Shea Road Lands Development Conceptual Site Servicing and Stormwater Management Report

Job #160400900

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0	Conceptual Site Servicing and Stormwater Management Report	Ana Paerez	April 17, 2018	Kris Kilborn
1	Conceptual Site Servicing and Stormwater Management Report	Ana Paerez	October 15, 2018	Kris Kilborn

Sign-off Sheet

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Kris Kilborn

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1.0 INTRODUCTION AND BACKGROUND

The following revised servicing and stormwater management (SWM) report has been prepared to address comments to the first engineering submission for draft plan approval of April 2018. Specifically, the proposed development layout has been revised to increase the size of the proposed school block and to revise the location of the proposed park to be adjacent to the school. An additional hydraulic analysis has been provided to reflect the interim condition in which the adjacent Tartan Lands are undeveloped and water servicing for the proposed development is provided through a connection to the existing Shea road watermain and a second connection to the Fernbank Road watermain. The conceptual sanitary sewer design sheet has been revised to reflect the latest City guidelines and the sanitary section of the report has been revised to further describe phasing and timing of future developments to be serviced through the proposed trunk sewer. The SWM analysis has been revised to reflect the proposed development layout changes and to address City comments on the modeling and the proposed Fernbank SWM Pond 4 layout. A letter summarizing the engineering comments to the previous submissions along with Stantec responses are included in **Appendix E**.

Stantec Consulting Ltd. has been retained by 1384341 Ontario Inc. to provide a conceptual servicing plan to support the proposed Shea Road Lands Development. The subject property is located on the north-western quadrant of the intersection of Shea Road and Fernbank Road in the City of Ottawa as shown in **Figure 1.**

The proposed development comprises approximately 25.7 ha of land, and comprises a school block, a designated park area, a SWM block, and a mix of townhomes, semi-detached homes, and single family units. The intent of this report is to provide a servicing scenario for the proposed site that is free of conflicts, includes future development, and utilizes the existing local infrastructure in accordance with the background studies.

Figure 1: Approximate Location of Shea Road Lands Development

1.1 BACKGROUND

In 2008, the City of Ottawa completed the Fernbank Community Design Plan (FCDP). The FCDP covers approximately 675 ha of land between the established communities of Stittsville, Kanata West and Kanata South. The community extends from Hazeldean Road to the north, the Carp River and Terry Fox Drive to the east, Fernbank Road to the south and the existing Urban Area of Stittsville to the west.

In conjunction with preparation of the Community Design Plan, several Class Environmental Assessment Studies/Master Plans were also prepared. Two of those were the Master Servicing Study (MSS) for water and sanitary and an Environmental Management Plan (EMP) for the natural environment and stormwater management (SWM). Those reports identified planning level solutions for on-site storm drainage, wastewater collection and water supply and distribution to the community. The approved EMP and MSS recommended the construction of one stormwater management facility (referred to as Pond 4) and associated storm sewer systems to provide stormwater management for the Fernbank Community tributary to the Faulkner Drain Tributary.

IBI Group prepared a Conceptual Servicing and SWM Report in 2013 to address servicing requirements for the subject lands as well as the lands owned by Tartan Homes as shown in **Figure 1**. IBI's report identified that the urban boundary had been extended southerly to include an area called OPA 76 - Area 6, which resulted in an increase in the size of the trunk sanitary sewer routed through the site to service the additional Area 6 lands. Since then, the proposed draft plans have been revised, the City of Ottawa SWM guidelines have been updated, an additional section of sanitary trunk sewer has been installed on Robert Grant Avenue, a site servicing report has been completed for Phase 1 of the CRT lands that will provide a sanitary outlet for the proposed site, and a conceptual design brief has been prepared for Area 6, south of the site which will be serviced through the proposed site sanitary trunk sewer and connected to the existing Fernbank Road watermain which will also be used to service the proposed site. **Figure 2** shows the extent of the existing and approved watermains and sanitary sewers in the area.

Stantec submitted the Fernbank SWM Pond 4 Design Brief in April 2018 to ensure the proposed SWM pond block was sized appropriately to provide the level of treatment required for the catchment area as outlined in the background documents and/or revised in recent correspondence, and to obtain the necessary approvals from Hydro One within their transmission corridor (see correspondence in **Appendix C.6**). City comments regarding the proposed SWM pond layout/grading that affect the available storage in the SWM pond have been addressed in this submission and reflected on the drawings and SWM modeling (see comment response letter in **Appendix E**). However, comments that relate to drawing details and maintenance will be addressed in a second submission of the Fernbank SWM Pond 4 Design Brief during the detailed design stage of the subdivision. A summary of the results from the detailed pond design as it pertains to the conceptual site storm servicing plan will be provided in the SWM section of this report.

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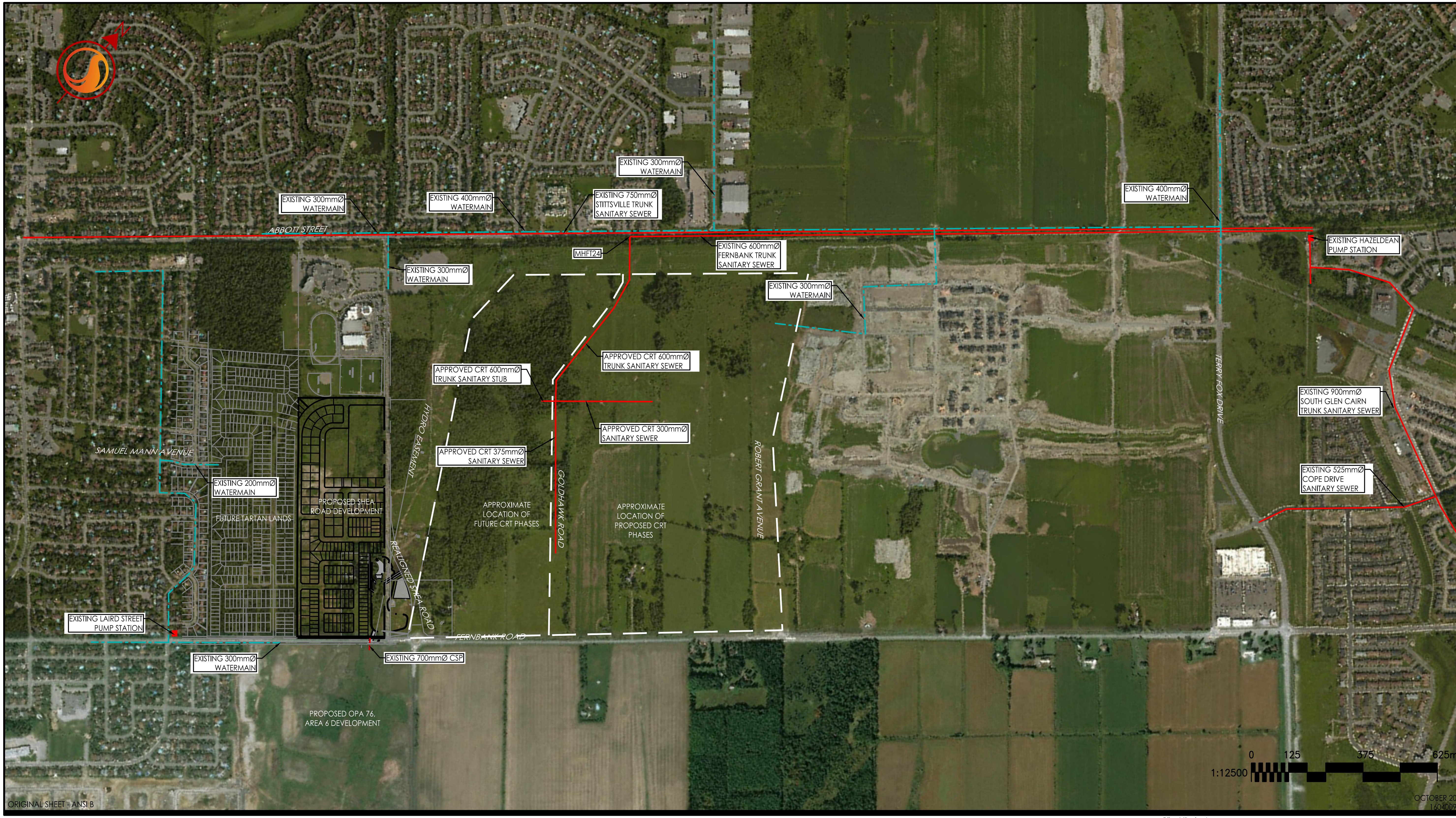

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Legend

(dash-dot line)	EXISTING WATERMAIN
(solid line)	EXISTING/APPROVED SANITARY SEWER

Notes

1. APPROXIMATE LOCATION OF APPROVED SANITARY SEWERS WITHIN CRT LANDS BASED ON DESIGN BRIEF OF CRT LANDS PHASE 1 FERNBANK COMMUNITY (IBI, JULY 2017)

Client/Project
1384341 ONTARIO LTD.
SHEA ROAD LANDS
DESIGN BRIEF

Figure No.
2

Title
EXISTING/APPROVED WATERMAINS AND SANITARY SEWERS

1.2 OBJECTIVE

This servicing report is being prepared in support of draft plan approval for the Shea Road Lands Development. This report will provide a recommended servicing plan for the major municipal infrastructure needed to support development of the subject property. The review will be a macro level detail study with further details to be confirmed and provided during the detailed design process. This report will demonstrate how proposed municipal servicing is in conformance with the MSS and EMP recommendations. Any deviation from the MSS documents will also be identified with rationalization for the change.

1.3 BACKGROUND RESOURCES

The following documents were referenced in the preparation of this report:

- *Fernbank Community Design Plan Existing Conditions Report – Storm Drainage and Hydrology,* Novatech Engineering Consultants Ltd., January 2007
- *Fernbank Community Design Plan Environmental Management Plan,* Novatech Engineering Consultants Ltd., June 24, 2009
- *Fernbank Community Design Plan Master Servicing Study,* Novatech Engineering Consultants Ltd., June 24, 2009
- *Geotechnical Investigation Proposed Residential Development Shea Road, Ottawa, Ontario,* Golder Associates, October 2011
- *Conceptual Site Servicing Plan, Stormwater Management Plan and Erosion and Sediment Control Plan Shea Road Lands Fernbank Community*, IBI Group, March 2013
- *Conceptual Site Servicing Study Davidson Lands – OPA 76 Area 6a, Stittsville South*, IBI Group, November 2015
- *Fernbank Community Sanitary Trunk Sewer Design Report,* Novatech Engineering Consultants Ltd., January 2012
- *Fernbank Pond 4 Stormwater Management Facility Design Brief*, Stantec Consulting Ltd., December 8, 2017
- *CRT Lands Phase 1 Fernbank Community Design Brief,* IBI Group, July 2017
- *Geotechnical Investigation Proposed Residential Development 5957 and 5969 Fernbank Road, Ottawa, Ontario,* Golder Associates, September 2018

Additional documents referenced in designing the conceptual servicing plan for the Shea Road Lands Development include:

- *Stormwater Management Planning and Design Manual*, Ministry of the Environment (Ontario), March 2003
- *Ottawa Design Guidelines – Water Distribution*, City of Ottawa, July 2010
- *City of Ottawa Sewer Design Guidelines*, 2nd Ed., City of Ottawa, October 2012
- *Technical Bulletin PIEDTB-2016-01 Revisions to Ottawa Design Guidelines – Sewer,* City of Ottawa, September 2016

2.0 POTABLE WATER

The Fernbank Community is located within the City's 3W Pressure Zone which includes most of Kanata and Stittsville. Potable water to this area is pressurized at the Glen Cairn Pump Station where a major water storage reservoir (Glen Cairn Reservoir) is located. Two of the major watermains into this pressure zone from the pump station are located along Hazeldean Road and Terry Fox Drive. Another main adjacent to the subject site is located in Abbott Street and the Trans Canada Trail.

The Fernbank Community Design Plan MSS completed a review of the existing water plan adjacent to the area and made recommendations for improvements and expansion to the City's water transmission and distribution system to support the proposed Fernbank Community. **Figure 2** indicates the limits of existing watermains in the vicinity of the subject property while excerpts from IBI's servicing report for the subject lands regarding the watermain plan are included in **Appendix A.5.**

The site will ultimately be serviced through three watermain connections: a 200 mm diameter watermain on Samuel Mann Avenue, a 400 mm diameter watermain on Fernbank Road, and a 300 mm diameter watermain on Shea Road south of the intersection with Abbott Street East. The proposed 300 mm diameter watermain will be extended along Shea Road to the south as shown on **Drawing OSSP-1** to service future developments.

The conceptual site servicing plan for OPA 76 Area 6 Tartan lands immediately south of the development included in **Appendix A.5** shows that the 400 mm diameter watermain on Fernbank Road will be extended to the existing 300 mm diameter watermain as part of their development. Based on recent conversations with Tartan, it is our understanding that the first phase of the Area 6 development which includes the Fernbank watermain extension and upgrade will take place in 2018 and as such, it will be available to service the proposed Shea Road Development. In contrast, Tartan indicated that the potential timeline for their residential development immediately west of the proposed Shea Road Development is approximately 5 years, and as such, it is anticipated that the proposed site will be constructed prior to the Tartan Development to the west. As a result, an interim scenario has been assessed assuming the lands to the west are undeveloped and the proposed site is serviced through two watermain connections: the 400 mm diameter watermain on Fernbank Road, and the 300 mm diameter watermain on Shea Road south of the intersection with Abbott Street East.

Proposed ground elevations for the site vary from approximately 110.5 m to 115.0 m. Boundary conditions provided by the City of Ottawa for both interim and ultimate conditions are summarized in **Table 1** below (as well as in **Appendix A.1**).

Table 1: Ultimate and Interim Boundary Conditions

Demand Scenario	Ultimate Condition Scenario - Head (m)			Interim Condition Scenario - Head (m)	
	Samuel Mann Connection	Fernbank Connection	Shea Connection	Fernbank Connection	Shea Connection
Maximum HGL	160.6	160.5	160.8	160.6	160.6
Peak Hour HGL	153.6	153.2	154.7	154.0	154.0
Max. Day plus Fire (10,000 L/min)	149.4	148.4	154.8	144.5	154.0
Max. Day plus Fire (15,000 L/min)	141.1	139.4	151.5	131.1	150.4

2.1 WATER DEMANDS

Water demands for the development were estimated using the City of Ottawa Water Distribution Design Guidelines. A daily rate of 15,000 L/ha/d was used for the proposed school. See **Appendix A.2** for detailed domestic water demand estimates.

The Interim scenario only includes demands from the proposed site, whereas the ultimate scenario includes the proposed site in addition to demands from the future Tartan development to the west. The average day demand (AVDY) for both the ultimate and interim scenarios of site was determined to be 12.1 L/s and 5.0 L/s. The maximum daily demand (MXDY) was determined to be 29.8 L/s and 11.9L/s and was calculated as 1.5 times the AVDY (school block) and 2.5 times the AVDY for all other areas (residential). The peak hour demand (PKHR) totaled 65.2 L/s and 25.8 L/s and was calculated as 1.8 times the MXDY (school block) and 2.2 times the MXDY for all other areas (residential).

The fire flow requirement was capped at 10,000 L/min (167 L/s) as per the City of Ottawa Technical Bulletin ISDTB-2014-02 (May 2014), provided that firewalls with a minimum two-hour fire-resistance rating that comply with OBC Div. B, Subsection 3.1.10, are constructed to separate townhouse blocks to the lesser of seven dwelling units and 600 m^2 of building area, and that a minimum 10 m separation exists between rear yards. A 15,000 L/min fire flow requirement was used for the school block.

2.2 HYDRAULIC MODEL RESULTS

A hydraulic model was used to simulate the proposed development conditions based on boundary conditions provided by the City of Ottawa. Separate boundary conditions were applied for both the ultimate and interim scenarios. Demands from Area 6 which will be developed south of the site were not included in the boundary conditions. However, correspondence with the city confirmed the addition of Area 6 will have no significant decrease to the HGL and will be included at the detailed design stage. The hydraulic analysis was completed with H2OMAP Water Software and assessed the internal network and connections to the surrounding infrastructure. The model was tested under average day, peak hour, and maximum day plus fire flow conditions.

The proposed watermain layout allows serviceable pressures to be maintained under average day, peak hour, and maximum day plus fire flow demands. The minimum and maximum pressures modeled from both interim and ultimate condition scenarios are summarized in **Table 2** below. These pressures are within the serviceable limit of 40 to 80 psi (276 to 552 kPa) as per City of Ottawa guidelines.

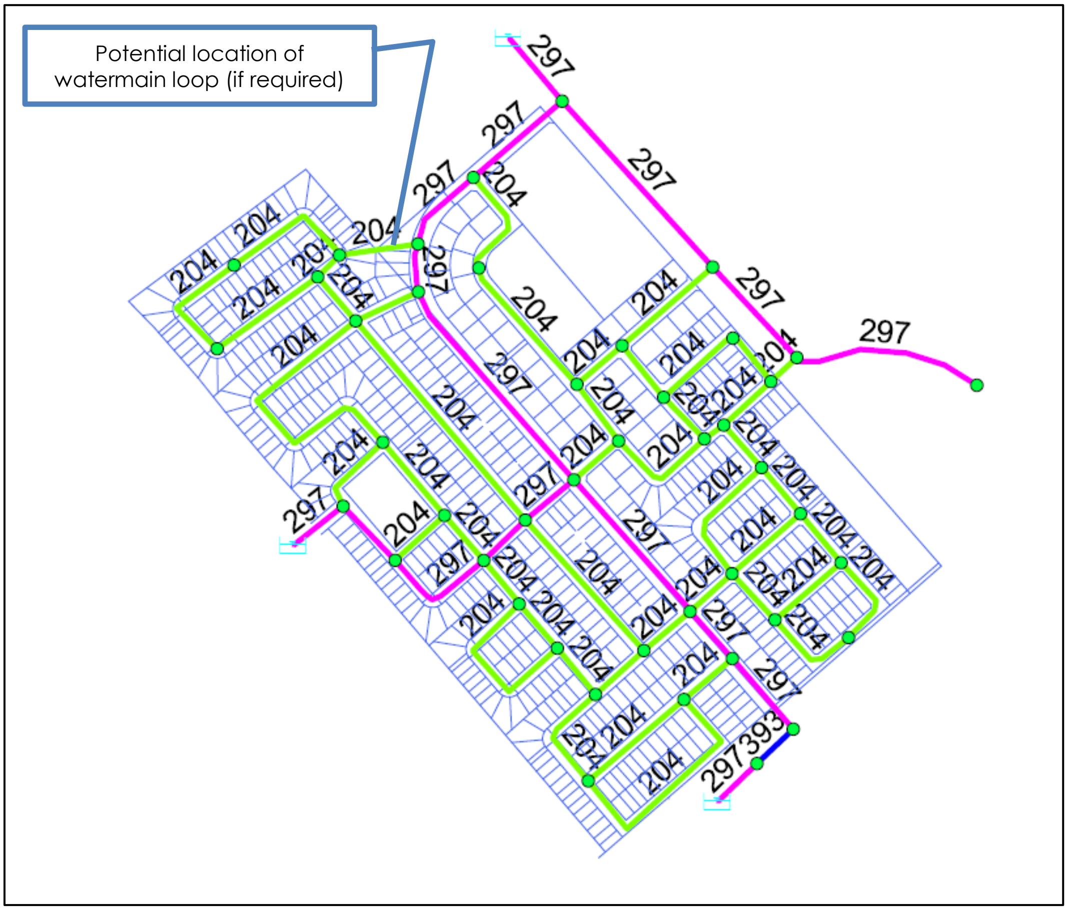
Table 2: Minimum and Maximum Pressures Within the Ultimate and Interim Scenarios

	Interim Scenario		**Ultimate Scenario**	
	(psi)	**(KPa)**	**(psi)**	**(KPa)**
Minimum Pressure	58.1	401	53.8	371
Maximum Pressure	74.1	511	74.1	511

A fire flow analysis was carried out using the hydraulic model to determine the anticipated amount of flow that can be provided for the proposed development under maximum day plus fire flow demands while maintaining a minimum pressure of 20 psi. A fire flow demand of 167 L/s was used for all residential nodes, while a fire flow demand of 250 L/s was used for node 30 which is adjacent to the proposed school block. Results of the modeling analysis indicate that flows in excess of 192 L/s and 337 L/s for the interim and 195 L/s and 583 L/s at all residential nodes and node 30 respectively, can be delivered while still maintaining a residual pressure of 140 kPa (20 psi). Results of the hydraulic modeling are included for reference in **Appendix A.3**.

Figure 3 below shows the diameter sizes of both the proposed site and Tartan Lands to the west.

Figure 3: Watermain Layout and Connections to Existing Infrastructure



Potential looping between the proposed site and future Tartan lands site to the west will be confirmed at the detailed design stage of the future Tartan development (by others).

2.2.1 SUMMARY OF FINDINGS

Based on the findings of the report, the proposed water network is capable of servicing the proposed development and meets all servicing requirements as per City of Ottawa standards under typical demand conditions (peak hour and average day conditions) as well as under emergency fire demand conditions (maximum day + fire flow).

3.0 WASTEWATER SERVICING

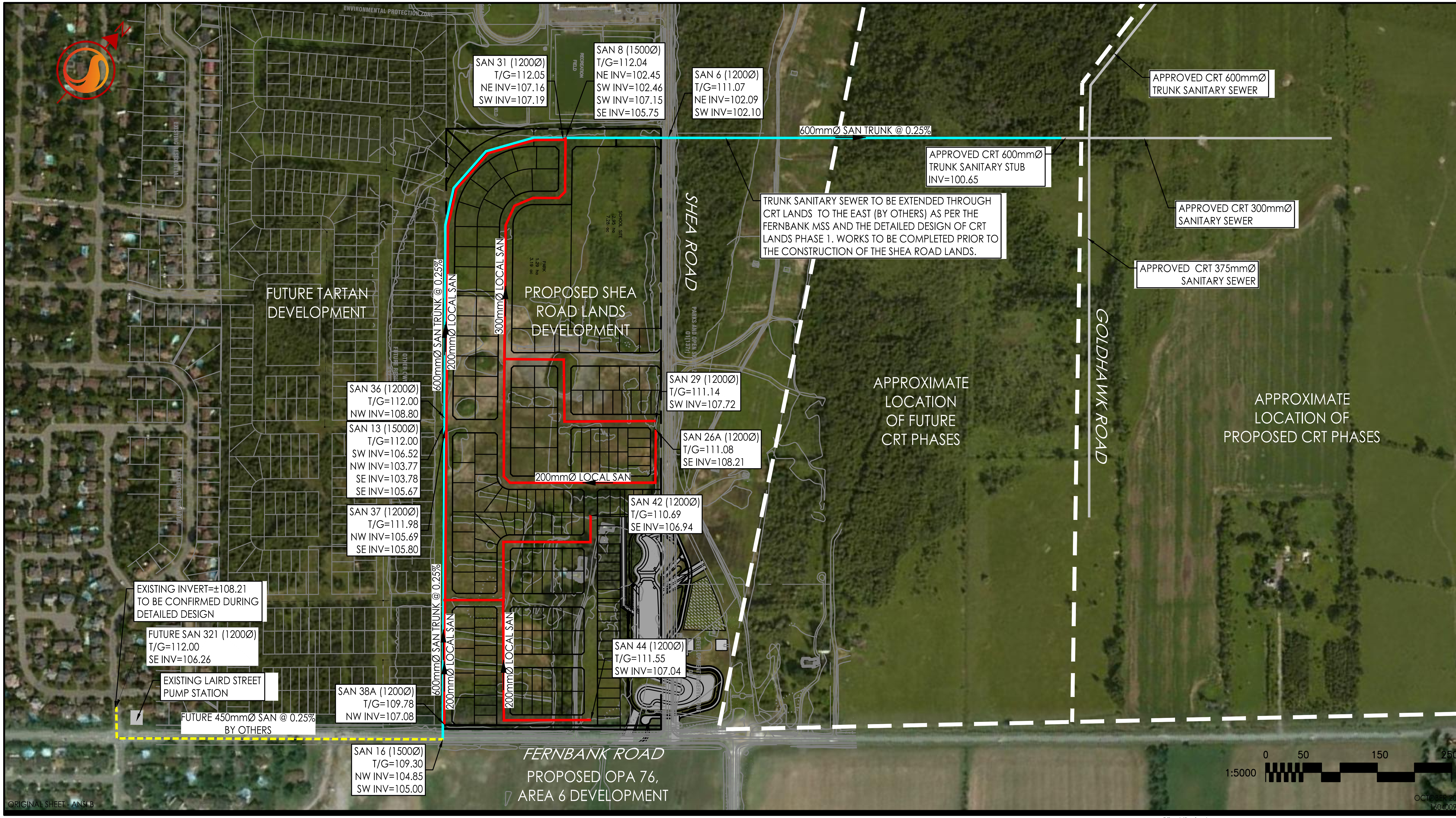
3.1 BACKGROUND

The June 2009 Fernbank MSS outlined the Hazeldean Pump Station (HPS) as the recommended wastewater outlet for all lands in the Fernbank Community, including the subject site. Among other areas in Kanata, including Bridlewood, Kanata South Business Park and the Glen Cairn Community, the HPS also serves most developed lands in Stittsvile west of Terry Fox Drive and south of Hazeldean Road.

Subsequently to the 2009 Fernbank MSS report, Novatech Consulting Engineers Ltd. completed the Fernbank Community Sanitary Trunk Sewer Design Report in 2012. The Fernbank trunk Sewer report recommended construction of the Fernbank Trunk Sewer in the Hydro One easement adjacent to the Trans Canada Trail. The upper reach of the trunk Sewer, which conveys sewage peak flows from the Fernbank Community to the HPS was designed as a 600 mm diameter pipe at 0.39% slope and was proposed to be constructed immediately north of the CRT lands at MH-FT24, running along the Trans Canada Trail parallel to the Stittsville Trunk sewer on Abbott Street as shown on **Figure 2**.

In July 2017, IBI prepared the CRT Lands Phase 1 Design Brief which outlines the proposed sanitary sewer sizing for the CRT lands which will serve as the immediate sanitary outlet for the proposed Shea Road Development and future Tartan Lands to the west. The 2009 Fernbank MSS recommended construction of a 525 mm diameter sub-trunk sewer along Goldhawk Drive and a 450 mm diameter sewer oversized for external lands west of Shea Road. However, as part of the design for the CRT Phase 1 lands, the City of Ottawa requested that the CRT sanitary sewer be oversized to account for wastewater flows from the existing Laird Street Pump Station and also expected flow from the 2012 OPA Area 6 expansion lands, which were brought into the urban envelope in 2012 as part of the last Official Plan review by the City. As a result, the recommended sanitary sewer extension through the CRT Lands included a 600 mm diameter pipe as opposed to the 450/525 mm diameter pipes recommended in the Fernbank MSS report to be able to convey external flows of 192 L/s (108 L/s from the Liard Street Pump Station and 84 L/s from the OPA 76 Area 6 lands). These external flows are in addition to other upstream flows from future developments within the Fernbank CDP area (i.e. Shea Road and Tartan Lands Developments). **Figure 4** shows the conceptual wastewater servicing plan for the proposed development.

The timing for the Laird Street pump station decommissioning and re-direction of sewage peak flows to the proposed site sanitary sewers has not been confirmed and as such, for the purpose of this report, it has been assumed and shown on the drawings that the sanitary trunk sewer along Fernbank Road from the Laird Street Pumping station to the proposed Cope Drive sanitary trunk sewer will be installed in the future by others.



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Legend

(grey line)	EXISTING/APPROVED SANITARY SEWER
(cyan line)	PROPOSED TRUNK SANITARY SEWER
(red line)	PROPOSED LOCAL SANITARY SEWER
(yellow dashed line)	FUTURE SANITARY SEWER

Notes

1. APPROXIMATE LOCATION OF APPROVED SANITARY SEWERS WITHIN CRT LANDS AND 600 mm DIA. STUB INVERT AS PER THE DESIGN BRIEF OF CRT LANDS PHASE 1 FERNBANK COMMUNITY (IBI, JULY 2017)

Client/Project
1384341 ONTARIO LTD.
SHEA ROAD LANDS
DESIGN BRIEF

Figure No.
4

Title
CONCEPTUAL WASTEWATER
SERVICING PLAN

The 2009 MSS Report completed a sanitary hydraulic gradient (HGL) analysis. The recommended HPS overflow system included a diversion to the Monahan Drain Constructed Wetlands Stormwater Management Facility, which resulted in a predicted HGL at the station of 95.0 m. Based on the 2009 estimated HGL, the overflow would protect all development lands in the Fernbank Community and most of the existing sewershed.

However, a revised HGL analysis was undertaken as part of IBI's 2017 Servicing brief for the CRT Lands which mentions that the City advised that the current sanitary hydraulic grade line (HGL) at the Hazeldean Pump Station is now 95.30 m as opposed to the 95.0 m HGL predicted in the 2009 MSS review. The revised HGL analysis indicated that the sanitary HGL along the trunk sewer is lower than previously predicted in the Fernbank MSS Report even though more wastewater is included in the latest analysis. The HGL at MHFT24 (outlet of the CRT lands) was 99.93 m in the current analysis, compared to 100.75 m obtained in the 2009 MSS. Either way, the sanitary HGL does not impact the subject lands given that the lowest road elevation is approximately 110.5 m.

3.2 DESIGN CRITERIA

The conceptual sanitary sewer design sheet included in **Appendix B.1** has been revised to address City comments and reflect the latest City guidelines as shown below. The revised sanitary sewer design criteria differs from the criteria previously used in the 2009 Fernbank MSS as shown in the table below.

Table 3: Sanitary Sewer Design Criteria Comparison

Design Parameters	Revised Design Criteria (City Guidelines)	2009 Fernbank MSS Criteria
Minimum Velocity (m/s)	0.6	
Maximum Velocity (m/s)	3.0	
Manning roughness coefficient for all smooth wall pipes	0.013	
Minimum size	200mm dia. for residential areas, 250mm for commercial areas	
Single Family Persons per unit	3.4	3.3
Townhouse Persons per unit	2.7	2.5
Average Apartment Persons per unit	1.8	1.8
Extraneous Flow Allowance (L/s/ha)	0.33	0.28
Manhole Spacing (m)	120 m	
Minimum Cover (m)	2.5 m	
Average Daily Discharge / Person (L/cap/day)	280	350
Harmon Correction Factor	0.8	1.0
Institutional Daily Flow (L/ha/day)	28,000	28,000

3.3 PROPOSED SERVICING

Wastewater from the proposed Shea Road Lands Development will be conveyed through the sanitary trunk sewers within the future CRT lands which ultimately connect to the existing Fernbank trunk sewer on the Trans Canada Trail as shown on the MSS Drawing No. 101108-SAN included in **Appendix B.2**. The conceptual main trunk sewer alignment is shown on **Drawing OSA-1**. As identified on **Drawing OSA-1,** a higher level sanitary sewer is proposed in all right of ways where the trunk sanitary sewer exceeds 5 m in depth to avoid deep residential service connections to the main and facilitate any potential future service repairs.

The site sanitary trunk sewers will be sized to service the proposed development, the Tartan development west of the site (draft plan provided in **Appendix B.2**), as well as OPA Area 6 expansion lands which are estimated to generate approximately 84 L/s of sewage peak flows. Additionally, an allowance of 108 L/s has been included from the existing Laird Street Pump Station (see report excerpts in **Appendix B.2**). The conceptual sanitary sewer design sheet can be found in **Appendix B.1**. A breakdown of the estimated sewage peak flows is shown in **Table 4**.

The sewage peak flows to be conveyed through the proposed site to the trunk sewers within the CRT lands are summarized in **Table 4** below.

Table 4: Estimated Wastewater Peak Flows

Property	Population (persons)	Institutional Area (ha)	Residential/Institutional Peak Flow (L/s)	Total Area (ha)	Extraneous Flow (L/s)	Total Peak Flow (L/s)
Shea Road and Tartan Developments	2,833	2.96	28.26	49.53	16.34	44.60
Area 6	N/A	N/A	N/A	N/A	N/A	84.00
Laird Street Pump Station	N/A	N/A	N/A	N/A	N/A	108.00

4.0 STORM DRAINAGE

The proposed development encompasses approximately 25.7 ha of land and comprises a school block, designated park land, a stormwater management (SWM) block, and a mix of single family homes, semi-detached units and town homes. Post development runoff from the development will be directed to a proposed SWM wet pond which will provide quantity and quality control (80% TSS removal) of runoff before discharging to a tributary of the Faulkner Municipal Drain through an existing 700 mm diameter CSP crossing Fernbank Road. The proposed SWM facility, identified as Pond 4 in the Fernbank Community EMP, will receive runoff from approximately 59.2 ha of land including the proposed development, a portion of Shea Road right of way, the adjacent Tartan development to the west and the SWM pond footprint area. **Drawing OSD-1** shows the overall major and minor system flow direction as well as the proposed SWM Pond layout.

The storm drainage objective is to complete a conceptual stormwater management plan for the proposed development that meets all relevant design criteria.

4.1 BACKGROUND

IBI Group prepared a Conceptual Servicing and SWM Report in 2013 to address servicing requirements for the subject lands owned by Tartan and Cavanagh (see **Drawing OSD-1**). IBI's report identified that a hydro corridor extends south on the east side of the subject site, crossing Fernbank Road at Shea Road, partially within the proposed Pond 4 location. The report outlined the stage-storage relationship representing Pond 4 in the EMP and MSS was used in their SWMHYMO hydrologic model. IBI's conceptual design provided a SWM pond footprint to meet MOECC quality control volumetric requirements and to restrict post development peak flows from the overall development to pre-development levels as per the EMP. Report excerpts have been provided in **Appendix C.4**. **Table 5** shows the existing condition peak flows to the Faulkner Municipal Drain tributary at Fernbank Road, as presented in the Fernbank EMP.

Table 5: Existing Condition Peak Flows to the Faulkner Tributary at Fernbank Road

Distribution	Peak Flow (m^3/s)					
	2-year	**5-year**	**10-year**	**25-year**	**50-year**	**100-year**
12hr AES	0.46	0.74	0.94	1.19	1.37	1.55
12hr SCS	0.48	0.82	1.05	1.39	1.58	1.83
24hr SCS	**0.51**	**0.83**	**1.05**	**1.32**	**1.55**	**1.85**

During the pre-consultation meeting for the proposed Shea Road Lands development in 2016 (see attached correspondence in **Appendix C.6**), the City advised that the allowable release rate from the Fernbank SWM Pond 4 should be coordinated with the work being done to update the Faulkner Municipal Drain Engineer Report by Andy Robinson of Robinson Consultants. Subsequent correspondence with Robinson Consultants confirmed that the existing 700 mm diameter culvert under Fernbank Road has a maximum capacity of 0.9 m^3/s with a 0.5 m head and as such, the 100-year outflow from the proposed SWM Pond 4 should be restricted to 0.9 m^3/s, instead of the 100-year pre-development condition peak flow of 1.85 m^3/s previously identified in the background reports.

Stantec circulated the conceptual SWM Pond 4 layout to HONI stakeholders and obtained approval on October 25, 2017 for the proposed footprint and measures provided to protect the existing Hydro structures and to provide adequate access for maintenance (correspondence included in **Appendix C.6**).

The first submission of the Fernbank SWM Pond 4 Design Brief was submitted by Stantec under separate cover in April 2018. The intent of the report was to demonstrate that the proposed SWM pond block was sized appropriately to provide the level of treatment required for the catchment area as outlined in the background documents and/or revised in recent correspondence, and to obtain the necessary approvals from Hydro One within their transmission corridor. City comments regarding the proposed SWM pond layout/grading that affect the available storage in the SWM pond have been addressed in this submission and reflected on the drawings and SWM modeling (see comment response letter in **Appendix E**). However, comments that relate to detailed pond drawing and maintenance requirements will be addressed in a second submission of the Fernbank SWM Pond 4 Design Brief during the detailed design stage of the subdivision.

Runoff from the proposed Fernbank SWM Pond 4 will outlet into the northern Fernbank Road side ditch which conveys runoff to the existing 700 mm diameter CSP (see **Drawing OSD-1**) that crosses Fernbank Road and discharges into an existing ditch. The existing ditch runs south and then east across the property south of Fernbank Road and ultimately discharges into the Shea Road side ditch. Runoff is then directed south along the western Shea Road side ditch towards Flewellyn Road and into an existing 2300 mm diameter CSP that discharges into the Faulkner Municipal Drain. The existing ditch that crosses the property south of Fernbank Road will be filled out as part of the future Area 6 development, and as such, an alternate outlet is required for the proposed Fernbank SWM Pond 4.

4.1.1 Fernbank SWM Pond 4 – Storm Outlet Assessment and Preferred Conceptual Drainage Option

In September 2018, Stantec completed the Fernbank SWM Pond 4 Storm Outlet Assessment and Preferred Conceptual Drainage Option (see **Appendix C.5**). The purpose of the exercise was to assess the capacity of a potential future condition drainage outlet for the proposed Fernbank SWM Pond 4 as agreed upon with the owners of the lands south of Fernbank Road. Based on discussions between the different owners, it is proposed to provide a pipe outlet for the Fernbank

SWM Pond 4 outflows, as well as for runoff from Fernbank Road as part of the development of the future area 6 developments.

In order to assess an alternate outlet for the Fernbank SWM Pond 4 from the existing 700 mm diameter CSP to the Shea roadside ditch, a detailed hydrologic/hydraulic analysis was performed in PCSWMM.

PCSWMM was used to estimate the volume of runoff generated during the future condition, which assumes the ultimate condition development for the Fernbank SWM Pond 4 and the future Area 6 and the commercial block at the intersection of Shea Road and Fernbank Road have been built (The letter report for the conceptual storm outlet as well as all associated appendices and drawings have been included in **Appendix C.5**).

In order to evaluate the hydraulic response of the Shea and Fernbank roadside ditches and the potential future structures during the 10- year storm under future conditions, a PCSWMM model was created to incorporate the detailed hydrology for each catchment, the proposed Fernbank SWM Pond 4, the potential future storm sewer to the Shea roadside ditch, as well as the existing/potential future drainage features along the Fernbank and Shea roadside ditches from the Fernbank SWM Pond 4 outlet to the existing 2300 mm diameter CSP crossing Flewellyn Road.

In order to address the existing ditch capacity issues along Shea Road and to convey the 100-year post development peak flows from the proposed Fernbank SWM Pond 4 to the Faulkner Municipal Drain after Area 6 is developed, assuming the existing outlet ditch is filled out, the hydraulic/hydrologic analysis was revised iteratively by revising culvert sizes and slopes and providing positive constant slopes along the roadside ditches towards Flewellyn Road. Based on the results of this analysis, the following conclusions were made about the potential future outlet:

1. A manhole structure is required to capture runoff from the existing 700 mm diameter CSP and direct it to the proposed 900 x 1200 mm concrete box storm sewer.
2. A ditch inlet catchbasin (DICB) is required to capture runoff from the southern Fernbank roadside ditch and direct it to the proposed manhole structure.
3. Approximately 348 m of 1200 x 900 mm concrete box storm sewer is required within the property south of Fernbank Road to re-direct runoff to the existing Shea roadside ditch.
4. Regrading of the Shea road side ditch at several locations is required to provide positive drainage.
5. Several culvert replacements are required along the Shea road side ditch system.

Significant work is required along the southern Fernbank Road side ditch and the western Shea Road side ditch to improve the existing drainage conditions and to redirect post development runoff from the Fernbank SWM Pond 4 to the Faulkner Municipal Drain, once Area 6 is developed and the existing outlet ditch is filled out.

4.2 DESIGN CONSTRAINTS AND REGULATORY REQUIREMENTS

The following summarizes the SWM criteria and constraints that will govern the detailed design of the proposed development as per the governing background studies and recent conversations with City staff.

- Design using the dual drainage principle.
- 'Enhanced' level of treatment as per MOECC recommendations which represents an equivalent 80% TSS removal to be provided in the Fernbank SWM Pond 4.
- Quantity control to be provided in the Fernbank SWM Pond 4 to match existing condition peak flows to the Faulkner Municipal Drain at Fernbank Road with a maximum release rate of 0.9 m^3/s.
- Maximum 100-year water depth of 0.35 m in road sags, including overflow spill depth.
- Average sag storage of 40 m^3/ha to be provided in residential areas.
- Proposed school block to provide 50 m^3/ha of on-site storage.
- Rear-yard storage is not to be included in calculations.
- Parks and open spaces are to have no surface ponding storage.
- 100-year hydraulic grade line (HGL) to be a minimum 0.30 m below lowest building underside of footing elevation.
- Design inlets along local roadways to capture the 2-year peak flow.
- Design inlets within the school block and along collector roadways to capture the 5-year peak flow.
- Design storm sewers along local and collector roadways to convey the 2-year and 5-year peak flow respectively under free-flow conditions using 2004 City of Ottawa I-D-F parameters and an inlet time of 10 minutes.
- Provide adequate emergency overflow conveyance to SWM Pond 4 as shown on **Drawing OSD-1**.
- The EMP and MSS outline target infiltration rates for the lands tributary to the Faulkner Drain Tributary. Specifically, the MSS identifies a post development infiltration target of 80 mm/year.
- Design and submit a detailed erosion control plan.

4.3 PROPOSED CONDITIONS

Site sewers will outlet to the proposed SWM Pond 4 that will provide quality control and mitigate post development peak flows to the target peak outflows. Inlet control devices at road low points will be sized at the detailed design stage to restrict inflow rates to the sewer to the 2-year runoff for local streets and the 5-year runoff for the school block and for collector roads (Shea Road and Cope Drive) as per the City design criteria. Storm sewer sizes for the proposed development and the adjacent Tartan development are included only for the larger sewers as shown in the storm sewer design sheet included in **Appendix C.1**. All storm sewer sizes will be reviewed and confirmed during the detailed design stage. Major system peak flows from the entire site will be directed towards the proposed SWM pond (see **Drawing OSD-1**).

4.3.1 End of Pipe Stormwater Management Facility

The conceptual design of Pond 4 was presented in the EMP and MSS to match existing condition peak flows. However, as mentioned in **Section 4.1**, the 100-year outflow from the proposed SWM Pond 4 will be restricted to 0.9 m^3/s, instead of the 100-year pre-development condition peak flow of 1.85 m^3/s previously identified in the background reports. The SWM facility is proposed to be located north of Fernbank Road within the hydro corridor and has been designed to provide water quality and water quantity control of stormwater runoff from the subject site and the adjacent Tartan development. The SWM facility has been designed as a wet pond with one minor system inlet, two major system inlets and an outlet to the Fernbank road side ditch which discharges into the Faulkner Drain tributary through an existing 700 mm diameter CSP. The proposed design assumes the portion of Shea Road tributary to the SWM Pond will have an urban cross section with proposed grades based on the Fernbank MSS grading plan. The location of Pond 4 is indicated on **Drawing OSD-1**.

The normal water level in the SWM pond has been set at 105.75 m as per the Fernbank Community EMP. The maximum permanent water depth within the forebay and main cell of the facility is 1.5 m. The required level of treatment for the proposed SWM Pond is 'enhanced' or 80% TSS removal as per the Jock River Reach 2 Subwatershed Study.

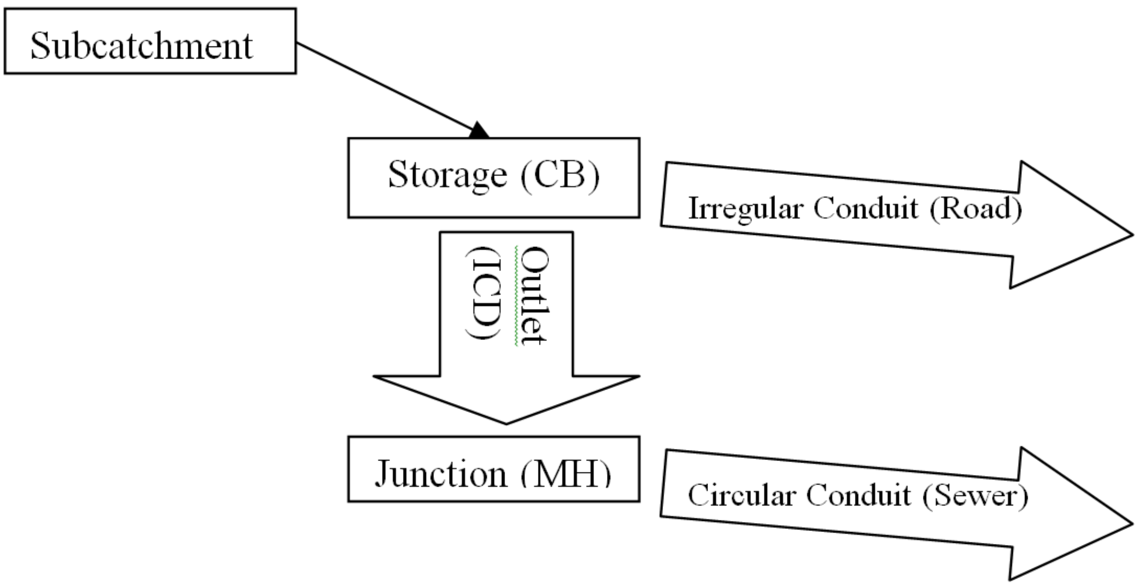
4.4 POST DEVELOPMENT CONCEPTUAL MODELLING RATIONALE

Hydrologic and hydraulic modeling of the SWM pond design was completed using PCSWMM modeling software which uses the EPA-SWMM 5.1.012 computational engine for analysis. The included models can also be opened and reviewed using the free EPA-SWMM GUI. PCSWMM model layout, input parameters, and example input file are provided in **Appendix C**. Electronic model files are provided on the enclosed CD. As previously noted, the site design is currently at a conceptual level and will be further refined at the detailed design stage. The following sections summarize the input parameters used in the conceptual post development model.

4.4.1 SWMM Dual Drainage Methodology

The proposed development is modeled in one modeling program as a dual conduit system (see **Figure 5**), with: 1) circular conduits representing the sewers & junction nodes representing manholes; 2) irregular conduits using street-shaped cross-sections to represent the approximate overland road network and storage nodes representing catchbasins. The dual drainage systems are connected via outlet link objects from storage node (i.e. CB) to junction (i.e. MH), and represent inlet control devices (ICDs). Subcatchments are linked to the storage node on the surface so that generated hydrographs are directed there firstly.

Figure 5 : Schematic Representing Model Object Roles



Storage nodes are used in the model to represent catchbasins. The invert of the storage node represents the invert of the CB and the rim of the storage node represents the top of the CB plus the allowable flow depth on the segment. For the purpose of this conceptual SWM plan, CB inverts have been assumed to be 1.8 m below the top of the CB and a flow depth of 0.60 m has been assumed on grassed swale segments and of 0.35 m on road segments.

Storage nodes on street catchments were assigned a storage curve assuming a maximum storage of 40 m^3/ha while a maximum storage of 50 m^3/ha was assumed for the school block. Storage curves in PCSWMM are required to be input as depth-area curves, as such an equivalent area was calculated at a depth of 2.15 m and kept constant at the rim depth. All storage was assumed to occur between the top of the CB (1.8 m head) and a 0.35 m depth (2.15 m head) prior to spilling into the downstream segment. If the available storage volume in a storage node is exceeded, flows spill above the storage node and into the downstream irregular conduit (representing roads) and continue routing through the system until ultimately flows reach the outfall of the major system. No storage has been accounted for within storage nodes at park areas and some street catchments that are expected to have no sags. Capture curves were defined for each catchment to restrict outlet link flows to the 2-year and 5-year rate for local streets, and the school and collector roads respectively.

4.4.2 Land Use

The proposed site and adjacent Tartan Development will be developed as a mixture of low and medium density residential areas with two park areas and a school. The existing recreational area located at the northern end of the site has been included in the analysis since it sheet drains towards the site under existing conditions. A portion of Shea Road to the west also contributes stormwater runoff to the proposed system. The tributary drainage area was divided into semi-lumped drainage areas reflective of the conceptual design of the minor system. The post-development drainage scheme is indicated on **Drawing OSD-1**.

Typical impervious ratios for single family and townhouse units applied across the site were based on the *Tartan/Cavanagh Conceptual Site Servicing Plan, Stormwater Management Plan and Erosion and Sediment Control Plan* (IBI Group, March 2013), which were based on typical runoff coefficients. The overall imperviousness for the Fernbank Pond 4 drainage area is 52%, which is higher than the EMP and MSS value of 44%.

4.4.3 Design Storms

The 3 hour Chicago distribution was selected to estimate the 2-year and 5-year capture rates for the proposed subcatchments, and to assess the 100-year HGL across the proposed development. The Chicago distribution was selected due to its tendency to generate high peak flows in urban catchments, similar to the future development. The SCS distribution was selected due to its tendency to produce a greater total volume of runoff. The following storm events were used to evaluate the minor and major systems performance and assess the worst-case HGL across the development:

- 2-year, 3 hour Chicago storm, 10-minute time step (2yr3hrChicago)
- 5-year, 3 hour Chicago storm, 10-minute time step (5yr3hrChicago)
- 100-year, 3 hour Chicago storm, 10-minute time step (100yr3hrChicago)
- 100-year, 24 hour SCS storm Type II, 12-minute time step from IBI (100yr24hrSCS)
- 100-year, 12 hour SCS storm Type II, 30-minute time step (100yr12hrSCS)

4.4.3.1 Critical Storms

The 24 hour SCS Type II distribution was selected in the EMP as the critical storm and as such, this storm distribution has been used to compare the proposed SWM pond outflow to the allowable. The following events were run to assess pond operating levels for various storm events:

- 2-year, 24 hour SCS storm Type II, 10 min time step from IBI (2yr24hrSCS)
- 5-year, 24 hour SCS storm Type II, 10 min time step from IBI (5yr24hrSCS)
- 10-year, 24 hour SCS storm Type II, 10 min time step (10yr24hrSCS)
- 25-year, 24 hour SCS storm Type II, 10 min time step (25yr24hrSCS)
- 100-year, 24 hour SCS storm Type II, 12-minute time step from IBI (100yr24hrSCS)

4.4.3.2 Water Quality Event

The 25mm event with a 4-hour Chicago storm distribution was used to size the pond forebay and the bypass structure.

4.4.3.3 Climate Change Storms

As per City of Ottawa Sewer Design Guidelines 2012, drainage systems are to be 'stress tested' for climate change scenarios by using a 20% increase in the City's 100-year storm intensities. Therefore, the following climate change storm scenario was modeled:

- 100-year, 12 hour SCS storm Type II + 20%, 30-minute time step (100yr12hrSCS_20%)

All hydrologic and hydraulic modeling files are available on the enclosed compact disc located at the back of the report.

4.4.4 Boundary Conditions

In the previous version of the report, a static backwater elevation of 106.53 m was used to assess the worst-case HGL across the site. This static backwater elevation corresponded to the elevation of the existing 700 mm diameter CSP crossing Fernbank Road with a 0.5 m head (CSP inv=105.33 m). However, the City required detailed calculations were provided in the revised report to confirm the backwater elevation upstream of the existing 700 mm culvert because of the implications of the boundary condition on the design of the SWM pond and the upstream subdivision. As a result, the PCSWMM model used in the Fernbank SWM Pond 4 conceptual future outlet assessment was added to the proposed development model such that the proposed and future developments tributary to the proposed SWM Pond, the proposed Fernbank SWM Pond 4, the proposed pipe outlet through the future Area 6 development and the improved Shea Road side ditch system to Flewellyn Road are all included in one post development model.

4.4.5 Modeling Parameters

Table 6 presents the general subcatchment parameters used:

Table 6: General Subcatchment Parameters

Subcatchment Parameter	Value
Infiltration Method	Horton
Max. Infil. Rate (mm/hr)	76.2
Min. Infil. Rate (mm/hr)	13.2
Decay Constant (1/hr)	4.14
N Imperv	0.013

Subcatchment Parameter	Value
N Perv	0.25
Dstore Imperv (mm)	1.57
Dstore Perv (mm)	4.67
Zero Imperv (%)	0

Table 7 presents the individual parameters that vary for each of the conceptual subcatchments tributary to the proposed SWM Pond. Detailed parameter information used in the Fernbank SWM Pond 4 Conceptual Future Outlet Assessment (Stantec, September 2018) are included in **Appendix C.5**.

Table 7: Conceptual Subcatchment Parameters

Area ID	Area (ha)	Width (m)	Slope (%)	% Impervious	Runoff Coefficient	Subarea Routing	% Routed
POND	3.15	280.0	2.0	40.0%	0.48	OUTLET	100
L218A	6.70	2358.0	1.0	55.7%	0.59	OUTLET	100
L211A	9.08	2655.0	1.0	50.0%	0.55	OUTLET	100
L206A	2.68	939.0	1.0	58.6%	0.61	OUTLET	100
L203A	6.66	1974.0	1.0	58.6%	0.61	OUTLET	100
L131A	1.64	492.0	1.0	58.6%	0.61	OUTLET	100
L128B	2.39	167.0	2.0	7.1%	0.25	PERVIOUS	100
L121B	1.29	291.0	1.0	7.1%	0.25	PERVIOUS	100
L121A	2.16	494.0	1.0	58.6%	0.61	OUTLET	100
L116A	2.33	566.0	1.0	58.6%	0.61	OUTLET	100
L113A	5.65	1952.0	1.0	58.6%	0.61	OUTLET	100
L109B	1.61	116.0	2.0	7.1%	0.25	PERVIOUS	100
L107A	1.46	392.0	1.0	58.6%	0.61	OUTLET	100
F108A	2.95	664.0	2.0	71.4%	0.70	OUTLET	100
C128A	1.29	315.0	1.0	58.6%	0.61	OUTLET	100
C127A	2.52	656.0	1.0	58.6%	0.61	OUTLET	100
C125A	1.10	248.0	1.0	58.6%	0.61	OUTLET	100
C123A	1.66	567.0	1.0	58.6%	0.61	OUTLET	100
C109C	0.29	118.0	0.5	64.3%	0.65	OUTLET	100
C109A	0.58	362.0	1.0	64.3%	0.65	OUTLET	100
C106B	0.96	241.0	1.0	42.9%	0.50	OUTLET	100
C106A	1.01	292.0	1.0	64.3%	0.65	OUTLET	100

1. The width parameter was estimated as twice the road/rear yard swale for two-sided catchments and equal to the length of the road/rear yard swale for one-sided catchments. The width parameter for the school block was defined as 225m/ha as per the City of Ottawa Sewer Design Guidelines.

Table 8 summarizes the storage node parameters used in the conceptual model. All roadway catchbasins with sag storage have been modeled as having an outlet invert of 2.5 m below the rim elevation so that the assumed surface storage occurs between the top of grate (head of 1.8 m) and a ponding depth of 0.35 m (head of 2.15 m). An additional surface flow depth of 0.35 m was assumed on top of the maximum storage depth to be able to route spill flows through the major system. Grassed swales were assumed to have a depth of 0.6 m; however, no storage was assumed within park/grassed areas. Road areas without storage are modeled assuming catchbasin depths of 2.15 m (1.8m to the top of grate plus a flow depth of 0.35 m).

Table 8: Storage Node Parameters

Storage Node	Invert Elevation (m)	Rim Elevation (m)	Total Depth (m)	Surface Storage (m^3)
218A-S	110.79	113.29	2.50	262
211A-S	109.79	112.29	2.50	358
206A-S	109.79	112.29	2.50	106
203A-S	109.31	111.81	2.50	260
131A-S	108.90	111.40	2.50	66
128B-S	112.25	112.85	0.60	0
121B-S	109.30	111.70	2.40	0
121A-S	109.58	112.08	2.50	85
116A-S	108.76	111.26	2.50	92
113A-S	109.19	111.69	2.50	223
109B-S	112.07	112.67	0.60	0
107A-S	109.11	111.61	2.50	59
108A-S	108.32	110.82	2.50	150
128A-S	110.69	113.19	2.50	52
127A-S	110.18	112.68	2.50	98
125A-S	110.04	112.19	2.15	0
123A-S	109.21	111.71	2.50	65
109C-S	109.19	111.69	2.50	11
109A-S	110.04	112.19	2.15	0
106B-S	108.77	110.92	2.15	0
106A-S(1)	108.57	110.72	2.15	0

1. Surface ponding in sag storage was assumed to be 40 m^3/ha.
2. School Block (storage node 108A-S) was assumed to provide 50 m^3/ha of on-site storage.

As per the Ottawa Sewer Design Guidelines (OSDG 2012), Manning's roughness values of 0.013 were used for sewer modeling and overland flow corridors representing roadways.

Table 9 summarizes the outlet link maximum flow rates for the 100-year, 3hr Chicago storm event.

Table 9: Conceptual Minor System Capture Rates

Outlet Name	Inlet Node	Outlet Node	Invert Elevation (m)	100-year Minor System Capture Rate (L/s)
106A-IC	106A-S(1)	106	108.57	219.1
106B-IC	106B-S	106	108.77	88.8
107A-IC	107A-S	107	109.11	203.5

Outlet Name	Inlet Node	Outlet Node	Invert Elevation (m)	100-year Minor System Capture Rate (L/s)
108A-IC	108A-S	108	108.32	738.9
109A-IC	109A-S	109	110.04	130.4
109C-IC	109C-S	109	109.19	65.4
113A-IC	113A-S	113	109.19	787.5
116A-IC	116A-S	116	108.76	325.1
121A-IC	121A-S	121	109.58	299.7
121B-IC	121B-S	121	109.3	2.3
123A-IC	123A-S	123	109.21	354.6
125A-IC	125A-S	125	110.04	213.0
127A-IC	127A-S	127	110.18	525.3
128A-IC	128A-S	128	110.685	267.3
131A-IC	131A-S	131	108.9	227.7
203A-IC	203A-S	203	109.31	967.9
206A-IC	206A-S	206	109.79	373.0
211A-IC	211A-S	211	109.79	1085.6
218A-IC	218A-S	218	110.79	891.2

Exit losses at manholes were set for all pipe segments based on the flow angle through the structure. Exit losses were assigned as per City guidelines (Appendix 6b), see **Table 10** below.

Table 10: Exit Loss Coefficients for Bends at Manholes

Degrees	Coefficient
11	0.060
22	0.140
30	0.210
45	0.390
60	0.640
90	1.320
180	0.020

Other parameters applied within the model include the following:

- Orifice Discharge Coefficient = 0.61 (circular)
- Weir Discharge Coefficient = 1.7

4.5 CONCEPTUAL MODEL RESULTS AND DISCUSSION

The following section summarizes the key hydrologic and hydraulic conceptual model results. For detailed model results or inputs please refer to the example input file in **Appendix C.3** and the electronic model files on the enclosed CD.

4.5.1 Proposed Development Conceptual Hydraulic Grade Line Analysis

The worst case 100-year hydraulic grade line (HGL) elevation across the proposed development and the adjacent Tartan development was estimated using the Fernbank Pond 4 PCSWMM model for the 100-year, 3 hour Chicago and the 100-year, 12 hour and 24 hour SCS Type II storms with the conceptual future outlet through Area 6 and the Shea road side ditch system improvements as described in **Section 4.1.1**. **Table 11** below presents the clearance between the trunk sewer worst case HGL and the proposed road grade along the trunk sewer. The storm sewer design sheet is included in **Appendix C.1**. The climate change scenario was also run to stress-test the system.

Table 11: Fernbank Pond 4 HGL Results along Future Trunk Sewers

STM MH	Prop. Grade (m)		100-year Storms				100-year Increased by 20%	
		3 HR Chicago HGL (m)	24 HR SCS HGL (m)	12 HR SCS HGL (m)	Worst-Case HGL (m)	Prop. Grade-HGL Clearance (m)	12 HR SCS +20% HGL (m)	Prop. Grade-HGL Clearance (m)
100B	108.15	107.24	107.35	107.39	107.39	0.76	107.64	0.51
101	108.45	107.23	107.35	107.39	107.39	1.06	107.64	0.81
102	108.81	107.23	107.35	107.39	107.39	1.42	107.65	1.16
103	110.53	107.81	107.77	107.79	107.81	2.72	107.84	2.69
104	110.36	107.92	107.89	107.88	107.92	2.44	107.90	2.46
106	110.10	108.01	107.97	107.96	108.01	2.09	107.98	2.12
107	111.23	108.05	108.02	108.01	108.05	3.18	108.02	3.21
108	111.11	108.13	108.11	108.08	108.13	2.98	108.11	3.00
109	111.00	108.33	108.33	108.32	108.33	2.67	108.33	2.67
110	110.46	108.04	108.00	108.02	108.04	2.42	108.07	2.39
111	110.61	108.24	108.21	108.23	108.24	2.37	108.27	2.34
112	111.55	108.87	108.83	108.86	108.87	2.68	108.98	2.57
113	111.80	109.22	109.21	109.22	109.22	2.58	109.27	2.53
114	110.87	108.18	108.14	108.17	108.18	2.69	108.22	2.65
115	110.94	108.28	108.25	108.28	108.28	2.66	108.33	2.61
116	111.07	108.48	108.44	108.48	108.48	2.59	108.53	2.54

STM MH	Prop. Grade (m)		100-year Storms				100-year Increased by 20%	
		3 HR Chicago HGL (m)	24 HR SCS HGL (m)	12 HR SCS HGL (m)	Worst-Case HGL (m)	Prop. Grade-HGL Clearance (m)	12 HR SCS +20% HGL (m)	Prop. Grade-HGL Clearance (m)
117	111.28	108.55	108.51	108.55	108.55	2.73	108.60	2.68
118	111.68	108.68	108.65	108.69	108.69	2.99	108.74	2.94
119	111.75	108.71	108.67	108.71	108.71	3.04	108.76	2.99
120	111.79	108.74	108.70	108.74	108.74	3.05	108.79	3.00
121	111.86	108.77	108.73	108.77	108.77	3.09	108.82	3.04
122	112.02	108.60	108.56	108.60	108.60	3.42	108.65	3.37
123	111.48	108.92	108.87	108.95	108.95	2.53	109.00	2.48
124	112.00	109.01	108.97	109.08	109.08	2.92	109.13	2.87
125	109.83	109.10	109.06	109.17	109.17	0.66	109.23	0.60
126	112.54	109.06	109.01	109.08	109.08	3.46	109.14	3.40
127	113.00	109.26	109.21	109.29	109.29	3.71	109.36	3.64
128	112.59	109.51	109.46	109.55	109.55	3.04	109.62	2.97
129	110.95	108.23	108.18	108.18	108.23	2.72	108.20	2.75
130	110.94	108.60	108.57	108.57	108.60	2.34	108.57	2.37
131	111.14	108.77	108.77	108.77	108.77	2.37	108.77	2.37
200	113.32	109.06	109.02	109.10	109.10	4.22	109.15	4.17
201	115.71	109.23	109.19	109.27	109.27	6.44	109.31	6.40
202	115.86	109.27	109.23	109.31	109.31	6.55	109.36	6.50
203	116.79	109.45	109.41	109.48	109.48	7.31	109.53	7.26
204	113.43	109.13	109.08	109.20	109.20	4.22	109.26	4.16
205	116.54	109.26	109.21	109.33	109.33	7.21	109.39	7.15
206	116.50	109.45	109.39	109.52	109.52	6.98	109.58	6.92
207	112.93	108.66	108.62	108.67	108.67	4.26	108.72	4.21
208	113.70	108.73	108.68	108.73	108.73	4.97	108.78	4.92
209	114.17	108.92	108.87	108.93	108.93	5.24	108.98	5.19
210	114.12	108.95	108.90	108.96	108.96	5.16	109.01	5.11
211	114.11	109.04	108.99	109.05	109.05	5.06	109.10	5.01
212	113.31	109.42	109.36	109.45	109.45	3.86	109.52	3.79
213	113.94	109.55	109.49	109.58	109.58	4.36	109.66	4.28
214	113.75	109.58	109.51	109.61	109.61	4.14	109.68	4.07
215	113.69	109.63	109.56	109.66	109.66	4.03	109.74	3.95

STM MH	Prop. Grade (m)		100-year Storms				100-year Increased by 20%	
		3 HR Chicago HGL (m)	24 HR SCS HGL (m)	12 HR SCS HGL (m)	Worst-Case HGL (m)	Prop. Grade-HGL Clearance (m)	12 HR SCS +20% HGL (m)	Prop. Grade-HGL Clearance (m)
216	113.16	109.71	109.64	109.75	109.75	3.41	109.82	3.34
217	114.15	109.75	109.68	109.79	109.79	4.36	109.86	4.29
218	114.20	109.95	109.84	109.99	109.99	4.21	110.07	4.13

The model results indicate that there is sufficient clearance between the worst case 100-year HGL and the proposed road grades with the exception of STM125 where a clearance of 0.66 m to the worst-case HGL is observed. Given that the proposed site has been graded to match existing grades along Fernbank Road, which is much lower than the proposed site, a steep slope section is proposed at the southern end of Cope Drive. As a result, a section of the proposed storm sewer between STM125 and STM124 will need to be insulated and alternative house design for foundation drainage will need to be investigated for some of the proposed units between these manholes at the detailed design stage.

Detailed grading of the future developments should be based on the above results to ensure that a minimum clearance of 0.3 m is provided between all under side of footings (USFs) and the 100-year HGL, and that no basement flooding occurs in the climate change scenario.

4.5.2 Major Flow

It is proposed that all major flow from the proposed development and the adjacent Tartan development cascade to the Fernbank SWM Pond 4. There are two major flow outlets proposed to the pond. The maximum overland flow was evaluated at these two downstream locations. The western major flow inlet is proposed to be a walkway block through the proposed development, while the eastern major flow inlet is proposed to be through Shea Road as shown on **Drawing OSD-1**.

The PCSWMM model is based on lumped drainage areas with major system storage represented in storage nodes that overestimate the major system peak flows to the proposed SWM Pond. It is anticipated that the actual major system peak flow contribution to the SWM Pond will be much lower once detailed grading is completed and the actual road configuration with available sag storage is included in the model during detailed design.

The western major flow inlet through the walkway was modeled in PCSWMM as a trapezoidal channel with a 4m-wide bottom, 3:1 side slopes, longitudinal slope of 1.9%, and 0.5 m depth. Similarly, the eastern major flow inlet from Shea Road was modeled as a trapezoidal channel with 2m-wide bottom, 10:1 side slopes, 2.8% longitudinal slope, and 0.5 m depth. The maximum normal flow depth and velocity have been obtained from PCSWMM and the results are presented in **Table 12** below for the 100-year, 3 hour Chicago storm which is commonly used to evaluate the urban component of dual drainage, specifically on-site detention.

Table 12: 100-Year, 3hr Chicago Overland Flow Results

Location	Peak Flow (L/s)	Depth (m)
Western Major System Inlet to Pond- Walkway	3,272	0.33
Western Inlet Most Downstream Street	3,302	0.31
Eastern Major System Inlet to Pond – Shea Road	788	0.10
Eastern Inlet Most Downstream Street	852	0.13

4.5.3 Pond Hydraulic Modeling Results

Each PCSWMM model scenario was analysed for the peak pond inflow and discharge rate as well as for peak pond HGL. **Table 13** below summarizes the peak pond outflow rates for the different storm events. Modelling of the proposed Fernbank SWM Pond 4 for the different storm events indicates that the proposed stage-storage and stage-discharge curves provide sufficient detention of runoff to meet the target release rates which were obtained from the Fernbank Community EMP and from recent correspondence with the City and Robinson Consultants. The Chicago storm scenarios were used to estimate the minor system capture rates and to assess the worst case 100-year HGL across the site. The climate change scenario was not intended to provide a level of service but was modeled to stress-test the design.

Table 13: Fernbank Pond 4 Peak Outflow Rates and Water Levels

Storm Event	Peak Pond Inflow (m^3/s)	Peak Pond Discharge (m^3/s)	Pond Water Level (m)	Target Peak outflow (m^3/s)
25mm 4hr Chicago	3.76	0.079	106.21	N/A
2yr3hrChicago	4.96	0.120	106.33	N/A
5yr3hrChicago	6.02	0.223	106.55	N/A
100yr3hrChicago	10.89	0.694	107.22	0.90
100yr12hrSCS	8.31	0.814	107.39	0.90
2yr24hrSCS	4.17	0.153	106.41	0.51
5yr24hrSCS	5.56	0.251	106.60	0.83
10yr24hrSCS	6.03	0.326	106.72	0.90
25yr24hrSCS	6.47	0.442	106.89	0.90
100yr24hrSCS	9.27	0.790	107.35	0.90

Storm Event	Peak Pond Inflow (m^3/s)	Peak Pond Discharge (m^3/s)	Pond Water Level (m)	Target Peak outflow (m^3/s)
100yr12hrSCS_20%	11.19	2.342	107.64	N/A

4.6 FERNBANK SWM POND 4 DESIGN COMPONENTS

The following sections describe the stormwater management design approach and hydraulic results for the proposed stormwater management facility. **Drawing POND-1** shows a plan view of the proposed SWM pond. Detailed pond cross sections will be provided in the second submission of the Pond design brief during the detailed design stage of the subdivision.

4.6.1 SWM Pond Design Approach

The proposed Fernbank SWM Pond 4 is designed to meet the quality control requirements outlined above and to achieve all physical design criteria established for wet pond facilities by the Ministry of the Environment and Climate Change. These physical design criteria are provided in the MOECC's Stormwater Management Design and Planning Manual (March 2003).

From the preceding sections, the general design approach for the SWMF is as follows:

1. Provide MOECC Enhanced water quality treatment, thereby establishing the permanent pool and extended detention volumes
2. Size inlet structure and forebay based on generated inflow and MOECC guidelines
3. Restrict post development peak flows to pre-development levels with a maximum release rate of 0.9 m^3/s
4. Consider environmental and operations and maintenance concerns in orientation and design of all pond components

Detailed forebay calculations are provided in **Appendix C.4**.

4.6.2 Pond Grading and Storage Design

Side slopes for safety (max 3:1) have been provided throughout the facility and along the forebay berm. These slopes are varied throughout to promote a less-engineered, more aesthetically pleasing design, where sufficient room is available.

4.6.2.1 Water Quality Control

The required level of treatment for the proposed SWM Pond is 'enhanced' or 80% as per the Jock River Reach 2 Subwatershed Study. **Table 14** illustrates how the proposed end-of-pipe SWMF design provides this level of treatment. Detailed pond design calculations have been provided in **Appendix C.4**.

Table 14: Fernbank Pond 4 MOECC Stormwater Quality Volumetric Requirements

Drainage Area (ha)	Actual % Imp.	Water Quality Unit Volume Requirements			Water Quality Volume Requirements		Water Quality Volumes Provided	
		Total Unit Volume (m^3/ha)	Permanent Pool (m^3/ha)	Extended Detention (m^3/ha)	Permanent Pool (m^3)	Extended Detention (m^3)	Permanent Pool (m^3)	Extended Detention (m^3)
59.2	52	182	142.3	40.0	8,421	2,368	10,518	5,312

The normal water level in the SWM pond has been set at 105.75 m as per the Fernbank Community EMP.

4.6.2.2 Water Quantity Control

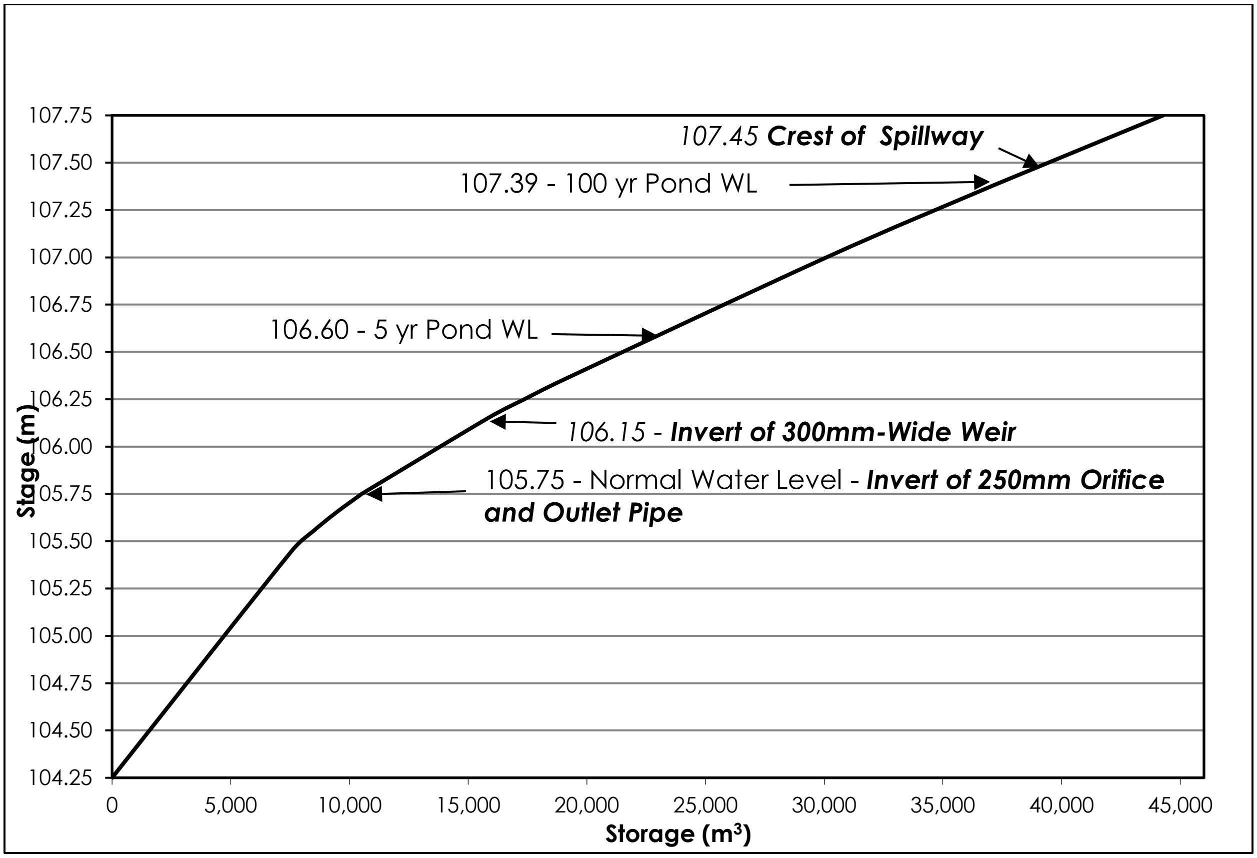
On-site water quantity control is provided for the future residential site at a unit rate of 40 m^3/ha with the exception of the school block that has been assumed to provide on-site storage of 50 m^3/ha. Overland flow from the future development lands will be directed to the SWM Pond through the proposed roads. Preliminary design of the storm sewers across the future development was based on available proposed road profiles as shown in the storm sewer design sheet included in **Appendix C.1**.

The SWM facility is required to restrict post development peak flows to pre-development levels with a maximum release rate of 0.9 m^3/s. The first 0.4 m of active storage is controlled by a 250 mm orifice (invert at 105.75 m). The secondary pond outlet occurs via a 300 mm-wide by 1,150 mm-high weir with a weir crest invert at 106.15 m. A 10.0 m-wide rip-rap lined spillway at invert 107.45 m is also provided as an emergency overflow path. The pond flow regulators are located within a common outlet chamber which subsequently discharges to the Fernbank Road side ditch via a 975 mm diameter storm sewer. The spillway discharges directly to the Fernbank Road side ditch.

4.6.2.3 Stage-Storage Relationship

The stage-storage relationship for the entire facility was established using the average end area method as presented in **Appendix C.4**.

Figure 6: Fernbank Pond 4 Stage-Storage Relationship



4.6.3 Forebay Design

The purpose of the forebay is to act as the primary settling zone in the pond for the initial influx of coarse sediment and associated pollutants flushing off the sewershed. The forebay is designed to provide sufficient cross-section and length to reduce velocities and promote settling, minimize resuspension of settled solids, minimize percentage of overall permanent pool, provide sufficient sediment storage for infrequent clean out (>5 years), and have adequate accessibility and bottom-treatment for maintenance operations.

The required forebay characteristics dictate a required forebay settling length of 27.8 m. Similarly, the required forebay dispersion length is equal to 60.2 m. The provided length is approximately 68.0 m. The resulting length to width ratio of the proposed configuration is approximately 3:1, also meeting MOECC design recommendations. The provision of 1.5 m depth within the forebay provides for 0.5 m sediment accumulation prior to recommended cleanout while maintaining 1.0 m permanent pool depth, thereby minimizing the risk of scour and re-suspension. The designed sediment storage volume provided in the bottom 0.5 m corresponds to an estimated sediment removal frequency of approximately 9 years for the forebay.

4.6.4 Outlet Design

The outlet will be located opposite the inlet and will drain to the Fernbank Road side ditch and ultimately to the Faulkner Municipal Drain tributary. A concrete outlet structure will house the required extended detention orifice, quantity control weir, and outlet pipes, including the associated maintenance infrastructure (i.e. sluice gates, etc.).

4.6.4.1 Extended Detention Control

The design of the required outlet structure incorporates a dual control configuration. Firstly, a 250 mm orifice provides an approximate 40-hour extended detention for quality control. The entire extended detention volume is stored between 105.75 m and 106.15 m, as calculated below.

<u>Required Storage:</u>
Tributary Area = 59.20 ha
Extended Detention Storage = 40 m^3/ha
Storage = 59.20 x 40 = 2,368 m^3

<u>Provided Storage</u>:
Pond area at NWL = 11,490 m^2
Pond area at 106.15 = 15,072 m^2
Provided Depth = 106.15 – 105.75 = 0.4 m
Provided Extended Detention Active Volume = 5,312 m^3

4.6.4.2 Flow Control Weir

Quantity control of the pond discharge above the extended detention elevation is provided by a flow control weir within the outlet structure. This weir has been incorporated into the outlet to meet the quantity control target peak flows which correspond to post to pre-development levels to a maximum of 0.9 m^3/s dictated by the capacity of the existing 700 mm diameter CSP crossing Fernbank Road. A 300 mm-wide weir with invert at 106.15 m is proposed to meet quantity control requirements.

4.6.4.3 Overland Spillway

The emergency spillway location is separate from the outlet control structure. The emergency spillway elevation is set to 107.45 m and acts as a broad-crested weir, approximately 10.0 m wide. Should the stormwater management facility outlet structure clog or be subject to rare rainfall events (beyond the 100-year event), the spillway is designed to safely convey runoff to the Fernbank Road side ditch.

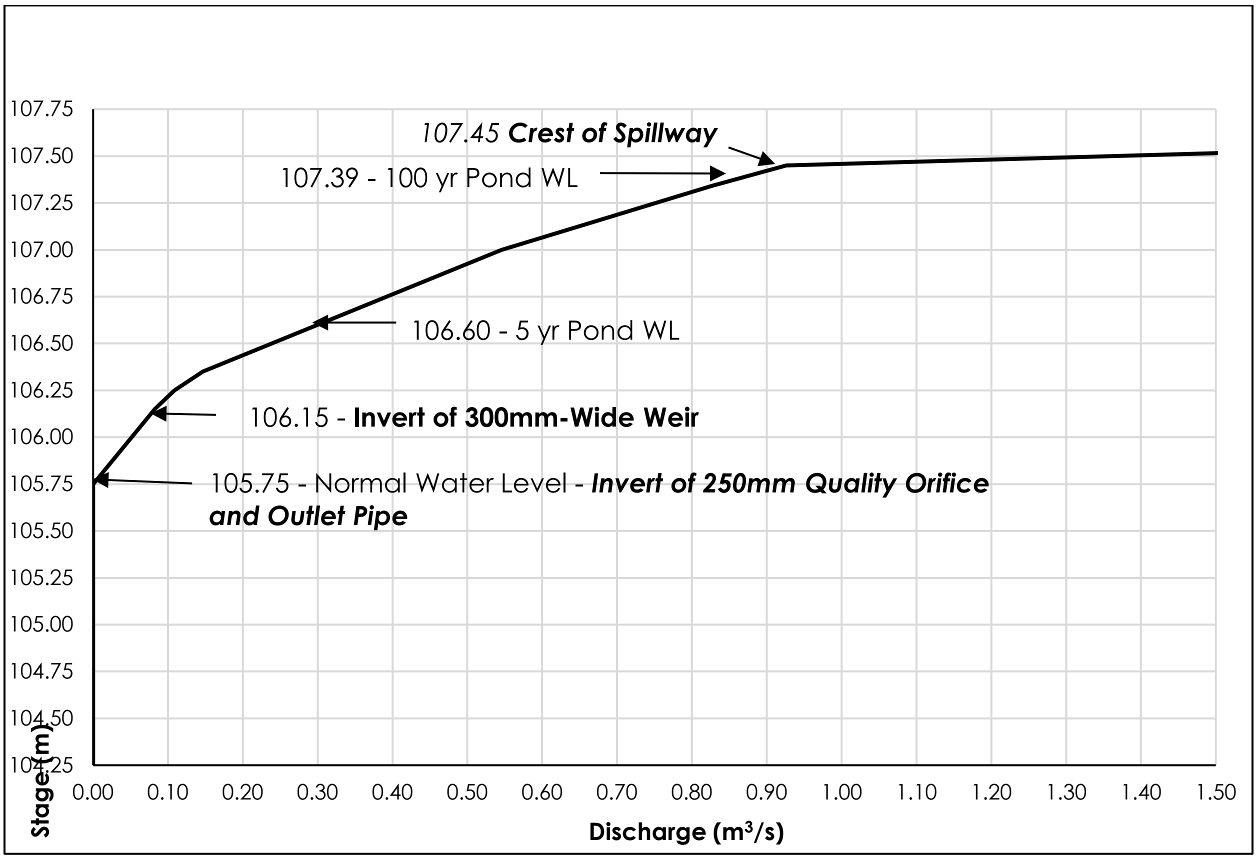
4.6.4.4 Outlet Channel

The proposed concrete outlet structure will discharge into a 975 mm diameter storm sewer, which will outlet into a proposed channel sized to service the SWM pond requirements with a maximum conveyance capacity of 3.5 m^3/s including a 0.3 m freeboard (Inlet and outlet pipe calculations, and outlet channel calculations are provided in **Appendix C.4**).

4.6.4.5 Stage-Discharge Relationship

A stage-discharge relationship was estimated using standard orifice and weir equations as outlined in **Appendix C.4**. The resulting stage-discharge relationship is presented in **Figure 7** below.

Figure 7: Stage-Discharge Relationship for Fernbank SWM Pond 4



4.6.5 Pond Performance

As **Table 15** indicates, the water quality objectives of the SWM facility are met by providing extended detention of 24-48 hours and exceeding the MOECC recommended water quality volumes.

Table 15: Interim SWM Facility Operational Characteristics

SWM Basin Parameters	Basin Value
Total Contributing Area	59.20 ha
Imperviousness of Contributing Area [of Sewershed Area]	52.0 %
Unit Area Storage Volume Requirements as per SWMPD Manual	182 m^3/ha
Required Total Water Quality Volume	10,789 m^3
Wet Pond Bottom Elevation	104.25 m
Required Permanent Pool Volume	8,421 m^3
Permanent Pool Volume Provided (excluding sediment storage)	10,518 m^3
Permanent Pool Elevation	105.75 m
Permanent Pool Surface Area	11,490 m^2
Required Extended Detention Volume	2,368 m^3
Extended Detention Volume Provided	5,312 m^3
Peak Release Rate for Extended Detention	0.083 m^3/s
Extended Detention Drawdown Time	40 hours
Extended Detention Elevation (Weir 1Crest)	106.15 m
5 Year Storm Maximum Ponding Level (24hr SCS)	106.60 m
5 Year Storm Peak Pond Release (24hr SCS)	0.251 m^3/s
100 Year Storm Maximum Ponding Level (12hr SCS)	107.39 m
100 Year Storm Peak Pond Release (12hr SCS)	0.814 m^3/s
100 Year Storm Active Volume Required (12hr SCS)	25,973 m^3
Top of Berm (minimum grade of surrounding properties)	107.80 m
Forebay Parameters	
Forebay Bottom Elevation	104.25 m
Sediment Accumulation Depth	0.50 m
Forebay Depth from Permanent Pool	1.50 m
Required Forebay Length	60.2 m
Actual Forebay Length	68.0 m
Clean Out Frequency	~9 years
Outlet Parameters	
Quality Orifice Size (Orifice #1)	250 mm
Quality Orifice Invert (Orifice #1)	105.75 m
Quantity Weir Size (Weir #1)	300mm-W x 1150mm-H
Quantity Weir Cres Invert	106.15 m
Emergency Spillway Weir Crest Length	10.00 m
Emergency Spillway Weir Crest Elevation	107.45 m

4.6.6 Other Considerations

Additional key design notes include the following:

- A 5-m wide access road which consists of 3-m wide pavement and 1-m wide gravel shoulders has been provided for ease of inspection and maintenance of the inlet, forebay and main cell. The access road will have an engineered base consisting of granular 'A' and granular 'B' for durability and strength, while the surface will be asphaltic concrete for erosion protection. The route has been designed with a minimum slope to facilitate maintenance equipment maneuverability

5.0 GEOTECHNICAL CONSIDERATIONS AND GRADING

A Geotechnical Report was prepared by Golder Associates for the subject lands in September 2018. The geotechnical investigation concluded that the site consists of deposits of silts and sands over glacial till over limestone bedrock. There are no grade raise restrictions for house construction on this site. A Permit to Take Water (PTTW) was recommended to be obtained for the site servicing work due to the potential for groundwater inflow in areas of rock excavation (excerpts from the geotechnical report are included in **Appendix D**)

Preliminary grading for the proposed site has been provided as shown on **Drawing OGP-1.** Grading design has been provided to direct overland flows from the proposed development and future Tartan development to the west to the proposed Fernbank SWM Pond 4. Proposed grades along Shea Road were obtained from the Fernbank MSS Master Grading Plan which assumed Shea Road will be fully urbanized and slightly raised to direct overland flow to the Fernbank SWM Pond 4. Proposed grades along Fernbank Road have been established to match existing grades and as such, a retaining wall will be required along most of the southern edge of the site and a steep slope will be required at the southern end of Cope Drive. Future road grades within the future Tartan development to the west were obtained from the Conceptual Site Servicing Study for Shea Road Lands prepared by IBI in March 2013.

6.0 EROSION CONTROL DURING CONSTRUCTION

Erosion and sediment controls must be in place during construction. The following recommendations to the contractor will be included in contract documents.

1. Until the local storm sewer and SWM pond are constructed, groundwater in trenches will be pumped into a filter mechanism prior to release to the environment. After construction of the SWM facility, any construction dewatering will be routed to the nearest storm sewer.
2. Seepage barriers to be constructed in any temporary drainage ditches.
3. Install a silt fence along the site perimeter.
4. Limit extent of exposed soils at any given time.
5. Re-vegetate exposed areas as soon as possible.
6. Minimize the area to be cleared and grubbed.
7. Protect exposed slopes with plastic or synthetic mulches.
8. Provide sediment traps and basins during dewatering.
9. Install sediment traps (such as SiltSack® by Terrafix) between catchbasins and frames.
10. Plan construction at proper time to avoid flooding.

The contractor will, at every rainfall, complete inspections and guarantee proper performance. The inspection is to include:

1. Verification that water is not flowing under silt barriers.
2. Clean and change silt traps at catchbasins.

7.0 UTILITIES

As the subject site is bound by existing residential development to the west, Hydro, Bell, Gas and Cable servicing for the proposed development should be readily available through existing infrastructure. It is anticipated that existing infrastructure will be sufficient to provide the means of distribution for the proposed site. Exact size, location and routing of utilities, along with determination of any off-site works required for redevelopment, will be finalized after design circulation.

8.0 APPROVALS

The City of Ottawa will review and approve most development applications as they relate to provision of water supply, wastewater collection and disposal, and stormwater conveyance and treatment.

Ontario Ministry of Environment and Climate Change (MOECC) Environmental Compliance Approvals (ECA) will be required for the proposed subdivision works related to stormwater management, inlet control devices, storm sewers and sanitary sewers. The Rideau Valley Conservation Authority (RVCA) will be circulated on this submission.

An MOECC Permit to Take Water (PTTW) may be required for the site. The geotechnical consultant shall confirm at the time of application that a PTTW is required.

The Rideau Valley Conservation Authority (RVCA) will issue all required permits for the stormwater management facility.

9.0 CONCLUSIONS

9.1 WATER SERVICING

Based on the findings of the report, the proposed network is capable of servicing the development area and meets all servicing requirements in both the ultimate and interim scenario as per City of Ottawa standards under typical demand conditions (peak hour and average day conditions) as well as under emergency fire demand conditions (maximum day + fire flow). The available fire flow is anticipated to range between 11,700 – 44,802 L/min. Ultimately the site will be serviced via three watermain connections; a 200 mm diameter connection to Samuel Mann Avenue, a 400 mm diameter watermain on Fernbank Road, and a 300 mm diameter watermain on Shea Road south of the intersection with Abbott Street East.

9.2 SANITARY SERVICING

Wastewater from the proposed Shea Road Lands Development will be conveyed through the sanitary trunk sewers within the future CRT lands which ultimately connect to the existing Fernbank trunk sewer on the Trans Canada Trail.

A higher level sanitary sewer is proposed in all right of ways where the trunk sanitary sewers exceed 5 m in depth to avoid deep residential service connections to the main and facilitate any potential future service repairs.

The site sanitary trunk sewers will be sized to service the proposed development, the Tartan development west of the site, as well as OPA Area 6 expansion lands which are estimated to generate approximately 84 L/s of sewage peak flows. Additionally, an allowance of 108 L/s has been included from the existing Laird Street Pump Station.

9.3 STORMWATER SERVICING

The proposed stormwater management plan is in compliance with the requirements outlined in the background documents, the City of Ottawa Sewer Design Guidelines and the Ministry of the Environment and Climate Change Stormwater Management Planning and Design Manual.

Capture curves were defined for each catchment to restrict inflow rates to the sewer to the 2-year runoff for local streets and the 5-year runoff for the school block and for collector roads (Shea Road and Cope Drive) as per the City design criteria. Major system peak flows from the entire site will be directed towards the proposed Fernbank SWM Pond 4.

Quantity and 'Enhanced' quality control will be provided in the proposed Fernbank SWM Pond 4 to restrict peak flows from the site to the target peak outflows and to achieve 80% TSS removal prior to discharging into the Faulkner Municipal Drain.

Given that the proposed site has been graded to match existing grades along Fernbank Road, which is much lower than the proposed site, a steep slope section is proposed at the southern end of Cope Drive. As a result, a section of the proposed storm sewer between STM125 and STM124 will need to be insulated and alternative house design for foundation drainage will need to be investigated for some of the proposed units between these manholes at the detailed design stage.

9.4 UTILITIES

Utility infrastructure exists within the general area of the subject site. It is anticipated that existing infrastructure will be sufficient to provide a means of distribution for the proposed site. Exact size, location and routing of utilities will be finalized at the detailed design stage.

Appendix A POTABLE WATER SERVICING ANALYSIS

A.1 BOUNDARY CONDITIONS

From:	Surprenant, Eric
To:	Rathnasooriya, Thakshika
Cc:	Paerez, Ana
Subject:	RE: Hydraulic Boundary Conditions - Shea Road Lands Development
Date:	Monday, December 18, 2017 9:06:05 AM
Attachments:	image001.gif Shea Road Lands Development.docx

Hello Thakshika,

Please refer to the attached as it relates to the your request for boundary conditions for the above development.

Thanks

Eric Surprenant, C.E.T. / 613 580-2424 ext.:27794

Project Manager, Infrastructure Approvals

Development Review Suburban Services Branch
Planning, Infrastructure and Economic Development Dept.

Gestionaire de projets, Approbation de l'infrastructure
Examen des demandes d'aménagement (Services Suburbains Ouest)
Services de la planification, de l'infrastructure et du développement économique

City of Ottawa | Ville d'Ottawa
613.580.2424 ext./poste 27794
ottawa.ca/planning / ottawa.ca/urbanisme

From: Rathnasooriya, Thakshika [mailto:Thakshika.Rathnasooriya@stantec.com]
Sent: December 11, 2017 10:30 AM
To: Surprenant, Eric <Eric.Surprenant@ottawa.ca>
Cc: Paerez, Ana <Ana.Paerez@stantec.com>
Subject: Hydraulic Boundary Conditions - Shea Road Lands Development

Good morning Eric,

I am looking for watermain hydraulic boundary conditions for the proposed Shea Road Lands Development which is located at the north-west quadrant of the intersection of Shea Road and Fernbank road. We anticipate 3 watermain connections to the proposed Tartan and Cavanagh development as shown in the attached figure.

Connection 1 – existing 200mm
Connection 2 – proposed 400mm (Fernbank Road).
Connection 3 – existing 300mm stub south of the intersection of Shea Road and Abbott Street (Shea Road).

The intended land use is a school block, park land, and mixed residential development consisting of for 343 single family homes and 570 semi-detached or townhomes , as well as 2.58 ha of land designated for low density residential, assumed with 60 units/ha for a total of 155 units.

Please confirm Area 6 (plan attached) demands have been included when generating boundary conditions(not included in demands below).

Estimated domestic demands and fire flow requirements for the site are as follows:
Average Day Demand – 13.5L/s
Max Day Demand - 33.4L/s
Peak Hour Demand - 73.2L/s
Fire Flow Requirement per Technical Bulletin ISDTB-2014-02 section 4.2.11– capped at 167L/s (10,000 L/min) for single detached dwellings, side-by-side town and row houses provided a minimum separation distance between the backs of adjacent units by 10m, and 15,000 L/min for the proposed school block.

Thanks,

Shika Rathnasooriya
Engineering Intern
Stantec
400 - 1331 Clyde Avenue, Ottawa ON K2C 3G4
Phone: (613) 722-4420
Thakshika.Rathnasooriya@stantec.com

Boundary Conditions Shea Road Lands Development

Information Provided

Date provided: 15 December 2017

Scenario	Demand	
	L/min	L/s
Average Daily Demand	810	13.5
Maximum Daily Demand	2004	33.4
Peak Hour	4392	73.2
Fire Flow Demand # 1	10000	166.7
Fire Flow Demand # 2	15000	250.0

Location

Results

Connection 1 - Samuel Mann Ave

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	160.6	63.7
Peak Hour	153.6	53.8
Max Day plus Fire (10,000 l/min)	149.4	47.8
Max Day plus Fire (15,000 l/min)	141.1	36.0

[1] Ground Elevation = 115.7 m

Connection 2 - Fernbank Rd

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	160.5	68.9
Peak Hour	153.2	58.5
Max Day plus Fire (10,000 l/min)	148.4	51.6
Max Day plus Fire (15,000 l/min)	139.4	38.8

[1] Ground Elevation = 112.1 m

Connection 3 - Shea Rd

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	160.8	68.2
Peak Hour	154.7	59.6
Max Day plus Fire (10,000 l/min)	154.8	59.6
Max Day plus Fire (15,000 l/min)	151.5	55.0

[1] Ground Elevation = 112.9 m

Notes:

1) As per the Ontario Building Code in areas that may be occupied, the static pressure at any fixture shall not exceed 552 kPa (80 psi.) Pressure control measures to be considered are as follows, in order of preference:
   a) If possible, systems to be designed to residual pressures of 345 to 552 kPa (50 to 80 psi) in all occupied areas outside of the public right-of-way without special pressure control equipment.
   b) Pressure reducing valves to be installed immediately downstream of the isolation valve in the home/ building, located downstream of the meter so it is owner maintained.

Disclaimer

The boundary condition information is based on current operation of the city water distribution system. The computer model simulation is based on the best information available at the time. The operation of the water distribution system can change on a regular basis, resulting in a variation in boundary conditions. The physical properties of watermains deteriorate over time, as such must be assumed in the absence of actual field test data. The variation in physical watermain properties can therefore alter the results of the computer model simulation. Fire Flow analysis is a reflection of available flow in the watermain; there may be additional restrictions that occur between the watermain and the hydrant that the model cannot take into account.

From:	Armstrong, Justin
To:	Rathnasooriya, Thakshika
Subject:	RE: Hydraulic Boundary Conditions - Shea Road Lands Development
Date:	Thursday, October 11, 2018 11:18:43 AM
Attachments:	image001.gif Shea Road Lands Development_Interm_BC.docx Pages from R-2418_Fernbank_Vol2.pdf

Hi Shika,

Please see e-mail below concerning BC locations and Area 6. Further to that point, whether or not Area 6 was included in the boundary conditions would depend on whether or not you considered that when calculating your demands.

Please see attached Interim Boundary Conditions as per your request.

Regards,

Justin Armstrong, E.I.T.
Engineering Intern
Planning, Infrastructure and Economic Development Department - Services de la planification, de l'infrastructure et du développement économique
Development Review - West Branch
City of Ottawa | Ville d'Ottawa
110 Laurier Avenue West Ottawa, ON | 110, avenue. Laurier Ouest. Ottawa (Ontario) K1P 1J1
613.580.2400 ext./poste 21746, justin.armstrong@ottawa.ca

From: Bougadis, John
Sent: Thursday, October 11, 2018 10:55 AM
To: Armstrong, Justin <justin.armstrong@ottawa.ca>; Aliu, Astrit <astrit.aliu@ottawa.ca>
Subject: RE: Hydraulic Boundary Conditions - Shea Road Lands Development

Hi Justin,

Including domestic demands for Area 6 will not significantly decrease HGLs at the BCs locations. In addition, fire loads and not domestic demands drive sizing of local watermains.

Sizing of larger watermains (>305 mm) are determined in Master Servicing Studies (see attached for Fernbank).

John

From: Armstrong, Justin
Sent: Thursday, October 11, 2018 10:11 AM
To: Aliu, Astrit <astrit.aliu@ottawa.ca>
Cc: Bougadis, John <John.Bougadis@ottawa.ca>

Subject: FW: Hydraulic Boundary Conditions - Shea Road Lands Development

Hey Astrit,

Can you confirm that the development of Area 6 was considered for the Shea Road Subdivision Boundary Conditions (attached), as well as the interim boundary conditions you just completed for Shea Road Subdivision? (see e-mail below for more details)

Thanks,

Justin

From: Rathnasooriya, Thakshika <Thakshika.Rathnasooriya@stantec.com>
Sent: Thursday, October 11, 2018 10:02 AM
To: Armstrong, Justin <justin.armstrong@ottawa.ca>
Subject: RE: Hydraulic Boundary Conditions - Shea Road Lands Development

Hi Justin,

Would you be able to confirm if area 6 was included in the ultimate boundary conditions that were provided by Eric in December of 2017? As well, can you please ensure it is included in the interim boundary conditions as the site(area 6) is anticipated to begin constructed this year.

Please don't hesitate to give me a call if you want to discuss.

Thanks,

Shika Rathnasooriya
Engineering Intern

Direct: 613-724-4081
Thakshika.Rathnasooriya@stantec.com

Stantec
400 - 1331 Clyde Avenue
Ottawa ON K2C 3G4 CA

From: Rathnasooriya, Thakshika
Sent: Tuesday, October 02, 2018 2:49 PM
To: 'justin.armstrong@ottawa.ca' <justin.armstrong@ottawa.ca>
Cc: 'Surprenant, Eric' <Eric.Surprenant@ottawa.ca>; Kilborn, Kris <kris.kilborn@stantec.com>; Paerez, Ana <Ana.Paerez@stantec.com>
Subject: RE: Hydraulic Boundary Conditions - Shea Road Lands Development

Hi Justin,

Eric has already provided us with boundary conditions for both the Tartan and Cavanagh development with the assumption they would be constructed at similar times. In the event that the Cavanagh development is constructed first, would you be able to provide us with interim boundary conditions for two connections. The first connection would be to an existing 300mm watermain stub located at the intersection of Abbot Street East and Shea Road. The second connection would be a proposed 400mm watermain along Fernbank Road that is anticipated to be serviced this year(confirmed by Pierre Dufresne from Tartan).

The intended land use for Cavanagh is a school block, park land, and mixed residential development consisting of for 138 single family homes and 263 semi-detached or townhomes.

Estimated domestic demands and fire flow requirements for the site are as follows:

Average Day Demand – 5.3L/s
Max Day Demand - 12.7L/s
Peak Hour Demand - 27.7L/s
Fire Flow Requirement per Technical Bulletin ISDTB-2014-02 section 4.2.11– capped at 167L/s (10,000 L/min) for single detached dwellings, side-by-side town and row houses provided a minimum separation distance between the backs of adjacent units by 10m, and 15,000 L/min for the proposed school block.

Thanks,

Shika Rathnasooriya
Engineering Intern

Direct: 613-724-4081
Thakshika.Rathnasooriya@stantec.com

BOUNDARY CONDITIONS

Boundary Conditions For: Shea Road Lands Developments - Interm

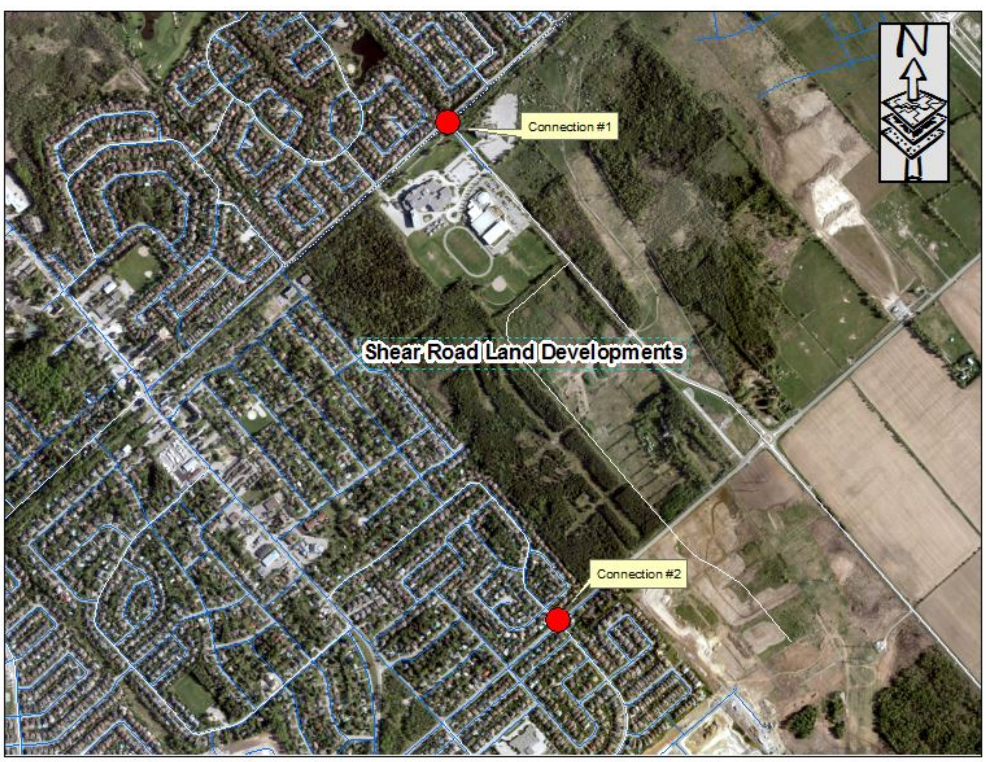
Date of Boundary Conditions: 2018-Oct-11

Provided Information:

Scenario	Demand	
	L/min	L/s
Average Daily Demand	318	5.3
Maximum Daily Demand	762	12.7
Peak Hour	1,662	27.7
Fire Flow #1 Demand	10,000	166.7
Fire Flow #2 Demand	15,000	250.0

Number Of Connections: 2

Location:



BOUNDARY CONDITIONS

Results:

Connection #: 1

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	160.6	69.0
Peak Hour	154.0	59.7
Max Day Plus Fire (10,000) L/min	154.0	58.5
Max Day Plus Fire (15,000) L/min	150.4	53.4

[1]Elevation: **112.850 m**

Connection #: 2

Demand Scenario	Head (m)	Pressure[1] (psi)
Maximum HGL	160.6	69.0
Peak Hour	154.0	59.7
Max Day Plus Fire (10,000) L/min	144.5	46.1
Max Day Plus Fire (15,000) L/min	131.1	27.1

[1]Elevation: **112.850 m**

Notes:

1) As per the Ontario Building Code in areas that may be occupied, the static pressure at any fixture shall not exceed 552 kPa (80 psi.) Pressure control measures to be considered are as follows, in order of preference:

a) If possible, systems to be designed to residual pressures of 345 to 552 kPa (50 to 80 psi) in all occupied areas outside of the public right-of-way without special pressure control equipment.
b) Pressure reducing valves to be installed immediately downstream of the isolation valve in the home/ building, located downstream of the meter so it is owner maintained.

Disclaimer

The boundary condition information is based on current operation of the city water distribution system. The computer model simulation is based on the best information available at the time. The operation of the water distribution system can change on a regular basis, resulting in a variation in boundary conditions. The physical properties of watermains deteriorate over time, as such must be assumed in the absence of actual field test data. The variation in physical watermain properties can therefore alter the results of the computer model simulation. Fire Flow analysis is a reflection of available flow in the watermain; there may be additional restrictions that occur between the watermain and the hydrant that the model cannot take into account.

A.2 HYDRAULIC MODEL PARAMETERS

Interim Conditions Shea Road - Domestic Water Demand Estimates (Cavanagh)

Densities as per City Guidelines:

Towns and Semis	2.7	ppu
Singles	3.4	ppu

Building ID	Area (ha)	Population	Daily Rate of Demand [1]	Avg Day Demand [2]		Max Day Demand [3]		Peak Hour Demand [3]	
				(L/min)	(L/s)	(L/min)	(L/s)	(L/min)	(L/s)
Residential 1		189	350	45.9	0.77	114.8	1.91	252.7	4.21
School	2.95	-	15000	30.7	0.51	46.1	0.77	83.0	1.38
Total				**76.7**	**1.3**	**160.9**	**2.7**	**335.6**	**5.6**
Residential 2		143	350	34.8	0.58	87.0	1.45	191.3	3.19
Residential 3		148	350	36.1	0.60	90.2	1.50	198.4	3.31
Residential 4		309	350	75.2	1.25	188.0	3.13	413.6	6.89
Residential 5		165	350	40.0	0.67	100.1	1.67	220.2	3.67
Residential 6		143	350	34.8	0.58	87.0	1.45	191.3	3.19
Residential 14		68	350	16.5	0.28	41.3	0.69	90.9	1.52
Total Site :				**297.5**	**5.0**	**713.1**	**11.9**	**1550.4**	**25.8**

1 Average day water demand for residential areas equal to 350 L/cap/d and 15,000 L/ha/d for the school block

2 City of Ottawa water demand criteria used to estimate peak demand rates for residential areas are as follows:

maximum day demand rate = 2.5 x average day demand rate for residential, 1.5 for Institutional

maximum hour demand rate = 2.2 x maximum day demand rate for residential, 1.8 for institutional

Ultimate Conditions Shea Road - Domestic Water Demand Estimates

Densities as per City Guidelines:

Towns and Semis	2.7	ppu
Singles	3.4	ppu

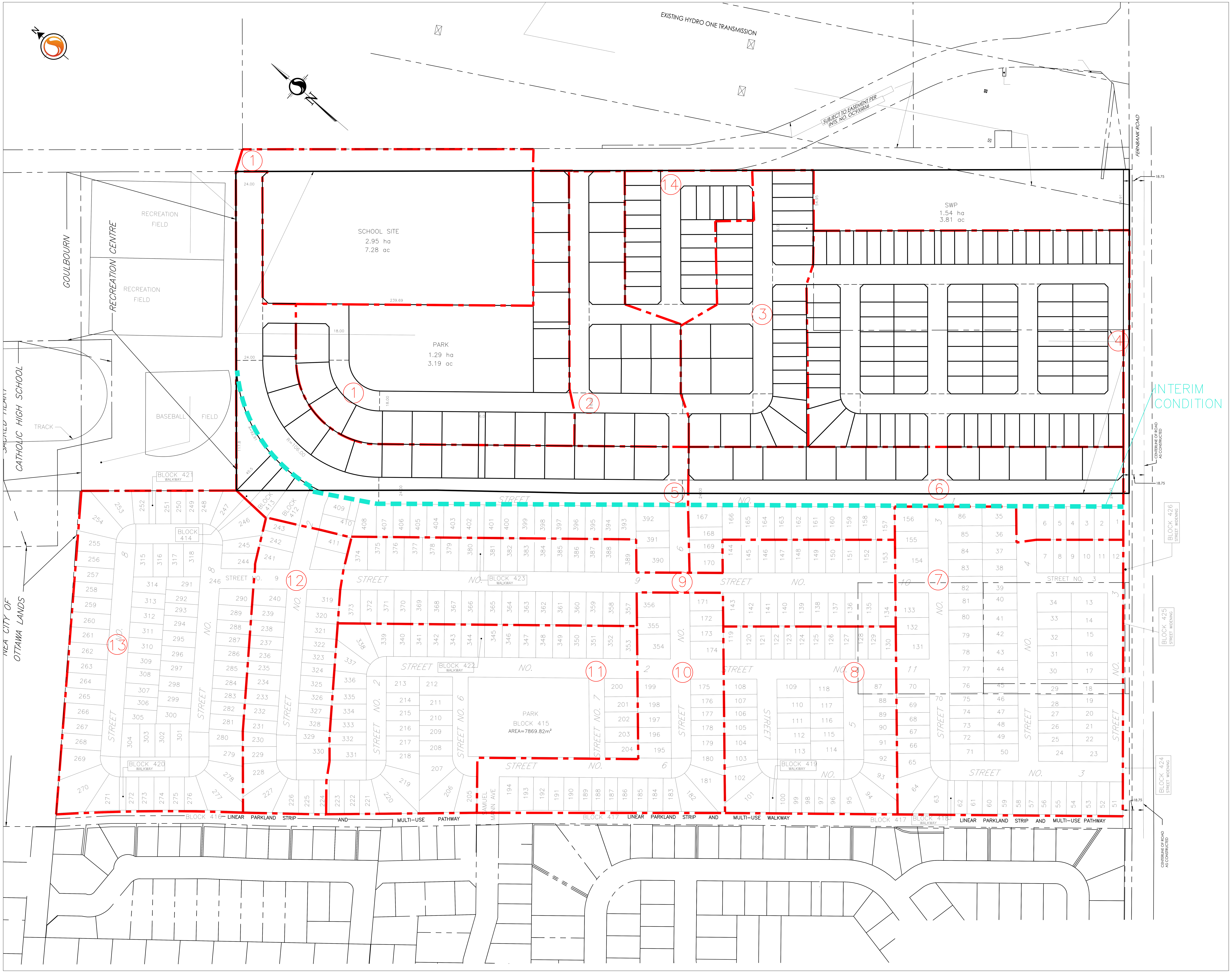
Building ID	Area (ha)	Population	Daily Rate of Demand [1]	Avg Day Demand [2]		Max Day Demand [3]		Peak Hour Demand [3]	
				(L/min)	(L/s)	(L/min)	(L/s)	(L/min)	(L/s)
Residential 1		189	350	45.9	0.77	114.8	1.91	252.7	4.21
School	2.95	-	15000	30.7	0.51	46.1	0.77	83.0	1.38
Total				**76.7**	**1.3**	**160.9**	**2.7**	**335.6**	**5.6**
Residential 2		143	350	34.8	0.58	87.0	1.45	191.3	3.19
Residential 3		148	350	36.1	0.60	90.2	1.50	198.4	3.31
Residential 4		309	350	75.2	1.25	188.0	3.13	413.6	6.89
Residential 5		289	350	70.2	1.17	175.5	2.93	386.2	6.44
Residential 6		231	350	56.2	0.94	140.4	2.34	308.9	5.15
Residential 7		372	350	90.5	1.51	226.3	3.77	497.8	8.30
Residential 8		150	350	36.4	0.61	90.9	1.52	200.0	3.33
Residential 9		286	350	69.6	1.16	173.9	2.90	382.6	6.38
Residential 10		115	350	27.9	0.47	69.8	1.16	153.5	2.56
Residential 11		190	350	46.1	0.77	115.3	1.92	253.7	4.23
Residential 12		120	350	29.1	0.48	72.7	1.21	159.9	2.66
Residential 13		255	350	62.0	1.03	154.9	2.58	340.9	5.68
Residential 14		68	350	16.5	0.28	41.3	0.69	90.9	1.52
Total Site :				**727.2**	**12.1**	**1787.2**	**29.8**	**3913.3**	**65.2**

1 Average day water demand for residential areas equal to 350 L/cap/d and 15,000 L/ha/d for the school block

2 City of Ottawa water demand criteria used to estimate peak demand rates for residential areas are as follows:

maximum day demand rate = 2.5 x average day demand rate for residential, 1.5 for Institutional

maximum hour demand rate = 2.2 x maximum day demand rate for residential, 1.8 for institutional



PRELIMINARY
OVERALL SITE SERVICING PLAN

1:1250 0 12.5 37.5 62.5m

OSSP-1 1 0

A.3 HYDRAULIC MODELING RESULTS- INTERIM

Hydraulic Model Results - Average Day Analysis

Junction Results

ID	Demand	Elevation	Head	Pressure	
	(L/s)	(m)	(m)	(psi)	(Kpa)
1	0.00	111.18	160.59	70.25	484.36
15	0.00	110.50	160.59	71.21	490.98
16	0.58	111.24	160.59	70.16	483.74
17	0.00	111.04	160.59	70.45	485.74
18	0.00	111.08	160.59	70.39	485.32
19	0.00	111.39	160.59	69.95	482.29
2	0.00	110.93	160.59	70.60	486.77
20	0.00	112.00	160.60	69.08	476.29
29	0.00	113.00	160.59	67.66	466.50
3	0.60	110.68	160.59	70.96	489.26
30	0.51	111.50	160.60	69.79	481.19
31	0.00	108.50	160.59	74.06	510.63
32	0.00	112.04	160.59	69.02	475.88
33	0.00	110.18	160.59	71.67	494.15
34	0.00	110.72	160.59	70.90	488.84
35	0.00	110.92	160.59	70.62	486.91
36	0.00	110.76	160.59	70.84	488.43
37	0.00	110.60	160.59	71.07	490.01
38	0.00	112.60	160.59	68.23	470.43
4	0.00	111.31	160.59	70.06	483.05
40	0.77	111.64	160.59	69.59	479.81
41	1.25	111.36	160.59	69.99	482.57
45	0.28	111.14	160.59	70.30	484.70
46	0.00	112.50	160.60	68.37	471.40
47	0.00	109.30	160.60	72.92	502.77
5	0.67	112.00	160.59	69.08	476.29
6	0.58	111.52	160.59	69.76	480.98

Pipe Results

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness	Flow (L/s)	Velocity (m/s)
100	1002	46	274.00	297	120	2.64	0.04
101	46	47	215.33	393	120	2.64	0.02
12	5	6	232.94	297	120	-1.08	0.02
13	6	20	84.02	297	120	-2.64	0.04
16	15	1	158.26	204	110	0.53	0.02
17	32	40	406.64	204	110	0.47	0.01
18	1	16	76.53	204	110	0.41	0.01
19	16	17	76.28	204	110	-0.47	0.01
20	3	37	534.76	204	110	-0.08	0.00
21	17	3	76.71	204	110	0.32	0.01
23	17	5	78.45	204	110	-0.79	0.02
24	47	20	134.19	297	120	2.64	0.04
27	19	41	106.46	204	110	0.66	0.02
28	18	19	25.78	204	110	-0.01	0.00
71	29	5	324.23	297	120	0.38	0.01
74	4	6	103.34	204	110	-0.97	0.03
76	30	32	338.30	297	120	0.85	0.01
77	1004	30	551.41	297	120	2.60	0.04
78	30	15	250.82	297	120	1.24	0.02
79	15	33	163.59	297	120	0.71	0.01
80	32	38	118.93	297	120	0.38	0.01
81	33	31	254.27	297	120	0.00	0.00
82	34	33	46.74	204	110	-0.71	0.02
83	2	45	200.46	204	110	-0.08	0.00
84	1	2	87.88	204	110	0.12	0.00
85	2	3	76.99	204	110	0.20	0.01
86	37	34	84.84	204	110	-0.35	0.01
87	4	19	83.42	204	110	0.67	0.02
88	18	35	84.26	204	110	-0.58	0.02
89	4	35	120.48	204	110	0.26	0.01
90	4	36	185.71	204	110	0.04	0.00
91	35	36	79.88	204	110	-0.32	0.01
92	36	37	75.38	204	110	-0.28	0.01
93	38	29	64.32	297	120	0.38	0.01
96	40	16	203.07	204	110	-0.30	0.01
97	41	18	131.37	204	110	-0.59	0.02
99	45	34	78.76	204	110	-0.36	0.01

Hydraulic Model Results -Peak Hour Analysis

Junction Results

ID	Demand	Elevation	Head	Pressure	
	(L/s)	(m)	(m)	(psi)	(Kpa)
1	0.00	111.18	153.87	60.68	418.38
15	0.00	110.50	153.88	61.67	425.20
16	3.19	111.24	153.86	60.59	417.76
17	0.00	111.04	153.87	60.88	419.76
18	0.00	111.08	153.85	60.81	419.27
19	0.00	111.39	153.85	60.37	416.24
2	0.00	110.93	153.87	61.04	420.86
20	0.00	112.00	153.91	59.57	410.72
29	0.00	113.00	153.88	58.12	400.73
3	3.31	110.68	153.87	61.39	423.27
30	1.38	111.50	153.89	60.27	415.55
31	0.00	108.50	153.88	64.51	444.78
32	0.00	112.04	153.88	59.49	410.17
33	0.00	110.18	153.88	62.12	428.30
34	0.00	110.72	153.87	61.34	422.93
35	0.00	110.92	153.86	61.05	420.93
36	0.00	110.76	153.86	61.28	422.51
37	0.00	110.60	153.87	61.51	424.10
38	0.00	112.60	153.88	58.69	404.66
4	0.00	111.31	153.86	60.49	417.07
40	4.21	111.64	153.86	60.02	413.83
41	6.89	111.36	153.84	60.39	416.38
45	1.52	111.14	153.87	60.74	418.79
46	0.00	112.50	153.94	58.92	406.24
47	0.00	109.30	153.93	63.45	437.48
5	3.67	112.00	153.88	59.54	410.52
6	3.19	111.52	153.89	60.23	415.27

Pipe Results

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness	Flow (L/s)	Velocity (m/s)
100	1002	46	274.00	297	120	13.91	0.20
101	46	47	215.33	393	120	13.91	0.11
12	5	6	232.94	297	120	-5.51	0.08
13	6	20	84.02	297	120	-13.91	0.20
16	15	1	158.26	204	110	2.99	0.09
17	32	40	406.64	204	110	2.61	0.08
18	1	16	76.53	204	110	2.28	0.07
19	16	17	76.28	204	110	-2.51	0.08
20	3	37	534.76	204	110	-0.40	0.01
21	17	3	76.71	204	110	1.74	0.05
23	17	5	78.45	204	110	-4.25	0.13
24	47	20	134.19	297	120	13.91	0.20
27	19	41	106.46	204	110	3.64	0.11
28	18	19	25.78	204	110	-0.07	0.00
71	29	5	324.23	297	120	2.41	0.03
74	4	6	103.34	204	110	-5.21	0.16
76	30	32	338.30	297	120	5.02	0.07
77	1004	30	551.41	297	120	13.45	0.19
78	30	15	250.82	297	120	7.05	0.10
79	15	33	163.59	297	120	4.06	0.06
80	32	38	118.93	297	120	2.41	0.03
81	33	31	254.27	297	120	0.00	0.00
82	34	33	46.74	204	110	-4.06	0.12
83	2	45	200.46	204	110	-0.46	0.01
84	1	2	87.88	204	110	0.71	0.02
85	2	3	76.99	204	110	1.17	0.04
86	37	34	84.84	204	110	-2.08	0.06
87	4	19	83.42	204	110	3.71	0.11
88	18	35	84.26	204	110	-3.18	0.10
89	4	35	120.48	204	110	1.42	0.04
90	4	36	185.71	204	110	0.09	0.00
91	35	36	79.88	204	110	-1.76	0.05
92	36	37	75.38	204	110	-1.68	0.05
93	38	29	64.32	297	120	2.41	0.03
96	40	16	203.07	204	110	-1.60	0.05
97	41	18	131.37	204	110	-3.25	0.10
99	45	34	78.76	204	110	-1.98	0.06

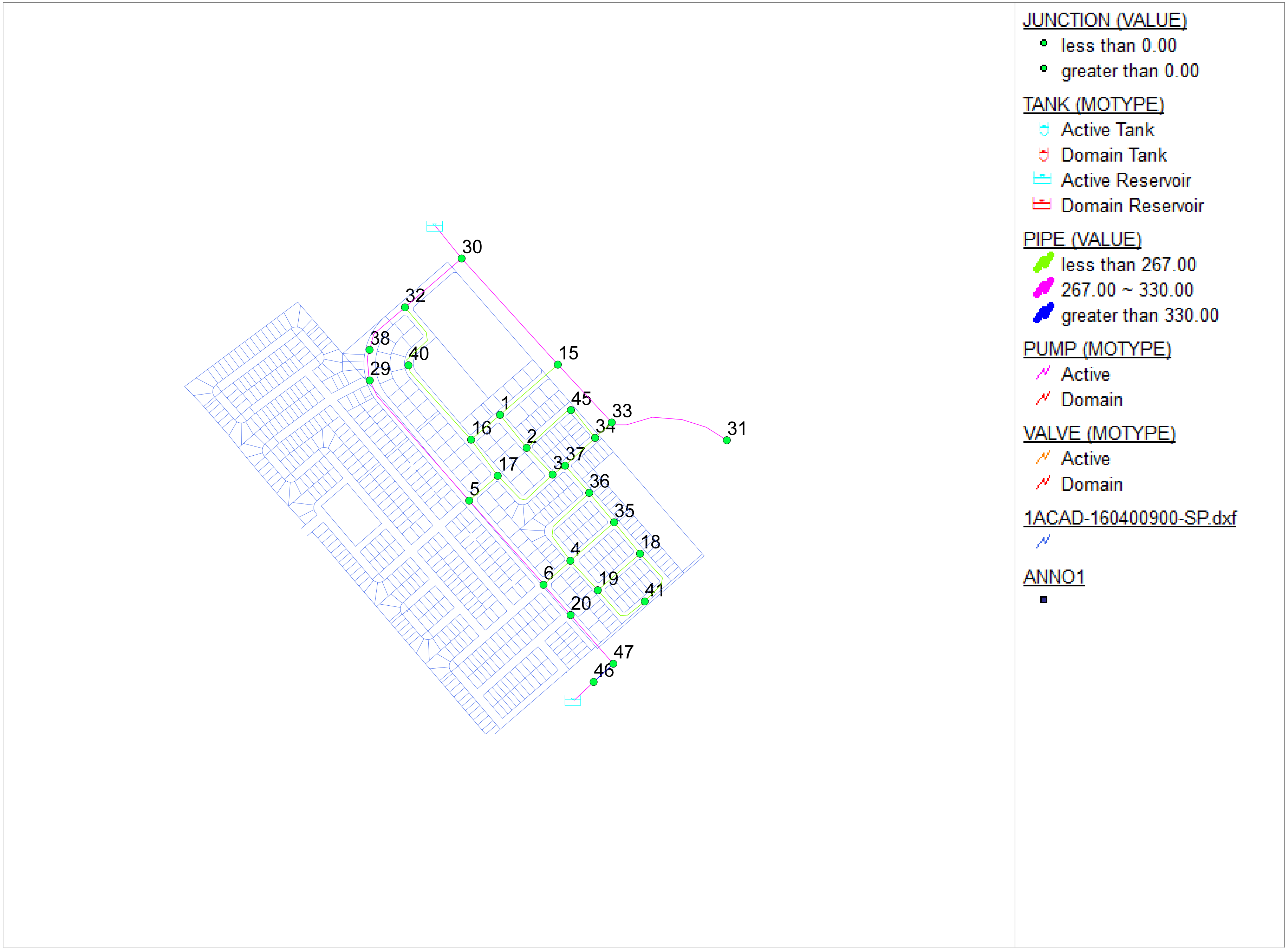
Hydraulic Model Results -Fire Flow Analysis (167 L/s)

ID	Static Demand	Static Pressure		Static Head	Fire-Flow Demand	Residual Pressure		Available Flow at Hydrant	Available Flow Pressure	
	(L/s)	(psi)	(Kpa)	(m)	(L/s)	(psi)	(Kpa)	(L/s)	(psi)	(Kpa)
16	1.45	53.51	368.94	148.88	167	41.01	282.76	305.18	20	137.90
3	1.50	54.16	373.42	148.78	167	41.57	286.62	305.16	20	137.90
40	1.91	53.04	365.70	148.95	167	27.53	189.81	197.31	20	137.90
41	3.13	52.23	360.12	148.10	167	26.16	180.37	192.08	20	137.90
45	0.69	53.76	370.66	148.95	167	36.87	254.21	253.84	20	137.90
5	1.67	51.79	357.08	148.43	167	44.01	303.44	390.18	20	137.90
6	1.45	51.39	354.32	147.67	167	45.16	311.37	428.79	20	137.90

Hydraulic Model Results -Fire Flow Analysis (250 L/s)

ID	Static Demand	Static Pressure		Static Head	Fire-Flow Demand	Residual Pressure		Available Flow at Hydrant	Available Flow Pressure	
	(L/s)	(psi)	(Kpa)	(m)	(L/s)	(psi)	(Kpa)	(L/s)	(psi)	(Kpa)
30	0.77	43.81	302.06	142.32	250	26.76	184.50	337.03	20	137.90

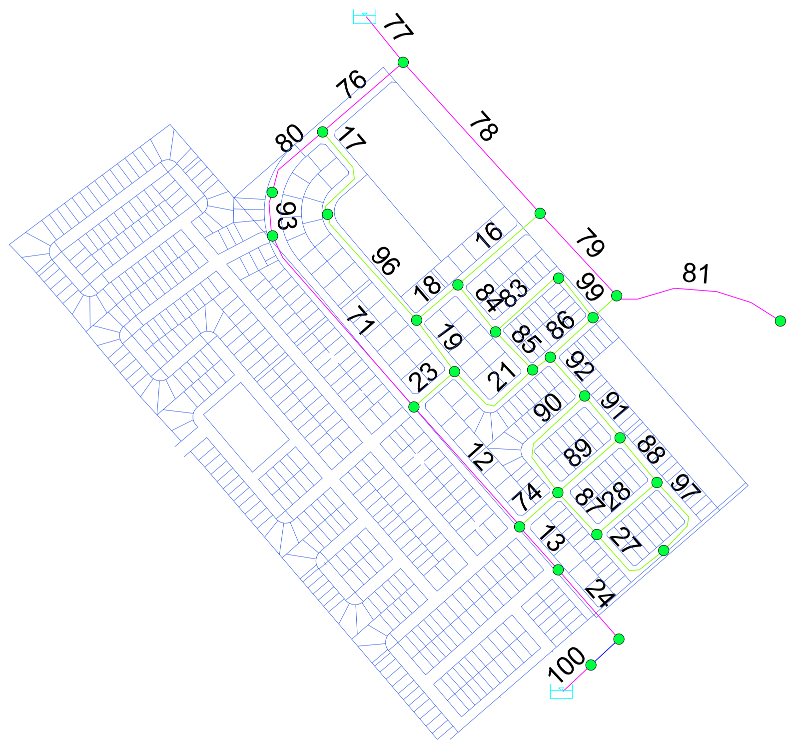
160400900-INTERIM-JUNCTION ID



Prepared By:

Date: 10/11/2018 12:22:26 PM

160400900-INTERIM-PIPE ID



JUNCTION (VALUE)
- less than 0.00
- greater than 0.00

TANK (MOTYPE)
- Active Tank
- Domain Tank
- Active Reservoir
- Domain Reservoir

PIPE (VALUE)
- less than 267.00
- 267.00 ~ 330.00
- greater than 330.00

PUMP (MOTYPE)
- Active
- Domain

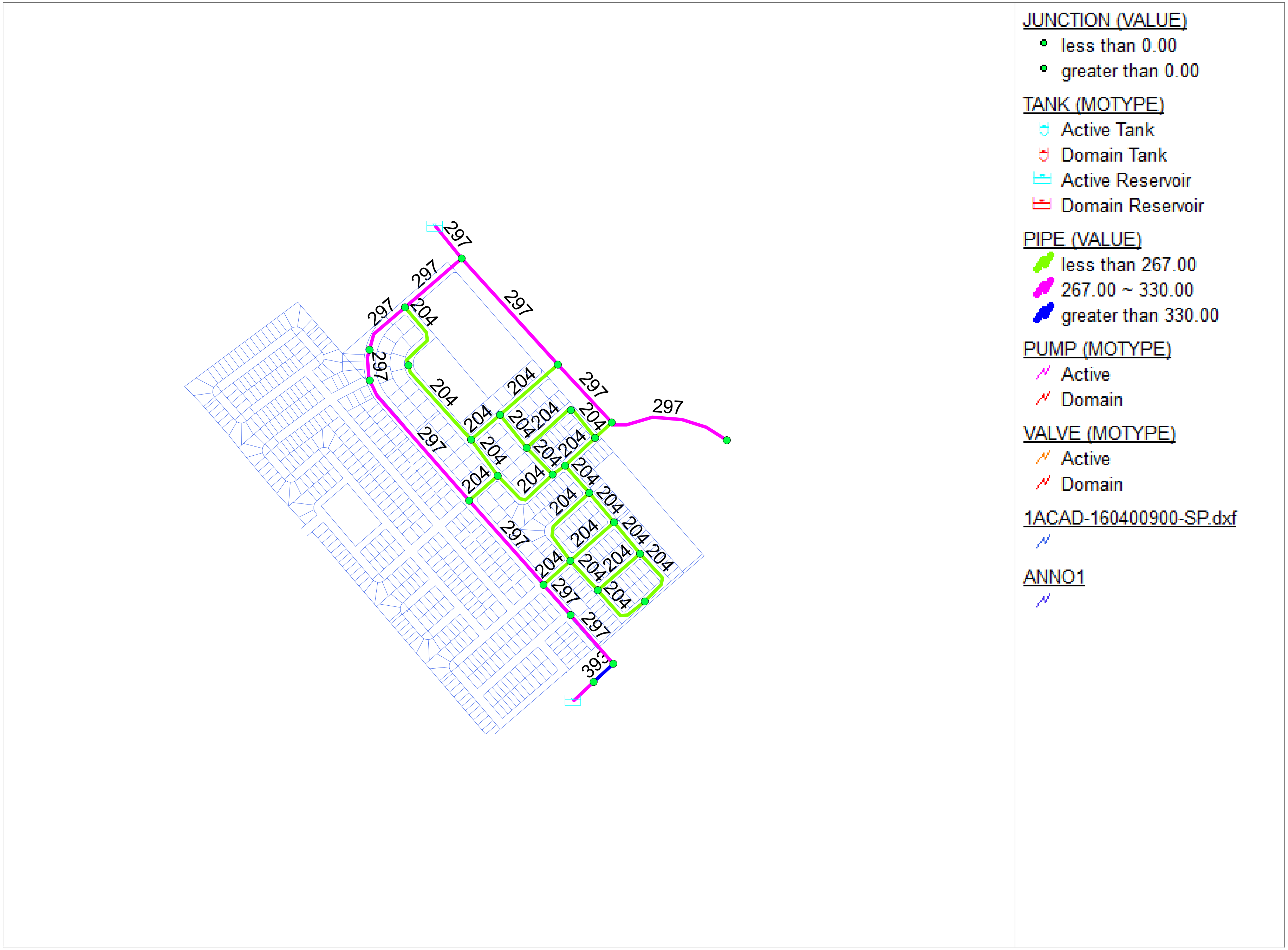
VALVE (MOTYPE)
- Active
- Domain

1ACAD-160400900-SP.dxf

ANNO1

Prepared By: Date: 10/11/2018 12:22:49 PM

160400900-INTERIM-PIPE DIAMETER



Prepared By:

Date: 10/11/2018 12:23:40 PM

A.4 HYDRAULIC MODELING RESULTS- ULTIMATE

Hydraulic Model Results - Average Day Analysis

Junction Results

ID	Demand	Elevation	Head	Pressure	
	(L/s)	(m)	(m)	(psi)	(Kpa)
1	0.00	111.18	160.60	70.25	484.36
10	0.47	113.71	160.59	66.64	459.47
11	0.77	114.00	160.59	66.23	456.64
12	0.48	113.31	160.60	67.22	463.47
13	0.00	113.98	160.60	66.27	456.92
15	0.00	110.50	160.61	71.24	491.19
16	0.58	111.24	160.60	70.17	483.81
17	0.00	111.04	160.59	70.45	485.74
18	0.00	111.08	160.58	70.37	485.19
19	0.00	111.39	160.58	69.93	482.15
2	0.00	110.93	160.60	70.61	486.84
20	0.00	112.00	160.56	69.04	476.02
21	0.00	114.00	160.59	66.24	456.71
22	0.00	114.50	160.60	65.53	451.82
23	0.00	115.50	160.57	64.07	441.75
24	0.00	113.43	160.57	67.01	462.02
25	0.00	115.00	160.58	64.79	446.71
26	0.00	114.50	160.59	65.53	451.82
27	0.00	114.20	160.58	65.94	454.64
28	0.00	114.10	160.60	66.10	455.75
29	0.00	113.00	160.60	67.66	466.50
3	0.60	110.68	160.59	70.96	489.26
30	0.51	111.50	160.63	69.84	481.53
31	0.00	108.50	160.61	74.08	510.77
32	0.00	112.04	160.61	69.05	476.09
33	0.00	110.18	160.61	71.69	494.29
34	0.00	110.72	160.60	70.91	488.91
35	0.00	110.92	160.58	70.60	486.77
36	0.00	110.76	160.58	70.83	488.36
37	0.00	110.60	160.59	71.07	490.01
38	0.00	112.60	160.60	68.24	470.50
39	0.00	114.00	160.60	66.24	456.71
4	0.00	111.31	160.58	70.04	482.91
40	0.77	111.64	160.60	69.60	479.88
41	1.25	111.36	160.58	69.97	482.43
42	1.03	114.35	160.60	65.74	453.26
45	0.28	111.14	160.60	70.31	484.77
46	0.00	112.50	160.54	68.30	470.91
47	0.00	109.30	160.55	72.86	502.36
5	1.17	112.00	160.59	69.07	476.22
6	0.94	111.52	160.57	69.73	480.77
7	1.51	113.30	160.57	67.21	463.40
8	0.61	114.50	160.58	65.51	451.68
9	1.16	112.88	160.59	67.82	467.61

Pipe Results

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness	Flow (L/s)	Velocity (m/s)
100	1002	46	274.00	297	120.00	-11.92	0.17
101	46	47	215.33	393	120.00	-11.92	0.10
12	5	6	232.94	297	120.00	7.34	0.11
13	6	20	84.02	297	120.00	10.04	0.14
16	15	1	158.26	204	110.00	2.82	0.09
17	32	40	406.64	204	110.00	1.67	0.05
18	1	16	76.53	204	110.00	1.64	0.05
19	16	17	76.28	204	110.00	1.96	0.06
20	3	37	534.76	204	110.00	0.53	0.02
21	17	3	76.71	204	110.00	-0.87	0.03
23	17	5	78.45	204	110.00	2.83	0.09
24	47	20	91.31	297	120.00	-11.92	0.17
27	19	41	106.46	204	110.00	0.64	0.02
28	18	19	25.78	204	110.00	0.50	0.02
30	1001	22	83.80	297	120.00	6.50	0.09
31	10	9	76.64	297	120.00	2.74	0.04
32	9	5	83.66	297	120.00	0.63	0.01
33	21	10	158.33	297	120.00	4.36	0.06
34	22	21	99.06	297	120.00	5.41	0.08
35	10	27	74.72	204	110.00	2.95	0.09
36	27	8	77.24	204	110.00	1.92	0.06
37	8	25	79.52	204	110.00	2.34	0.07
38	9	7	233.50	204	110.00	2.36	0.07
39	27	8	245.92	204	110.00	1.03	0.03
41	23	24	166.24	204	110.00	1.11	0.03
43	24	20	84.08	204	110.00	1.88	0.06
45	23	24	326.37	204	110.00	0.77	0.02
47	23	25	155.57	204	110.00	-1.88	0.06
49	25	7	86.57	204	110.00	0.46	0.01
51	7	6	80.24	204	110.00	1.31	0.04
53	22	26	114.16	204	110.00	1.08	0.03
55	26	11	126.60	204	110.00	1.51	0.05
57	21	11	88.50	204	110.00	1.05	0.03
59	11	10	79.05	204	110.00	1.80	0.05
61	12	9	346.52	204	110.00	1.41	0.04
63	26	12	395.25	204	110.00	-0.43	0.01
65	13	39	397.34	204	110.00	-0.69	0.02
67	28	13	163.60	204	110.00	0.01	0.00
69	13	12	76.83	204	110.00	0.69	0.02
71	29	5	324.23	297	120.00	5.05	0.07
73	12	29	91.71	204	110.00	-1.63	0.05
74	4	6	103.34	204	110.00	2.33	0.07
76	30	32	155.05	297	120.00	10.07	0.15
77	1004	30	551.41	297	120.00	17.55	0.25
78	30	15	296.72	297	120.00	6.97	0.10
79	15	33	163.59	297	120.00	4.15	0.06
80	32	38	118.93	297	120.00	8.40	0.12
81	33	31	254.27	297	120.00	0.00	0.00
82	34	33	46.74	204	110.00	-4.15	0.13
83	2	45	200.46	204	110.00	-0.82	0.02
84	1	2	87.88	204	110.00	1.18	0.04
85	2	3	76.99	204	110.00	2.00	0.06
86	37	34	84.84	204	110.00	-3.06	0.09
87	4	19	83.42	204	110.00	0.14	0.00
88	18	35	84.26	204	110.00	-1.11	0.03
89	4	35	120.48	204	110.00	-0.94	0.03
90	4	36	185.71	204	110.00	-1.53	0.05
91	35	36	79.88	204	110.00	-2.05	0.06
92	36	37	75.38	204	110.00	-3.58	0.11
93	38	29	64.32	297	120.00	6.68	0.10
94	39	42	185.11	204	110.00	1.04	0.03
95	39	38	105.01	204	110.00	-1.72	0.05
96	40	16	203.07	204	110.00	0.90	0.03
97	41	18	131.37	204	110.00	-0.61	0.02
98	42	28	171.36	204	110	0.01	0.00
99	45	34	78.76	204	110	-1.10	0.03

Hydraulic Model Results -Peak Hour Analysis

Junction Results

ID	Demand	Elevation	Head	Pressure	
	(L/s)	(m)	(m)	(psi)	(Kpa)
1	0.00	111.18	153.41	60.04	413.96
10	2.56	113.71	153.40	56.42	389.00
11	4.23	114.00	153.43	56.05	386.45
12	2.66	113.31	153.42	57.02	393.14
13	0.00	113.98	153.42	56.07	386.59
15	0.00	110.50	153.50	61.13	421.48
16	3.19	111.24	153.40	59.93	413.21
17	0.00	111.04	153.39	60.20	415.07
18	0.00	111.08	153.31	60.03	413.89
19	0.00	111.39	153.31	59.59	410.86
2	0.00	110.93	153.41	60.39	416.38
20	0.00	112.00	153.30	58.71	404.79
21	0.00	114.00	153.46	56.09	386.73
22	0.00	114.50	153.52	55.47	382.45
23	0.00	115.50	153.31	53.75	370.60
24	0.00	113.43	153.31	56.69	390.87
25	0.00	115.00	153.32	54.48	375.63
26	0.00	114.50	153.46	55.38	381.83
27	0.00	114.20	153.36	55.67	383.83
28	0.00	114.10	153.41	55.89	385.35
29	0.00	113.00	153.43	57.48	396.31
3	3.31	110.68	153.39	60.72	418.65
30	1.38	111.50	153.61	59.86	412.72
31	0.00	108.50	153.48	63.94	440.85
32	0.00	112.04	153.50	58.95	406.45
33	0.00	110.18	153.48	61.55	424.37
34	0.00	110.72	153.43	60.71	418.58
35	0.00	110.92	153.32	60.28	415.62
36	0.00	110.76	153.34	60.53	417.34
37	0.00	110.60	153.39	60.82	419.34
38	0.00	112.60	153.45	58.07	400.38
39	0.00	114.00	153.43	56.05	386.45
4	0.00	111.31	153.32	59.72	411.76
40	4.21	111.64	153.40	59.37	409.34
41	6.89	111.36	153.30	59.62	411.07
42	5.68	114.35	153.41	55.52	382.80
45	1.52	111.14	153.42	60.10	414.38
46	0.00	112.50	153.27	57.95	399.55
47	0.00	109.30	153.28	62.52	431.06
5	6.44	112.00	153.38	58.82	405.55
6	5.15	111.52	153.32	59.42	409.69
7	8.30	113.30	153.32	56.89	392.25
8	3.33	114.50	153.34	55.21	380.66
9	6.38	112.88	153.38	57.58	397.00

Pipe Results

ID	From Node	To Node	Length (m)	Diameter (mm)	Roughness	Flow (L/s)	Velocity (m/s)
100	1002	46	274.00	297	120	-15.23	0.22
101	46	47	215.33	393	120	-15.23	0.13
12	5	6	232.94	297	120	16.29	0.24
13	6	20	84.02	297	120	12.69	0.18
16	15	1	158.26	204	110	7.98	0.24
17	32	40	406.64	204	110	5.40	0.17
18	1	16	76.53	204	110	5.13	0.16
19	16	17	76.28	204	110	3.13	0.10
20	3	37	534.76	204	110	0.90	0.03
21	17	3	76.71	204	110	-0.84	0.03
23	17	5	78.45	204	110	3.97	0.12
24	47	20	91.31	297	120	-15.23	0.22
27	19	41	106.46	204	110	3.64	0.11
28	18	19	25.78	204	110	0.44	0.01
30	1001	22	83.80	297	120	32.91	0.47
31	10	9	76.64	297	120	14.80	0.21
32	9	5	83.66	297	120	6.14	0.09
33	21	10	158.33	297	120	19.00	0.27
34	22	21	99.06	297	120	24.98	0.36
35	10	27	74.72	204	110	8.27	0.25
36	27	8	77.24	204	110	5.39	0.16
37	8	25	79.52	204	110	4.94	0.15
38	9	7	233.50	204	110	5.73	0.18
39	27	8	245.92	204	110	2.88	0.09
41	23	24	166.24	204	110	1.50	0.05
43	24	20	84.08	204	110	2.54	0.08
45	23	24	326.37	204	110	1.04	0.03
47	23	25	155.57	204	110	-2.54	0.08
49	25	7	86.57	204	110	2.40	0.07
51	7	6	80.24	204	110	-0.17	0.01
53	22	26	114.16	204	110	7.93	0.24
55	26	11	126.60	204	110	4.88	0.15
57	21	11	88.50	204	110	5.98	0.18
59	11	10	79.05	204	110	6.63	0.20
61	12	9	346.52	204	110	3.45	0.11
63	26	12	395.25	204	110	3.05	0.09
65	13	39	397.34	204	110	-1.34	0.04
67	28	13	163.60	204	110	-2.08	0.06
69	13	12	76.83	204	110	-0.74	0.02
71	29	5	324.23	297	120	12.63	0.18
73	12	29	91.71	204	110	-3.81	0.12
74	4	6	103.34	204	110	1.71	0.05
76	30	32	155.05	297	120	26.77	0.39
77	1004	30	551.41	297	120	47.56	0.69
78	30	15	296.72	297	120	19.40	0.28
79	15	33	163.59	297	120	11.42	0.16
80	32	38	118.93	297	120	21.38	0.31
81	33	31	254.27	297	120	0.00	0.00
82	34	33	46.74	204	110	-11.42	0.35
83	2	45	200.46	204	110	-2.19	0.07
84	1	2	87.88	204	110	2.85	0.09
85	2	3	76.99	204	110	5.04	0.15
86	37	34	84.84	204	110	-7.71	0.24
87	4	19	83.42	204	110	3.20	0.10
88	18	35	84.26	204	110	-3.69	0.11
89	4	35	120.48	204	110	-1.43	0.04
90	4	36	185.71	204	110	-3.49	0.11
91	35	36	79.88	204	110	-5.12	0.16
92	36	37	75.38	204	110	-8.60	0.26
93	38	29	64.32	297	120	16.44	0.24
94	39	42	185.11	204	110	3.60	0.11
95	39	38	105.01	204	110	-4.94	0.15
96	40	16	203.07	204	110	1.19	0.04
97	41	18	131.37	204	110	-3.25	0.10
98	42	28	171.36	204	110	-2.08	0.06
99	45	34	78.76	204	110	-3.71	0.11

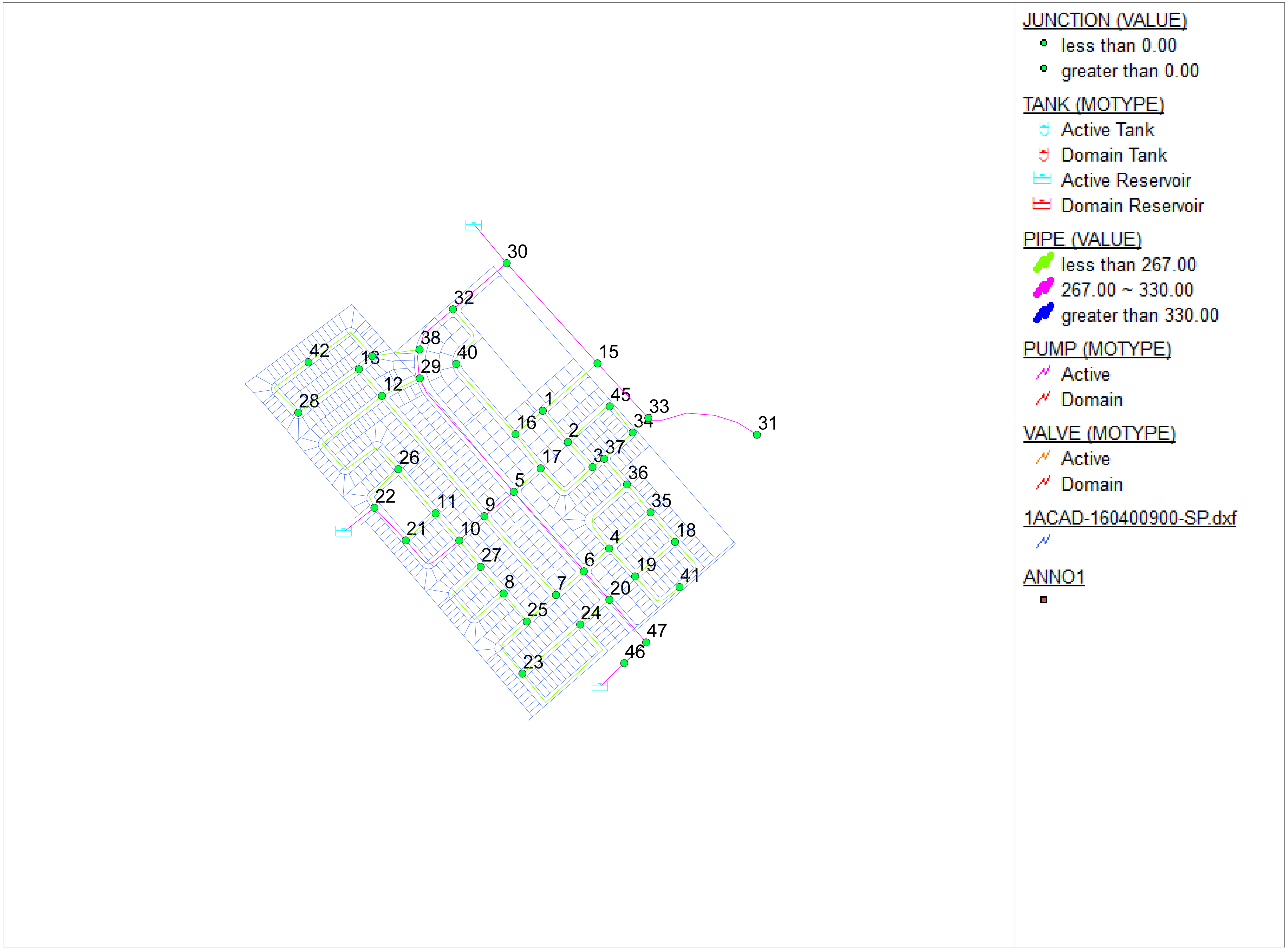
Hydraulic Model Results -Fire Flow Analysis (167 L/s)

ID	Static Demand	Static Pressure		Static Head	Fire-Flow Demand	Residual Pressure		Available Flow at Hydrant	Available Flow Pressure	
	(L/s)	(psi)	(Kpa)	(m)	(L/s)	(psi)	(Kpa)	(L/s)	(psi)	(Kpa)
10	1.16	50.83	350.46	149.47	167	48.69	335.71	743.16	20	137.90
11	1.92	50.41	347.57	149.46	167	45.97	316.95	491.48	20	137.90
12	1.21	51.76	356.87	149.72	167	45.89	316.40	427.58	20	137.90
16	1.45	54.99	379.15	149.92	167	46.95	323.71	381.26	20	137.90
3	1.50	55.70	384.04	149.86	167	47.40	326.81	376.24	20	137.90
30	0.77	55.65	383.70	150.65	250	49.25	339.57	639.97	20	137.90
40	1.91	54.51	375.84	149.98	167	33.83	233.25	224.38	20	137.90
41	3.13	54.32	374.53	149.57	167	32.20	222.01	215.78	20	137.90
42	2.58	50.37	347.29	149.78	167	26.88	185.33	195.42	20	137.90
45	0.69	55.23	380.80	149.99	167	42.49	292.96	294.81	20	137.90
5	2.93	53.37	367.98	149.54	167	51.25	353.36	746.70	20	137.90
6	2.34	53.84	371.22	149.39	167	51.49	355.01	710.94	20	137.90
7	3.77	51.31	353.77	149.39	167	45.91	316.54	440.03	20	137.90
8	1.52	49.64	342.26	149.42	167	41.05	283.03	330.64	20	137.90
9	2.90	52.06	358.94	149.50	167	49.92	344.19	740.80	20	137.90

Hydraulic Model Results -Fire Flow Analysis (250 L/s)

ID	Static Demand	Static Pressure		Static Head	Fire-Flow Demand	Residual Pressure		Available Flow at Hydrant	Available Flow Pressure	
	(L/s)	(psi)	(Kpa)	(m)	(L/s)	(psi)	(Kpa)	(L/s)	(psi)	(Kpa)
30	0.77	52.68	363.22	148.56	250	42.13	290.48	582.71	20	137.90

160400900-ULTIMATE- JUNCTION ID



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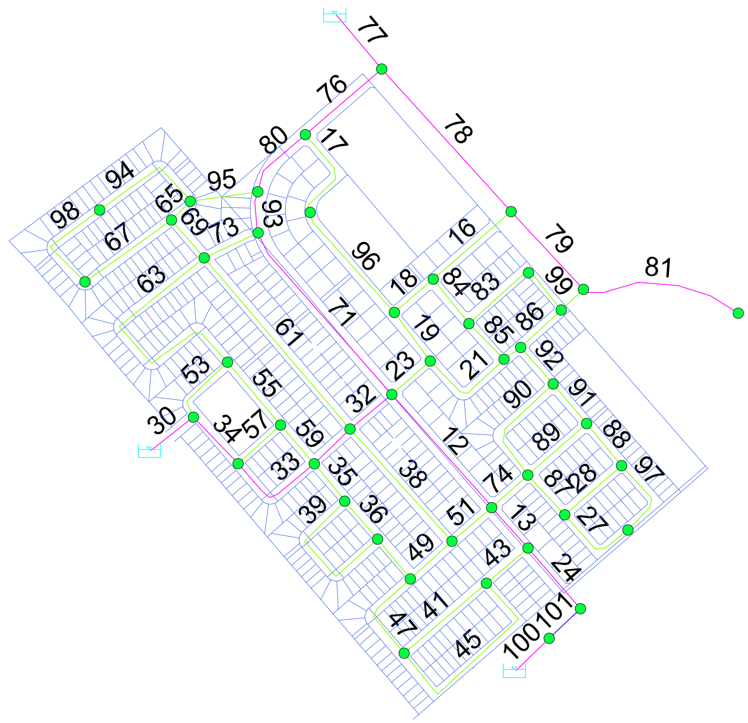
Date: 10/11/2018 12:20:39 PM

160400900-ULTIMATE-PIPE ID



JUNCTION (VALUE)
- less than 0.00
- greater than 0.00

TANK (MOTYPE)
- Active Tank
- Domain Tank
- Active Reservoir
- Domain Reservoir

PIPE (VALUE)
- less than 267.00
- 267.00 ~ 330.00
- greater than 330.00

PUMP (MOTYPE)
- Active
- Domain

VALVE (MOTYPE)
- Active
- Domain

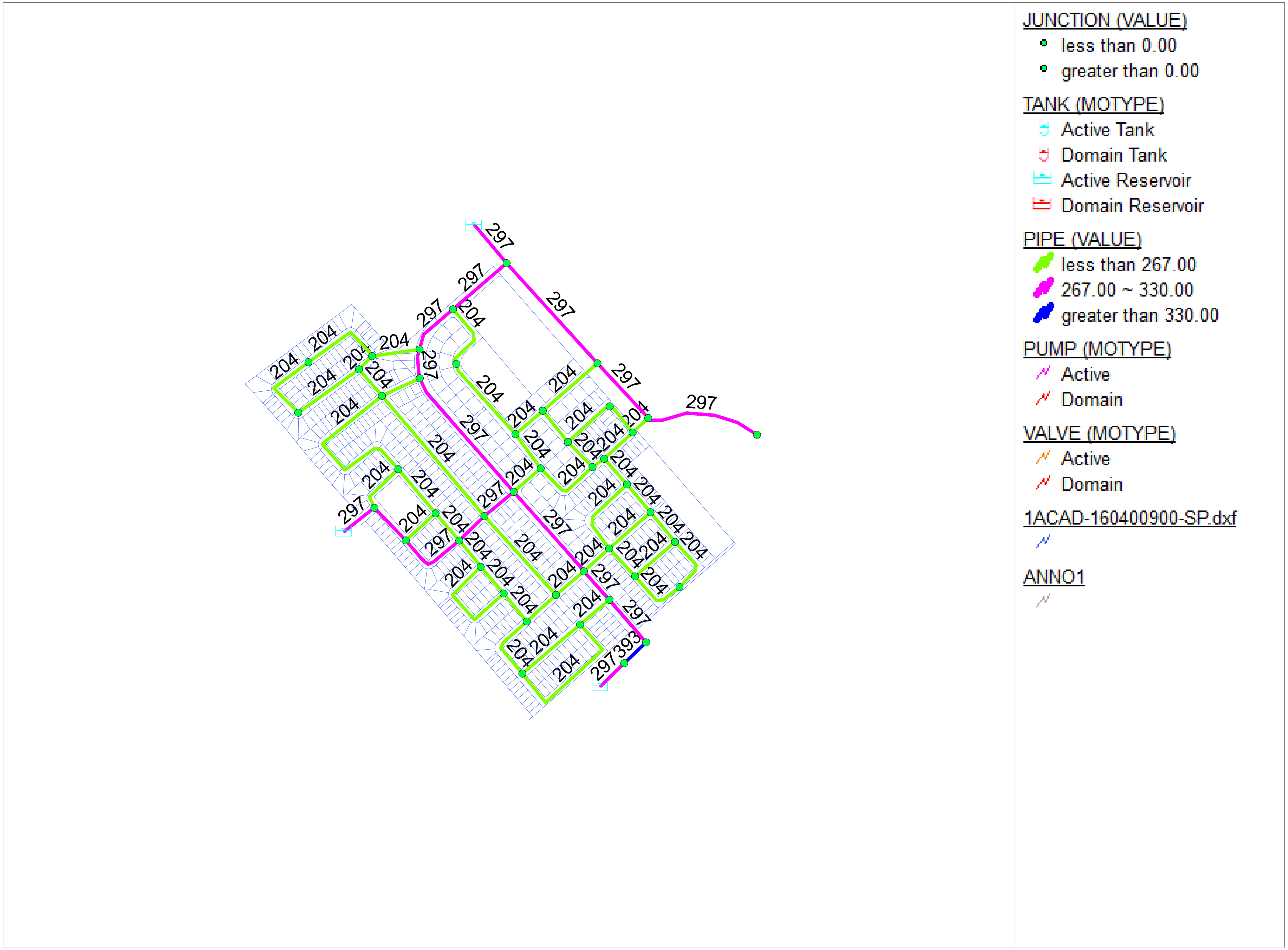
1ACAD-160400900-SP.dxf

ANNO1

Prepared By:

Date: 10/11/2018 12:21:08 PM

160400900-ULTIMATE-PIPE DIAMETER



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A.5 WATERMAIN DESIGN BACKGROUND REPORT EXCERPTS

2. WATER SUPPLY

2.1 Existing Conditions

The Fernbank Community is located within the City's 3W Pressure Zone which includes most of Kanata and Stittsville and is one of the most rapidly growing areas in the City. Potable water to this area is pressurized at the Glen Cairn Pump Station where a major water storage reservoir (Glen Cairn Reservoir) is located. Two of the major watermains into this pressure zone from the pump station are located along Hazeldean Road and Terry Fox Drive. Another main adjacent to the subject site is located in Abbott Street and the Trans Canada Trail. In support of the FCDP, the June 24, 2009 MSS completed a review of the existing water plan adjacent to area and made recommendations for improvements and expansion to the City's water transmission and distribution system to support the proposed development. Figure 4 indicates the limits of existing watermains in the vicinity of the subject property.

2.2 Master Servicing Study

The Master Servicing Study recommended a conceptual water plan for the FCDP. A copy of the recommended plan, Watermain Layout Drawing No. 101108-WM, Revision 3, is included in Appendix B. For the subject lands, there are two connections to existing 200 mm diameter mains shown on the MSS. One is on Fernbank Road at the south end of the site and the other at Samuel Mann Avenue at the west side of the site. At the north east corner of the site the MSS identifies a connection to an existing 300 mm diameter watermain north on Shea Road. Along Shea Road in the subject area the MSS shows a 300 mm watermain with connections to the east at both ends.

2.3 Design Criteria

In order to determine the watermain plan needed to adequately service the subject site, a hydraulic model was prepared using H20 MAP software by MWH Soft Inc. The City of Ottawa supplied boundary conditions at Fernbank Road and Samuel Mann Avenue.

The following parameters were also used in the analysis for the subject site:

Residential:

• Average Daily Demand (ADD)		350 l/cap/day
• Maximum Daily Demand (MDD) – 2 X MDD		875 l/cap/day
• Peak Hourly Demand – 2.2 X MDD		1925 l/cap/day
• Fire Demand	- singles & townhouse	133 l/s (8000 l/min)

Institutional

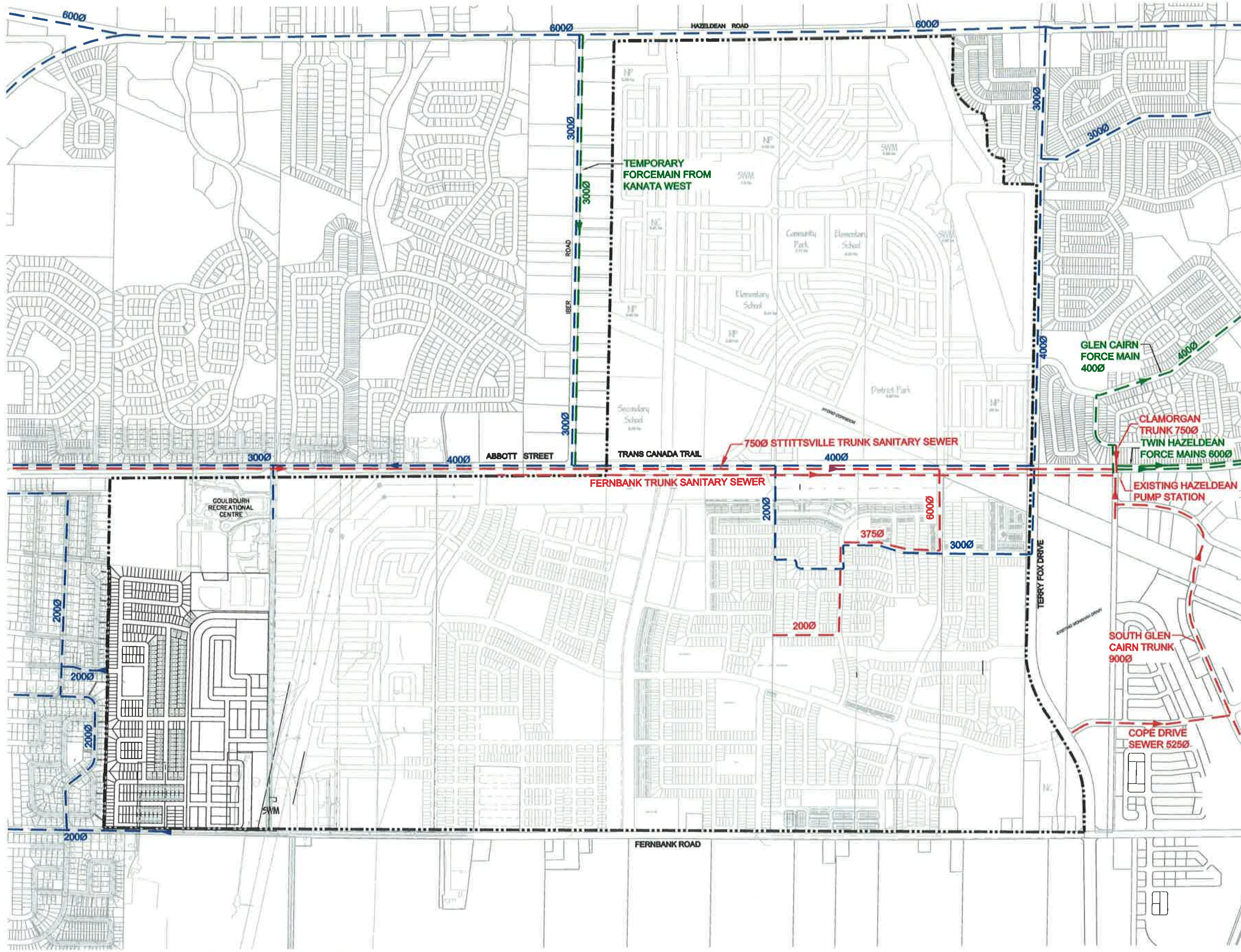
• Average Daily Demand (ADD)	15,000 l/ha/day
• Maximum Daily Demand (MDD) – 1.5 (ADD)	22,500 l/ha/day
• Maximum Hourly Demand – 1.8 (MDD)	40,500 l/ha/day
• Fire Demand	250 l/s (15,000 l/min)

Hydraulic Gradient

• Minimum – max hour	275 kPa
• Minimum – max day and fire	140 kPa

LEGEND

- 300Ø — EXISTING WATERMAIN AND DIAMETER
- 300Ø — EXISTING SANITARY SEWER AND DIAMETER
- 300Ø — EXISTING FORCEMAINS AND DIAMETER
- —··—··— LIMITS OF FERNBANK COMMUNITY DESIGN PLAN



J:\11218_FernbankLand\5.9 Drawings\59civil\current\ReportFigs_2013-01-29\11218-Fig1-5base.dwg Sheet Set: ####

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IBI GROUP

Scale: 1 : 15 000

Project Title: CONCEPTUAL SITE SERVICING STUDY
SHEA ROAD LANDS
FERNBANK COMMUNITY

Drawing Title: EXISTING WATERMAINS AND SANITARY SEWERS

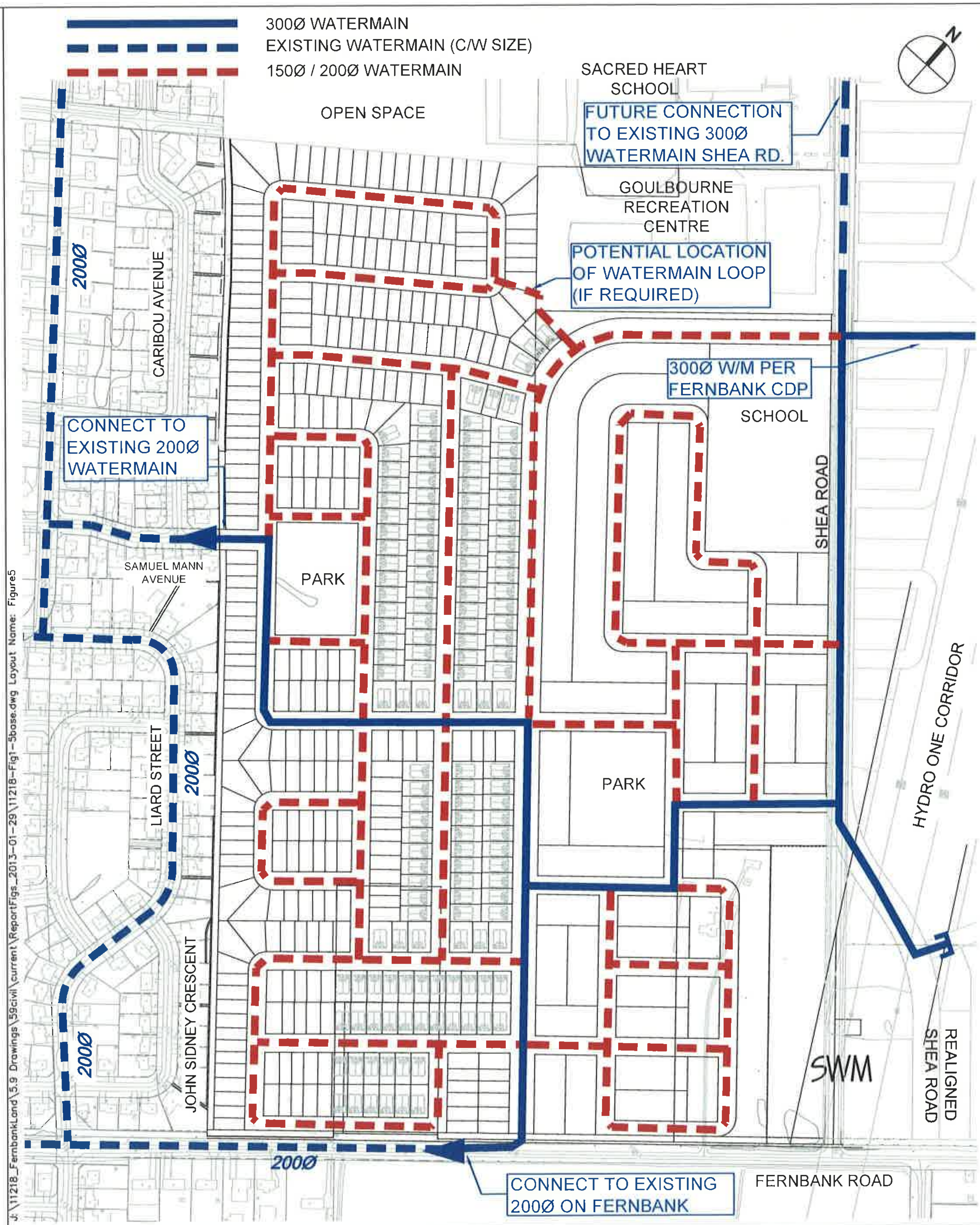
Sheet No.: FIGURE 4

A copy of the hydraulic analysis report and details on boundary conditions are included in Appendix B.

2.4 Proposed Water Plan

The proposed watermain layout for the subject lands is shown on Figure 5. As per the MSS connections to existing mains are shown at Fernbank Road and Samuel Mann Avenue. The two connection locations are joined together with a 300 mm watermain which will be part of the first phase of construction. A 300 mm watermain will be extended from the connection points to Shea Road. As per the MSS, a 300 mm watermain will be constructed on Shea Road with future connections to the north and east of the subject lands. The remaining watermains will be 150 mm or 200 mm diameter determined by hydraulic modelling during detailed design.

Results of the preliminary hydraulic modeling included in Appendix B shows that the peak hour pressures and fire flows exceed the City criteria. A check with the maximum hydraulic grade line under basic day conditions has all areas less than 550 kPa so that pressure reducing valves will not be required on this site.



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IBI GROUP

CONCEPTUAL SITE SERVICING STUDY
SHEA ROAD LANDS
FERNBANK COMMUNITY

PROPOSED WATER PLAN

FIGURE 5

Scale 1:3000

Project Title
CONCEPTUAL SITE SERVICING STUDY
DAVIDSON LANDS-OPA 76 AREA 6a
STITTSVILLE SOUTH

Drawing Title
COMBINED SERVICES PLAN

Sheet No.

Appendix B SANITARY SEWER CALCULATIONS

B.1 CONCEPTUAL SANITARY SEWER DESIGN SHEET

Stantec

SUBDIVISION:

SHEA ROAD LANDS

DATE: 10/11/2018
REVISION: 1
DESIGNED BY: WAJ
CHECKED BY: AMP

FILE NUMBER: 160400900

SANITARY SEWER DESIGN SHEET
(City of Ottawa)

DESIGN PARAMETERS

MAX PEAK FACTOR (RES.)=	4.0	AVG. DAILY FLOW / PERSON	280 L/p/day	MINIMUM VELOCITY	0.60 m/s
MIN PEAK FACTOR (RES.)=	2.0	COMMERCIAL	28,000 L/ha/day	MAXIMUM VELOCITY	3.00 m/s
PEAKING FACTOR (INDUSTRIAL):	2.4	INDUSTRIAL (HEAVY)	55,000 L/ha/day	MANNINGS n	0.013
PEAKING FACTOR (ICI >20%):	1.5	INDUSTRIAL (LIGHT)	35,000 L/ha/day	BEDDING CLASS	B
PERSONS / SINGLE	3.4	INSTITUTIONAL	28,000 L/ha/day	MINIMUM COVER	2.50 m
PERSONS / TOWNHOME	2.7	INFILTRATION	0.33 L/s/ha	HARMON CORRECTION FACTOR	0.8
PERSONS / APARTMENT	1.8				

LOCATION			RESIDENTIAL AREA AND POPULATION									COMMERCIAL		INDUSTRIAL (L)		INDUSTRIAL (H)		INSTITUTIONAL		GREEN / UNUSED		C+I+I	INFILTRATION			TOTAL	PIPE								
AREA ID NUMBER	FROM M.H.	TO M.H.	AREA (ha)	UNITS SINGLE	UNITS TOWN	UNITS APT	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)	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (L/s)	FLOW (L/s)	LENGTH (m)	DIA (mm)	MATERIAL	CLASS	SLOPE (%)	CAP. (FULL) (L/s)	CAP. V PEAK FLOW (%)	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
Tartan Area R318A - Future sanitary sewers not part of proposed development	318	317	6.79	105	8	0	379	6.79	379	3.43	4.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	6.79	6.79	2.2	6.4	187.0	200	PVC	SDR 35	0.32	18.9	34.07%	0.60	0.45
	317	316	0.00	0	0	0	0	6.79	379	3.43	4.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	6.79	2.2	6.4	17.4	200	PVC	SDR 35	0.32	18.9	34.07%	0.60	0.45
	316	315	0.00	0	0	0	0	6.79	379	3.43	4.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	6.79	2.2	6.4	53.1	200	PVC	SDR 35	0.32	18.9	34.07%	0.60	0.45
	315	314	0.00	0	0	0	0	6.79	379	3.43	4.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	6.79	2.2	6.4	18.5	200	PVC	SDR 35	0.32	18.9	34.07%	0.60	0.45
	314	313	0.00	0	0	0	0	6.79	379	3.43	4.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	6.79	2.2	6.4	27.0	200	PVC	SDR 35	0.32	18.9	34.07%	0.60	0.45
	313	312	0.00	0	0	0	0	6.79	379	3.43	4.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	6.79	2.2	6.4	79.7	200	PVC	SDR 35	0.32	18.9	34.07%	0.60	0.45
	312	11	0.00	0	0	0	0	6.79	379	3.43	4.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	6.79	2.2	6.4	94.4	200	PVC	SDR 35	0.32	18.9	34.07%	0.60	0.45
Tartan Area R311A - Not part of proposed development	311	310	8.30	67	108	0	519	8.30	519	3.37	5.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	8.30	8.30	2.7	8.4	81.1	200	PVC	SDR 35	0.32	18.9	44.49%	0.60	0.49
	310	309	0.00	0	0	0	0	8.30	519	3.37	5.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	8.30	2.7	8.4	18.1	200	PVC	SDR 35	0.32	18.9	44.49%	0.60	0.49
Tartan Area G309A - Not part of proposed development	309	308	0.00	0	0	0	0	8.30	519	3.37	5.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.79	0.0	0.79	9.09	3.0	8.7	262.2	200	PVC	SDR 35	0.32	18.9	45.87%	0.60	0.49
	308	307	0.00	0	0	0	0	8.30	519	3.37	5.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.0	0.00	9.09	3.0	8.7	79.0	200	PVC	SDR 35	0.32	18.9	45.87%	0.60	0.49
	307	13	0.00	0	0	0	0	8.30	519	3.37	5.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.0	0.00	9.09	3.0	8.7	81.0	200	PVC	SDR 35	0.32	18.9	45.87%	0.60	0.49
Tartan Area R303A - Not part of proposed development	303	302	6.66	59	94	0	454	6.66	454	3.40	5.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	6.66	6.66	2.2	7.2	143.6	200	PVC	SDR 35	0.32	18.9	38.06%	0.60	0.47
	302	301	0.00	0	0	0	0	6.66	454	3.40	5.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	6.66	2.2	7.2	17.9	200	PVC	SDR 35	0.32	18.9	38.06%	0.60	0.47
	301	300	0.00	0	0	0	0	6.66	454	3.40	5.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	6.66	2.2	7.2	158.2	200	PVC	SDR 35	0.32	18.9	38.06%	0.60	0.47
	300	14	0.00	0	0	0	0	6.66	454	3.40	5.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	6.66	2.2	7.2	81.0	200	PVC	SDR 35	0.32	18.9	38.06%	0.60	0.47
Tartan Area R306A - Not part of proposed development	306	305	2.68	21	46	0	196	2.68	196	3.52	2.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	2.68	2.68	0.9	3.1	160.9	200	PVC	SDR 35	0.32	18.9	16.48%	0.60	0.37
	305	304	0.00	0	0	0	0	2.68	196	3.52	2.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	2.68	0.9	3.1	78.1	200	PVC	SDR 35	0.32	18.9	16.48%	0.60	0.37
	304	15	0.00	0	0	0	0	2.68	196	3.52	2.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	2.68	0.9	3.1	81.0	200	PVC	SDR 35	0.32	18.9	16.48%	0.60	0.37
Laird Street PS and Area 6 Peak Flows - Future sanitary sewer on Fernbank Road (by Others)	321	320	0.00	0	0	0	0	0.00	0	3.80	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	108.0	41.1	450	CONCRETE	100-D	0.25	150.3	71.86%	0.92	0.87
	320	319	0.00	0	0	0	0	0.00	0	3.80	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	108.0	170.8	450	CONCRETE	100-D	0.25	150.3	71.86%	0.92	0.87
	319	16	0.00	0	0	0	0	0.00	0	3.80	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	108.0	267.8	450	CONCRETE	100-D	0.25	150.3	71.86%	0.92	0.87
	16	15	0.00	0	0	0	0	0.00	0	3.80	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	0.00	0.0	192.0	106.8	600	CONCRETE	100-D	0.25	323.7	59.32%	1.11	1.00
	15	14	0.00	0	0	0	0	2.68	196	3.52	2.2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	2.68	0.9	195.1	79.9	600	CONCRETE	100-D	0.25	323.7	60.28%	1.11	1.00
R42A	42	41	2.05	34	0	0	116	2.05	116	3.58	1.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	2.05	2.05	0.7	2.0	35.1	200	PVC	SDR 35	0.32	18.9	10.67%	0.60	0.32
	41	40	0.00	0	0	0	0	2.05	116	3.58	1.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	2.05	0.7	2.0	117.0	200	PVC	SDR 35	0.32	18.9	10.67%	0.60	0.32
	40	39	0.00	0	0	0	0	2.05	116	3.58	1.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	2.05	0.7	2.0	79.0	200	PVC	SDR 35	0.32	18.9	10.67%	0.60	0.32
R44A	44	43	2.69	43	0	0	146	2.69	146	3.56	1.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	2.69	2.69	0.9	2.6	117.6	200	PVC	SDR 35	0.32	18.9	13.59%	0.60	0.35
	43	39	0.00	0	0	0	0	2.69	146	3.56	1.7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	2.69	0.9	2.6	161.0	200	PVC	SDR 35	0.32	18.9	13.59%	0.60	0.35
R39A	39	14	0.95	14	0	0	48	5.69	309	3.46	3.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.95	5.69	1.9	5.3	81.0	200	PVC	SDR 35	0.32	18.9	28.26%	0.60	0.43
	14	13	0.00	0	0	0	0	15.03	959	3.25	10.1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	15.03	5.0	207.1	234.0	600	CONCRETE	100-D	0.25	323.7	63.97%	1.11	1.02
R38AA	38A	38	1.11	6	23	0	83	1.11	83	3.61	1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	1.11	1.11	0.4	1.3	168.7	200	PVC	SDR 35	0.32	18.9	7.04%	0.60	0.29
R38A	38	37	1.67	10	30	0	115	2.77	198	3.52	2.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	1.67	2.77	0.9	3.2	227.0	200	PVC	SDR 35	0.32	18.9	16.75%	0.60	0.37
	37	13	0.00	0	0	0	0	2.77	198	3.52	2.3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.00	2.77	0.9	3.2	5.6	200	PVC	SDR 35	0.32	18.9	16.75%	0.60	0.37
	13	12	0.00	0	0	0	0	26.10	1676	3.12	16.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.0	0.00	26.89	8.9	217.8	271.3	600	CONCRETE	100-D	0.25	323.7	67.29%	1.11	1.04
	12	11	0.00	0	0	0	0	26.10	1676	3.12	16.9	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.0	0.00	26.89	8.9	217.8	49.5	600	CONCRETE	100-D	0.25	323.7	67.29%	1.11	1.04
	11	10	0.00	0	0	0	0	32.89	2055	3.06	20.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.0	0.00	33.68	11.1	223.5	66.2	600	CONCRETE	100-D	0.25	323.7	69.05%	1.11	1.05
	10	9	0.00	0	0	0	0	32.89	2055	3.06	20.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.0	0.00	33.68	11.1	223.5	66.2	600	CONCRETE	100-D	0.25	323.7	69.05%	1.11	1.05
	9	8	0.00	0	0	0	0	32.89	2055	3.06	20.4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.79	0.0	0.00	33.68	11.1	223.5	42.8	600	CONCRETE	100-D	0.25	323.7	69.05%	1.11	1.05

SUBDIVISION:

SHEA ROAD LANDS

DATE: 10/11/2018
REVISION: 1
DESIGNED BY: WAJ
CHECKED BY: AMP

SANITARY SEWER DESIGN SHEET
(City of Ottawa)

FILE NUMBER: 160400900

DESIGN PARAMETERS

MAX PEAK FACTOR (RES.)=	4.0	AVG. DAILY FLOW / PERSON	280 L/p/day	MINIMUM VELOCITY	0.60 m/s
MIN PEAK FACTOR (RES.)=	2.0	COMMERCIAL	28,000 L/ha/day	MAXIMUM VELOCITY	3.00 m/s
PEAKING FACTOR (INDUSTRIAL):	2.4	INDUSTRIAL (HEAVY)	55,000 L/ha/day	MANNINGS n	0.013
PEAKING FACTOR (ICI >20%):	1.5	INDUSTRIAL (LIGHT)	35,000 L/ha/day	BEDDING CLASS	B
PERSONS / SINGLE	3.4	INSTITUTIONAL	28,000 L/ha/day	MINIMUM COVER	2.50 m
PERSONS / TOWNHOME	2.7	INFILTRATION	0.33 L/s/ha	HARMON CORRECTION FACTOR	0.8
PERSONS / APARTMENT	1.8				

LOCATION			RESIDENTIAL AREA AND POPULATION									COMMERCIAL		INDUSTRIAL (L)		INDUSTRIAL (H)	
AREA ID NUMBER	FROM M.H.	TO M.H.	AREA (ha)	UNITS SINGLE	UNITS TOWN	UNITS APT	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)
R36A	36	35	2.25	15	37	0	151	2.25	151	3.55	1.7	0.00	0.00	0.00	0.00	0.00	0.00
R35A	35	34	1.60	4	24	0	78	3.84	229	3.50	2.6	0.00	0.00	0.00	0.00	0.00	0.00
	34	33	0.00	0	0	0	0	3.84	229	3.50	2.6	0.00	0.00	0.00	0.00	0.00	0.00
	33	32	0.00	0	0	0	0	3.84	229	3.50	2.6	0.00	0.00	0.00	0.00	0.00	0.00
	32	31	0.00	0	0	0	0	3.84	229	3.50	2.6	0.00	0.00	0.00	0.00	0.00	0.00
	31	8	0.00	0	0	0	0	3.84	229	3.50	2.6	0.00	0.00	0.00	0.00	0.00	0.00
R29A	29	28	1.59	15	21	0	108	1.59	108	3.59	1.3	0.00	0.00	0.00	0.00	0.00	0.00
	28	27	0.00	0	0	0	0	1.59	108	3.59	1.3	0.00	0.00	0.00	0.00	0.00	0.00
R27A	27	22	1.41	0	45	0	122	3.00	229	3.50	2.6	0.00	0.00	0.00	0.00	0.00	0.00
R26AA	26A	26	1.67	26	0	0	88	1.67	88	3.61	1.0	0.00	0.00	0.00	0.00	0.00	0.00
	26	25	0.00	0	0	0	0	1.67	88	3.61	1.0	0.00	0.00	0.00	0.00	0.00	0.00
R25A	25	24	1.32	2	41	0	118	2.99	206	3.51	2.3	0.00	0.00	0.00	0.00	0.00	0.00
	24	23	0.00	0	0	0	0	2.99	206	3.51	2.3	0.00	0.00	0.00	0.00	0.00	0.00
	23	22	0.00	0	0	0	0	2.99	206	3.51	2.3	0.00	0.00	0.00	0.00	0.00	0.00
R22A, G22B	22	21	1.48	0	42	0	113	7.47	549	3.36	6.0	0.00	0.00	0.00	0.00	0.00	0.00
	21	20	0.00	0	0	0	0	7.47	549	3.36	6.0	0.00	0.00	0.00	0.00	0.00	0.00
	20	19	0.00	0	0	0	0	7.47	549	3.36	6.0	0.00	0.00	0.00	0.00	0.00	0.00
	19	18	0.00	0	0	0	0	7.47	549	3.36	6.0	0.00	0.00	0.00	0.00	0.00	0.00
	18	17	0.00	0	0	0	0	7.47	549	3.36	6.0	0.00	0.00	0.00	0.00	0.00	0.00
	17	8	0.00	0	0	0	0	7.47	549	3.36	6.0	0.00	0.00	0.00	0.00	0.00	0.00
R8A	8	7	0.29	0	0	0	0	44.50	2833	2.97	27.3	0.00	0.00	0.00	0.00	0.00	0.00
I7AA	7A	7	0.00	0	0	0	0	0.00	0	3.80	0.0	0.00	0.00	0.00	0.00	0.00	0.00
	7	6	0.00	0	0	0	0	44.50	2833	2.97	27.3	0.00	0.00	0.00	0.00	0.00	0.00

LOCATION			INSTITUTIONAL		GREEN / UNUSED		C+I+I	INFILTRATION			TOTAL	PIPE								
AREA ID NUMBER	FROM M.H.	TO M.H.	AREA (ha)	ACCU. AREA (ha)	AREA (ha)	ACCU. AREA (ha)	PEAK FLOW (l/s)	TOTAL AREA (ha)	ACCU. AREA (ha)	INFILT. FLOW (L/s)	FLOW (L/s)	LENGTH (m)	DIA (mm)	MATERIAL	CLASS	SLOPE (%)	CAP. (FULL) (L/s)	CAP. V PEAK FLOW (%)	VEL. (FULL) (m/s)	VEL. (ACT.) (m/s)
R36A	36	35	0.00	0.00	0.00	0.00	0.0	2.25	2.25	0.7	2.5	258.7	200	PVC	SDR 35	0.32	18.9	**13.10%**	0.60	0.34
R35A	35	34	0.00	0.00	0.00	0.00	0.0	1.60	3.84	1.3	3.9	51.9	200	PVC	SDR 35	0.32	18.9	**20.46%**	0.60	0.39
	34	33	0.00	0.00	0.00	0.00	0.0	0.00	3.84	1.3	3.9	64.6	200	PVC	SDR 35	0.32	18.9	**20.46%**	0.60	0.39
	33	32	0.00	0.00	0.00	0.00	0.0	0.00	3.84	1.3	3.9	65.7	200	PVC	SDR 35	0.32	18.9	**20.46%**	0.60	0.39
	32	31	0.00	0.00	0.00	0.00	0.0	0.00	3.84	1.3	3.9	38.2	200	PVC	SDR 35	0.32	18.9	**20.46%**	0.60	0.39
	31	8	0.00	0.00	0.00	0.00	0.0	0.00	3.84	1.3	3.9	3.7	200	PVC	SDR 35	0.32	18.9	**20.46%**	0.60	0.39
R29A	29	28	0.00	0.00	0.00	0.00	0.0	1.59	1.59	0.5	1.8	123.0	200	PVC	SDR 35	0.32	18.9	**9.39%**	0.60	0.31
	28	27	0.00	0.00	0.00	0.00	0.0	0.00	1.59	0.5	1.8	83.0	200	PVC	SDR 35	0.32	18.9	**9.39%**	0.60	0.31
R27A	27	22	0.00	0.00	0.00	0.00	0.0	1.41	3.00	1.0	3.6	80.0	200	PVC	SDR 35	0.32	18.9	**18.98%**	0.60	0.38
R26AA	26A	26	0.00	0.00	0.00	0.00	0.0	1.67	1.67	0.5	1.6	71.3	200	PVC	SDR 35	0.32	18.9	**8.37%**	0.60	0.30
	26	25	0.00	0.00	0.00	0.00	0.0	0.00	1.67	0.5	1.6	196.0	200	PVC	SDR 35	0.32	18.9	**8.37%**	0.60	0.30
R25A	25	24	0.00	0.00	0.00	0.00	0.0	1.32	2.99	1.0	3.3	11.7	200	PVC	SDR 35	0.32	18.9	**17.62%**	0.60	0.37
	24	23	0.00	0.00	0.00	0.00	0.0	0.00	2.99	1.0	3.3	67.7	200	PVC	SDR 35	0.32	18.9	**17.62%**	0.60	0.37
	23	22	0.00	0.00	0.00	0.00	0.0	0.00	2.99	1.0	3.3	89.9	200	PVC	SDR 35	0.32	18.9	**17.62%**	0.60	0.37
R22A, G22B	22	21	0.00	0.00	1.29	1.29	0.0	2.77	8.76	2.9	8.9	180.7	300	PVC	SDR 35	0.20	42.9	**20.65%**	0.61	0.40
	21	20	0.00	0.00	0.00	1.29	0.0	0.00	8.76	2.9	8.9	28.1	300	PVC	SDR 35	0.20	42.9	**20.65%**	0.61	0.40
	20	19	0.00	0.00	0.00	1.29	0.0	0.00	8.76	2.9	8.9	28.1	300	PVC	SDR 35	0.20	42.9	**20.65%**	0.61	0.40
	19	18	0.00	0.00	0.00	1.29	0.0	0.00	8.76	2.9	8.9	33.7	300	PVC	SDR 35	0.20	42.9	**20.65%**	0.61	0.40
	18	17	0.00	0.00	0.00	1.29	0.0	0.00	8.76	2.9	8.9	11.7	300	PVC	SDR 35	0.20	42.9	**20.65%**	0.61	0.40
	17	8	0.00	0.00	0.00	1.29	0.0	0.00	8.76	2.9	8.9	72.8	300	PVC	SDR 35	0.20	42.9	**20.65%**	0.61	0.40
R8A	8	7	0.00	0.00	0.00	2.07	0.0	0.29	46.57	15.4	234.6	67.9	600	CONCRETE	100-D	0.25	323.7	**72.49%**	1.11	1.06
I7AA	7A	7	2.96	2.96	0.00	0.00	1.4	2.96	2.96	1.0	2.4	12.0	200	PVC	SDR 35	0.32	18.9	**12.75%**	0.60	0.34
	7	6	0.00	2.96	0.00	2.07	1.0	0.00	49.53	16.3	236.6	70.1	600	CONCRETE	100-D	0.25	323.7	**73.09%**	1.11	1.07

B.2 SANITARY DESIGN BACKGROUND REPORT EXCERPTS AND CORRESPONDENCE

From:	Bougadis, John
To:	Balima, Nadege
Subject:	RE: 27970 - PDFs and Design sheet for City
Attachments:	image002.png Pages from (2013.12.19)Area6_MSR.pdf Pages from 07 - Annex A.2 - Wastewater Project Sheets.pdf

---

Hi Nadege,

We can speak more on this on Monday. I have attached the two pieces of information which relate to diverting the area 6 PS (ultimate capacity of 84 l/s) and Liard PS (ultimate capacity of 108 l/s) to the future Fernbank trunk via the CRT Phase 1 Lands.

Thanks

John
x14990

From: Balima, Nadege
Sent: 2017/01/13 3:21 PM
To: Bougadis, John
Subject: RE: 27970 - PDFs and Design sheet for City

Thanks for your prompt reply John.
My next question was therefore going to be: should this be identified somewhere/to someone? Would it be useful for IBI include the information from this analysis in their report to show the exercise was done or was this simply an attempt to see if more future growth could be accommodated?
Thanks,

Nadege.

From: Bougadis, John
Sent: Friday, January 13, 2017 1:22 PM
To: Balima, Nadege
Subject: RE: 27970 - PDFs and Design sheet for City

Hi Nadege,

The future flow allowance must consider at least 192 l/s (Liard PS rated capacity =108 l/s plus Area 6/Stittsville South Pump station rated capacity of 84 l/s). The total flow I provided considered future flows beyond the current urban boundary.

I don't have a problem if the future flow allowance is reduced to 192 l/s to alleviate issues IBI is currently having with their design. The only problem I see is that capacity may not be available in this area to accommodate growth beyond the urban boundary. This will have to be assessed at that time.

Thanks

John

x14990

|**From:** Balima, Nadege
Sent: 2017/01/13 12:29 PM
To: Bougadis, John
Subject: FW: 27970 - PDFs and Design sheet for City

Hi John,
Please see below for your information.
I haven't had a chance to discuss this with you and I have to head out for the rest of the day.
I'll contact you next week to go over this issue.
Thanks,

Nadège Balima, P.Eng., M.P.M., LEED Green Assoc.
Project Manager, Infrastructure Approvals
Development Review Services (West)
613.580.2424 ext. 13477

From: Jim Moffatt [mailto:jmoffatt@IBIGroup.com]
Sent: Wednesday, January 11, 2017 10:17 AM
To: Balima, Nadege
Cc: Jim Burghout; Shawn Malhotra; Karlinda Hinds
Subject: FW: 27970 - PDFs and Design sheet for City

As per our conversation yesterday, the recent request from the City to include an additional 110 l/s in the sub trunk sewer in the CRT property will have a detrimental effect on the design of the subdivision. The sub trunk sewer was already at capacity and cannot accept additional flows without increasing its slope. The increased slope will essentially mean that we will have to raise grades over large portions of the site to avoid sewer conflicts. Attached for your reference are copies of the revised spreadsheets and marked drawings which indicate the impact to the sanitary design. The spreadsheets shown the sewer deficiencies with the new flows added and the marked drawings shown the needed sewer slope to accommodate the added flows.This design assumes we maintain the proposed sewer size of 600mm dia which matches the existing trunk sewer size.
As you may recall the MSS document recognized that there could be a significant grade raise within the subdivision and to counter this recommended that the stormwater outlet, the Flewellyn Drain, be lowered to reduce HGL's and the need for significant grade raises and fill requirements. Adding additional flows to the proposed 600mm dia trunk sewer puts us back in the pre MSS situation and generally goes against the intent of the MSS recommendations in this respect. Additionally there are areas within the subdivision that are approaching recommended grade raise limits and those areas cannot accommodate any upward changes to the proposed grades.
All this to say we need to collectively review the need to handle the extra about 300 l/s (Laird Street PS, Area 6 and the 100l/s for future areas) that were never anticipated in the MSS document. However we need to do this in a timely fashion since we are about to get our approvals on the pond and outlet channel and our clients wants to complete the first phase by fall '17.
Let me know your thoughts on this matter.

Jim Moffatt

Associate | Manager, Land Engineering
email jmoffatt@IBIGroup.com web www.ibigroup.com

IBI GROUP
400-333 Preston Street
Ottawa ON K1S 5N4 Canada
tel +1 613 225 1311 fax +1 613 225 9868

From: Karlinda Hinds
Sent: Wednesday, January 11, 2017 9:00 AM
To: Jim Moffatt <jmoffatt@IBIGroup.com>
Subject: 27970 - PDFs and Design sheet for City

Karlinda Hinds

email Karlinda.Hinds@ibigroup.com web www.ibigroup.com

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NOTE:
THE POSITION OF ALL POLE LINES, CONDUITS, WATERMAINS, SEWERS AND OTHER UNDERGROUND AND OVERGROUND UTILITIES AND STRUCTURES IS NOT NECESSARILY SHOWN ON THE CONTRACT DRAWINGS, AND WHERE SHOWN, THE ACCURACY OF THE POSITION OF SUCH UTILITIES AND STRUCTURES IS NOT GUARANTEED. BEFORE STARTING WORK, DETERMINE THE EXACT LOCATION OF ALL SUCH UTILITIES AND STRUCTURES AND ASSUME ALL LIABILITY FOR DAMAGE TO THEM.

No.	REVISION	DATE	BY
3	ISSUED WITH MASTER SERVICING STUDY	MAY 25/09	MAB
2	UPDATED WITH DRAFT MASTER SERVICING STUDY	SEP 12/08	MAB
1	ISSUED WITH DRAFT MASTER SERVICING STUDY	MAY 02/08	MAB

LICENSED PROFESSIONAL ENGINEER M.A. BISSETT PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER J.G. RIDDELL PROVINCE OF ONTARIO

NOVATECH ENGINEERING CONSULTANTS LTD.
ENGINEERS & PLANNERS
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com

DESIGN	KJM
CHECKED	MAB
DRAWN	KJM
CHECKED	MAB
APPROVED	JGR

SCALE 1 : 5000

CITY OF OTTAWA
FERNBANK CDP

SANITARY DRAINAGE AREA PLAN

PROJECT No. 101108-0
DATE AUGUST 2007
DRAWING No. 101108-SAN

Table 3.2 Elements Tributary to MH-FT18

DESIGN	AREA (HA)	POPULATION
2012	13.19	538
CRT Phase 1*	12.21	524

** The areas and populations for the MH-FT24 outlet have been adjusted to account for OP Expansion Area 6.*

As is evident from these tables, the areas and population estimates for each outlet are relatively consistent. There are to be some minor differences expected between final design, when final lotting is known, and the more macro focused master study estimates. Therefore, the sanitary design is in general conformance with the 2012 Trunk Sewer Report.

There are some changes now recommended to the sanitary drainage area boundaries, especially along the west side of Robert Grant Avenue and the drainage divide along the Phase 1A limits. The changes are identified in **Figure 3.1**. The significant change is that the school site, Block 361, adjacent to Robert Grant Avenue is now proposed to be serviced from Cope Drive and be tributary to the proposed 600 mm Ø sub-trunk sewer in Goldhawk Drive. The MSS report recommended that the school site be tributary eastward to the Fernbank Crossing development. The change is recommended because of ownership boundaries.

Upstream of MH-FT24 on the Fernbank Trunk Sewer, the 2009 MSS document recommended construction of a 525 mm diameter sub-trunk sewer along Goldhawk Drive and a 450 mm diameter sewer oversized for external lands west of Shea Road. A copy of the 2009 MSS Sanitary Drainage Area Plan (Drawing 101108-SAN) is included in **Appendix D**. Since the 2009 MSS report was completed, the City of Ottawa has requested that the CRT sanitary sewer be oversized to account for wastewater flows to the existing Laird Street Pump Station and also expected flow from the 2012 OPA Area 6 expansion lands. The latter areas were brought into the urban envelope in 2012 as part of the last Official Plan review by the City.

In accordance with recent instructions from the City of Ottawa, an allowance for external flows of 192 l/s has been provided in the proposed 600 mm Ø sub-trunk sewer in the subject property, 108 l/s for the Liard Street Pump Station and 84 l/s for the OPA 76 Area 6 lands. Refer to an e-mail string last dated January 31, 2017 from the City located in **Appendix B**.

Therefore, the recommended sanitary sewer extension through the CRT Phase 1 site to accommodate the revised design criteria is now a 600 mm diameter pipe as opposed to the 450/525 pipe recommended in the MSS report.

As recently agreed with the City, the proposed 600 mm diameter sanitary sub-trunk sewer through the CRT property has been sized to accommodate the following external flows:

• Liard Street Pump Station	108 l/s
• OPA 76 Area 6 Pump Station	84 l/s
	192 l/s

Those flows are in addition to other upstream flows from future developments within the Fernbank CDP area.

IBI GROUP

IBI Group
400-333 Preston Street
Ottawa, Ontario
K1S 5N4

SANITARY SEWER DESIGN SHEET

PROJECT: CRT DEVELOPMENT
LOCATION: CITY OF OTTAWA
CLIENT: CRT DEVELOPMENT INC.

LOCATION				RESIDENTIAL									ICI AREAS							INFILTRATION ALLOWANCE			TOTAL	PROPOSED SEWER DESIGN						
				UNIT TYPES				AREA	POPULATION		PEAK	PEAK	AREA (Ha)						PEAK	AREA (Ha)		FLOW	FLOW	CAPACITY	LENGTH	DIA	SLOPE	VELOCITY	AVAILABLE CAPACITY	
		FROM	TO								FACTOR	FLOW	INSTITUTIONAL		COMMERCIAL		INDUSTRIAL		FLOW									(full)		
STREET	AREA ID	MH	MH	SF	SD	TH	APT	(Ha)	IND	CUM		(L/s)	IND	CUM	IND	CUM	IND	CUM	(L/s)	IND	CUM	(L/s)	(L/s)	(L/s)	(m)	(mm)	(%)	(m/s)	L/s	(%)
																							0.00							
	LSPS	Allowance						0.00	0.0	0.0													108.00							
	STITTSVILLE 6 PS		110A					0.00	0.0	0.0				0.00		0.00		0.00	0.00				84.00							
Future Street	INST.3	BLKHD	110A					0.00	0.0	0.0			2.47	2.47		0.00		0.00	2.14											
	PARK4	BLKHD	110A					0.83	0.0	0.0				0.00		0.00		0.00	0.00											
	PARK5	BLKHD	110A					1.04	0.0	0.0				0.00		0.00		0.00	0.00											
	RES.9	BLKHD	110A					34.81	2610.8	2610.8				0.00		0.00		0.00	0.00											
	RES.7	BLKHD	110A					4.24	318.0	318.0				0.00		0.00		0.00	0.00											
	RES.13	BLKHD	110A					2.22	133.2	133.2				0.00		0.00		0.00	0.00											
	RES.12	BLKHD	110A					43.89	2633.4	2633.4				0.00		0.00		0.00	0.00											
	INST.4	BLKHD	110A					0.00	0.0	0.0			2.44	2.44		0.00		0.00	2.12											
	COMM.	BLKHD	110A					0.00	0.0	0.0				0.00	0.63	0.63		0.00	0.55											
	HYD.4	BLKHD	110A					3.06	0.0	0.0				0.00		0.00		0.00	0.00											
	RES.8	BLKHD	110A					2.30	172.5	172.5				0.00		0.00		0.00	0.00											
	HYD.5	BLKHD	110A					5.20	0.0	0.0				0.00		0.00		0.00	0.00											
Future Street	RES.11	BLKHD	110A					6.91	414.6	414.6				0.00		0.00		0.00	0.00											
	PARK6	BLKHD	110A					1.19	0.0	0.0				0.00		0.00		0.00	0.00											
	RES.10	BLKHD	110A					1.92	115.2	115.2				0.00		0.00		0.00	0.00											
	HYD.3	BLKHD	110A					6.31	0.0	0.0				0.00		0.00		0.00	0.00											
TOTAL		**BLKHD**	**110A**					**113.92**		**6397.7**	**3.14**	**81.49**		**4.91**		**0.63**		**0.00**	**4.81**	**119.46**	**119.46**	**33.45**	**311.74**	**320.28**	**24.02**	**600**	**0.25**	**1.097**	**8.54**	**2.67**
GOLDHAWK DRIVE		**110A**	**109A**					**0.00**	**0.0**	**9779.6**	**2.96**	**117.43**		**14.32**		**0.63**		**0.00**	**12.98**	**0.00**	**186.59**	**52.25**	**374.66**	**378.96**	**61.28**	**600**	**0.35**	**1.298**	**4.30**	**1.14**
GOLDHAWK DRIVE	**110A**	**1101A**	**1092A**	**1**				**0.18**	**3.3**	**3.3**	**4.00**	**0.05**								**0.18**	**0.18**	**0.05**	**0.10**	**28.63**	**61.28**	**200**	**0.70**	**0.883**	**28.52**	**99.64**
GOLDHAWK DRIVE		**109A**	**108A**					**0.00**	**0.0**	**9782.9**	**2.96**	**117.47**		**14.32**		**0.63**		**0.00**	**12.98**	**0.00**	**186.77**	**52.30**	**374.74**	**378.96**	**57.50**	**600**	**0.35**	**1.298**	**4.22**	**1.11**
GOLDHAWK DRIVE	**109A**	**1091A**	**1082A**	**5**				**0.32**	**16.5**	**16.5**	**4.00**	**0.27**								**0.32**	**0.32**	**0.09**	**0.36**	**28.63**	**57.50**	**200**	**0.70**	**0.883**	**28.27**	**98.75**
GOLDHAWK DRIVE		**108A**	**107A**					**0.00**	**0.0**	**9799.4**	**2.96**	**117.64**		**14.32**		**0.63**		**0.00**	**12.98**	**0.00**	**187.09**	**52.39**	**375.00**	**378.96**	**53.32**	**600**	**0.35**	**1.298**	**3.96**	**1.05**
GOLDHAWK DRIVE	**108A**	**1081A**	**1072A**	**4**				**0.30**	**13.2**	**13.2**	**4.00**	**0.21**							**0.00**	**0.30**	**0.30**	**0.08**	**0.30**	**28.63**	**53.32**	**200**	**0.70**	**0.883**	**28.33**	**98.96**
GOLDHAWK DRIVE		**107A**	**106A**					**0.00**	**0.0**	**9812.6**	**2.96**	**117.77**		**14.32**		**0.63**		**0.00**	**12.98**	**0.00**	**187.39**	**52.47**	**375.22**	**378.96**	**62.94**	**600**	**0.35**	**1.298**	**3.74**	**0.99**
GOLDHAWK DRIVE	**107A**	**1071A**	**1062A**	**7**				**0.31**	**23.1**	**23.1**	**4.00**	**0.37**		**0.00**		**0.00**		**0.00**	**0.00**	**0.31**	**0.31**	**0.09**	**0.46**	**28.63**	**62.94**	**200**	**0.70**	**0.883**	**28.17**	**98.39**
GOLDHAWK DRIVE		**106A**	**105A**					**0.00**	**0.0**	**9835.7**	**2.96**	**118.01**		**14.32**		**0.63**		**0.00**	**12.98**	**0.00**	**187.70**	**52.56**	**375.54**	**378.96**	**60.09**	**600**	**0.35**	**1.298**	**3.42**	**0.90**
GOLDHAWK DRIVE	**106A**	**1061A**	**1052A**	**2**				**0.24**	**6.6**	**6.6**	**4.00**	**0.11**		**0.00**		**0.00**		**0.00**	**0.00**	**0.24**	**0.24**	**0.07**	**0.17**	**28.63**	**60.09**	**200**	**0.70**	**0.883**	**28.45**	**99.39**
		105A	**104A**					**0.00**	**0.0**	**10558.3**	**2.93**	**125.37**		**14.32**		**0.63**		**0.00**	**12.98**	**0.00**	**200.47**	**56.13**	**386.48**	**389.64**	**72.85**	**600**	**0.37**	**1.335**	**3.16**	**0.81**
GOLDHAWK DRIVE	**105A**	**1051A**	**1042A**	**7**				**0.45**	**23.1**	**23.1**	**4.00**	**0.37**								**0.45**	**0.45**	**0.13**	**0.50**	**27.59**	**72.85**	**200**	**0.65**	**0.851**	**27.09**	**98.19**
GOLDHAWK DRIVE		**104A**	**103A**					**0.00**	**0.0**	**10581.4**	**2.93**	**125.60**		**14.32**		**0.63**		**0.00**	**12.98**	**0.00**	**200.92**	**56.26**	**386.84**	**389.64**	**48.77**	**600**	**0.37**	**1.335**	**2.80**	**0.72**
GOLDHAWK DRIVE	**104A**	**1041A**	**1032A**	**9**				**0.47**	**29.7**	**29.7**	**4.00**	**0.48**							**0.00**	**0.47**	**0.47**	**0.13**	**0.61**	**27.59**	**48.77**	**200**	**0.65**	**0.851**	**26.97**	**97.78**
GOLDHAWK DRIVE		**103A**	**102A**					**0.00**	**0.0**	**10611.1**	**2.93**	**125.90**		**14.32**		**0.63**		**0.00**	**12.98**	**0.00**	**201.39**	**56.39**	**387.27**	**389.64**	**45.00**	**600**	**0.37**	**1.335**	**2.37**	**0.61**
GOLDHAWK DRIVE	**103A, HYD1**	**1031A**	**1021A**	**6**				**2.01**	**19.8**	**19.8**	**4.00**	**0.32**							**0.00**	**2.01**	**2.01**	**0.56**	**0.88**	**27.59**	**45.00**	**200**	**0.65**	**0.851**	**26.70**	**96.80**
GOLDHAWK DRIVE	**102A**	**102A**	***FT-24 (EX)***					**0.12**	**0.0**	**10630.9**	**2.93**	**126.10**		**14.32**		**0.63**		**0.00**	**12.98**	**0.12**	**203.52**	**56.99**	**388.07**	**389.64**	**102.59**	**600**	**0.37**	**1.335**	**1.57**	**0.40**
HYDRO EASEMENT		***FT-24 (EX)***	***FT-23 (EX)***					**0.00**	**0.0**	**10650.7**	**2.93**	**126.30**		**14.32**		**0.63**		**0.00**	**12.98**	**0.00**	**205.53**	**57.55**	**388.83**	**400.03**	**107.50**	**600**	**0.39**	**1.371**	**11.20**	**2.80**

Design Parameters:

Residential			ICI Areas			Peak Factor
SF	3.3	p/p/u	INST	50,000	L/Ha/day	1.5
TH/SD	2.5	p/p/u	COM	50,000	L/Ha/day	1.5
APT	1.8	p/p/u	IND	35,000	L/Ha/day	MOE Chart
Low	60	p/p/Ha				
Med	75	p/p/Ha				
High	90	p/p/Ha				

Notes:

1. Mannings coefficient (n) = 0.013
2. Demand (per capita): 350 L/day
3. Infiltration allowance: 0.28 L/s/Ha
4. Residential Peaking Factor:
   Harmon Formula = 1+(14/(4+P^0.5))
   where P = population in thousands

Designed: J.I.M.

Checked: P.K.

Dwg. Reference: 27970 - 501, 501A, 501B

No.	Revision	Date
1.	Submission No. 1 to City of Ottawa	2013-08-29
2.	Submission No. 2 to City of Ottawa	2014-01-22
3.	Submission No. 3 to City of Ottawa	2014-08-22
4.	Submission No. 4 to City of Ottawa	2015-06-15
5.	Submission No. 5 to City of Ottawa	2016-11-10
6.	Submission for MOE Approval	2017-02-10
7.	Resubmission for MOE Approval	2017-07-14

File Reference:	Date:	Sheet No:
27970.5.7.1	2017-07-14	4 of 4

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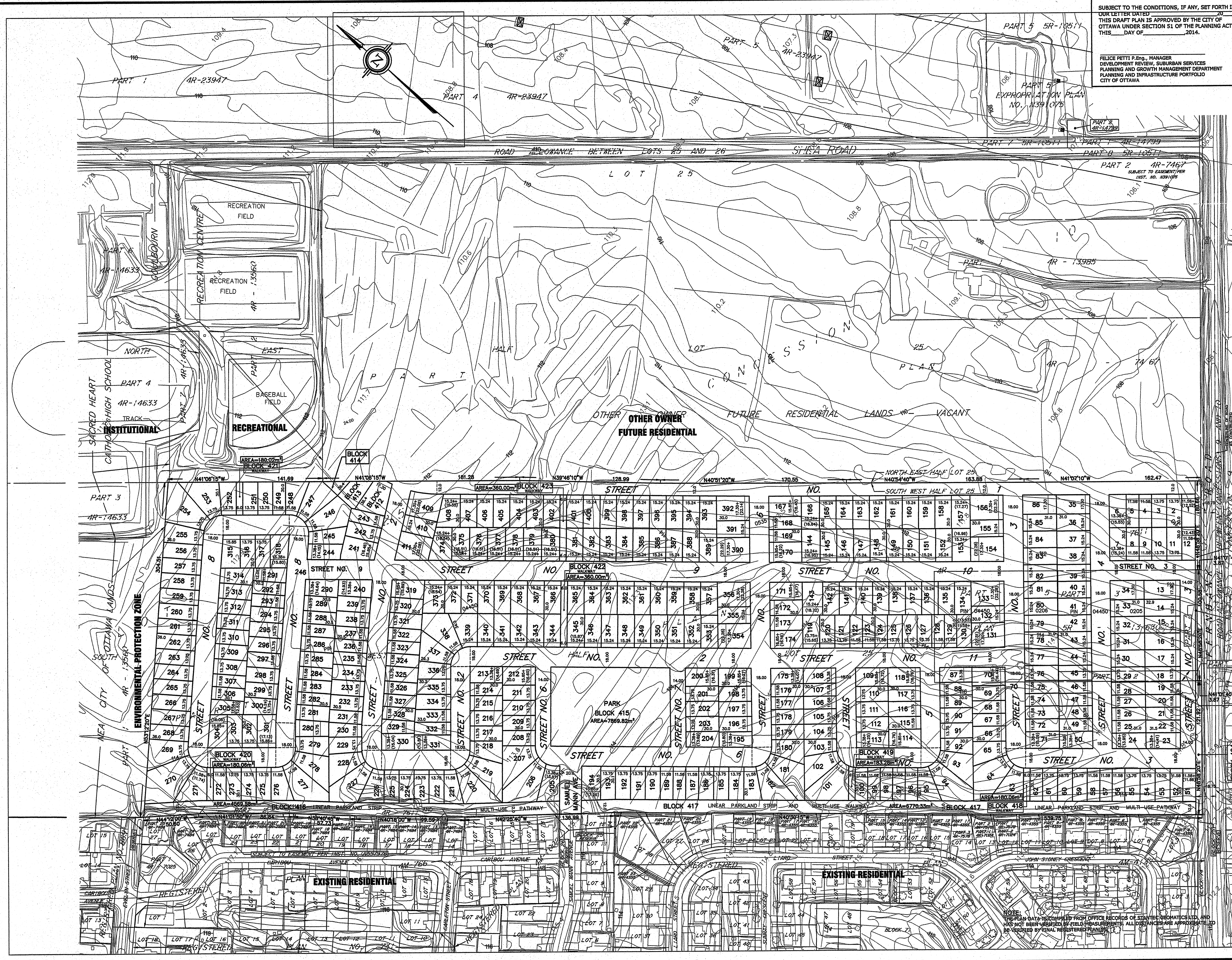
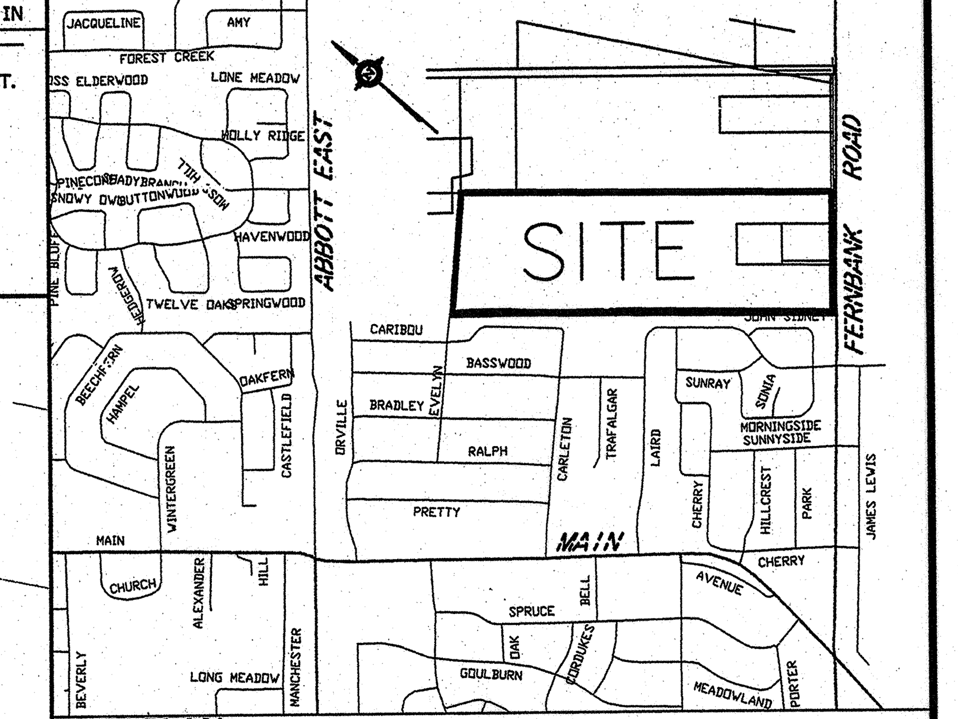


SUBJECT TO THE CONDITIONS, IF ANY, SET FORTH IN OUR LETTER DATED ______________20___
THIS DRAFT PLAN IS APPROVED BY THE CITY OF OTTAWA UNDER SECTION 51 OF THE PLANNING ACT.
THIS____DAY OF____________,2014.

FELICE PETTI P.Eng., MANAGER
DEVELOPMENT REVIEW, SUBURBAN SERVICES
PLANNING AND GROWTH MANAGEMENT DEPARTMENT
PLANNING AND INFRASTRUCTURE PORTFOLIO
CITY OF OTTAWA



KEY PLAN

DRAFT PLAN OF SUBDIVISION of

PART OF THE SOUTH HALF OF LOT 25 CONCESSION 10

GEOGRAPHIC TOWNSHIP OF GOULBOURN

CITY OF OTTAWA

Scale 1 : 1500

60 45 30 15 0 30 60 Metres

METRIC CONVERSION

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

SURVEYOR'S CERTIFICATE

I HEREBY CERTIFY THAT THE BOUNDARIES OF THE SUBJECT LANDS AND THEIR RELATIONSHIP TO ADJOINING LANDS HAVE BEEN ACCURATELY SHOWN.

08/05/14
DATE

BRIAN J. WEBSTER
ONTARIO LAND SURVEYOR

OWNER'S CERTIFICATE

I HEREBY AUTHORIZE THIS DRAFT PLAN OF SUBDIVISION TO BE SUBMITTED ON MY BEHALF.

DATED : 5 Aug. 2014

DOUG LAZIER
2087875 ONTARIO LTD.
PRESIDENT
I HAVE THE AUTHORITY
TO BIND THE CORPORATION

SCHEDULE OF LAND USE			
LOT/BLOCK	USE	UNITS	AREA (Ha/ac)
1 TO 12, 19 TO 28, 46 TO 75, 87 TO 130, 167 TO 338	SINGLES	264	12.19/30.13
13 TO 18, 29 TO 45, 76 TO 86, 131 TO 166, 339 TO 414	SEMI-DETACHED	282	6.93/17.12
415 TO 417	PARK AND OPEN SPACE		1.92/4.75
418 TO 423	WALKWAY		0.14/0.36
424 TO 426	STREET WIDENING		0.14/0.36
STREETS			7.58/18.73
TOTAL		546	28.90/71.45

INFORMATION: REQUIRED UNDER SECTION 51 (17) OF THE PLANNING ACT R.S.O. 1990

a. SEE PLAN
b. SEE PLAN
c. SEE PLAN
d. SEE PROPOSED LAND USE SCHEDULE (ABOVE)
e. SEE PLAN
f. SEE PLAN
g. SEE PLAN
h. CITY WATER AVAILABLE \ WELL
i. SEE SOIL REPORT
j. SEE TOPOGRAPHICAL INFORMATION
k. ALL CITY SERVICES AVAILABLE
l. NO EASEMENTS REGISTERED ON TITLE

Stantec Geomatics Ltd.
Ontario Land Surveyors
Canada Lands Surveyors
Stantec
1331 CLYDE AVENUE, SUITE 400, OTTAWA, ON. K2C 3G4
PHONE (613)722-4420 FAX (613)722-2799
brian.webster@stantec.com
stantec.com

DRAWN BY:CEC	CHECKED BY:	PM: FP	FIELD: N/A	PROJECT No.: 161612417-131

From:	Jim Moffatt
To:	Kilborn, Kris
Cc:	"ccollins@thomascavanagh.ca"
Subject:	RE: Cope Drive Fernbank Community
Date:	Wednesday, August 22, 2018 1:59:49 PM

See below answers in red. Let me know about the meeting. Pierre is also interested in attending and he is good for the times mentioned.

Jim Moffatt

Associate | Manager, Land Engineering

Please note that our phone extensions have been updated. New extensions effective June 20, 2018.

IBI GROUP
400-333 Preston Street
Ottawa ON K1S 5N4 Canada
tel +1 613 225 1311 ext 64043 fax +1 613 225 9868

Logo

From: Kilborn, Kris [mailto:kris.kilborn@stantec.com]
Sent: Wednesday, August 22, 2018 12:15 PM
To: Jim Moffatt <jmoffatt@IBIGroup.com>
Cc: 'ccollins@thomascavanagh.ca' <ccollins@thomascavanagh.ca>
Subject: Cope Drive Fernbank Community

Good afternoon Jim

Wondering if you could provide me with any Design drawings for sanitary sewer extension along Cope Drive heading westerly from Goldhawk Drive. These are not done. No immediate timeline from CRT for this design
If nothing is designed, could you provide me with the design invert elevation for the 600 stub for the future development. The stub elevation is 100.65m and the design slope is 0.25%
As per my voice message, Cavanagh is looking to set up a meeting to discuss timing of CRT development, Design and approval of CRT future lands along Cope Drive as they require the Sanitary sewer for development of their lands abutting Shea and Fernbank. Am available to meet Thursday (tomorrow) 10:00am to 2:00pm: Friday and Monday all day after 10:00am and Tuesday before 2:00pm

In addition could you provide me with the cross section that you were utilizing for Cope Drive within CRT designed area. Will forward separately.

Please give me a call at your earliest convenience.

Kris Kilborn

Senior Associate, Community Development,
Business Center Sector Leader (BCSL)

Direct: 613 724-4337
Mobile: 613 297-0571
Fax: 613 722-2799
kris.kilborn@stantec.com

Stantec
400 - 1331 Clyde Avenue
Ottawa ON K2C 3G4 CA

Appendix C STORMWATER MANAGEMENT CALCULATIONS

C.1 CONCEPTUAL STORM SEWER DESIGN SHEET

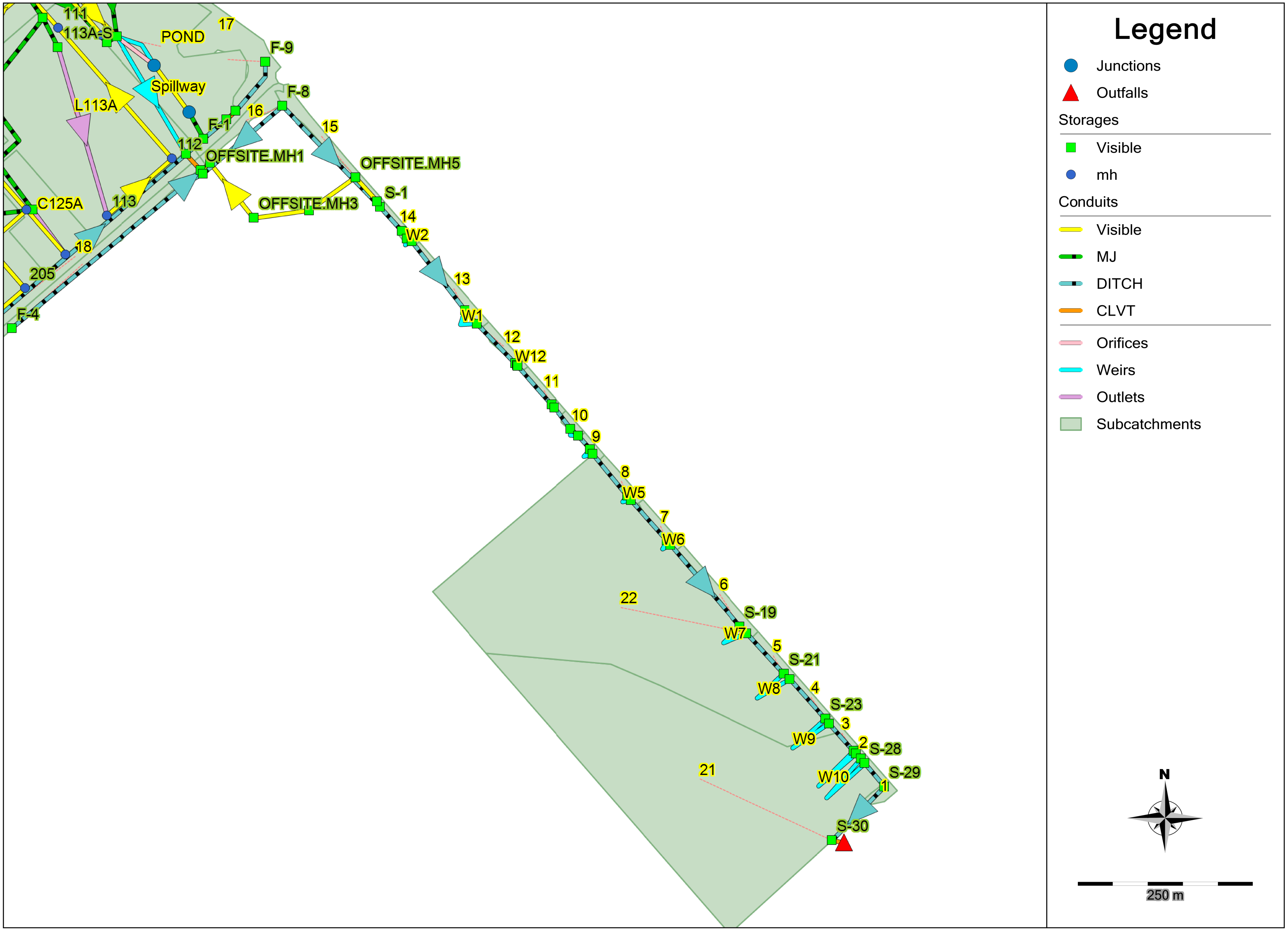
Stantec

SHEA ROAD LANDS		STORM SEWER DESIGN SHEET (City of Ottawa)	DESIGN PARAMETERS
DATE:	2018-10-11		I = a / (t+b)^{c} (As per City of Ottawa Guidelines, 2012)
REVISION:	1		
DESIGNED BY:	WAJ	FILE NUMBER: 160400900	
CHECKED BY:	AMP		

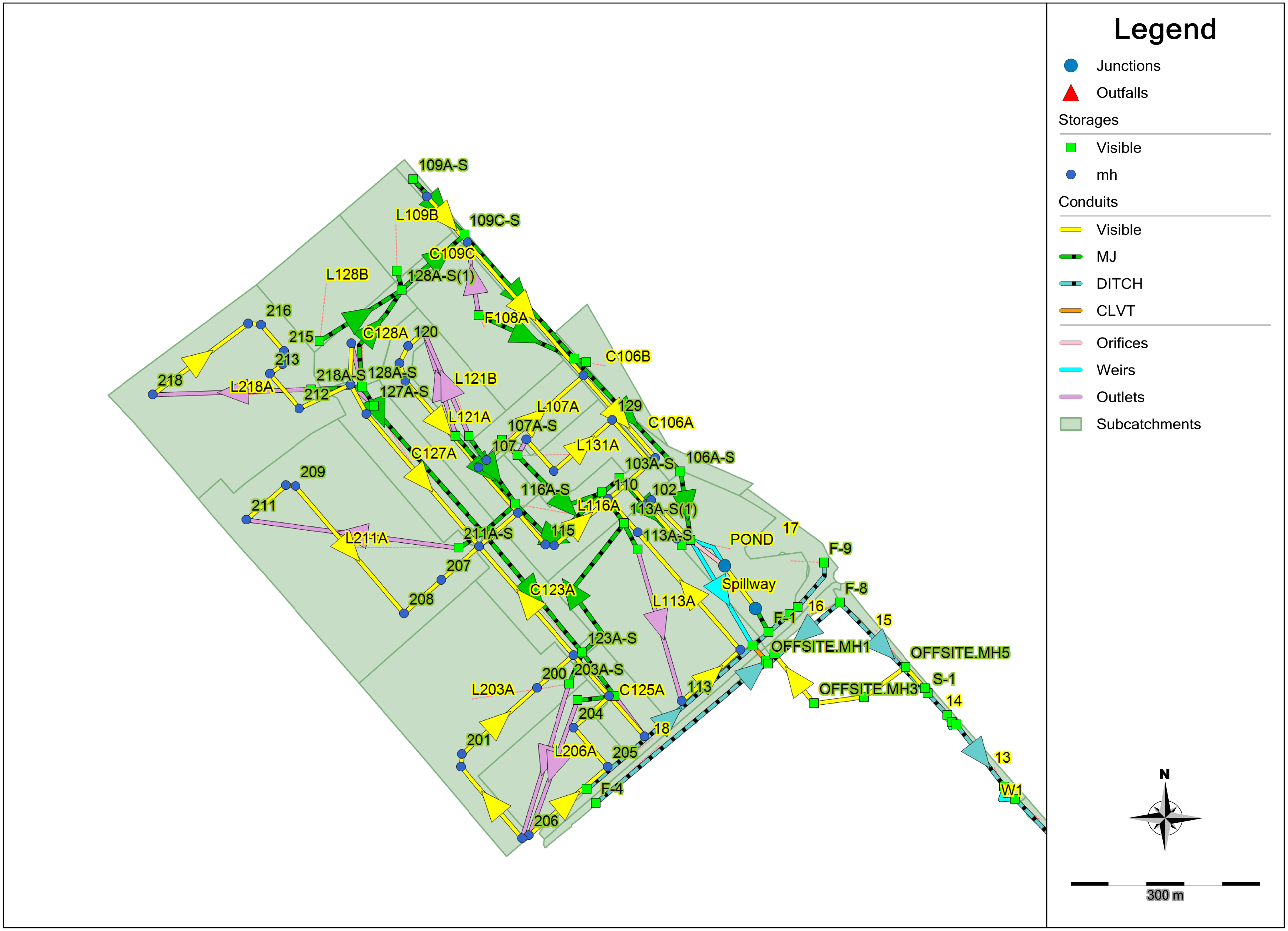
	1:2 yr	1:5 yr	1:10 yr	1:100 yr				
a =	732.951	998.071	1174.184	1735.688	MANNING'S n =	0.013	BEDDING CLASS =	B
b =	6.199	6.053	6.014	6.014	MINIMUM COVER:	2.00	m	
c =	0.810	0.814	0.816	0.820	TIME OF ENTRY	10	min	

LOCATION			DRAINAGE AREA																									PIPE SELECTION											
AREA ID NUMBER	FROM M.H.	TO M.H.	AREA (2-YEAR) (ha)	AREA (5-YEAR) (ha)	AREA (10-YEAR) (ha)	AREA (100-YEAR) (ha)	AREA (ROOF) (ha)	C (2-YEAR) (-)	C (5-YEAR) (-)	C (10-YEAR) (-)	C (100-YEAR) (-)	A x C (2-YEAR) (ha)	ACCUM AxC (2YR) (ha)	A x C (5-YEAR) (ha)	ACCUM. AxC (5YR) (ha)	A x C (10-YEAR) (ha)	ACCUM. AxC (10YR) (ha)	A x C (100-YEAR) (ha)	ACCUM. AxC (100YR) (ha)	T of C (min)	$I_{2\text{-YEAR}}$ (mm/h)	$I_{5\text{-YEAR}}$ (mm/h)	$I_{10\text{-YEAR}}$ (mm/h)	$I_{100\text{-YEAR}}$ (mm/h)	$Q_{CONTROL}$ (L/s)	ACCUM. $Q_{CONTROL}$ (L/s)	Q_{ACT} (CIA/360) (L/s)	LENGTH (m)	PIPE WIDTH OR DIAMETE (mm)	PIPE HEIGHT (mm)	PIPE SHAPE (-)	MATERIAL (-)	CLASS (-)	SLOPE %	Q_{CAP} (FULL) (L/s)	% FULL (-)	VEL. (FULL) (m/s)	VEL. (ACT) (m/s)	TIME OF FLOW (min)
C128A, L128B	128	127	2.39	1.29	0.00	0.00	0.00	0.25	0.61	0.00	0.00	0.597	0.597	0.789	0.789	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	355.7	65.2	525	525	CIRCULAR	CONCRETE	-	0.80	401.3	**88.64%**	1.80	1.82	0.60
																				10.60																			
Tartan Area L218A - Future storm sewers, not part of proposed development	218	217	6.70	0.00	0.00	0.00	0.00	0.59	0.00	0.00	0.00	3.954	3.954	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	843.7	188.6	1050	1050	CIRCULAR	CONCRETE	-	0.15	1103.3	**76.47%**	1.23	1.20	2.61
	217	216	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	3.954	0.000	0.000	0.000	0.000	0.000	0.000	12.61	68.04	92.15	107.96	157.73	0.0	0.0	747.4	19.8	1050	1050	CIRCULAR	CONCRETE	-	0.15	1103.4	**67.73%**	1.23	1.16	0.29
	216	215	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	3.954	0.000	0.000	0.000	0.000	0.000	0.000	12.90	67.21	91.02	106.63	155.78	0.0	0.0	738.3	55.6	1050	1050	CIRCULAR	CONCRETE	-	0.15	1103.3	**66.92%**	1.23	1.16	0.80
	215	214	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	3.954	0.000	0.000	0.000	0.000	0.000	0.000	13.70	65.01	88.00	103.08	150.57	0.0	0.0	714.1	21.2	1050	1050	CIRCULAR	CONCRETE	-	0.15	1103.4	**64.72%**	1.23	1.14	0.31
	214	213	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	3.954	0.000	0.000	0.000	0.000	0.000	0.000	14.01	64.21	86.90	101.78	148.66	0.0	0.0	705.3	25.1	1050	1050	CIRCULAR	CONCRETE	-	0.15	1103.3	**63.92%**	1.23	1.14	0.37
	213	212	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	3.954	0.000	0.000	0.000	0.000	0.000	0.000	14.38	63.28	85.62	100.28	146.46	0.0	0.0	695.0	72.8	1050	1050	CIRCULAR	CONCRETE	-	0.15	1103.3	**63.00%**	1.23	1.13	1.07
	212	127	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	3.954	0.000	0.000	0.000	0.000	0.000	0.000	15.45	60.72	82.12	96.17	140.42	0.0	0.0	667.0	89.3	1050	1050	CIRCULAR	CONCRETE	-	0.15	1103.3	**60.45%**	1.23	1.12	1.33
																				16.78																			
C127A	127	126	0.00	2.52	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.000	4.551	1.540	2.329	0.000	0.000	0.000	0.000	16.78	57.86	78.22	91.57	133.68	0.0	0.0	1237.5	53.8	1050	1050	CIRCULAR	CONCRETE	-	0.30	1560.4	**79.30%**	1.75	1.72	0.52
	126	122	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	4.551	0.000	2.329	0.000	0.000	0.000	0.000	17.30	56.82	76.79	89.90	131.22	0.0	0.0	1215.1	274.5	1200	1200	CIRCULAR	CONCRETE	-	0.15	1575.3	**77.14%**	1.35	1.31	3.48
																				20.78																			
C125A	125	124	0.00	1.10	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.000	0.000	0.671	0.671	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	194.2	85.1	600	600	CIRCULAR	CONCRETE	-	0.15	248.1	**78.28%**	0.85	0.83	1.70
																				11.70																			
Tartan Area L206A - Future storm sewers, not part of proposed development	206	205	2.68	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00	1.636	1.636	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	348.9	164.8	750	750	CIRCULAR	CONCRETE	-	0.15	449.8	**77.57%**	0.99	0.96	2.86
	205	204	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	1.636	0.000	0.000	0.000	0.000	0.000	0.000	12.86	67.33	91.18	106.81	156.05	0.0	0.0	305.9	82.2	750	750	CIRCULAR	CONCRETE	-	0.15	449.8	**68.00%**	0.99	0.92	1.48
	204	124	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	1.636	0.000	0.000	0.000	0.000	0.000	0.000	14.34	63.36	85.74	100.42	146.66	0.0	0.0	287.9	75.0	750	750	CIRCULAR	CONCRETE	-	0.15	449.8	**64.00%**	0.99	0.91	1.37
																				15.72																			
	124	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	1.636	0.000	0.671	0.000	0.000	0.000	0.000	15.72	60.13	81.31	95.21	139.02	0.0	0.0	424.7	85.9	825	825	CIRCULAR	CONCRETE	-	0.15	580.0	**73.23%**	1.05	1.01	1.42
																				17.13																			
Tartan Area L203A - Future storm sewers, not part of proposed development	203	202	6.66	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00	4.061	4.061	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	866.4	148.5	1050	1050	CIRCULAR	CONCRETE	-	0.15	1103.3	**78.53%**	1.23	1.21	2.05
	202	201	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	4.061	0.000	0.000	0.000	0.000	0.000	0.000	12.05	69.75	94.50	110.73	161.79	0.0	0.0	786.8	20.3	1050	1050	CIRCULAR	CONCRETE	-	0.15	1103.4	**71.31%**	1.23	1.17	0.29
	201	200	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	4.061	0.000	0.000	0.000	0.000	0.000	0.000	12.34	68.87	93.29	109.30	159.70	0.0	0.0	776.9	158.6	1050	1050	CIRCULAR	CONCRETE	-	0.15	1103.3	**70.41%**	1.23	1.17	2.26
	200	123	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	4.061	0.000	0.000	0.000	0.000	0.000	0.000	14.59	62.75	84.90	99.43	145.21	0.0	0.0	707.8	77.8	1050	1050	CIRCULAR	CONCRETE	-	0.15	1103.3	**64.16%**	1.23	1.14	1.14
																				15.73																			
C123A	123	122	0.00	1.66	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.000	5.697	1.014	1.685	0.000	0.000	0.000	0.000	17.13	57.15	77.24	90.43	132.00	0.0	0.0	1266.0	227.9	1350	1350	CIRCULAR	CONCRETE	-	0.10	1760.8	**71.90%**	1.19	1.14	3.34
																				20.47																			
Tartan Area L211A - Future storm sewers, not part of proposed development	211	210	9.08	0.00	0.00	0.00	0.00	0.55	0.00	0.00	0.00	4.997	4.997	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	1066.0	83.0	1200	1200	CIRCULAR	CONCRETE	-	0.10	1286.2	**82.88%**	1.10	1.10	1.26
	210	209	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	4.997	0.000	0.000	0.000	0.000	0.000	0.000	11.26	72.28	97.97	114.82	167.80	0.0	0.0	1003.2	15.6	1200	1200	CIRCULAR	CONCRETE	-	0.10	1286.2	**78.00%**	1.10	1.08	0.24
	209	208	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	4.997	0.000	0.000	0.000	0.000	0.000	0.000	11.50	71.49	96.88	113.53	165.91	0.0	0.0	992.2	264.0	1200	1200	CIRCULAR	CONCRETE	-	0.10	1286.2	**77.14%**	1.10	1.07	4.10
	208	207	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	4.997	0.000	0.000	0.000	0.000	0.000	0.000	15.60	60.38	81.66	95.62	139.62	0.0	0.0	838.1	79.1	1200	1200	CIRCULAR	CONCRETE	-	0.10	1286.2	**65.16%**	1.10	1.02	1.29
	207	122	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	4.997	0.000	0.000	0.000	0.000	0.000	0.000	16.89	57.64	77.91	91.21	133.15	0.0	0.0	800.0	79.9	1200	1200	CIRCULAR	CONCRETE	-	0.10	1286.2	**62.20%**	1.10	1.01	1.32
																				18.21																			
	122	116	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	15.244	0.000	4.014	0.000	0.000	0.000	0.000	20.78	50.81	68.58	80.25	117.07	0.0	0.0	2916.1	81.0	1800	1800	CIRCULAR	CONCRETE	-	0.10	3792.1	**76.90%**	1.44	1.41	0.96
																				21.74																			
L121B, L121A	121	120	3.45	0.00	0.00	0.00	0.00	0.48	0.00	0.00	0.00	1.642	1.642	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	350.2	33.1	750	750	CIRCULAR	CONCRETE	-	0.15	449.8	**77.86%**	0.99	0.97	0.57
	120	119	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	1.642	0.000	0.000	0.000	0.000	0.000	0.000	10.57	74.68	101.27	118.70	173.51	0.0	0.0	340.6	29.9	750	750	CIRCULAR	CONCRETE	-	0.15	449.8	**75.71%**	0.99	0.95	0.52
	119	118	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	1.642	0.000	0.000	0.000	0.000	0.000	0.000	11.09	72.85	98.76	115.74	169.15	0.0	0.0	332.2	29.9	750	750	CIRCULAR	CONCRETE	-	0.15	449.8	**73.85%**	0.99	0.95	0.53
	118	117	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	1.642	0.000	0.000	0.000	0.000	0.000	0.000	11.62	71.10	96.36	112.91	165.01	0.0	0.0	324.2	179.3	750	750	CIRCULAR	CONCRETE	-	0.15	449.8	**72.08%**	0.99	0.94	3.17
	117	116	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	1.642	0.000	0.000	0.000	0.000	0.000	0.000	14.79	62.27	84.25	98.66	144.08	0.0	0.0	284.0	95.0	750	750	CIRCULAR	CONCRETE	-	0.15	449.8	**63.13%**	0.99	0.90	1.75
																				16.54																			
L116A	116	115	2.33	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00	1.419	18.305	0.000	4.014	0.000	0.000	0.000	0.000	21.74	49.39	66.64	77.97	113.74	0.0	0.0	3254.3	66.0	1800	1800	CIRCULAR	CONCRETE	-	0.10	3792.1	**85.82%**	1.44	1.45	0.76
	115	114	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	18.305	0.000	4.014	0.000	0.000	0.000	0.000	22.50	48.33	65.20	76.28	111.26	0.0	0.0	3184.4	14.9	1950	1950	CIRCULAR	CONCRETE	-	0.10	4694.4	**67.83%**	1.52	1.43	0.17
	114	110	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	18.305	0.000	4.014	0.000	0.000	0.000	0.000	22.67	48.09	64.88	75.90	110.70	0.0	0.0	3168.8	113.3	1950	1950	CIRCULAR	CONCRETE	-	0.10	4694.4	**67.50%**	1.52	1.43	1.33
																				24.00																			
L113A	113	112	5.65	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00	3.447	3.447	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	735.3	123.5	825	825	CIRCULAR	CONCRETE	-	0.30	820.2	**89.65%**	1.49	1.52	1.36
	112	111	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	3.447	0.000	0.000	0.000	0.000	0.000	0.000	11.36	71.96	97.53	114.30	167.04	0.0	0.0	688.9	247.0	825	825	CIRCULAR	CONCRETE	-	0.30	820.2	**83.99%**	1.49	1.49	2.77
	111	110	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	3.447	0.000	0.000	0.000	0.000	0.000	0.000	14.12	63.92	86.50	101.32	147.98	0.0	0.0	611.9	70.7	825	825	CIRCULAR	CONCRETE	-	0.30	820.2	**74.61%**	1.49	1.44	0.82
																				14.94																			
	110	103	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	21.751	0.000	4.014	0.000	0.000	0.000	0.000	24.00	46.38	62.54	73.16	106.68	0.0	0.0	3499.5	40.0	2100	2100	CIRCULAR	CONCRETE	-	0.10	5720.2	**61.18%**	1.60	1.45	0.46
																				24.46																			
C109A, C109C, L109B	109	108	1.61	0.87	0.00	0.00	0.00	0.25	0.65	0.00	0.00	0.402	0.402	0.567	0.567	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	250.1	97.6	675	675	CIRCULAR	CONCRETE	-	0.12	303.8	**82.32%**	0.82	0.82	1.99
F108A	108	106	0.00	2.95	0.00	0.00	0.00	0.00	0.70	0.00	0.00	0.000	0.402	2.065	2.632	0.000	0.000	0.000	0.000	11.99	69.94	94.76	111.03	162.24	0.0	0.0	771.1	279.7	1200	1200	CIRCULAR	CONCRETE	-	0.12	1409.0	**54.73%**	1.21	1.06	4.40
																				16.38																			
L107A	107	106	1.46	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00	0.892	0.892	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	190.4	204.0	900	900	CIRCULAR	CONCRETE	-	0.10	597.2	**31.88%**	0.91	0.68	4.99
																				14.99																			
C106B, C106A	106	105	0.00	1.97	0.00	0.00	0.00	0.00	0.58	0.00	0.00	0.000	1.295	1.136	3.769	0.000	0.000	0.000	0.000	16.38	58.69	79.35	92.90	135.63	0.0	0.0	1041.7	172.5	1350	1350	CIRCULAR	CONCRETE	-	0.10	1760.8	**59.16%**	1.19	1.07	2.68
	105	104	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	1.295	0.000	3.769	0.000	0.000	0.000	0.000	19.06	53.60	72.39	84.72	123.63	0.0	0.0	950.6	11.1	1350	1350	CIRCULAR	CONCRETE	-	0.10	1760.8	**53.98%**	1.19	1.05	0.18
																				19.23																			
L131A	131	130	1.64	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00	0.999	0.999	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	0.0	0.0	213.1	66.3	525	525	CIRCULAR	CONCRETE	-	0.30	245.7	**86.72%**	1.10	1.11	1.00
	130	129	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.999	0.000	0.000	0.000	0.000	0.000	0.000	11.00	73.17	99.20	116.26	169.92	0.0	0.0	203.0	123.0	525	525	CIRCULAR	CONCRETE	-	0.30	245.7	**82.61%**	1.10	1.10	1.87
	129	104	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.999	0.000	0.000	0.000	0.000	0.000	0.000	12.87	67.30	91.14	106.77	155.98	0.0	0.0	186.7	89.6	525	525	CIRCULAR	CONCRETE	-	0.30	245.7	**75.98%**	1.10	1.06	1.40
																				14.27																			
	104	103	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	2.294	0.000	3.769	0.000	0.000	0.000	0.000	19.23	53.30	71.98	84.24	122.93	0.0	0.0	1093.1	47.5	1350	1350	CIRCULAR	CONCRETE	-	0.10	1751.6	**62.41%**	1.19	1.09	0.73
																				19.96																			
	103	102	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	24.045	0.000	7.783	0.000	0.000	0.000	0.000	24.46	45.81	61.78	72.26	105.36	0.0	0.0	4395.5	46.0	2100	2100	CIRCULAR	CONCRETE	-	0.12	6312.8	**69.63%**	1.77	1.66	0.46
																				24.92																			
Forebay Inlet (sized for 25mm)	102	101	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	24.92	45.26	61.03	71.38	104.07	3672.8	3672.8	3672.8	9.9	1500	1500	CIRCULAR	CONCRETE	-	0.26	3784.9	**97.04%**	2.07	2.16	0.08
	101	100	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	24.99	45.17	60.91	71.24	103.86	0.0	3672.8	3672.8	21.5	1500	1500	CIRCULAR	CONCRETE	-	0.26	3760.8	**97.66%**	2.06	2.15	0.17
																				25.16									1500	1500									
Bypass Inlet (Sized for 100-yr Minor System Capture in Excess of Forebay Inlet Capture)	102	100B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	24.92	45.26	61.03	71.38	104.07	3240.9	3240.9	3240.9	72.8	2400	1200	RECTANGULAR	CONCRETE	-	0.30	6587.4	**49.20%**	2.29	1.94	0.63
	100B	100A	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	25.54	44.54	60.04	70.22	102.38	0.0	3240.9	3240.9	18.5	2400	1200	RECTANGULAR	CONCRETE	-	0.50	8476.0	**38.24%**	2.94	2.32	0.13
																				25.68									2400	1200									
SWM Pond Outlet Pipe (Sized for maximum allowable release rate)	150	150B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	10.00	76.81	104.19	122.14	178.56	900.0	900.0	900.0	21.4	975	975	CIRCULAR	CONCRETE	-	0.20	1036.6	**86.82%**	1.34	1.36	0.26
																				10.26									975	975									

C.2 PCSWMM LAYOUT



111
113A-S
POND
17
F-9
Spillway
F-8
L113A
16
F-1
15
112
OFFSITE.MH1
OFFSITE.MH5
S-1
C125A
113
OFFSITE.MH3
14
W2
18
205
13
F-4
W1
12
W12
11
10
9
8
W5
7
W6
6
22
S-19
W7
5
S-21
W8
4
S-23
3
W9
2
S-28
21
W10
S-29
1
S-30
Legend
Junctions
Outfalls
Storages
Visible
mh
Conduits
Visible
MJ
DITCH
CLVT
Orifices
Weirs
Outlets
Subcatchments
N
250 m



Legend
Junctions
Outfalls
Storages
Visible
mh
Conduits
Visible
MJ
DITCH
CLVT
Orifices
Weirs
Outlets
Subcatchments
N
300 m
109A-S
L109B
109C-S
C109C
128A-S(1)
L128B
F108A
216
215
C128A
120
213
218
L218A
218A-S
128A-S
212
127A-S
L121B
C106B
L121A
L107A
129
C106A
107A-S
107
L131A
C127A
106A-S
103A-S
110
102
116A-S
L116A
113A-S(1)
209
211
L211A
211A-S
115
113A-S
POND
17
F-9
207
Spillway
208
C123A
F-8
L113A
16
F-1
15
123A-S
OFFSITE.MH1
OFFSITE.MH5
200
203A-S
S-1
L203A
C125A
113
OFFSITE.MH3
14
204
18
201
L206A
205
13
F-4
W1
206

C.3 POST DEVELOPMENT PCSWMM MODEL INPUT EXAMPLE

```
[TITLE]


[OPTIONS]
;;Options            Value
;;------------------ ------------
FLOW_UNITS           LPS
INFILTRATION         HORTON
FLOW_ROUTING         DYNWAVE
START_DATE           11/17/2017
START_TIME           00:00:00
REPORT_START_DATE    11/17/2017
REPORT_START_TIME    00:00:00
END_DATE             11/19/2017
END_TIME             00:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:01:00
WET_STEP             00:05:00
DRY_STEP             00:05:00
ROUTING_STEP         10
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         ELEVATION
MIN_SLOPE            0
MAX_TRIALS           8
HEAD_TOLERANCE       0.0015
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              4

[EVAPORATION]
;;Type          Parameters
;;------------- ----------
CONSTANT     0.0
DRY_ONLY     NO

[RAINGAGES]
;;               Rain      Time   Snow   Data
;;Name           Type      Intrvl Catch  Source
;;-------------- --------- ------ ------ ----------
RG1              INTENSITY 0:10   1.0    TIMESERIES 100yr_3hr_Chicago_Ottawa

[SUBCATCHMENTS]
;;                                                Total    Pcnt.             Pcnt.
  Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope
  Length   Pack
;;-------------- ---------------- ---------------- -------- -------- -------- --------
-------- -------- --------
;0.46
1                RG1              S-29             0.128237 37.143   84.9     2
  0
;0.41
10               RG1              S-11             0.055757 30       40.7     2
```

```
 0
;0.41
11          RG1         S-9         0.086428 30      83.1    2
 0
;0.41
12          RG1         S-6         0.112653 30      83.9    2
 0
;0.41
13          RG1         S-5         0.188556 30      150.8   2
 0
;0.41
14          RG1         S-2         0.081117 30      75.2    2
 0
;0.49
15          RG1         S-1         0.288332 41.429  213.3   2
 0
;0.53
16          RG1         F-8         0.252825 47.143  148     2
 0
;0.53
17          RG1         F-9         1.183028 47.143  346.7   1
 0
;0.47
18          RG1         F-10        0.757785 38.571  463     2
 0
;0.47
19          RG1         F-4         0.619363 38.571  468.3   2
 0
;0.41
2           RG1         S-27        0.015479 30      17.1    2
 0
;0.2
21          RG1         S-30        9.799874 0       2205    0.5
 0
;0.2
22          RG1         S-20        9.497755 0       2138    0.5
 0
;0.41
3           RG1         S-25        0.059797 30      55.9    2
 0
;0.41
4           RG1         S-23        0.069436 30      76.1    2
 0
;0.41
5           RG1         S-21        0.100617 30      80.6    2
 0
;0.41
6           RG1         S-19        0.205038 30      164.3   2
 0
;0.41
7           RG1         S-17        0.108557 30      86.2    2
 0
;0.41
8           RG1         S-15        0.107641 30      82.2    2
 0
;0.41
9           RG1         S-13        0.044049 30      42.8    2
 0
;0.65
C106A       RG1         106A-S(1)   1.009102 64.28   292     1
 0
;0.20
C106B       RG1         106B-S      0.960483 42.857  241     1
```

```
  0
;0.65
C109A            RG1              109A-S           0.58286  64.286   362      1
  0
C109C            RG1              109C-S           0.28776  64.286   118      0.5
  0
;0.61
C123A            RG1              123A-S           1.663001 58.571   567      1
  0
;0.61
C125A            RG1              125A-S           1.10323  58.571   248      1
  0
;0.61
C127A            RG1              127A-S           2.523952 58.571   656      1
  0
;0.61
C128A            RG1              128A-S           1.293885 58.6     315      1
  0
;0.70
F108A            RG1              108A-S           2.951249 71.429   664      2
  0
;0.61
L107A            RG1              107A-S           1.463098 58.571   392      1
  0
;PARK
L109B            RG1              109B-S           1.609925 7.1      116      2
  0
;0.61
L113A            RG1              113A-S           5.649987 58.571   1952     1
  0
;0.61
L116A            RG1              116A-S           2.326564 58.571   566      1
  0
;0.61
L121A            RG1              121A-S           2.161796 58.571   494      1
  0
;0.25
L121B            RG1              121B-S           1.291788 7.143    291      1
  0
;PARK
L128B            RG1              128B-S           2.3862   7.143    167      2
  0
;0.61
L131A            RG1              131A-S           1.6374   58.571   492      1
  0
;0.61
L203A            RG1              203A-S           6.657404 58.571   1974     1
  0
;0.61
L206A            RG1              206A-S           2.681205 58.571   939      1
  0
;0.55
L211A            RG1              211A-S           9.084765 50       2655     1
  0
;0.59
L218A            RG1              218A-S           6.702376 55.714   2358     1
  0
;0.48
POND             RG1              POND-S           3.145486 40       280      2
  0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo
```

```
PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ----------
----------
1                0.013      0.25       1.57       4.67       0          PERVIOUS
100
10               0.013      0.25       1.57       4.67       0          PERVIOUS
100
11               0.013      0.25       1.57       4.67       0          PERVIOUS
100
12               0.013      0.25       1.57       4.67       0          PERVIOUS
100
13               0.013      0.25       1.57       4.67       0          PERVIOUS
100
14               0.013      0.25       1.57       4.67       0          PERVIOUS
100
15               0.013      0.25       1.57       4.67       0          PERVIOUS
100
16               0.013      0.25       1.57       4.67       0          PERVIOUS
100
17               0.013      0.25       1.57       4.67       0          PERVIOUS
100
18               0.013      0.25       1.57       4.67       0          PERVIOUS
100
19               0.013      0.25       1.57       4.67       0          PERVIOUS
100
2                0.013      0.25       1.57       4.67       0          PERVIOUS
100
21               0.013      0.25       1.57       4.67       0          PERVIOUS
100
22               0.013      0.25       1.57       4.67       0          PERVIOUS
100
3                0.013      0.25       1.57       4.67       0          PERVIOUS
100
4                0.013      0.25       1.57       4.67       0          PERVIOUS
100
5                0.013      0.25       1.57       4.67       0          PERVIOUS
100
6                0.013      0.25       1.57       4.67       0          PERVIOUS
100
7                0.013      0.25       1.57       4.67       0          PERVIOUS
100
8                0.013      0.25       1.57       4.67       0          PERVIOUS
100
9                0.013      0.25       1.57       4.67       0          PERVIOUS
100
C106A            0.013      0.25       1.57       4.67       0          OUTLET
C106B            0.013      0.25       1.57       4.67       0          OUTLET
C109A            0.013      0.25       1.57       4.67       0          OUTLET
C109C            0.013      0.25       1.57       4.67       0          OUTLET
C123A            0.013      0.25       1.57       4.67       0          OUTLET
C125A            0.013      0.25       1.57       4.67       0          OUTLET
C127A            0.013      0.25       1.57       4.67       0          OUTLET
C128A            0.013      0.25       1.57       4.67       0          OUTLET
F108A            0.013      0.25       1.57       4.67       0          OUTLET
L107A            0.013      0.25       1.57       4.67       0          OUTLET
L109B            0.013      0.25       1.57       4.67       0          PERVIOUS
100
L113A            0.013      0.25       1.57       4.67       0          OUTLET
L116A            0.013      0.25       1.57       4.67       0          OUTLET
L121A            0.013      0.25       1.57       4.67       0          OUTLET
L121B            0.013      0.25       1.57       4.67       0          PERVIOUS
100
L128B            0.013      0.25       1.57       4.67       0          PERVIOUS
```

```
100
L131A           0.013      0.25       1.57       4.67       0          OUTLET
L203A           0.013      0.25       1.57       4.67       0          OUTLET
L206A           0.013      0.25       1.57       4.67       0          OUTLET
L211A           0.013      0.25       1.57       4.67       0          OUTLET
L218A           0.013      0.25       1.57       4.67       0          OUTLET
POND            0.013      0.25       1.57       4.67       0          OUTLET

[INFILTRATION]
;;Subcatchment   MaxRate    MinRate    Decay      DryTime    MaxInfil
;;-------------- ---------- ---------- ---------- ---------- ----------
1               76.2       13.2       4.14       7          0
10              76.2       13.2       4.14       7          0
11              76.2       13.2       4.14       7          0
12              76.2       13.2       4.14       7          0
13              76.2       13.2       4.14       7          0
14              76.2       13.2       4.14       7          0
15              76.2       13.2       4.14       7          0
16              76.2       13.2       4.14       7          0
17              76.2       13.2       4.14       7          0
18              76.2       13.2       4.14       7          0
19              76.2       13.2       4.14       7          0
2               76.2       13.2       4.14       7          0
21              76.2       13.2       4.14       7          0
22              76.2       13.2       4.14       7          0
3               76.2       13.2       4.14       7          0
4               76.2       13.2       4.14       7          0
5               76.2       13.2       4.14       7          0
6               76.2       13.2       4.14       7          0
7               76.2       13.2       4.14       7          0
8               76.2       13.2       4.14       7          0
9               76.2       13.2       4.14       7          0
C106A           76.2       13.2       4.14       7          0
C106B           76.2       13.2       4.14       7          0
C109A           76.2       13.2       4.14       7          0
C109C           76.2       13.2       4.14       7          0
C123A           76.2       13.2       4.14       7          0
C125A           76.2       13.2       4.14       7          0
C127A           76.2       13.2       4.14       7          0
C128A           76.2       13.2       4.14       7          0
F108A           76.2       13.2       4.14       7          0
L107A           76.2       13.2       4.14       7          0
L109B           76.2       13.2       4.14       7          0
L113A           76.2       13.2       4.14       7          0
L116A           76.2       13.2       4.14       7          0
L121A           76.2       13.2       4.14       7          0
L121B           76.2       13.2       4.14       7          0
L128B           76.2       13.2       4.14       7          0
L131A           76.2       13.2       4.14       7          0
L203A           76.2       13.2       4.14       7          0
L206A           76.2       13.2       4.14       7          0
L211A           76.2       13.2       4.14       7          0
L218A           76.2       13.2       4.14       7          0
POND            76.2       13.2       4.14       7          0

[JUNCTIONS]
;;               Invert     Max.       Init.      Surcharge  Ponded
;;Name           Elev.      Depth      Depth      Depth      Area
;;-------------- ---------- ---------- ---------- ---------- ----------
105             106.281    3.899      0          0          0
HWL130B         105.7      2.3        0          0          0
outlet          105.55     2.2        0          0          0
```

```
[OUTFALLS]
;;                Invert     Outfall      Stage/Table      Tide
;;Name            Elev.      Type         Time Series      Gate Route To
;;--------------- ---------- ------------ ---------------- ---- ----------------
SU31              99.51      FREE                          NO

[STORAGE]
;;                Invert   Max.     Init.    Storage    Curve
Ponded   Evap.
;;Name            Elev.    Depth    Depth    Curve      Params
Area     Frac.     Infiltration parameters
;;--------------- -------- -------- -------- ---------- -------- -------- --------
-------- -------- -----------------------
100B              105.547  2.599    0        FUNCTIONAL 0        0        1.13     0
      0
101               105.308  3.142    0        FUNCTIONAL 0        0        1.13     0
      0
102               105.364  3.441    0        FUNCTIONAL 0        0        1.13     0
      0
102A-S(1)         107.5    0.7      0        FUNCTIONAL 0        0        0        0
      0
103               105.466  5.06     0        FUNCTIONAL 0        0        1.13     0
      0
103A-S            110.37   0.5      0        FUNCTIONAL 0        0        0        0
      0
104               106.267  4.094    0        FUNCTIONAL 0        0        1.13     0
      0
106               106.513  3.591    0        FUNCTIONAL 0        0        1.13     0
      0
106A-S            108.27   0.5      0        FUNCTIONAL 0        0        0        0
      0
106A-S(1)         108.57   2.15     0        FUNCTIONAL 0        0        0        0
      0
106B-S            108.77   2.15     0        FUNCTIONAL 0        0        0        0
      0
107               107.167  4.065    0        FUNCTIONAL 0        0        1.13     0
      0
107A-S            109.11   2.5      0        TABULAR    107A-S                     0
      0
108               106.999  4.111    0        FUNCTIONAL 0        0        1.13     0
      0
108A-S            108.32   2.5      0        TABULAR    108A-S                     0
      0
109               107.641  3.359    0        FUNCTIONAL 0        0        1.13     0
      0
109A-S            110.04   2.15     0        FUNCTIONAL 0        0        0        0
      0
109B-S            112.07   0.6      0        FUNCTIONAL 0        0        0        0
      0
109C-S            109.19   2.5      0        TABULAR    109C-S                     0
      0
110               105.57   4.894    0        FUNCTIONAL 0        0        1.13     0
      0
110A-S            110.47   0.35     0        FUNCTIONAL 0        0        0        0
      0
111               107.057  3.548    0        FUNCTIONAL 0        0        1.13     0
      0
112               107.807  3.745    0        FUNCTIONAL 0        0        1.13     0
      0
113               108.238  3.56     0        FUNCTIONAL 0        0        1.13     0
      0
113A-S            109.19   2.5      0        TABULAR    113A-S                     0
      0
```

113A-S(1)	108.53	2.5	0	TABULAR	113A-S			0	0
114	105.833	5.036	0	FUNCTIONAL	0	0	1.13	0	0
115	105.878	5.06	0	FUNCTIONAL	0	0	1.13	0	0
116	106.094	4.973	0	FUNCTIONAL	0	0	1.13	0	0
116A-S	108.76	2.5	0	TABULAR	116A-S			0	0
117	107.286	3.99	0	FUNCTIONAL	0	0	1.13	0	0
118	107.56	4.116	0	FUNCTIONAL	0	0	1.13	0	0
119	107.609	4.141	0	FUNCTIONAL	0	0	1.13	0	0
120	107.684	4.103	0	FUNCTIONAL	0	0	1.13	0	0
121	107.738	4.117	0	FUNCTIONAL	0	0	1.13	0	0
121A-S	109.58	2.5	0	TABULAR	121A-S			0	0
121B-S	109.3	2.4	0	FUNCTIONAL	0	0	0	0	0
122	106.235	5.781	0	FUNCTIONAL	0	0	1.13	0	0
122A-S	111.84	0.35	0	FUNCTIONAL	0	0	0	0	0
123	106.913	4.571	0	FUNCTIONAL	0	0	1.13	0	0
123A-S	109.21	2.5	0	TABULAR	123A-S			0	0
124	107.567	4.431	0	FUNCTIONAL	0	0	1.13	0	0
125	107.919	1.914	0	FUNCTIONAL	0	0	1.13	0	0
125A-S	110.04	2.15	0	FUNCTIONAL	0	0	0	0	0
126	107.247	5.291	0	FUNCTIONAL	0	0	1.13	0	0
127	107.558	5.445	0	FUNCTIONAL	0	0	1.13	0	0
127A-S	110.18	2.5	0	TABULAR	127A-S			0	0
128	108.605	3.985	0	FUNCTIONAL	0	0	1.13	0	0
128A-S	110.685	2.5	0	TABULAR	128A-S			0	0
128A-S(1)	111.875	0.35	0	FUNCTIONAL	0	0	0	0	0
128B-S	112.25	0.6	0	FUNCTIONAL	0	0	0	0	0
129	107.36	3.59	0	FUNCTIONAL	0	0	1.13	0	0
130	107.79	3.152	0	FUNCTIONAL	0	0	1.13	0	0
131	108.048	3.093	0	FUNCTIONAL	0	0	1.13	0	0
131A-S	108.9	2.5	0	TABULAR	131A-S			0	0
200	107.33	5.994	0	FUNCTIONAL	0	0	1.13	0	0
201	107.572	8.134	0	FUNCTIONAL	0	0	1.13	0	

```
      0
202               107.632  8.232    0        FUNCTIONAL 0        0        1.13     0
      0
203               107.885  8.901    0        FUNCTIONAL 0        0        1.13     0
      0
203A-S            109.31   2.5      0        TABULAR    203A-S                     0
      0
204               107.754  5.671    0        FUNCTIONAL 0        0        1.13     0
      0
205               107.938  8.601    0        FUNCTIONAL 0        0        1.13     0
      0
206               108.245  8.255    0        FUNCTIONAL 0        0        1.13
1.13     0
206A-S            109.79   2.5      0        TABULAR    206A-S                     0
      0
207               106.915  6.011    0        FUNCTIONAL 0        0        1.13     0
      0
208               106.997  6.703    0        FUNCTIONAL 0        0        1.13     0
      0
209               107.321  6.846    0        FUNCTIONAL 0        0        1.13     0
      0
210               107.367  6.754    0        FUNCTIONAL 0        0        1.13     0
      0
211               107.48   6.634    0        FUNCTIONAL 0        0        1.13     0
      0
211A-S            109.79   2.5      0        TABULAR    211A-S                     0
      0
212               107.752  5.557    0        FUNCTIONAL 0        0        1.13     0
      0
213               107.921  6.019    0        FUNCTIONAL 0        0        1.13     0
      0
214               108.019  5.733    0        FUNCTIONAL 0        0        1.13     0
      0
215               108.081  5.613    0        FUNCTIONAL 0        0        1.13     0
      0
216               108.194  4.968    0        FUNCTIONAL 0        0        1.13     0
      0
217               108.254  5.896    0        FUNCTIONAL 0        0        1.13     0
      0
218               108.566  5.634    0        FUNCTIONAL 0        0        1.13     0
      0
218A-S            110.79   2.5      0        TABULAR    218A-S                     0
      0
F-1               105.55   1.3      0        FUNCTIONAL 0        0        0        0
      0
F-10              112.25   0.75     0        FUNCTIONAL 0        0        0        0
      0
F-11              105.68   1        0        FUNCTIONAL 0        0        0        0
      0
F-12              105.64   0.97     0        FUNCTIONAL 0        0        0        0
      0
F-2               105.28   1.62     0        FUNCTIONAL 0        0        0        0
      0
F-4               112.23   0.66     0        FUNCTIONAL 0        0        0        0
      0
F-5               104.41   1.49     0        FUNCTIONAL 0        0        0        0
      0
F-8               106      0.23     0        FUNCTIONAL 0        0        0        0
      0
F-9               106.04   0.75     0        FUNCTIONAL 0        0        0        0
      0
OFFSITE.MH1       105.14   1.7      0        FUNCTIONAL 0        0        0        0
      0
```

OFFSITE.MH2	104.9	1.81	0	FUNCTIONAL	0	0	1.13	0	0
OFFSITE.MH3	104.5	1.94	0	FUNCTIONAL	0	0	1.13	0	0
OFFSITE.MH4	104.4	1.92	0	FUNCTIONAL	0	0	1.13	0	0
OFFSITE.MH5	104.2	2.85	0	FUNCTIONAL	0	0	1.13	0	0
OFFSITE.MH6	104.1	2.45	0	FUNCTIONAL	0	0	1.13	0	0
POND-S	104.25	3.5	1.5	TABULAR	POND			0	0
S-1	104.45	0.91	0	FUNCTIONAL	0	0	0	0	0
S-10	102.6	1.1	0	FUNCTIONAL	0	0	0	0	0
S-11	102.55	1.55	0	FUNCTIONAL	0	0	0	0	0
S-12	102.53	2.09	0	FUNCTIONAL	0	0	0	0	0
S-13	102.51	0.94	0	FUNCTIONAL	0	0	0	0	0
S-14	102.49	1.18	0	FUNCTIONAL	0	0	0	0	0
S-15	102.35	1	0	FUNCTIONAL	0	0	0	0	0
S-16	102.33	1.26	0	FUNCTIONAL	0	0	0	0	0
S-17	102.2	1.1	0	FUNCTIONAL	0	0	0	0	0
S-18	102.18	1.32	0	FUNCTIONAL	0	0	0	0	0
S-19	101.78	1.2	0	FUNCTIONAL	0	0	0	0	0
S-2	103.92	0.76	0	FUNCTIONAL	0	0	0	0	0
S-20	101.69	1.39	0	FUNCTIONAL	0	0	0	0	0
S-21	101.52	1.18	0	FUNCTIONAL	0	0	0	0	0
S-22	101.51	1.19	0	FUNCTIONAL	0	0	0	0	0
S-23	101.36	1.46	0	FUNCTIONAL	0	0	0	0	0
S-24	101.35	1.47	0	FUNCTIONAL	0	0	0	0	0
S-25	101.24	1.43	0	FUNCTIONAL	0	0	0	0	0
S-26	101.22	1.65	0	FUNCTIONAL	0	0	0	0	0
S-27	101.21	0.99	0	FUNCTIONAL	0	0	0	0	0
S-28	101.13	1.11	0	FUNCTIONAL	0	0	0	0	0
S-29	100.77	1.18	0	FUNCTIONAL	0	0	0	0	0
S-3	103.88	0.73	0	FUNCTIONAL	0	0	0	0	0
S-30	99.63	2.27	0	FUNCTIONAL	0	0	0	0	0
S-4	103.52	0.98	0	FUNCTIONAL	0	0	0	0	0
S-5	103.2	0.9	0	FUNCTIONAL	0	0	0	0	

```
      0
S-6              102.8    1.1      0        FUNCTIONAL 0        0        0        0
      0
S-7              102.7    1.08     0        FUNCTIONAL 0        0        0        0
      0
S-8              102.69   1.09     0        FUNCTIONAL 0        0        0        0
      0
S-9              102.61   1.09     0        FUNCTIONAL 0        0        0        0
      0
SU1              102.69   1.09     0        FUNCTIONAL 0        0        0        0
      0

[CONDUITS]
;;               Inlet            Outlet                      Manning    Inlet
Outlet     Init.      Max.
;;Name           Node             Node             Length     N          Offset
Offset     Flow       Flow
;;-------------- ---------------- ---------------- ---------- ---------- ----------
---------- ---------- ----------
101-100          101              POND-S           21.532     0.013      105.608
105.552    0          0
102-101          102              101              9.87       0.013      105.664
105.638    0          0
103-102          103              102              45.979     0.013      105.77
105.714    0          0
104-103          104              103              47.498     0.013      106.567
106.52     0          0
105-104          105              104              11.063     0.013      106.581
106.57     0          0
106-105          106              105              172.525    0.013      106.813
106.641    0          0
107-106          107              106              203.977    0.013      107.467
107.263    0          0
108-106          108              106              279.662    0.013      107.299
106.963    0          0
109-108          109              108              97.573     0.013      107.941
107.824    0          0
110-103          110              103              39.956     0.013      105.87
105.83     0          0
111-110          111              110              70.746     0.013      107.357
107.145    0          0
112-111          112              111              247.036    0.013      108.107
107.366    0          0
113-112          113              112              123.545    0.013      108.538
108.167    0          0
114-110          114              110              113.342    0.013      106.133
106.02     0          0
115-114          115              114              14.893     0.013      106.178
106.163    0          0
116-115          116              115              65.993     0.013      106.394
106.328    0          0
117-116          117              116              94.969     0.013      107.586
107.444    0          0
118-117          118              117              179.275    0.013      107.86
107.591    0          0
119-118          119              118              29.92      0.013      107.909
107.864    0          0
120-119          120              119              29.917     0.013      107.984
107.939    0          0
121-120          121              120              33.061     0.013      108.038
107.989    0          0
122-116          122              116              81         0.013      106.535
106.454    0          0
```

```
123-122            123              122              227.891     0.013      107.213
106.985     0          0
124-123            124              123              85.874      0.013      107.867
107.738     0          0
125-124            125              124              85.068      0.013      108.219
108.092     0          0
126-122            126              122              274.488     0.013      107.547
107.135     0          0
127-126            127              126              53.76       0.013      107.858
107.697     0          0
128-127            128              127              65.24       0.013      108.905
108.383     0          0
129-104            129              104              89.552      0.013      107.66
107.392     0          0
130-129            130              129              123         0.013      108.09
107.72      0          0
131-130            131              130              66.34       0.013      108.348
108.15      0          0
200-123            200              123              77.768      0.013      107.63
107.513     0          0
201-200            201              200              158.607     0.013      107.872
107.634     0          0
202-201            202              201              20.319      0.013      107.932
107.902     0          0
203-202            203              202              148.464     0.013      108.185
107.962     0          0
204-124            204              124              75.004      0.013      108.054
107.942     0          0
205-204            205              204              82.176      0.013      108.238
108.114     0          0
206-205            206              205              164.822     0.013      108.545
108.298     0          0
207-122            207              122              79.926      0.013      107.215
107.135     0          0
208-207            208              207              79.1        0.013      107.297
107.218     0          0
209-208            209              208              264.023     0.013      107.621
107.357     0          0
210-209            210              209              15.557      0.013      107.667
107.651     0          0
211-210            211              210              83.021      0.013      107.78
107.697     0          0
212-127            212              127              89.327      0.013      108.052
107.918     0          0
213-212            213              212              72.822      0.013      108.221
108.112     0          0
214-213            214              213              25.111      0.013      108.319
108.281     0          0
215-214            215              214              21.157      0.013      108.381
108.349     0          0
216-215            216              215              55.562      0.013      108.494
108.411     0          0
217-216            217              216              19.773      0.013      108.554
108.524     0          0
218-217            218              217              188.555     0.013      108.866
108.584     0          0
Bypass1            102              100B             72.8        0.013      106.5
106.28      0          0
Bypass2            100B             POND-S           18.5        0.01       105.85
105.75      0          0
C1                 128A-S           128A-S(1)        183.2       0.013      112.835
111.875     0          0
C10                122A-S           116A-S           76          0.013      111.84
```

						110.91	0	0
C11	122A-S	123A-S	230	0.013	111.84	111.36	0	0
C12	125A-S	123A-S	81	0.013	111.84	111.36	0	0
C13	203A-S	123A-S	20	0.013	111.46	111.36	0	0
C14	206A-S	125A-S	20	0.013	111.94	111.84	0	0
C15	HWL130B	F-1	17.5	0.035	105.7	105.55	0	0
C16	123A-S	113A-S(1)	300	0.013	111.36	110.63	0	0
C17	116A-S	110A-S	192	0.013	110.91	110.47	0	0
C18	121B-S	116A-S	2	0.025	111.1	111.06	0	0
C19	107A-S	131A-S	85	0.013	111.26	111.05	0	0
C2	121A-S	116A-S	402	0.013	111.73	110.91	0	0
C20	F-4	F-5	371	0.035	112.23	105.5	0	0
C21	106A-S	POND-S	20	0.013	108	107.44	0	0
C23	110A-S	103A-S	40	0.013	110.47	110.37	0	0
C24	113A-S(1)	110A-S	67	0.013	110.63	110.47	0	0
C25	102A-S(1)	POND-S	10	0.025	107.5	107.35	0	0
C26	103A-S	102A-S(1)	153	0.025	110.37	107.5	0	0
C27	128B-S	128A-S(1)	2	0.025	112.25	112.03	0	0
C28	109B-S	128A-S(1)	2	0.025	112.07	112.025	0	0
C29	106B-S	106A-S(1)	10	0.013	110.57	110.37	0	0
C3	128A-S(1)	109C-S	120	0.013	111.875	111.34	0	0
C30	109A-S	109C-S	50	0.013	111.84	111.34	0	0
C31	outlet	HWL130B	21.4	0.013	105.75	105.7	0	0
C32	F-1	F-2	30.3	0.035	105.55	105.33	0	0
C33	OFFSITE.MH1	OFFSITE.MH2	24	0.013	105.13	105.08	0	0
C34	OFFSITE.MH2	OFFSITE.MH3	138	0.013	105.07	104.81	0	0
C35	S-1	S-2	58	0.035	104.45	103.92	0	0
C36	S-2	S-3	12.7	0.035	103.92	103.88	0	0
C37	OFFSITE.MH3	OFFSITE.MH4	63	0.013	104.8	104.68	0	0
C38	S-4	S-5	120.6	0.035	103.52	103.2	0	0
C39	F-8	S-1	205	0.035	106	104.45	0	0
C4	109C-S	106A-S(1)	212	0.013	111.34	110.37	0	0

```
C40              F-10             F-2              362.7      0.035      112.25
105.28     0          0
C40_1            S-6              S-7              84.01      0.035      102.8
102.7      0          0
C40_2            SU1              S-9              80.4       0.035      102.69
102.61     0          0
C41              F-8              F-5              146.4      0.035      106
105.5      0          0
C42              S-10             S-11             37.6       0.035      102.6
102.55     0          0
C43              F-9              F-11             79.1       0.035      106.04
105.68     0          0
C44              S-12             S-13             27.5       0.035      102.53
102.51     0          0
C45              S-8              SU1              1          0.035      102.69
102.69     0          0
C46              S-14             S-15             75.2       0.035      102.49
102.35     0          0
C47              F-12             F-1              25         0.035      105.64
105.55     0          0
C48              S-16             S-17             76         0.035      102.33
102.2      0          0
C49              F-5              OFFSITE.MH1      3          0.035      105.15
105.14     0          0
C5               106A-S(1)        106A-S           350        0.013      110.37
108        0          0
C50              S-18             S-19             159.9      0.035      102.18
101.78     0          0
C51              OFFSITE.MH4      OFFSITE.MH5      74         0.013      104.67
104.54     0          0
C52              S-20             S-21             83.13      0.035      101.69
101.52     0          0
C53              OFFSITE.MH5      OFFSITE.MH6      48         0.013      104.53
104.46     0          0
C54              S-22             S-23             70.5       0.035      101.51
101.36     0          0
C55              OFFSITE.MH6      S-1              1          0.013      104.45
104.44     0          0
C56              S-24             S-25             53.5       0.035      101.35
101.24     0          0
C57              131A-S           110A-S           121        0.013      111.05
110.47     0          0
C58              S-26             S-27             8.3        0.035      101.22
101.21     0          0
C59              128A-S           127A-S           53         0.013      112.835
112.33     0          0
C6               108A-S           106A-S(1)        5          0.013      110.47
110.37     0          0
C60              S-28             S-29             48.8       0.035      101.13
100.77     0          0
C61              S-29             S-30             39.4       0.035      100.77
99.63      0          0
C62              113A-S           113A-S(1)        350        0.013      111.34
110.63     0          0
C7               218A-S           128A-S           20         0.013      112.94
112.835    0          0
C8               127A-S           122A-S           275        0.013      112.33
111.84     0          0
C9               211A-S           122A-S           20         0.013      111.94
111.84     0          0
CLVT-1           F-2              OFFSITE.MH1      18.9       0.024      105.28
105.14     0          0
CLVT-10          S-15             S-16             7.3        0.024      102.35
```

```
102.33      0          0
CLVT-11           S-17              S-18              7.1         0.024       102.2
102.18      0          0
CLVT-12           S-19              S-20              3.1         0.024       101.78
101.69      0          0
CLVT-13           S-21              S-22              4           0.024       101.52
101.51      0          0
CLVT-14           S-23              S-24              3.1         0.024       101.36
101.35      0          0
CLVT-15           S-25              S-26              9           0.024       101.24
101.22      0          0
CLVT-16           S-27              S-28              3.1         0.024       101.21
101.13      0          0
CLVT-17           S-30              SU31              25          0.024       99.63
99.51       0          0
CLVT-2            F-11              F-12              30.1        0.024       105.68
105.64      0          0
CLVT-4            S-3               S-4               5.4         0.024       103.88
103.52      0          0
CLVT-5            S-5               S-6               25.4        0.024       103.2
102.8       0          0
CLVT-6            S-7               S-8               3.1         0.024       102.7
102.69      0          0
CLVT-7            S-9               S-10              2.93        0.024       102.61
102.6       0          0
CLVT-8            S-11              S-12              15          0.024       102.55
102.53      0          0
CLVT-9            S-13              S-14              7.5         0.024       102.51
102.49      0          0
Pipe_69           105               104               11.063      0.013       106.596
106.585     0          0

[ORIFICES]
;;                Inlet             Outlet            Orifice      Crest        Disch.
 Flap Open/Close
;;Name            Node              Node              Type         Height       Coeff.
 Gate Time
;;-------------- ---------------- ---------------- ------------ ----------
---------- ---- ----------
C22               POND-S            outlet            SIDE         105.75       0.61
 NO   0

[WEIRS]
;;                Inlet             Outlet            Weir         Crest        Disch.
 Flap End        End
;;Name            Node              Node              Type         Height       Coeff.
 Gate Con.       Coeff.     Surcharge  RoadWidth  RoadSurf
;;-------------- ---------------- ---------------- ------------ ----------
---------- ---- -------- ---------- ---------- ---------- ----------
Pond-weir         POND-S            outlet            TRANSVERSE   106.15       1.7
 NO   0          0          YES
Spillway          POND-S            F-2               TRANSVERSE   107.45       1.74
 NO   0          0          YES
W1                S-5               S-6               TRANSVERSE   103.7        1.74
 NO   0          0          YES
W10               S-25              S-26              TRANSVERSE   102.67       1.74
 NO   0          0          YES
W11               S-27              S-28              TRANSVERSE   102.14       1.74
 NO   0          0          YES
W12               S-7               S-8               TRANSVERSE   103.13       1.74
 NO   0          0          YES
W13               S-9               S-10              TRANSVERSE   103.51       1.74
 NO   0          0          YES
```

```
W2                S-3               S-4               TRANSVERSE   104.33     1.74
 NO   0        0         YES
W3                S-11              S-12              TRANSVERSE   103.96     1.74
 NO   0        0         YES
W4                S-13              S-14              TRANSVERSE   103.41     1.74
 NO   0        0         YES
W5                S-15              S-16              TRANSVERSE   103.29     1.74
 NO   0        0         YES
W6                S-17              S-18              TRANSVERSE   103.1      1.74
 NO   0        0         YES
W7                S-19              S-20              TRANSVERSE   102.88     1.74
 NO   0        0         YES
W8                S-21              S-22              TRANSVERSE   102.42     1.74
 NO   0        0         YES
W9                S-23              S-24              TRANSVERSE   102.45     1.74
 NO   0        0         YES

[OUTLETS]
;;                Inlet             Outlet            Outflow    Outlet
Qcoeff/                      Flap
;;Name            Node              Node              Height     Type
QTable            Qexpon     Gate
;;-------------- ---------------- ---------------- ---------- ----------------
---------------- ---------- ----
106A-IC           106A-S(1)         106               108.57     TABULAR/HEAD
106A-IC                      NO
106B-IC           106B-S            106               108.77     TABULAR/HEAD
106B-IC                      NO
107A-IC           107A-S            107               109.11     TABULAR/HEAD
107A-IC                      NO
108A-IC           108A-S            108               108.32     TABULAR/HEAD
108A-IC                      NO
109A-IC           109A-S            109               110.04     TABULAR/HEAD
109A-IC                      NO
109C-IC           109C-S            109               109.19     TABULAR/HEAD
109C-IC                      NO
113A-IC           113A-S            113               109.19     TABULAR/HEAD
113A-IC                      NO
116A-IC           116A-S            116               108.76     TABULAR/HEAD
116A-IC                      NO
121A-IC           121A-S            121               109.58     TABULAR/HEAD
121A-IC                      NO
121B-IC           121B-S            121               109.3      TABULAR/HEAD
121B-IC                      NO
123A-IC           123A-S            123               109.21     TABULAR/HEAD
123A-IC                      NO
125A-IC           125A-S            125               110.04     TABULAR/HEAD
125A-IC                      NO
127A-IC           127A-S            127               110.18     TABULAR/HEAD
127A-IC                      NO
128A-IC           128A-S            128               110.685    TABULAR/HEAD
128A-IC                      NO
131A-IC           131A-S            131               108.9      TABULAR/HEAD
131A-IC                      NO
203A-IC           203A-S            203               109.31     TABULAR/HEAD
203A-IC                      NO
206A-IC           206A-S            206               109.79     TABULAR/HEAD
206A-IC                      NO
211A-IC           211A-S            211               109.79     TABULAR/HEAD
211A-IC                      NO
218A-IC           218A-S            218               110.79     TABULAR/HEAD
218A-IC                      NO
```

```
[XSECTIONS]
;;Link           Shape        Geom1            Geom2      Geom3      Geom4      Barrels
;;-------------- ------------ ---------------- ---------- ---------- ---------- ----------
101-100          CIRCULAR     1.5              0          0          0          1
102-101          CIRCULAR     1.5              0          0          0          1
103-102          CIRCULAR     2.1              0          0          0          1
104-103          CIRCULAR     1.35             0          0          0          1
105-104          CIRCULAR     1.35             0          0          0          1
106-105          CIRCULAR     1.35             0          0          0          1
107-106          CIRCULAR     0.9              0          0          0          1
108-106          CIRCULAR     1.2              0          0          0          1
109-108          CIRCULAR     0.675            0          0          0          1
110-103          CIRCULAR     2.1              0          0          0          1
111-110          CIRCULAR     0.825            0          0          0          1
112-111          CIRCULAR     0.825            0          0          0          1
113-112          CIRCULAR     0.825            0          0          0          1
114-110          CIRCULAR     1.95             0          0          0          1
115-114          CIRCULAR     1.95             0          0          0          1
116-115          CIRCULAR     1.8              0          0          0          1
117-116          CIRCULAR     0.75             0          0          0          1
118-117          CIRCULAR     0.75             0          0          0          1
119-118          CIRCULAR     0.75             0          0          0          1
120-119          CIRCULAR     0.75             0          0          0          1
121-120          CIRCULAR     0.75             0          0          0          1
122-116          CIRCULAR     1.8              0          0          0          1
123-122          CIRCULAR     1.35             0          0          0          1
124-123          CIRCULAR     0.825            0          0          0          1
125-124          CIRCULAR     0.6              0          0          0          1
126-122          CIRCULAR     1.2              0          0          0          1
127-126          CIRCULAR     1.05             0          0          0          1
128-127          CIRCULAR     0.525            0          0          0          1
129-104          CIRCULAR     0.525            0          0          0          1
```

130-129	CIRCULAR	0.525	0	0	0	1
131-130	CIRCULAR	0.525	0	0	0	1
200-123	CIRCULAR	1.05	0	0	0	1
201-200	CIRCULAR	1.05	0	0	0	1
202-201	CIRCULAR	1.05	0	0	0	1
203-202	CIRCULAR	1.05	0	0	0	1
204-124	CIRCULAR	0.75	0	0	0	1
205-204	CIRCULAR	0.75	0	0	0	1
206-205	CIRCULAR	0.75	0	0	0	1
207-122	CIRCULAR	1.2	0	0	0	1
208-207	CIRCULAR	1.2	0	0	0	1
209-208	CIRCULAR	1.2	0	0	0	1
210-209	CIRCULAR	1.2	0	0	0	1
211-210	CIRCULAR	1.2	0	0	0	1
212-127	CIRCULAR	1.05	0	0	0	1
213-212	CIRCULAR	1.05	0	0	0	1
214-213	CIRCULAR	1.05	0	0	0	1
215-214	CIRCULAR	1.05	0	0	0	1
216-215	CIRCULAR	1.05	0	0	0	1
217-216	CIRCULAR	1.05	0	0	0	1
218-217	CIRCULAR	1.05	0	0	0	1
Bypass1	RECT_CLOSED	1.2	2.4	0	0	1
Bypass2	RECT_CLOSED	1.2	2.4	0	0	1
C1	IRREGULAR	24mROW	0	0	0	1
C10	IRREGULAR	18mROW	0	0	0	1
C11	IRREGULAR	24mROW	0	0	0	1
C12	IRREGULAR	24mROW	0	0	0	1
C13	IRREGULAR	18mROW	0	0	0	1
C14	IRREGULAR	18mROW	0	0	0	1
C15	TRAPEZOIDAL	0.65	1	3	3	1
C16	IRREGULAR	18mROW	0	0	0	1
C17	IRREGULAR	18mROW	0	0	0	1

C18	TRIANGULAR	0.6	3.6	0	0	1
C19	IRREGULAR	18mROW	0	0	0	1
C2	IRREGULAR	18mROW	0	0	0	1
C20	IRREGULAR	FERN-1	0	0	0	1
C21	TRAPEZOIDAL	0.5	2	10	10	1
C23	IRREGULAR	18mROW	0	0	0	1
C24	IRREGULAR	18mROW	0	0	0	1
C25	TRAPEZOIDAL	0.5	4	3	3	1
C26	TRAPEZOIDAL	0.5	4	3	3	1
C27	TRIANGULAR	0.6	3.6	0	0	1
C28	TRIANGULAR	0.6	3.6	0	0	1
C29	IRREGULAR	18mROW	0	0	0	1
C3	IRREGULAR	24mROW	0	0	0	1
C30	IRREGULAR	24mROW	0	0	0	1
C31	CIRCULAR	0.975	0	0	0	1
C32	IRREGULAR	DITCH-A	0	0	0	1
C33	RECT_CLOSED	0.9	1.2	0	0	1
C34	RECT_CLOSED	0.9	1.2	0	0	1
C35	IRREGULAR	DITCH-B	0	0	0	1
C36	IRREGULAR	DITCH-C	0	0	0	1
C37	RECT_CLOSED	0.9	1.2	0	0	1
C38	IRREGULAR	DITCH-C1	0	0	0	1
C39	IRREGULAR	SHEA-1	0	0	0	1
C4	IRREGULAR	24mROW	0	0	0	1
C40	IRREGULAR	FERN-4	0	0	0	1
C40_1	IRREGULAR	DITCH-D3	0	0	0	1
C40_2	IRREGULAR	DITCH-D	0	0	0	1
C41	IRREGULAR	FERN-3	0	0	0	1
C42	IRREGULAR	DITCH-D1	0	0	0	1
C43	IRREGULAR	FERN-5	0	0	0	1
C44	IRREGULAR	DITCH-D2	0	0	0	1

C45	IRREGULAR	DITCH-D4	0	0	0	1
C46	IRREGULAR	DITCH-E	0	0	0	1
C47	IRREGULAR	FERN-6	0	0	0	1
C48	IRREGULAR	DITCH-F	0	0	0	1
C49	CIRCULAR	0.375	0	0	0	1
C5	IRREGULAR	24mROW	0	0	0	1
C50	IRREGULAR	DITCH-G	0	0	0	1
C51	RECT_CLOSED	0.9	1.2	0	0	1
C52	IRREGULAR	DITCH-H	0	0	0	1
C53	RECT_CLOSED	0.9	1.2	0	0	1
C54	IRREGULAR	DITCH-I	0	0	0	1
C55	RECT_CLOSED	0.9	1.2	0	0	1
C56	IRREGULAR	DITCH-J	0	0	0	1
C57	IRREGULAR	18mROW	0	0	0	1
C58	IRREGULAR	DITCH-J1	0	0	0	1
C59	IRREGULAR	24mROW	0	0	0	1
C6	IRREGULAR	16.5mROW	0	0	0	1
C60	IRREGULAR	DITCH-K	0	0	0	1
C61	IRREGULAR	DITCH-L	0	0	0	1
C62	IRREGULAR	18mROW	0	0	0	1
C7	IRREGULAR	18mROW	0	0	0	1
C8	IRREGULAR	24mROW	0	0	0	1
C9	IRREGULAR	18mROW	0	0	0	1
CLVT-1	CIRCULAR	0.7	0	0	0	1
CLVT-10	CIRCULAR	0.9	0	0	0	1
CLVT-11	CIRCULAR	0.9	0	0	0	1
CLVT-12	CIRCULAR	0.9	0	0	0	1
CLVT-13	CIRCULAR	0.9	0	0	0	1
CLVT-14	CIRCULAR	0.9	0	0	0	1
CLVT-15	CIRCULAR	0.9	0	0	0	1
CLVT-16	CIRCULAR	0.9	0	0	0	1
CLVT-17	CIRCULAR	2.3	0	0	0	1

```
CLVT-2           CIRCULAR     0.45             0          0          0          1

CLVT-4           CIRCULAR     0.35             0          0          0          1

CLVT-5           CIRCULAR     0.5              0          0          0          1

CLVT-6           CIRCULAR     0.7              0          0          0          1

CLVT-7           CIRCULAR     0.9              0          0          0          1

CLVT-8           CIRCULAR     0.9              0          0          0          1

CLVT-9           CIRCULAR     0.9              0          0          0          1

Pipe_69          CIRCULAR     1.35             0          0          0          1

C22              CIRCULAR     0.25             0          0          0
Pond-weir        RECT_OPEN    1.15             0.3        0          0
Spillway         RECT_OPEN    1                10         3          3
W1               RECT_OPEN    0.3              4          10         10
W10              RECT_OPEN    0.3              4          10         10
W11              RECT_OPEN    0.3              4          10         10
W12              RECT_OPEN    0.3              4          10         10
W13              RECT_OPEN    0.3              4          10         10
W2               RECT_OPEN    0.3              4          10         10
W3               RECT_OPEN    0.3              4          10         10
W4               RECT_OPEN    0.3              4          10         10
W5               RECT_OPEN    0.3              4          10         10
W6               RECT_OPEN    0.3              4          10         10
W7               RECT_OPEN    0.3              4          10         10
W8               RECT_OPEN    0.3              4          10         10
W9               RECT_OPEN    0.3              4          10         10

[TRANSECTS]

;Full street, width = 8.5m, curb = 0.15m , cross-slope = 0.02m/m, bank-slope =
0.02m/m, bank-height = 0.23m.
NC 0.02     0.02     0.013
X1 16.5mROW          7        4        12.5     0.0       0.0       0.0      0.0
0.0
GR 0.23     0        0.15     4        0        4         0.13     8.25     0
12.5
GR 0.15     12.5     0.23     16.5

;Full street, width = 8.5m, curb = 0.15m , cross-slope = 0.03m/m, bank-slope =
0.02m/m, bank-height = 0.245m.
NC 0.025    0.025    0.013
X1 18mROW            7        10       18.5     0.0       0.0       0.0      0.0
0.0
GR 0.35     0        0.15     10       0        10        0.13     14.25    0
18.5
GR 0.15     18.5     0.35     28

;Full street, width = 8.5m, curb = 0.15m , cross-slope = 0.03m/m, bank-slope =
0.02m/m, bank-height = 0.27m.
NC 0.02     0.02     0.013
X1 20mROW            7        10       18.5     0.0       0.0       0.0      0.0
0.0
GR 0.35     0        0.15     10       0        10        0.13     14.25    0
18.5
GR 0.15     18.5     0.35     28.5
```

```
;Full street, width = 24m, curb = 0.15m , cross-slope = 0.02m/m, bank-slope =
0.02m/m, bank-height = 0.23m.
NC 0.025    0.025    0.013
X1 24mROW           7        10       21       0.0       0.0       0.0      0.0
0.0
GR 0.35     0        0.15     10        0        10       0.165    15.5     0
21
GR 0.15     21       0.35     31

NC 0.035    0.035    0.035
X1 DITCH-A          3        0.0      8.4      0.0       0.0       0.0      0.0
0.0
GR 105.9    0        105.55   3.3       106.83   8.4

NC 0.035    0.035    0.035
X1 DITCH-B          4        0.0      6.3      0.0       0.0       0.0      0.0
0.0
GR 105.26   0        104.45   2.66      106.46   5        106.56   6.3

NC 0.045    0.045    0.045
X1 DITCH-C          4        0.0      6.9      0.0       0.0       0.0      0.0
0.0
GR 104.61   0        103.92   2.1       105.48   5        105.6    6.9

NC 0.045    0.045    0.045
X1 DITCH-C1         4        0.0      6.9      0.0       0.0       0.0      0.0
0.0
GR 104.21   0        103.52   2.1       105.08   5        105.2    6.9

NC 0.045    0.045    0.045
X1 DITCH-D          4        0.0      6.62     0.0       0.0       0.0      0.0
0.0
GR 103.55   0        102.7    1.77      104.7    5.19     104.9    6.62

NC 0.045    0.045    0.045
X1 DITCH-D1         4        0.0      6.62     0.0       0.0       0.0      0.0
0.0
GR 103.54   0        102.69   1.77      104.7    5.19     104.9    6.62

NC 0.045    0.045    0.045
X1 DITCH-D2         4        0.0      6.62     0.0       0.0       0.0      0.0
0.0
GR 103.41   0        102.56   1.77      104.57   5.19     104.77   6.62

NC 0.045    0.045    0.045
X1 DITCH-D3         4        0.0      0.0      0.0       0.0       0.0      0.0
0.0
GR 103.65   0        102.8    1.77      104.81   5.19     105.01   6.62

NC 0.035    0.035    0.035
X1 DITCH-D4         4        0.0      6.62     0.0       0.0       0.0      0.0
0.0
GR 103.23   0        102.38   1.77      104.38   5.19     104.58   6.62

NC 0.045    0.045    0.045
X1 DITCH-E          4        0.0      9.4      0.0       0.0       0.0      0.0
0.0
GR 103.11   0        103.01   3.7       102.55   6.6      104.29   9.4

NC 0.045    0.045    0.045
X1 DITCH-F          5        0.0      5.2      0.0       0.0       0.0      0.0
0.0
GR 103.07   0        102.61   1.5       102.36   2.5      102.5    3        104.14
```

```
5.2

NC 0.045     0.045     0.045
X1 DITCH-G             6         0.0       7         0.0        0.0        0.0       0.0
0.0
GR 103.03    0         102.45    1         102.21    2.5        102.45     3.2       104.09
6
GR 104.17    7

NC 0.045     0.045     0.045
X1 DITCH-H             5         0.0       5.2       0.0        0.0        0.0       0.0
0.0
GR 102.88    0         102.07    1.5       101.85    2.9        102.45     3.8       103.66
5.2

NC 0.045     0.045     0.045
X1 DITCH-I             4         0.0       5         0.0        0.0        0.0       0.0
0.0
GR 102.31    0         101.65    2.5       103.24    4.2        103.35     5

NC 0.045     0.045     0.045
X1 DITCH-J             6         0.0       4.7       0.0        0.0        0.0       0.0
0.0
GR 102.44    0         101.63    0.8       101.55    1.1        101.74     1.5       103.25
3.7
GR 103.38    4.7

NC 0.045     0.045     0.045
X1 DITCH-J1            6         0.0       4.7       0.0        0.0        0.0       0.0
0.0
GR 102.12    0         101.31    0.8       101.23    1.1        101.42     1.5       102.93
3.7
GR 103.06    4.7

NC 0.045     0.045     0.045
X1 DITCH-K             6         0.0       5.2       0.0        0.0        0.0       0.0
0.0
GR 101.94    0         101.28    1.2       101.13    1.6        101.18     1.8       102.8
4.2
GR 102.96    5.2

NC 0.035     0.035     0.035
X1 DITCH-L             5         0.0       5         0.0        0.0        0.0       0.0
0.0
GR 102.16    0         100.9     2.1       100.77    2.5        100.93     2.8       102.42
5

NC 0.035     0.035     0.035
X1 FERN-1              3         0.0       7.7       0.0        0.0        0.0       0.0
0.0
GR 112.79    0         112.23    3.4       113.58    7.7

NC 0.035     0.035     0.035
X1 FERN-2              3         0.0       6.8       0.0        0.0        0.0       0.0
0.0
GR 106.29    0         106       1.13      107.53    6.8

NC 0.035     0.035     0.035
X1 FERN-3              3         0.0       5.5       0.0        0.0        0.0       0.0
0.0
GR 105.89    0         105.43    1.2       106.5     5.5

NC 0.035     0.035     0.035
```

```
X1 FERN-4          3        0.0       8.2       0.0        0.0        0.0       0.0
0.0
GR 112.69   0        112.25   2.6       113.79   8.2

NC 0.035    0.035    0.035
X1 FERN-5          3        0.0       5.3       0.0        0.0        0.0       0.0
0.0
GR 106.45   0        106.04   1.2       107.26   5.3

NC 0.035    0.035    0.035
X1 FERN-6          3        0.0       0.0       0.0        0.0        0.0       0.0
0.0
GR 106.05   0        105.64   1.2       106.86   5.3

NC 0.035    0.035    0.035
X1 FERN-7          3        0.0       5.5       0.0        0.0        0.0       0.0
0.0
GR 105.76   0        105.3    1.2       106.37   5.5

NC 0.035    0.035    0.035
X1 SHEA-1          4        0.0       5.42      0.0        0.0        0.0       0.0
0.0
GR 106.55   0        106      1.45      106       2.17      107.08   5.42

[LOSSES]
;;Link            Inlet      Outlet     Average    Flap Gate  SeepageRate
;;-------------- ---------- ---------- ---------- ---------- ----------
102-101           0          1.32       0          NO         0
103-102           0          1.32       0          NO         0
104-103           0          1.32       0          NO         0
105-104           0          0.06       0          NO         0
106-105           0          0.02       0          NO         0
107-106           0          1.32       0          NO         0
108-106           0          0.06       0          NO         0
109-108           0          0.06       0          NO         0
110-103           0          1.32       0          NO         0
111-110           0          0.02       0          NO         0
112-111           0          0.06       0          NO         0
113-112           0          0.02       0          NO         0
114-110           0          0.06       0          NO         0
115-114           0          0.64       0          NO         0
116-115           0          0.39       0          NO         0
117-116           0          0.06       0          NO         0
118-117           0          0.06       0          NO         0
119-118           0          0.21       0          NO         0
120-119           0          0.39       0          NO         0
121-120           0          0.21       0          NO         0
122-116           0          0.02       0          NO         0
123-122           0          1.32       0          NO         0
124-123           0          0.06       0          NO         0
125-124           0          0.06       0          NO         0
126-122           0          0.02       0          NO         0
127-126           0          0.14       0          NO         0
128-127           0          0.21       0          NO         0
129-104           0          1.32       0          NO         0
130-129           0          1.32       0          NO         0
131-130           0          0.02       0          NO         0
200-123           0          1.32       0          NO         0
201-200           0          0.06       0          NO         0
202-201           0          0.39       0          NO         0
203-202           0          0.39       0          NO         0
204-124           0          1.32       0          NO         0
205-204           0          1.32       0          NO         0
```

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206-205          0          0.02       0          NO         0
207-122          0          0.06       0          NO         0
208-207          0          0.06       0          NO         0
209-208          0          0.02       0          NO         0
210-209          0          0.39       0          NO         0
211-210          0          0.64       0          NO         0
212-127          0          1.32       0          NO         0
213-212          0          1.32       0          NO         0
214-213          0          0.02       0          NO         0
215-214          0          0.64       0          NO         0
216-215          0          0.64       0          NO         0
217-216          0          0.39       0          NO         0
218-217          0          0.39       0          NO         0
C33              0          1.32       0          NO         0
C34              0          0.39       0          NO         0
C37              0          0.39       0          NO         0
C51              0          1.32       0          NO         0
C53              0          0.14       0          NO         0
Pipe_69          0          0.06       0          NO         0

[CURVES]
;;Name           Type       X-Value    Y-Value   
;;-------------- ---------- ---------- ----------
106A-IC          Rating     0          0         
106A-IC                     1.8        207       
106A-IC                     2.15       232       

106B-IC          Rating     0          0         
106B-IC                     1.8        88        
106B-IC                     2.8        99        

107A-IC          Rating     0          0         
107A-IC                     1.8        184       
107A-IC                     2.15       202       
107A-IC                     2.5        206       

108A-IC          Rating     0          0         
108A-IC                     1.8        668       
108A-IC                     2.15       735       
108A-IC                     2.5        748       

109A-IC          Rating     0          0         
109A-IC                     1.8        128       
109A-IC                     2.15       140       
109A-IC                     2.5        143       

109B-IC          Rating     0          0         
109B-IC                     1.8        1.2       
109B-IC                     2.15       1.3       

109C-IC          Rating     0          0         
109C-IC                     1.8        59        
109C-IC                     2.15       65        
109C-IC                     2.5        66        

113A-IC          Rating     0          0         
113A-IC                     1.8        710       
113A-IC                     2.15       781       
113A-IC                     2.5        795       

116A-IC          Rating     0          0         
116A-IC                     1.8        292       
116A-IC                     2.15       321       
```

```
116A-IC                     2.5         327

121A-IC          Rating     0           0
121A-IC                     1.8         271
121A-IC                     2.15        298
121A-IC                     2.5         303

121B-IC          Rating     0           0
121B-IC                     1.8         2.2
121B-IC                     2.15        2.4
121B-IC                     2.4         2.5

123A-IC          Rating     0           0
123A-IC                     1.8         319
123A-IC                     2.15        350
123A-IC                     2.5         357

125A-IC          Rating     0           0
125A-IC                     1.8         204
125A-IC                     2.15        224

127A-IC          Rating     0           0
127A-IC                     1.8         473
127A-IC                     2.15        520
127A-IC                     2.5         529

128A-IC          Rating     0           0
128A-IC                     1.8         241
128A-IC                     2.15        265
128A-IC                     2.5         270

131A-IC          Rating     0           0
131A-IC                     1.8         206
131A-IC                     2.15        226
131A-IC                     2.5         230

203A-IC          Rating     0           0
203A-IC                     1.8         837
203A-IC                     2.15        920
203A-IC                     2.5         1004

206A-IC          Rating     0           0
206A-IC                     1.8         337
206A-IC                     2.15        370
206A-IC                     2.5         377

211A-IC          Rating     0           0
211A-IC                     1.8         976
211A-IC                     2.15        1073
211A-IC                     2.5         1093

218A-IC          Rating     0           0
218A-IC                     1.8         802
218A-IC                     2.15        882
218A-IC                     2.5         898

102A-S           Storage    0           0
102A-S                      1.8         0
102A-S                      2.15        380
102A-S                      2.65        380

106A-S           Storage    0           0
106A-S                      1.8         0
```

106A-S		2.15	100
107A-S	Storage	0	0
107A-S		1.8	0
107A-S		2.15	195
107A-S		2.5	195
108A-S	Storage	0	0
108A-S		1.8	0
108A-S		2.15	539
108A-S		2.5	539
109A-S	Storage	0	0
109A-S		1.8	0
109A-S		2.15	100
109C-S	Storage	0	0
109C-S		1.8	0
109C-S		2.15	35
109C-S		2.5	35
111A-S	Storage	0	0
111A-S		1.8	0
111A-S		2.15	305
111A-S		2.5	305
112A-S	Storage	0	0
112A-S		1.8	0
112A-S		2.15	103
112A-S		2.65	103
113A-S	Storage	0	0
113A-S		1.8	0
113A-S		2.15	629
113A-S		2.5	629
116A-S	Storage	0	0
116A-S		1.8	0
116A-S		2.15	223
116A-S		2.5	223
118A-S	Storage	0	0
118A-S		1.8	0
118A-S		2.15	50
119A-S	Storage	0	0
119A-S		1.8	0
119A-S		2.15	322
119A-S		2.5	322
121A-S	Storage	0	0
121A-S		1.8	0
121A-S		2.15	290
121A-S		2.5	290
123A-S	Storage	0	0
123A-S		1.8	0
123A-S		2.15	161
123A-S		2.5	161
127A-S	Storage	0	0
127A-S		1.8	0
127A-S		2.15	259

```
127A-S                              2.5         259

128A-S            Storage    0           0
128A-S                       1.8         0
128A-S                       2.15        157
128A-S                       2.5         157

131A-S            Storage    0           0
131A-S                       1.8         0
131A-S                       2.15        203
131A-S                       2.5         203

203A-S            Storage    0           0
203A-S                       1.8         0
203A-S                       2.15        695
203A-S                       2.5         695

206A-S            Storage    0           0
206A-S                       1.8         0
206A-S                       2.15        328
206A-S                       2.5         328

211A-S            Storage    0           0
211A-S                       1.8         0
211A-S                       2.15        906
211A-S                       2.5         906

218A-S            Storage    0           0
218A-S                       1.8         0
218A-S                       2.15        695
218A-S                       2.5         695

POND              Storage    0.00        5252
POND                         1.20        8110
POND                         1.30        9236
POND                         1.40        10362
POND                         1.50        11490
POND                         1.90        15072
POND                         2.00        15665
POND                         2.10        16258
POND                         2.75        18009
POND                         3.09        18925
POND                         3.20        19204
POND                         3.50        19500

[REPORT]
INPUT       YES
CONTROLS    NO
SUBCATCHMENTS ALL
NODES ALL
LINKS ALL

[TAGS]
Subcatch    1                Offsite
Subcatch    10               Offsite
Subcatch    11               Offsite
Subcatch    12               Offsite
Subcatch    13               Offsite
Subcatch    14               Offsite
Subcatch    15               Offsite
Subcatch    16               Offsite
Subcatch    17               Offsite
Subcatch    18               Offsite
```

Subcatch	19	Offsite
Subcatch	2	Offsite
Subcatch	21	Offsite
Subcatch	22	Offsite
Subcatch	3	Offsite
Subcatch	4	Offsite
Subcatch	5	Offsite
Subcatch	6	Offsite
Subcatch	7	Offsite
Subcatch	8	Offsite
Subcatch	9	Offsite
Subcatch	C106A	Site-Shea
Subcatch	C106B	Site-RESID
Subcatch	C109A	Site-SHEA
Subcatch	C109C	Site
Subcatch	C123A	Site-Cope
Subcatch	C125A	Site-Cope
Subcatch	C127A	Site-Cope
Subcatch	C128A	Site
Subcatch	F108A	SCHOOL
Subcatch	L107A	Site
Subcatch	L109B	Site-PARK
Subcatch	L113A	Site
Subcatch	L116A	Site
Subcatch	L121A	Site
Subcatch	L121B	Site-PARK
Subcatch	L128B	Site-PARK
Subcatch	L131A	Site
Subcatch	L203A	Tartan
Subcatch	L206A	Tartan
Subcatch	L211A	Tartan
Subcatch	L218A	Tartan
Subcatch	POND	Site-Pond
Node	100B	MH
Node	101	MH
Node	102	MH
Node	103	MH
Node	104	MH
Node	106	MH
Node	107	MH
Node	108	MH
Node	109	MH
Node	110	MH
Node	111	MH
Node	112	MH
Node	113	MH
Node	114	MH
Node	115	MH
Node	116	MH
Node	117	MH
Node	118	MH
Node	119	MH
Node	120	MH
Node	121	MH
Node	122	MH
Node	123	MH
Node	124	MH
Node	125	MH
Node	126	MH
Node	127	MH
Node	128	MH
Node	129	MH
Node	130	MH

Node	131	MH
Node	200	MH
Node	201	MH
Node	202	MH
Node	203	MH
Node	204	MH
Node	205	MH
Node	206	MH
Node	207	MH
Node	208	MH
Node	209	MH
Node	210	MH
Node	211	MH
Node	212	MH
Node	213	MH
Node	214	MH
Node	215	MH
Node	216	MH
Node	217	MH
Node	218	MH
Link	101-100	PROP.PIPE
Link	102-101	PROP.PIPE
Link	103-102	PROP.PIPE
Link	104-103	PROP.PIPE
Link	105-104	PROP.PIPE
Link	106-105	PROP.PIPE
Link	107-106	PROP.PIPE
Link	108-106	PROP.PIPE
Link	109-108	PROP.PIPE
Link	110-103	PROP.PIPE
Link	111-110	PROP.PIPE
Link	112-111	PROP.PIPE
Link	113-112	PROP.PIPE
Link	114-110	PROP.PIPE
Link	115-114	PROP.PIPE
Link	116-115	PROP.PIPE
Link	117-116	PROP.PIPE
Link	118-117	PROP.PIPE
Link	119-118	PROP.PIPE
Link	120-119	PROP.PIPE
Link	121-120	PROP.PIPE
Link	122-116	PROP.PIPE
Link	123-122	PROP.PIPE
Link	124-123	PROP.PIPE
Link	125-124	PROP.PIPE
Link	126-122	PROP.PIPE
Link	127-126	PROP.PIPE
Link	128-127	PROP.PIPE
Link	129-104	PROP.PIPE
Link	130-129	PROP.PIPE
Link	131-130	PROP.PIPE
Link	200-123	FUT.PIPE
Link	201-200	FUT.PIPE
Link	202-201	FUT.PIPE
Link	203-202	FUT.PIPE
Link	204-124	FUT.PIPE
Link	205-204	FUT.PIPE
Link	206-205	FUT.PIPE
Link	207-122	FUT.PIPE
Link	208-207	FUT.PIPE
Link	209-208	FUT.PIPE
Link	210-209	FUT.PIPE
Link	211-210	FUT.PIPE

Link	212-127	FUT.PIPE
Link	213-212	FUT.PIPE
Link	214-213	FUT.PIPE
Link	215-214	FUT.PIPE
Link	216-215	FUT.PIPE
Link	217-216	FUT.PIPE
Link	218-217	FUT.PIPE
Link	Bypass1	PROP.PIPE
Link	Bypass2	PROP.PIPE
Link	C1	MJ
Link	C10	MJ
Link	C11	MJ
Link	C12	MJ
Link	C13	MJ
Link	C14	MJ
Link	C15	mj
Link	C16	MJ
Link	C17	MJ
Link	C18	MJ
Link	C19	MJ
Link	C2	MJ
Link	C20	DITCH
Link	C21	MJ
Link	C23	MJ
Link	C24	MJ
Link	C25	MJ
Link	C26	MJ
Link	C27	MJ
Link	C28	MJ
Link	C29	MJ
Link	C3	MJ
Link	C30	MJ
Link	C31	PROP.PIPE
Link	C32	DITCH
Link	C33	OFFSITE_PIPE
Link	C34	PIPE
Link	C35	DITCH
Link	C36	DITCH
Link	C37	OFFSITE_PIPE
Link	C38	DITCH
Link	C39	DITCH
Link	C4	MJ
Link	C40	DITCH
Link	C40_1	DITCH
Link	C40_2	DITCH
Link	C41	DITCH
Link	C42	DITCH
Link	C43	DITCH
Link	C44	DITCH
Link	C45	DITCH
Link	C46	DITCH
Link	C47	DITCH
Link	C48	DITCH
Link	C49	OFFSITE_PIPE
Link	C5	MJ
Link	C50	DITCH
Link	C51	OFFSITE_PIPE
Link	C52	DITCH
Link	C53	OFFSITE_PIPE
Link	C54	DITCH
Link	C55	OFFSITE_PIPE
Link	C56	DITCH
Link	C57	MJ

```
Link        C58             DITCH
Link        C59             MJ
Link        C6              MJ
Link        C60             DITCH
Link        C61             DITCH
Link        C62             MJ
Link        C7              MJ
Link        C8              MJ
Link        C9              MJ
Link        CLVT-1          CLVT
Link        CLVT-10         CLVT
Link        CLVT-11         CLVT
Link        CLVT-12         CLVT
Link        CLVT-13         CLVT
Link        CLVT-14         CLVT
Link        CLVT-15         CLVT
Link        CLVT-16         CLVT
Link        CLVT-17         CLVT
Link        CLVT-2          CLVT
Link        CLVT-4          CLVT
Link        CLVT-5          CLVT
Link        CLVT-6          CLVT
Link        CLVT-7          CLVT
Link        CLVT-8          CLVT
Link        CLVT-9          CLVT
Link        Pipe_69         PROP.PIPE
Link        Spillway        MJ

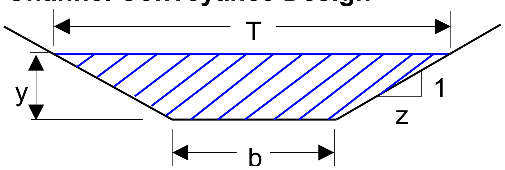
[MAP]
DIMENSIONS       350859.68455     5011874.5909     353096.69845     5013944.0011
UNITS            Meters
```

C.4 FERNBANK SWM POND 4 PRELIMINARY DESIGN CALCULATIONS

Job # 160400900 - Fernbank Pond 4

Date: 30-Nov-17

Channel Conveyance Design



$$\boxed{A = (b + z \cdot y)y}$$

$$\boxed{P = b + 2 \cdot y \cdot \sqrt{1 + z^2}}$$

$$\boxed{R = \frac{A}{P}} \quad \boxed{T = b + 2zy}$$

$$\boxed{Q = \frac{A}{n} R^{2/3} \sqrt{S}} \quad \boxed{V = \frac{Q}{A}}$$

$$\boxed{Fr = \sqrt{\frac{Q^2 T}{gA^3}}}$$

	Expected Flow Depth		w Freeboard	
n=	0.025		0.025	
z=	3		3	
b=	1		1	
y=	0.35		0.65	
A=	0.7175		1.9175	
P=	3.213594		5.110961	
R=	0.22327		0.375174	
S=	0.0075		0.0075	
T=	3.1		4.9	
Q=	**0.915**	m^3/s	3.455	m^3/s
V=	1.27	m/s	1.80	m/s
Fr # =	0.846084		0.91969	

100 Year Flow Generated =	1.000	m^3/s
Full Flow Channel Capacity =	3.455	m^3/s

Channel OK

160400900 Shea Road Development Pond Design Brief - Fernbank Pond 4

Stormwater Quality Volumetric Requirements

Pond	Drainage Area (ha)	Actual % Imp.	MOE Control Level	Water Quality Unit Volume Requirments			Water Quality Volume Requirements			Water Quality Volumes Provided			
				Total Unit Volume (m^3/ha)	Permanent Pool (m^3/ha)	Extended Detention (m^3/ha)	Permanent Pool (m^3)	Extended Detention (m^3)	Total MOE Volume	Permanent Pool (m^3)	Extended Detention (m^3)	Total MOE Volume	Actual Provided Unit Volume (m^3/ha)
Fernbank Pond 4	59.20	52	Enhanced - 80% TSS Removal	182	142.3	40	8,421	2,368	10,789	10,518	5,312	15,831	267

*Enhanced Water Level protection as specified by Fernbank Community Master Servicing Study

For use in Interpolation of above formulae

		Wetpond				Wetland			
%	0	35	55	70	85	35	55	70	85
Enhanced - 80% TSS Removal	0	140	190	225	250	80	105	120	140
Normal - 70% TSS Removal	0	90	110	130	150	60	70	80	90
Basic - 60% TSS Removal	0	60	75	85	95	60	60	60	60

160400900 Shea Road Development Pond Design Brief - Fernbank Pond 4
Stage-Storage-Discharge Summary

Stage	Discharge	Storage		Depth	Forebay			Main Cell			
		Active	Total*		Area	Incremental Volume	Accumulated Volume	Area	Incremental Volume	Accumulated Volume	
(m)	(m^3/s)	(m^3)	(m^3)	(m)	(m^2)	(m^3)	(m^3)	(m^2)	(m^3)	(m^3)	
104.25		0	0	0.00	752	0	0	4,500	0	0	
105.45		0	7,579	1.20	1,348	1,260	1,260	6,761	6,756	6,756	
105.55		0	8,446	1.30	2,048	170	1,430	7,188	697	7,454	
105.65		0	9,426	1.40	2,747	240	1,670	7,616	740	8,194	
105.75		0	10,518	1.50	3,446	310	1,980	8,043	783	8,977	Permanent Pool
105.75		0	10,518	1.50	0	0	1,980	11,490	0	8,977	Permanent Pool
106.15		5,312	15,831	0.40	0	0	1,980	15,072	5,312	14,289	
106.25		6,849	17,367	0.50	0	0	1,980	15,665	1,537	15,826	
106.35		8,445	18,964	0.60	0	0	1,980	16,258	1,596	17,422	
107.00		19,582	30,100	1.25	0	0	1,980	18,009	11,137	28,559	
107.34		25,861	36,379	1.59	0	0	1,980	18,925	6,279	34,838	
107.45		27,958	38,476	1.70	0	0	1,980	19,204	2,097	36,935	
107.75		33,764	44,282	2.00	0	0	1,980	19,500	5,806	42,741	

* Total pond including forebay, excluding sediment storage (see forebay calculations)

160400900 Shea Road Development Pond Design Brief - Fernbank Por

Conceptual Outlet Structure Discharge Calculations

Elevation (m)	Overflow Outlet			Piped Outlet			Control	Weir 1	Total Discharge
		Spillway	Total	Orifice 1	Orifice 2				
104.25									0.000
105.55									0.000
105.65									0.000
105.75									0.000
105.75		0.000	0.000	0.000	0.000		0.000	0.000	0.000
106.15		0.000	0.000	0.083	0.000		0.000	0.000	**0.083**
106.25		0.000	0.000	0.092	0.000		0.000	0.016	**0.108**
106.35		0.000	0.000	0.101	0.000		0.000	0.046	**0.147**
107.00		0.000	0.000	0.146	0.000		0.000	0.400	**0.546**
107.34		0.000	0.000	0.165	0.000		0.000	0.662	**0.827**
107.45		0.000	0.000	0.170	0.000		0.000	0.756	**0.926**
107.65		1.556	1.556	0.180	0.000		0.000	0.937	**2.673**
107.75		2.859	2.859	0.184	0.000		0.000	1.032	**4.076**

Discharge (m^3/s)

1. Outlet structure consists of reverse-sloped lowflow pipe connected to orifice #1 (created by equivalent sluice gate orientation)
2. Secondary outlet is Weir#1 in weir wall inside structure

Parameters

Spillway Weir

Crest Elevation	107.45 m
Crest Width	10 m*
Weir Coeff.	1.740

Orifice 1

Orifice Centre	105.875 m
Perimeter	0.785 m
Orifice Invert	105.75 m
Area	0.0491 m^2
Orifice Diameter	250 mm
Orifice Coeff.	0.61
Orientation	Vertical
Permanent Pool	105.75 m

Orifice 2

Orifice Centre	108.23 m
Perimeter	1.445 m
Orifice Invert	108.00 m
Area	0.1662 m^2
Orifice Diameter	460 mm
Orifice Coeff.	0.61
Orientation	Vertical

Weir 1

Top of Weir Structure	107.30 m
Max Perimeter	0.300 m
Weir Crest Invert	106.15 m
Max Open Area	0.345 m^2
Weir Dimensions (Height x Length)	1.15 m Height, 0.30 m Len
Side Walls	Vertical
Weir Coeff.	1.700

0.3 m long weir at inv. = 106.15
250 mm lowflow outlet at inv. = 105.75 m
460 mm outlet at inv. = 108 m

Water Quality Extended Detention Summary

Required Extended Detention Time	24-48 hrs for water quality drawdown		
Actual Extended Detention Time	40 hrs	Q_{peak}	0.083 m^3/s
Extended Detention Elevation	106.15 m	Q_{avg}	0.041 m^3/s

Watershed Area (ha)		59.20
Percent Impervious		51.9%
Water Quality Criteria	Enhanced - 80% TSS Removal	
Req'd Ext. Det. Volume (m^3/ha)		40
Req'd Ext. Det. Volume (m^3)		2,368
Provided Ext. Det. (m^3)		5,312
Req'd Perm. Pool Volume (m^3/ha)		142.3
Req'd Perm. Pool Volume (m^3)		8,421
Provided Perm. Pool Volume (m^3)		10,518

Discharge Rates from PCSWMM (m^3/s)

Storm	Pond Inflow	Allowable	Pond Outflow	Storage (ha-m)	Water Level
25mm, 4hr Chi	3.761	N/A	0.079	6164	106.21
2-yr, 24hr SCS	4.174	0.480	0.153	9389	106.41
5-yr, 24hr SCS	5.557	0.760	0.251	12688	106.60
10-yr, 24hr SCS	6.026	0.900	0.326	14812	106.72
25-yr, 24hr SCS	6.466	0.900	0.442	17780	106.89
100-yr, 24hr SCS	9.273	0.900	0.790	25973	107.35
100-yr+20, 12hr SCS	11.185	N/A	2.342	31598	107.64
100-yr, 12hr SCS	8.308	0.900	0.814	25973	107.39
100-yr, 3hr Chi	10.891	N/A	0.694	23721	107.22
July 1, 1979	9.633	N/A	1.430	29868	107.55

$$Q = CA\sqrt{2g\left(h_2 - h_1 + \frac{D}{2000}\right)}$$

Where,
h2 = elevation at stage 2 (m)
h1 = elevation at stage 1 (m)
D = orifice diameter (mm)
C = orifice coefficient
A = orifice open area (m^2)

$$Q = CL(h_2 - h_1)^{1.5}$$

h2 = elevation at stage 2 (m)
h1 = elevation at stage 1 (m)
L = weir crest length (m)
C = weir coefficient

Weir flow calculation for orifice below centreline:

$$\theta = 2\cos^{-1}\left(1 - \frac{2h}{D}\right) = 2\,\mathrm{acos}\left(1 - \frac{2h}{D}\right)$$

$$P_w = \frac{D\theta}{2}$$

h = water level stage (m)
D = orifice diameter (m)
θ = angle based on water level (radians)
P_W = Wetted Perimeter = Crest Length (m)

160400900 Shea Road Development Pond Design Brief - Fernbank Pond 4

Sediment Forebay Sizing Calculations

Using MOE - Stormwater Management Planning and Design Manual (2003)

Forebay

Settling Length @ Perm. Pool

Dist =	$\text{sqrt}(r^*Q_p/v_s)$		r : 1 = L to W ratio	r =	2.8	Average
=	**27.8**	**m**	Q_p = peak SWM outflow during quality storm	Q_p =	0.083	Note 1.
			v_s = settling velocity for 0.15 mm particles (m/s)	v_s =	0.0003	

Dispersion Length @ Perm. Pool

			y_d = total depth of sediment in forebay (m)	y_d =	0.5	
Dist =	8Q/dv		Q = 25mm max inlet flow (m^3/s)	Q =	3.761	Note 2.
=	**60.2**	**m**	d = depth of perm pool in forebay (m)	d =	1.0	
			v_f = desired vel in forebay (m/s)	v_f =	0.5	
Provided =	**68.0**	**m**	**Length Criteria Satisfied**	**Provided L:W =**	**2.2**	

Velocity @ Forebay Berm

			y = total depth of forebay from perm. pool (m)	y =	1.0	Assume max. sediment depth
v =	Q/A		b = bottom width of forebay (m)	b =	20	at forebay end
=	**0.16**	**m/s**	Q = 25mm inlet flow (m^3/s)	Q =	3.761	
			A = cross-sectional area (m^2)	A =	23.78	Note 3.
			Target velocity = 0.15	V_{targ} =	0.15	

Velocity Too High!

Cleanout Frequency

Table 6.3 MOE SWMPD Manual

			Water Quality Level	Enhanced - 80% TSS Removal		
			A_{sew} = Contributing Sewer Area (ha)	A_{sew} =	59.20	
cleanout =	Vol/(load*A_{sew}*effic)		Imp = Percent Impervious (%)	Imp =	51.9%	
=	**9.3**	**years**	load = Sediment Loading (m^3/ha)	load =	1.0	Assume same as overall
			effic = Removal Efficiency (%) - Enhanced - 80% TSS Removal Level	effic =	80%	Note 4.
			Targ = Cleanout Frequency Target (years)	Targ =	6	
			Vol = Sediment volume (m^3)	Vol =	438	Note 5.

Surface Area Check

SA_f/SA_{pp} =	**30.0%**	SA_f = Forebay Surface Area (m^2)	SA_f =	3,446
		SA_{pp} = Total Permanent Pool Surface Area (m^2)	SA_{pp} =	11,489
		Targ = Forebay size (as % of Permanent Pool Area)	Targ =	33%

Therefore, **The forebay size is OK!**

Notes

1. Peak pond outflow at extended detention elevation
2. Inlet flow is 25mm inflow from PCSWMM model
3. Cross-sectional area based on depth above maximum sedimentation depth (0.5 m)
4. Interpolated based on percent impervious
5. Volume of bottom 0.5 m depth, the maximum sediment accumulation depth

160400900 Shea Road Development Pond Design Brief - Fernbank Pond 4

Flow Augmentation Calculation

Falling Head Orifice Equation (used for approximating detention time).
(as per Equation 4.10 in MOE SWMPDM)

a)

$$t = \frac{2 * A_p}{CA_0(2g)^{0.5}} (h_1^{0.5} - h_2^{0.5})$$

where:

- t= drawdown time (seconds)
- A_p= pond surface area (sq.m),
- C= discharge coefficient
- A_0= area of orifice (sq.m)
- h_1= starting water elevation above orifice (m)
- h_2= ending water elevation above orifice (m)

Check for Detention Time

Ap	15071.8	m^2	Approximate pond area
C	0.6		
orifice dia.	0.25	m	
h1	0.40	m	
h2	0.00	m	
Ao =	0.04909	sq.m	
t =	146135.1707	s	
	1.7	days	
	40.6	**hours**	

Equation 4.11

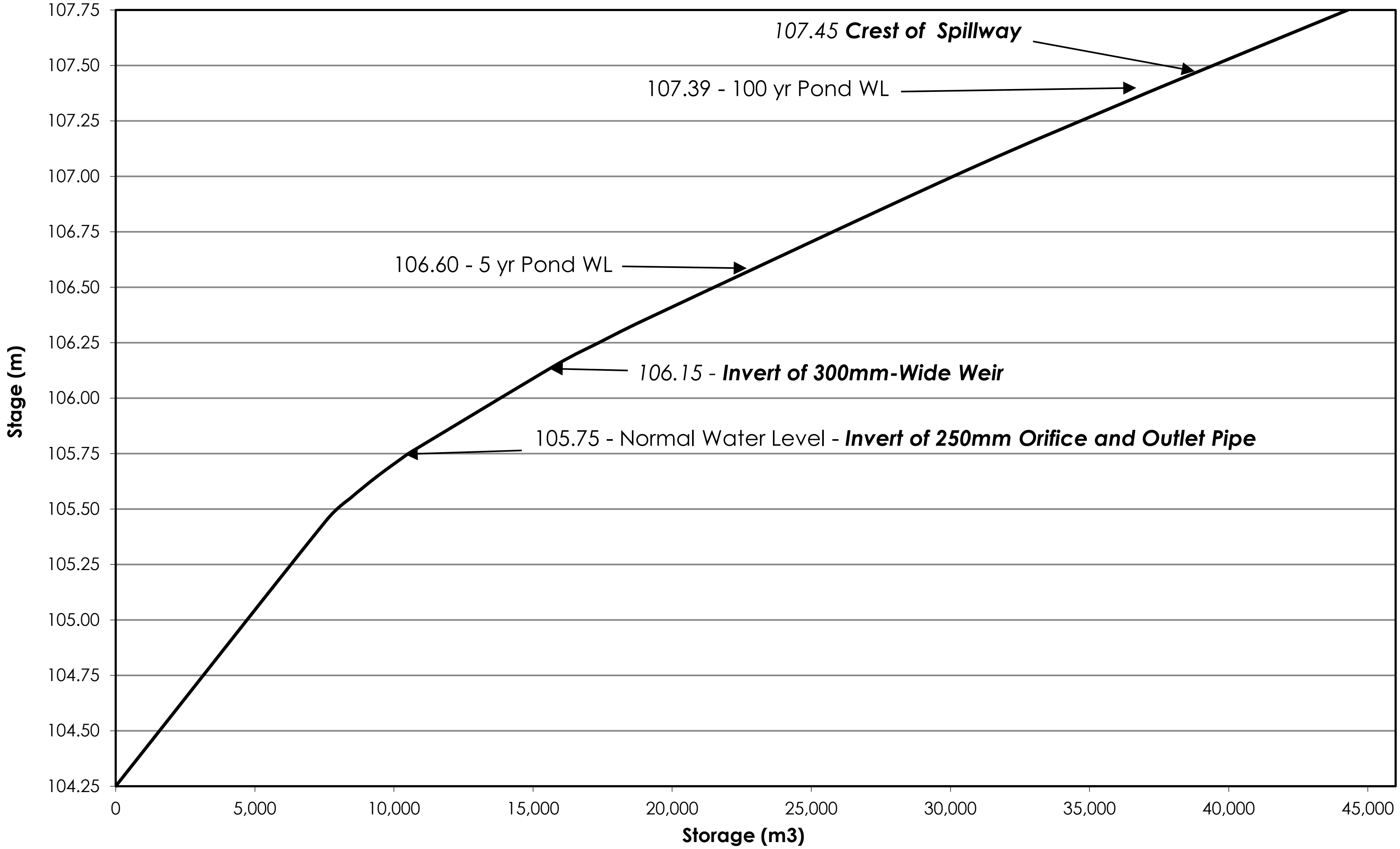
b)

$$t = \frac{0.66C_2h^{1.5} + 2C_3h^{0.5}}{2.75A_0}$$

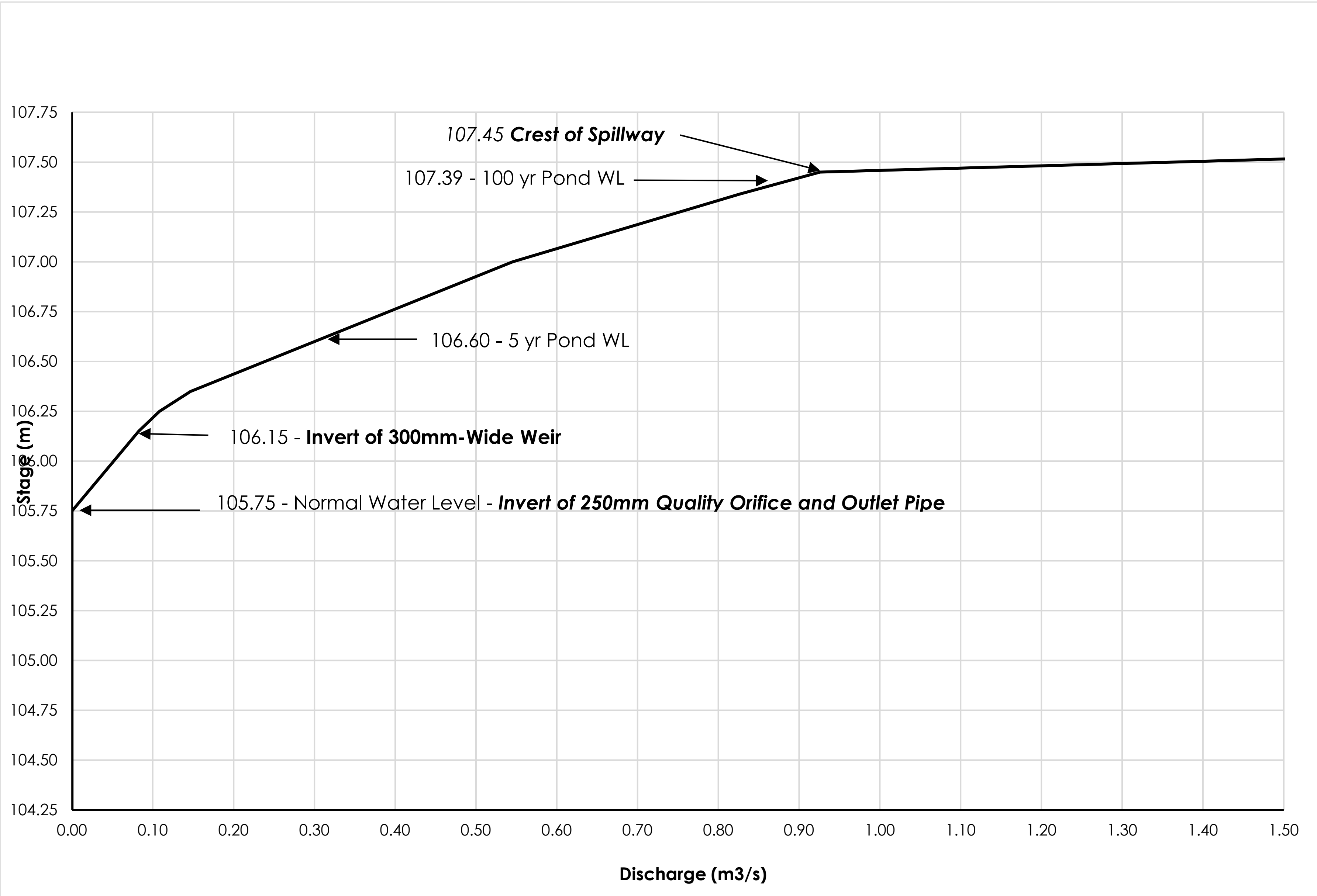
Where:

- t= drawdown time (seconds)
- A_0= cross sectional area of orifice (sq.m)
- h= maximum water elevation above the orifice (m)
- C_2= slope coefficient from the area-depth linear regression
- C_3= intercept form the area-depth linear regression

A_0	0.0491	sq.m
h	0.40	m
C_2	2966	
C_3	15071.8	
t=	144897	s
	1.7	days
	40.2	**hours**



107.45 Crest of Spillway
107.39 - 100 yr Pond WL
106.60 - 5 yr Pond WL
106.15 - Invert of 300mm-Wide Weir
105.75 - Normal Water Level - Invert of 250mm Orifice and Outlet Pipe
Stage (m)
Storage (m3)
107.75
107.50
107.25
107.00
106.75
106.50
106.25
106.00
105.75
105.50
105.25
105.00
104.75
104.50
104.25
0
5,000
10,000
15,000
20,000
25,000
30,000
35,000
40,000
45,000


107.45 Crest of Spillway
107.39 - 100 yr Pond WL
106.60 - 5 yr Pond WL
106.15 - Invert of 300mm-Wide Weir
105.75 - Normal Water Level - Invert of 250mm Quality Orifice and Outlet Pipe
Stage (m)
Discharge (m3/s)
107.75
107.50
107.25
107.00
106.75
106.50
106.25
106.00
105.75
105.50
105.25
105.00
104.75
104.50
104.25
0.00
0.10
0.20
0.30
0.40
0.50
0.60
0.70
0.80
0.90
1.00
1.10
1.20
1.30
1.40
1.50

C.5 FERNBANK SWM POND 4 ULTIMATE OUTLET ANALYSIS

Stantec Consulting Ltd.
400 - 1331 Clyde Avenue, Ottawa ON K2C 3G4

September 11, 2018
File: 160400900

Attention: **Eric Surprenant**, C.E.T.
City of Ottawa
Infrastructure Approvals
110 Laurier Avenue West
Ottawa, ON K1P 1J1

Dear Mr. Surprenant,

Reference: Fernbank SWM Pond 4 – Storm Outlet Assessment and Preferred Conceptual Drainage Option

Runoff from the proposed Fernbank SWM Pond 4 will outlet into the northern Fernbank Road side ditch which conveys runoff to an existing 700 mm diameter CSP (see CLVT-1 on **Drawing FUT-1**) that crosses Fernbank Road and discharges into an existing ditch. The existing ditch runs south and then east across the property south of Fernbank Road and ultimately discharges into the Shea Road side ditch at node S-2 (see **Drawing FUT-1**). Runoff is then directed south along the western Shea Road side ditch towards Flewellyn Road and into an existing 2300 mm diameter CSP that discharges into the Faulkner Municipal Drain. It is our understanding that the existing ditch that crosses the property south of Fernbank Road will be filled out as part of the future Area 6 and commercial developments.

The purpose of this exercise is to assess the capacity of a potential future condition drainage outlet for the proposed Fernbank SWM Pond 4 as agreed upon with the owners of the lands south of Fernbank Road. Based on discussions between the different owners, it is proposed to provide a pipe outlet for the Fernbank SWM Pond 4 outflows, as well as for runoff from Fernbank Road as part of the development of the future area 6 and commercial developments (see **Drawing FUTSD-2**).

The Environmental Management Plan (EMP) for the Fernbank Community identified the design criteria for the Fernbank SWM Pond 4 as ‘Enhanced’ water quality treatment (80% TSS removal) and post to pre-development quantity control. However, further consultation with the City of Ottawa confirmed that based on the drainage analysis for the Faulkner Municipal Drain, the allowable release rate for the Fernbank SWM Pond 4 should be restricted to 0.9 m^3/s, which is approximately equivalent to the 10-year pre-development peak flows. As a result, the addition of the proposed Fernbank SWM Pond 4 will improve the existing drainage conditions downstream.

DETAILED TOPOGRAPHIC SURVEY

A detailed topographic survey was done to obtain detailed ditch cross sections along the Fernbank roadside ditch, the Shea roadside ditch and the existing agricultural ditch south of

Fernbank crossing the Davidson/Tartan lands. In addition, culvert inverts, sizes and lengths were also recorded. The existing ditch cross sections and existing culvert information are shown on **Drawings SEC-1** and **SEC-2** and **Drawings FUT-1** to **FUT-3**. The following is a summary of the conclusions drawn from the detailed topographic survey.

- Existing drainage patterns show that runoff from node F-8 (See **Drawing FUT-1**) at the intersection of Shea Road and Fernbank Road flows west along the southern Fernbank Road side ditch to the existing ditch that currently crosses the property south of Fernbank and discharges downstream into the Shea Road side ditch.
- The existing western Shea roadside ditch is very flat with sections of negative slopes.
- The western Shea roadside ditch has a low point at node S-8 (see **Drawing FUT-2**) with an invert of 102.35 m, followed by a high point approximately 1 m downstream with an invert of 102.70 m.
- Several of the existing culverts as shown on the Existing Culvert Schedule on **Drawing FUT-3** are undersized and/or have negative slopes.

CONCEPTUAL FUTURE DEVELOPMENT CONDITION

It is our understanding that the existing ditch that crosses the property south of Fernbank Road will be filled out as part of the future Area 6 and Commercial developments and as such, an alternate outlet to direct runoff from the proposed Fernbank SWM Pond 4 to the Faulkner Municipal Drain is required.

In order to assess an alternate outlet for the Fernbank SWM Pond 4 from the existing 700 mm diameter CSP to the Shea roadside ditch, a detailed hydrologic/hydraulic analysis was performed in PCSWMM.

PCSWMM was used to estimate the volume of runoff generated during the future condition, assuming the ultimate condition development for the Fernbank SWM Pond 4 has been completed and the future Area 6 and the commercial block at the intersection of Shea Road and Fernbank Road have been built. The drainage areas included in the proposed condition analysis are shown on **Drawing FUTSD-1** and **Drawing FUTSD-2**, while **Drawings FUT-1** to **FUT-3** show the proposed storm sewer outlet for the Fernbank SWM Pond 4, existing drainage features, and potential future improvements along Fernbank and Shea Road included in the hydraulic analysis. The input file for the 100-year, 24-hour SCS storm as obtained from PCSWMM is attached, while digital modeling files have been saved in the attached CD.

In order to evaluate the hydraulic response of the Shea and Fernbank roadside ditches and the potential future structures during the 100 year storm under future conditions, a PCSWMM model was created to incorporate the detailed hydrology for each catchment, the proposed Fernbank SWM Pond 4, the potential future storm sewer to the Shea roadside ditch, as well as the existing/potential future drainage features along the Fernbank and Shea roadside ditches from the Fernbank SWM Pond 4 outlet to the existing 2300 mm diameter CSP crossing Flewellyn Road (see **Drawing FUTSD-1** and **Drawing FUTSD-2**). The conceptual storm sewer design sheet for the proposed pipe outlet is attached.

MODELING PARAMETERS

Detailed hydrologic and hydraulic parameters for the Shea Road Lands Development and the Fernbank SWM Pond 4 have been provided in the *Shea Road Lands Development Conceptual Site Servicing and Stormwater Management Report* (Stantec, April 2018), and the *Fernbank Pond 4 Stormwater Management Facility Design Brief* (Stantec, April 2018) respectively.

Table 1 presents the general hydrologic subcatchment parameters used:

Table 1: General Subcatchment Parameters

Subcatchment Parameter	Value
Infiltration Method	Horton
Max. Infil. Rate (mm/hr)	76.2
Min. Infil. Rate (mm/hr)	13.2
Decay Constant (1/hr)	4.14
N Imperv	0.013
N Perv (grassed areas/agricultural lands)	0.25
N Perv (heavily wooded areas)	0.40
Dstore Imperv (mm)	1.57
Dstore Perv (mm)	4.67
Zero Imperv (%)	0

Table 2 presents the individual parameters that vary for each of the offsite subcatchments as shown on **Drawings FUTSD-1** and **FUTSD-2** (Fernbank SWM Pond 4 with existing ditch outlet filled out as part of future developments south of Fernbank).

Reference: Fernbank SWM Pond 4 – Storm Outlet Assessment and Preferred Conceptual Drainage Option

Table 2: Conceptual Subcatchment Parameters

Area ID	Outlet	Area (ha)	Width (m)	% Impervious	Runoff Coefficient	Subarea Routing	% Routed
1	S-29	0.13	84.90	37.14	0.46	PERVIOUS	100
2	S-27	0.02	17.10	30.00	0.41	PERVIOUS	100
3	S-25	0.06	55.90	30.00	0.41	PERVIOUS	100
4	S-23	0.07	76.10	30.00	0.41	PERVIOUS	100
5	S-21	0.10	80.60	30.00	0.41	PERVIOUS	100
6	S-19	0.21	164.30	30.00	0.41	PERVIOUS	100
7	S-17	0.11	86.20	30.00	0.41	PERVIOUS	100
8	S-15	0.11	82.20	30.00	0.41	PERVIOUS	100
9	S-13	0.04	42.80	30.00	0.41	PERVIOUS	100
10	S-11	0.06	40.70	30.00	0.41	PERVIOUS	100
11	S-9	0.09	83.10	30.00	0.41	PERVIOUS	100
12	S-6	0.11	83.90	30.00	0.41	PERVIOUS	100
13	S-5	0.19	150.80	30.00	0.41	PERVIOUS	100
14	S-2	0.08	75.20	30.00	0.41	PERVIOUS	100
15	S-1	0.29	213.30	41.43	0.49	PERVIOUS	100
16	F-8	0.25	148.00	47.14	0.53	PERVIOUS	100
17	F-9	1.18	346.70	47.14	0.53	PERVIOUS	100
18	F-10	0.76	463.00	38.57	0.47	PERVIOUS	100
19	F-4	0.62	468.30	38.57	0.47	PERVIOUS	100
21	S-30	9.80	2205.00	0.00	0.20	PERVIOUS	100
22	S-20	9.50	2138.00	0.00	0.20	PERVIOUS	100

FUTURE CONDITION MODELING RESULTS

In order to address the existing ditch capacity issues along Shea Road and to convey the 100-year post development peak flows from the proposed Fernbank SWM Pond 4 to the Faulkner Municipal Drain after Area 6 is developed, assuming the existing outlet ditch is filled out, the hydraulic/hydrologic analysis was revised iteratively by revising culvert sizes and slopes and providing positive constant slopes along the roadside ditches towards Flewellyn Road. Based on the results of this analysis, the following conclusions can be made about the potential future outlet:

1. A manhole structure is required at node F-3 to capture runoff from the existing 700 mm diameter CSP and direct it to the proposed 900 x 1200 mm concrete box storm sewer.

2. A ditch inlet catchbasin (DICB) is required at node F-5 to capture runoff from the southern Fernbank roadside ditch and direct it to the proposed manhole structure.

3. Approximately 348 m of 1200 x 900 mm concrete box storm sewer is required within the property south of Fernbank Road as shown on **Drawing FUT-1** to re-direct runoff to the existing Shea roadside ditch at S-1.

4. The pipe layout shown is conceptual and the horizontal alignment can be revised as required as long as the minimum slope of 0.15% is provided and sufficient cover is provided over the pipe.

Table 6 summarizes the recommended ditch inverts, cross sections and longitudinal slopes, while **Table 7** summarizes the proposed culvert schedule.

Table 3: Future Condition Improved Roadside Ditch Characteristics

Upstream Node ID	Downstream Node ID	Upstream Invert (m)	Downstream Invert (m)	Longitudinal Slope (%)	Main Channel X-Section	Max. Depth within Channel (m)	100-year Depth (m)
F-1	F-2	105.55	105.33	0.73	V-shape	1.30	0.65
F-4	F-5	112.23	105.50	1.81	V-shape	0.66	0.20
F-8	F-5	106.00	105.50	0.34	V-shape	0.23	0.11
F-8	S-1	106.00	104.45	0.76	V-shape	0.23	0.11
F-9	F-11	106.04	105.68	0.46	V-shape	0.75	0.49
F-10	F-2	112.25	105.28	1.92	V-shape	0.75	0.22
F-12	F-1	105.64	105.55	0.36	V-shape	0.97	0.56
S-1	S-2	104.45	103.92	0.91	V-shape	0.91	0.57
S-2	S-3	103.92	103.88	0.32	V-shape	0.76	0.68
S-4	S-5	103.52	103.20	0.27	V-shape	0.98	0.76
S-6	S-7	102.80	102.70	0.12	V-shape	1.10	0.97
S-8	SU1	102.69	102.69	0.00	V-shape	1.09	0.96
SU1	S-9	102.69	102.61	0.10	V-shape	1.09	0.96
S-10	S-11	102.60	102.55	0.13	V-shape	1.10	0.92
S-12	S-13	102.53	102.51	0.07	V-shape	2.09	0.83
S-14	S-15	102.49	102.35	0.19	V-shape	1.18	0.69
S-16	S-17	102.33	102.20	0.17	V-shape	1.26	0.73

Reference: Fernbank SWM Pond 4 – Storm Outlet Assessment and Preferred Conceptual Drainage Option

Upstream Node ID	Downstream Node ID	Upstream Invert (m)	Downstream Invert (m)	Longitudinal Slope (%)	Main Channel X-Section	Max. Depth within Channel (m)	100-year Depth (m)
S-18	S-19	102.18	101.78	0.25	V-shape	1.32	0.63
S-20	S-21	101.69	101.52	0.20	V-shape	1.39	0.92
S-22	S-23	101.51	101.36	0.21	V-shape	1.19	0.97
S-24	S-25	101.35	101.24	0.21	V-shape	1.47	1.01
S-26	S-27	101.22	101.21	0.12	V-shape	1.65	0.84
S-28	S-29	101.13	100.77	0.74	V-shape	1.11	0.81
S-29	S-30	100.77	99.63	2.90	V-shape	1.18	0.54

Table 4: Future Condition Improved Culvert Schedule

Culvert ID	Upstream Invert (m)	Downstream Invert (m)	Culvert Length (m)	Culvert Diameter (mm)	Culvert Slope (%)	100-year Upstream Water Elevation (m)	100-year Downstream Water Elevation (m)
CLVT-1	105.28	105.14	18.9	700	0.74	106.19	105.74
CLVT-2	105.68	105.64	30.1	450	0.13	106.53	106.20
CLVT-4	103.88	103.52	5.4	350	6.67	104.53	104.28
CLVT-5	103.20	102.80	25.4	500	1.57	103.91	103.77
CLVT-6	102.70	102.69	3.1	700	0.32	103.67	103.65
CLVT-7	102.61	102.60	2.9	900	0.34	103.54	103.52
CLVT-8	102.55	102.53	15.0	900	0.13	103.45	103.36
CLVT-9	102.51	102.49	7.5	900	0.27	103.24	103.18
CLVT-10	102.35	102.33	7.3	900	0.27	103.12	103.06
CLVT-11	102.20	102.18	7.1	900	0.28	102.89	102.81
CLVT-12	101.78	101.69	3.1	900	2.90	102.61	102.61
CLVT-13	101.52	101.51	4.0	900	0.25	102.52	102.48
CLVT-14	101.36	101.35	3.1	900	0.32	102.40	102.36
CLVT-15	101.24	101.22	9.0	900	0.22	102.17	102.06
CLVT-16	101.21	101.13	3.1	900	2.58	101.96	101.94
CLVT-17	99.63	99.51	25.0	2300	0.48	100.33	N/A

Reference: Fernbank SWM Pond 4 – Storm Outlet Assessment and Preferred Conceptual Drainage Option

CLVT-2, CLVT-8 and CLVT-15 represent entrance crossings, while CLVT-1 represents the Fernbank crossing and CLVT-17 represents the Flewellyn crossing. The rest of the culverts are provided at hydro pole locations for maintenance access and flow over these culverts has been represented in the model through weirs as shown in the table below.

Table 5: Future Condition Weir Results

Weir ID	Inlet Node	Outlet Node	Culvert ID	Length (m)	Weir Crest Elev. (m)	100-year Flow (L/s)
W1	S-5	S-6	CLVT-5	4.0	103.70	637.58
W2	S-3	S-4	CLVT-4	4.0	104.33	620.44
W3	S-11	S-12	CLVT-8	4.0	103.96	0.00
W4	S-13	S-14	CLVT-9	4.0	103.41	0.00
W5	S-15	S-16	CLVT-10	4.0	103.29	0.00
W6	S-17	S-18	CLVT-11	4.0	103.10	0.00
W7	S-19	S-20	CLVT-12	4.0	102.88	0.00
W8	S-21	S-22	CLVT-13	4.0	102.42	166.94
W9	S-23	S-24	CLVT-14	4.0	102.45	0.00
W10	S-25	S-26	CLVT-15	4.0	102.67	0.00
W11	S-27	S-28	CLVT-16	4.0	102.14	0.00
W12	S-7	S-8	CLVT-6	4.0	103.13	402.53
W13	S-9	S-10	CLVT-7	4.0	103.51	26.32

As shown in the above tables and discussion, significant work is required along the southern Fernbank Road side ditch and the western Shea Road side ditch to improve the existing drainage conditions and to redirect post development runoff from the Fernbank SWM Pond 4 to the Faulkner Municipal Drain, once Area 6 and the adjacent commercial block are developed and the existing outlet ditch is filled out.

Regards,

STANTEC CONSULTING LTD.

Reference: Fernbank SWM Pond 4 – Storm Outlet Assessment and Preferred Conceptual Drainage Option

Ana Paerez, P. Eng.
Water Resources Engineer
Phone: (506) 204-5856
Ana.Paerez@stantec.com

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APPENDIX A - STORM SEWER DESIGN SHEET

Stantec

Fernbank SWM Pond 4 - Conceptual Storm Outlet Through Robinson's Lands

DATE: 2018-09-11
REVISION: 0
DESIGNED BY: WAJ
CHECKED BY: AMP

STORM SEWER DESIGN SHEET
(City of Ottawa)

FILE NUMBER: 160400900

DESIGN PARAMETERS

$I = a / (t+b)^c$ (As per City of Ottawa Guidelines, 2012)

	1:2 yr	1:5 yr	1:10 yr	1:100 yr
a =	732.951	998.071	1174.184	1735.688
b =	6.199	6.053	6.014	6.014
c =	0.810	0.814	0.816	0.820

MANNING'S n = 0.013
BEDDING CLASS = B
MINIMUM COVER: 2.00 m
TIME OF ENTRY 10 min

LOCATION / DRAINAGE AREA

AREA ID NUMBER	FROM M.H.	TO M.H.	AREA (2-YEAR) (ha)	AREA (5-YEAR) (ha)	AREA (10-YEAR) (ha)	AREA (100-YEAR) (ha)	AREA (ROOF) (ha)	C (2-YEAR) (-)	C (5-YEAR) (-)	C (10-YEAR) (-)	C (100-YEAR) (-)	A x C (2-YEAR) (ha)	ACCUM AxC (2YR) (ha)	A x C (5-YEAR) (ha)	ACCUM. AxC (5YR) (ha)	A x C (10-YEAR) (ha)	ACCUM. AxC (10YR) (ha)	A x C (100-YEAR) (ha)	ACCUM. AxC (100YR) (ha)	T of C (min)	$I_{2\text{-YEAR}}$ (mm/h)	$I_{5\text{-YEAR}}$ (mm/h)	$I_{10\text{-YEAR}}$ (mm/h)	$I_{100\text{-YEAR}}$ (mm/h)	$Q_{CONTROL}$ (L/s)	ACCUM. $Q_{CONTROL}$ (L/s)	Q_{ACT} (CIA/360) (L/s)
Proposed Fernabank SWM Pond 4 Outlet through Robinson's Lands																											
Fernbank Pond 4 Outflow, 17, 18	EX.700 UP	PROP. MH1	1.94	0.00	0.00	0.00	0.00	0.51	0.00	0.00	0.00	0.983	0.983	0.000	0.000	0.000	0.000	0.000	0.000	25.84	44.21	59.59	69.69	101.60	900.0	900.0	1020.7
16, 19	PROP. MH1	PROP. MH2	0.87	0.00	0.00	0.00	0.00	0.49	0.00	0.00	0.00	0.424	1.407	0.000	0.000	0.000	0.000	0.000	0.000	25.97	44.06	59.38	69.45	101.25	0.0	900.0	1072.1
	PROP. MH2	PROP. MH3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	1.407	0.000	0.000	0.000	0.000	0.000	0.000	26.28	43.72	58.93	68.91	100.46	0.0	900.0	1070.8
	PROP. MH3	PROP. MH4	0.00	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00	0.000	1.407	0.000	0.000	0.000	0.000	0.000	0.000	28.04	41.89	56.43	65.98	96.17	0.0	900.0	1063.6
	PROP. MH4	PROP. MH5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	1.407	0.000	0.000	0.000	0.000	0.000	0.000	28.85	41.10	55.36	64.73	94.34	0.0	900.0	1060.6
	PROP. MH5	PROP. MH6	0.00	0.00	0.00	0.00	0.00	0.61	0.00	0.00	0.00	0.000	1.407	0.000	0.000	0.000	0.000	0.000	0.000	29.83	40.20	54.14	63.29	92.23	0.0	900.0	1057.1
	PROP. MH6	HEADWALL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.000	1.407	0.000	0.000	0.000	0.000	0.000	0.000	30.50	39.60	53.33	62.34	90.84	0.0	900.0	1054.7
																				30.51							

PIPE SELECTION

FROM M.H.	TO M.H.	LENGTH (m)	PIPE WIDTH OR DIAMETE (mm)	PIPE HEIGHT (mm)	PIPE SHAPE (-)	MATERIAL (-)	CLASS (-)	SLOPE %	Q_{CAP} (FULL) (L/s)	% FULL (-)	VEL. (FULL) (m/s)	VEL. (ACT) (m/s)	TIME OF FLOW (min)
EX.700 UP	PROP. MH1	18.9	750	750	CIRCULAR	CONCRETE	-	0.74	999.1	**102.16%**	2.19	2.31	0.14
PROP. MH1	PROP. MH2	24.0	1200	900	RECTANGULAR	CONCRETE	-	0.19	1464.3	**73.22%**	1.36	1.30	0.31
PROP. MH2	PROP. MH3	138.0	1200	900	RECTANGULAR	CONCRETE	-	0.19	1464.3	**73.13%**	1.36	1.30	1.76
PROP. MH3	PROP. MH4	63.0	1200	900	RECTANGULAR	CONCRETE	-	0.19	1464.3	**72.64%**	1.36	1.30	0.81
PROP. MH4	PROP. MH5	74.0	1200	900	RECTANGULAR	CONCRETE	-	0.18	1425.3	**74.41%**	1.32	1.27	0.97
PROP. MH5	PROP. MH6	48.0	1200	900	RECTANGULAR	CONCRETE	-	0.15	1301.1	**81.24%**	1.20	1.19	0.67
PROP. MH6	HEADWALL	1.0	1200	900	RECTANGULAR	CONCRETE	-	0.15	1301.1	**81.06%**	1.20	1.19	0.01

APPENDIX B – PCSWMM INPUT FILE EXAMPLE

```
[TITLE]


[OPTIONS]
;;Options            Value
;;------------------ ------------
FLOW_UNITS           LPS
INFILTRATION         HORTON
FLOW_ROUTING         DYNWAVE
START_DATE           11/17/2017
START_TIME           00:00:00
REPORT_START_DATE    11/17/2017
REPORT_START_TIME    00:00:00
END_DATE             11/18/2017
END_TIME             06:00:00
SWEEP_START          01/01
SWEEP_END            12/31
DRY_DAYS             0
REPORT_STEP          00:01:00
WET_STEP             00:05:00
DRY_STEP             00:05:00
ROUTING_STEP         5
ALLOW_PONDING        NO
INERTIAL_DAMPING     PARTIAL
VARIABLE_STEP        0.75
LENGTHENING_STEP     0
MIN_SURFAREA         0
NORMAL_FLOW_LIMITED  BOTH
SKIP_STEADY_STATE    NO
FORCE_MAIN_EQUATION  H-W
LINK_OFFSETS         ELEVATION
MIN_SLOPE            0
MAX_TRIALS           8
HEAD_TOLERANCE       0.0015
SYS_FLOW_TOL         5
LAT_FLOW_TOL         5
MINIMUM_STEP         0.5
THREADS              4

[EVAPORATION]
;;Type          Parameters
;;------------- ----------
CONSTANT     0.0
DRY_ONLY     NO

[RAINGAGES]
;;               Rain      Time   Snow   Data
;;Name           Type      Intrvl Catch  Source
;;-------------- --------- ------ ------ ----------
RG1              INTENSITY 0:12   1.0    TIMESERIES 100yr_24hr_SCS_IBI_12min

[SUBCATCHMENTS]
;;                                                 Total    Pcnt.             Pcnt.
  Curb     Snow
;;Name           Raingage         Outlet           Area     Imperv   Width    Slope
  Length   Pack
;;-------------- ---------------- ---------------- -------- -------- --------
-------- -------- --------
;0.46
1                RG1              S-29             0.128237 37.143   84.9     2
  0
;0.41
10               RG1              S-11             0.055757 30       40.7     2
```

```
  0
;0.41
11                RG1               S-9               0.086428 30       83.1     2
  0
;0.41
12                RG1               S-6               0.112653 30       83.9     2
  0
;0.41
13                RG1               S-5               0.188556 30       150.8    2
  0
;0.41
14                RG1               S-2               0.081117 30       75.2     2
  0
;0.49
15                RG1               S-1               0.288332 41.429   213.3    2
  0
;0.53
16                RG1               F-8               0.252825 47.143   148      2
  0
;0.53
17                RG1               F-9               1.183028 47.143   346.7    1
  0
;0.47
18                RG1               F-10              0.757785 38.571   463      2
  0
;0.47
19                RG1               F-4               0.619363 38.571   468.3    2
  0
;0.41
2                 RG1               S-27              0.015479 30       17.1     2
  0
;0.2
21                RG1               S-30              9.799874 0        2205     0.5
  0
;0.2
22                RG1               S-20              9.497755 0        2138     0.5
  0
;0.41
3                 RG1               S-25              0.059797 30       55.9     2
  0
;0.41
4                 RG1               S-23              0.069436 30       76.1     2
  0
;0.41
5                 RG1               S-21              0.100617 30       80.6     2
  0
;0.41
6                 RG1               S-19              0.205038 30       164.3    2
  0
;0.41
7                 RG1               S-17              0.108557 30       86.2     2
  0
;0.41
8                 RG1               S-15              0.107641 30       82.2     2
  0
;0.41
9                 RG1               S-13              0.044049 30       42.8     2
  0
C106A             RG1               106A-S(1)         1.009065 64.286   292      1
  0
C106B             RG1               106B-S            0.960483 0        241      1
  0
C109A             RG1               109A-S            0.58286  64.286   362      1
```

```
  0
C116A            RG1              116A-S           1.663001 58.571   567      1
  0
C118A            RG1              118A-S           1.040192 58.571   244      1
  0
C119A            RG1              119A-S           2.523952 58.571   656      1
  0
C121A            RG1              121A-S           1.293885 58.571   315      1
  0
F108A            RG1              108A-S           2.444837 71.429   200      2
  0
L102A            RG1              102A-S           2.515228 58.571   556      1
  0
L107A            RG1              107A-S           3.995616 58.571   1864     1
  0
L109B            RG1              109B-S           1.609925 0        116      2
  0
L109C            RG1              109C-S           0.28776  64.286   118      0.5
  0
L111A            RG1              111A-S           3.521316 50       536      1
  0
L112A            RG1              112A-S           1.727354 58.571   353      1
  0
L113A            RG1              113A-S           3.335419 58.571   816      1
  0
L121B            RG1              121B-S           2.3862   0        167      2
  0
L203A            RG1              203A-S           6.657405 58.571   1974     1
  0
L206A            RG1              206A-S           2.681205 58.571   939      1
  0
L211A            RG1              211A-S           9.084765 50       2655     1
  0
L218A            RG1              218A-S           6.702376 55.714   2358     1
  0
POND             RG1              POND-S           3.128864 40       280      2
  0

[SUBAREAS]
;;Subcatchment   N-Imperv   N-Perv     S-Imperv   S-Perv     PctZero    RouteTo
PctRouted
;;-------------- ---------- ---------- ---------- ---------- ---------- ----------
----------
1                0.013      0.25       1.57       4.67       0          PERVIOUS
100
10               0.013      0.25       1.57       4.67       0          PERVIOUS
100
11               0.013      0.25       1.57       4.67       0          PERVIOUS
100
12               0.013      0.25       1.57       4.67       0          PERVIOUS
100
13               0.013      0.25       1.57       4.67       0          PERVIOUS
100
14               0.013      0.25       1.57       4.67       0          PERVIOUS
100
15               0.013      0.25       1.57       4.67       0          PERVIOUS
100
16               0.013      0.25       1.57       4.67       0          PERVIOUS
100
17               0.013      0.25       1.57       4.67       0          PERVIOUS
100
18               0.013      0.25       1.57       4.67       0          PERVIOUS
100
```

```
19                0.013      0.25       1.57       4.67       0          PERVIOUS
100
2                 0.013      0.25       1.57       4.67       0          PERVIOUS
100
21                0.013      0.25       1.57       4.67       0          PERVIOUS
100
22                0.013      0.25       1.57       4.67       0          PERVIOUS
100
3                 0.013      0.25       1.57       4.67       0          PERVIOUS
100
4                 0.013      0.25       1.57       4.67       0          PERVIOUS
100
5                 0.013      0.25       1.57       4.67       0          PERVIOUS
100
6                 0.013      0.25       1.57       4.67       0          PERVIOUS
100
7                 0.013      0.25       1.57       4.67       0          PERVIOUS
100
8                 0.013      0.25       1.57       4.67       0          PERVIOUS
100
9                 0.013      0.25       1.57       4.67       0          PERVIOUS
100
C106A             0.013      0.25       1.57       4.67       0          OUTLET
C106B             0.013      0.25       1.57       4.67       0          PERVIOUS
100
C109A             0.013      0.25       1.57       4.67       0          OUTLET
C116A             0.013      0.25       1.57       4.67       0          OUTLET
C118A             0.013      0.25       1.57       4.67       0          OUTLET
C119A             0.013      0.25       1.57       4.67       0          OUTLET
C121A             0.013      0.25       1.57       4.67       0          OUTLET
F108A             0.013      0.25       1.57       4.67       0          OUTLET
L102A             0.013      0.25       1.57       4.67       0          OUTLET
L107A             0.013      0.25       1.57       4.67       0          OUTLET
L109B             0.013      0.25       1.57       4.67       0          PERVIOUS
100
L109C             0.013      0.25       1.57       4.67       0          OUTLET
L111A             0.013      0.25       1.57       4.67       0          OUTLET
L112A             0.013      0.25       1.57       4.67       0          OUTLET
L113A             0.013      0.25       1.57       4.67       0          OUTLET
L121B             0.013      0.25       1.57       4.67       0          PERVIOUS
100
L203A             0.013      0.25       1.57       4.67       0          OUTLET
L206A             0.013      0.25       1.57       4.67       0          OUTLET
L211A             0.013      0.25       1.57       4.67       0          OUTLET
L218A             0.013      0.25       1.57       4.67       0          OUTLET
POND              0.013      0.25       1.57       4.67       0          OUTLET

[INFILTRATION]
;;Subcatchment   MaxRate    MinRate    Decay      DryTime    MaxInfil
;;-------------- ---------- ---------- ---------- ---------- ----------
1                 76.2       13.2       4.14       7          0
10                76.2       13.2       4.14       7          0
11                76.2       13.2       4.14       7          0
12                76.2       13.2       4.14       7          0
13                76.2       13.2       4.14       7          0
14                76.2       13.2       4.14       7          0
15                76.2       13.2       4.14       7          0
16                76.2       13.2       4.14       7          0
17                76.2       13.2       4.14       7          0
18                76.2       13.2       4.14       7          0
19                76.2       13.2       4.14       7          0
2                 76.2       13.2       4.14       7          0
21                76.2       13.2       4.14       7          0
```

```
22                76.2        13.2        4.14        7           0
3                 76.2        13.2        4.14        7           0
4                 76.2        13.2        4.14        7           0
5                 76.2        13.2        4.14        7           0
6                 76.2        13.2        4.14        7           0
7                 76.2        13.2        4.14        7           0
8                 76.2        13.2        4.14        7           0
9                 76.2        13.2        4.14        7           0
C106A             76.2        13.2        4.14        7           0
C106B             76.2        13.2        4.14        7           0
C109A             76.2        13.2        4.14        7           0
C116A             76.2        13.2        4.14        7           0
C118A             76.2        13.2        4.14        7           0
C119A             76.2        13.2        4.14        7           0
C121A             76.2        13.2        4.14        7           0
F108A             76.2        13.2        4.14        7           0
L102A             76.2        13.2        4.14        7           0
L107A             76.2        13.2        4.14        7           0
L109B             76.2        13.2        4.14        7           0
L109C             76.2        13.2        4.14        7           0
L111A             76.2        13.2        4.14        7           0
L112A             76.2        13.2        4.14        7           0
L113A             76.2        13.2        4.14        7           0
L121B             76.2        13.2        4.14        7           0
L203A             76.2        13.2        4.14        7           0
L206A             76.2        13.2        4.14        7           0
L211A             76.2        13.2        4.14        7           0
L218A             76.2        13.2        4.14        7           0
POND              76.2        13.2        4.14        7           0

[JUNCTIONS]
;;                Invert      Max.        Init.       Surcharge   Ponded
;;Name            Elev.       Depth       Depth       Depth       Area
;;-------------- ---------- ---------- ---------- ---------- ----------
100B              105.5       2.65        0           0           0
101               105.477     3.003       0           0           0
102               105.519     3.291       0           0           0
;3000mm
103               105.634     4.792       0           0           0
;2400mm
104               106.282     4.089       0           0           0
;3000mm
105               106.296     3.848       0           0           0
;2400mm
106               106.568     3.592       0           0           0
;1800mm
107               107.154     4.796       0           0           0
;2400mm
108               106.958     4.152       0           0           0
;1200mm
109               107.704     3.296       0           0           0
;1800mm
110               107.377     3.775       0           0           0
;1500mm
111               108.049     3.192       0           0           0
;3000mm
112               105.941     4.867       0           0           0
;1500mm
113               107.298     3.65        0           0           0
114               106.079     4.943       0           0           0
;2400mm
115               106.226     5.79        0           0           0
;2400mm
```

```
116                 106.904    4.58       0          0          0
;1800mm
117                 107.558    4.44       0          0          0
;1200mm
118                 107.91     2.906      0          0          0
;2400mm
119                 107.238    5.3        0          0          0
;2400mm
120                 107.549    5.454      0          0          0
;1200mm
121                 108.596    3.994      0          0          0
;2400mm
200                 107.32     6.004      0          0          0
;2400mm
201                 107.563    8.143      0          0          0
;2400mm
202                 107.623    8.241      0          0          0
;2400mm
203                 107.876    8.91       0          0          0
;1800mm
204                 107.745    5.68       0          0          0
;1800mm
205                 107.928    8.611      0          0          0
;1500mm
206                 108.236    8.264      0          0          0
;2400mm
207                 106.906    6.02       0          0          0
;3000mm
208                 106.988    6.712      0          0          0
;2400mm
209                 107.312    6.855      0          0          0
;2400mm
210                 107.358    6.763      0          0          0
;2400mm
211                 107.471    6.643      0          0          0
;2400mm
212                 107.743    5.566      0          0          0
;3000mm
213                 107.912    6.028      0          0          0
;2400mm
214                 108.01     5.742      0          0          0
;2400mm
215                 108.072    5.622      0          0          0
;2400mm
216                 108.185    4.977      0          0          0
;2400mm
217                 108.245    5.905      0          0          0
;2400mm
218                 108.557    5.643      0          0          0
HWL130B             105.7      2.3        0          0          0
outlet              105.55     2.2        0          0          0

[OUTFALLS]
;;                  Invert     Outfall      Stage/Table      Tide
;;Name              Elev.      Type         Time Series      Gate Route To
;;-------------- ---------- ------------ ---------------- ---- ----------------
SU31                99.51      FREE                          NO

[STORAGE]
;;                  Invert   Max.     Init.    Storage    Curve
Ponded   Evap.
;;Name              Elev.    Depth    Depth    Curve      Params
Area     Frac.     Infiltration parameters
```

```
;;-------------- -------- -------- -------- ---------- -------- -------- --------
-------- -------- ----------------------
102A-S           108.12   2.65     0        TABULAR    102A-S                     0
      0
102A-S(1)        107.5    0.7      0        FUNCTIONAL 0        0        0        0
      0
106A-S           108.27   0.5      0        FUNCTIONAL 0        0        0        0
      0
106A-S(1)        108.56   2.15     0        FUNCTIONAL 0        0        0        0
      0
106B-S           109.1    2.8      0        FUNCTIONAL 0        0        0        0
      0
107A-S           108.24   2.5      0        TABULAR    107A-S                     0
      0
108A-S           108.85   2.5      0        TABULAR    108A-S                     0
      0
109A-S           110.2    2.15     0        FUNCTIONAL 0        0        0        0
      0
109B-S           112      0.6      0        FUNCTIONAL 0        0        0        0
      0
109C-S           109.35   2.5      0        TABULAR    109C-S                     0
      0
111A-S           108.44   2.5      0        TABULAR    111A-S                     0
      0
112A-S           108.22   2.65     0        TABULAR    112A-S                     0
      0
113A-S           108.53   2.5      0        TABULAR    113A-S                     0
      0
116A-S           109.23   2.5      0        TABULAR    116A-S                     0
      0
118A-S           110.06   2.15     0        FUNCTIONAL 0        0        0        0
      0
119A-S           109.73   2.5      0        TABULAR    119A-S                     0
      0
121A-S           109.72   2.5      0        TABULAR    121A-S                     0
      0
121A-S(1)        112.87   0.35     0        FUNCTIONAL 0        0        0        0
      0
121B-S           112.25   0.6      0        FUNCTIONAL 0        0        0        0
      0
203A-S           109.25   2.5      0        TABULAR    203A-S                     0
      0
206A-S           109.73   2.5      0        TABULAR    206A-S                     0
      0
211A-S           109.75   2.5      0        TABULAR    211A-S                     0
      0
218A-S           110.73   2.5      0        TABULAR    218A-S                     0
      0
F-1              105.55   1.3      0        FUNCTIONAL 0        0        0        0
      0
F-10             112.25   0.75     0        FUNCTIONAL 0        0        0        0
      0
F-11             105.68   1        0        FUNCTIONAL 0        0        0        0
      0
F-12             105.64   0.97     0        FUNCTIONAL 0        0        0        0
      0
F-2              105.28   1.62     0        FUNCTIONAL 0        0        0        0
      0
F-4              112.23   0.66     0        FUNCTIONAL 0        0        0        0
      0
F-5              104.41   1.49     0        FUNCTIONAL 0        0        0        0
      0
F-8              106      0.23     0        FUNCTIONAL 0        0        0        0
```

0

F-9	106.04	0.75	0	FUNCTIONAL	0	0	0	0	0
POND-S	104.25	3.5	1.5	TABULAR	POND			0	0
PROP.MH1	105.14	1.7	0	FUNCTIONAL	0	0	0	0	0
PROP.MH2	104.9	1.81	0	FUNCTIONAL	0	0	1.13	0	0
PROP.MH3	104.5	1.94	0	FUNCTIONAL	0	0	1.13	0	0
PROP.MH4	104.4	1.92	0	FUNCTIONAL	0	0	1.13	0	0
PROP.MH5	104.2	2.85	0	FUNCTIONAL	0	0	1.13	0	0
PROP.MH6	104.1	2.45	0	FUNCTIONAL	0	0	1.13	0	0
S-1	104.45	0.91	0	FUNCTIONAL	0	0	0	0	0
S-10	102.6	1.1	0	FUNCTIONAL	0	0	0	0	0
S-11	102.55	1.55	0	FUNCTIONAL	0	0	0	0	0
S-12	102.53	2.09	0	FUNCTIONAL	0	0	0	0	0
S-13	102.51	0.94	0	FUNCTIONAL	0	0	0	0	0
S-14	102.49	1.18	0	FUNCTIONAL	0	0	0	0	0
S-15	102.35	1	0	FUNCTIONAL	0	0	0	0	0
S-16	102.33	1.26	0	FUNCTIONAL	0	0	0	0	0
S-17	102.2	1.1	0	FUNCTIONAL	0	0	0	0	0
S-18	102.18	1.32	0	FUNCTIONAL	0	0	0	0	0
S-19	101.78	1.2	0	FUNCTIONAL	0	0	0	0	0
S-2	103.92	0.76	0	FUNCTIONAL	0	0	0	0	0
S-20	101.69	1.39	0	FUNCTIONAL	0	0	0	0	0
S-21	101.52	1.18	0	FUNCTIONAL	0	0	0	0	0
S-22	101.51	1.19	0	FUNCTIONAL	0	0	0	0	0
S-23	101.36	1.46	0	FUNCTIONAL	0	0	0	0	0
S-24	101.35	1.47	0	FUNCTIONAL	0	0	0	0	0
S-25	101.24	1.43	0	FUNCTIONAL	0	0	0	0	0
S-26	101.22	1.65	0	FUNCTIONAL	0	0	0	0	0
S-27	101.21	0.99	0	FUNCTIONAL	0	0	0	0	0
S-28	101.13	1.11	0	FUNCTIONAL	0	0	0	0	0
S-29	100.77	1.18	0	FUNCTIONAL	0	0	0	0	0
S-3	103.88	0.73	0	FUNCTIONAL	0	0	0	0	0

```
S-30             99.63    2.27     0        FUNCTIONAL 0        0        0        0
      0
S-4              103.52   0.98     0        FUNCTIONAL 0        0        0        0
      0
S-5              103.2    0.9      0        FUNCTIONAL 0        0        0        0
      0
S-6              102.8    1.1      0        FUNCTIONAL 0        0        0        0
      0
S-7              102.7    1.08     0        FUNCTIONAL 0        0        0        0
      0
S-8              102.69   1.09     0        FUNCTIONAL 0        0        0        0
      0
S-9              102.61   1.09     0        FUNCTIONAL 0        0        0        0
      0
SU1              102.69   1.09     0        FUNCTIONAL 0        0        0        0
      0

[CONDUITS]
;;               Inlet            Outlet                      Manning    Inlet
Outlet     Init.      Max.
;;Name           Node             Node             Length     N          Offset
Offset     Flow       Flow
;;-------------- ---------------- ---------------- ---------- ---------- ----------
---------- ---------- ----------
C1               121A-S(1)        121A-S           20         0.013      112.87
111.87     0          0
C10              119A-S           113A-S           20         0.013      111.88
110.68     0          0
C11              119A-S           116A-S           20         0.013      111.88
111.38     0          0
C12              118A-S           116A-S           86         0.013      111.86
111.38     0          0
C13              203A-S           116A-S           4          0.013      111.4
111.38     0          0
C14              206A-S           118A-S           4          0.013      111.88
111.86     0          0
C15              HWL130B          F-1              17.5       0.035      105.7
105.55     0          0
C16              116A-S           113A-S           20         0.013      111.38
110.68     0          0
C17              113A-S           112A-S           20         0.013      110.68
110.37     0          0
C18              111A-S           112A-S           48         0.013      110.59
110.37     0          0
C19              107A-S           106A-S(1)        6          0.013      110.39
110.36     0          0
C2               102              100B             72.87      0.013      106.5
106.28     0          0
C20              F-4              F-5              371        0.035      112.23
105.5      0          0
C21              106A-S           POND-S           20         0.013      108
107.44     0          0
C23              102A-S           102A-S(1)        5          0.025      110.27
107.5      0          0
C24              100B             POND-S           22         0.013      105.85
105.75     0          0
C25              102A-S(1)        POND-S           10         0.025      107.5
107.35     0          0
C26              112A-S           102A-S(1)        153        0.025      110.37
107.5      0          0
C27              121B-S           121A-S           2          0.025      112.25
112        0          0
C28              109B-S           121A-S           2          0.025      112
```

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111.87      0           0
C29                     106B-S          106A-S(1)       2           0.025       110.9
110.36      0           0
C3                      121A-S          109C-S          20          0.013       111.87
111.5       0           0
C30                     109A-S          109C-S          50          0.013       112
111.5       0           0
C31                     outlet          HWL130B         24.7        0.013       105.75
105.7       0           0
C32                     F-1             F-2             30.3        0.035       105.55
105.33      0           0
C33                     PROP.MH1        PROP.MH2        24          0.013       105.13
105.08      0           0
C34                     PROP.MH2        PROP.MH3        138         0.013       105.07
104.81      0           0
C35                     S-1             S-2             58          0.035       104.45
103.92      0           0
C36                     S-2             S-3             12.7        0.035       103.92
103.88      0           0
C37                     PROP.MH3        PROP.MH4        63          0.013       104.8
104.68      0           0
C38                     S-4             S-5             120.6       0.035       103.52
103.2       0           0
C39                     F-8             S-1             205         0.035       106
104.45      0           0
C4                      109C-S          106A-S(1)       20          0.013       111.5
110.36      0           0
C40                     F-10            F-2             362.7       0.035       112.25
105.28      0           0
C40_1                   S-6             S-7             84.01       0.035       102.8
102.7       0           0
C40_2                   SU1             S-9             80.4        0.035       102.69
102.61      0           0
C41                     F-8             F-5             146.4       0.035       106
105.5       0           0
C42                     S-10            S-11            37.6        0.035       102.6
102.55      0           0
C43                     F-9             F-11            79.1        0.035       106.04
105.68      0           0
C44                     S-12            S-13            27.5        0.035       102.53
102.51      0           0
C45                     S-8             SU1             1           0.035       102.69
102.69      0           0
C46                     S-14            S-15            75.2        0.035       102.49
102.35      0           0
C47                     F-12            F-1             25          0.035       105.64
105.55      0           0
C48                     S-16            S-17            76          0.035       102.33
102.2       0           0
C49                     F-5             PROP.MH1        3           0.035       105.15
105.14      0           0
C5                      106A-S(1)       106A-S          100         0.013       110.36
108         0           0
C50                     S-18            S-19            159.9       0.035       102.18
101.78      0           0
C51                     PROP.MH4        PROP.MH5        74          0.013       104.67
104.54      0           0
C52                     S-20            S-21            83.13       0.035       101.69
101.52      0           0
C53                     PROP.MH5        PROP.MH6        48          0.013       104.53
104.46      0           0
C54                     S-22            S-23            70.5        0.035       101.51
101.36      0           0
```

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C55                 PROP.MH6          S-1               1           0.013       104.45
104.44      0           0
C56                 S-24              S-25              53.5        0.035       101.35
101.24      0           0
C58                 S-26              S-27              8.3         0.035       101.22
101.21      0           0
C6                  108A-S            106A-S(1)         5           0.013       111
110.95      0           0
C60                 S-28              S-29              48.8        0.035       101.13
100.77      0           0
C61                 S-29              S-30              39.4        0.035       100.77
99.63       0           0
C7                  218A-S            121A-S(1)         2           0.013       112.88
112.87      0           0
C8                  121A-S(1)         119A-S            20          0.013       112.87
111.88      0           0
C9                  211A-S            119A-S            4           0.013       111.9
111.88      0           0
CLVT-1              F-2               PROP.MH1          18.9        0.024       105.28
105.14      0           0
CLVT-10             S-15              S-16              7.3         0.024       102.35
102.33      0           0
CLVT-11             S-17              S-18              7.1         0.024       102.2
102.18      0           0
CLVT-12             S-19              S-20              3.1         0.024       101.78
101.69      0           0
CLVT-13             S-21              S-22              4           0.024       101.52
101.51      0           0
CLVT-14             S-23              S-24              3.1         0.024       101.36
101.35      0           0
CLVT-15             S-25              S-26              9           0.024       101.24
101.22      0           0
CLVT-16             S-27              S-28              3.1         0.024       101.21
101.13      0           0
CLVT-17             S-30              SU31              25          0.024       99.63
99.51       0           0
CLVT-2              F-11              F-12              30.1        0.024       105.68
105.64      0           0
CLVT-4              S-3               S-4               5.4         0.024       103.88
103.52      0           0
CLVT-5              S-5               S-6               25.4        0.024       103.2
102.8       0           0
CLVT-6              S-7               S-8               3.1         0.024       102.7
102.69      0           0
CLVT-7              S-9               S-10              2.93        0.024       102.61
102.6       0           0
CLVT-8              S-11              S-12              15          0.024       102.55
102.53      0           0
CLVT-9              S-13              S-14              7.5         0.024       102.51
102.49      0           0
Pipe_1              102               101               9.87        0.013       105.66
105.64      0           0
Pipe_22             112               103               156.728     0.013       106.241
106.084     0           0
Pipe_23             110               104               140.191     0.013       107.677
107.257     0           0
Pipe_24_(1)         111               110               203.904     0.013       108.349
107.737     0           0
Pipe_27             117               116               85.874      0.013       107.858
107.729     0           0
Pipe_28             118               117               85.068      0.013       108.21
108.083     0           0
Pipe_29_(1)         116               115               227.891     0.013       107.204
```

```
106.976    0         0
Pipe_3_(1)       106              105              212.193    0.013      106.868
106.656    0         0
Pipe_30_(1)      119              115              274.488    0.013      107.538
107.126    0         0
Pipe_31          120              119              53.76      0.013      107.849
107.688    0         0
Pipe_32          121              120              65.24      0.013      108.896
108.374    0         0
Pipe_35          107              106              135.621    0.013      107.454
107.318    0         0
Pipe_43          103              102              45.979     0.013      105.77
105.71     0         0
Pipe_44          113              112              66.392     0.013      107.598
107.366    0         0
Pipe_47          204              117              75.004     0.013      108.045
107.933    0         0
Pipe_48          205              204              82.176     0.013      108.228
108.105    0         0
Pipe_49          206              205              164.822    0.013      108.536
108.288    0         0
Pipe_5           108              106              240        0.013      107.258
107.018    0         0
Pipe_50          200              116              77.768     0.013      107.62
107.504    0         0
Pipe_50_(1)      201              200              158.607    0.013      107.863
107.625    0         0
Pipe_51          202              201              20.319     0.013      107.923
107.893    0         0
Pipe_52          203              202              148.464    0.013      108.176
107.953    0         0
Pipe_53          207              115              79.926     0.013      107.206
107.126    0         0
Pipe_53_(1)      208              207              79.1       0.013      107.288
107.209    0         0
Pipe_54          209              208              264.023    0.013      107.612
107.348    0         0
Pipe_55          210              209              15.557     0.013      107.658
107.642    0         0
Pipe_56          211              210              83.021     0.013      107.771
107.688    0         0
Pipe_58          218              217              188.555    0.013      108.857
108.575    0         0
Pipe_59          217              216              19.773     0.013      108.545
108.515    0         0
Pipe_6           109              108              97.573     0.013      108.004
107.858    0         0
Pipe_61          212              120              89.327     0.013      108.043
107.909    0         0
Pipe_62          213              212              72.822     0.013      108.212
108.103    0         0
Pipe_63          214              213              25.111     0.013      108.31
108.272    0         0
Pipe_63_(1)      215              214              21.157     0.013      108.372
108.34     0         0
Pipe_63_(1)_(1)  216              215              55.562     0.013      108.485
108.402    0         0
Pipe_64          114              112              77.623     0.013      106.379
106.301    0         0
Pipe_65          115              114              87.275     0.013      106.526
106.439    0         0
Pipe_68          104              103              47.498     0.013      106.582
106.534    0         0
```

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Pipe_69          105              104              11.063     0.013      106.596
106.585    0         0
Pipe_7           101              POND-S           21.827     0.013      105.61
105.55     0         0

[ORIFICES]
;;               Inlet            Outlet           Orifice      Crest      Disch.
 Flap Open/Close
;;Name           Node             Node             Type         Height     Coeff.
 Gate Time
;;-------------- ---------------- ---------------- ------------ ----------
---------- ---- ----------
C22              POND-S           outlet           SIDE         105.75     0.61
 NO   0

[WEIRS]
;;               Inlet            Outlet           Weir         Crest      Disch.
 Flap End      End
;;Name           Node             Node             Type         Height     Coeff.
 Gate Con.     Coeff.     Surcharge  RoadWidth  RoadSurf
;;-------------- ---------------- ---------------- ------------ ----------
---------- ---- -------- ---------- ---------- ---------- ----------
Pond-weir        POND-S           outlet           TRANSVERSE   106.15     1.7
 NO   0        0          YES
Spillway         POND-S           F-1              TRANSVERSE   107.65     1.74
 NO   0        0          YES
W1               S-5              S-6              TRANSVERSE   103.7      1.74
 NO   0        0          YES
W10              S-25             S-26             TRANSVERSE   102.67     1.74
 NO   0        0          YES
W11              S-27             S-28             TRANSVERSE   102.14     1.74
 NO   0        0          YES
W12              S-7              S-8              TRANSVERSE   103.13     1.74
 NO   0        0          YES
W13              S-9              S-10             TRANSVERSE   103.51     1.74
 NO   0        0          YES
W2               S-3              S-4              TRANSVERSE   104.33     1.74
 NO   0        0          YES
W3               S-11             S-12             TRANSVERSE   103.96     1.74
 NO   0        0          YES
W4               S-13             S-14             TRANSVERSE   103.41     1.74
 NO   0        0          YES
W5               S-15             S-16             TRANSVERSE   103.29     1.74
 NO   0        0          YES
W6               S-17             S-18             TRANSVERSE   103.1      1.74
 NO   0        0          YES
W7               S-19             S-20             TRANSVERSE   102.88     1.74
 NO   0        0          YES
W8               S-21             S-22             TRANSVERSE   102.42     1.74
 NO   0        0          YES
W9               S-23             S-24             TRANSVERSE   102.45     1.74
 NO   0        0          YES

[OUTLETS]
;;               Inlet            Outlet           Outflow    Outlet
Qcoeff/                     Flap
;;Name           Node             Node             Height     Type
QTable           Qexpon     Gate
;;-------------- ---------------- ---------------- ---------- ----------------
---------------- ---------- ----
102A-IC          102A-S           102              108.12     TABULAR/HEAD
102A-IC                     NO
106A-IC          106A-S(1)        106              108.56     TABULAR/HEAD
```

106A-IC		NO			
106B-IC	106B-S		106	109.1	TABULAR/HEAD
106B-IC		NO			
107A-IC	107A-S		107	108.24	TABULAR/HEAD
107A-IC		NO			
108A-IC	108A-S		108	108.85	TABULAR/HEAD
108A-IC		NO			
109A-IC	109A-S		109	110.2	TABULAR/HEAD
109A-IC		NO			
109C-IC	109C-S		109	109.35	TABULAR/HEAD
109C-IC		NO			
111A-IC	111A-S		111	108.44	TABULAR/HEAD
111A-IC		NO			
112A-IC	112A-S		112	108.22	TABULAR/HEAD
112A-IC		NO			
113A-IC	113A-S		113	108.53	TABULAR/HEAD
113A-IC		NO			
116A-IC	116A-S		116	109.23	TABULAR/HEAD
116A-IC		NO			
118A-IC	118A-S		118	110.06	TABULAR/HEAD
118A-IC		NO			
119A-IC	119A-S		119	109.73	TABULAR/HEAD
119A-IC		NO			
121A-IC	121A-S		121	109.72	TABULAR/HEAD
121A-IC		NO			
203A-IC	203A-S		203	109.25	TABULAR/HEAD
203A-IC		NO			
206A-IC	206A-S		206	109.73	TABULAR/HEAD
206A-IC		NO			
211A-IC	211A-S		211	109.75	TABULAR/HEAD
211A-IC		NO			
218A-IC	218A-S		218	110.73	TABULAR/HEAD
218A-IC		NO			

[XSECTIONS]

;;Link	Shape	Geom1	Geom2	Geom3	Geom4	Barrels
C1	IRREGULAR	24mROW	0	0	0	1
C10	IRREGULAR	18mROW	0	0	0	1
C11	IRREGULAR	24mROW	0	0	0	1
C12	IRREGULAR	24mROW	0	0	0	1
C13	IRREGULAR	18mROW	0	0	0	1
C14	IRREGULAR	18mROW	0	0	0	1
C15	TRAPEZOIDAL	0.65	1	3	3	1
C16	IRREGULAR	18mROW	0	0	0	1
C17	IRREGULAR	18mROW	0	0	0	1
C18	IRREGULAR	18mROW	0	0	0	1
C19	IRREGULAR	18mROW	0	0	0	1
C2	RECT_CLOSED	1.35	2.1	0	0	1

C20	IRREGULAR	FERN-1	0	0	0	1
C21	TRAPEZOIDAL	0.5	2	10	10	1
C23	TRAPEZOIDAL	0.5	1	3	3	1
C24	RECT_CLOSED	1.35	2.1	0	0	1
C25	TRAPEZOIDAL	0.5	4	3	3	1
C26	TRAPEZOIDAL	0.5	4	3	3	1
C27	TRIANGULAR	0.6	3.6	0	0	1
C28	TRIANGULAR	0.6	3.6	0	0	1
C29	TRIANGULAR	1	6	0	0	1
C3	IRREGULAR	24mROW	0	0	0	1
C30	IRREGULAR	24mROW	0	0	0	1
C31	CIRCULAR	1.05	0	0	0	1
C32	IRREGULAR	DITCH-A	0	0	0	1
C33	RECT_CLOSED	0.9	1.2	0	0	1
C34	RECT_CLOSED	0.9	1.2	0	0	1
C35	IRREGULAR	DITCH-B	0	0	0	1
C36	IRREGULAR	DITCH-C	0	0	0	1
C37	RECT_CLOSED	0.9	1.2	0	0	1
C38	IRREGULAR	DITCH-C1	0	0	0	1
C39	IRREGULAR	SHEA-1	0	0	0	1
C4	IRREGULAR	24mROW	0	0	0	1
C40	IRREGULAR	FERN-4	0	0	0	1
C40_1	IRREGULAR	DITCH-D3	0	0	0	1
C40_2	IRREGULAR	DITCH-D	0	0	0	1
C41	IRREGULAR	FERN-3	0	0	0	1
C42	IRREGULAR	DITCH-D1	0	0	0	1
C43	IRREGULAR	FERN-5	0	0	0	1
C44	IRREGULAR	DITCH-D2	0	0	0	1
C45	IRREGULAR	DITCH-D4	0	0	0	1
C46	IRREGULAR	DITCH-E	0	0	0	1
C47	IRREGULAR	FERN-6	0	0	0	1
C48	IRREGULAR	DITCH-F	0	0	0	1

C49	CIRCULAR	0.375	0	0	0	1
C5	IRREGULAR	24mROW	0	0	0	1
C50	IRREGULAR	DITCH-G	0	0	0	1
C51	RECT_CLOSED	0.9	1.2	0	0	1
C52	IRREGULAR	DITCH-H	0	0	0	1
C53	RECT_CLOSED	0.9	1.2	0	0	1
C54	IRREGULAR	DITCH-I	0	0	0	1
C55	RECT_CLOSED	0.9	1.2	0	0	1
C56	IRREGULAR	DITCH-J	0	0	0	1
C58	IRREGULAR	DITCH-J1	0	0	0	1
C6	IRREGULAR	16.5mROW	0	0	0	1
C60	IRREGULAR	DITCH-K	0	0	0	1
C61	IRREGULAR	DITCH-L	0	0	0	1
C7	IRREGULAR	18mROW	0	0	0	1
C8	IRREGULAR	24mROW	0	0	0	1
C9	IRREGULAR	18mROW	0	0	0	1
CLVT-1	CIRCULAR	0.7	0	0	0	1
CLVT-10	CIRCULAR	0.9	0	0	0	1
CLVT-11	CIRCULAR	0.9	0	0	0	1
CLVT-12	CIRCULAR	0.9	0	0	0	1
CLVT-13	CIRCULAR	0.9	0	0	0	1
CLVT-14	CIRCULAR	0.9	0	0	0	1
CLVT-15	CIRCULAR	0.9	0	0	0	1
CLVT-16	CIRCULAR	0.9	0	0	0	1
CLVT-17	CIRCULAR	2.3	0	0	0	1
CLVT-2	CIRCULAR	0.45	0	0	0	1
CLVT-4	CIRCULAR	0.35	0	0	0	1
CLVT-5	CIRCULAR	0.5	0	0	0	1
CLVT-6	CIRCULAR	0.7	0	0	0	1
CLVT-7	CIRCULAR	0.9	0	0	0	1
CLVT-8	CIRCULAR	0.9	0	0	0	1

CLVT-9	CIRCULAR	0.9	0	0	0	1
Pipe_1	CIRCULAR	1.5	0	0	0	1
Pipe_22	CIRCULAR	1.8	0	0	0	1
Pipe_23	CIRCULAR	0.675	0	0	0	1
Pipe_24_(1)	CIRCULAR	0.675	0	0	0	1
Pipe_27	CIRCULAR	0.825	0	0	0	1
Pipe_28	CIRCULAR	0.6	0	0	0	1
Pipe_29_(1)	CIRCULAR	1.35	0	0	0	1
Pipe_3_(1)	CIRCULAR	1.35	0	0	0	1
Pipe_30_(1)	CIRCULAR	1.2	0	0	0	1
Pipe_31	CIRCULAR	1.05	0	0	0	1
Pipe_32	CIRCULAR	0.525	0	0	0	1
Pipe_35	CIRCULAR	0.9	0	0	0	1
Pipe_43	CIRCULAR	2.1	0	0	0	1
Pipe_44	CIRCULAR	0.675	0	0	0	1
Pipe_47	CIRCULAR	0.75	0	0	0	1
Pipe_48	CIRCULAR	0.75	0	0	0	1
Pipe_49	CIRCULAR	0.75	0	0	0	1
Pipe_5	CIRCULAR	1.2	0	0	0	1
Pipe_50	CIRCULAR	1.05	0	0	0	1
Pipe_50_(1)	CIRCULAR	1.05	0	0	0	1
Pipe_51	CIRCULAR	1.05	0	0	0	1
Pipe_52	CIRCULAR	1.05	0	0	0	1
Pipe_53	CIRCULAR	1.2	0	0	0	1
Pipe_53_(1)	CIRCULAR	1.2	0	0	0	1
Pipe_54	CIRCULAR	1.2	0	0	0	1
Pipe_55	CIRCULAR	1.2	0	0	0	1
Pipe_56	CIRCULAR	1.2	0	0	0	1
Pipe_58	CIRCULAR	1.05	0	0	0	1
Pipe_59	CIRCULAR	1.05	0	0	0	1
Pipe_6	CIRCULAR	0.6	0	0	0	1
Pipe_61	CIRCULAR	1.05	0	0	0	1

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Pipe_62          CIRCULAR     1.05             0          0          0          1

Pipe_63          CIRCULAR     1.05             0          0          0          1

Pipe_63_(1)      CIRCULAR     1.05             0          0          0          1

Pipe_63_(1)_(1)  CIRCULAR     1.05             0          0          0          1

Pipe_64          CIRCULAR     1.8              0          0          0          1

Pipe_65          CIRCULAR     1.8              0          0          0          1

Pipe_68          CIRCULAR     1.35             0          0          0          1

Pipe_69          CIRCULAR     1.35             0          0          0          1

Pipe_7           CIRCULAR     1.5              0          0          0          1

C22              CIRCULAR     0.25             0          0          0
Pond-weir        RECT_OPEN    1.15             0.3        0          0
Spillway         RECT_OPEN    1                10         3          3
W1               RECT_OPEN    0.3              4          10         10
W10              RECT_OPEN    0.3              4          10         10
W11              RECT_OPEN    0.3              4          10         10
W12              RECT_OPEN    0.3              4          10         10
W13              RECT_OPEN    0.3              4          10         10
W2               RECT_OPEN    0.3              4          10         10
W3               RECT_OPEN    0.3              4          10         10
W4               RECT_OPEN    0.3              4          10         10
W5               RECT_OPEN    0.3              4          10         10
W6               RECT_OPEN    0.3              4          10         10
W7               RECT_OPEN    0.3              4          10         10
W8               RECT_OPEN    0.3              4          10         10
W9               RECT_OPEN    0.3              4          10         10

[TRANSECTS]

;Full street, width = 8.5m, curb = 0.15m , cross-slope = 0.02m/m, bank-slope =
0.02m/m, bank-height = 0.23m.
NC 0.02     0.02     0.013
X1 16.5mROW         7        4        12.5     0.0       0.0       0.0      0.0
0.0
GR 0.23     0        0.15     4        0        4        0.13     8.25     0
12.5
GR 0.15     12.5     0.23     16.5

;Full street, width = 8.5m, curb = 0.15m , cross-slope = 0.03m/m, bank-slope =
0.02m/m, bank-height = 0.245m.
NC 0.025    0.025    0.013
X1 18mROW           7        10       18.5     0.0       0.0       0.0      0.0
0.0
GR 0.35     0        0.15     10       0        10       0.13     14.25    0
18.5
GR 0.15     18.5     0.35     28

;Full street, width = 8.5m, curb = 0.15m , cross-slope = 0.03m/m, bank-slope =
0.02m/m, bank-height = 0.27m.
NC 0.02     0.02     0.013
X1 20mROW           7        10       18.5     0.0       0.0       0.0      0.0
0.0
GR 0.35     0        0.15     10       0        10       0.13     14.25    0
18.5
```

```
GR 0.15     18.5     0.35     28.5

;Full street, width = 24m, curb = 0.15m , cross-slope = 0.016m/m, bank-slope =
0.02m/m, bank-height = 0.23m.
NC 0.025    0.025    0.014
X1 24mROW           7        10       21       0.0       0.0       0.0      0.0
0.0
GR 0.35     0        0.15     10        0        10        0.13     15.5     0
21
GR 0.15     21       0.35     31

NC 0.035    0.035    0.035
X1 DITCH-A          3        0.0      8.4      0.0       0.0       0.0      0.0
0.0
GR 105.9    0        105.55   3.3       106.83   8.4

NC 0.035    0.035    0.035
X1 DITCH-B          4        0.0      6.3      0.0       0.0       0.0      0.0
0.0
GR 105.26   0        104.45   2.66      106.46   5         106.56   6.3

NC 0.045    0.045    0.045
X1 DITCH-C          4        0.0      6.9      0.0       0.0       0.0      0.0
0.0
GR 104.61   0        103.92   2.1       105.48   5         105.6    6.9

NC 0.045    0.045    0.045
X1 DITCH-C1         4        0.0      6.9      0.0       0.0       0.0      0.0
0.0
GR 104.21   0        103.52   2.1       105.08   5         105.2    6.9

NC 0.045    0.045    0.045
X1 DITCH-D          4        0.0      6.62     0.0       0.0       0.0      0.0
0.0
GR 103.55   0        102.7    1.77      104.7    5.19      104.9    6.62

NC 0.045    0.045    0.045
X1 DITCH-D1         4        0.0      6.62     0.0       0.0       0.0      0.0
0.0
GR 103.54   0        102.69   1.77      104.7    5.19      104.9    6.62

NC 0.045    0.045    0.045
X1 DITCH-D2         4        0.0      6.62     0.0       0.0       0.0      0.0
0.0
GR 103.41   0        102.56   1.77      104.57   5.19      104.77   6.62

NC 0.045    0.045    0.045
X1 DITCH-D3         4        0.0      0.0      0.0       0.0       0.0      0.0
0.0
GR 103.65   0        102.8    1.77      104.81   5.19      105.01   6.62

NC 0.035    0.035    0.035
X1 DITCH-D4         4        0.0      6.62     0.0       0.0       0.0      0.0
0.0
GR 103.23   0        102.38   1.77      104.38   5.19      104.58   6.62

NC 0.045    0.045    0.045
X1 DITCH-E          4        0.0      9.4      0.0       0.0       0.0      0.0
0.0
GR 103.11   0        103.01   3.7       102.55   6.6       104.29   9.4

NC 0.045    0.045    0.045
X1 DITCH-F          5        0.0      5.2      0.0       0.0       0.0      0.0
```

```
0.0
GR 103.07   0        102.61   1.5      102.36   2.5      102.5    3        104.14
5.2

NC 0.045    0.045    0.045
X1 DITCH-G          6        0.0      7        0.0      0.0       0.0      0.0
0.0
GR 103.03   0        102.45   1        102.21   2.5      102.45   3.2      104.09
6
GR 104.17   7

NC 0.045    0.045    0.045
X1 DITCH-H          5        0.0      5.2      0.0      0.0       0.0      0.0
0.0
GR 102.88   0        102.07   1.5      101.85   2.9      102.45   3.8      103.66
5.2

NC 0.045    0.045    0.045
X1 DITCH-I          4        0.0      5        0.0      0.0       0.0      0.0
0.0
GR 102.31   0        101.65   2.5      103.24   4.2      103.35   5

NC 0.045    0.045    0.045
X1 DITCH-J          6        0.0      4.7      0.0      0.0       0.0      0.0
0.0
GR 102.44   0        101.63   0.8      101.55   1.1      101.74   1.5      103.25
3.7
GR 103.38   4.7

NC 0.045    0.045    0.045
X1 DITCH-J1         6        0.0      4.7      0.0      0.0       0.0      0.0
0.0
GR 102.12   0        101.31   0.8      101.23   1.1      101.42   1.5      102.93
3.7
GR 103.06   4.7

NC 0.045    0.045    0.045
X1 DITCH-K          6        0.0      5.2      0.0      0.0       0.0      0.0
0.0
GR 101.94   0        101.28   1.2      101.13   1.6      101.18   1.8      102.8
4.2
GR 102.96   5.2

NC 0.035    0.035    0.035
X1 DITCH-L          5        0.0      5        0.0      0.0       0.0      0.0
0.0
GR 102.16   0        100.9    2.1      100.77   2.5      100.93   2.8      102.42
5

NC 0.035    0.035    0.035
X1 FERN-1           3        0.0      7.7      0.0      0.0       0.0      0.0
0.0
GR 112.79   0        112.23   3.4      113.58   7.7

NC 0.035    0.035    0.035
X1 FERN-2           3        0.0      6.8      0.0      0.0       0.0      0.0
0.0
GR 106.29   0        106      1.13     107.53   6.8

NC 0.035    0.035    0.035
X1 FERN-3           3        0.0      5.5      0.0      0.0       0.0      0.0
0.0
GR 105.89   0        105.43   1.2      106.5    5.5
```

```
NC 0.035    0.035    0.035
X1 FERN-4           3        0.0      8.2      0.0       0.0       0.0      0.0
0.0
GR 112.69   0        112.25   2.6      113.79   8.2

NC 0.035    0.035    0.035
X1 FERN-5           3        0.0      5.3      0.0       0.0       0.0      0.0
0.0
GR 106.45   0        106.04   1.2      107.26   5.3

NC 0.035    0.035    0.035
X1 FERN-6           3        0.0      0.0      0.0       0.0       0.0      0.0
0.0
GR 106.05   0        105.64   1.2      106.86   5.3

NC 0.035    0.035    0.035
X1 FERN-7           3        0.0      5.5      0.0       0.0       0.0      0.0
0.0
GR 105.76   0        105.3    1.2      106.37   5.5

NC 0.035    0.035    0.035
X1 SHEA-1           4        0.0      5.42     0.0       0.0       0.0      0.0
0.0
GR 106.55   0        106      1.45     106      2.17      107.08   5.42

[LOSSES]
;;Link           Inlet      Outlet     Average    Flap Gate  SeepageRate
;;-------------- ---------- ---------- ---------- ---------- ----------
C2               0          0.39       0          NO         0
C24              0          0.06       0          NO         0
C33              0          1.32       0          NO         0
C34              0          0.39       0          NO         0
C37              0          0.39       0          NO         0
C51              0          1.32       0          NO         0
C53              0          0.14       0          NO         0
Pipe_1           0          0.39       0          NO         0
Pipe_22          0          1.32       0          NO         0
Pipe_23          0          1.32       0          NO         0
Pipe_24_(1)      0          1.32       0          NO         0
Pipe_27          0          0.06       0          NO         0
Pipe_28          0          0.06       0          NO         0
Pipe_29_(1)      0          0.02       0          NO         0
Pipe_3_(1)       0          0.02       0          NO         0
Pipe_30_(1)      0          0.02       0          NO         0
Pipe_31          0          0.14       0          NO         0
Pipe_32          0          0.21       0          NO         0
Pipe_35          0          1.32       0          NO         0
Pipe_43          0          1.32       0          NO         0
Pipe_44          0          1.32       0          NO         0
Pipe_47          0          1.32       0          NO         0
Pipe_48          0          1.32       0          NO         0
Pipe_49          0          0.02       0          NO         0
Pipe_5           0          0.06       0          NO         0
Pipe_50          0          1.32       0          NO         0
Pipe_50_(1)      0          0.06       0          NO         0
Pipe_51          0          0.39       0          NO         0
Pipe_52          0          0.39       0          NO         0
Pipe_53          0          0.06       0          NO         0
Pipe_53_(1)      0          0.06       0          NO         0
Pipe_54          0          0.02       0          NO         0
Pipe_55          0          0.39       0          NO         0
Pipe_56          0          0.64       0          NO         0
```

Pipe_58	0	0.39	0	NO	0
Pipe_59	0	0.39	0	NO	0
Pipe_6	0	0.06	0	NO	0
Pipe_61	0	1.32	0	NO	0
Pipe_62	0	1.32	0	NO	0
Pipe_63	0	0.02	0	NO	0
Pipe_63_(1)	0	0.64	0	NO	0
Pipe_63_(1)_(1)	0	0.64	0	NO	0
Pipe_64	0	0.02	0	NO	0
Pipe_65	0	0.02	0	NO	0
Pipe_68	0	1.32	0	NO	0
Pipe_69	0	0.06	0	NO	0
Pipe_7	0	0.64	0	NO	0

```
[CURVES]
;;Name           Type       X-Value    Y-Value
;;-------------- ---------- ---------- ----------
102A-IC          Rating     0          0
102A-IC                     1.8        315
102A-IC                     2.15       315
102A-IC                     2.65       316

106A-IC          Rating     0          0
106A-IC                     1.8        207
106A-IC                     2.15       207

106B-IC          Rating     0          0
106B-IC                     1.8        18
106B-IC                     2.8        18

107A-IC          Rating     0          0
107A-IC                     1.8        504
107A-IC                     2.15       504
107A-IC                     2.5        505

108A-IC          Rating     0          0
108A-IC                     1.8        518
108A-IC                     2.15       518
108A-IC                     2.5        519

109A-IC          Rating     0          0
109A-IC                     1.8        128
109A-IC                     2.15       128

109B-IC          Rating     0          0
109B-IC                     1.8        1
109B-IC                     2.15       1

109C-IC          Rating     0          0
109C-IC                     1.8        40
109C-IC                     2.15       41
109C-IC                     2.5        41

111A-IC          Rating     0          0
111A-IC                     1.8        375
111A-IC                     2.15       375
111A-IC                     2.5        375

112A-IC          Rating     0          0
112A-IC                     1.8        216
112A-IC                     2.15       216
112A-IC                     2.65       216
```

```
113A-IC          Rating     0          0
113A-IC                     1.8        418
113A-IC                     2.15       418
113A-IC                     2.5        418

116A-IC          Rating     0          0
116A-IC                     1.8        319
116A-IC                     2.15       319
116A-IC                     2.5        320

118A-IC          Rating     0          0
118A-IC                     1.8        193
118A-IC                     2.15       193

119A-IC          Rating     0          0
119A-IC                     1.8        473
119A-IC                     2.15       473
119A-IC                     2.5        474

119A-IC(1)       Rating     0          0
119A-IC(1)                  1.8        473
119A-IC(1)                  2.15       473

121A-IC          Rating     0          0
121A-IC                     1.8        241
121A-IC                     2.15       241
121A-IC                     2.5        242

121B-IC          Rating     0          0
121B-IC                     1.8        1
121B-IC                     2.15       1

203A-IC          Rating     0          0
203A-IC                     1.8        837
203A-IC                     2.15       837
203A-IC                     2.5        837

206A-IC          Rating     0          0
206A-IC                     1.8        337
206A-IC                     2.15       337
206A-IC                     2.5        337

211A-IC          Rating     0          0
211A-IC                     1.8        976
211A-IC                     2.15       976
211A-IC                     2.5        976

218A-IC          Rating     0          0
218A-IC                     1.8        802
218A-IC                     2.15       802
218A-IC                     2.5        802

102A-S           Storage    0          0
102A-S                      1.8        0
102A-S                      2.15       380
102A-S                      2.65       380

106A-S           Storage    0          0
106A-S                      1.8        0
106A-S                      2.15       100

107A-S           Storage    0          0
107A-S                      1.8        0
```

```
107A-S                          2.15        450
107A-S                          2.5         450

108A-S           Storage        0           0
108A-S                          1.8         0
108A-S                          2.15        1870
108A-S                          2.5         1870

109A-S           Storage        0           0
109A-S                          1.8         0
109A-S                          2.15        100

109C-S           Storage        0           0
109C-S                          1.8         0
109C-S                          2.15        41
109C-S                          2.5         41

111A-S           Storage        0           0
111A-S                          1.8         0
111A-S                          2.15        305
111A-S                          2.5         305

112A-S           Storage        0           0
112A-S                          1.8         0
112A-S                          2.15        103
112A-S                          2.65        103

113A-S           Storage        0           0
113A-S                          1.8         0
113A-S                          2.15        265
113A-S                          2.5         265

116A-S           Storage        0           0
116A-S                          1.8         0
116A-S                          2.15        175
116A-S                          2.5         175

118A-S           Storage        0           0
118A-S                          1.8         0
118A-S                          2.15        50

119A-S           Storage        0           0
119A-S                          1.8         0
119A-S                          2.15        322
119A-S                          2.5         322

121A-S           Storage        0           0
121A-S                          1.8         0
121A-S                          2.15        166
121A-S                          2.5         166

203A-S           Storage        0           0
203A-S                          1.8         0
203A-S                          2.15        695
203A-S                          2.5         695

206A-S           Storage        0           0
206A-S                          1.8         0
206A-S                          2.15        328
206A-S                          2.5         328

211A-S           Storage        0           0
211A-S                          1.8         0
```

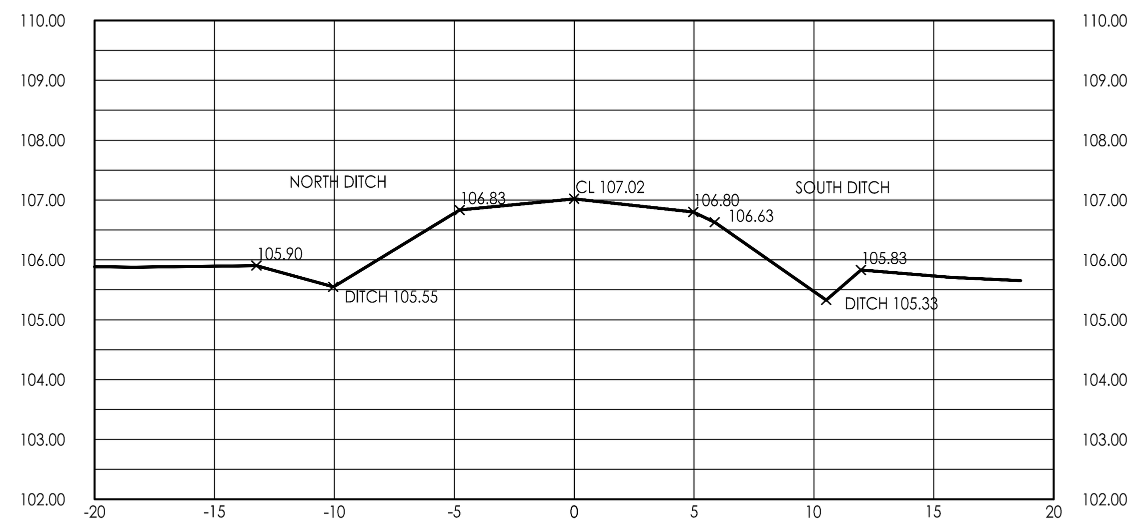
```
211A-S                          2.15        906
211A-S                          2.5         906

218A-S          Storage         0           0
218A-S                          1.8         0
218A-S                          2.15        695
218A-S                          2.5         695

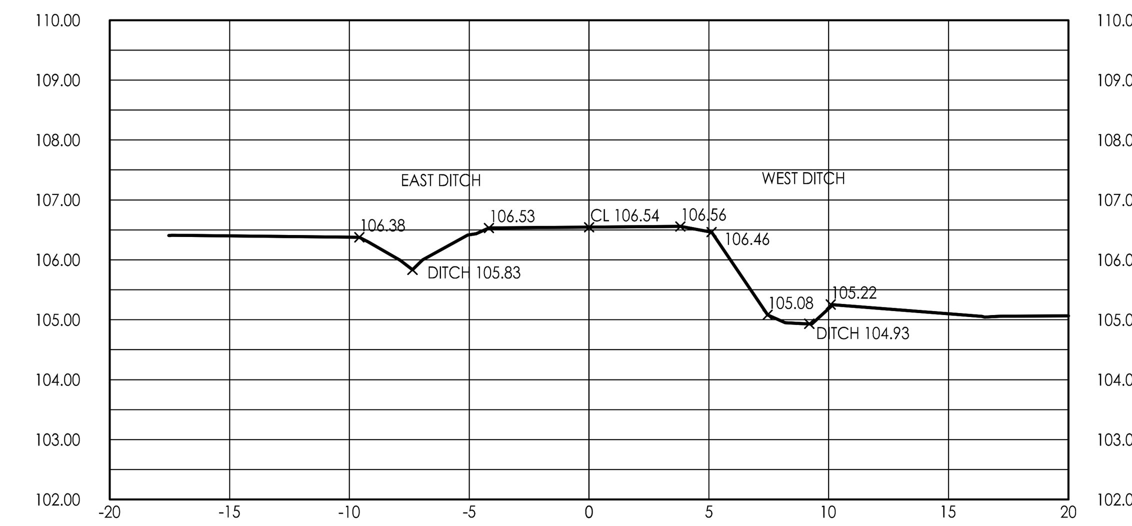
POND            Storage         0.00        4995
POND                            1.20        6920
POND                            1.30        8659
POND                            1.40        10399
POND                            1.50        12138
POND                            1.90        15072
POND                            2.00        15665
POND                            2.10        16258
POND                            2.75        18009
POND                            3.09        18925
POND                            3.20        19204
POND                            3.50        19500


;;-------------- ---------------- ----------------
```

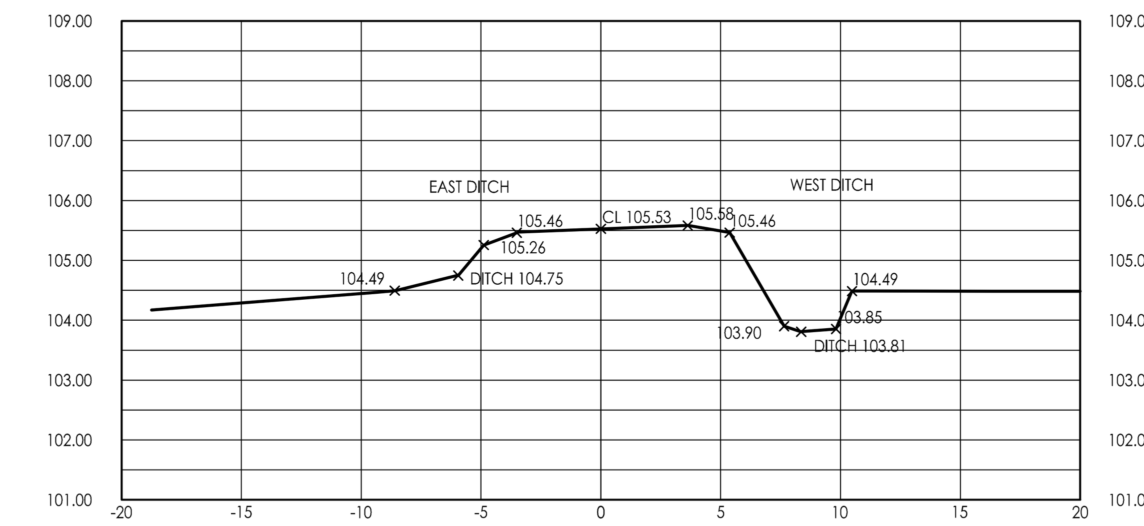
APPENDIX C – CONCEPTUAL DRAWINGS



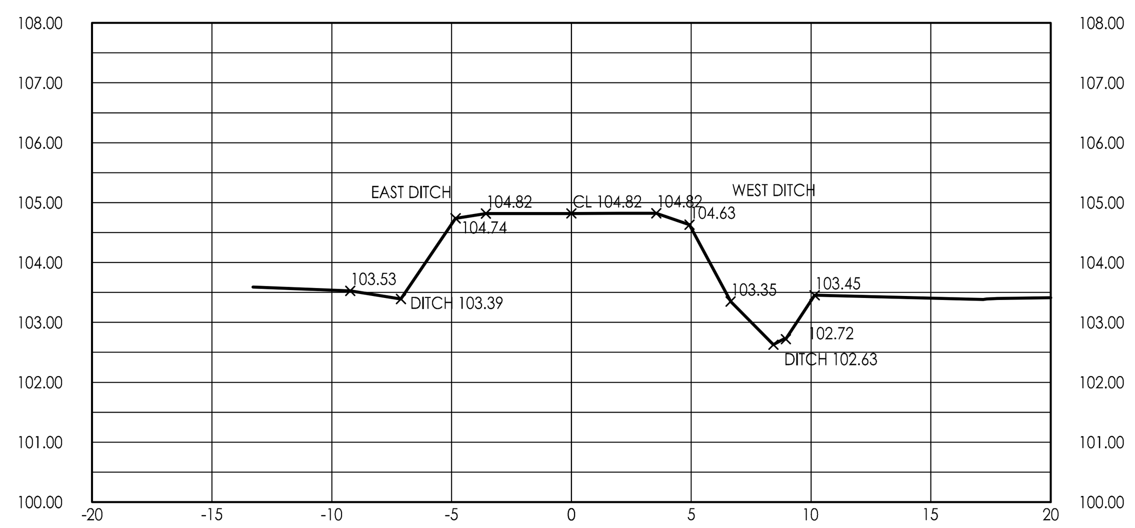
SECTION A-A



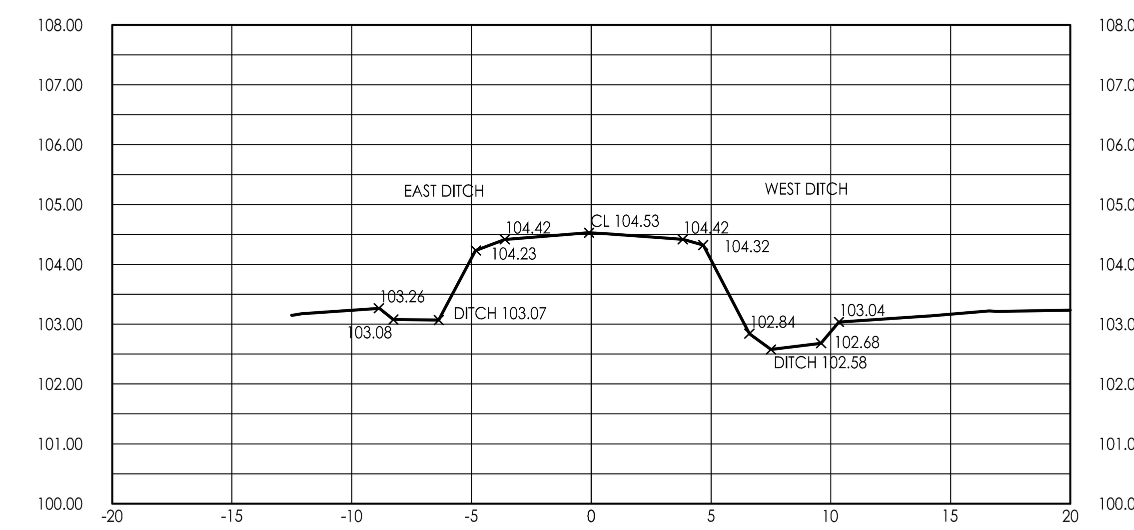
SECTION B-B



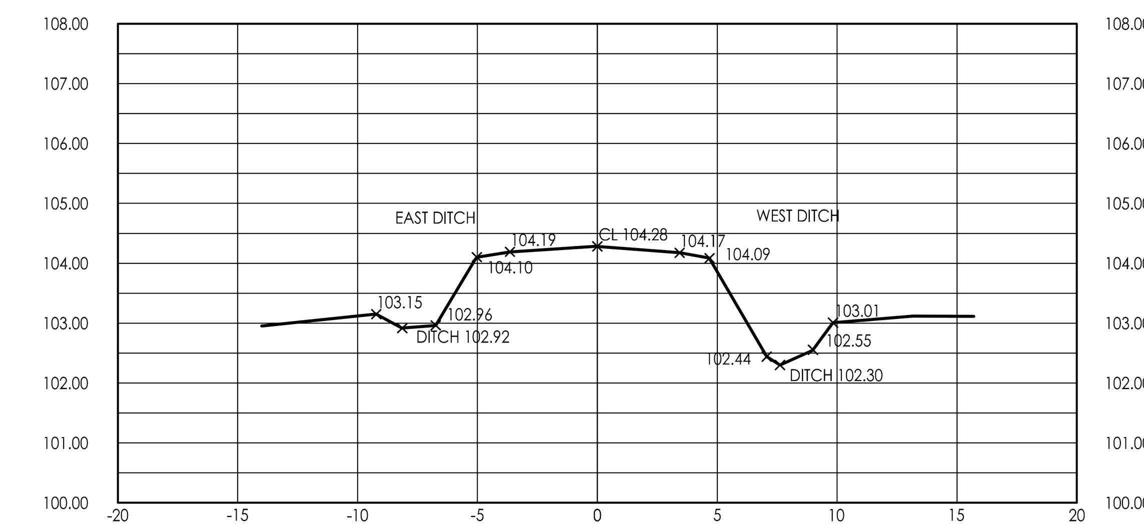
SECTION C-C



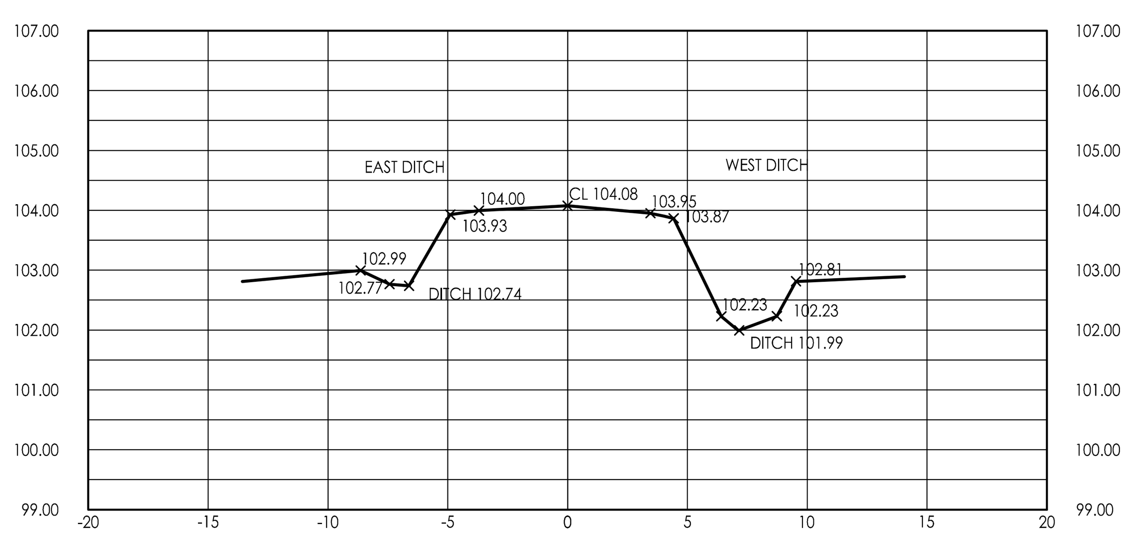
SECTION D-D



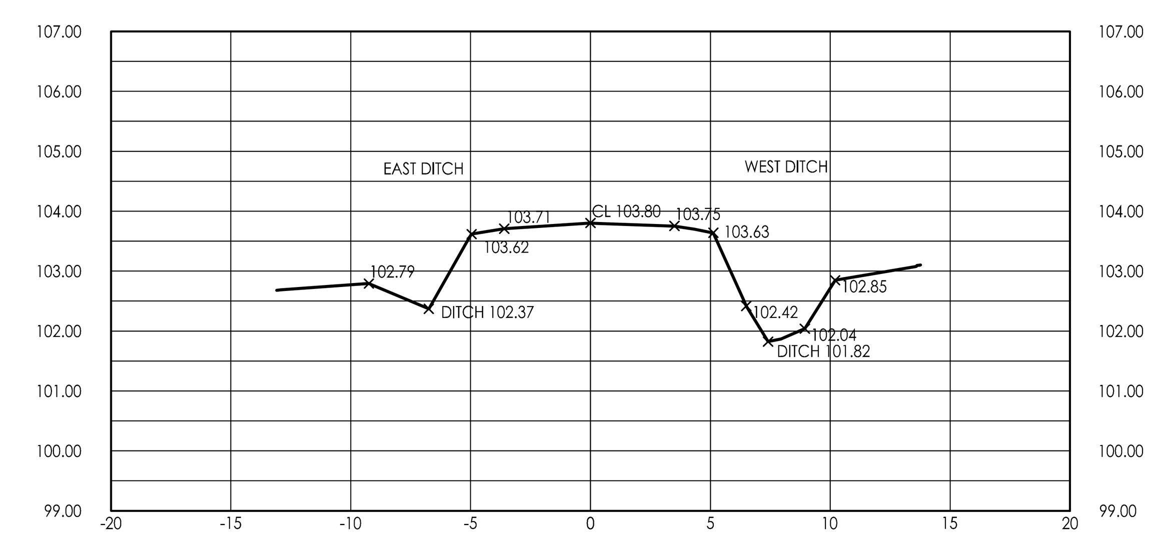
SECTION E-E



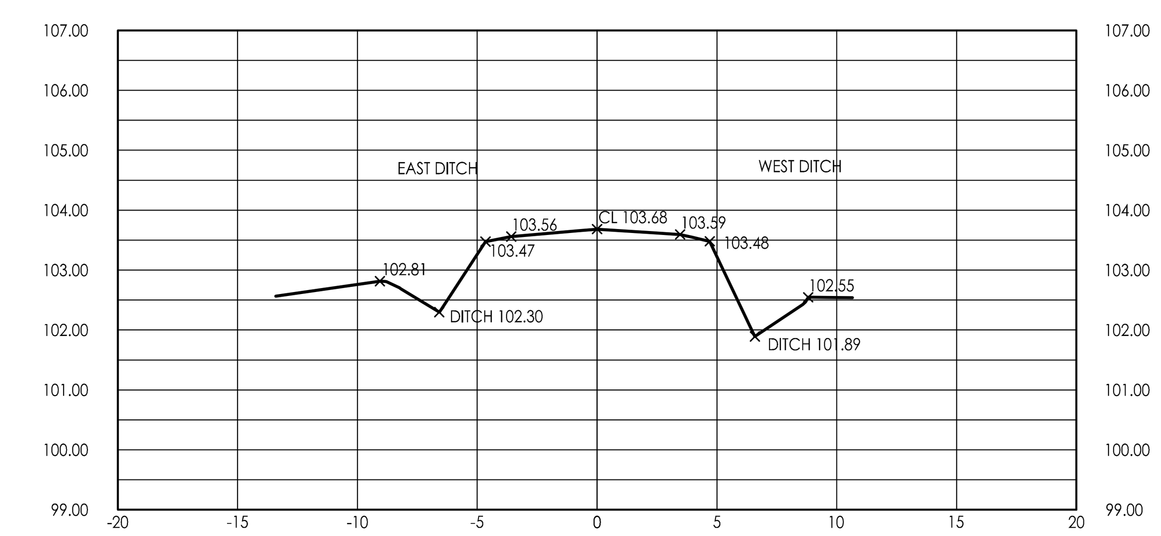
SECTION F-F



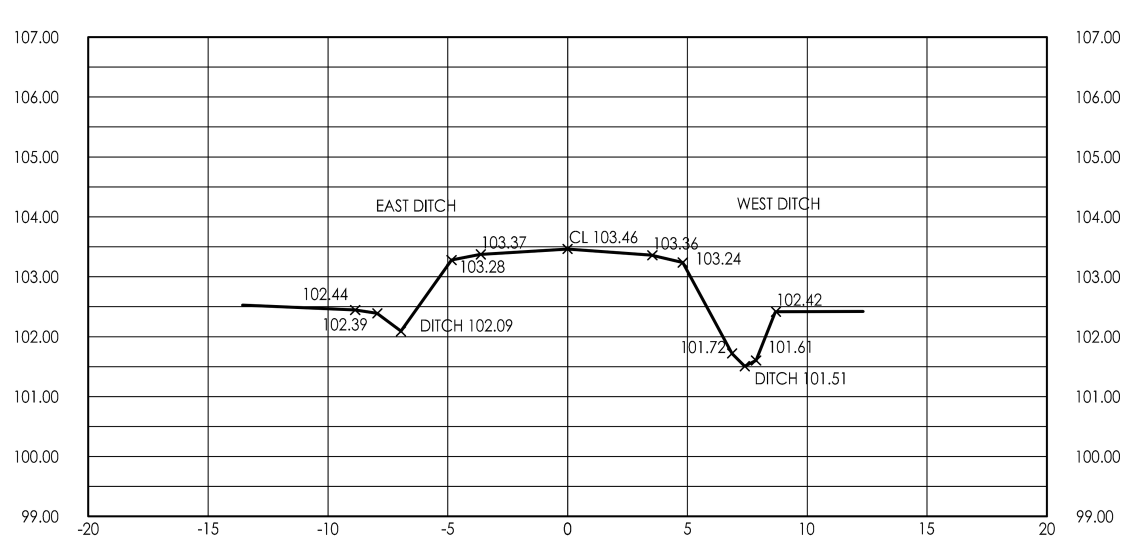
SECTION G-G



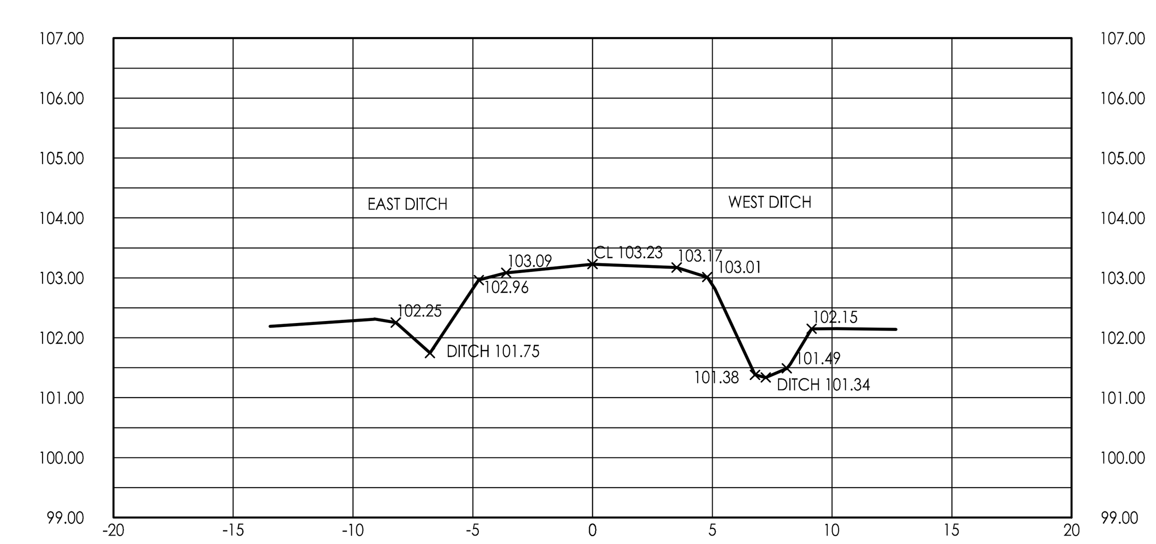
SECTION H-H



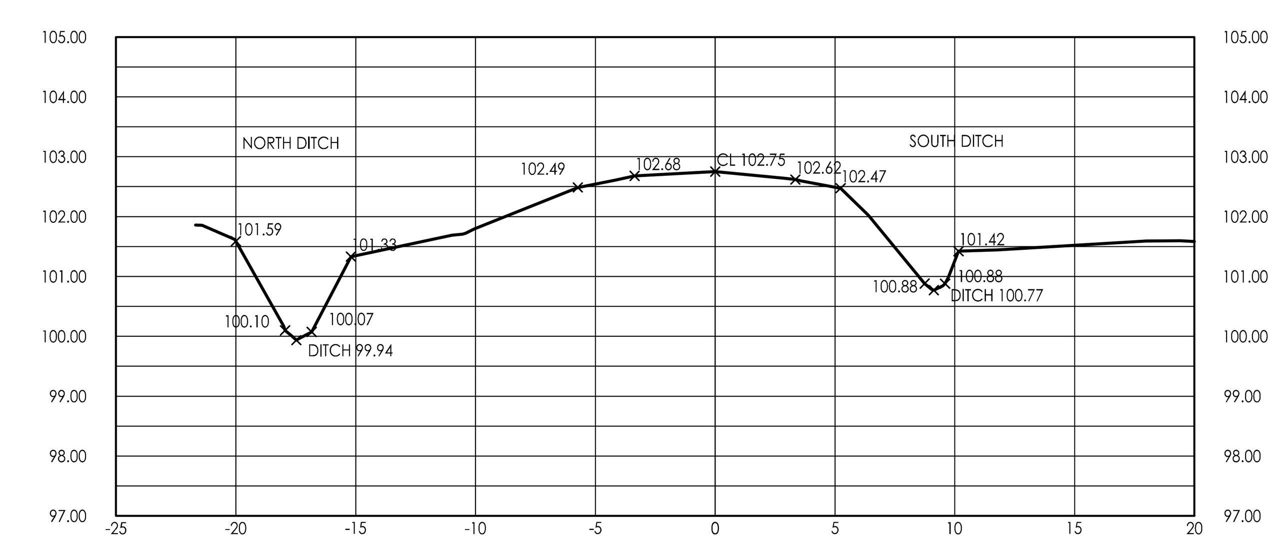
SECTION I-I



SECTION J-J



SECTION K-K



SECTION L-L

Stantec

Stantec Consulting Ltd.
400 - 1331 Clyde Avenue
Ottawa ON
Tel. 613.722.4420
www.stantec.com

Legend

Notes

1. PROPOSED DRAINAGE IMPROVEMENTS HAVE NOT BEEN COORDINATED WITH THE CITY OF OTTAWA, HYDRO OTTAWA, AND CONSERVATION AUTHORITY. THESES DRAWINGS HAVE BEEN PROVIDED TO ILLUSTRATE THE OFF–SITE WORKS RECOMMENDED AS PART OF THE FERNBANK SWM POND 4 PROJECT TO IMPROVE CURRENT DRAINAGE CONDITIONS ALONG SHEA ROAD.
2. THESE CONCEPTUAL DRAWINGS SHOULD NOT BE USED FOR CONSTRUCTION.
3. THESE DRAWINGS SHOULD BE READ IN CONJUNCTION WITH THE LETTER "FERNBANK SWM POND 4 – STORM OUTLET ASSESSMENT AND CONCEPTUAL DRAINAGE IMPROVEMENTS" PREPARED BY STANTEC CONSULTING LTD., SEPTEMBER 8, 2018.

1	ISSUED FOR REVIEW	WAJ	KJK	18.09.11
Revision		By	Appd.	YY.MM.DD

File Name: 160400900-SEC	WAJ	KJK	AMP	18.05.01
	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Permit-Seal

Client/Project

1384341 ONTARIO LTD.

SHEA ROAD LANDS
FAULKNER DRAIN ANALYSIS
OTTAWA, ON

Title

FERNBANK SWM POND 4 - STORM OUTLET
ASSESSMENT OF EXISTING CROSS SECTIONS

Project No. 160400900

Scale H1:250 V1:100

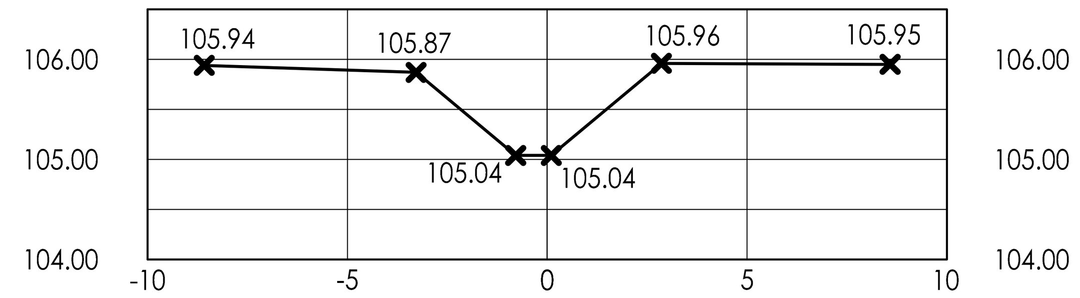
Drawing No. SEC-1

Sheet 1 of 7

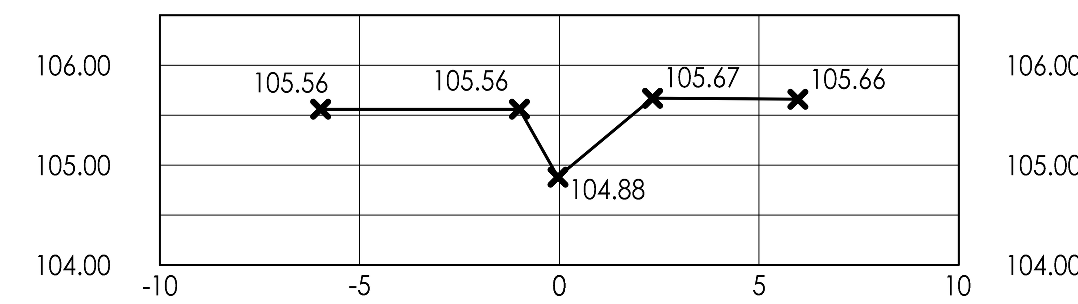
Revision 1

W:\active\160400900_cavanagh_stittsville\design\drawing\Ditch Analysis\160400900-SEC-Existing Conditions.dwg
2018/09/12 11:04 AM By: Rathnasooriya, Thakshila

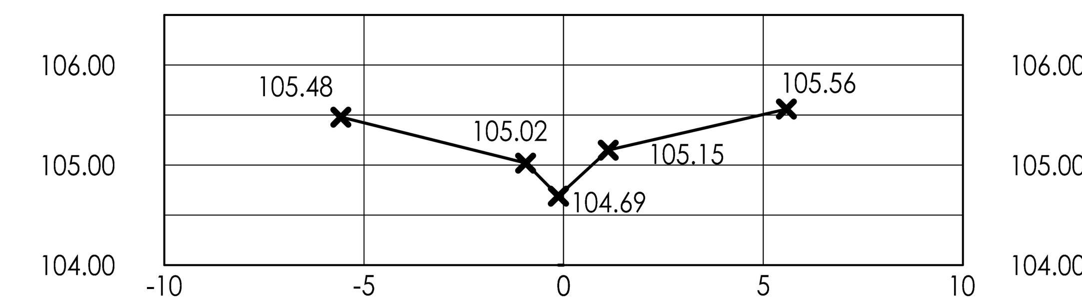
ORIGINAL SHEET - ARCH D



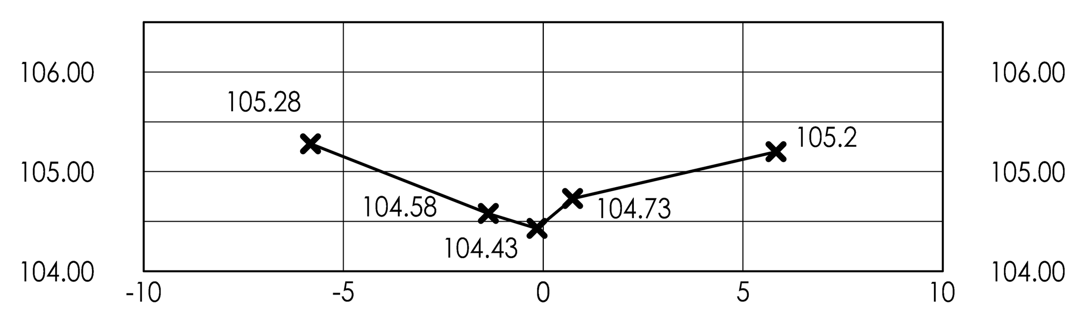
SECTION M-M



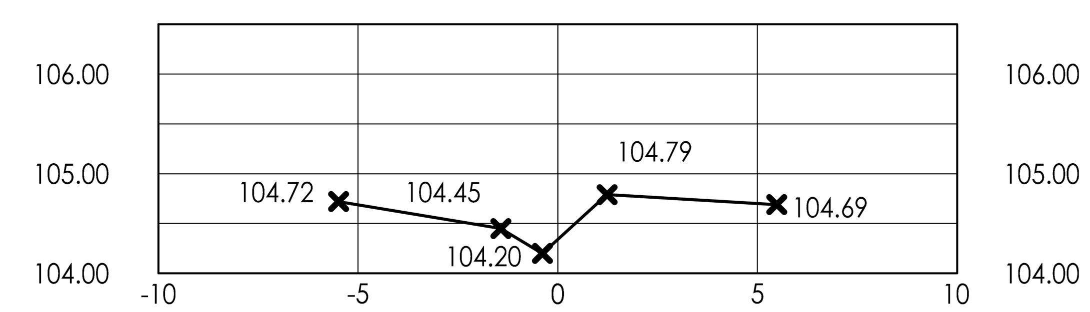
SECTION N-N



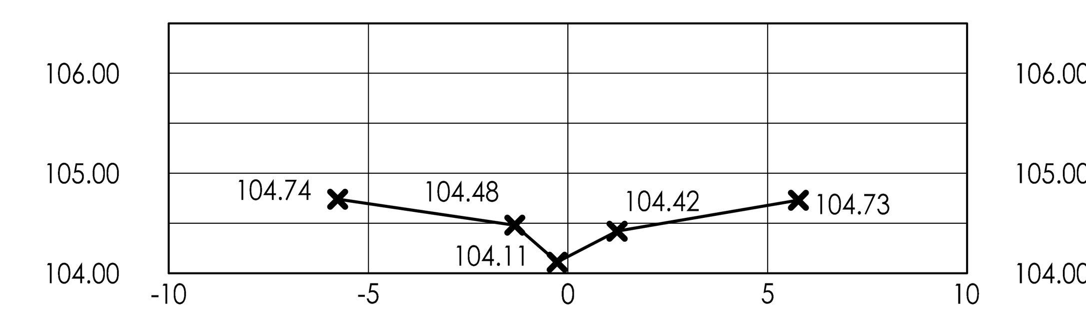
SECTION O-O



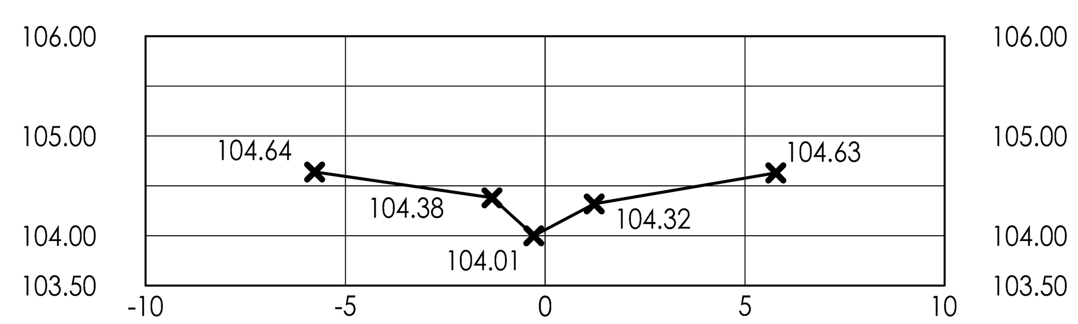
SECTION P-P



SECTION Q-Q



SECTION R-R



SECTION S-S

Stantec

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400 - 1331 Clyde Avenue
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www.stantec.com

Legend

Notes

1. PROPOSED DRAINAGE IMPROVEMENTS HAVE NOT BEEN COORDINATED WITH THE CITY OF OTTAWA, HYDRO OTTAWA, AND CONSERVATION AUTHORITY. THESES DRAWINGS HAVE BEEN PROVIDED TO ILLUSTRATE THE OFF–SITE WORKS RECOMMENDED AS PART OF THE FERNBANK SWM POND 4 PROJECT TO IMPROVE CURRENT DRAINAGE CONDITIONS ALONG SHEA ROAD.
2. THESE CONCEPTUAL DRAWINGS SHOULD NOT BE USED FOR CONSTRUCTION.
3. THESE DRAWINGS SHOULD BE READ IN CONJUNCTION WITH THE LETTER "FERNBANK SWM POND 4 – STORM OUTLET ASSESSMENT AND CONCEPTUAL DRAINAGE IMPROVEMENTS" PREPARED BY STANTEC CONSULTING LTD., SEPTEMBER 8, 2018.

1 ISSUED FOR REVIEW	WAJ	KJK	18.09.11
Revision	By	Appd.	YY.MM.DD

File Name: 160400900-SEC	WAJ	KJK	AMP	18.05.01
	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Permit-Seal

Client/Project
1384341 ONTARIO LTD.

SHEA ROAD LANDS
FAULKNER DRAIN ANALYSIS
OTTAWA, ON

Title
FERNBANK SWM POND 4 - STORM OUTLET ASSESSMENT OF EXISTING CROSS SECTIONS

Project No. 160400900

Scale H1:150 V1:100 (0, 2.5, 7.5, 12.5; 0, 1.0, 3.0, 5.0m)

Drawing No. SEC-2 | Sheet 2 of 7 | Revision 1

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2018/09/12 11:05 AM By: Rathnasooriya, Thakshika

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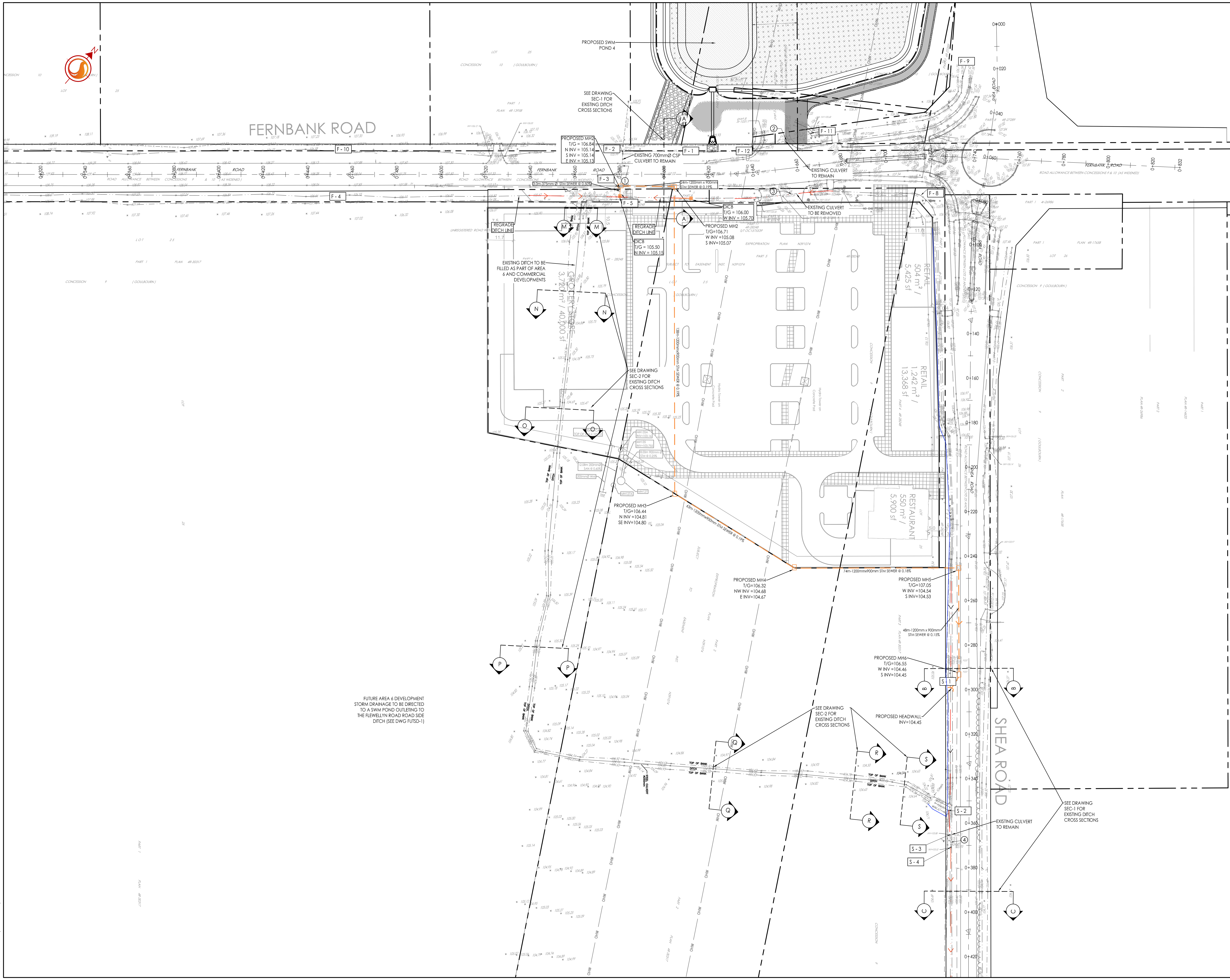

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1	CULVERT ID (SEE CULVERT SCHEDULE ON FUT - 3 DWG)
F - 7	DITCH NODE ID (SEE OFF - 3 DWG)
	PROPOSED DITCH REGRADING
	PROPOSED STORM SEWER
	PROPOSED BOX MAINTENANCE HOLE
	PROPOSED DICB

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	Dwn.	Chkd.	Dsgn.	YY.MM.DD

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Client/Project
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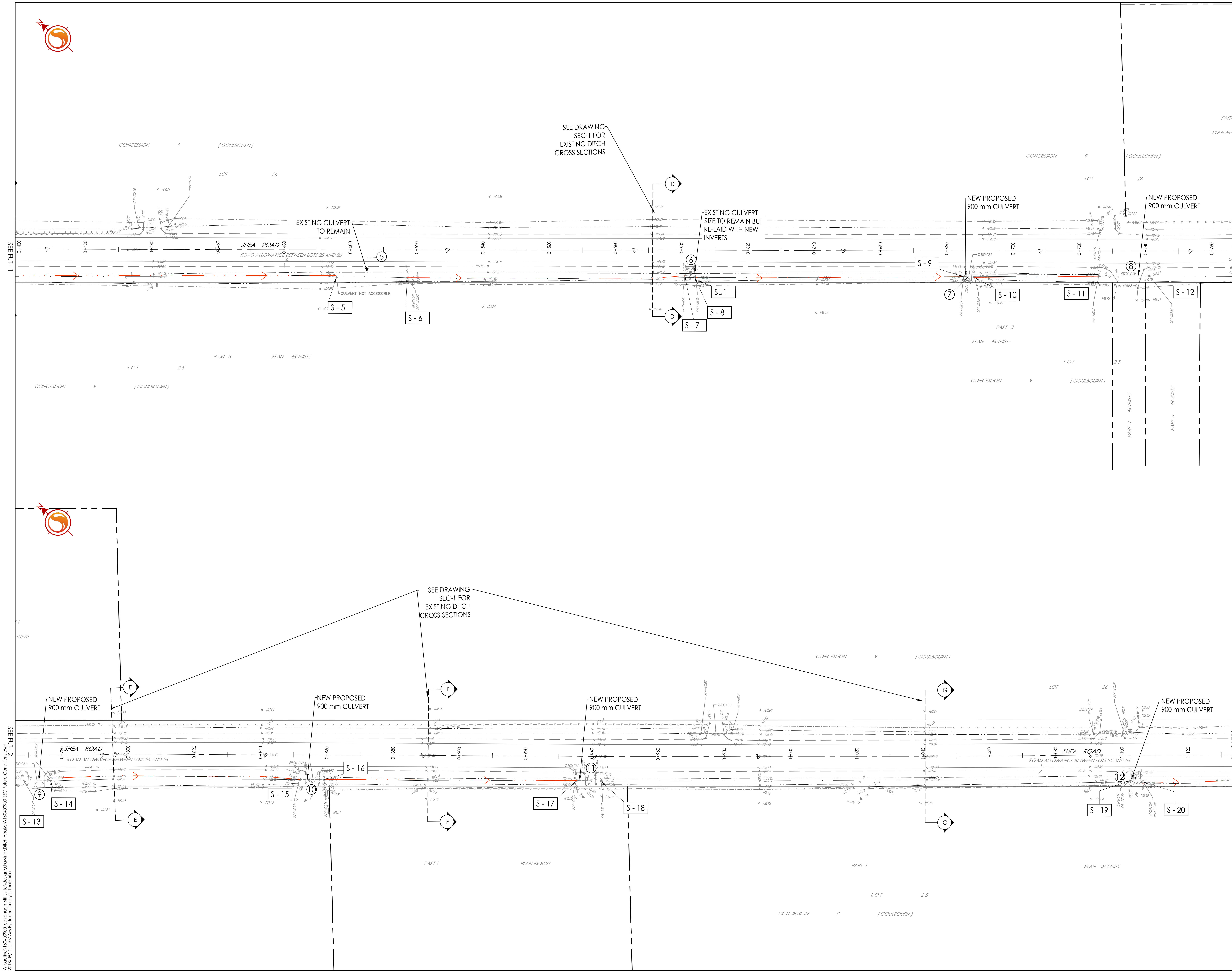
SHEA ROAD LANDS
FAULKNER DRAIN ANALYSIS
OTTAWA, ON

Title
FERNBANK SWM POND 4 - FUTURE OUTLET CONCEPTUAL DRAINAGE IMPROVEMENTS

Project No.	Scale
160400900	1:750 (0, 7.5, 22.5, 37.5m)

Drawing No.	Sheet	Revision
FUT-1	3 of 7	1



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F - 7	DITCH NODE ID (SEE OFF - 3 DWG)
	PROPOSED DITCH REGRADING
	PROPOSED STORM SEWER
□	PROPOSED DICB

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Revision

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	Dwn.	Chkd.	Dsgn.	YY.MM.DD

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SHEA ROAD LANDS
FAULKNER DRAIN ANALYSIS
OTTAWA, ON

Title

FERNBANK SWM POND 4 - FUTURE OUTLET
CONCEPTUAL DRAINAGE IMPROVEMENTS

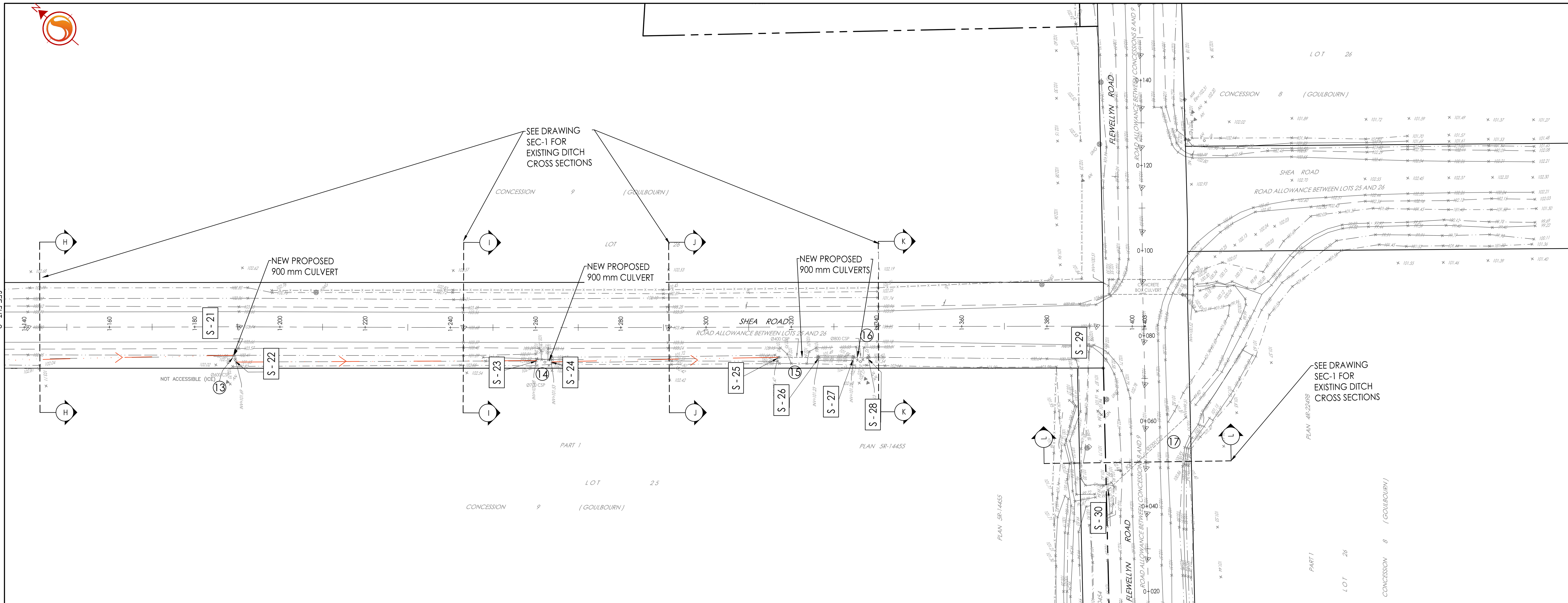
Project No. 160400900

Scale 1:500

Drawing No. FUT-2

Sheet 4 of 7

Revision 1



EXISTING CULVERT SCHEDULE					
CULVERT	U/S INVERT	D/S INV	LENGTH (m)	DIAMETER (mm)	SLOPE
1	105.28	105.14	18.9	700	0.74%
2	105.68	105.64	30.1	300	0.13%
3	105.47	105.43	25.0	600	0.16%
4	103.88	103.52	5.4	350	6.67%
5	103.20	120.80	25.4	500	1.57%
6	102.40	102.38	3.1	700	0.65%
7	102.64	102.69	2.9	600	-1.72%
8	102.55	102.56	15.0	700	-0.07%
9	102.47	102.55	7.5	600	-1.07%
10	102.31	102.36	7.3	500	-0.68%
11	102.10	102.21	7.1	500	-1.55%
12	101.78	101.69	3.1	800	2.90%
13	101.61	101.69	4.0	600	-2.00%
14	101.48	101.53	3.1	700	-1.61%
15	101.47	101.23	9.0	400	2.67%
16	101.25	101.13	3.1	800	3.87%
17 *	99.63	99.51	25.0	2300	0.48%

* 2300 mm CULVERT SIZE HAS NOT BEEN ASSESSED

PROPOSED CULVERT SCHEDULE					
CULVERT	U/S INVERT	D/S INV	LENGTH (m)	DIAMETER (mm)	SLOPE
1	105.28	105.14	18.9	700	0.74%
2	105.68	105.64	30.1	450	0.13%
4	103.88	103.52	5.4	350	6.67%
5	103.20	102.80	25.4	500	1.57%
6	102.70	102.69	3.1	700	0.32%
7	102.61	102.60	2.9	900	0.34%
8	102.55	102.53	15.0	900	0.13%
9	102.51	102.49	7.5	900	0.27%
10	102.35	102.33	7.3	900	0.27%
11	102.20	102.18	7.1	900	0.28%
12	101.78	101.69	3.1	900	2.90%
13	101.52	101.51	4.0	900	0.25%
14	101.36	101.35	3.1	900	0.32%
15	101.24	101.22	9.0	900	0.22%
16	101.21	101.13	3.1	900	2.58%
17 *	99.63	99.51	25.0	2300	0.48%

* 2300 mm CULVERT SIZE HAS NOT BEEN ASSESSED

PROPOSED/ EXISTING DITCH SCHEDULE				
SEGMENT ID	UP NODE	DS NODE	UP INV	DS INV
C61	S-29	S-30	100.77	99.63
C60	S-28	S-29	101.13	100.77
C58	S-26	S-27	101.22	101.21
C56	S-24	S-25	101.35	101.24
C54	S-22	S-23	101.51	101.36
C52	S-20	S-21	101.69	101.52
C50	S-18	S-19	102.18	101.78
C49	F-5	F-13	105.14	105.04
C48	S-16	S-17	102.33	102.20
C47	F-12	F-1	105.64	105.55
C46	S-14	S-15	102.49	102.35
C45	S-8	SU1	102.69	102.69
C44	S-12	S-13	102.53	102.51
C43	F-9	F-11	106.04	105.68
C42	S-10	S-11	102.60	102.55
C41	F-8	F-5	106.00	105.50
C40_2	SU1	S-9	102.69	102.61
C40_1	S-6	S-7	102.80	102.70
C40	F-10	F-2	112.25	105.28
C39	F-8	S-1	106.00	104.45
C38	S-4	S-5	103.52	103.20
C36	S-2	S-3	103.92	103.88
C35	S-1	S-2	104.45	103.92
C32	F-1	F-2	105.55	105.33
C20	F-4	F-5	112.23	105.50

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	PROPOSED DITCH REGRADING
	EXISTING DITCH
	PROPOSED DICB

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Revision		By	Appd.	YY.MM.DD
File Name: 160400900-SEC	WAJ	KJK	AMP	18.05.01
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Client/Project
1384341 ONTARIO LTD.

SHEA ROAD LANDS
FAULKNER DRAIN ANALYSIS
OTTAWA, ON

Title
FERNBANK SWM POND 4 - FUTURE OUTLET CONCEPTUAL DRAINAGE IMPROVEMENTS

Project No. 160400900
Scale 1:500 0 5 15 25m

Drawing No. FUT-3
Sheet 5 of 7
Revision 1

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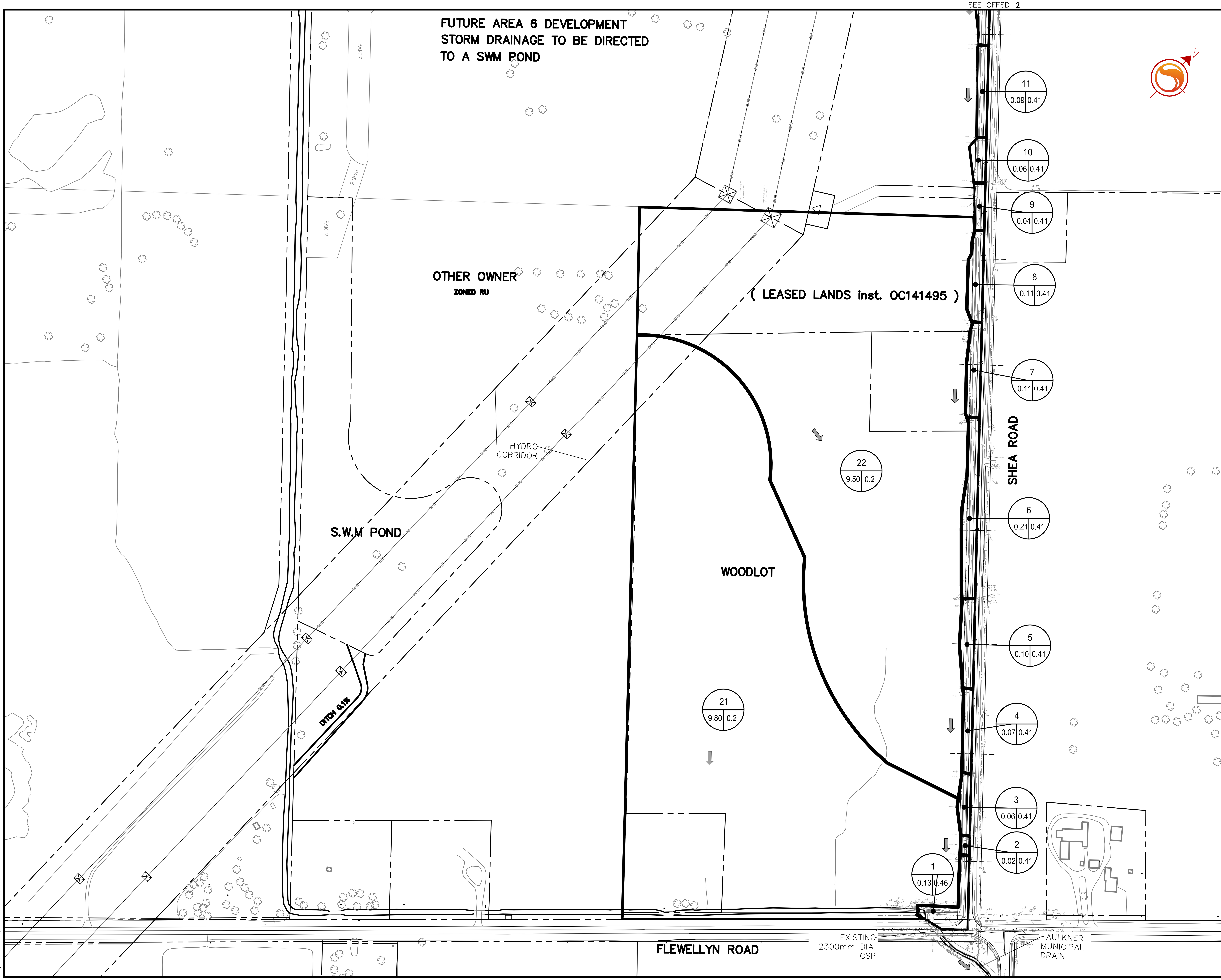
2018/09/12 11:07 AM By: Rathnasooriya, Thakshika

ORIGINAL SHEET - ARCH D



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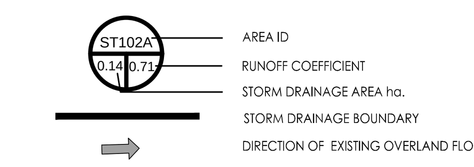

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SHEA ROAD LANDS
FAULKNER DRAIN ANALYSIS
OTTAWA, ON

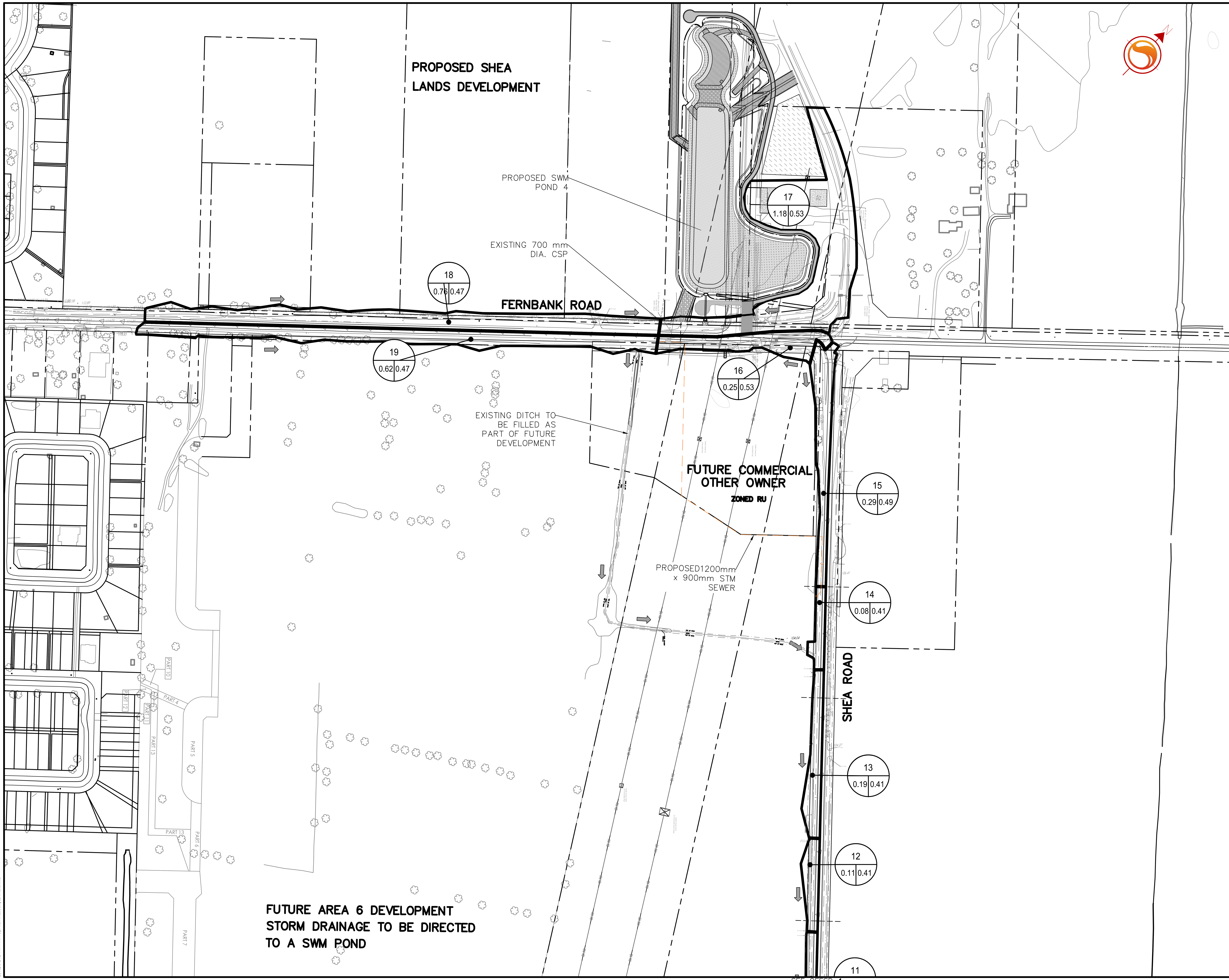
Title

FERNBANK SWM POND 4 - FUTURE OUTLET STORM DRAINAGE PLAN

Project No.	Scale
160400900	1:1500 0 15 45 75m

Drawing No.	Sheet	Revision
FUTSD-1	6 of 7	1

ORIGINAL SHEET - ARCH D



SEE OFFSD-1

ORIGINAL SHEET - ARCH D

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ST102A
0.14 0.71

- AREA ID
- RUNOFF COEFFICIENT
- STORM DRAINAGE AREA ha.
- STORM DRAINAGE BOUNDARY
- DIRECTION OF EXISTING OVERLAND FLOW
- PROPOSED STORM SEWER

Notes

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FAULKNER DRAIN ANALYSIS
OTTAWA, ON

Title

FERNBANK SWM POND 4 - FUTURE OUTLET
STORM DRAINAGE PLAN

Project No. 160400900

Scale 1:1500 0 15 45 75m

Drawing No. FUTSD-2

Sheet 7 of 7

Revision 1

C.6 STORM DESIGN BACKGROUND REPORT EXCERPTS AND CORRESPONDENCE

FERNBANK

COMMUNITY DESIGN PLAN

ENVIRONMENTAL MANAGEMENT PLAN
Volume 1 of 2

As Approved by Council
JUNE 24, 2009

Monahan Drain Modeling Results - Summer Event

For the summer event (24-hr SCS distribution), the Fernbank CDP model provides a very close correlation to the RVCA model. The greatest difference in peak flow occurs for the 100-year event: The 100-year peak flow is 41.8 m^3/s for the Fernbank CDP model vs. 40.0 m^3/s for the RVCA model, a difference of approximately 4.5%.

Modeled peak flows from both the RVCA (2004) and Novatech (2007) simulations are both slightly higher than the peak flows modeled by J.L. Richards in 1993. The primary reason for the increase in flows is that J.L. Richards used IDF data from the former City of Kanata in their analysis, which generate slightly smaller runoff volumes than the current City of Ottawa IDF parameters.

Monahan Drain Modeling Results - Spring Event

The model results for the J.L. Richards spring event have been included in **Table 4-1** for comparison purposes, but it should be noted that the 1993 analysis only considered a 24-hour rain-on-snow event and not a 10-day event.

There is a good correlation between the RVCA and Novatech 100-year peak flows for the spring event (10-day Rain+Snow). The 100-year peak flow is 20.1 m3/s for the Fernbank CDP model vs. 21.0 m^3/s for the RVCA model, a difference of approximately 4.5%. The spring peak flows do not correlate as closely for the more frequent return periods. The primary reason for the difference in peak flows is likely due to the influence of the Monahan Drain Constructed Wetlands: The wetlands are modeled as a discrete element in the Fernbank CDP model, while the RVCA model does not specifically account for storage and routing through the wetlands. The wetlands do significantly attenuate peak flows for smaller storm events, but the attenuation effect is reduced for larger storm events.

It should be noted that the Jock River Flood Risk Mapping - Hydrology Report states "…the calibration/validation effort concentrated on the simulation of high flows for the purpose of flood risk mapping, and that the estimates of more frequent Return Period Flows, such as the 2 year and 5 year, should be used with caution."

The Fernbank CDP SWMHYMO model provides a good correlation of peak flows to the RVCA model for the full range of summer events (24-hr SCS distribution), and good correlation to the RVCA model for the 100-year spring event. Therefore, the Fernbank CDP model of the Monahan Drain will provide a good benchmark for the analysis of impacts resulting from development of the Fernbank CDP on the downstream Monahan and Flewellyn Drains.

Faulkner Drain

The Fernbank CDP lands situated northwest of Shea Road are tributary to the Faulkner Drain, which is in turn tributary to Flowing Creek. The lands within the Fernbank Community represent only 48.5 hectares of the 4945 hectare area comprising the Flowing Creek Watershed (approximately 1%), and any meaningful comparison to the Flowing Creek Subwatershed model used in the Jock River Hydrology Study is not possible for this area.

Existing conditions for the Fernbank CDP lands tributary to the Faulkner Drain have instead been modeled based on the physical characteristics of the watershed. Modeling parameters were derived as follows:

- The soil types (and corresponding CN values) have been verified through test pit data;
- The drainage area has been verified based on detailed topographic mapping;
- The time to peak (t_p) has been calculated based on the average slope, length and land use within the catchment.

Table 4-2: Existing Conditions Peak Flows

	Peak Flow (m^3/s)						
	Distribution	2yr	5yr	10yr	25yr	50yr	100yr
Carp Subwatershed							
Carp Headwaters +	12hr AES	2.53	3.92	4.86	6.08	6.93	7.79
Carp River West Tributary	12hr SCS	2.76	**4.46**	**5.62**	**7.27**	**8.20**	**9.39**
HEC-RAS Station 44751	24hr SCS	**2.91**	4.45	5.52	6.84	7.92	9.38
Fernbank Lands north of West	12hr AES	0.65	1.05	1.33	1.74	2.04	2.36
Tributary + Westcreek Meadows	12hr SCS	0.84	**1.46**	**1.90**	**2.53**	**2.90**	**3.37**
HEC-RAS Station 44548	24hr SCS	**0.89**	1.46	1.86	2.37	2.76	3.34
Hazeldean Creek @	12hr AES	0.91	1.38	1.72	2.19	2.53	2.94
Carp River	12hr SCS	**1.82**	**2.65**	**3.28**	**4.42**	**4.74**	**5.45**
HEC-RAS Station 43966	24hr SCS	1.49	2.16	2.68	3.40	3.98	4.83
Jock Subwatershed							
Monahan Drain @	12hr AES	**1.21**	**1.99**	**2.54**	**3.24**	**3.74**	4.24
Terry Fox Drive	12hr SCS	1.13	1.87	2.39	3.13	3.55	4.10
	24hr SCS	1.21	1.92	2.42	3.05	3.57	**4.28**
Flewellyn Drain @	12hr AES	1.12	**1.83**	**2.33**	**2.97**	**3.42**	3.88
Fernbank Road	12hr SCS	1.05	1.76	2.25	2.97	3.37	3.90
	24hr SCS	**1.13**	1.81	2.28	2.88	3.37	**4.05**
Faulkner Tributary @	12hr AES	0.46	0.74	0.94	1.19	1.37	1.55
Fernbank Road	12hr SCS	0.48	0.82	1.05	1.39	1.58	1.83
	24hr SCS	**0.51**	**0.83**	**1.05**	**1.32**	**1.55**	**1.85**

Critical Storm Distributions

The 12-hour SCS distribution appears to be the critical storm distribution for lands in the Carp River subwatershed. This is consistent with the 12-hour SCS distribution used in the Carp River XP-SWMM hydrologic modeling (CH2MHill, MVC).

The 12 hour AES distribution generates higher peak flows for the more frequent return periods on both the Monahan Drain and the Flewellyn Drain. However, the 24hr SCS distribution generates the highest 100-year peak flows for all three catchment areas in the Jock River subwatershed. The 24-hour distribution was used in the Jock River Flood Risk Mapping analysis (PSR Group, RVCA).

6.4 SWM Criteria - Jock River Subwatershed

Stormwater management criteria for the Fernbank Community lands tributary to the Jock River subwatershed have been developed based on the recommendations of the Jock River Reach 2 River Subwatershed Study and input from RVCA:

- The proposed stormwater management strategy will need to adhere to all applicable policies and guidelines of the Rideau Valley Conservation Authority; the City of Ottawa, MOE, and other approvals agencies.

Quality Control / Fish Habitat

- Level 1 - Enhanced protection for lands tributary to the Jock River (80% long term TSS removal);
- End-of-pipe facilities will be designed to provide extended detention storage for both baseflow enhancement and water quality control.
- The proposed development must have no adverse impacts on downstream fish habitat.
- The Monahan Drain, Flewellyn and Faulkner Drains have been classified as intermittent watercourses that provide indirect habitat supporting tolerant warm/cool water fish communities. Temperature mitigation measures are to be incorporated into all proposed SWM facilities tributary to the Jock River, with the goal of ensuring that the temperature of discharged stormwater does not exceed the following target values:
    - Maximum Discharge Temperature = 25ºC
    - Preferred Discharge Temperature = 22ºC

Quantity Control

- Ensure the proposed SWM infrastructure will not result in any adverse impacts on flood elevations or increase the extent of flooding in downstream watercourses.
- Ensure the Monahan Drain ponds are designed to have no adverse impacts the function of the Monahan Drain Constructed Wetlands SWM Facility. No additional analysis of the Constructed Wetlands will be required provided that the proposed development conforms to the following:
    - The main branch of the Monahan Drain is retained upstream of Terry Fox Drive;
    - Fernbank lands tributary to the Monahan Drain to be serviced by 3 SWM facilities:
        - One SWM facility at the headwaters of the Monahan Drain;
        - Two SWM facilities on each side of the Monahan Drain upstream of Terry Fox Drive.
    - The design of the Constructed Wetlands assumed a total drainage area tributary to the Monahan Drain upstream of Terry Fox Drive of approximately 296 hectares with an average imperviousness of 46%.
- Post-development peak flows are not to exceed pre-development levels for all storms up to the 100-year event.
    - **Pre-Development Peak Flow targets are listed in Table 4-2.**

Erosion control / Fluvial Geomorphology

- Continuous hydrologic modeling should be used to demonstrate that the proposed development will not result in an adverse change to the geomorphology of the outlet watercourses. The number of exceedences of the erosion thresholds established by the fluvial geomorphic analysis should not increase under post-development conditions.
    - **Critical flow (Erosion) targets for watercourses are listed in Table 3-7.**

Section 8.0 Post Development Storm Drainage Conditions

8.1 Hydrology

The post-development hydrologic analysis of the Fernbank community has been completed using the SWMHYMO hydrologic model, and includes both event-based modeling (2-100yr), and continuous modeling using long-term rainfall data for the City of Ottawa. The results of the pre-development analysis were used as a benchmark for the evaluation of post-development conditions.

8.1.1 Storm Drainage Areas

The post-development storm drainage areas used in the hydrologic model are based on the storm drainage area plans developed as part of the master servicing study. Minor system capture rates have been approximated at 100 L/s/ha. Major system storage has been approximated at 50 m^3/ha.

Post-development drainage areas have been established based on the proposed macro grading plan for the road network through the Fernbank Community. The grading plan can be found in the Master Servicing Study. The proposed grading plan results in changes to the drainage areas between the Flewellyn, Faulkner, and Monahan Drains. RVCA has confirmed that the proposed post-development drainage areas are acceptable. Correspondence is provided in **Appendix B**.

8.1.2 Modeling Parameters

The impervious values used in the post-development conditions analysis are based on the proposed land use plan from the Fernbank CDP and correspond to the runoff coefficients used in the storm sewer design sheets from the Master Servicing Study.

- The minor system capture rate was established at 100 L/s/ha.
- Major system storage in roadways was estimated at 50 m^3/ha.

Post-development drainage areas are shown on **Figure 8.1**. Modeling parameters are listed in **Table 8-1**.

Table 8-1: Post-Development Storm Drainage Areas to SWM Facilities

SWM Pond ID	Drainage Area[1] (ha)	Imperviousness		Soil CN	Major System Storage (m^3)	Minor System Capture Rate (m^3/s)
		Directly Connected	Total			
Carp River						
P1	77.13	0.45	0.56	80.5	3,857	7.71
P2	23.14	0.47	0.59	80.5	1,157	2.31
P3	91.68	0.34	0.43	80.5	4,584	9.17
Faulkner Drain						
P4	57.94	0.35	0.44	80.5	2,897	5.79
Flewellyn Drain						
P5	138.56	0.32	0.40	80.5	6,928	13.86
Monahan Drain						
P6	98.65	0.39	0.49	80.5	4,933	9.87
P7	43.09	0.29	0.36	80.5	2,155	4.31
P8	62.57	0.42	0.53	80.5	3,129	6.26

1. Drainage area does not include SWMF Block (refer to Figure 8.1)

FERNBANK COMMUNITY DESIGN PLAN

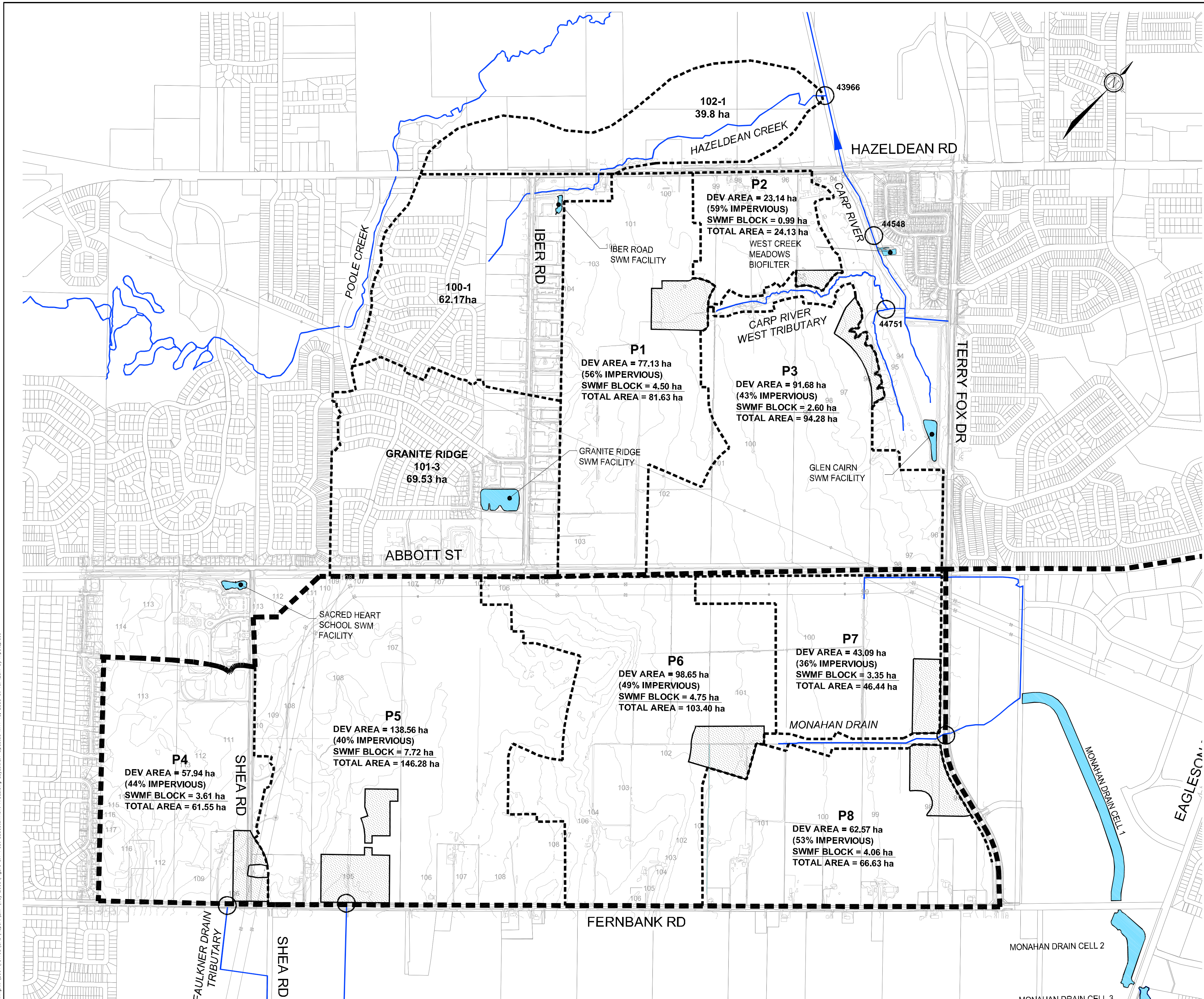
City of Ottawa

ENVIRONMENTAL MANAGEMENT PLAN

FIGURE 8.1

Post-Development Conditions

Storm Drainage Subcatchments



HYDROGRAPH LOCATIONS

44751 HEC-RAS INFLOW NODE ID (CARP RIVER ONLY)

0 50 100 200 400 600 metres

SCALE : 1:6000 -B1 Sheet

SCALE : Not to Scale -Report

MAY 2009

NOVATECH ENGINEERING CONSULTANTS LTD.

ENGINEERS & PLANNERS

9.2 Faulkner Drain SWM Facility

The recommended SWM strategy for the Fernbank Community lands west of Shea Road includes the construction of a SWM facility at the northwest corner of Shea Road and Fernbank Road to provide water quality, erosion, and peak flow control. This facility will outlet to a tributary of the Faulkner Drain that flows southwards from Fernbank Road.

The location of the Faulkner Drain SWM facility is flexible, and two optional locations for this facility were shown in **Figure 7.3** to accommodate current land ownership in this area. This concept shows the facility located partially in the hydro corridor. The placement of the Faulkner Drain can be re-visited as development plans are brought forward in this area.

Conceptual design details for the proposed Faulkner Drain SWM facility (P4) are provided in **Table 9-4**. A conceptual design drawing for this facility is provided as **Figure 9.4**.

Table 9-4: Faulkner Drain SWM Facility (P4)

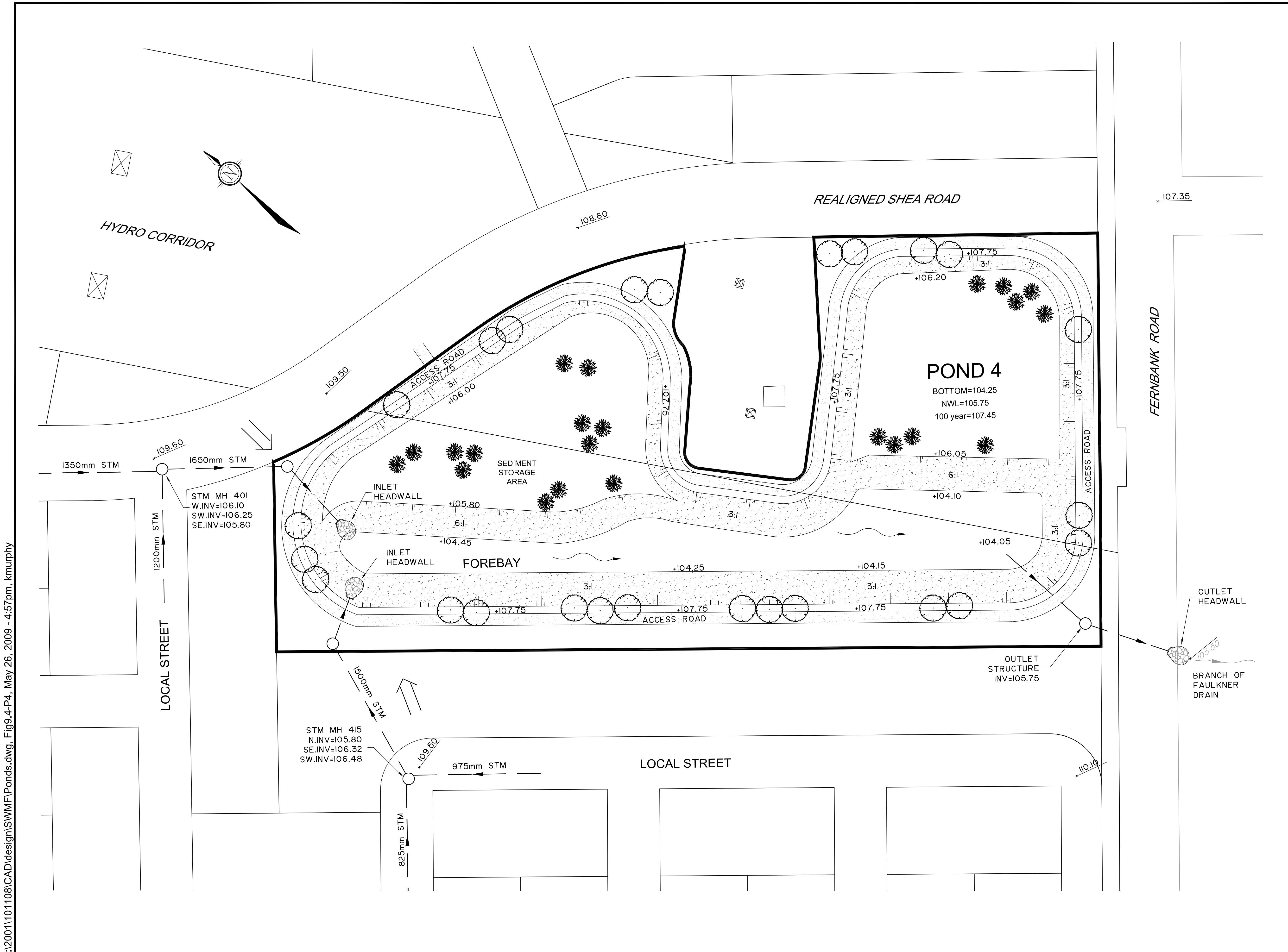
Area of SWM Block	3.61 ha		
Drainage Area to SWMF	57.94 ha	(44% Impervious)	
Quality Control	Enhanced 7,200 m^3 2,400 m^3	(80% TSS Removal) Req. Permanent Pool Volume Req. Extended Detention Volume	
Quantity Control	100yr 1.75 m^3/s	(post-to-pre) Target 100yr Release Rate	
Stage	**Elevation (m)**	**Volume (m3)**	**Release Rate (m^3/s)**
Bottom	104.25	0	0.00
Normal Water Level	105.75	8,700*	0.00
Extended Detention Storage	106.00	2,400	0.04
1:2yr	106.65	13,400	0.29
1:5yr	109.85	18,300	0.45
1:10yr	107.05	21,300	0.67
1:25yr	107.10	24,200	1.05
1:50yr	107.25	26,450	1.35
1:100yr	107.45	29,600	1.75

* Permanent Pool Volume

9.3 Flewellyn Drain SWM Facility

The recommended SWM strategy for the Fernbank Community lands tributary to the Flewellyn Drain includes the construction of a SWM facility to provide water quality, erosion, and peak flow control for the proposed development prior to outletting to the Flewellyn Drain.

Portions of the Flewellyn Drain downstream of the site do not have the capacity to convey the 1:100 year pre-development peak flow, and the increase in runoff associated with development has the potential to increase the extent of flooding in those areas. The facility has been designed to provide reduce post-development peak flows to less than pre-development conditions for larger storm events (>1:10yr event) to reduce the potential for downstream flooding. Storage requirements have been based on providing sufficient storage to control post-development flooding volumes (volume of flow above channel capacity) to pre-development levels.



FERNBANK COMMUNITY DESIGN PLAN

City of Ottawa

ENVIRONMENTAL MANAGEMENT PLAN

FIGURE 9.4

SWMF POND 4

LEGEND

ACCESS ROAD
DIRECTION OF POND FLOW
STORM SEWER AND DIRECTION OF FLOW
101.25 / 100.25 PROPOSED GRADE / EXISTING GRADE
+96.65 PROPOSED GRADE
HEADWALL C/W RIPRAP
MAJOR OVERLAND FLOW DIRECTION
NWL NORMAL WATER LEVEL
STORM MANHOLE
3:1 TERRACING (MAX SLOPE)
TREE
WATER TOLERANT TREE
EXISTING BRUSH LINE
EX. NATURAL CHANNEL & DIRECTION OF FLOW

SCALE : 1:1250

JUNE 2009

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TARTAN/CAVANAGH

CONCEPTUAL SITE SERVICING PLAN
STORMWATER MANAGEMENT PLAN AND EROSION AND SEDIMENT CONTROL PLAN
SHEA ROAD LANDS
FERNBANK COMMUNITY

Project: 11218-5.2.2

MARCH 2013

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GROUP

4. STORMWATER MANAGEMENT

4.1 Background

The stormwater management strategy for the Fernbank Community has been outlined in the Fernbank EMP and MSS. The approved EMP and MSS recommend the construction of one stormwater management facility (referred to as Pond 4) and associated storm sewer systems to provide stormwater management for the Fernbank Community tributary to the Faulkner Drain Tributary. Pond 4 is to provide water quality and quantity control for approximately 60 ha of proposed development northeast of Fernbank Road and Shea Road, and south of Abbott Street East. The proposed SWM facility will outlet to the Faulkner Drain Tributary, which starts on the south side of Fernbank Road. According to the EMP and MSS, the Faulkner Drain Tributary is classified as an intermittent watercourse providing indirect fish habitat.

Under existing conditions, the subject site is comprised of uncultivated grass lands and wooded areas. The site topography is generally between elevations 114 m and 107 m with most of the site draining towards the Faulkner Drain Tributary, itself tributary to the Jock River. The EMP and MSS identify that a northwest portion of the site drains east and south to the Flewellyn Drain, also tributary to the Jock River. The existing topography and general drainage patterns are presented on Figure 7.

In 2012, the City updated its stormwater management criteria from that previously established for the EMP and MSS. The proposed conceptual design is based on the latest stormwater management criteria.

4.2 Objective

The stormwater management objective is to complete the conceptual storm servicing of the lands tributary to Pond 4, as well as to confirm the pond size that was presented in the EMP and MSS.

4.3 Design Constraints and Regulatory Requirements

4.3.1 WATER QUALITY CONTROL

Water quality control targets were established in the "Jock River Reach One Subwatershed Study," (Stantec 2007), and maintained in the EMP and MSS. With respect to suspended solids, it was concluded in the Subwatershed Study that all stormwater facilities discharging to the Jock River must be designed to provide an Enhanced Level of Protection, which corresponds to 80% TSS removal as per the Ontario Ministry of the Environment (MOE) Stormwater Management Planning and Design Manual (March 2003).

According to the EMP and MSS, temperature mitigation measures are to be incorporated into SWM facilities tributary to the Jock River. Specifically, the goal is for the discharged stormwater to not exceed a temperature of 25°C and the preferred temperature identified is 22°C.

4.3.2 WATER QUANTITY CONTROL

Water quantity control criteria for the Faulkner Drain Tributary were outlined in the EMP and MSS. Post-development peak flows are not to exceed pre-development levels for all storm events up to the 100 year event.

potential network for the subject site. Storm sewer sizes are included only for the larger sewers which are also identified in the MSS report. All minor storm sewer sizes will be reviewed and confirmed at the time of detailed design. Major flow will cascade overland from the northern portion of the site downstream to the southern limits of the site, where it will overflow to Pond 4. Conceptual major flow routing is presented on Figure 6.

4.4.2 END-OF-PIPE SWM FACILITY

The conceptual design of Pond 4 was presented in the EMP and MSS. The facility is proposed to be located north of Fernbank Road at the hydro corridor and is designed to provide water quality and water quantity control of stormwater runoff from the subject site. It is designed as a wet pond with two minor system inlets and an outlet to the Faulkner Drain Tributary. In accordance with the EMP and MSS, there are no proposed changes to the Faulkner Drain Tributary. The location of Pond 4 is indicated on Figure 6.

The stage-storage relationship representing Pond 4 in the EMP and MSS has been maintained in the current SWMHYMO evaluation. It is presented in Table 4.1.

Table 4.1 Pond 4 conceptual design data from EMP and MSS

Elevation (m)	Extended Storage (ha-m)
104.25	0
106.00	0.240
106.65	1.340
106.85	1.830
107.05	2.130
107.10	2.420
107.25	2.645
107.45	2.960

As discussed above, the stormwater management facility is designed to provide an Enhanced Level of Protection. According to the MOE Stormwater Management Planning and Design Manual (March 2003), treatment volume is a function of drainage area, the type of pond, the urban imperviousness ratio, and the Level of Protection. The Enhanced Level of Protection corresponds to end-of-pipe storage volumes required for the long-term average removal of 80% of total suspended solids. The storage requirements suggested by the MOE Manual and those provided based on the above conceptual design are summarized in the following table. Supporting calculations are provided in Appendix E.

Table 4.2 Water quality volumes

Enhanced Protection Level 80% Removal of TSS							
Tributary Urban Area (ha)	Imp.% Pond Type Unit Storage	Storage Volume (cu-m)					
		Permanent		Extended Detention		Total	
		Required	Design	Required	Design	Required	Design
56.57	57% Wet Pond 195 cu-m/ha	8749	8700	2263	2400	11012	11100

According to MOE guidelines, the required total storage for the facility is 11012 cu-m. The total water quality storage provided by the proposed facility is 11100 cu-m, which consists of permanent storage of 8700 cu-m and 2400 cu-m of extended detention storage. Due to the increase in imperviousness within the tributary drainage area, the required permanent volume slightly exceeds the permanent volume provided by the conceptual design (by 49 cu-m). This additional volume requirement will be accommodated at the detailed design stage. In practical terms, the bottom of the pond could be lowered by 20 mm to gain the additional volume. The potential to further oversize the permanent volume will be considered at the detailed design stage, as will the use of a bottom-draw outlet, to mitigate temperature increases of the stormwater discharge.

The 25 mm 4 hour Chicago storm simulation indicates that the extended detention drawdown time will be greater than 48 hours. The outflow hydrograph from the facility is presented in Appendix E.

4.5 Hydrological Evaluation

4.5.1 EXISTING CONDITIONS

Existing conditions hydrological analysis was completed in the EMP and MSS. The study area was evaluated using the SWMHYMO computer model. This technique offers single storm event flow generation and routing. The existing conditions model was executed using the 24 hour SCS Type II design storm with 2 through 100 year return periods with a 60 minute time step. Relevant excerpts from the EMP and MSS are enclosed as reference in Appendix D, including a copy of the 100 year existing conditions SWMHYMO input and summary output, as well as Figure 4.1 "Existing Conditions Storm Drainage Subcatchments." A summary of peak flows in the Faulkner Drain Tributary at Fernbank Road are presented in the below table.

Table 4.3 Summary of pre-development flow rates

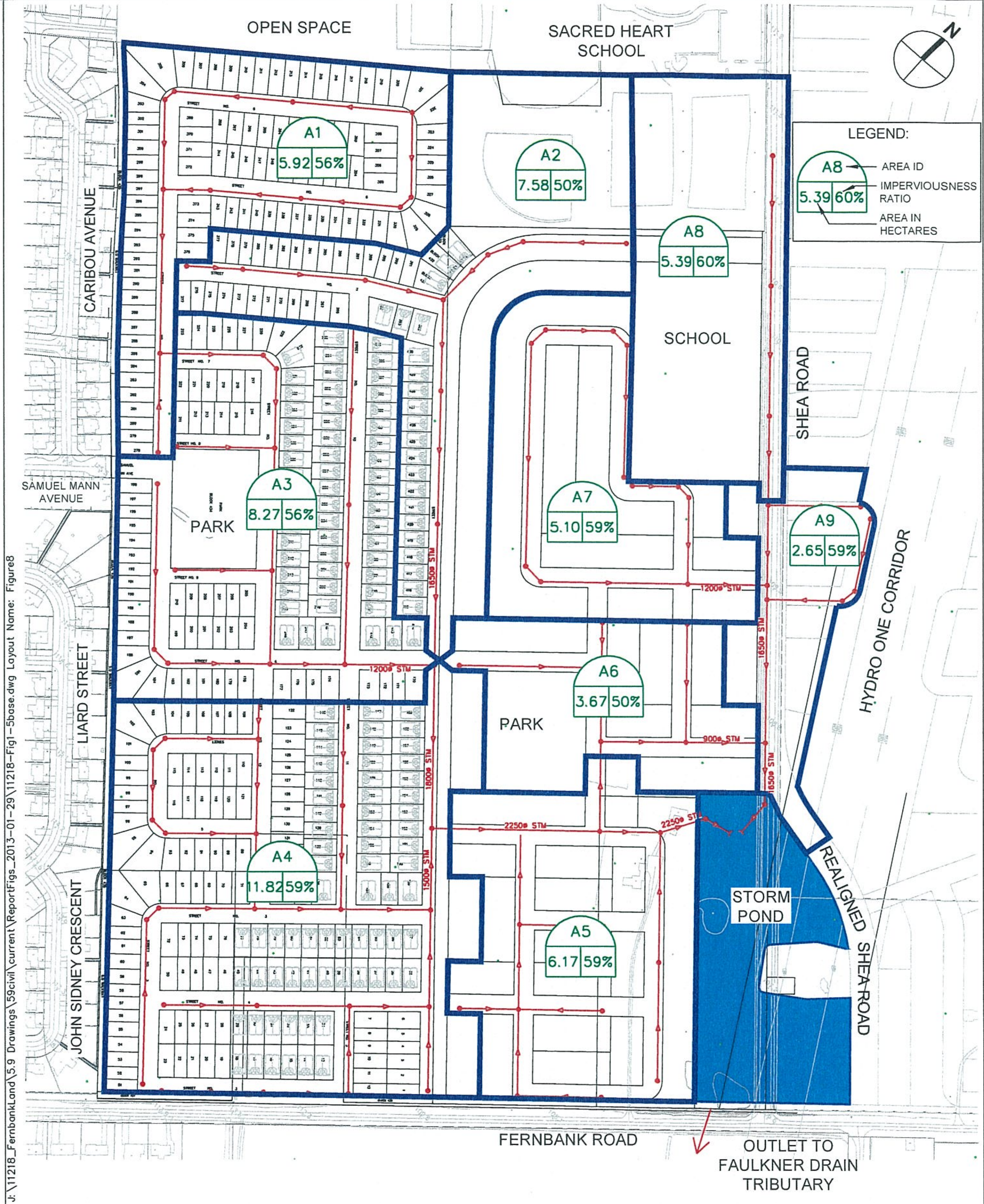
Peak Flow (cms)	24 hour SCS Type II Design Storm		
	2 Year	5 Year	100 Year
Faulkner Drain Tributary at Fernbank Road	0.48	0.76	1.75

4.5.2 POST-DEVELOPMENT CONDITIONS

As mentioned in Section 4.4.1, hydrological analysis of the proposed dual drainage system was conducted using SWMHYMO. This technique offers a single storm event flow generation and routing. The overall post-development SWMHYMO model of the Faulkner Drain Tributary used in the EMP and MSS has been updated to reflect the proposed changes to the tributary drainage area. The model has been revised to isolate the study area tributary to Pond 4. Land use, selected modeling routines, and input parameters are discussed in the following sections. A post-development model schematic and model files are included in Appendix E. As previously noted, the design is currently at a conceptual level and will be further refined at the detailed design stage.

<u>**Land Use**</u>

The site will be developed as a mixture of low and medium density residential areas with two park areas and a school. The existing recreational area located at the northern end of the site that abuts Shea Road to the west also contributes stormwater runoff to the proposed system. The tributary drainage area was divided into semi-lumped drainage areas reflective of the conceptual design of the minor system. The post-development drainage scheme is indicated in Figure 8.



Plot Style: AIA STANDARD COLOR-HALF.CTB Plot Scale: 1:1 Plotted At: Feb. 13, 13 2:28 PM Printed By: DON SIURNA Last Saved By: DSIURNA Last Saved At: Feb. 13, 13

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CONCEPTUAL SITE SERVICING STUDY
SHEA ROAD LANDS
FERNBANK COMMUNITY

STORM DRAINAGE
AREA PLAN

FIGURE 8

Storms and Drainage Area Parameters

The main hydrology parameters are summarized below and in Table 4.4. Supporting calculations are presented in Appendix E.

- **Design storms:** The site was evaluated using the following storms:
  - 25 mm 4 hour Chicago 12 minute time step (for water quality simulation);
  - 2, 5 and 100 year 24 hour SCS Type II design storm events, 12 minute time step (the EMP and MSS identified the 24 hour SCS Type II as the design storm);
  - 100 year 24 hour SCS Type II design storm events + 20% increase in intensity, 12 minute time step (stress test per City of Ottawa guidelines);
  - 100 year 3 hour Chicago storm event with a 10 minute time step (for dual drainage evaluation, specifically major flow conveyance); and,
  - July 1, 1979, August 4, 1988, and August 8, 1996 storms (historical storms per City of Ottawa guidelines).

- **Area**: Semi-lumped drainage areas are based on the proposed minor system network of storm sewers. The total drainage area contributing minor and major flow to Pond 4 measures 56.57 ha. This is consistent with the drainage area presented in the EMP and MSS of 57.94 ha. The pond block area of 3.61 ha has been maintained as in the EMP and MSS.

- **Imperviousness:** Typical total and directly connected impervious ratios for single family and townhouse units based on typical runoff coefficients have been applied across the site. The calculations to support the runoff coefficients are included in Appendix E. The overall weighted average for the Pond 4 drainage area is 57%, which is higher than the EMP and MSS value of 44%.

- **Minor system capture:** Based on 2012 City guidelines, the minor system capture is based on 5 year rational method flow with a fixed time of concentration of 10 minutes. This results in an overall average unit rate of 170 l/s/ha across the site, which is higher than the EMP and MSS unit flow rate of 100 l/s/ha applied to the Pond 4 drainage area. Supporting calculations are enclosed in Appendix E.

- **Surface storage:** Available surface storage has been approximated based on the macro grading plan. An average unit value of 40 cu-m/ha was applied to the semi-lumped drainage areas in the SWMHYMO model. This value is slightly lower than EMP and MSS value of 50 cu-m/ha.

- **Infiltration:** Infiltration losses were selected to be consistent with the City of Ottawa Sewer Design Guidelines. The Horton values are as follows: f_o = 76.2 mm/h, f_c = 13.2 mm/h, k = 0.00115 s^{-1}.

- **Length:** The impervious length is based on an average of the measured length of the trunk through the catchment and the calculated length based on the SWMHYMO user's manual. The pervious length is based on an average lot depth. This approach is consistent with City of Ottawa Sewer Design Guidelines. Relevant calculations are enclosed in Appendix E.

- **Initial Abstraction (Depression Storage):** Depression storage depths of 1.57 mm and 4.67 mm were used for impervious and pervious areas, respectively. These values are consistent with those in the City of Ottawa Sewer Design Guidelines.

Performance of the Pond

The performance of Pond 4 is summarized in the below table.

Table 4.8 Summary of Pond 4 stage, storage and discharge during various storm events
Post-development conditions SWMHYMO model file: D008.dat

	Storage (ha-m)	Discharge (cms)	Elevation (m)
Permanent Storage	0.87	N/A	105.75
25 mm 4 hour Chicago	0.66*	0.136	106.05
2 year 24 hour SCS Type II	1.19*	0.256	106.31
5 year 24 hour SCS Type II	1.67*	0.397	106.78
100 year 24 hour SCS Type II (Design Storm)	**2.83***	**1.579**	**107.37**
100 year 24 hour SCS Type II + 20%	3.40*	2.314	107.73**
100 year 3 hour Chicago	2.56*	1.230	107.19
July 1 1979	3.39*	2.285	107.72**
August 1988	2.82*	1.574	107.36
August 1996	2.64*	1.341	107.25

** Extended storage only*
*** Extrapolated values*

The maximum water level during the 100 year design storm is 107.37 m, which closely corresponds to the Pond 4 100 year water level published in the EMP and MSS of 107.45 m. It is suggested that at the detailed design stage consideration be given to providing an emergency overflow in the pond at elevation 107.37 m. This provision would allow overflow from the pond during the 100 year 24 hour SCS Type II storm with 20% increase in intensity as well as the July 1, 1979 storm.

4.6 Hydraulic Grade Line Analysis

No submerged inlets

The maximum water level in the pond is proposed to be 107.37 m during the design storm (100 year 24 hour SCS Type II storm). This is below the obvert elevation of the two inlet pipes to the pond (107.55 m). There is therefore no anticipated hydraulic grade line in the upstream storm system. The required 0.3 m minimum clearance between the underside of footing and storm obvert or hydraulic grade line would therefore be governed by the storm obvert.

The emergency overflow at elevation 107.37 m recommended in Section 4.5.3 would allow for overflow during emergency conditions, preventing the water level in the pond from exceeding the maximum 100 year design water level of 107.37 m.

The hydraulic grade line will be confirmed at the detailed design stage.

From: Paerez, Ana
To: Kilborn, Kris
Subject: RE: Shea Road Lands Cavanagh
Date: Thursday, October 06, 2016 3:51:00 PM
Attachments: image003.png

Hi Kris,
Based on the email below, we will have to restrict post development peak flows from the Tartan/Cavanagh development to approximately 10 year pre-development levels (~0.9 cms). That being said, the SWM pond block will be significantly bigger than what was originally shown in the EMP.
I will be flying to Ottawa on Tuesday and will be at the office on Wednesday so we can touch base then.
Happy Thanksgiving!!
Ana

Ana M. Paerez, P. Eng.
Municipal Engineer
Stantec
Phone: 506-863-0127
Fax: 506-858-8698
ana.paerez@stantec.com

From: Kilborn, Kris
Sent: Thursday, October 06, 2016 2:30 PM
To: Paerez, Ana <Ana.Paerez@stantec.com>
Subject: FW: Shea Road Lands Cavanagh

Ana

Please see email below from Andy Robinson on the flow from pond 4.
I am out of the office on Friday, but maybe we can touch base next Tuesday or wed when you are in Ottawa
Sincerely

Kris Kilborn
Associate, Community Development
Business Center Sector Leader (BCSL)
Stantec
400 - 1331 Clyde Avenue Ottawa ON K2C 3G4
Phone: (613) 724-4337
Cell: (613) 297-0571
Fax: (613) 722-2799
kris.kilborn@stantec.com

From: Andy Robinson [mailto:ajrobinson@rcii.com]
Sent: Thursday, October 06, 2016 11:59 AM
To: 'Surprenant, Eric'; Kilborn, Kris

Cc: Ryan, David W; Gagne, Marc (TUPW)
Subject: RE: Shea Road Lands Cavanagh

Eric & Kris,

In our initial review of the Hydrotechnical Report prepared by Novatech in support of development in Area 6, we pointed out that the culvert under Fernbank Road had a capacity of 0.75 to 0.9 cms. (the 0.9 is with a 0.5 m head). The community development plan used a release rate of 1.75 cms. from Pond 4. Therefore, our position (from the perspective of the flow reaching the Faulkner Municipal Drain) is that the flow from north of Fernbank Road should be limited to a maximum of 0.9 cms.

The update of the Faulkner Municipal Drain is ongoing, but cannot be advance very far until we have the final agreed upon hydrology (pre and post development) and the final plan of the proposed developments (Cavanagh and Tartan) north of Fernbank Road. This includes any modifications to the watershed boundary.

In order to reduce the duplication of effort we generally rely upon the hydrology report completed by the engineer working for the developer, which in turn will have been reviewed and approved by the City. We do review the reports to make sure that we are in agreement. Where there could be a difference for instant is the release rate from Pond 4. From the perspective of the Municipal Drain we will require that the maximum flow rate at Fernbank Road not exceed the present capacity of the controlling culvert under Fernbank Road, whereas the development approvals may be governed by the higher release rate from Pond 4 in the documents supporting the Community Development plan.

Andy

Andy Robinson, P.Eng.
Robinson Consultants Inc.
Ph: (613) 592-6060 ext. 104

From: Surprenant, Eric [mailto:Eric.Surprenant@ottawa.ca]
Sent: October-03-16 12:05 PM
To: 'Kilborn, Kris'
Cc: Ryan, David W; Gagne, Marc (TUPW); Andy Robinson
Subject: RE: Shea Road Lands Cavanagh

Kris,

Sorry for the delay, I started getting back to you but got side tracked. See below my responses in red. Please don't hesitate to contact me if you would like to discuss further.

Thanks

Eric Surprenant, C.E.T. / 613 580-2424 ext.:27794
Project Manager, Infrastructure Approvals

Development Review Suburban Services Branch
Planning, Infrastructure and Economic Development Dept.

Gestionaire de projets, Approbation de l'infrastructure
Examen des demandes d'aménagement (Services Suburbains Ouest)
Services de la planification, de l'infrastructure et du développement économique

City of Ottawa | Ville d'Ottawa
613.580.2424 ext./poste 27794
ottawa.ca/planning / ottawa.ca/urbanisme

From: Kilborn, Kris [mailto:kris.kilborn@stantec.com]
Sent: October 03, 2016 9:53 AM
To: Surprenant, Eric
Subject: RE: Shea Road Lands Cavanagh

Good Monday morning Eric

Just thought I would circle back around on my request for information of sept 21.
Please get back to me at your earliest convenience
Regards

Kris Kilborn
Associate, Community Development
Business Center Sector Leader (BCSL)
Stantec
400 - 1331 Clyde Avenue Ottawa ON K2C 3G4
Phone: (613) 724-4337
Cell: (613) 297-0571
Fax: (613) 722-2799
kris.kilborn@stantec.com

From: Kilborn, Kris
Sent: Wednesday, September 21, 2016 3:19 PM
To: 'Eric.Surprenant@ottawa.ca' (Eric.Surprenant@ottawa.ca) (Eric.Surprenant@ottawa.ca)
Subject: Shea Road Lands Cavanagh

Good afternoon Eric hope all is well.
Further to our preconsultation meeting for the Cavanagh Shea Road Development on July 13 2016 and to the comments received on
July 25, we have reviewed all of the background information for the site, including the previous submission by IBI on Behalf of Tartan and Cavanagh and have a few outstanding items that we would like clarification on from the City.

1. Based on meeting notes from the pre-consultation meeting, the design of Pond 4 needs to include an additional 1,200 m^3. Need confirmation on the design requirements for the pond (i.e. volume requirements, target release rates, imperviousness).

The release rate and Pond 4 design question is somewhat multi-facet. At present the release rate should be coordinated with the work being done by Andy Robinson of Robinson Consultants since Andy is the Drainage Engineer having been appointed through By-Law to look at the Faulkner MD. Pond 4 and this development fall within the drainage area for the Faulkner MD. As discussed at our pre-consult meeting the Fernbank EMP identified a release rate which may be greater than what the Fernbank road crossing culvert may be able to handle at this time, however as stated it will be important to coordinate with the drainage engineer on your design release rate and any additional storage. The Fernbank EMP can be used for the initial pond design, imperviousness etc…however, the revised Sewer Design Guidelines should be applied where your conceptual design is concerned. (Give me a call if you require further clarifications)

2. Based on the pre-consultation meeting notes, there is an on-going review/update of the Faulkner Drain. Need to review the finalized report. Is this report available?

The update to the Drainage Report is currently ongoing. Please see #1. I have copied our Drainage Superintendent(s) and Andy Robinson on this as they may be able to update you further.

3. Please confirm that this development will be utilizing the latest City bulletin with revisions to the SWM guidelines and will l be implemented for this site.

Please see #1.

4. The pre-consultation meeting notes state "reconcile and review the release rate across Fernbank Road". Need clarification. Is there a document where this information can be obtained?

Please see #1.

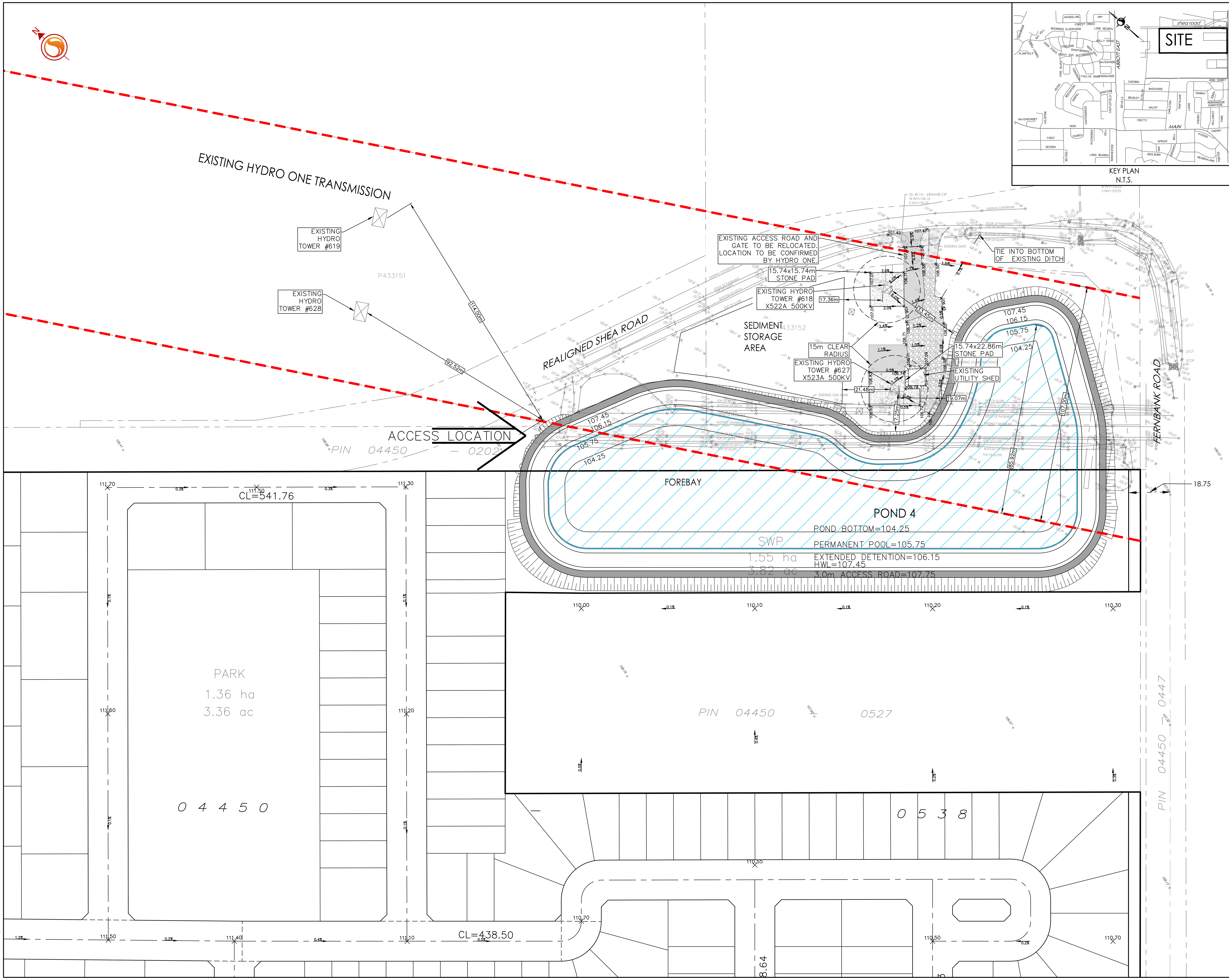
5. IBi's servicing report for Tartan and Cavanagh's lands state that the urban boundary was extended southerly resulting in extended alignment of the sanitary trunk sewer and an increase in peak flows to be routed through our site. Need additional information on the additional drainage area, land use and location. Is there a master servicing report or Drainage Drawings available for the lands south of Fernbank Road.

Area 6 lands will be draining through the Fernbank Lands. Presently a section of the oversized sanitary sewer is being designed through the CRT lands (in Goldhawk Drive). Coordination of the oversized sanitary sewer to accommodate Area 6 flows should be coordinated with CRT's consultants (IBI) and Novatech who are designing the new Area 6 Pump Station and it's forcemains.

Please get back to me at your earliest convenience

Sincerely

Kris Kilborn
Associate, Community Development
Business Center Sector Leader (BCSL)
Stantec
400 - 1331 Clyde Avenue Ottawa ON K2C 3G4
Phone: (613) 724-4337
Cell: (613) 297-0571
Fax: (613) 722-2799
kris.kilborn@stantec.com



Stantec

Stantec Consulting Ltd.
400 - 1331 Clyde Avenue
Ottawa ON
Tel. 613.722.4420
www.stantec.com

Legend

106.15 PROPOSED ELEVATION

106.88 EXISTING ELEVATION

8.07m DIMENSION FROM HYDRO ONE FACILITIES TO PROPOSED GRADE CHANGE

ACCESS LOCATION POND ACCESS

EXISTING GRAVEL ACCESS TO BE REINSTATED

EXISTING GRAVEL ACCESS TO BE REMOVED

PROPOSED GRAVEL ACCESS

PERMANENT POOL (105.75):
A=13860m²
V=17250m³

EXTENDED DETENTION (106.15):
A=15140m²
V=5800m³

Notes

		By	Appd.	YY.MM.DD
3	REVISED ACCESS	WAJ	KJK	17.10.19
2	REVISED ACCESS AND PAD LOCATIONS	WAJ	KJK	17.08.31
1	REVISED AS PER HYDRO ONE COMMENTS	WAJ	KJK	17.07.13

Revision

File Name: 160400900-D8	WAJ	KJK	WAJ	16.11.29
	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Permit-Seal

Client/Project
1384341 ONTARIO LTD.

SHEA ROAD LANDS

OTTAWA, ON

Title
PRELIMINARY
SITE AND GRADING PLAN
HYDRO ONE CORRIDOR

Project No. 160400900 | Scale 1:750 | 0 7.5 22.5 37.5m

Drawing No. GP-1 | Sheet 1 of 4 | Revision 3

V:\active\160400900_cavanagh_stittsville\design\drawing\160400900-HYDRO-CRC.dwg
2017/10/25 12:08 PM By: Johnson, Warren

ORIGINAL SHEET - ARCH D

Hydro One Networks Inc.
Facilities & Real Estate
P.O. Box 4300
Markham, ON L3R 5Z5
Courier:
185 Clegg Road
Markham, ON L6G 1B7

hydro one

SENT VIA COURIER

1384341 Ontario Limited
C/O Cavanagh Land Holdings
9094 Cavanagh Road
Ashton, Ontario
K0A 1B0

Attention: Jeffrey Cavanagh

October 25th, 2017

Re: Hydro One Technical Review For Proposed Encroachment on 500 kV Transmission Corridor Easement Part of Lot 26, Concession 10, Goulbourn Township, City of Ottawa being PINS # 04450-0538 & 04450-2052 HONI FILE #: GOULBOURN TWP 635.06-5979 – Shea Road Storm Water Management Pond (SWMP)

Dear Mr. Cavanagh:

Hydro One Networks Inc. (hereafter reffered to as "HONI") have completed the technical review of the proposed 1384341 Ontario Ltd. (here after reffered to as "CAVANAGH") construction and ecroachment activities at the location described above where HONI employs an Easement Right of Way (HONI corridor) permitting its 500 kV electrical overhead transmission facilities.

HONI is now prepared to approve the proposal based on the following drawings prepared and submitted by Stantec Consulting Ltd: GP-1, Preliminary Site and Grading Plan- Hydro One Corridor – (Revision #3 October 19, 2017) subject to CAVANAGH not deviating from the submitted plans noted above and signing and returning the acknowledgement section together with this letter. CAVANAGH is required to sign a HONI Construction Agreement prior to the commencement of any construction activities. CAVANAGH acknowledges that HONI also requires an Encroachment Agreement for the installations on the HONI corridor between HONI and the land owner, and that HONI will not be responsible for any costs associated with registering the Encroachment Agreement on title of the property.

A: SITE SPECIFIC REQUIREMENTS:

1. Proponent is to contact HONI Agent/Land Technician Bruce Froats at (613) 720-0266, (with minimum 72-hours notice) to arrange a Pre & Post site construction meeting, prior to the start of construction & on completion of construction. Temporary barriers must be erected and maintained in an upright state along the limit of the intended uses, in order to restrict access to unauthorized areas of the corridor. The temporary fencing must be a minimum 4-foot-high orange nylon snow fence. Maintained in an upright condition for the duration of construction and installed a minimum of three meters away from all HONI owned structures/equipment within the work zones. ***Temporary fencing must be installed prior to Pre-Construction Meeting.***

2. Proponent is to mark all poles and guy wires on the property within the construction zone with bright markers, such as yellow plastic guards on the guy wires, and either red or yellow tape or paint on the poles at eye level and lower, to avoid potential hazards. These markers must be in place prior to construction and left on and kept in good condition for the duration of the construction.

3. Proponent must erect signage on the HONI corridor clearly indicating the overhead dangers that exist. Signs must be clearly visible and maintained up at all times. Lifting of cranes, loaders, dump boxes, etc. are to be permitted as long as appropriate clearances are kept at all times. Reference to OHSA section 186 should be noted on signage.

4. HONI endeavors to maintain corridor lands in a safe condition, without ruts and other potential damage that can occur as a result of construction traffic. Please leave the corridor lands as good as, or better than found.

5. HONI will not be responsible for any damages done to any infrastructure installed within the HONI corridor, due to routine maintenance or storm work.

6. No plantings are permitted within the HONI corridor that will grow higher than 4 metres above the present grade.

B: GENERAL CONDITIONS

1. Clearance Around HONI Structures

- A 3.0 meter radius around HONI structures must be left unpaved for access to tower footings if necessary.

- HONI requires 15 meters of clearance on all sides around its transmission structures as measured from the tower legs in order to carry out maintenance operations. No storage or staging activities should occur within this area during construction except as approved otherwise in writing.

2. Corridor Conditions

- The proponent must ensure no grading/excavation work is carried out using heavy machinery within 10 metres of the tower footings. Within 10 metres of tower footings grading/excavation work must be carried out by hand or by using a VAC system in order to protect the tower foundations.

- No fill material must be placed on the HONI corridor, except where it is required for grading, underground installations, or drainage/storm water management.

3. Storm Water Management

- The proponent must ensure the proposed works do not interfere with the natural drainage patterns along this stretch of the HONI corridor and does not result in standing water within 15.0 meters of the existing HONI structure bases or anywhere else on the corridor.

- The proponent will be held liable for any damage to HONI facilities as a result of flooding or standing water caused by the subject project.

- There shall be no catch basin installations along hydro corridors which are not positioned within a paved roadway.

4. Vertical Clearance

- Heavy construction equipment working directly underneath the HONI conductors must satisfy OSHA clearances as indicated under 'General Requirements'.

- A pre-construction meeting with HONI's Land Use Agent assigned to the project is required to ensure that the proponent and/or its contractors are well aware of all safety requirements.

- All proposed works on the corridor are subject to adequate overhead transmission line clearance from the high voltage conductors to the proposed ground elevations.

5. Access Route

- Access to HONI facilities must not be obstructed, at any time, during construction or after the facilities are in service. The site must be kept free of all debris and equipment which could prohibit access to HONI facilities.

- The proponent should note that the remaining unoccupied width of the corridor is at least 6.0 metres for longitudinal corridor access and mid-span maintenance of the lines. Access routes should not have a slope greater than 10%.

6. Safety & Security

- A HONI lines technician assigned to the area must verify that clearance requirements are maintained from all structures, guardrails, light posts, etc.

- The proponent must be cognizant of the fact that construction of the proposed development will be carried out directly underneath 500 kV transmission lines, and as such the proponent must meet with the HONI Lines Technician assigned to this project prior to the start of construction in order to obtain an entry permit and to discuss clearance issues.

- It is the responsibility of the Proponent and/or Contractor to ensure that OHSA clearances are maintained to electrical components during any activity on site. A Transmission Lines Technician will assist, if required, for a tailgate meeting to provide guidance when working near energized facilities.

- The proponent is responsible for maintaining security of the site and for the safety of the people working within the corridor.

7. Liabilities

- The Proponent will assume all liability associated with this secondary land use.

- In the case of emergency work, the proponent may be required to suspend its operations until HONI crews have completed their work.

8. Future Development/Upgrades

- In the event of any future development on the HONI corridor, the proponent must notify HONI for review and approval prior to the commencement of any construction work.

- Any relocation/replacement/modification of HONI structures will be carried out at the proponent's expense.

B: PROHIBITED/RESTRICTED ACTIVITIES:

1. Burning of brush or other agricultural, or construction debris is strictly prohibited on HONI corridors.

2. Tower bases are to be kept clear of plantings, material- equipment storage or debris of any kind at all times.

3. Flammables are not to be used or stored on the HONI corridor.

4. Drainage is not to be directed towards HONI structures as a result of this project. Drainage flows that exist on Hydro corridor lands are to remain unchanged, unless improved to drain directly into a catch basin.

5. Any proposed grade change on the HONI corridor must be submitted for review and approval prior to any works taking place.

6. If at any time the lands are used for inappropriate purposes, (i.e. anything not specified in the licence or conditions letter) this agreement will be subject to cancellation HONI upon written notice.

7. No snow dumping within the HONI corridor. Snow must be removed off all road/parking surfaces and disposed of off-site.

C: TRANSMISSION LINES ISSUES:

1. **Overhead Transmission Line conductors:**
   The position of Transmission Line conductors is dynamic. They move up and down each day as the ambient temperature and the electrical load changes. It is possible for the low point at midspan to vary by 10ft (3m) as conditions change. All clearance requirements are based on the calculated maximum loaded condition (maximum sag) which can occur at any time due to system operating requirements.

2. **Clearances to Transmission Line conductors:**

hydro one

It is the constructor's responsibility to ensure that safe working clearances as specified in The Ontario Occupational Health & Safety Act (OHSA) for workers and equipment are maintained at all times during construction activities.

The Transmission Line(s) involved with this proposal operate at 500 kV and the safe working clearance requirements are 6.0 meters, as per Section 186, "Proximity", of the Occupational Health & Safety Act (OHSA).

Workers and Equipment operating in the vicinity of energized overhead conductors may require the use of a competent designated signaler as per OHSA regulations if:

A) Any part of the equipment could rotate or extend closer to the conductor than the safe working clearance required
B) An inadvertent movement by the worker, including the length of any hand held tools or equipment could be closer to the conductor than the safe working clearance required.

The Ministry of Labour (MOL) monitors construction site activity to ensure that safe working clearance is maintained at all times. Failure to do so may result in action by the MOL. If safe-working clearances for workers and equipment cannot be maintained at all times during construction activities, HONI may be able to provide circuit outages at the expense of the proponent.

3. Access to Transmission Line structures must be maintained at all times. HONI maintenance and repair equipment includes large heavy rubber tired road vehicles and large heavy tracked equipment. An adequately sized work zone must be maintained at the base of a structure at all times. No activity that restricts access to structures will be permitted on any HONI corridor.

Please also note the ***Hydro One General Requirements*** which can be found attached. In this regard, please execute the acknowledgement section section of this letter. Once your construction schedule has been confirmed, please contact the undersigned to obtain copies of the required Construction & Encroachment Agreements. Please be advised, no constructions activities are permitted prior to the Construction & Encroachment Agreements being duly executed.

Should you have any questions, please contact the undersigned at Greg.Gowan@HydroOne.com or call (905) 946-6232. Please reference the above-noted file number in any correspondence or voice mails.

Yours truly,

HYDRO ONE NETWORKS INC.

Greg Gowan
Real Estate Coordinator

Attachments: Hydro One General Requirements
Hydro One Acceptable Species List

ACKNOWLEDGEMENT

I/We acknowledge having read this letter and agree to adhere to and be bound by these terms and conditions. Having the authority to bind the corporation, I/We understand and acknowledge that a breach of any of these conditions automatically negates and nullifies HONI's permission for the proposed construction/installation on its easement lands.

138431 ONTARIO LIMITED

Per:______________________________

Name:
Title:

Per:______________________________

Name:
Title:

I/We Have Authority to Bind the Corporation.

General Requirements

Hydro One Transmission Lines Minimum Vertical Clearance
The vertical clearances from high voltage transmission lines over or alongside land likely to be travelled by road vehicles including highways, streets, alleys, lanes, driveways and other road must meet the following Hydro One requirements:

Line Voltage (kV)	Required Vertical Clearance (m)
115	6.7
230	7.3
500	16.6

OHSA Safe Working Clearance
There is/are high voltage Transmission Line(s) in the vicinity of this proposal. The highest voltage(s) is/are indicated above. According to the Occupational Health & Safety Act (OHSA), section 188, the safe working clearance requirements are as follows:

Line Voltage (kV)	Required Vertical Clearance (m)
115	3.0
230	4.5
500	6.0

The position of Transmission Line conductors is dynamic. They raise and lower each day as the ambient temperature and the electrical load changes. It is possible for the low point at mid-span to vary by 4.6 meters (15 ft) as conditions change.

All clearance requirements are based on the calculated maximum loaded condition (maximum sag) which can occur at any time due to system operating requirements. **It is the Proponents responsibility to ensure that safe working clearances as specified in The Ontario Occupational Health & Safety Act (OHSA) for workers and equipment are maintained at all times during construction activities.**

The installation of signs warning of overhead high voltage power lines are required as per The Ontario Occupational Health & Safety Act (OHSA). A dedicated signaler may also be required as per OHSA.

Prohibited Activities

- There shall be no storage of any material on the ROW without permission of Hydro One. Any debris on the ROW shall be removed on an ongoing basis.
- There shall be no storage or tipping of garbage dumpsters on the ROW.
- There shall be no storage or dispensing of gasoline or any other combustible substance on the Hydro One ROW.

Light standards, flag poles, power distribution pole lines or other aerial installations are **not** permitted on the Hydro One ROW, whether temporary or permanent, without the written approval from Hydro One, Transmission Lines.

Proponent must maintain a 6 meter wide access route to structures at all times. Failure to do so will result in the Proponent's responsibility for any costs incurred by Hydro One in regaining this access to perform maintenance or repairs.

The Proponent is responsible for arranging all underground locates prior to digging, auguring or performing any excavation works on the Hydro One ROW.

Hydro One is not responsible for any damages or injuries resulting from the effect of adverse weather conditions. This would include any damages or injuries from ice falling from structures or conductors as a result of an ice storm

All underground utilities have to be designed to allow for vehicular traffic to pass over. Type of vehicles to be accommodated includes large utility vehicles and cranes.

Any Hydro One transmission structure located within 10 meters of any construction activity related to this proposal shall have a temporary orange snow fence erected 3 meters around tower footprint and maintained in an upright position for the duration of construction. Proponent will be responsible for any damage to Hydro One facilities.

The Proponent's use of the Hydro One ROW, during construction or post construction, as it relates to this proposal may be interrupted with or without notice for Hydro One to perform maintenance or emergency repairs. Hydro One will not compensate Proponent for any lost revenue or any other costs to the Proponent due to the interruption.

Plantings shall have a maximum mature height of 3 meters.

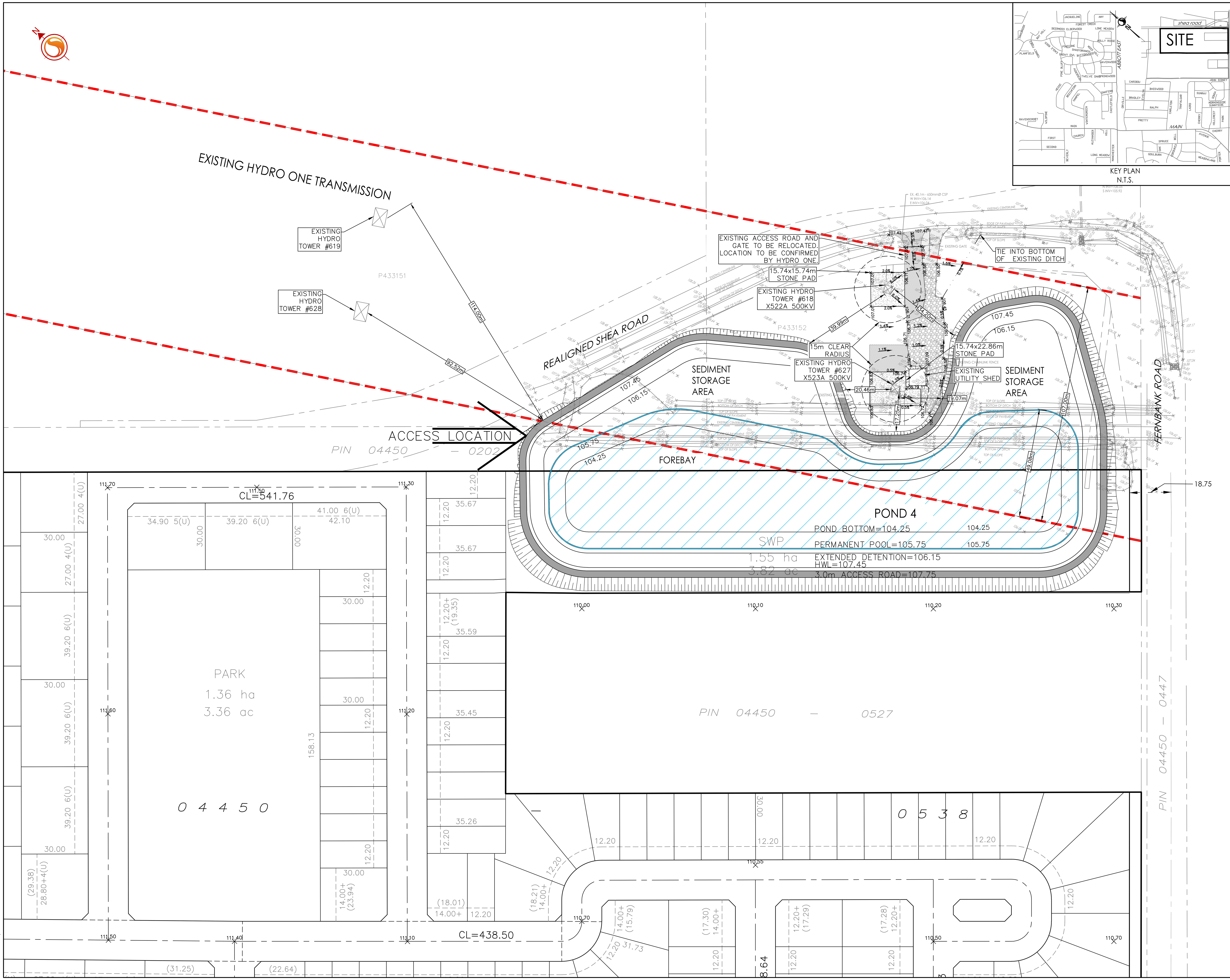
Acceptable Species List

Suggested Compatible Landscaping Species

For Hydro One Networks Inc. Rights of Way

Dogwoods	Gray Dogwood	Cornus racemosa
	Red Oiser Dogwood	Cornus sericea
	Alternate Leaf Dogwood	Cornus alternifolia
Elderberry		Sambucus canadensis
Forsythia		Forsythia ovata
Honeysuckle		Lonicera spp.
High Bush Cranberry		Viburnum trilobum
Mugo Pine		Pinus mugo mugo

This list provides a selection of low-growing shrubs that are permitted to be planted "on" Hydro One Rights of Way. It must be noted that these shrubs should not be planted in such a way as to impede access.



Stantec

Stantec Consulting Ltd.
400 - 1331 Clyde Avenue
Ottawa ON
Tel. 613.722.4420
www.stantec.com

Legend

106.15 PROPOSED ELEVATION
106.88 EXISTING ELEVATION
8.07m DIMENSION FROM HYDRO ONE FACILITIES TO PROPOSED GRADE CHANGE
ACCESS LOCATION POND ACCESS
EXISTING GRAVEL ACCESS TO BE REINSTATED
EXISTING GRAVEL ACCESS TO BE REMOVED
PROPOSED GRAVEL ACCESS

PERMANENT POOL (105.75):
A=11450m²
V=13876m³

EXTENDED DETENTION (106.15):
A=16418m²
V=5544m³

Notes

		By	Appd.	YY.MM.DD
3	REVISED ACCESS	WAJ	KJK	17.10.19
2	REVISED ACCESS AND PAD LOCATIONS	WAJ	KJK	17.08.31
1	REVISED AS PER HYDRO ONE COMMENTS	WAJ	KJK	17.07.13

Revision

File Name: 160400900-D8	WAJ	KJK	WAJ	16.11.29
	Dwn.	Chkd.	Dsgn.	YY.MM.DD

Permit-Seal

Client/Project

1384341 ONTARIO LTD.

SHEA ROAD LANDS

OTTAWA, ON

Title

PRELIMINARY
SITE AND GRADING PLAN
HYDRO ONE CORRIDOR

Project No. 160400900
Scale 1:750

Drawing No. GP-1
Sheet 1 of 4
Revision 3

ORIGINAL SHEET - ARCH D

Appendix D GEOTECHNICAL INVESTIGATION EXCERPTS

GOLDER

REPORT

Geotechnical Investigation

Proposed Residential Development 5957 and 5969 Fernbank Road
Ottawa, Ontario

Submitted to:

1384341 Ontario Ltd.
9094 Cavanagh Road
Ashton, Ontario
K0A 1B0

Submitted by:

Golder Associates Ltd.
1931 Robertson Road Ottawa, Ontario, K2H 5B7 Canada

+1 613 592 9600

1784392

September 2018

Distribution List

1 e-copy - 1384341 Ontario Ltd.

1 e-copy - Golder

Based on a review of published geological maps and previous subsurface investigations carried out in the vicinity of the site, the subsurface conditions on this site are expected to consist primarily of a deposit of glacial till over shallow bedrock. The depth to the bedrock surface is indicated to range between about 1 and 5 metres below the existing ground surface. Based on published geologic mapping, the bedrock is indicated to consist of limestone with dolomite interbeds of the Gull River Formation.

3.0 PROCEDURE

The fieldwork for the geotechnical investigation was carried out on December 14 and 15, 2017. During that time, 15 test pits (numbered 17-01 to 17-15, inclusive) were excavated at the approximate locations shown on the site plan, Figure 1.

The test pits were advanced using a track mounted hydraulic excavator supplied and operated by Cavanagh Construction of Ottawa, Ontario. The test pits were excavated to depths ranging from about 0.2 metres (refusal on the bedrock surface) to 4.5 metres below the existing ground surface.

The soils exposed on the sides of the test pits were classified by visual and tactile examination. Grab samples were obtained from the major soil strata encountered in the test pits. The groundwater seepage conditions were observed in the open test pits and the test pits were loosely backfilled upon completion of excavating and sampling.

The fieldwork was supervised by an experienced technician from our staff who logged the soils encountered and collected the soil samples. The soil samples obtained during the fieldwork were brought to our laboratory for further examination by the project engineer and for laboratory testing. The laboratory testing included grain size distribution testing and natural water content determination.

One soil sample from test pit 17-08 was submitted to Eurofins Environmental Testing Canada for basic chemical analysis related to potential sulphate attack on buried concrete elements and corrosion of buried ferrous elements.

The test pit locations were selected, picketed in the field, and subsequently surveyed by Golder Associates personnel using precision GPS survey unit. The elevations are referenced to Geodetic datum.

4.0 SUBSURFACE CONDITIONS

4.1 General

The subsurface conditions encountered in the test pits are shown on the Record of Test Pits in Table 1. The results of the basic chemical analyses on the selected soil sample from test pit 17-08 are provided in Appendix A.

In general, the subsurface conditions at this site consists of deposits of silts and sands over glacial till over limestone bedrock. Practical refusal to excavating was encountered in most of the test pits at depths varying from about 0.2 to 3.3 metres below the existing ground surface.

The following sections present a more detailed overview of the subsurface conditions encountered in the test pits.

4.2 Topsoil and Fill

A layer of fill exists at the ground surface at test pit 17-05. The fill at this location consists of sand containing brush (likely a windrow) with a thickness of about 0.5 metres.

A layer of topsoil exists at the ground surface, or below the fill, at all of the test pit locations, except test pit 17-09. The topsoil ranges from about 100 to 750 millimetres, but more typically between about 200 and 350 millimetres, in thickness.

A layer of rock fill was encountered below the topsoil at test pit 17-06. The rock fill consists of sand and gravel containing cobbles, and extends down to a depth of about 1.2 metres below the existing ground surface.

4.3 Sand and Silt

Discontinuous deposits of sand, silt, silty sand, and sandy silt, exist below the topsoil and fill in test pits 17-01, 17-03, 17-04, and 17-07 to 17-15. The sand and silt deposits were fully penetrated in most of the test pits, and were proven to extend to depths ranging from about 0.2 to 3.3 metres below the existing ground surface. These deposits were not fully penetrated in test pit 17-12, but were proven to extend to a depth of about 4.2 metres below the existing ground surface.

The measured water content on two samples of the sand and silt deposit ranges from about 10 to 11 percent.

The results of grain size distribution testing carried out on one sample of the sand and silt deposit are shown on Figure 2.

4.4 Glacial Till

A discontinuous deposit of glacial till was encountered below the topsoil and sand and silt layers in test pits 17-01, 17-02, 17-05, 17-06, 17-07, 17-11, 17-14, and 17-15. The glacial till generally consists of a heterogeneous mixture of gravel, cobbles, and boulders in a soil matrix of silty sand to sandy silt. The glacial till extends to depths ranging from about 0.9 to 4.5 metres below the existing ground surface.

The measured water content on three samples of the glacial till deposit range from about 9 to 22 percent.

The results of grain size distribution testing carried out on two samples of the glacial till are shown on Figure 3.

4.5 Bedrock

Refusal to excavating was encountered at all of the test pit locations, except test pits 17-12 and 17-14, at depths ranging from about 0.2 to 3.3 metres below the existing ground surface.

The following table summarizes the ground surface, depth to refusal, and refusal elevations as encountered at the test pit locations.

Test Pit Number	Ground Surface Elevation (m)	Bedrock Surface Depth (m)	Refusal Elevation (m)
17-01	111.1	0.9	110.2
17-02	109.5	1.1	108.4
17-03	111.8	1.3	110.5
17-04	112.0	1.3	110.7
17-05	113.6	1.6	112.0
17-06	111.3	1.5	109.8
17-07	108.9	1.8	107.1
17-08	109.5	0.4	109.1
17-09	111.6	0.2	111.4
17-10	110.6	1.9	108.7
17-11	109.7	2.1	107.6
17-12	107.2	> 4.2	< 103.0
17-13	105.9	3.3	102.6
17-14	106.8	> 4.5	< 102.3
17-15	108.6	1.6	107.0

4.6 Groundwater

Groundwater seepage and wet soil conditions were generally present at depths ranging from about 1.3 to 2.1 metres below the existing ground surface.

It should be noted that groundwater levels are expected to fluctuate seasonally. Higher groundwater levels are expected during wet periods of the year, such as spring.

4.7 Corrosion

One soil sample from test pit 17-08 was submitted to Eurofins Environmental Testing Canada for basic chemical analysis related to potential sulphate attack on buried concrete elements and corrosion of buried ferrous elements.

The results of this testing are provided in Appendix A and are summarized below.

Test Pit / Sample Number	Sample Depth (m)	Chloride (%)	SO_4 (%)	pH	Resistivity (Ohm-cm)
17-08 / 1	0.1 – 0.4	<0.002	0.02	7.28	9,090

5.0 DESIGN AND CONSTRUCTION CONSIDERATIONS

5.1 General

This section of the report provides engineering guidelines on the geotechnical design aspects of the project based on our interpretation of the available information described herein and project requirements. Contractors bidding on or undertaking the works should examine the factual results of the investigation, satisfy themselves as to the adequacy of the factual information for construction, and make their own interpretation of the factual data as it affects their proposed construction techniques, schedule, safety, and equipment capabilities.

Reference should be made to the "Important Information and Limitations of This Report" which follows the text but forms an integral part of this document.

5.2 Site Grading

The subsurface conditions on this site generally consist of deposits of silts and sands over glacial till, underlain by bedrock. Refusal to excavating was encountered at depths ranging from about 0.2 to 3.3 metres below the existing ground surface.

No practical restrictions apply to the thickness of grade raise fill which may be placed on the site from a foundation design perspective.

As a general guideline regarding the site grading, the preparation for filling of the site should include stripping any topsoil, fill, and organic matter to improve the settlement performance of structures, services, and roadways. Topsoil, fill, and organic matter are not suitable as general fill and should be stockpiled separately for re-use in landscaping applications only. In areas with no proposed structures, services, or roadways, these materials may be left in-place provided some settlement of the ground surface following filling can be tolerated.

Groundwater seepage was generally encountered at depths ranging from about 1.3 to 2.1 metres below the existing ground surface. More significant groundwater flow should be expected for excavations that extend below the groundwater level in these areas. Therefore, in these areas, consideration should be given (but not necessary from a geotechnical perspective) to setting the grading in order to limit the required depths of excavation (particularly for basements) since groundwater management requirements and costs increase with excavation depth below the groundwater level.

It is understood that drainage tiles may exist on the site. All drainage tiles should be removed. Within building footprints and below service trenches, the surrounding bedding/fill for the tile should also be removed (i.e., the existing trench for the drainage tile should be stripped to native soil or bedrock) and the resulting trench should be backfilled with Ontario Provincial Standard Specification (OPSS) Granular B Type II compacted to 95% of its maximum Proctor dry density.

Where the drainage tiles underlie landscaped areas or roadways, any suitable and compactable general fill may be used after removal of the drainage tiles, except within 1.8 metres depth of roadway surfaces where the fill used should match the native soils for frost heave compatibility.

5.3 Foundations

With the exception of the topsoil, the native undisturbed inorganic soils and bedrock on this site are considered suitable for the support of conventional wood frame houses on spread footing foundations. For design purposes, strip footing foundations, up to 1 metre in width, can be designed using a maximum allowable bearing pressure of 100 kilopascals for the overburden soils, consistent with design in accordance with Part 9 of the Ontario Building Code. For footings founded on or within bedrock, an allowable bearing pressure of 250 kilopascals may be used.

The post-construction total and differential settlements of footings supported on soil and sized using the above maximum allowable bearing pressure should be less than 25 and 15 millimetres, respectively, provided that the soil at or below founding level is not disturbed before or during construction. Footings on bedrock should experience negligible settlements.

Some of the overburden soils on this site contain cobbles and boulders. Any cobbles or boulders in footing areas which have been loosened by the excavation process should be removed and the cavity filled with lean concrete.

At some locations on the property, and depending on the amount of proposed grade raise (i.e., filling), the inorganic subgrade elevation may be lower than the underside of footing elevation. At these locations, the subgrade may be raised to the footing elevation using suitable engineered fill. The engineered fill should consist of Ontario Provincial Standard Specification (OPSS) Granular B Type II. All fill material should be placed in maximum 300 millimetre thick lifts and compacted to at least 95 percent of the material's standard Proctor maximum dry density (SPMDD) using suitable vibratory compaction equipment. The engineered fill material must be placed within the full zone of influence of the house foundations. The zone of influence is considered to extend out and down from the edge of the perimeter footings at a slope of 1 horizontal to 1 vertical. The same bearing pressures provided above may be used on properly constructed engineered fill pads.

Where the subgrade at footing level changes from bedrock to overburden, differential settlement could result at this transition due to the different settlement properties of these materials. To limit the magnitude of the differential settlement, transition details (such as placing additional reinforcing steel in the foundation walls) may be required. Where sloping bedrock is encountered, stepped footings may also need to be considered. The structural engineering consultant should be contacted for input on these issues.

There may be portions of the site where the shallow sandy deposits will be exposed at footing/subgrade level. Prior to construction of footings or the placement of engineered fill within these areas, the surface of the native sandy material should be proof rolled to provide surficial densification of any loose or disturbed material.

Since these shallow sandy deposits, wherever present, are typically loose, they could be potentially liquefiable in an earthquake (i.e., potentially subject to temporary strength loss and post-earthquake settlements). That potential issue is not however considered relevant to the house design because:

- The potential post-earthquake differential settlements would be relatively small in relation to the expected collapse potential of a house (and the objective of earthquake-resistant design is only to avoid collapse and to provide for safe exit).
- The proof rolling of the sandy subgrade soils, as specified above, would densify any such soils in the immediate area of the footings and therefore the directly supporting soils would be non-liquefiable.

5.4 Seismic Design Considerations

The seismic design provisions of the 2012 Ontario Building Code (OBC) depend, in part, on the shear wave velocity of the upper 30 metres of soil and/or bedrock below founding level. Based on the 2012 Ontario Building Code methodology, this site can be assigned a Site Class of D.

Although the seismic Site Class is not directly applicable to structures designed in accordance with Part 9 of the OBC (i.e., conventional housing), this assessment is provided to address City of Ottawa requirements that relate to housing on Site Class E sites.

5.5 Frost Protection

The soils at this site are frost susceptible. For frost protection purposes, all exterior footings or interior footings in unheated areas should be provided with a minimum of 1.5 metres of earth cover. Isolated, exterior footings adjacent to surfaces which are cleared of snow cover during winter months should be provided with a minimum of 1.8 metres of earth cover. Houses with conventional depth basements would satisfy these requirements.

5.6 Basement Excavations

Excavations for basements will be made through overburden deposits. Bedrock is also expected to be encountered for standard house foundations, but will depend on the proposed grading for the site.

No unusual problems are anticipated with excavating the overburden materials using large hydraulic excavating equipment, recognizing that significant cobble and boulder removal can be expected in areas of the site. Boulders larger than 0.3 metres in diameter should be removed from the excavation side slopes for worker safety.

If required, shallow depths of bedrock removal could be accomplished using mechanical methods (such as hoe ramming in conjunction with line drilling). Deeper excavations into bedrock would likely require blasting. Further details on blasting are provided in Section 5.9.1 of this report.

Above the water table, side slopes should be stable in the short term at 1 horizontal to 1 vertical (Type 3 soil in accordance with the Occupational Health and Safety Act of Ontario (OHSA)). Below the water table, side slopes of 3 horizontal to 1 vertical (Type 4 soil in accordance with the OHSA) will be required to prevent sloughing of the sandier soils.

Near-vertical excavation side slopes in the bedrock should be feasible.

Based on present groundwater levels, excavations deeper than about 1.3 metres will extend below the groundwater level. Groundwater inflow into the excavations should feasibly be handled by pumping from sumps within the excavations. The actual rate of groundwater inflow will depend on many factors including the contractor's schedule and rate of excavation, the size of the excavation, the number of working areas being excavated at one time, and the time of year at which the excavation is made. Also, there may be instances where significant volumes of precipitation, surface runoff and/or groundwater collects in an open excavation, and must be pumped out.

Where the subgrade is found to be wet and sensitive to disturbance, consideration should be given to placing a mud slab of lean concrete over the subgrade (following inspection and approval by geotechnical personnel) or a 150 millimetre thick layer of OPSS Granular A underlain by a non-woven geotextile, to protect the subgrade from construction traffic.

Under the new regulations, a Permit-To-Take-Water (PTTW) is required from the Ministry of the Environment and Climate Change (MOECC) if a volume of water greater than 400,000 litres per day is pumped from the excavations. If the volume of water to be pumped will be less than 400,000 litres per day, but more than 50,000 litres per day, the water taking will not require a PTTW, but will need to be registered in the Environmental Activity and Sector Registry (EASR) as a prescribed activity. Considering the size of the development and the groundwater information collected during the investigation, it is considered likely that a PTTW would be required for this project. Assistance with carrying out the PTTW application can be provided, if requested.

5.7 Basement and Garage Floor Slabs

In preparation for the construction of the basement floor slabs, all loose, wet, and disturbed material should be removed from beneath the floor slab. Provision should be made for at least 200 millimetres of 19 millimetre crushed clear stone to form the base of the basement floor slabs. The underslab fill should be compacted to at least 95 percent of the materials standard Proctor maximum dry density.

To prevent hydrostatic pressure build up beneath the basement floor slabs, it is suggested that the granular base for the floor slabs be positively drained. This can be achieved by providing a hydraulic link between the underfloor fill and exterior drainage system.

The groundwater level was generally observed to be at about 1.3 to 2.1 metres depth. Although not required from a geotechnical perspective, raising of site grades in areas with a high water table would be beneficial in reducing the water control measures for foundation construction. Similarly, since significant and sustained groundwater inflow into the foundation drainage system would ideally be avoided, the founding depths should be set above the groundwater level.

Where the groundwater level is encountered above subgrade level, a geotextile could be required between the clear stone underslab fill and the sandy subgrade soils, to avoid loss of fine soil particles from the subgrade soil into the voids in the clear stone and ultimately into the drainage system. In the extreme case, loss of fines into the clear stone could cause ground loss beneath the slab and plugging of the drainage system. Where a geotextile is required, it should consist of a Class II non-woven geotextile with a Filtration Opening Size (FOS) not exceeding about 100 microns, in accordance with Ontario Provincial Standard Specification (OPSS) 1860.

The garage backfill should be placed in maximum 300 millimetre thick lifts and be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

The granular base for the garage floor slabs should consist of at least 150 millimetres of Granular A compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

5.8 Basement Walls and Foundation Wall Backfill

The soils at this site are highly frost susceptible and should not be used as backfill directly against exterior, unheated, or well insulated foundation elements. To avoid problems with frost adhesion and heaving, these foundation elements should be backfilled with non-frost susceptible sand or sand and gravel conforming to the requirements for OPSS Granular B Type I or, alternatively, a bond break such as the Platon system sheeting could be placed against the foundation walls.

Drainage of the basement wall backfill should be provided by means of a perforated pipe subdrain in a surround of 19 millimetre clear stone, fully wrapped in geotextile, which leads by gravity drainage to an adjacent storm sewer or sump pit. Conventional damp proofing of the basement walls is appropriate with the above design approach.

Where design of basement walls in accordance with Part 4 of the 2012 Ontario Building Code is required, walls backfilled with granular material and effectively drained as described above should be designed to resist lateral earth pressures calculated using a triangular distribution of the stress with a base magnitude of $K_o\gamma H$, where:

K_o = The lateral earth pressure coefficient in the 'at rest' state, use 0.5;

γ = The unit weight of the granular backfill, use 21.5 kilonewtons per cubic metre; and,

H = The height of the basement wall in metres.

If Platon System sheeting or similar water barrier product is used against the foundation walls, then hydrostatic groundwater pressures should also be considered in the calculation of the lateral earth pressures.

5.9 Site Servicing

5.9.1 Excavations

Excavations for the installation of site services will be made through sand and silt deposits, glacial till and into the underlying bedrock.

No unusual problems are anticipated with trenching in the overburden using conventional hydraulic excavating equipment, recognizing that cobbles and boulders can be expected in the glacial till. Boulders larger than 0.3 metres in size should be removed from excavation side slopes for worker safety.

The soils above the groundwater table would generally be classified as a Type 3 soil in accordance with the Occupational Health and Safety Act of Ontario. As such, these excavations may be made with side slopes at 1 horizontal to 1 vertical. Where trenches for the installation of services extend below the water table, the excavation side slopes would need to be no steeper than 3H:1V (Type 4 soil). Alternatively, the excavations could be carried out using steeper side slopes with all manual labour carried out within a fully braced, steel trench box for worker safety.

Some groundwater inflow into the trenches should be expected. However, it should be possible to handle the groundwater inflow by pumping from well filtered sumps established in the floor of the excavations, provided suitably sized pumps are used.

The actual rate of groundwater inflow into the trench will depend on many factors including the contractor's schedule and rate of excavation, the size of the excavation, and the time of year at which the excavation is carried out. There may also be instances where significant volumes of precipitation collect in an open excavation, and must be pumped out.

A PTTW is required from the Ministry of the Environment and Climate Change (MOECC) if a volume of water greater than 400,000 litres per day is pumped from the excavations. If the volume of water to be pumped will be less than 400,000 litres per day, but more than 50,000 litres per day, the water taking will not require a PTTW, but will need to be registered in the EASR as a prescribed activity. It is anticipated, due to the size of the project, that the contractor may have several trenches open at one time and that a PTTW may need to be obtained for the overall project.

If required, it is expected that the bedrock removal for this project will be carried out using drill and blast techniques. Mechanical methods of rock removal (such as hoe ramming) can likely be carried out for depths of about one metre; however, this work would likely be slow and tedious.

Near vertical trench walls in the bedrock should stand unsupported for the construction period.

If blasting is used, it should be controlled to limit the peak particle velocities at all adjacent structures or services such that blast induced damage will be avoided. This will require blast designs by a specialist in this field.

A pre-blast survey should be carried out of all of the surrounding structures. Selected existing interior and exterior cracks in the structures should be identified during the pre-blast survey and should be monitored for lateral or shear movements by means of pins, glass plate telltales and/or movement telltales.

The contractor should be limited to only small controlled shots. The following frequency dependent peak vibration limits at the nearest structures and services are suggested.

Frequency Range (Hertz)	Vibration Limits (millimetres/second)
< 10	5
10 to 40	5 to 50 (sliding scale)
> 40	50

These limits should be practical and achievable on this project.

It is recommended that the monitoring of ground vibration intensities (peak ground vibrations and accelerations) from the blasting operations be carried out both in the ground adjacent to the closest structures and within the structures themselves.

If excavations are made through the bedrock, the groundwater inflow from the bedrock could at first be relatively significant. That inflow may potentially diminish with time and continued pumping.

5.9.2 Bedding and Backfill

At least 150 millimetres of OPSS Granular A should be used as pipe bedding for sewer and water pipes. Where unavoidable disturbance to the subgrade surface does occur, it may be necessary to place a sub-bedding layer consisting of compacted OPSS Granular B Type II beneath the Granular A or to thicken the Granular A bedding. The bedding material should in all cases extend to the spring line of the pipe and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density. The use of clear crushed stone as a bedding layer should not be permitted anywhere on this project since fine particles from the sandy backfill materials or silty/sandy soils on the trench walls could potentially migrate into the voids in the clear crushed stone and cause loss of lateral pipe support.

Cover material, from spring line of the pipe to at least 300 millimetres above the top of pipe, should consist of OPSS Granular A or Granular B Type I with a maximum particle size of 25 millimetres. The cover material should be compacted to at least 95 percent of the material's standard Proctor maximum dry density.

It should generally be possible to re-use the sand, and silty sand as trench backfill, provided that they are not too wet to handle, place, and compact. Where the trench will be covered with hard surfaced areas, the type of native material placed in the frost zone (between subgrade level and 1.8 metres depth) should match the soil exposed on the trench walls for frost heave compatibility. Trench backfill should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

It should be possible to use the bedrock as trench backfill, provided the bedrock is well broken and broadly graded (maximum size of 300 millimetres). The rock fill, however, should only be placed from at least 300 millimetres above the pipes to minimize damage due to impact or point load. The rock fill should be limited to a maximum of 300 millimetres in size.

5.10 Pavement Design

In preparation for pavement construction, all topsoil, fill, disturbed, or otherwise deleterious materials (i.e., those materials containing organic material) should be removed from the roadway areas.

Pavement areas requiring grade raising to proposed subgrade level should be filled using acceptable (compactable and inorganic) earth borrow or OPSS Select Subgrade Material. These materials should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable compaction equipment.

The surface of the pavement subgrade should be crowned to promote drainage of the roadway granular structure. Perforated pipe sub-drains should be provided at subgrade level extending from the catch basins for a distance of at least 3 metres longitudinally, parallel to the curb in two directions.

The pavement structure for the interior 'local' roadways which will not experience bus or truck traffic should consist of:

Pavement Component	Thickness (millimetres)
Asphaltic Concrete	90
OPSS Granular A Base	150
OPSS Granular B Type II Subbase	375

The pavement structure for the interior roadway(s) with bus and truck traffic should consist of:

Pavement Component	Thickness (millimetres)
Asphaltic Concrete	90
OPSS Granular A Base	150
OPSS Granular B Type II Subbase	450

For arterial roadways, the subbase thickness should be increased to 600 millimetres.

The granular base and subbase materials should be uniformly compacted as per OPSS 310, Method A. The asphaltic concrete should be compacted in accordance with the procedures outlined in OPSS 310.

The composition of the asphaltic concrete pavement should be as follows:

- Superpave 12.5 mm Surface Course – 40 millimetres
- Superpave 19 mm Base Course – 50 millimetres

The asphaltic cement should consist of PG 58-34 and the design of the mixes should be based on a Traffic Category B for local roadways and Category D for collector roadways.

The above pavement designs are based on the assumption that the pavement subgrade has been acceptably prepared (i.e., where the trench backfill and grade raise fill have been adequately compacted to the required density and the subgrade surface not disturbed by construction operations or precipitation). Depending on the actual conditions of the pavement subgrade at the time of construction, it could be necessary to increase the thickness of the subbase and/or to place a woven geotextile beneath the granular materials.

5.11 Stormwater Management Pond

5.11.1 Temporary Pond Excavation

It is understood that the bottom of the excavation for the pond will generally extend about 3 to 6 metres below the existing ground surface, to about elevation 103.2 metres, which is about 2 to 4 metres below the groundwater level measured at the site. The proposed floor of the pond will generally be at about elevation 104.25 metres. At the inlet and outlet structures, additional subexcavation may be required locally to reach the founding elevations (which are not known at this time).

The general excavation for the pond will be through the topsoil, silt and sand deposits, and into the underlying glacial till. Based on the available information, the bedrock surface is below the proposed pond floor. However, bedrock may be encountered towards the north end of the pond.

No unusual problems are anticipated with excavating the overburden material using conventional hydraulic excavating equipment, although cobbles and boulders will be encountered within the glacial till. Temporary side slopes in the overburden should be stable in the short term at 1 horizontal to 1 vertical above the groundwater level and at 3 horizontal to 1 vertical below the groundwater level (i.e., Type 3 and Type 4 soils per the Occupational Health and Safety Act, respectfully) to the planned depths of excavation. Boulders larger than 300 millimetres in diameter must be removed from the excavation side slopes for worker safety.

Near-vertical excavation side slopes in the bedrock should be feasible.

The stand-up time for exposed side slopes in the overburden will be extremely short and the subgrade will be disturbed if left exposed. The rate of groundwater inflow from the overburden could be significant. Based on past experience at adjacent sites and particularly where excavations are deeper, some pre-draining of the overburden may be required. For example, several sumps could be constructed and pre-pumping of the overburden carried out. Pre-pumping for a couple of weeks prior to construction will likely be reasonable.

It is suggested that a test excavation be carried out at the location of the pond to help the contractor evaluate the groundwater management requirements.

Based on the available information, the floor of the pond is expected to consist of deposits of silts and sands and possibly glacial till. Bedrock may be encountered at the north end of the pond. The soils and bedrock at this site are expected to have high hydraulic conductivities. Groundwater inflow from the overburden will at first be relatively significant but should diminish with time and continued pumping.

Basal heaving of the excavation floor could result while excavating portions of the pond where there is limited overburden cover over the bedrock surface. Basal heaving occurs where the piezometric pressure in the bedrock exceeds the weight of the overburden cover between the excavation floor and the bedrock surface. Basal heaving would disturb the pond subgrade during construction, likely making it un-trafficable for equipment and difficult to shape. The rate of groundwater inflow would also increase significantly.

The following options could be considered to address the issue of basal heave and the resulting potential for subgrade disturbance during construction:

- The pond could be excavated 'in the wet', such that water would be maintained in the pond during excavation and the weight of that water would help resist the uplift pressures. However, the difficulties that would be experienced with shaping the pond floor and placing the clay liner if excavating 'in the wet' should be considered.
- Additional subexcavation of the overburden could be carried out to the bedrock surface. This would eliminate the potential for subgrade disturbance, however would deepen the pond depth, which may not be feasible for design.
- Pre-drainage of the overburden to at least 1 metre below the pond floor, by constructing several sumps and pre-pumping of the overburden and bedrock. This requirement would necessitate lowering the groundwater level in the underlying bedrock to about elevation 102.5 metres. The specific method of reducing the piezometric pressures in the overburden and/or bedrock should be selected and designed by the contractor. However, it is expected that this lowering could conceivably be achieved by installing and pumping from multiple wells around the perimeter of the pond, and possibly within the excavation itself. The groundwater level in the bedrock would need to be monitored, particularly in the area between the wells, and excavation for the pond construction should not proceed until the piezometric pressure has been sufficiently lowered.
- Soils on this site are sensitive to disturbance by construction traffic and ponded water. It would be impractical for equipment to travel within the excavation without first constructing haul roads to prevent softening and disturbance of the exposed subgrade. Therefore, excavation of the pond in one bench, with the equipment working from existing ground surface and not travelling within the excavation, may be necessary.

5.11.2 Groundwater Management

The excavation for the pond is expected to extend below the groundwater level. While the groundwater inflow during construction are expected to be high, the groundwater inflow into the excavation should feasibly be handled by pumping from several sumps within the excavation.

The actual rate of groundwater inflow to the excavation will depend on many factors including the contractor's schedule and rate of excavation, the size of the excavation and the time of year at which the excavation is made. Also, there may be instances where significant volumes of precipitation, surface runoff and/or groundwater collects in the open excavation, and must be pumped out.

For construction dewatering that exceeds a rate of 50 m³/day (50,000 L/day), but less than 400 m³/day (400,000 L/day), a Ministry of Environment and Climate Change (MOECC) Environmental Activity and Sector Registration (EASR) is required, and must be supported by a water taking plan. For pumping that exceeds 400 m³/day (400,000 L/day), a MOECC Permit To Take Water (PTTW) would be required.

Given the overall size of the project, the depth of excavation, the groundwater levels, and the potentially high hydraulic conductivity of the sand and silt deposits, it is likely that construction dewatering for the pond would exceed 400 m³/day (400,000 L/day). It is therefore recommended that a PTTW be obtained from the MOECC for this project.

5.11.3 Permanent Pond Side Slopes

The permanent side slopes for the proposed storm water management pond will consist of deposits of sands and silts and possibly into the glacial till.

It is understood that the permanent pool water level in the pond will be at about elevation 105.75 metres, and up to about elevation 107.34 metres during a 100-year storm event. It is also understood that the permanent pond sides will be sloped at about 3 horizontal to 1 vertical to 5 horizontal to 1 vertical.

The stability of the proposed pond side slopes was evaluated for drained (long-term, static) and undrained (seismic) conditions, in which effective stress soil parameters were used. Theoretically, a slope with a factor of safety of less than 1.0 will fail and one with a factor of safety of 1.0 or greater will stand. However, because the modeling is not exact and natural variations exist for all of the parameters affecting slope stability, a factor of safety of 1.5 is generally used to define a stable slope for static loading conditions. A factor of safety of 1.1 is used to define a stable slope for seismic loading conditions.

The results of limit equilibrium stability analyses indicate that the pond side slopes have a factor of safety of at least 1.5 against long term instability if inclined at 3 horizontal to 1 vertical (3H:1V), or flatter, which is acceptable. For seismic loading conditions, the analyses indicate that the slope should have a factor of safety of at least 1.1, which is also acceptable. During construction, some sloughing of the pond slopes should be expected when initially excavated due to the groundwater inflow. The rate of groundwater inflow will reduce with time and continued pumping. The side slopes should therefore first be cut within the pond footprint to a somewhat steeper inclination, such as 2 horizontal to 1 vertical, and only flattened to the final crest of slope once the rate of groundwater inflow has reduced and sloughing will no longer occur. This process will minimize the need to rebuild the slopes. Due to the mainly non-cohesive nature of the native soils at the site, some minor sloughing of the side slopes may still occur after construction but prior to the vegetation being established. Although the sloughing would not impair the short term use of the pond, it may require some additional maintenance/repair following construction.

To limit the potential for erosion (and/or sloughing) of the pond side slopes, the slopes should be covered with topsoil and vegetated as quickly as possible. Consideration could also be given to providing temporary erosion protection by the use of a biodegradable erosion control blanket.

5.11.4 Inlet and Outlet Structures

The proposed structures for the pond include concrete bypass structures, two inlet structures, and one concrete outlet structure. The founding elevations for the proposed structures are not known at this time. The design guidelines in this section of the report should be confirmed as the design progresses.

The excavation guidelines provided in Section 5.11.1 of this report are also generally applicable for the inlet and outlet structures.

The subsurface conditions in the area of the inlet and outlet structures consist of up to about 3.3 to greater than 4.2 metres of sandy silt, sand and silt, and silt and possibly glacial till overlying bedrock.

It is considered that the proposed inlet structures could be supported on spread footing placed within the sand and silt deposits, glacial till or bedrock.

The SLS bearing resistance for spread footings founded within overburden may be taken as 75 kilopascals. The ULS factored bearing resistance may be taken as 150 kilopascals. The ULS factored bearing resistance may be taken as 250 kilopascals for structures founded on the bedrock.

The post-construction total and differential settlements of footings sized using the above SLS net bearing resistance should be less than about 25 and 15 millimetres, respectively, provided that the soil at or below founding level is not disturbed during construction.

Structures should be provided with a minimum of 1.5 metres of earth cover. Insulation of the bearing surface with high density insulation could be considered as an alternative to earth cover for frost protection, if required.

The seismic design provisions of the 2012 Ontario Building Code (OBC) depend, in part, on the shear wave velocity of the upper 30 metres of soil and/or bedrock below founding level. Based on the 2012 Ontario Building Code methodology, this site can be assigned a Site Class of D for the structures.

The soils at this site are highly frost susceptible and, as such, should not be used as backfill against the structures. To avoid frost adhesion of the backfill to the structure and heaving of the foundations, the structure should be backfilled with non-frost susceptible sand or sand and gravel conforming to the requirements for Ontario Provincial Standard Specification OPSS Granular B Type I. However, that backfill material would be more permeable than the native soils and therefore could form a preferential conduit for seepage losses around the structure, which could then erode that material and form a direct conduit for the flow of retained water. It is therefore proposed that the surface of the backfill be capped with low permeability soil (no more than about 0.5 metres thick) wherever it could be in contact with the retained water.

The structure walls or head walls should be designed to resist lateral earth pressures calculated using a triangular distribution of the stress, which may be determined as follows:

$$\sigma_h(z) = K\,(\gamma\, z + q)$$

Where:

	$\sigma_h(z)$	=	The lateral earth pressure at depth 'z' (kPa);
	z	=	The depth below ground surface (m);
	K	=	The at-rest pressure coefficient, K_0, for non-yielding walls, use 0.5 or the active pressure coefficient, K_a, for yielding walls, use 0.33;
	γ	=	The unit weight of the backfill soil (kN/m^3), use 21.5 kilonewtons per cubic metre; and,
	q	=	The surcharge due to live loads on the ground surface above the structures (kPa).

If the walls allow lateral yielding, active earth pressures should be used in the design of the structure. If the walls do not allow for lateral yielding, at-rest earth pressures should be assumed for the design. The value of the surcharge due to live loading (q) should consider the potential construction loads from equipment or materials. A value of no less than 15 kilopascals could be reasonable.

Hydrostatic water pressures should also be considered for the portion of the foundation walls below the measured groundwater level.

These lateral earth pressures would increase under seismic loading conditions. The earthquake-induced dynamic pressure distribution, which is to be added to the static earth pressure distribution, is a linear distribution with maximum pressure at the top of the wall and minimum pressure at its toe (i.e., an inverted triangular pressure distribution). The combined pressure distribution (static plus seismic) may be determined as follows:

$$\sigma_h(z) = K \gamma z + (K_{AE} - K) \gamma (H-z)$$

Where: K_{AE} = The seismic earth pressure coefficient, use 0.7, and,

H = The total depth to the bottom of the foundation wall (m).

The above seismic earth pressure coefficient assumes that the back of the wall is vertical and the ground surface behind the wall is flat. Where sloping backfill is present above the top of the wall, the lateral earth pressures under seismic loading conditions should be calculated by treating the weight of the backfill located above the top of the wall as a surcharge.

The K_{AE} value for yielding walls is applicable provided the wall can move up to 75 millimetres at this site.

In addition, the potential hydrodynamic pressures from the groundwater should be considered under seismic loading conditions for that portion of the foundation wall below the groundwater level. The additional hydrodynamic pressure may be calculated using the following expression:

$$p(z) = 1.5\, k_h\, \gamma_w\, (h^*z)^{1/2}$$

Where: $p(z)$ =The additional hydrodynamic water pressure, at depth z below the water table;

k_h =The design horizontal ground acceleration, 0.30,

γ_w =The unit weight of water, use 9.81 kN/m^3; and,

h =The total depth of water.

All of the above lateral earth pressure equations and parameters are given in an unfactored format.

5.11.5 Inlet and Outlet Pipes

As discussed previously in Sections 5.11.1 and 5.11.2 of this report, the stand-up time of the soils below the groundwater table will be extremely short and pre-drainage of the overburden may be required. Groundwater inflow into the excavations should be expected. However, it should be possible to handle the groundwater inflow by pumping from well filtered sumps established in the floor of the excavation.

At least 150 millimetres of OPSS Granular A should be used as pipe bedding. Where unavoidable disturbance to the subgrade surface does occur, it may be necessary to place a sub-bedding layer consisting of 300 millimetres of compacted OPSS Granular B Type II beneath the Granular A or to thicken the Granular A bedding. The bedding material should in all cases extend to the spring line of the pipe and should be compacted to at least 95 percent of the standard Proctor maximum dry density. The use of clear crushed stone as a bedding layer should not be permitted anywhere on this project since fine particles from the sandy backfill materials could potentially migrate into the voids in the clear crushed stone and cause loss of lateral pipe support.

Cover material, from spring line of the pipe to at least 300 millimetres above the top of pipe, should consist of OPSS Granular A or Granular B Type I with a maximum particle size of 25 millimetres. The cover material should be compacted to at least 95 percent of the standard Proctor maximum dry density using suitable vibratory compaction equipment.

It should generally be possible to re-use the layered sand and silt above the groundwater level as trench backfill. The sand and silt deposits below the water table may be too wet to handle and will likely need to be wasted or used as general landscape fill. Where the trench will be covered with hard surfaced areas, the type of native material placed in the frost zone (between subgrade level and 1.8 metres depth) should match the soil exposed on the trench walls for frost heave compatibility. Trench backfill should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the materials standard Proctor maximum dry density using suitable compaction equipment.

5.11.6 Re-use of Excavated Materials

Excavated materials from the pond may be re-used as landscape fill on other portions of the site. These soils may initially be too wet to easily handle and shape and compact into place. It may be necessary to allow them to drain/dry out somewhat prior to their re-use.

5.11.7 Access Road for Maintenance

A roadway will be provided along the north, east, and south sides of the pond to provide access to the inlet and outlet control structures for inspection and maintenance purposes.

In preparation for pavement construction, all topsoil and deleterious material (i.e., material containing organic material) should be removed from all pavement areas.

Sections requiring grade raising to the proposed subgrade level should be filled using acceptable (compactable and inorganic) earth borrow or OPSS Select Subgrade Material meeting the requirements of OPSS.MUNI 212 and 1010, respectively. These materials should be placed in maximum 300 millimetre thick lifts and should be compacted to at least 95 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment.

The surface of the subgrade should be crowned to promote drainage of the pavement granular structure.

Provided that the access road will be used fairly infrequently by light equipment, the pavement structure should consist of:

Pavement Component	Thickness (millimetres)
Asphaltic Concrete	50
OPSS Granular A Base	150
OPSS Granular B Type II Subbase	300

The granular base and subbase materials should be uniformly compacted to at least 100 percent of the material's standard Proctor maximum dry density using suitable vibratory compaction equipment. The asphaltic concrete should be compacted in accordance with Table 10 of OPSS 310.

The composition of the asphaltic concrete pavement should be as follows:

- Superpave 12.5 Surface Course – 50 millimetres, PG 58-34

The above pavement design is based on the assumption that the pavement subgrade has been acceptably prepared (i.e., where grade raise fill has been adequately compacted to the required density and the subgrade surface not disturbed by construction operations or precipitation). Depending on the actual conditions of the pavement subgrade at the time of construction, it could be necessary to increase the thickness of the subbase and/or to place a woven geotextile beneath the granular materials.

5.11.8 Pond Maintenance and Access

If the pond floor needs to be trafficable, the bottom of the pond should be lined with a material such as rip-rap, a synthetic geocell erosion layer, or interlocking concrete blocks to minimize disturbance to the subgrade and allow for maintenance vehicles to travel in the pond. A geotextile may also be required in addition to the materials mentioned above.

5.12 Corrosion & Cement Type

One soil sample from test pit 17-08 was submitted to Eurofins Environmental Testing Canada for chemical analysis related to potential corrosion of buried steel elements and sulphate attack on buried concrete elements. The results of this testing are provided in Appendix A.

The results indicate that concrete made with Type GU Portland cement should be acceptable for substructures. The results also indicate a moderate potential for corrosion of exposed ferrous metal, which should be considered in the design of substructures.

5.13 Pools, Decks and Additions

5.13.1 Above Ground and In Ground Pools

No special geotechnical considerations are necessary for the installation of above-ground or in-ground pools.

5.13.2 Decks

There are no special geotechnical considerations for decks on this site.

5.13.3 Additions

Any proposed addition to a house (regardless of size) will require a geotechnical assessment. Written approval from a geotechnical engineer should be required by the City prior to the building permit being issued.

6.0 ADDITIONAL CONSIDERATIONS

The soils at this site are sensitive to disturbance from ponded water, construction traffic, and frost.

The test pits excavated and filled on site constitute zones of disturbance to the surficial soils. These could affect the performance of surface structures/foundations. The test pit locations were selected to be outside of proposed building areas (i.e., within the roadways); however, the site plan has changed since the investigation and there may be instances where a test pit underlies a proposed structure. In that case, the backfill soil in the test pit will need to be removed and replaced with engineered fill.

All footing and subgrade areas should be inspected by experienced geotechnical personnel prior to filling or concreting to ensure that soil having adequate bearing capacity has been reached and that the bearing surfaces have been properly prepared. The placing and compaction of any engineered fill as well as sewer bedding and backfill should be inspected to ensure that the materials used conform to the specifications from both a grading and compaction point of view.

At the time of the writing of this report, only preliminary details for the proposed development were available. Golder Associates should be retained to review the final drawings and specifications for this project prior to tendering to ensure that the guidelines in this report have been adequately interpreted.

7.0 CLOSURE

We trust that this report contains sufficient information for your present purposes. If you have any questions regarding this report or if we can be of further service to you on this project, please call us.

Yours truly,

Golder Associates Ltd.

LICENSED PROFESSIONAL ENGINEER
W. CAVERS
100077934
Sept 20/18
PROVINCE OF ONTARIO

William Cavers, P.Eng.
Associate, Senior Geotechnical Engineer

WC/WAM/mvrd/sg
https://golderassociates.sharepoint.com/sites/16191g/deliverables/geotech report/1784392 rpt-001-rev3-geotech report 2018-09-20 final.docx

Appendix E CITY COMMENTS AND RESPONSE

Stantec Consulting Ltd.
400 - 1331 Clyde Avenue, Ottawa ON K2C 3G4

October 15, 2018
File: 160400900

Attention: **Eric Suprenant**, CET.
Project Manager, Development Review
Planning, Infrastructure and Economic Development
City of Ottawa

Dear Mr. Suprenant,

Reference: Shea Road Development, 5969 Fernbank Road Draft Plan of Subdivision Proposal - Response to City Comments

Please find below response to comments provided by the City dated July 16, 2018, followed by response to comments provided by the RVCA, dated June 27, 2018.

CITY COMMENTS DATED JULY 16, 2018

Development Conceptual Site Servicing and Stormwater Management Report, Revision 0, dated April 17, 2018, prepared by Stantec Consulting Ltd.:

Water:

1. The City prefers the watermain layout approved in the MSS for this area as shown in Figure 5 of Appendix A4. The Shea Road watermain should extend further south and connect to the watermain linking junctions 2 and 3 (refer to modeling figures in Appendix A3). In addition, a secondary watermain is required to link Junction 29 to 13 as shown in the MSS.
Stantec (October 2018): The watermain analysis has been revised accordingly.
2. Please discuss the coordination of watermain servicing/looping design with neighbouring development to the west (Tartan lands). Additionally, ensure coordination and incorporation of all neighboring properties, including any holdout properties along Fernbank.
Stantec (October 2018): Timing for the adjacent Tartan lands is still not known with certitude, but it is our understanding, they could be 2 or 3 years away. As such, an interim scenario has been assessed assuming Tartan Lands are not developed with watermain connections to Shea Road and Fernbank only.
3. Please discuss phasing with respect to connection timeline for connection to future 400mm diameter watermain along Fernbank Road.
Stantec (October 2018): Based on recent correspondence received from Tartan, phase 1 servicing for Area 6, which includes the watermain extension to the existing watermain on Fernbank Road is scheduled for 2018. Additional discussion has been added to the text of the report and the correspondence has been included in an appendix.

Reference: Shea Road Development, 5969 Fernbank Road Draft Plan of Subdivision Proposal - Response to City Comments

4. Please discuss timeline of Shea Road watermain extension and clarify coordination of construction.
Stantec (October 2018): Shea Road watermain extension is required to service the proposed site and will take place during the first phase of construction.

Sanitary:

5. In paragraph 3.1, when referring to the diversion to the Monahan Constructed Wetlands Stormwater Management Facility, do you mean the Didsbury Ditch and Hazeldean Pump Station diversion chamber and overflow? Please clarify.
Stantec (October 2018): The servicing brief for Phase 1 of the CRT lands prepared by IBI outlined the Hazeldean pumping station overflow outlet to be the Monahan Constructed Wetlands Stormwater Management Facility. The HGL analysis for the sanitary system would as a result be based on the 100-year water level of the Monahan SWM Facility.
6. Please discuss, in greater detail, sanitary coordination with Tartan lands to the west, CRT lands to the east, and Area 6 lands to the south including if extension of Fernbank Trunk is necessary and ensure oversizing of Goldhawk Road sewer is confirmed. Additionally, discuss 600mm diameter trunk running through subdivision rather than original oversize sewer configuration that was to run along Goldhawk.
Stantec (October 2018): The following text has been added to Section 3.1 of the Servicing and SWM Report.
In July 2017, IBI prepared the CRT Lands Phase 1 Design Brief which outlines the proposed sanitary sewer sizing for the CRT lands which will serve as the immediate sanitary outlet for the proposed Shea Road Development and future Tartan Lands to the west. The 2009 Fernbank MSS recommended construction of a 525 mm diameter sub-trunk sewer along Goldhawk Drive and a 450 mm diameter sewer oversized for external lands west of Shea Road. However, as part of the design for the CRT Phase 1 lands, the City of Ottawa requested that the CRT sanitary sewer be oversized to account for wastewater flows from the existing Laird Street Pump Station and also expected flow from the 2012 OPA Area 6 expansion lands, which were brought into the urban envelope in 2012 as part of the last Official Plan review by the City. As a result, the recommended sanitary sewer extension through the CRT Lands included a 600 mm diameter pipe as opposed to the 450/525 mm diameter pipes recommended in the Fernbank MSS report to be able to convey external flows of 192 L/s (108 L/s from the Liard Street Pump Station and 84 L/s from the OPA 76 Area 6 lands). These external flows are in addition to other upstream flows from future developments within the Fernbank CDP area (i.e. Shea Road and Tartan Lands Developments).

The timing for the Laird Street pump station decommissioning and re-direction of sewage peak flows to the proposed site sanitary sewers has not been confirmed and as such, for the purpose of this report, it has been assumed and shown on the drawings that the sanitary trunk sewer along Fernbank Road from the Laird Street Pumping station to the proposed Cope Drive sanitary trunk sewer will be installed in the future by others.

7. Please show proposed higher level sewer locations on sanitary servicing plan.
   Stantec (October 2018): High level sanitary sewer has been added to the servicing plans.
8. The updated wastewater flow generation parameters should be used to estimate peak flows as shown in table 1. This can be done during detailed design.
   Stantec (October 2018): Updated parameters have been used for the sanitary design sheet.

Storm:

9. Please provide a copy of construction agreement and Hydro clearance concerning storm pond construction within Hydro easement.
   Stantec (October 2018): The required information has been included in Appendix C6 of the Servicing and SWM report.
10. Please ensure conformity with CDP Master Grading Plan while coordinating with CRT grading transitions to ensure pond operating levels and depth of storm sewers (i.e. cover over pipe) does not cause submerged pipes.
    Stantec (October 2018): The master grading plan provided for the proposed development takes into account the proposed future grades within the Tartan Subdivision as shown in IBI's Servicing Report of March 2013. The permanent pool of the Fernbank SWM Pond 4 has been set at 105.75m as per the Fernbank MSS and IBI's 2013 Servicing Report, which results in a very small section of sewers being partially submerged (approx. 68m from STM103 to the forebay). In addition, the storm sewers have been extended through the future Tartan Development to ensure sufficient cover, based on the proposed grades shown in IBI's 2013 servicing report.
11. All requirements relating to the MOECC applications, DFO authorization, and Conservation Authority approvals and permits shall be the owner's responsibility.
    Stantec (October 2018): Noted.

Fernbank Pond 4 Servicing and Grading Plan DWG. No. Pond-1

12. Based on the current layout of the facility, especially south north portion of the wet cell it appears that there will be a stagnant water zone. We would suggest providing this part of

Reference: Shea Road Development, 5969 Fernbank Road Draft Plan of Subdivision Proposal - Response to City Comments

the wet cell with a small peninsula at the southern side of the pond as indicated on the drawing to improve water circulation.
Stantec (October 2018): The proposed pond configuration has been revised accordingly.

13. The reinforced access ramp has to be widen to 5m for the heavy equipment (shovel, damp trucks) to travel down to the sediment forebay during the sediment removal activity.
Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision since the width of the access road to the forebay bottom does not impact the active storage provided.
14. Please provide the reinforced access road also to the sediment management area.
Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.
15. Change the width of the asphalt service road to 5 m (3m plus 1m shoulder at each side)
Stantec (October 2018): The proposed pond configuration has been revised accordingly.
16. The reinforced outlet channel seems to be inadequate …
Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.
17. Please change the design of the berm separation as per our suggestion and decrease the berm's width to approximately 5m.
Stantec (October 2018): The proposed pond configuration has been revised accordingly.
18. Remove the dewatering structure.
Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.

Pond Sections DWG. No Pond-2

19. Please change the design of the berm separation as per our suggestion and decrease the berm's width to approximately 5m.
Redesign the permeable separation berm to impermeable to accommodate the pond dewatering as indicated. (See drawing mark-up)
Stantec (October 2018): The proposed pond configuration has been revised accordingly.
20. Please enhance the design the pond outlet structure to facilitate dewatering operations.
Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.
21. Please provide the outlet channel profile with all relevant features related to the connection to the existing roadside ditch. The outlet channel connection should not be perpendicular to the existing ditch.

Reference: Shea Road Development, 5969 Fernbank Road Draft Plan of Subdivision Proposal - Response to City Comments

Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.

22. The longitudinal profile needs to be revised based on the design of the peninsula to provide the flow pattern in the pond.
    Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.

Pond Sections DWG. No Pond-5

23. Please adjust the reinforced grass road width to 5m.
    Stantec (October 2018): The proposed pond configuration has been revised accordingly.

Section F-F

24. The top of bank of the emergency overflow has to be min 2.5 m to prevent the erosion of the slope. Please indicate the material that will be placed in the core of the structure to assure that it will not leak.
    Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.

Section G-G:

25. The outlet channel seems to be inadequate. The bottom of the channel is only 1.0m wide, please revise and enlarge. The outlet pipe of 1050mm DIA is discharging into the relatively small and shallow channel.
    Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.

Detail Sheet DWG. DS-1 and DS-2

26. The detail of all structures are incomplete. All structures have to be provided with grading plan, proper inverts and water levels.
    Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.
27. Show extent of any submerged pipes.
    Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.

Outlet Structure

28. Provide the support of the structure by an amour stone wall or by a modular stone blocks headwall parallel to the side slope.

Reference: Shea Road Development, 5969 Fernbank Road Draft Plan of Subdivision Proposal - Response to City Comments

Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.

29. The redesigned outlet structure should be provided with the riveted grating, access hatch off commercial availability (e.g. honey comb similar to OPSD 403.010 provided with the recessed locking hasp which does not create a tripping hazards. Based on the location of the access ladder and the sluice gate it appears 2 access 750mm x 800mm hinged access covers would be required.
Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.
30. The top has to be provided with a built floor sleeve plate for sluice gate into grating.
Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.
31. The orifice should be protected by a stainless steel debris hood.
Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.
32. Please provide the outlet structure with relevant features to facilitate dewatering operations. Introduce the pond a pipe or a drain opening and a sluice gate. Include the sump pit in to the bottom of the structure to accommodate a portable pump.
Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.
33. The weir orientation needs to be verified. The weir needs to be protected by a weir grate. The Detail of all features require to be in the 1:50 scale.
Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.
34. Please indicate the details of the sluice gate, weir grate, pipe grate on headwalls, stainless steel debris hood and orifice.
Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.
35. Remove the drawdown structure detail.
Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.
36. Remove the sluice gate schematic and design the sluice gate accordingly.
Stantec (October 2018): This comment will be addressed in the second submission of the Fernbank SWM Pond 4 design brief during the detailed design of the subdivision.
37. Adjust the asphalt access road to 3 m and 1m shoulder at both side.
Stantec (October 2018): The proposed pond configuration has been revised accordingly.

Fernbank Pond 4 SWMF Design Brief

Reference: Shea Road Development, 5969 Fernbank Road Draft Plan of Subdivision Proposal - Response to City Comments

38. Section 1.1: "The 59.2 ha tributary area is approximately 52% impervious" however an imperviousness of 55% is shown in Table 5. Please revised accordingly.
Stantec (October 2018): The imperviousness of the catchment area has been changed to 52% in the pond calculations.
39. Section 1.2: "correspondence with Robinson Consutlants confirmed that the existing 700 mm diameter culvert under Fernbank Road has a maximum capacity of 0.9 m3/s with a 0.5 m head." Further in the report, we note that a fixed water level of 106.53 m was used as a boundary condition (culvert obvert + 0.5m). Because of the implications of the boundary condition on the design of the pond and the upstream subdivision, detailed calculations must be provided in the report to confirm the backwater elevation upstream of the existing 700 mm culvert.
Stantec (October 2018): The PCSWMM model used in the Fernbank SWM Pond 4 conceptual future outlet assessment has been added to the proposed development model such that the proposed and future developments tributary to the proposed SWM Pond, the proposed Fernbank SWM Pond 4, the proposed pipe outlet through the future Area 6 development and the improved Shea Road side ditch system to Flewellyn Road are all included in the post development model.
40. Section 2.3.4: Based on the Fernbank MSS (Table 6.4), the major system storage for school block should be 50 m3/ha. Please revise accordingly.
Stantec (October 2018): The modeling has been revised accordingly.
41. Section 2.4.1: Please also provide the results for the 12hr SCS storm distribution.
Stantec (October 2018): The 24hr SCS was identified as the critical storm for quantity control in the EMP and as such, this storm was used to assess the quantity control for the proposed SWM Pond for the different return periods. However, the 100-year, 12hr SCS has been used to assess the HGL across the site and to ensure pond outflow during this storm is less than the 0.9 m^3/s maximum allowable.
42. Section 2.4.4: At detailed design, the storm sewers within the proposed subdivision must also be stress tested with the 100-hr 3hr Chicago +20%.
Stantec (October 2018): Noted.
43. Section 2.4.5: "a free flowing outfall was used as boundary condition for the 2, 5, 10, 25, and 100 year, 24 hour SCS Type II storms in order to compare the proposed SWM pond outflow hydrographs to the allowable release rate." While it is useful to present the results for the "free flowing outfall" scenario, the comparison of the proposed SWM pond outflow hydrographs to the 0.9 cms should be based on the static downstream boundary conditions using a fixed water level of 106.53 m, which represents the actual hydraulic conditions generated by the downstream existing culvert. Please revise the design of the pond to ensure that the maximum permissible release rate of 0.9 cms is not exceeded under those conditions.

Reference: Shea Road Development, 5969 Fernbank Road Draft Plan of Subdivision Proposal - Response to City Comments

Stantec (October 2018): The PCSWMM model used in the Fernbank SWM Pond 4 conceptual future outlet assessment has been added to the proposed development model such that the proposed and future developments tributary to the proposed SWM Pond, the proposed Fernbank SWM Pond 4, the proposed pipe outlet through the future Area 6 development and the improved Shea Road side ditch system to Flewellyn Road are all included in the post development model.

Shea Road Lands Conceptual Site Servicing and SWM Report

44. Table 10: We note that a lumped hydrologic/hydraulic model was used to represent the major/minor system within the proposed subdivision. For example, roads are modeled with continuous grades and the major system storage is represented by storage nodes. It is our understanding that the model will be refined at detailed design with the actual road sag storage and that major system flows to the pond will be lower than the values presented in Table 10. There should be some wording on that matter in the report.
Stantec (October 2018): The following text has been added to Section 4.5.2 of the report. The PCSWMM model is based on lumped drainage areas with major system storage represented in storage nodes that overestimate the major system peak flows to the proposed SWM Pond. It is anticipated that the actual major system peak flow contribution to the SWM Pond will be much lower once detailed grading is completed and the actual road configuration with available sag storage is included in the model during detailed design.
45. Please note that the rear yard runoff from the existing homes along the western limit of Shea Road Lands Subdivision is presently captured by catch basins and conveyed through the storm sewer system of the existing subdivision. The contribution to this existing storm sewer cannot be increased, therefore please explain how the rear yard runoff from the future homes adjacent to the existing development will be captured and conveyed to Pond 4. Is there going to be another swale with a series of catch basins?
Stantec (October 2018): Detailed design of the future Tartan Development, adjacent to the existing subdivision, is outside of the scope of this project. Runoff from the future Tartan Development, in its entirety, has been assumed to be directed to the Fernbank SWM Pond 4 through the site storm sewers.
46. It is highly recommended to use a runoff coefficient of at least 0.25 for parks to account for pathways, potential parking lots and small buildings. Please revise accordingly.
Stantec (October 2018): Runoff coefficient of 0.25 has been used for parks.
47. To avoid two subsequent 90 degrees bends on a large storm sewer, it would be preferable to move STM 102 approximately 10 m upstream toward STM 103. This would result in two 45 degrees bend.

Reference: Shea Road Development, 5969 Fernbank Road Draft Plan of Subdivision Proposal - Response to City Comments

Stantec (October 2018): Moving STM 102 would cause the inlet pipe to go through lot 105. Also, this may cause the angle between the inlet pipe and bypass pipe to be too sharp to allow for a proper connection. More consideration will be given during detailed design.

Draft Plan

48. Ensure full coordination as it relates to CRT Draft Plan for Street alignment, more particularly Shea Road where if crosses the Hydro corridor. Hydro clearance may have a significant impact on Shea Road corridor / alignment and considering that the tie in point with the Shea Road / CRT lands plan of subdivision, the alignment will need to be coordinated between all parties, including Hydro prior to draft plan approval. Conditions shall be drafted in these regards.
Stantec (October 2018): Noted
49. Ensure that all proposed open space blocks, including floodplain lines are all clearly identified. Also, ensure that all development is being proposed outside of the 100 year flood limits.
Stantec (October 2018): The 100-year water level in the proposed Fernbank SWM Pond 4 has been clearly identified in all engineering drawings which show all that all proposed developments are outside of the 100-year flood limits.
50. Please ensure that all pathway corridors throughout this development, around proposed storm facility are shown on the plan and that connection to between neighbouring developments and this development are fully coordinated.
Stantec (October 2018): Walkways have been shown to access the proposed SWM facility.
51. Ensure coordination of Cope cross-section through this development with CRT established Cope cross-section.
Stantec (October 2018): The proposed Cope Drive cross section will consist of a 24m-wide right of way as per the approved CDP.
52. Show concept and servicing details for lands west of proposed pond as well as access.
Stantec (October 2018): The revised draft plan includes the residential block west of the SWM Pond block.

Geotechnical Investigation, dated February 2018, prepared by Golder Associates Ltd.

53. Ensure that Geotechnical recommendations relating to obtaining Permit to Take Water are followed.
Stantec (October 2018): Noted. Permit to Take Water recommendations are provided in Page 9 of the Geotechnical Investigation prepared by Golder Associates in September 2018.

Reference: Shea Road Development, 5969 Fernbank Road Draft Plan of Subdivision Proposal - Response to City Comments

54. Be advised, at detailed design Geotechnical recommendations must be in keeping with approved tree and sensitive soil guidelines.
    Stantec (October 2018): Noted.
55. At detailed design the Geotechnical study should provide recommendations relating to all areas where drainage channels shall be decommissioned and reinstated where roads, services and/or dwelling units are being proposed.
    Stantec (October 2018): Noted.
56. Ensure that recommendations of the Geotechnical investigation include the decommissioning or removal of any drainage tiles encountered.
    Stantec (October 2018): Golder Associates prepared a Geotechnical Report for the subject site dated September 2018. Page 5 of the report states the following: "It is understood that drainage tiles may exist on site. All drainage tiles should be removed. Within building footprints and below service trenches, the surrounding bedding/fill for the tile should be removed (i.e., the existing trench for the drainage tile should be stripped to native soil or bedrock) and the resulting trench should be backfilled with Ontario Provincial Standard Specification (OPSS) Granular B Type II compacted to 95% of its maximum Proctor dry density.
    Where the drainage tiles underlie landscaped areas or roadways, any suitable and compactable general fill may be used after removal of the drainage tiles, except within 1.8 metres depth of roadway surfaces where the fill used should match the native soils for frost heave compatibility."

General Comments

57. FEMP identifies potential wells in Fernbank community. Although ESA indicates that no wells were seen for this particular site, if a well is encountered it shall need to be decommissioned in accordance with O.Reg.903.
    Stantec (October 2018): Noted.
58. Phase 1 ESA mentions no response was received from MOECC and TSSA regarding ECA requirements and the potential presence of fuel storage tanks/other petroleum related infrastructure respectively. This information will need to be provided prior to Draft Plan approval.
    Stantec (October 2018): Noted.

RVCA COMMENTS DATED JUNE 27, 2018

Stormwater Management

Reference: Shea Road Development, 5969 Fernbank Road Draft Plan of Subdivision Proposal - Response to City Comments

The proposed stormwater management facility (Pond 4) is identified as providing enhanced protection levels of a minimum 80% total suspended solid removal prior to its outlet to the Faulkner Drain tributary. "Enhanced" protection is required as part of the criteria established through Jock River Reach 2 study. The Design requirements note that water quantity protection is to maintain pre- to post-development levels. We will rely on the City of Ottawa to ensure that the stormwater management is consistent with the design assumptions for the receiving Faulkner municipal drain.

Stantec (October 2018): Noted.

The Faulkner Drains has been classified as intermittent watercourses that provide indirect habitat supporting tolerant warm/cool water fish communities. Temperature mitigation measures are to be incorporated into all proposed SWM facilities tributary to the Jock River, per the Fernbank Community Design Plan, with the goal of ensuring that the temperature of discharged stormwater does not exceed the following target values: maximum discharge temperature of 25°C and a preferred discharge temperature of 22°C. Temperature as it relates to quality control is not identified in the supporting Stormwater management report submitted in support of the subdivision. Please provide clarification if the proposed design is achieving the targets set out, or if additional design is required to be incorporated.

Stantec (October 2018): Outflows from the proposed SWM pond will discharge into the Fernbank roadside ditch and will subsequently be captured into a storm sewer system consisting of 348 m of 1200mm x 900mm concrete box sewer, and will then be conveyed by the Shea roadside ditch for approximately 1.1 km before discharging into the Faulkner Municipal Drain.
Given that the point of discharge of the proposed SWM pond is approximately 1.4 km upstream of the Faulkner Drain, we trust the following temperature mitigation measures will be sufficient:

- A narrow pond configuration has been provided and a peninsula has been added to the wet cell in this submission to further elongate the SWM pond.
- A deep permanent pool of 1.5m has been provided.
- A landscaping plan will be provided to show bank plantings around the SWM pond and along the banks of the proposed outlet channel to promote shading and inhibit temperature increases.

It is noted that 100-year ponding depths will be maintained at a maximum 0.35 m in road sags. The RVCA requires that a maximum of 0.30 meter ponding depths be maintained for road ways and access purposes. Please clarify, that the proposed pond depths will not be greater than 0.3

Reference: Shea Road Development, 5969 Fernbank Road Draft Plan of Subdivision Proposal - Response to City Comments

metres at the road centerlines (noting that the standard proposed meets the City's design standards).

Stantec (October 2018): The proposed development will be designed to meet City of Ottawa Guidelines

The RVCA requests the opportunity to provide input on conditions of Draft Plan of Subdivision to ensure that design, implementation and monitoring of stormwater management are included subject to the RVCA's satisfaction.

Hydrogeology

The RVCA is generally satisfied with the hydrogeological study that was submitted in support of the proposed development but had requested several clarifications to the technical submission. The opportunity to provide input on conditions of Draft Plan of Subdivision are requested to ensure that design, implementation and monitoring are incorporated subject to the RVCA's satisfaction.

Stantec (October 2018): Noted.

Natural Heritage/Natural Hazards

Wetlands

An unevaluated wetland was identified for large portion of the site. An Environmental Impact Statement, prepared by Muncaster Environmental Planning Inc., dated February 2018, was submitted in support of the proposed subdivision. The report indicated, through on-site investigation, that no wetlands or aquatic habitat potential were observed.

Stantec (October 2018): Noted.

Organic Soils

Organic Soil mapping was identified on site. It was noted that peat was encountered in the test pits conducted on site, in the hydrogeological report, within the layer of topsoil at varying thicknesses. However not identified in the geotechnical report relying on the same test pits.

Further, peat soils were not identified in the Environmental Impact Statement submitted in support of the application. Please clarify the presence of organic materials and to what extent organic soils are present on site. Please elaborate how organic soils are being addressed as it relates to proposed development and construction.

Stantec (October 2018): Golder Associates prepared a Geotechnical Report for the subject site dated September 2018. The revised report identifies the organic soil present on site and provides recommendations

Watercourse/Stormwater outlet

The proposed subdivision is intended to outlet storm water to the south of the site into a tributary of the Faulkner Drain. The proposed outlet will require a permit under section 28 of the Conservation Authorities Act, as part of works associated with the stormwater management facility design.

Stantec (October 2018): Noted.

Zoning By-law Amendment

The proposed zoning amendment seeks to change the existing Rural Countryside Zone (RU) to Residential Third Density Subzone Z (R3Z), Park and Open Space Zone (O1) and Major Institutional Zone (I1). The zone changes are intend to accommodate 115 residential lots, 58 residential blocks, a park, school, walkways, and a stormwater management block.

The zoning change reflects the intended mix of uses on this block as part of the Fernbank Community Design Plan.

Stantec (October 2018): Noted.

Conclusion

The Rideau Valley Conservation Authority has no objections to the Zoning Amendment as it relates to land use for the subject lands. The RVCA requests the opportunity to the review and input on conditions related to the Draft Plan of Subdivision, as well as clarification to matters sought above.

Reference: Shea Road Development, 5969 Fernbank Road Draft Plan of Subdivision Proposal - Response to City Comments

Stantec (October 2018): Noted.

For any questions regarding the information contained in this letter, please feel free to contact me.

Regards,

STANTEC CONSULTING LTD.

Kris Kilborn
Project Manager, Community Development
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Water Resources Engineer
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Appendix F DRAWINGS