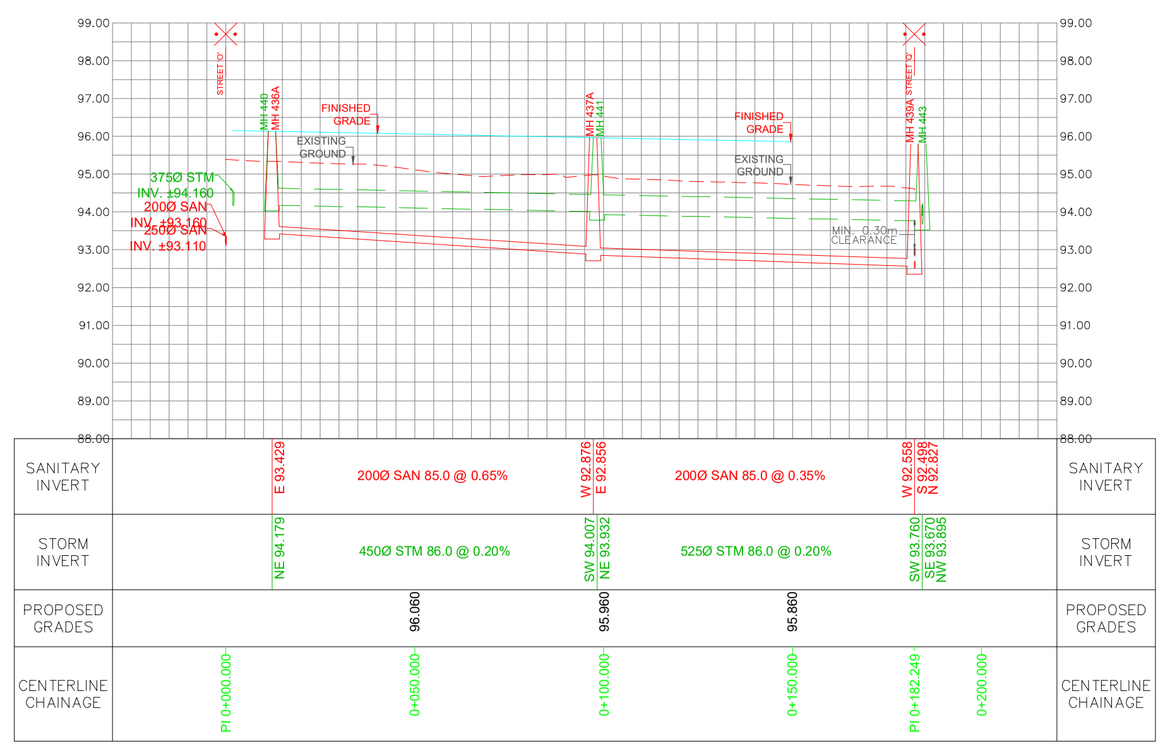
STREET 'K'



STREET 'G'



STREET 'L'



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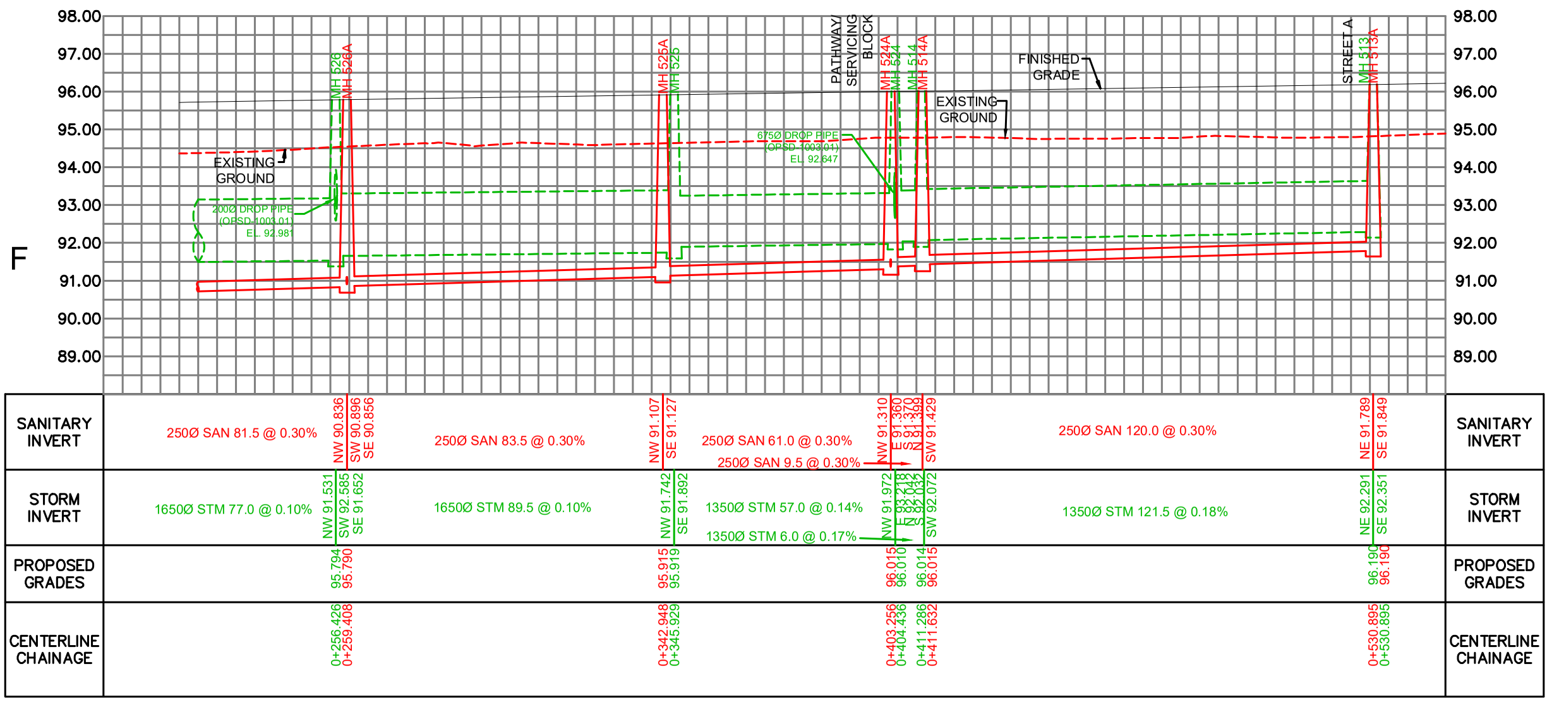
CAIVAN (RICHMOND NORTH) LTD.

CITY OF OTTAWA

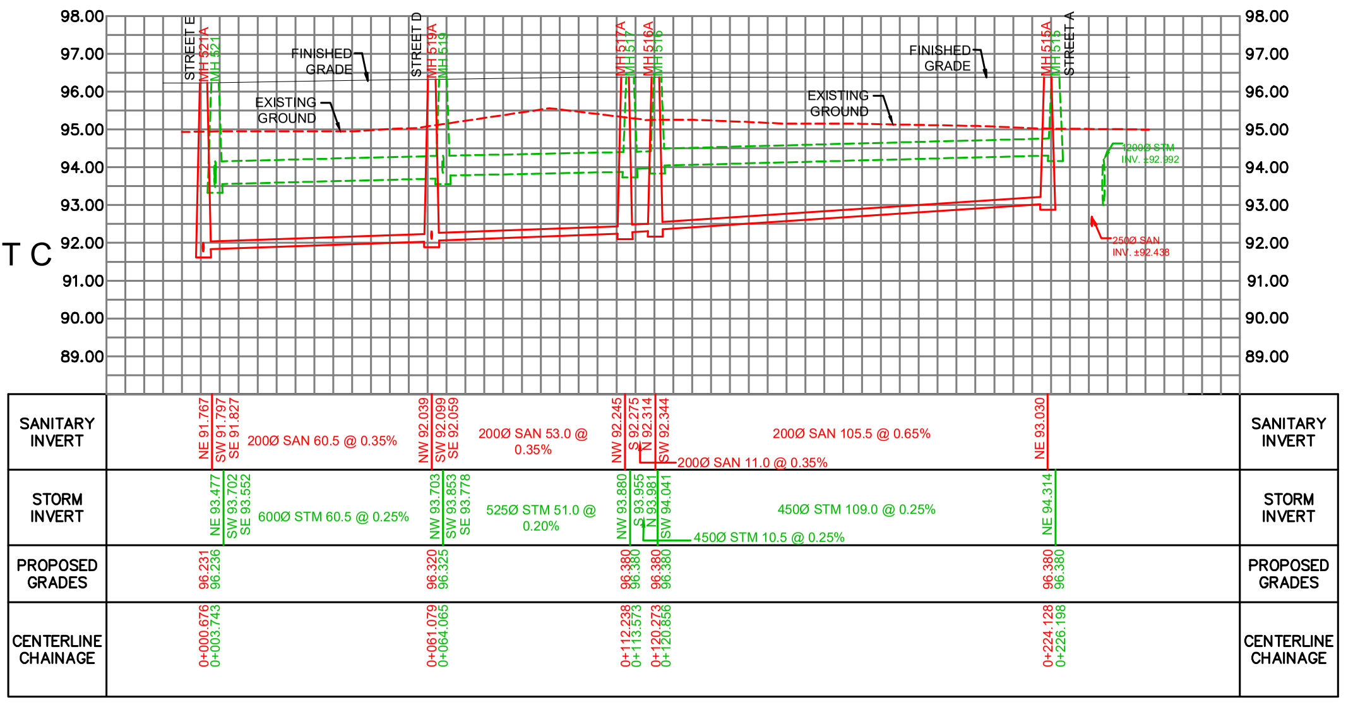
PROFILES
GREEN LANDS WEST AND EAST

SCALE:	1:2000	PROJECT No.:	1183
DATE:	AUGUST 2021	DRAWING:	4A

STREET F



STREET C



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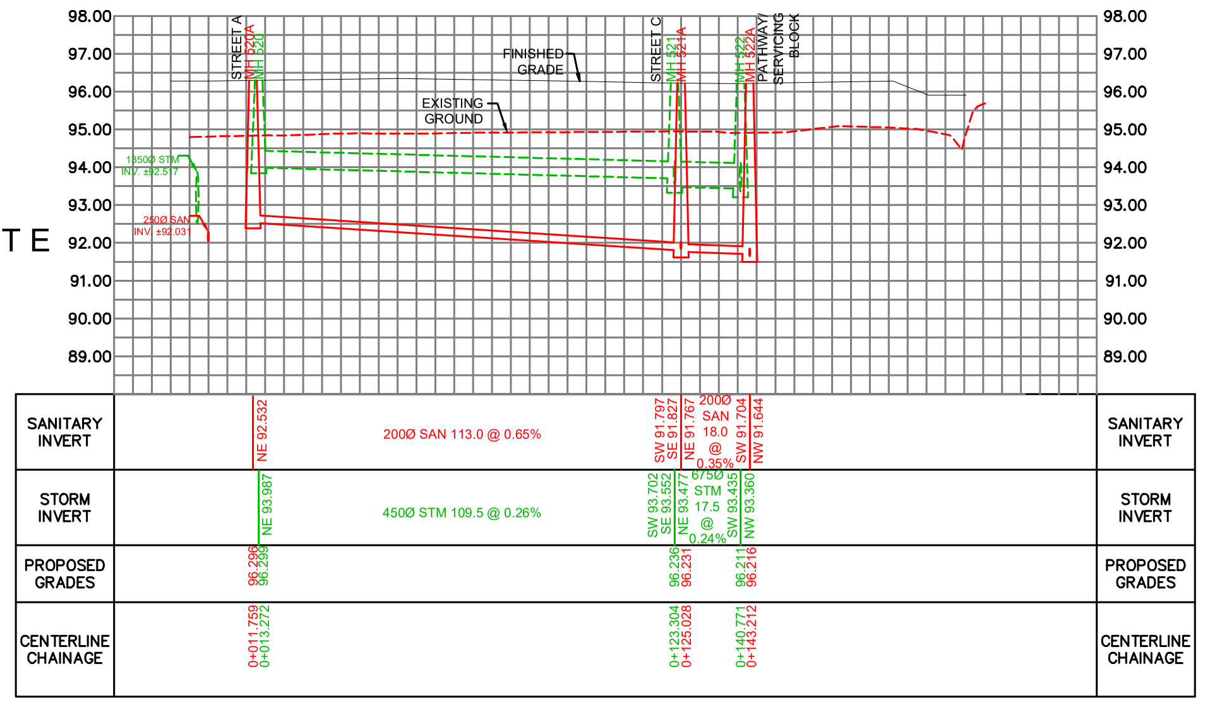

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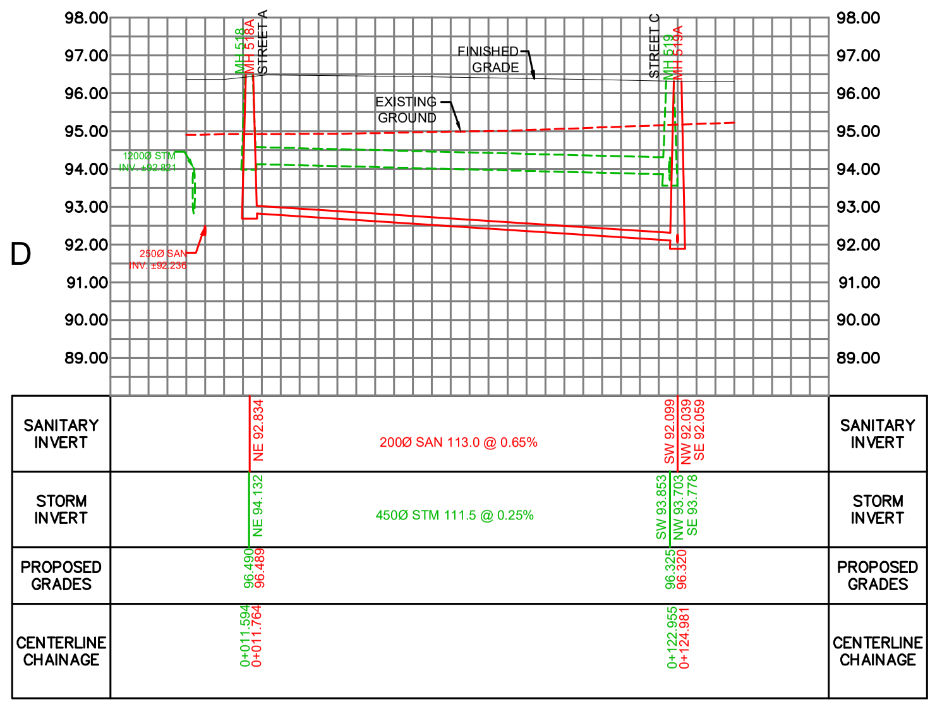

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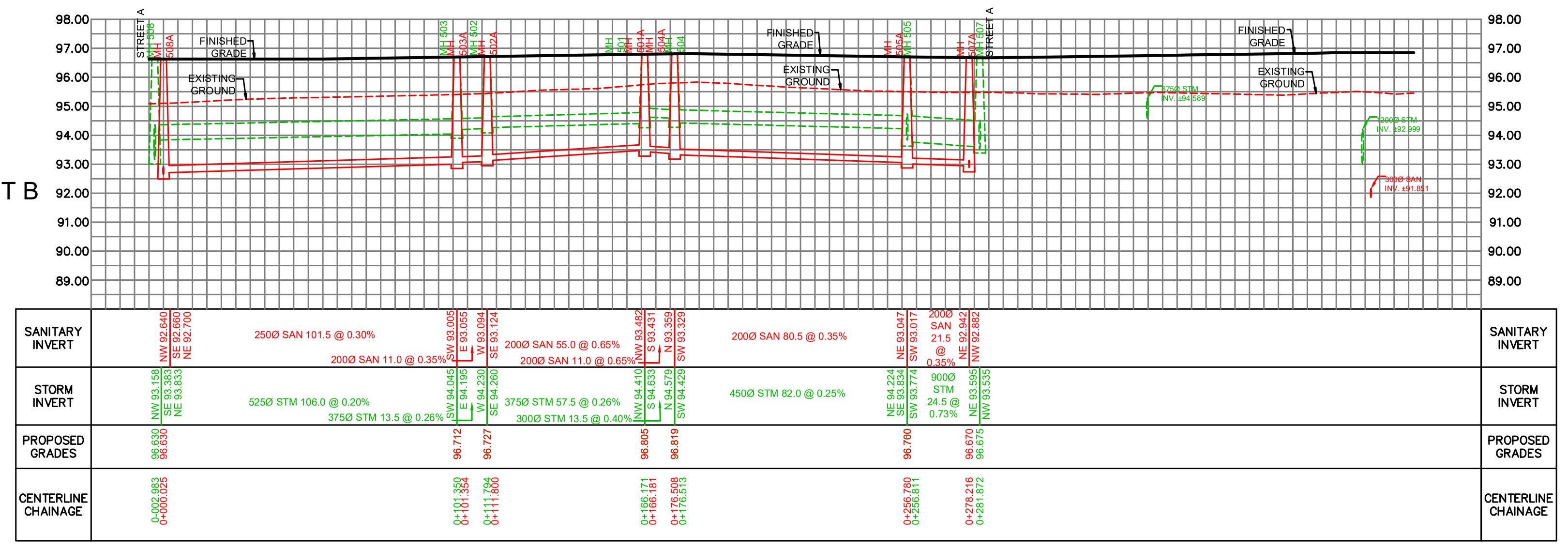

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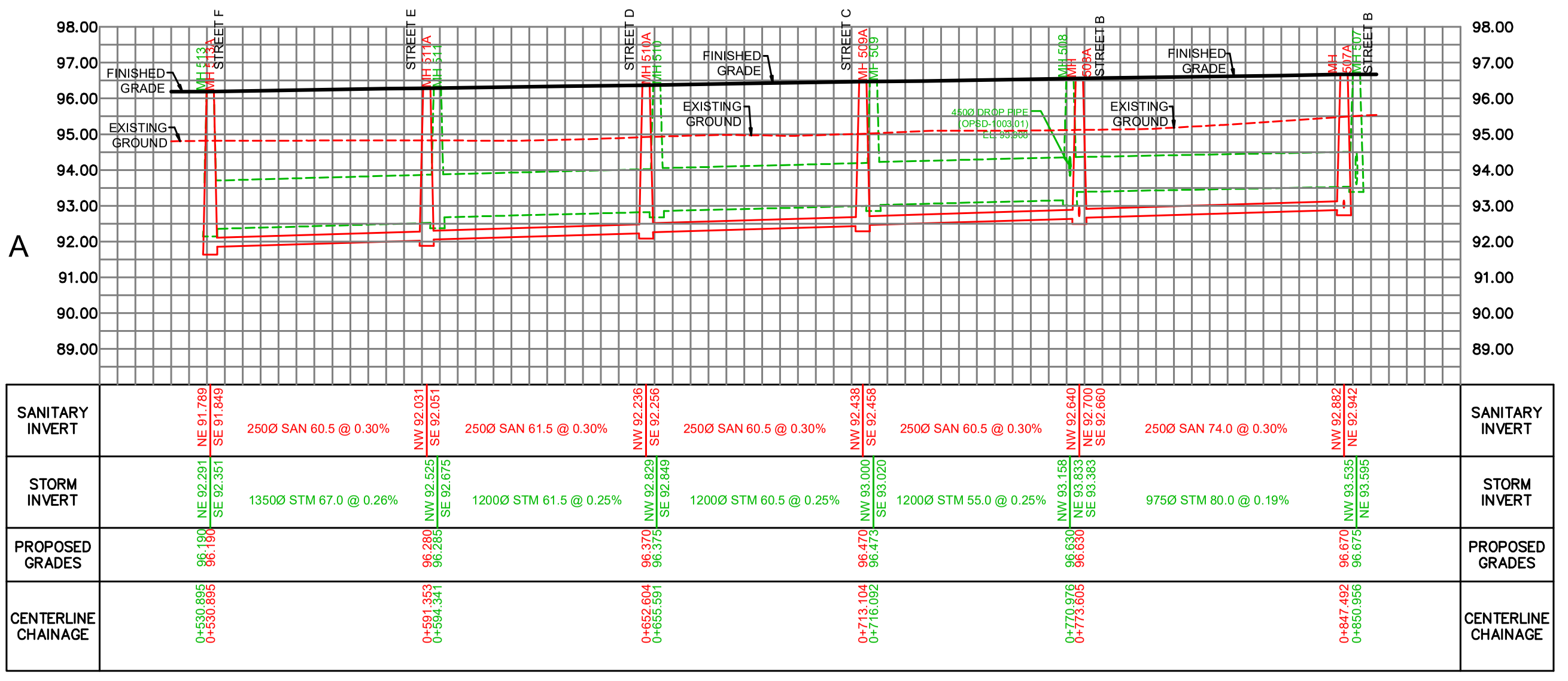
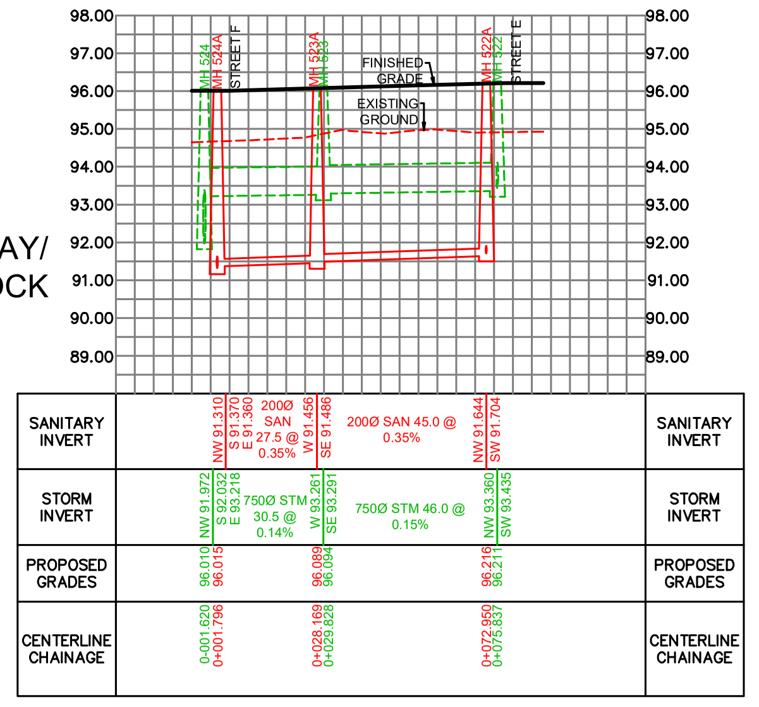


PATHWAY/
SERVICING BLOCK



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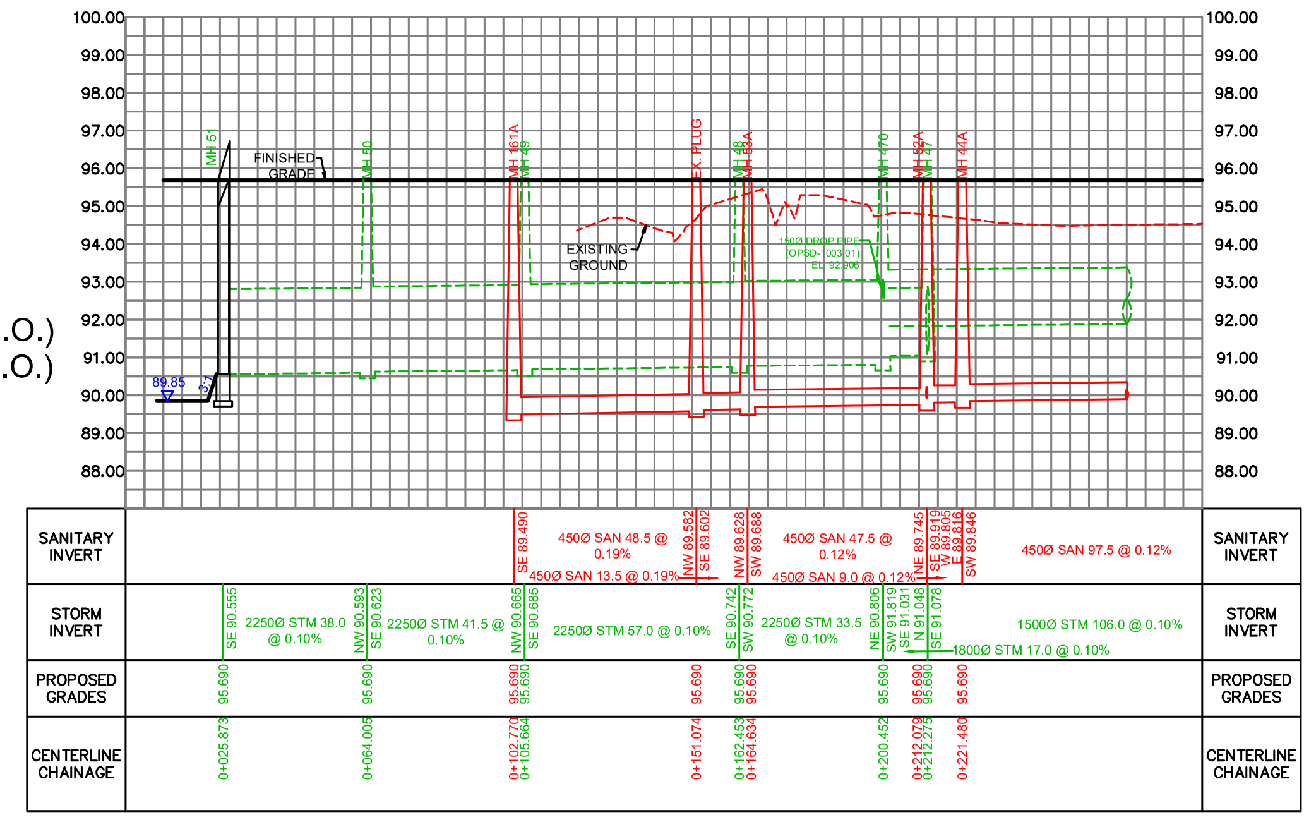
SAN TRUNK1 (B.O.)



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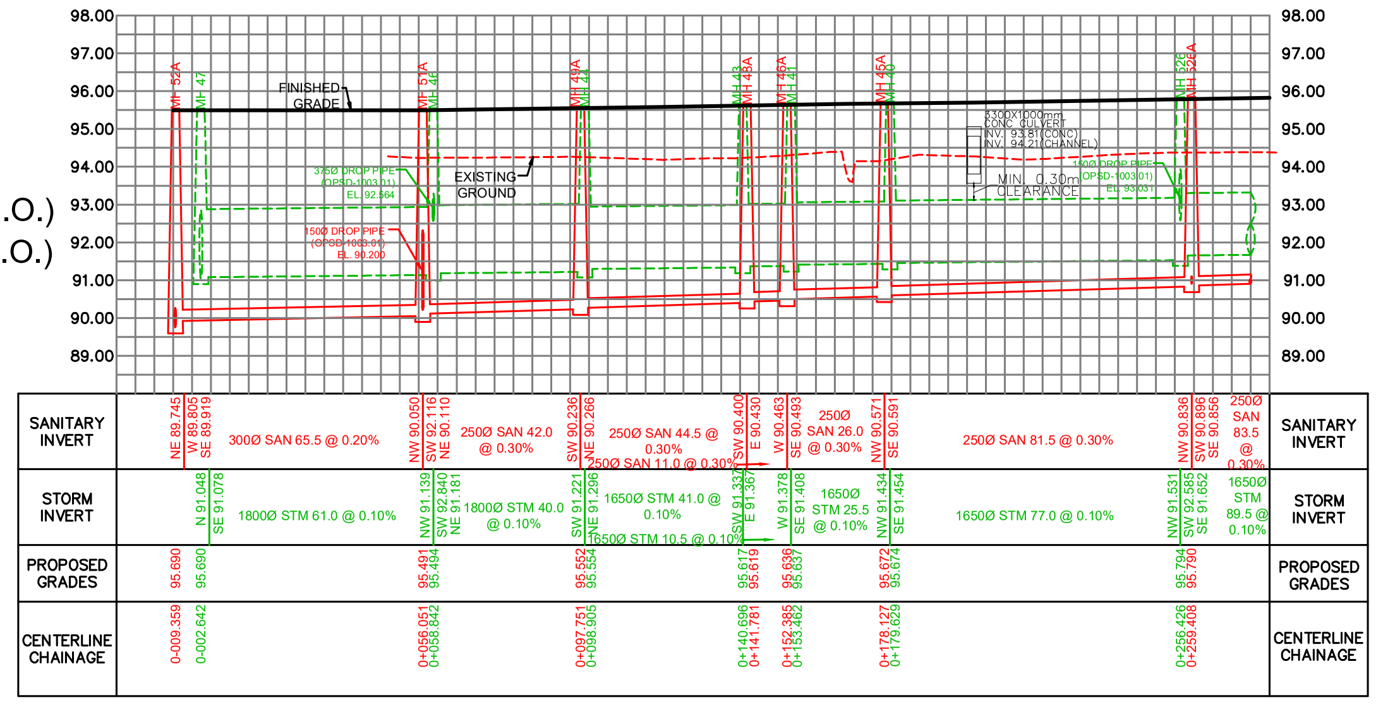

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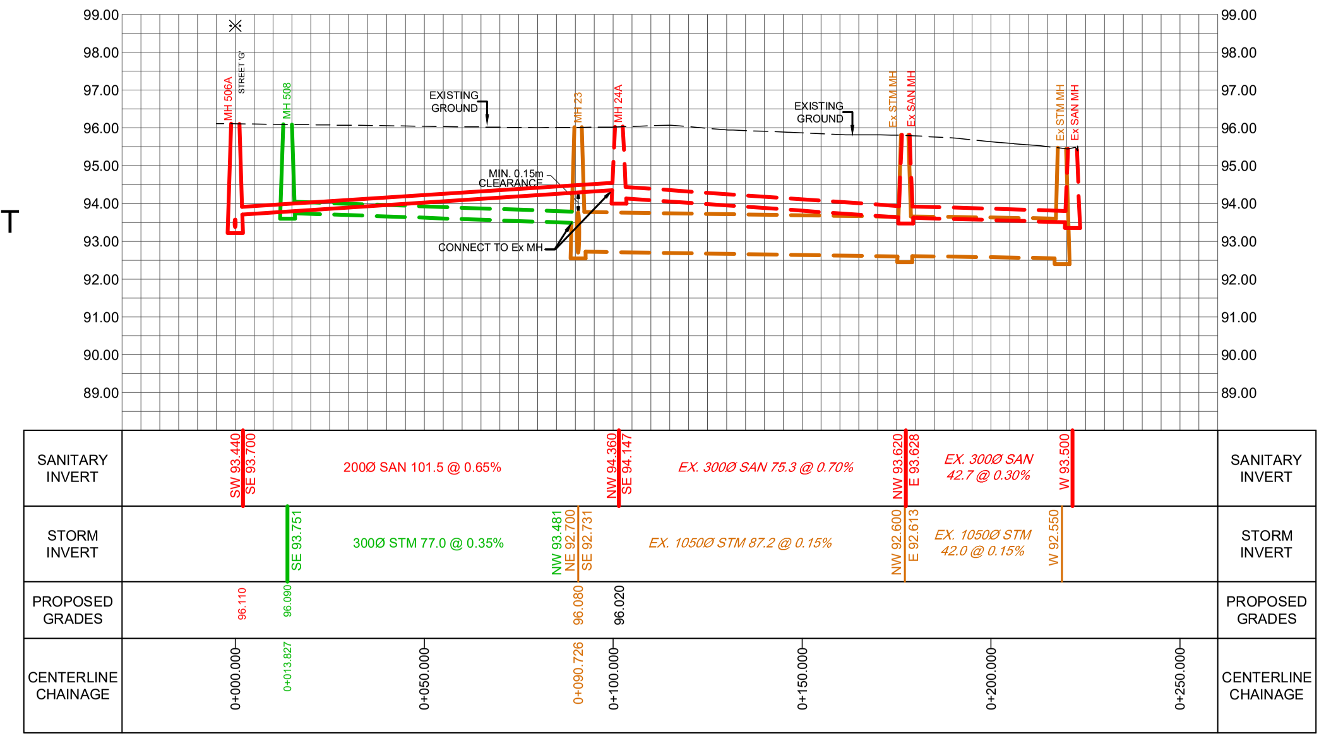
CITY OF OTTAWA

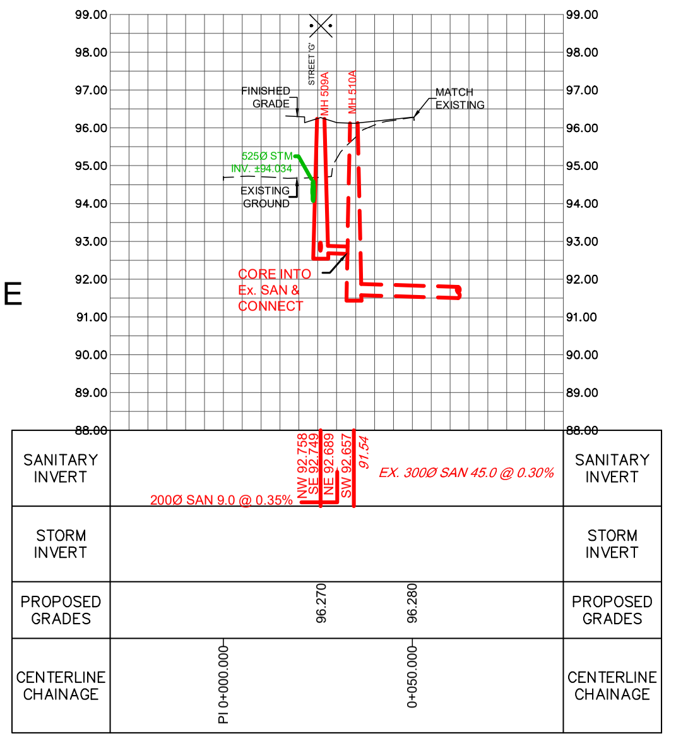
STORM AND SAN SERVICING
PROFILES
LAFFIN LANDS

SCALE:	1:2000	PROJECT No.:	20-1184
DATE:	AUGUST 2021	DRAWING:	4B

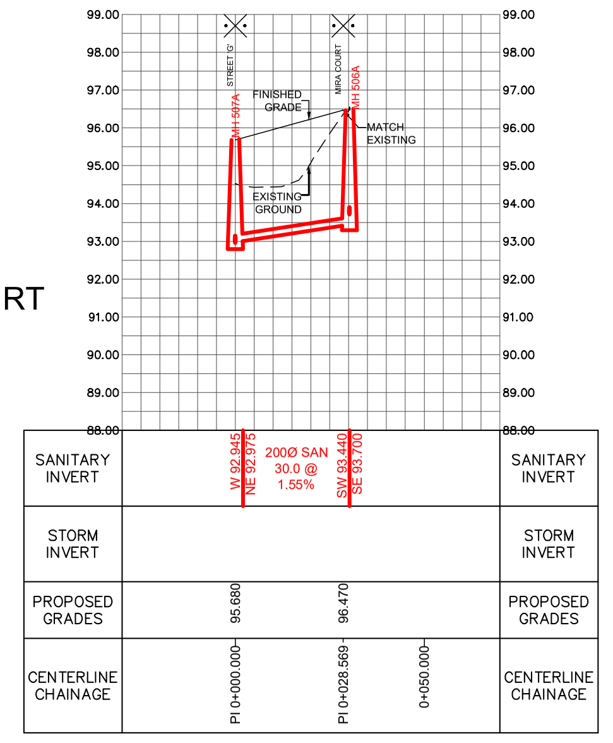
MIRA COURT



CEDARSTONE STREET



MIRA COURT



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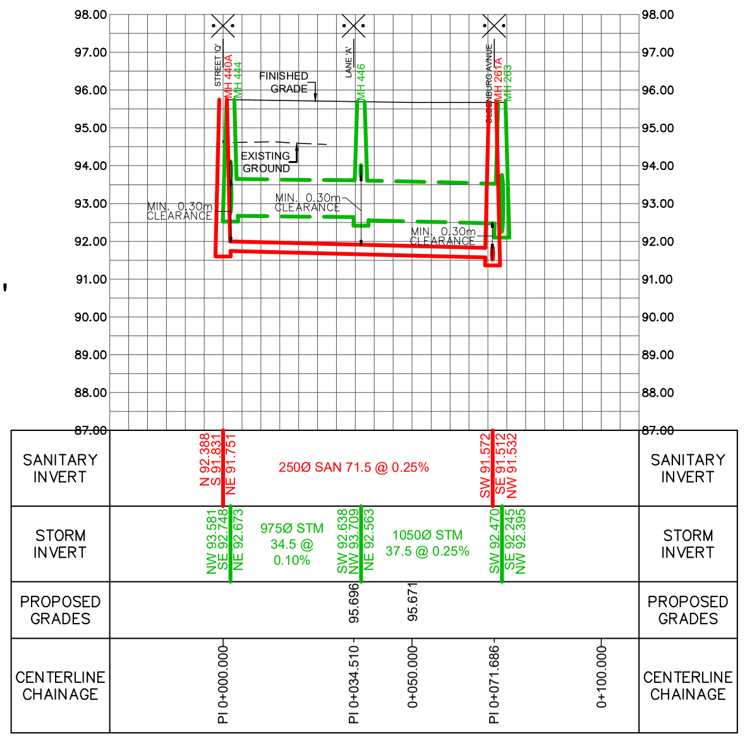

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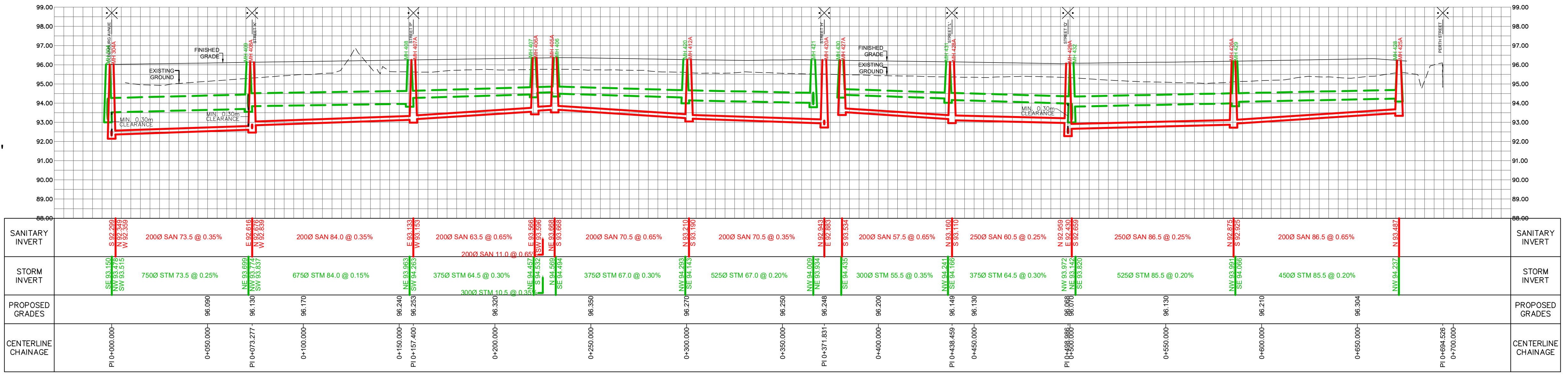

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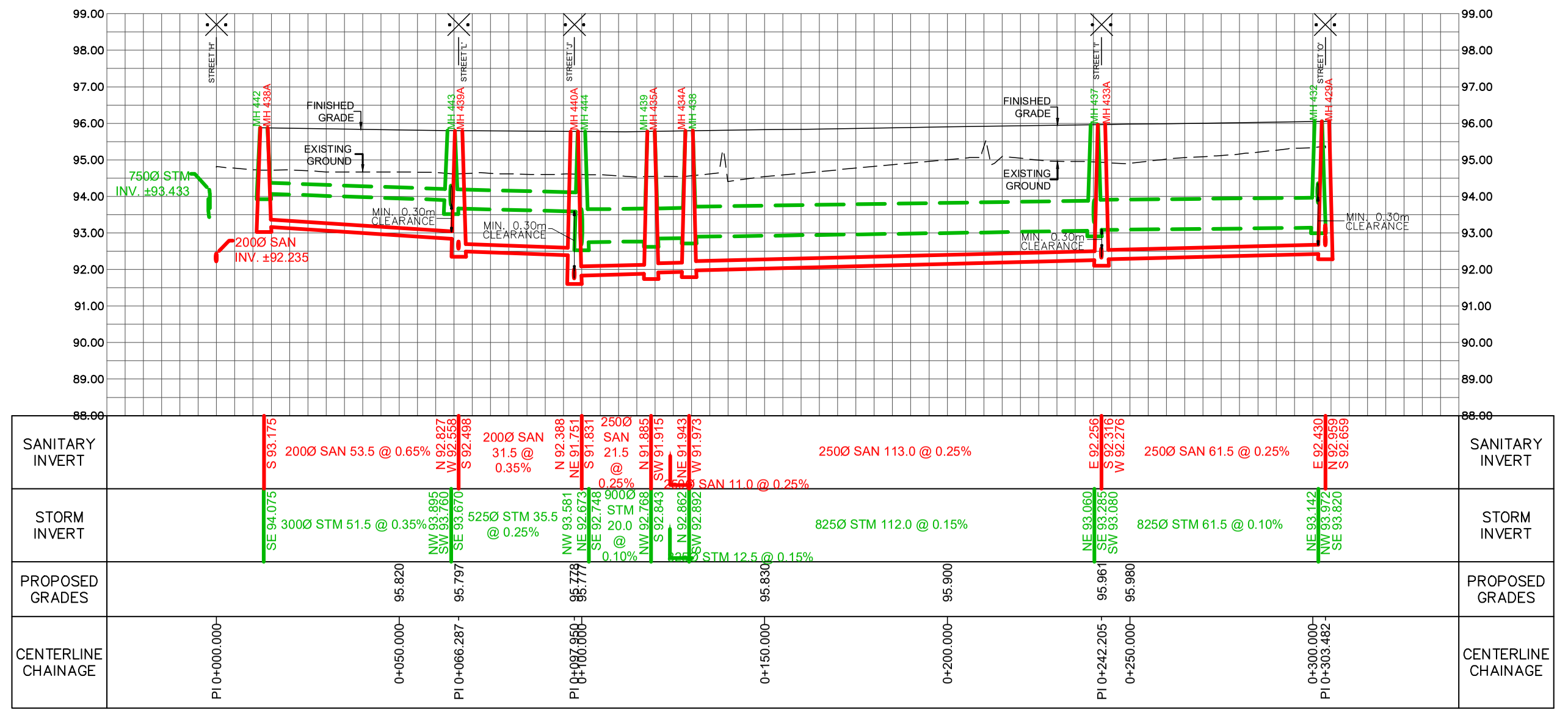

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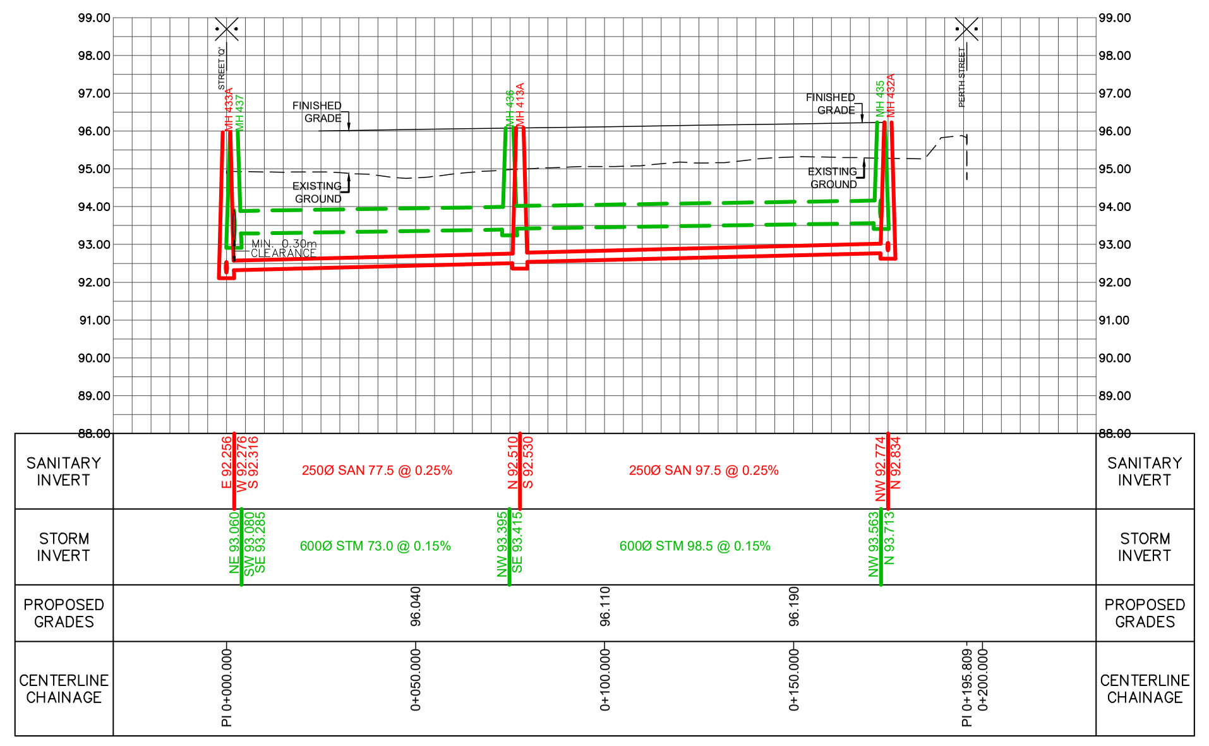
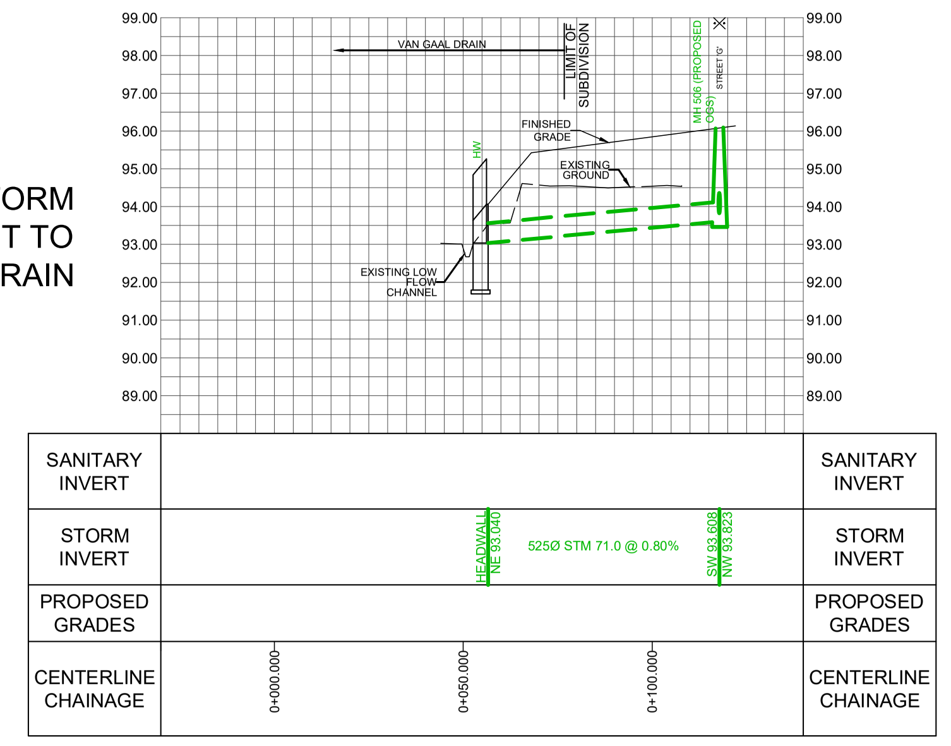


STREET G OGS STORM OUTLET TO VAN GAL DRAIN



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CITY OF OTTAWA

PROFILES
GREEN LANDS WEST AND EAST

SCALE: 1:2000
PROJECT No.: 1183
DATE: AUGUST 2021
DRAWING: 5A

LEGEND

▬ ▮ ▮ ▬	SUBJECT LANDS
◄	EXISTING DITCH
▮▮▮▮	STORM TRIBUTARY AREA
▮▮▮▮	EXTERNAL STORM TRIBUTARY AREA
◄	STORM TRUNK
▪▪▪▪	STORM TRUNK BY OTHERS
0.13Ha / 0.70 / MH 512 / MH 513	STORM FREQUENCY DRAINAGE AREA RUN-OFF COEFFICIENT UPSTREAM/DOWNSTREAM MANHOLE
0.96Ha / 0.7 / MH 13 / MH 20	STORM FREQUENCY EXTERNAL DRAINAGE AREA RUN-OFF COEFFICIENT UPSTREAM/DOWNSTREAM MANHOLE
⇧	EXTERNAL DRAINAGE

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CAIVAN (RICHMOND SOUTH) LTD.

CITY OF OTTAWA

OVERALL STM SERVICING
LAFFIN LANDS

SCALE:	1:3000	PROJECT No.:	20-1184
DATE:	AUGUST 2021	DRAWING:	6