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# FUNCTIONAL SERVICING REPORT

## FOR

# MINTO COMMUNITIES – CANADA & 2559688 ONTARIO INC. KANATA NORTH

CITY OF OTTAWA

PROJECT NO.: 17-982

SEPT 2019 – 2ND SUBMISSION

# FUNCTIONAL SERVICING REPORT FOR MINTO COMMUNITIES – CANADA & 2559688 ONTARIO INC. KANATA NORTH

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**MINTO COMMUNITIES – CANADA & 2559688 ONTARIO INC.**
**KANATA NORTH**

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# 1.0 INTRODUCTION

Minto Communities – Canada have retained David Schaeffer Engineering Ltd. (DSEL) to prepare a Functional Servicing Report (FSR) in support of their application for draft plan approval.

Minto Communities – Canada is proposing a residential development on 936 March Road (PIN 04527-1004) within the Kanata North Urban Expansion Area (KNUEA). The FSR study area encompasses lands owned by Minto Communities – Canada and 2559688 Ontario Inc., which are subject to development permit and zoning by-law amendment applications. The study area measures approximately 56 ha and is located north of the existing Brookside Subdivision, east of March Road and west of a former CN railway corridor. The subject area can be seen in ***Figure 1***.

The proposed draft plan of subdivision contemplates approximately 434 single detached units and 420 executive townhomes. The study area also contemplates a school site, neighborhood parks, a woodlot, a stormwater management pond block and two commercial mixed-use blocks fronting existing March Road. The roads are proposed to consist of 26 m wide Right-of-Way (ROW) collector roads, as well as 24 m wide ROW and 16.5 m wide ROW local roads. The proposed concept plan can be seen in ***Appendix A*** and ***Figure 2***. Corresponding development stats can be seen summarized in ***Table 1*** below.

**Table 1: Development Statistic Projections per July 9, 2019 Concept Plan**

| Land Use | Total Area (ha) | Projected Residential Units | Residential Population per Unit * | Projected Population * |
|---|---|---|---|---|
| **Residential & Roads** | 33.38 | 434 Singles | 3.4 | 1476 |
| | | 420 Towns | 2.7 | 1134 |
| **Commercial Mixed Use** | 9.35 | | | |
| **School** | 2.51 | | | |
| **Storm Pond** | 4.48 | | | |
| **Parks** | 3.02 | | | |
| **Open Space** | 0.13 | | | |
| **Creek Buffer** | 0.40 | | | |
| **Woodlot** | 2.40 | | | |
| **Total** | **55.67** | **854** | | **2610** |

** NOTE: Population projections may differ from population estimates used in background Transportation Studies, Planning Rationale, and other studies. Population projection and residential population per unit values are based on Ministry of Environment and Climate Change guidelines for servicing demand calculations. Local Roads included in Block estimates above.*

The FSR study area and surrounding lands are governed by the broader *Kanata North Community Design Plan* (CDP) *(City of Ottawa, June 28, 2016)* and the Kanata North Master Servicing Study (*MSS*) *(City of Ottawa, June 28 2016)*. The study area is considered as part of the southeast quadrant of the KNUEA within the *MSS*. The design plan and preliminary serviceability report were completed in order to prepare a preferred servicing strategy and cohesive development concept for the core KNUEA (181 ha total area). The reports identify existing infrastructure and environmental constraints, describe the neighbourhood-level trunk services that will service all properties within its study area, establish targets for future site-specific stormwater management plans, and identify required infrastructure upgrades to support the proposed development of the KNUEA.

The proposed draft plan is in conformance with the demonstration plan for the study area, prepared as part of the *MSS,* with the exception of minor alterations to the draft plan's road alignment and to land use locations within the study area.

This FSR is provided to demonstrate conformance with the design criteria of the City of Ottawa, the *MSS,* other background studies, and general industry practice. This FSR has also been prepared in accordance with the City of Ottawa's Servicing Study Guidelines for Development Applications, as demonstrated by the checklist included in ***Appendix A***.

## 1.1 Existing Conditions

Under existing conditions, the study area is predominantly occupied by agricultural uses. A forested area exists in the northeast corner of the study area. The lands to the west, north and east are also predominantly occupied by agricultural uses.

The existing elevations within the study area generally range from 79m to 70m. There is a ridge approximately 8 m in height located in the middle of the study area that runs in the north south direction. The soil profile in the area consists of topsoil, stiff silty clay underlain by glacial till and bedrock. The *MSS* indicates that the maximum permissible grade raise for the study area is up to 3.0 m. Similarly, the site geotechnical report recommends a permissible grade raise restriction of 3 m. Additional geotechnical details can be found within the *Geotechnical Investigation – Proposed Residential Development 936 March Road* (November 28, 2018, Paterson Group).

The proposed development is located within the jurisdiction of the Mississippi Valley Conservation Authority (MVCA). The study area is located within the Shirley's Brook sub-watershed.

The western portion of the study area drains to Shirley's Brook to the south via adjacent existing drainage channels. The eastern portion of the study area drains into Shirley's Brooke via existing drainage channels to the east. See ***Appendix B*** for details.

## 1.2 Required Permits / Approvals

The City of Ottawa must approve detailed engineering design drawings and reports prior to construction of the municipal infrastructure identified in this report. This is expected to occur as part of the approval process for *Planning Act* development applications.

The following additional approvals and permits listed in ***Table 2*** could be expected to be required prior to construction of the municipal infrastructure detailed herein. Please note that other permits and approvals may be required, as detailed in the other studies submitted as part of the *Planning Act* development applications (e.g. *Tree Conservation Report, Environmental Impact Statement, Phase 1 Environmental Site Assessment, etc.).*

## 1.3 Summary of Pre-Consultation

### 1.3.1 City of Ottawa, July 11th, 2018

A formal Pre-Application Consultation with City of Ottawa staff occurred July 11th, 2018. The purpose of the meeting was to discuss the proposed development, review technical considerations and identify/confirm the studies required to accompany the submission of a Plan of Subdivision application. A copy of the Pre-Application Consultation meeting notes can be found in ***Appendix A***.

**Table 2: Anticipated Permit/Approval Requirements**

| Agency | Permit/Approval Required | Trigger | Remarks |
|---|---|---|---|
| MVCA | Permit under Ontario Regulation 153/06, MVCA's Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation | Construction of new pond and alterations of existing watercourse. | Proposed stormwater management strategy is to have flows directed to new stormwater management pond per the *MSS*. Existing watercourses through the site may be altered as part of development. |
| MECP | Environmental Compliance Approval | Construction of new sanitary sewers, storm sewers, and stormwater management works. | The MECP is expected to review the stormwater collection system, wastewater collection system and stormwater management works by transfer of review submission. |
| MECP | Permit to Take Water | Construction of proposed land uses (e.g. basements for residential homes) and services. | Pumping of groundwater or surface water may be required during construction, given site conditions, proposed land uses, and on-site/off-site municipal infrastructure (Paterson Group, July 2018). |
| City of Ottawa | MOE Form 1 – Record of Watermains Authorized as a Future Alteration. | Construction of watermains. | The City of Ottawa is expected to review the watermains on behalf of the MOE through the Form 1 – Record of Watermains Authorized as a Future Alteration. |
| City of Ottawa | Commence Work Notification (CWN) | Construction of new sanitary and storm sewer throughout the subdivision. | The City of Ottawa will issue a commence work notification for construction of the sanitary and storm sewers once an ECA is issued by the MECP. |
| City of Ottawa / Private Landowners | Permission/license to access/occupation and/or legal property instruments. | Construction of servicing infrastructure (e.g. storm sewer, overland flow route) beyond the FSR study area. | Construction activities and permanent infrastructure beyond the FSR study area may trigger legal agreements. |

### 1.3.2 First Submission

The City of Ottawa and other affected parties provided comments to Minto Communities – Canada and 2559688 Ontario Inc. about the development concept and the original January 2019 submission of this Functional Servicing Report. A record of City comments and project team response is provided in ***Appendix A***.

# 2.0 GUIDELINES, PREVIOUS STUDIES, AND REPORTS

## 2.1 Existing Studies, Guidelines, and Reports

The following documents informed the preparation of this FSR report:

- Ottawa Sewer Design Guidelines, City of Ottawa, *SDG002,* October 2012. *(Sewer Design Guidelines)*
  - Technical Bulletin ISDTB-2014-01, Revisions to Ottawa Design Guidelines – Sewer, City of Ottawa, February 5, 2014. *(ISDTB-2014-01)*
  - Technical Bulletin PIEDTB-2016-01, Revisions to Ottawa Design Guidelines – Sewer, City of Ottawa, September 6, 2016. *(PIEDTB-2016-01)*
  - Technical Bulletin ISTB-2018-01, Revisions to Ottawa Design Guidelines – Sewer, City of Ottawa, March 21, 2018. *(ISTB-2018-01)*
- Ottawa Design Guidelines – Water Distribution, City of Ottawa, July 2010. *(Water Supply Guidelines)*
  - Technical Bulletin ISD-2010-2, City of Ottawa, December 15, 2010. *(ISDTB-2010-2)*
  - Technical Bulletin ISDTB-2014-02, City of Ottawa, May 27, 2014. *(ISDTB-2014-02)*
  - Technical Bulleting ISTB-2018-02, City of Ottawa, March 21, 2018. *(ISTB-2018-02)*
- Design Guidelines for Sewage Works, Ministry of the Environment, 2008. *(MOE* Design Guidelines*)*
- Stormwater Planning and Design Manual, Ministry of the Environment, March 2003. *(*SWMP Design Manual)
- Erosion & Sediment Control Guidelines for Urban Construction, Greater Golden Horseshoe Area Conservation Authorities, December 2006. *(E&S Guidelines)*
- Ontario Building Code Compendium, Ministry of Municipal Affairs and Housing Building Development Branch, 2012 and as updated from time to time. *(OBC)*
- Mississippi-Rideau Source Water Protection Plan, MVCA & RVCA, August 2014.
- Kanata North Community Design Plan, Novatech, June 28, 2016. *(CDP)*
- Kanata North Master Servicing Study, Novatech, June 28, 2016. *(MSS)*
- Kanata North Environmental Management Plan, Novatech, June 28, 2016. *(EMP)*
- Kanata North Transportation Master Plan, Novatech, June 28, 2016. *(TMP)*
- Geotechnical Investigation – Proposed Residential Development 936 March Road, Paterson Group, November 28, 2018.
- Briarridge Sanitary Pumping Station Pre-Design Report, Cumming Cockburn, March 2001, revised June 2001
- Shirley's Brook and Watt's Creek Phase 2 Stormwater Management Study (AECOM, April 2015)

# 3.0 WATER SUPPLY SERVICING

## 3.1 Existing Water Supply Services

The study area lies within the existing City of Ottawa 2Ww pressure zone. Existing 200mm and 300mm diameter trunk watermains exist within the residential subdivision to the south of the study area. These watermains are connected to existing 400mm diameter watermains within Klondike Road and March Road.

## 3.2 Water Supply Servicing Design

Water supply servicing and hydraulic analysis for the study area were contemplated as part of the *MSS*. The preferred design concept indicated by the *MSS*, for servicing of the study area, consists of connecting to the existing 200mm diameter watermain within Celtic Ridge Crescent and a proposed extension of the 400mm diameter watermain within March Road.

The proposed development will be serviced internally by a trunk 300mm diameter watermain and a network of local watermains to be designed in accordance with the *Water Supply Guidelines*, as summarized in ***Table 3*** below. Potable water will be supplied to the study area through pressurized local watermains on each street, connecting to the trunk 300mm diameter watermain. The proposed watermain network can be seen in ***Figure 4***.

**Table 3: Water Supply Design Criteria**

| Design Parameter | Value |
|---|---|
| Residential Single Family | 3.4 P/unit |
| Residential Semi-detached | 2.7 P/unit |
| Residential Townhouse/Back-to-Back | 2.1 P/unit |
| Residential Apartment (High Density) | 1.8 P/unit |
| Residential Average Daily Demand | 350 L/d/P |
| Residential Maximum Daily Demand ** | 2.5 x Average Daily * |
| Residential Maximum Hourly ** | 5.5 x Average Daily * |
| Minimum Watermain Size | 150mm diameter |
| Minimum Depth of Cover | 2.4m from top of watermain |
| During normal operating conditions desired operating pressure is within | 350kPa and 480kPa |
| During normal operating conditions pressure must not drop below | 275kPa |
| During normal operating conditions pressure must not exceed | 552kPa |
| During fire flow operating pressure must not drop below | 140kPa |

**Daily average based on Appendix 4-A from **Water Supply Guidelines.** Table updated to reflect ISD-2010-2.*
*** Residential Max. Daily and Max. Hourly peaking factors per MOE Guidelines for Drinking-Water Systems Table 3-3 for 0 to 500 persons. City Guidelines used for populations greater than 500 persons.*

Consistent with the *MSS*, the study area will be serviced entirely from the Zone 2Ww pressure zone and site grading is planned to not exceed 93m to maintain minimum pressures greater than 275kpa. Per the *MSS*, services where the grade is below 74m will likely require pressure reducing valves to keep maximum pressure below 552kpa.

Through the detailed design of the study area, a complete hydraulic analysis will be prepared for the water distribution network to confirm that water supply is available within the required pressure range under the anticipated demands during average day, peak hour and fire flow conditions prior to full buildout of the KNUEA. Depending on the status of other developments in the KNUEA, an interim condition or agreements for off-site works may be required to provide a looped network of watermains within the KNUEA. In circumstances where infrastructure may be required outside of the study area, land owner agreements will be put in place to facilitate cost sharing and access when necessary.

### 3.3 Water Supply Conclusion

Consistent with the *MSS*, potable water will be delivered to the proposed study area via a trunk 300mm diameter watermain running through the study area connecting to the existing watermain within Celtic Ridge Crescent and the proposed extension of the March Road watermain. Potable water will be supplied to the study area through pressurized local watermains on each street, connecting to the trunk 300mm diameter watermain.

A complete hydraulic analysis will be prepared at the time of detailed design. The watermain network will be sized to meet maximum hour and maximum day plus fire flow demands and conform to all relevant City Standards and policies and take into consideration the various draft plan configurations.

In circumstances where infrastructure may be required outside of the study area, there will be agreements in place facilitating cost sharing and access when necessary.

# 4.0 WASTEWATER SERVICING

## 4.1 Existing Wastewater Services

The existing residential subdivision to the south of the study area is serviced by the sanitary sewer network that conveys wastewater to the Briar Ridge Pump Station (BRPS), located south of Klondike Road and east of the former CN railway corridor. The BRPS discharges into the East March Trunk sanitary sewer. Two pumps are currently operating in the BRPS and a third is to be added when necessary per the *Briarridge Sanitary Pumping Station Pre-Design Report* (Cumming Cockburn, March 2001, revised June 2001). Furthermore, Hatch Limited has completed the independent *Briar Ridge Pump Station Capacity Assessment* (Hatch, September 21, 2018), which can be found in ***Appendix C***. It was recommended that the current pumps be replaced and a third pump be added alongside the replacement of the current pumps to service the expected future flows as the station is nearing 20 years of service, and are pumping at ~70 L/s, which is above the expected capacity of 61 L/s.

It is understood that at the time of this FSR, the City is undertaking its own assessment of the BRPS sewer system. It is anticipated that the results of this assessment will be available at the time of detailed design of the study area. The most up to date information regarding the BRPS will be incorporated into the HGL assessment of the study area at the time of detailed design.

The BRPS upgrades are also included in the *Infrastructure Master Plan* (City of Ottawa, 2013) (pg 219) and the *City of Ottawa 2014 Development Charges Background Study* (October 27, 2017) (pg B-22, item 10.5074) with anticipated timing for construction between 2019 & 2031. See ***Appendix B*** for details. The KNUEA owners' group is in the process of coordinating with the City to ensure that the BRPS upgrades are appropriately budgeted and scheduled to accommodate the buildout of the study area.

## 4.2 Wastewater Design

The wastewater servicing strategy for the study area was considered within the *MSS*, with a portion of the study area draining to the south and the remaining portion draining to the west.

Per the *MSS*, the eastern portion of the study area is to have its wastewater drain into existing sanitary infrastructure to the south of the study area before being conveyed to the Briar Ridge Pump Station. The BRPS then directs flows towards the East March Trunk sanitary sewer.

The remaining portion of the study area is to have its wastewater drain to a proposed 600mm diameter sanitary sewer within March Road before being conveyed to the proposed upsized sanitary sewers in Shirley's Brooke Drive and ultimately into the East March Trunk sanitary sewer, as identified in the *MSS*.

***Figure 5*** illustrates the proposed sanitary sewer network. Consistent with the *MSS*, the study area's wastewater servicing is split between the existing sanitary sewers draining south toward the BRPS and the proposed March Road sanitary sewer. The proposed location of the drainage split is the Shirley's Brooke Tributary 2 corridor, with all lands east of the split draining south. Preliminary sanitary drainage area information as well as sewer and road surface elevations can be seen in ***Figure 5*** and ***Appendix C***.

The proposed development will be serviced by a network of gravity sewers, ranging in diameter from 200mm to 450mm, designed in accordance with the wastewater design parameters from ISTB-2018-01 and the Sewer Design Guidelines, summarized in ***Table 4*** below. These design parameters represent a flow reduction from the outdated wastewater design parameters used during the *MSS* design.

**Table 4: Wastewater Design Criteria**

| Design Parameter | Value |
|---|---|
| Residential - Single Family | 3.4p/unit |
| Residential – Townhome/ Semi | 2.7p/unit |
| Residential Townhouse/Back-to-Back | 2.1 P/unit |
| Residential Apartment (High Density) | 1.8 P/unit |
| Average Daily Demand | 280 L/d/per |
| Peaking Factor | Harmon's Peaking Factor, where K=0.8 |
| Commercial / Institutional Flows | 28,000 L/gross ha/day |
| Commercial / Institutional Peak Factor | 1.5 if contribution >20%, otherwise 1.0 |
| Light Industrial Flows | 35,000 L/gross ha/day |
| Industrial Peaking Factor | Per Figure in Appendix 4-B, City of Ottawa Guidelines |
| Infiltration and Inflow Allowance | 0.33 L/s/gross ha for all areas |
| Park Peaking Factor | 1.0 |
| Sanitary sewers are to be sized employing the Manning's Equation | $Q = \frac{1}{n} A R^{2/3} S^{1/2}$ |
| Minimum Sewer Size | 200mm diameter |
| Minimum Manning's 'n' | 0.013 |
| Minimum Depth of Cover | 2.5m from crown of sewer to grade |
| Minimum Full Flowing Velocity | 0.6m/s |
| Maximum Full Flowing Velocity | 3.0m/s |
| *Extracted from Sections 4 and 6 of the City of Ottawa Sewer Design Guidelines, October 2012, Technical Bulletins, and recent residential subdivision in City of Ottawa.* | |

Per the *MSS*, the total anticipated peak flow conveyed through the study area to the existing BRPS sanitary infrastructure south of the study area is 66.49 L/s, see ***Appendix B***. Using the design parameters set out in ***Table 4***, a preliminary sanitary analysis was undertaken using the draft plan along with external drainage areas from the *MSS* and the existing Brookside subdivision to the south. As the exact alignment of residential homes in the subject area are not known at the time of this FSR, population densities that conservatively represent the current population projection were applied to the proposed residential areas to account for any possible changes in population at the detailed design stage. A population of 2,726 is considered for the study area compared to the 2,610 population anticipated by the concept plan. A calculated peak flow of 59.52 L/s is anticipated to discharge to the existing sanitary sewer network to the south (90% of the peak flow anticipated in the *MSS*).

Note that the study area's wastewater flows are proposed to connect into existing manhole MH225A within Celtic Ridge Crescent, upstream of the MH209A tie in location shown in the *MSS*. Recent survey information for existing MH209A (***Appendix C***) shows that the sanitary sewer is roughly 0.1m higher than reported in the *MSS*. As such, a new sanitary sewer alignment within the eastern Celtic Ridge boulevard or the rail corridor, between MH209A and MH225A as shown in the MSS, would be in conflict with the existing 1220x1930mm elliptical storm sewer running from Celtic Ridge Crescent to Shirley's Brook. Additional details can be found in ***Appendix C***. By connecting the new 450mm dia. sewer into MH225A, the *MSS* identified downstream sewer upsizing to 450mm dia. will need to extend to MH225A. The proposed upsized downstream sewer will not conflict with any of the existing infrastructure and has adequate capacity to service the study area's wastewater flows. The external sewer strategy will be finalized at the detailed design stage.

No further deviations from the *MSS* wastewater servicing strategy are proposed, aside from the use of the latest wastewater design parameters, the minor changes to the drainage split and the revised external sewer connection location. Consistent with the MSS, the proposed sanitary sewer network is to include an overflow outlet to Pond 3 at an elevation of 67.50m to provide relief to the existing trunk sewer along the rail corridor and not raise the HGL in the existing sanitary sewer downstream. An updated hydraulic gradeline analysis for the sanitary sewer system will be undertaken as part of the detailed design for the study area, based on results from the City of Ottawa's ongoing BRPS assessment and upgrade design.

The commercial mixed use blocks west of Shirley's Brooke Tributary 2 will drain towards the proposed 600mm diameter trunk sanitary sewer within March Road. The peak total flow will be lower than anticipated in the *MSS*, based on the City of Ottawa Sewer Design Guidelines' latest wastewater parameters and the reduced tributary area due to the drainage split change. In circumstances where infrastructure may be required outside of the study area, there will be agreements in place facilitating cost sharing and access when/where necessary.

### 4.3 Wastewater Servicing Conclusions

A network of local gravity sewers is proposed within the study area to convey flow to existing and proposed offsite sanitary sewers, in accordance with the *MSS*. The majority of the study area is intended to have its wastewater drain into the existing BRPS sanitary sewer system to the south of the study area and ultimately to the Briar Ridge Pump Station. The remaining portion of the study area is to have its wastewater drain to the proposed sanitary sewer within March Road before ultimately being conveyed into the East March Trunk sanitary sewer.

The sewers are to be designed in conformance with all relevant City of Ottawa and MECP Guidelines and Policies. Per ISTB-2018-01, the City's current design parameters represent a flow reduction from the outdated standards used within the *MSS*.

# 5.0 STORMWATER MANAGEMENT

## 5.1 Existing Stormwater Drainage

The study area is located within the Shirley's Brooke sub-watershed. Under existing conditions the western portion of the study area drains into Shirley's Brooke via Shirley's Brooke Tributary 2. The eastern portion of the study area drains into Shirley's Brooke to the east via existing drainage channels. See ***Appendix B*** for the existing drainage patterns for the study area.

## 5.2 Stormwater Management Strategy

The overall stormwater management strategy for the study area was considered within the *MSS*. Both the minor and major systems are to be directed towards the proposed stormwater management (SWM) Pond 3 to be situated in the northeast corner of the study area.

***Figure 3*** illustrates the proposed trunk storm sewer network. The trunk storm sewers, ranging in diameter from 750mm to 3000mm, collect stormwater runoff from the study area and portions of March Road. The storm sewer network ultimately drains towards SWM Pond 3 to the east. Local storm sewers will provide service to all roads and development blocks within the study area.

The study area will be serviced by a storm sewer designed in accordance with the amendment to the storm sewer and stormwater management elements of *PIETB-2016-01*. As such, the minor storm system is proposed to be designed for the following minimum rates of capture, deviating from the *MSS*:

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

Inlet control devices (ICD) will be employed to ensure that storm flows entering the minor system are limited to the flows described above. ***Table 5*** summarizes the standards that will be employed in the detailed design of the trunk and local storm sewers.

## Table 5: Storm Sewer Design Criteria

| Design Parameter | Value |
|---|---|
| Minor System Design Return Period | 2-Year (Local Streets), 5-Year (Collector Streets), 10-Year (Arterial Streets) – PIEDTB-2016-01 |
| Major System Design Return Period | 100-Year |
| Intensity Duration Frequency Curve (IDF)<br>2-year storm event:<br>A = 723.951, B = 6.199, C = 0.810<br>5-year storm event:<br>A = 998.071, B = 6.053, C = 0.814 | $i = \frac{A}{(t_c + B)^C}$ |
| Minimum Time of Concentration | 10 minutes |
| Rational Method | $Q = CiA$ |
| Runoff coefficient for paved and roof areas | 0.90 |
| Runoff coefficient for landscaped areas | 0.20 |
| Storm sewers are to be sized employing the Manning's Equation | $Q = \frac{1}{n} A R^{2/3} S^{1/2}$ |
| Minimum Sewer Size | 250 mm diameter |
| Minimum Manning's 'n' | 0.013 |
| Service Lateral Size | 100mm dia PVC SDR 28 with a minimum slope of 1.0%. |
| Minimum Depth of Cover | 1.7m from crown of sewer to grade *(based on recent residential subdivisions in City of Ottawa)* |
| Minimum Full Flowing Velocity | 0.8 m/s |
| Maximum Full Flowing Velocity | 6.0 m/s |
| Clearance from 100-Year Hydraulic Grade Line to Building Opening | 0.30 m |
| Max. Allowable Flow Depth on Municipal Roads | 35 cm above gutter (PIEDTB-2016-01) |
| Extent of Major System | To be contained within the municipal right-of-way or adjacent to the right-of-way provided that the water level must not touch any part of the building envelope and must remain below the lowest building opening during the stress test event (100-year + 20%) and 15cm vertical clearance is maintained between spill elevation on the street and the ground elevation at the nearest building envelope (PIEDTB-2016-01) |
| Stormwater Management Model | DDSWMM (release 2.1), SWMHYMO (v. 5.02) and XPSWMM (v. 10) |
| Model Parameters | Fo = 76.2 mm/hr, Fc = 13.2 mm/hr, DCAY = 4.14/hr, D.Stor.Imp. = 1.57 mm, D.Stor.Per. = 4.67 mm |
| Imperviousness | Based on runoff coefficient (C) where<br>Percent Imperviousness = (C - 0.2) / 0.7 x 100%. |
| Design Storms | Chicago 3-hour Design Storms and 24-hour SCS Type II Design Storms. Maximum intensity averaged over 10 minutes. |
| Historical Events | July 1st, 1979, August 4th, 1988 and August 8th, 1996 |
| Climate Change Street Test | 20% increase in the 100-year, 3-hour Chicago storm |
| *Extracted from City of Ottawa Sewer Design Guidelines, October 2012,* as amended by PIEDTB-2016-01, *and based on recently approved residential subdivision designs in City of Ottawa.* | |

Preliminary sizing of the storm sewer network is provided in ***Appendix D***, based on rational method calculations and the design parameters set out in ***Table 5***. Conservative runoff coefficients were applied based on the coefficients used within the *MSS,* see ***Appendix B*** for details. A peak rational method flow of 5230L/s was anticipated to outlet into Pond 3. Preliminary storm drainage area information as well as sewer and road surface elevations can be seen in ***Figure 3*** and ***Appendix D***.

Note that drainage swales to the east of the existing rail corridor, directing flow to Pond 3 are proposed to be replaced with storm sewers, based on the direction agreed upon by the land owners. Per the *Kanata North Community Pond 3 / Preliminary Stormwater Management Design* (JFSA, Sept 2019), there is expected to be standing water in a portion of the storm sewer system between the rail corridor (MH97) and Pond 3. There is no standing water anticipated within the study area's storm sewer network upstream of MH97. No additional deviations from the *MSS*'s stormwater management strategy are anticipated at this stage.

A hydraulic gradeline (HGL) analysis has been completed for the proposed storm sewer network as detailed in the *Kanata North Community Pond 3 / Preliminary Stormwater Management Design* (JFSA, Sept 2019), included in ***Appendix E***. The results of the analysis find that a 0.3m freeboard is provided between the hydraulic gradeline and the estimated underside of footing elevations (assumed 1.8m below ground level) throughout the study area. A detailed HGL analysis based on the 100-year 3-hour Chicago and 24-hour SCS design storms will be prepared and further analyzed, and the storm sewer network will be refined accordingly, at the detailed design stage.

Consistent with the *MSS*, major system drainage is proposed to be directed towards and along the local and collector roads, ultimately draining into SWM Pond 3 to the east. The existing ditches within the rail corridor will direct the overland flow from the study area to the culverts crossing the rail corridor to allow for the overland flow to drain towards Pond 3. Major system flow routing is illustrated on the conceptual grading plan ***Drawing 1***. The *MSS* and the *Geotechnical Investigation – Proposed Residential Development 936 March Road* (November 28, 2018, Paterson Group) both report a preliminary grade raise restriction of up to 3m. The conceptual grading plan does not propose any grades exceeding the 3m restriction.

## 5.3 Floodplain Mapping

An existing drainage channel, a tributary of Shirley's Brooke (referred to as Tributary 2 in the MSS), runs through the study area. According to the *EMP*, within the study area, the drainage channel has sufficient capacity to confine the 100-year peak flow within the top of bank and existing channel corridor. Existing floodplain limits from the *EMP* and *MSS* can be seen in ***Appendix B***. The draft plan includes a 40 m wide corridor and an additional 6 m buffer to respect the existing drainage channel and the 35m meander belt width identified within the *EMP*. Consistent with the *MSS*, a culvert will be installed under the proposed road crossing to convey the 100-year peak flow without stormwater overtopping the proposed road. An 1800x1200mm culvert is proposed as shown in the cross-section on ***Drawing 1***. The sizing of the culvert(s) will be confirmed during detailed design of the study area.

## 5.4 Proposed Outlet – Stormwater Management (SWM) Pond 3

Consistent with the *MSS*, the proposed outlet for both the minor and major systems from the proposed development is SWM Pond 3. Pond 3 is to be situated east of the study area and west of March Valley Road, and ultimately drains into Shirley's Brook. The Kanata North Land Owner's Group is advancing the proposal to pursue Shirley's Brook Realignment Alternatives Option 2, illustrated in Figure 6.5 of the EMP, see ***Appendix D***. Option 2 maintains the current alignment of Shirley's Brook within the March Valley Road ROW via rehabilitation and reinforcement of the existing channel and embankments.

The conceptual Pond 3 footprint is shown in ***Figure 7***. Consistent with the *MSS*, Pond 3 is to service stormwater runoff from both the study area and the future development lands to the north (northeast quadrant of the KNUEA). Drainage assumptions for the external drainage area are consistent with the MSS, as shown in ***Figure 9***. The proposed Pond 3 will provide Enhanced Protection quality control (80% TSS removal).

2-year, 5-year and 100-year quantity control target release rates were set in the *EMP* and *MSS*, based on the 24-hour SCS Type II design storm distribution. The quantity control requirements for Pond 3 have been reassessed within the *Kanata North Community Pond 3 / Preliminary Stormwater Management Design* (JFSA, Sept 2019), included in ***Appendix E***. Combining the *EMP* modeling with a model of Shirley's Brook created as part of the *Shirley's Brook and Watt's Creek Phase 2 Stormwater Management Study* (AECOM, April 2015), quantity control targets were determined to ensure 2 to 100-year post-development peak flows at all key nodes along the main branch on Shirley's Brook were equal to or less than pre-development levels. Additional details can be found in ***Appendix E***.

Pond 3 is proposed to operate at a permanent pool elevation of 64.80m, lower than the *MSS* proposed permanent pool elevation of 65.50m. It is noted that the *MSS* preliminary pond outlet and permanent pool was designed higher than the assumed water levels in Shirley's Brook, providing flexibility to lower the operating levels within the pond upon detailed design to best suit development conditions. The proposed 100-year water level in the pond is 66.80m, slightly below the MSS 100-year water level of 67.00m. Additional pond design details can be found in ***Appendix E***.

The proposed Pond 3 design does not include specific targets and controls to protect against erosion within Shirley's Brook, beyond the quantity and quality control targets described above and in ***Appendix E***.

The proposed Pond 3 has been designed to capture the spirit of the pond design in the *EMP* and *MSS*, while also meeting the quantity control targets necessary to maintain existing flow conditions within Shirley's Brook, and retaining as much of the adjacent woodlot as possible. An overlay of the proposed Pond 3 footprint onto aerial photo is illustrated in ***Figure 8***.

## 5.5 Low Impact Development Measures

Section 11.7.4 of the *EMP* states that “The alluvial sand deposits east of March Road represent the most suitable areas for LID within the KNUEA. The alluvial soils are relatively shallow and underlain by clay and/or bedrock, and do not provide any significant contribution to groundwater recharge. However, these soils can provide storage and attenuation of runoff, and contribute to baseflow in Shirley’s Brook.”

The suitability of LIDs for the proposed development have been evaluated from a geotechnical and hydrogeological perspective by Paterson Group, in the *Groundwater Infiltration Review* (Paterson Group, June 21, 2019). The recommendations of the memo conclude that "...existing conditions at the subject site currently allow for only minimal volumes of recharge to occur. As such, the applicability of secondary infiltration measures is considered limited for Low Impact Development Measures (LIDs), such as rear yard catch basins and amended topsoil finishes. It should also be noted that previous attempts within the City of Ottawa to induce additional surface water infiltration in similarly low permeability soils have resulted in detrimental effects to both homeowners and their properties due to poorly maintained drainage systems." A copy of the Paterson memo is included in ***Appendix D***.

LIDs have also been evaluated from an environmental perspective by McKinley Environmental Solutions, in the *Low Impact Development Measures (LIDs)* (McKinley Environmental Solutions, June 20, 2019). The recommendations of the memo concluded that ".... infiltration features (e.g. surface infiltration swales, ditches, etc.), may increase the likelihood that Black Legged Ticks will enter residential yards, particularly where those properties occur close to retained natural areas... Similarly, it is likely that such features will directly provide breeding habitat for mosquitos. The increased presence of Black Legged Ticks and/or mosquitos may have a detrimental effect on future homeowners and the community. It should be noted that infiltration features generally do not provide significant wildlife habitat values. Given their limited potential value to wildlife, coupled with their potential detrimental effects in terms of increasing the incidence of Black Legged Ticks and mosquitos, it is our professional opinion that the installation of infiltration features within the proposed development is unlikely to be beneficial to the natural features and functions of the Study Area." A copy of the McKinley Environmental Solutions memo is included in ***Appendix D***.

## 5.6 Stormwater Servicing Conclusions

Consistent with the *MSS*, a network of local gravity sewers is proposed within the study area to capture stormwater and convey the flows to the proposed trunk storm sewer network. The trunk storm sewer network will outlet into SWM Pond 3 via storm sewers traversing the adjacent undeveloped land. Flows not captured in the sewer network are to be directed towards SWM Pond 3 via the proposed roadways and existing drainage swales and culverts.

The storm sewer network and stormwater management facility designs are to be designed in conformance with all relevant City of Ottawa and MECP Guidelines.

# 6.0 UTILITIES

Utility services were consulted as part of the *MSS* process to provide information regarding their existing infrastructure, initial plans for servicing the KNUEA, and identify any known constraints.

Hydro Ottawa is reported to have overhead infrastructure running through the KNUEA on the east side of March Road. Per the *MSS*, the existing infrastructure on March Road will need to be upgraded in order to service the KNUEA.

Enbridge Gas is reported to have service extended off the 6" high-pressure gas main within the west side of March Road near the study area.

Bell and Rogers are reported to have services up to the intersection of March Road and Old Carp Road, southwest of the study area. Service to the KNUEA would extend off this location. Per the *MSS*, Rogers' existing infrastructure would require upgrading to service the KNUEA.

DSEL has begun coordination with the utility services to confirm the servicing plan for the study area.

## 7.0 EROSION AND SEDIMENT CONTROL

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

Prior to topsoil stripping, earthworks or underground construction, erosion and sediment controls will be implemented and will be maintained throughout construction.

Silt fence will be installed around the perimeter of the active part of the site and will be cleaned and maintained throughout construction. Silt fence will remain in place until the working areas have been stabilized and re-vegetated.

Catchbasins will have catchbasin inserts installed during construction to protect from silt entering the storm sewer system.

Specifically, the following recommendations to the Contractor will be included in contract documents.

- Limit extent of exposed soils at any given time.
- Re-vegetate exposed areas as soon as possible.
- Minimize the area to be cleared and grubbed.
- Protect exposed slopes with plastic or synthetic mulches.
- Install silt fence to prevent sediment from exiting the construction area and entering existing ditches/stormwater systems.
- Install mud mat at the construction access in order to prevent mud tracking onto adjacent roads.
- No refueling or cleaning of equipment near existing watercourses.
- Provide sediment traps and basins during dewatering.
- Install catchbasin inserts.
- 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:

- Verification that water is not flowing under silt barriers.
- Clean and change inserts at catch basins.

## 8.0 CONCLUSIONS AND RECOMMENDATIONS

The overall municipal servicing strategy for the study area was contemplated as part of the *Kanata North Community Design Plan (City of Ottawa, June 28, 2016)* and the Kanata North Master Servicing Study *(City of Ottawa, June 28 2016)*.

This *Functional Servicing Study* (FSR) (DSEL, September 2019) provides details on the planned on-site and off-site municipal services for the subject property and demonstrates that adequate municipal infrastructure capacity is expected to be available for the planned development of the study area.

Prior to detailed design of the infrastructure presented in this report, this FSR will require approval under the *Planning Act* as supporting information for the development applications. Project-specific approvals are also expected to be required for the infrastructure presented in this report from the City of Ottawa, Ministry of Environment, Conservation and Parks and Mississippi Valley Conservation Authority.

| | |
|---|---|
| Prepared by,<br>**David Schaeffer Engineering Ltd.** | Reviewed by,<br>**David Schaeffer Engineering Ltd.** |
| Per: Braden Kaminski, E.I.T. | Per: Matt Wingate, P.Eng |

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Prepared by,
**David Schaeffer Engineering Ltd.**

Per: Braden Kaminski, E.I.T.

Reviewed by,
**David Schaeffer Engineering Ltd.**

LICENSED PROFESSIONAL ENGINEER
R. M. WINGATE
100069090
Sept 12/19
PROVINCE OF ONTARIO

Per: Matt Wingate, P.Eng


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# Appendix A

**Development Study Checklist, Draft Plan of Subdivision, Record of Pre-Consultation, Record of City Comments**

# DEVELOPMENT SERVICING STUDY CHECKLIST

| | | |
|---|---|---|
| **4.1 General Content** | | |
| ☐ | Executive Summary (for larger reports only). | N/A |
| ☐ | Date and revision number of the report. | Title Page |
| ☐ | Location map and plan showing municipal address, boundary, and layout of proposed development. | Figure 1 |
| ☐ | Plan showing the site and location of all existing services. | Figures 3/4/5/6 |
| ☐ | Development statistics, land use, density, adherence to zoning and official plan, and reference to applicable subwatershed and watershed plans that provide context to applicable subwatershed and watershed plans that provide context to which individual developments must adhere. | Section 1.0 & Section 2.0 |
| ☐ | Summary of Pre-consultation Meetings with City and other approval agencies. | Section 1.3 & Appendix A |
| ☐ | Reference and confirm conformance to higher level studies and reports (Master Servicing Studies, Environmental Assessments, Community Design Plans), or in the case where it is not in conformance, the proponent must provide justification and develop a defendable design criteria. | All sections |
| ☐ | Statement of objectives and servicing criteria. | Section 1.0 & Section 3.2, Section 4.2, and Section 5.2 |
| ☐ | Identification of existing and proposed infrastructure available in the immediate area. | Sections 3.1, Section 4.1, and Section 5.1 |
| ☐ | Identification of Environmentally Significant Areas, watercourses and Municipal Drains potentially impacted by the proposed development (Reference can be made to the Natural Heritage Studies, if available). | Sections 1.1 & 1.2 |
| ☐ | Concept level master grading plan to confirm existing and proposed grades in the development. This is required to confirm the feasibility of proposed stormwater management and drainage, soil removal and fill constraints, and potential impacts to neighbouring properties. This is also required to confirm that the proposed grading will not impede existing major system flow paths. | Drawing 1 |
| ☐ | Identification of potential impacts of proposed piped services on private services (such as wells and septic fields on adjacent lands) and mitigation required to address potential impacts. | To be addressed in at detailed design. |
| ☐ | Proposed phasing of the development, if applicable. | N/A. Depends on landowner preferred timing |
| ☐ | Reference to geotechnical studies and recommendations concerning servicing. | Section 1.1 & Section 2.1 |
| ☐ | All preliminary and formal site plan submissions should have the following information:<br>-Metric scale<br>-North arrow (including construction North)<br>-Key plan<br>-Name and contact information of applicant and property owner<br>-Property limits including bearings and dimensions<br>-Existing and proposed structures and parking areas<br>-Easements, road widening and rights-of-way<br>-Adjacent street names | All Figures |

| | | |
|---|---|---|
| **4.2 Development Servicing Report: Water** | | |
| ☐ | Confirm consistency with Master Servicing Study, if available | Section 3.2 |
| ☐ | Availability of public infrastructure to service proposed development | MSS & Section 3.2 |
| ☐ | Identification of system constraints | MSS & Section 3.2 |
| ☐ | Identify boundary conditions | Detailed hydraulic assessment N/A for FSR |



*Extracted from the City of Ottawa-Servicing Study Guidelines for Development Applications

| | | |
|---|---|---|
| ☐ | Confirmation of adequate domestic supply and pressure | MSS.<br>Detailed hydraulic assessment N/A for FSR. |
| ☐ | Confirmation of adequate fire flow protection and confirmation that fire flow is calculated as per the Fire Underwriter's Survey. Output should show available fire flow at locations throughout the development. | MSS.<br>Detailed hydraulic assessment N/A for FSR. |
| ☐ | Provide a check of high pressures. If pressure is found to be high, an assessment is required to confirm the application of pressure reducing valves. | Detailed hydraulic assessment N/A for FSR. |
| ☐ | Definition of phasing constraints. Hydraulic modeling is required to confirm servicing for all defined phases of the project including the ultimate design | Detailed hydraulic assessment N/A for FSR. |
| ☐ | Address reliability requirements such as appropriate location of shut-off valves | Detailed hydraulic assessment N/A for FSR. |
| ☐ | Check on the necessity of a pressure zone boundary modification | MSS. |
| ☐ | Reference to water supply analysis to show that major infrastructure is capable of delivering sufficient water for the proposed land use. This includes data that shows that the expected demands under average day, peak hour and fire flow conditions provide water within the required pressure range | MSS.<br>Detailed hydraulic assessment N/A for FSR. |
| ☐ | Description of the proposed water distribution network, including locations of proposed connections to the existing system, provisions for necessary looping, and appurtenances (valves, pressure reducing valves, valve chambers, and fire hydrants) including special metering provisions. | MSS, Section 3.2 & Figure 5.<br>Detailed hydraulic assessment N/A for FSR. |
| ☐ | Description of off-site required feedermains, booster pumping stations, and other water infrastructure that will be ultimately required to service proposed development, including financing, interim facilities, and timing of implementation. | MSS. |
| ☐ | Confirmation that water demands are calculated based on the City of Ottawa Design Guidelines. | Section 3.2 |
| ☐ | Provision of a model schematic showing the boundary conditions locations, streets, parcels, and building locations for reference. | Detailed hydraulic assessment N/A for FSR. |

## 4.3 Development Servicing Report: Wastewater

| | | |
|---|---|---|
| ☐ | Summary of proposed design criteria (Note: Wet-weather flow criteria should not deviate from the City of Ottawa Sewer Design Guidelines. Monitored flow data from relatively new infrastructure cannot be used to justify capacity requirements for proposed infrastructure). | Section 4.2 |
| ☐ | Confirm consistency with Master Servicing Study and/or justifications for deviations. | Section 4.2 |
| ☐ | Consideration of local conditions that may contribute to extraneous flows that are higher than the recommended flows in the guidelines. This includes groundwater and soil conditions, and age and condition of sewers. | MSS |
| ☐ | Description of existing sanitary sewer available for discharge of wastewater from proposed development. | Section 4.1 & 4.2 |
| ☐ | Verify available capacity in downstream sanitary sewer and/or identification of upgrades necessary to service the proposed development. (Reference can be made to<br>previously completed Master Servicing Study if applicable) | MSS, Section 4.2, Figure 5, Appendix C |
| ☐ | Calculations related to dry-weather and wet-weather flow rates from the development in standard MOE sanitary sewer design table (Appendix 'C') format. | Appendix C |
| ☐ | Description of proposed sewer network including sewers, pumping stations, and forcemains. | MSS, Section 4.2, Appendix C & Figure 5 |



*Extracted from the City of Ottawa-Servicing Study Guidelines for Development Applications

| | | |
|---|---|---|
| ☐ | Discussion of previously identified environmental constraints and impact on servicing (environmental constraints are related to limitations imposed on the development in order to preserve the physical condition of watercourses, vegetation, soil cover, as well as protecting against water quantity and quality). | MSS |
| ☐ | Pumping stations: impacts of proposed development on existing pumping stations or requirements for new pumping station to service development. | MSS, Section 4.1 & 4.2 |
| ☐ | Forcemain capacity in terms of operational redundancy, surge pressure and maximum flow velocity. | MSS |
| ☐ | Identification and implementation of the emergency overflow from sanitary pumping stations in relation to the hydraulic grade line to protect against basement flooding. | MSS, Section 4.2 |
| ☐ | Special considerations such as contamination, corrosive environment etc. | MSS |

## 4.4 Development Servicing Report: Stormwater Checklist

| | | |
|---|---|---|
| ☐ | Description of drainage outlets and downstream constraints including legality of outlets (i.e. municipal drain, right-of-way, watercourse, or private property) | Section 1.1 & Section 5.1 |
| ☐ | Analysis of available capacity in existing public infrastructure. | MSS & Section 5.4 |
| ☐ | A drawing showing the subject lands, its surroundings, the receiving watercourse, existing drainage patterns, and proposed drainage pattern. | Figure 3, Appendix B |
| ☐ | Water quantity control objective (e.g. controlling post-development peak flows to pre-development level for storm events ranging from the 2 or 5 year event (dependent on the receiving sewer design) to 100 year return period); if other objectives are being applied, a rationale must be included with reference to hydrologic analyses of the potentially affected subwatersheds, taking into account long-term cumulative effects. | MSS, Section 5.4 & *Kanata North Community Pond 3 / Preliminary Stormwater Management Design* (JFSA, Sept 2019) |
| ☐ | Water Quality control objective (basic, normal or enhanced level of protection based on the sensitivities of the receiving watercourse) and storage requirements. | MSS & Section 5.4 |
| ☐ | Description of the stormwater management concept with facility locations and descriptions with references and supporting information | Section 5.2, Section 5.4 & Figures 3, 7-9 |
| ☐ | Set-back from private sewage disposal systems. | N/A |
| ☐ | Watercourse and hazard lands setbacks. | MSS, Section 5.3 |
| ☐ | Record of pre-consultation with the Ontario Ministry of Environment and the Conservation Authority that has jurisdiction on the affected watershed. | Record of consultation forthcoming. |
| ☐ | Confirm consistency with sub-watershed and Master Servicing Study, if applicable study exists. | MSS, Section 5.2, Section 5.3 & Section 5.4 |
| ☐ | Storage requirements (complete with calculations) and conveyance capacity for minor events (1:5 year return period) and major events (1:100 year return period). | *Kanata North Community Pond 3 / Preliminary Stormwater Management Design* (JFSA, Sept 2019) |
| ☐ | Identification of watercourses within the proposed development and how watercourses will be protected, or, if necessary, altered by the proposed development with applicable approvals. | MSS, Section 5.4 & *Kanata North Community Pond 3 / Preliminary Stormwater Management Design* (JFSA, Sept 2019) |
| ☐ | Calculate pre and post development peak flow rates including a description of existing site conditions and proposed impervious areas and drainage catchments in comparison to existing conditions. | *Kanata North Community Pond 3 / Preliminary Stormwater Management Design* (JFSA, Sept 2019) |
| ☐ | Any proposed diversion of drainage catchment areas from one outlet to another. | N/A |


*Extracted from the City of Ottawa-Servicing Study Guidelines for Development Applications

| | | |
|---|---|---|
| ☐ | Proposed minor and major systems including locations and sizes of stormwater trunk sewers, and stormwater management facilities. | Section 5.2, Appendix D & Figure 3 |
| ☐ | If quantity control is not proposed, demonstration that downstream system has adequate capacity for the post-development flows up to and including the 100-year return period storm event. | N/A |
| ☐ | Identification of potential impacts to receiving watercourses | MSS |
| ☐ | Identification of municipal drains and related approval requirements. | N/A |
| ☐ | Descriptions of how the conveyance and storage capacity will be achieved for the development. | *Kanata North Community Pond 3 / Preliminary Stormwater Management Design* (JFSA, Sept 2019) |
| ☐ | 100 year flood levels and major flow routing to protect proposed development from flooding for establishing minimum building elevations (MBE) and overall grading. | Section 5.3 & Drawing 1 |
| ☐ | Inclusion of hydraulic analysis including hydraulic grade line elevations. | *Kanata North Community Pond 3 / Preliminary Stormwater Management Design* (JFSA, Sept 2019) |
| ☐ | Description of approach to erosion and sediment control during construction for the protection of receiving watercourse or drainage corridors. | Section 7.0 |
| ☐ | Identification of floodplains – proponent to obtain relevant floodplain information from the appropriate Conservation Authority. The proponent may be required to delineate floodplain elevations to the satisfaction of the Conservation Authority if such information is not available or if information does not match current conditions. | MSS, Section 5.3 |
| ☐ | Identification of fill constraints related to floodplain and geotechnical investigation. | Section 1.1 |

## 4.5 Approval and Permit Requirements: Checklist

| | | |
|---|---|---|
| ☐ | Conservation Authority as the designated approval agency for modification of floodplain, potential impact on fish habitat, proposed works in or adjacent to a watercourse, cut/fill permits and Approval under Lakes and Rivers Improvement Act. The Conservation Authority is not the approval authority for the Lakes and Rivers Improvement ct. Where there are Conservation Authority regulations in place, approval under the Lakes and Rivers Improvement Act is not required, except in cases of dams as defined in the Act. | Section 1.2 |
| ☐ | Application for Certificate of Approval (CofA) under the Ontario Water Resources Act. | Section 1.2 |
| ☐ | Changes to Municipal Drains. | N/A |
| ☐ | Other permits (National Capital Commission, Parks Canada, Public Works and Government Services Canada, Ministry of Transportation etc.) | Section 1.2 |

## 4.6 Conclusion Checklist

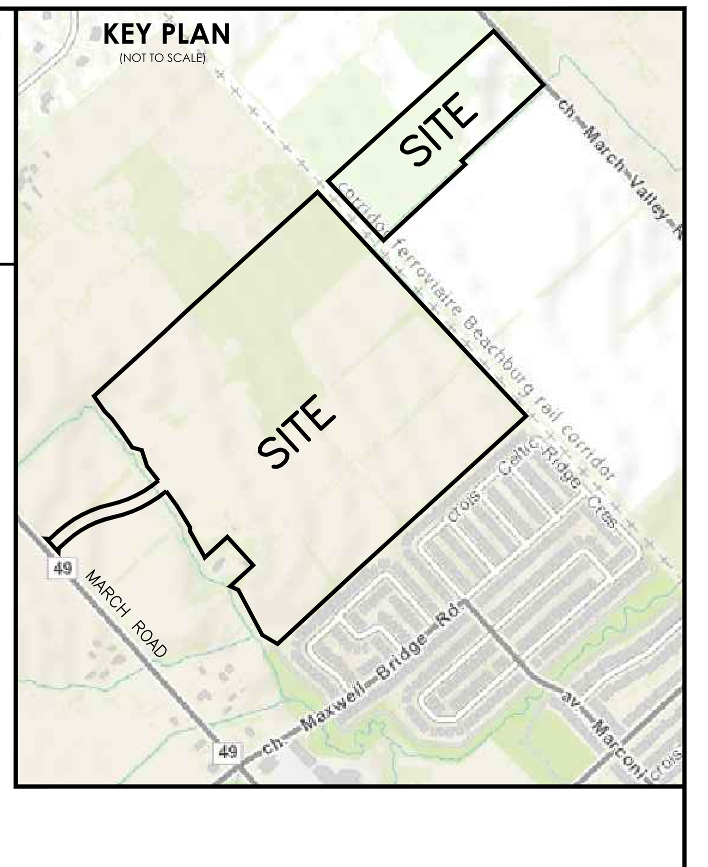
| | | |
|---|---|---|
| ☐ | Clearly stated conclusions and recommendations | Section 8.0 |
| ☐ | Comments received from review agencies including the City of Ottawa and information on how the comments were addressed. Final sign-off from the responsible reviewing agency. | Appendix A |
| ☐ | All draft and final reports shall be signed and stamped by a professional Engineer registered in Ontario | Section 8.0 |



*Extracted from the City of Ottawa-Servicing Study Guidelines for Development Applications


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______________,20___.

DERRICK MOODIE, MANAGER
DEVELOPMENT REVIEW-WEST
PLANNING, INFRASTRUCTURE AND ECONOMIC DEVELOPMENT DEPARTMENT, CITY OF OTTAWA




# DRAFT PLAN OF SUBDIVISION

## PART OF LOT 12
## CONCESSION 4
(GEOGRAPHIC TOWNSHIP OF MARCH)
## CITY OF OTTAWA

Scale 1:1250

20 0 20 40 60 80 METRES

**METRIC CONVERSION**

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

**GRID SCALE CONVERSION**

DISTANCES ARE GROUND AND CAN BE CONVERTED TO GRID BY MULTIPLYING BY THE COMBINED SCALE FACTOR OF 0.99992

**BEARING NOTE**

BEARINGS ARE DERIVED FROM PLAN 4R-31357 PREPARED BY OTHERS.

**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
i. SEE SOIL REPORT
j. SEE TOPOGRAPHICAL INFORMATION
k. ALL CITY SERVICES AVAILABLE
l. NO EASEMENTS REGISTERED ON TITLE

**SURVEYOR'S CERTIFICATE**

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

DATE

BRIAN J. WEBSTER
ONTARIO LAND SURVEYOR

NOTE:
THE PLAN DATA IS COMPILED FROM OFFICE RECORDS OF STANTEC GEOMATICS LTD. AND HAS NOT BEEN VERIFIED BY FIELD MEASUREMENTS. ALL DISTANCES ARE APPROXIMATE, TO BE VERIFIED BY FINAL REGISTERED PLAN(S).

Stantec Geomatics Ltd.
CANADA LANDS SURVEYORS
ONTARIO LAND SURVEYORS
1331 CLYDE AVENUE, SUITE 400
OTTAWA, ONTARIO, K2C 3G4
TEL. 613.722.4420 FAX. 613.722.2799
stantec.com

| DRAWN: CEC | CHECKED: * | PM: FP | PROJECT No.: 161613877-131 |
|---|---|---|---|

## Braden Kaminski

**From:** Beth Henderson <BHenderson@minto.com>
**Sent:** Monday, July 16, 2018 4:04 PM
**To:** Emilie Coyle; Paul Black; Miguel Tremblay - FoTenn Urban Planners & Designers (tremblay@fotenn.com); Steve Pichette; McKinley Environmental; Matt Wingate; Christopher Gordon (gogogordons.chris@rogers.com); Dave Gilbert (dgilbert@patersongroup.ca); Mark D'Arcy; 'Karyn Munch'; 'Ben Mortimer'; 'Webster, Brian'
**Subject:** FW: Pre-Consultation Follow-up: 936 March Road
**Attachments:** 936 March.pdf; Plan & Study List.pdf

Hi All
Please find attached and below the comments from the city from our pre consultation meeting last Wednesday July 11th 20118.
Thanks
Beth


Beth Henderson
Senior Land Development Manager
**MINTO COMMUNITIES - CANADA**
200-180 Kent St, Ottawa, ON K1P 0B6
**T** 613.782.2311
A division of The Minto Group

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**From:** McCreight, Laurel [mailto:Laurel.McCreight@ottawa.ca]
**Sent:** Friday, July 13, 2018 12:05 PM
**To:** Emilie Coyle <coyle@fotenn.com>
**Cc:** Beth Henderson <BHenderson@minto.com>
**Subject:** Pre-Consultation Follow-up: 936 March Road

Hi Emilie,

Please refer to the below regarding the Pre-Consultation Meeting held on Wednesday Jull 11th, 2018 for the property at 936 March Road for a proposed plan of subdivision. I have also attached the Plans & Study List.

**General**

- Proposal to develop a subdivision containing approximately 800 units, 396 being single-family dwellings and 400 being townhomes
- Two blocks have been severed, under an application to Committee of Adjustment, fronting onto March Road and retained by the current property owner for future commercial development
- The proposed subdivision will consist of a park block and school block along with the residential blocks
- The current proposal is generally consistent with the council approved Kanata North Community Design Plan
- The subject property currently contains an existing farmhouse that is being retained along with its access
- The western portion of the property contains a 40-metre creek corridor.
- The applicants are proposing a Zoning By-law Amendment for both the commercial and subdivision portions
- The commercial portion is proposing to be rezoned from Rural Countryside (RU) to General Mixed Use (GM)

**Planning/Urban Design**

- The property is subject to the Kanata North Community Design Plan (CDP)
- The subject property is currently zoned Rural Countryside (RU) with the intent of rezoning the property
- There is a concern regarding the applicant's proposal of rezoning RU to GM without a Master Plan for the remaining commercial blocks
    - A concept plan will be required to demonstrate layout of the site
- Please be aware of the gateway features in the CDP
    - There are currently two labelled potential community gateways where the CDP has a maximum of two
    - Potential neighbourhood gateway also identified
- Please provide more linkages throughout the site in the northwest corner towards the creek
- Consider realigning Block 42 to align the pathway to the street
    - It is understood that there is an easement on title for this existing access and it may be difficult to move the location
    - Please describe if this can / cannot be accommodated in the Planning Rationale
- The attached image also illustrates other linkages that are recommended
- The ideal layout would have the back-to-back townhomes block along the collector to allow for a multi-use pathway (MUP) and to ensure driveways do not interfere
- Please provide a similar form of housing located in the existing residential neighbourhood to the south (along the southern property line)
- A mixture of product type dispersed throughout the subdivision is encouraged
- There is a 6-metre MUP around the retained dwelling
- A right-of-way of 1.8 metres is preferable for tree planting along the MUP
- The hedge row in Block 34, the southern portion, is to be enhanced and retained
- Please note the woodlot is to be conveyed to the City as part of the natural heritage system and is to be shown separately on the plans from the stormwater management pond (two separate blocks)
- Discussion regarding the rail corridor
    - The corridor may be acquired, but there are no guarantees, depends on whether the City has the funds and how much of the corridor is actually being sold
    - At minimum, we should be protecting for the potential and access will need to be provided across the corridor for the SWM connection
- Please be aware of the location of clay soils and their relation to tree planting

**Engineering**

- Master Servicing Study to be followed
- Please incorporate LIDs where possible

**Transportation**

- Follow Traffic Impact Assessment Guidelines – Full Traffic Impact Assessment will be required.

  - Start this process as soon as possible
  - The application will not be deemed complete until the submission of the draft step 1-4, including the functional draft RMA package (if applicable) and/or monitoring report (if applicable)
- ROW protection on March Road between Urban Area Limit and Terry Fox Drive is 44.5m even (Note: An additional 5.0 m on the Greenbelt side may be required to construct a rural cross section)
- Noise Feasibility Impact Studies required prior to DPA and Detailed Noise Impact Assessment required prior to registration, for the following:
  - Road
  - Rail (if applicable)

**Environmental / Forestry**

- The Environmental Management Plan (EMP) and CDP will provide direction for the development
- When filling up the corridor limits, be cognizant of the transitions as there are regulations about drainage into the corridor
  - No retaining walls or rear yard drainage
- There are perched culverts along the rail ditch, if there is the opportunity to fix the culverts, the EMP suggests it be done
- Please be advised of the coordination that will have to take place for the obtaining of a turtle permit
  - A Ministry of Natural Resources permit may be required
- There is a high presence of butternut trees on the subject property with majority surrounding the existing dwelling that is being retained
- Further butternut planting is supported along the woodlot
- A tree permit is required prior to any tree removal on site
- A Tree Conservation Report will need to be submitted for review as part of the Plan of Subdivision submission requirements (can be combined with the EIS)

**Parks**

- Please provide further connectivity throughout the proposal from the streets to the park block
- It is anticipated the park may be suitable for more active uses

**Mississippi Valley Conservation Authority**

- The stormwater management pond at the bottom of the inlet is to be constructed as soon as possible and completed as part of the development
- Some temporary sediment ponds may be required for construction
- Be sure to implement the MSS.
- Current regulation mapping extends beyond the established corridor primarily into the proposed commercial block but there is spillage into the eastern side of the property
  - This results in the way of MNR however does not incorporate stormwater management controls until developed
- The flood limit anticipates full build up, upstream, with no stormwater management
- Flood plain mapping will be reduced to incorporate the stormwater management pond upon its completion
  - There is confidence it will be reduced to 40-metres
- There is currently an issue in the interim for crossing
  - If it is temporary, pre-servicing permits will be required
  - This will include a hydraulic-pumping analysis
  - The crossing on the map would have to look at flows and flooding
- The floodwater is currently over topping by 0.3metres
- Please show the reduced spill area on pond 2

Please do not hesitate to contact me if you have any questions.

Regards,
Laurel

**Laurel McCreight MCIP, RPP**
Planner
Development Review West
Urbaniste
Examen des demandes d'aménagement ouest

City of Ottawa | Ville d'Ottawa
613.580.2424 ext./poste 16587
ottawa.ca/planning / ottawa.ca/urbanisme

ABSENCE ALERT - I will be away from July 20 to August 8

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**17-982 Kanata North**
**Prepared by DSEL**
**12-Sep-19**

| Item No. | Comment Source | Comment Type | Comment No. | Comment | Response |
|---|---|---|---|---|---|
| 1 | Engineering Comments - March 1, 2019 | List of Drawings - Draft Plan of Subdivision | A1 | The Draft Plan of Subdivision specifies 16.5m local road right-of-ways (ROWs). The Geotechnical Investigation recommends a 4.5m setback from the foundation wall for typical street trees. Given the 16.5m ROW cross section presented in the Concept Plan Booklet, there is limited space within the ROW to accommodate the sidewalks, utility trench and street trees. In addition, it is unlikely that Hydro will approve a utility trench located under or immediately adjacent to the proposed sidewalk. Approval of the 16.5m ROW would require a detailed cross section design and sign off from all parties included in the CUP circulation prior to draft plan approval. As such, the City recommends an 18.0m ROW for all local roads. | |
| 2 | Engineering Comments - March 1, 2019 | List of Drawings - Draft Plan of Subdivision | A2 | What is the intended purpose of Block 60 abutting the railway corridor? The proposed grade difference between each end of the block is quite significant which will restrict accessible pedestrian connections. The block will also outlet to an existing ditch unless a new pathway is proposed within the rail corridor. | Noted. Block 60 has been removed in the modified development plan. |
| 3 | Engineering Comments - March 1, 2019 | List of Drawings - Conceptual Grading Plan | A3 | Additional grading information is required along the existing ditches within the rail corridor to identify the direction of flow and confirm conveyance of the major system from the proposed subdivision to the various culverts crossing the rail corridor. | Additional survey information and City 1k mapping information has been incldued in the design and the direction of flow can be found in the Drawing 1, Conceptual Grading Plan. |
| 4 | Engineering Comments - March 1, 2019 | List of Drawings - Conceptual Grading Plan | A4 | Within Park Block 62, the proposed interim grading appears to cut down the existing grades by up to 4.5m. The interim grading within the park should be adjusted to maintain the average existing grades where possible. In addition, please remove any terracing within the 6m pathway corridor adjacent Tributary 2. | The grading within the Neighbourhood Park has been updated to minimize cutting and terracing. The perimeter of the park block is to match existing grades in natural areas, with terracing along the proposed street network. |
| 5 | Engineering Comments - March 1, 2019 | List of Drawings - Conceptual Grading Plan | A5 | As per the EMP, the inlet channels to Pond 3 are to be designed to avoid sharp 90 degree bends. Please provide a more appropriate alignment of the inlet channel. | The inlet channel has been replaced with 3000mm dia. storm sewer to the Pond 3 south forebay. |
| 6 | Engineering Comments - March 1, 2019 | List of Drawings - Conceptual Grading Plan | A6 | How will pedestrians and cyclists access the “6.0m multiuse path” that leads to the SWM Pond, located south of the inlet channel? The pathway should encircle the entire pond to provide a loop for users of the path. | The alignment of the 6.0m multiuse path has been altered to be accessed via Street 10. The multiuse path connects to the pond access road, which encircles the north, east and south sides of the pond. Completing the pathway loop on the west side of the pond will require that an alignment be identified through the treed area. |
| 7 | Engineering Comments - March 1, 2019 | List of Reports - Functional Servicing Report | B1 | The referenced Geotechnical Investigation within the FSR is outdated. | This was a typo. The latest Geotechnical Investigation is now referenced in the revised FSR. |
| 8 | Engineering Comments - March 1, 2019 | List of Reports - Functional Servicing Report | B2 | Please provide discussions regarding the status of the proposed 400mm diameter watermain to be extended along March Road, given that this future watermain is required to service Minto’s development. The 400mm diameter watermain connection is required (in addition to the Celtic Ridge connection) once the number of housing units exceeds 50. | The 400mm March Road watermain extension is proceeding as a separate Kanata North land owners' community infrastructure project. We are of the understanding that this project is currently under review and will proceed in advance of the first phase of Minto's development. |
| 9 | Engineering Comments - March 1, 2019 | List of Reports - Functional Servicing Report | B3 | Avoid designing P-loop systems (refer to proposed watermains east of Street 2). | The P-loop described has been removed in the modified development plan. |
| 10 | Engineering Comments - March 1, 2019 | List of Reports - Functional Servicing Report | B4 | It is noted that the Briar Ridge PS upgrades are included in the Infrastructure Master Plan (City of Ottawa, 2013) and the City of Ottawa 2014 Development Charges Background Study (October 27, 2017). Please provide a copy of these cited pages in the report. | The referenced pages have been included in **Appendix B** of the revised FSR. |
| 11 | Engineering Comments - March 1, 2019 | List of Reports - Functional Servicing Report | B5 | Additional information is required regarding the following infrastructure upgrades required to service Minto’s development:<br>- New Overflow for Briar Ridge PS to Pond 3<br>- Pipe upgrades to existing 375mm diameter sewer within rail corridor north of Klondike Road<br>- New 600mm diameter sewer within Shirley's Brook Drive to connect to the East March Trunk Sewer<br>- Increase station capacity at Briar Ridge PS | - No new information related to the BRPS sewer system was available at the writing of the FSR. The proposed preliminary design incorporates a sanitary sewer overflow that is consistent with the recommendations in the Master Servicing Study, with a sewer overflow invert elevation of .<br>- Proposed pipe upgrades alongside the rail corridor and Celtic Ridge are illustrated on Figure 6 'Offsite Sanitary Servicing'. Existing sewer elevations have been surveyed to inform the design. |

<table>
<tr><td>12</td><td>Engineering Comments - March 1, 2019</td><td>List of Reports - Functional Servicing Report</td><td>B6</td><td>The FSR should include adequate information and documentation to confirm that excess pumping capacity is available at the Briar Ridge PS. Alternatively, please outline the design upgrades that would be required at the Briar Ridge PS to bring the station up to capacity to accept the additional flows from Minto's development.</td><td>The City is currently undertaking an assessment of the existing conditions of the BRPS, along with the design of proposed upgrades to service KNUEA development in accordance with the EMP/MSS. Hatch Limited completed an independent BRPS Capacity Assessment, dated September 21, 2018. The report has been added to Appendix C of the FSR.</td></tr>
<tr><td>13</td><td>Engineering Comments - March 1, 2019</td><td>List of Reports - Functional Servicing Report</td><td>B7</td><td>An HGL analysis will be required for the Briar Ridge PS to confirm adequate freeboard during the annual peak wet weather event and the rare peak wet weather event. The peak flow associated with the annual wet weather flow event shall be used to assess the HGL in the sanitary system assuming a catastrophic failure of the station (no pumping at all). The HGL under this situation cannot touch the building envelope (i.e. the underside of footing). The peak flow associated with the rare wet weather flow event shall be used to assess the maximum HGL in the sanitary system under normal pumping station conditions (i.e. station operating at its rated capacity). Under this scenario, the HGL must be at least 0.3m below the underside of footing. The HGL analysis must confirm to the City's Technical Bulletin ISTB-2018-01.</td><td>We will coordinate with City staff related to the ongoing BRPS conditions assessment and upgrade design. A full HGL analysis will be completed for the BRPS sanitary sewer system to support detailed site servicing and grading design, once results are available from the ongoing City assessment and design. The sanitary sewer HGL and overflow will be evaluated in accordance with City of Ottawa Technical Bulletin ISTD-2018-01.</td></tr>
<tr><td>14</td><td>Engineering Comments - March 1, 2019</td><td>List of Reports - Functional Servicing Report</td><td>B8</td><td>It is stated that "population densities that conservatively represent the current population projection were applied to the proposed residential areas." Please provide a table or further justification to support the residential population values that were used to calculate the sanitary peak flow.</td><td>Person per hectare values were determined for singles and townhomes based on sample areas and applied to the site. The person per hectare values are an accurate representation of the expected population in the subdivision and are conservative in nature to account for any possible changes in population at the detailed design stage.<br><table><tr><td></td><td>July 2019 Concept Plan</td><td>Sept 2019 Sanitary Design Sheet</td></tr><tr><td>Kanata North Subdivision Population</td><td>2610</td><td>2726</td></tr></table><br>As shown, the person per hectare values resulted in the sanitary sewer design sheets having a 5% buffer for futue population changes.</td></tr>
<tr><td>15</td><td>Engineering Comments - March 1, 2019</td><td>List of Reports - Functional Servicing Report</td><td>B9</td><td>Please provide preliminary invert/obvert pipe elevations and surface elevations on the sanitary sewer design sheet to provide a better understanding of the proposed depth of cover.</td><td>The preliminary sanitary sewer and surface design elevations are illustrated in Drawing 3 and Appendix C. This information is not typically duplicated in the sewer design sheet, due to the inherent risk for inconsistencies resulting from duplication, along with the additional maintenance required to update this information in two locations when design changes are made. We can produce a separate table to report the depth of cover over sewers, or profile drawings for streets, if that would be helpful to assist with engineering review.</td></tr>
<tr><td>16</td><td>Engineering Comments - March 1, 2019</td><td>List of Reports - Functional Servicing Report</td><td>B10</td><td>Please include a cross section of the Tributary 2 crossing, including the preliminary elevations of the proposed road surface, culvert, sanitary sewer, storm sewer, watermain, clay cap and bedrock along with all relevant offsets.</td><td>A cross section for the Tributary 2 crossing at Street 1 has been included in the Conceptual Grading plan (Drawing No. 1).</td></tr>
<tr><td>17</td><td>Engineering Comments - March 1, 2019</td><td>List of Reports - Functional Servicing Report</td><td>B11</td><td>Please summarize the stormwater criteria that is to be followed at the time of detailed design.</td><td>The quality, quantity and erosion control requirements to be followed during the detailed design are described in the Kanata North Community Pond 3 / Preliminary Stormwater Management Design (JFSA, Sept 2019), provided in Appendix E. The pond is to provide enhanced quality control and to ensure 2 to 100-year post-development peak flows at all key nodes along the main branch on Shirley's Brook are equal to or less than pre-development levels. The pond has not been designed to provide additional erosion control measures above what is proivded by the quality/quantity control targets above.</td></tr>
<tr><td>18</td><td>Engineering Comments - March 1, 2019</td><td>List of Reports - Functional Servicing Report</td><td>B12</td><td>The FSR does not include any information pertaining to the proposed outlet for Pond 3. Please include a cross section of the Pond 3 outlet, including preliminary elevations of the existing road surface (March Valley Road), proposed outlet pipe, water levels in Shirley's Brook and Pond 3.</td><td>The outlet cross section for Pond 3 is illustrated in Figure 7 of the FSR, with details for existing March Valley Road, proposed outlet pipe and water levels in Shirley's Brook and the proposed pond.</td></tr>
<tr><td>19</td><td>Engineering Comments - March 1, 2019</td><td>List of Reports - Functional Servicing Report</td><td>B13</td><td>Section 5.2 does not clearly identify how the major system flow is to cross the abandoned rail corridor from the proposed subdivision to Pond 3.</td><td>The following has been added to Section 5.2 "The existing ditches within the rail corridor will direct the overland flow to the culverts crossing the rail corridor to allow for the overland flow to drain towards Pond 3."</td></tr>
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|---|---|---|---|---|---|
| 20 | Engineering Comments - March 1, 2019 | List of Reports - Functional Servicing Report | B14 | Please provide a letter of permission from CN Rail for the proposed storm and sanitary sewer crossing the rail line. | The rail crossing permit will be pursued once the functional servicing design is accepted for draft plan approval. |
| 21 | Engineering Comments - March 1, 2019 | List of Reports - Functional Servicing Report | B15 | Please provide a letter of permission from Metcalfe Realty for the proposed minor and major system inlet channel to Pond 3, which confirms that an easement will be granted for the full width of the inlet channel including a maintenance buffer. | |
| 22 | Engineering Comments - March 1, 2019 | List of Reports - Functional Servicing Report | B16 | Please provide preliminary invert/obvert pipe elevations and surface elevations on the storm sewer design sheet to provide a better understanding of the proposed depth of cover. | The preliminary storm pipe and surface elevations for the sanitary sewer can be seen in **Drawing 2** and **Appendix D**. This information is not typically duplicated in the sewer design sheet, due to the inherent risk for inconsistencies resulting from duplication, along with the additional maintenance required to update this information in two locations when design changes are made. We can produce a separate table to report the depth of cover over sewers, or profile drawings for streets, if that would be helpful to assist with engineering review. |
| 23 | Engineering Comments - March 1, 2019 | List of Reports - Functional Servicing Report | B17 | The limits of the 3.0m temporary berm are not clear on Figure 6. In addition, the purpose of the 3.0m temporary berm has not been discussed in the report. | The temporary berm has been removed from the revised Pond 3 design. |
| 24 | Engineering Comments - March 1, 2019 | List of Reports - Functional Servicing Report | B18 | A hydrodynamic model of the conceptual design of SWM Pond 3 and connecting storm sewers documented in the MSS is to be completed to support the general pond stage-storage-discharge characteristics, inlet channel configuration, storm trunk sewer network design, and to demonstrate that the hydraulic design and grading plan are compatible to avoid basement flooding, and facilitate subsequent phased build-out in the catchment area of SWM Pond 3. | A hydrodynamic model of the pond and an HGL analysis for the subdivision storm sewer system has been prepared, and the results are presented in the Kanata North Community Pond 3 / Preliminary Stormwater Management Design (JFSA, Sept 2019), provided in **Appendix E**. The findings support the development of the proposed Pond 3 design and the study area's storm sewer network. |
| 25 | Engineering Comments - March 1, 2019 | List of Reports - Functional Servicing Report | B19 | The evaluation and selection of the preferred SWM approach in the Northeast and Southeast quadrants of Kanata North is documented in Figure 6-4 and Table 6-4 of the KN EMP. The preferred SWM approach is described in Section 6.4.3 of the EMP as follows:<br><br>*6.4.3 Northeast / Southeast Quadrants*<br>*The recommended SWM strategy for the KNUEA lands east of March Road is a single SWM facility located adjacent to March Valley Road* <u>*at the eastern limit of Woodlot S23.*</u> *Storm runoff from the KNUEA would be directed to the proposed facility through a pair of open channels on either side of the woodlot. The elevation of the proposed SWM facility will be low enough to accommodate the required sanitary overflow.*<br><br>The westward shift in the proposed location of the SWM Block in the Draft Plan represents a deviation from the location of the preferred SWM facility documented in the KN EMP. If the preferred location of the SWM Block is not consistent with the location documented in the EMP, a similar evaluation process to the one documented in the EMP is to be provided in the second submission justifying the revised location. | Pond 3 has been redesigned to retain as much of the woodlot as possible, based on while still meeting the required water level to accommodate sanitary overflow, and to provide quantity control to avoid peak flow and water level increases in Shirley's Brook. |
| 26 | Engineering Comments - March 1, 2019 | List of Reports - Functional Servicing Report | B20 | Since the EMP & MSS documentation did not anticipate use of an interim pond configuration, there is no formal implementation guideline of the steps necessary to transition from the interim pond configuration to the ultimate pond configuration. The City will require the FSR to document the implementation process leading to the construction of the ultimate SWM Pond and outlet, prior to supporting a SWM Block on the basis of an interim solution. | The revised Pond 3 design is representative of the ultimate design, without phasing or interim pond configuration. |

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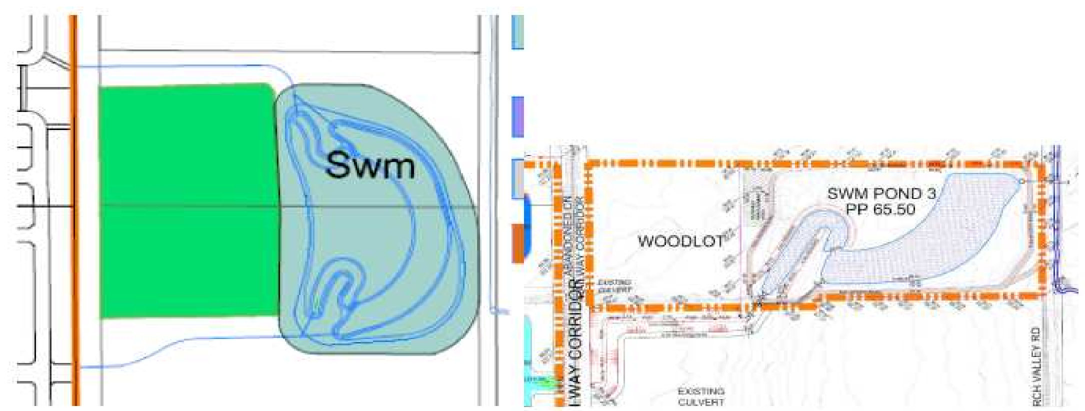
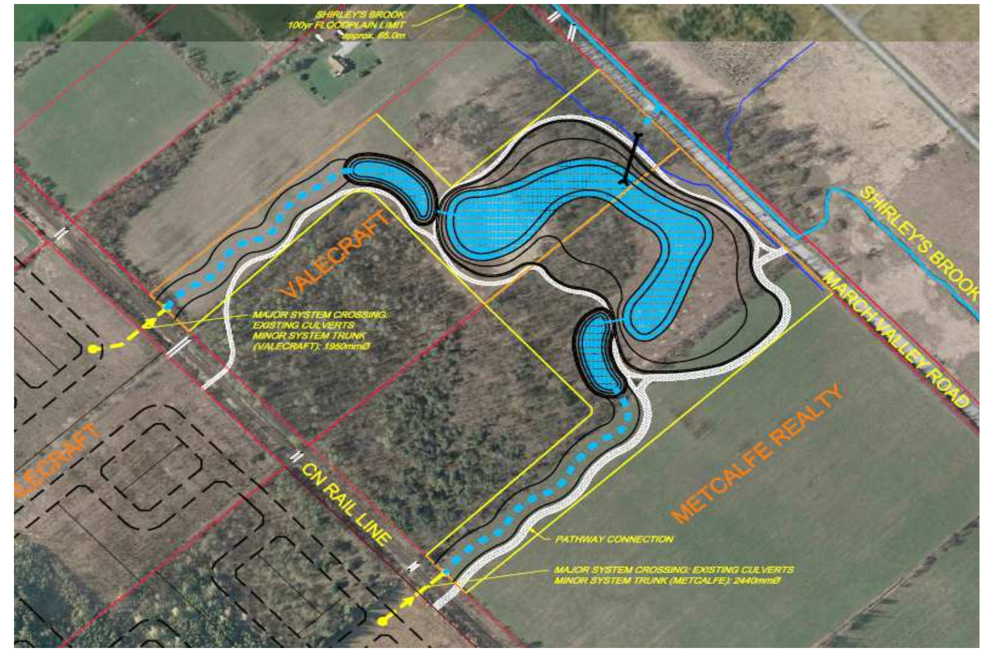
| 27 | Engineering Comments - March 1, 2019 | List of Reports - Functional Servicing Report | B21 | As noted in the comment on page 3 of the June 24, 2016 comments, a revision was made to the EMP to the effect that given the location of SWM Pond 3 in the Shirley's Brook watershed (near its outlet to the Ottawa River), there may in fact be no need to provide conventional post-to-pre quantity controls. Ideally, had there been more time available prior to the EMP proceeding to approval in June/July 2016, the requirement of whether or not quantity control was required would have been documented in the EMP. Such a change could potentially result in a smaller pond footprint (and therefore, revisions to the documentation in Figure 6.4 and Table 6.4). Instead, a text change was made that the decision about whether or not quantity control is required would be deferred to detailed design.<br><br>Because the scope of quantity control requirements will directly influence the size of the SWM Block, it is likely in all Parties interest to make the determination about the scope of quantity control requirements prior to Draft Plan approval (rather than at detailed design, as reflected in the revised EMP text). | Quantity control requirements for Pond 3 have been determined and are summarized in the Kanata North Community Pond 3 / Preliminary Stormwater Management Design (JFSA, Sept 2019), provided in **Appendix E**. Target pond ouflows were determined to ensure 2 to 100-year post-development peak flows at all key nodes along the main branch on Shirley's Brook are equal to or less than pre-development levels. |
| 28 | Engineering Comments - March 1, 2019 | List of Reports - Functional Servicing Report | B22 | Per Section 7.9.2 of the CDP (Core Services Staging), the development staging of the Shirley's Brook Realignment and Outlet for SWM Pond 3 is to occur concurrent with development of lands tributary to SWM Pond 3. The second submission of the FSR needs to provide additional details concerning the scope of work and the coordination between establishing the Pond 3 outlet and the Shirley's Brook realignment works. | The Kanata North Land owners group is advancing the proposal to pursue Shirley's Brook Realignment Aleternatives Option 2, illustrated in EMP Figure 6.5, as the preferred option to accommodate Shirley's Brook and the proposed Kanata North development. This option maitains the current alignment of Shirley's Brook within the March Valley Road right-of-way, via rehabilitation and reinforcement of the existing channel and embankments. |
| 29 | Stormwater Management Unit - March 1, 2019 | Stormwater Management | 1 | The stormwater management facility in the servicing brief is showing a small portion of the ultimate sized pond as identified in the MSS. While the interim pond is sized to service 56 ha in comparison to 181 ha for the ultimate pond, further analysis is required to demonstrate appropriate level of serviceability for the interim and ultimate conditions. It was discussed during the CDP stage that further analysis, including HGL, would be completed prior to draft plan approval.<br><br><br>MSS SWM Facility Servicing report | The revised Pond 3 design is representative of the ultimate deisgn. The HGL analysis is presented in **Appendix E** of the FSR. |

<table>
<tr><td>30</td><td>Stormwater Management Unit - March 1, 2019</td><td>Stormwater Management</td><td>2</td><td>The configuration of Pond 3 in the EMP does not reflect the design brief footprint. In addition, Pond 3 in the design brief does not respect the woodlot boundaries.<br><br></td><td>See Item No. 25.</td></tr>
<tr><td>31</td><td>Stormwater Management Unit - March 1, 2019</td><td>Stormwater Management</td><td>3</td><td>Provide a shorter distance between the sediment management area and the forebay while maintaining the access road between both areas. The forebay should not be surrounded by the 100 year ponding.</td><td>Refer to revised pond configuration illustrated in Figure 7.</td></tr>
<tr><td>32</td><td>Stormwater Management Unit - March 1, 2019</td><td>Stormwater Management</td><td>4</td><td>The access road around the pond should be clearly delineated and not conflict or encroach with the temporary berm.</td><td>The access road is delineated in Figure 7 and the temporary berm has been removed.</td></tr>
<tr><td>33</td><td>Stormwater Management Unit - March 1, 2019</td><td>Stormwater Management</td><td>5</td><td>The proposed channel discharging to Pond 3 will require a better hydraulic design without the 90 degree bend. None of the proposed designs in the MSS and the EMP have a 90 degree bend. In fact the pond extends beyond the woodlot limit. The design in the servicing report needs to be updated to reflect the EMP and MSS designs. In addition, the woodlot will require a buffer zone between the tree line and the channel to ensure no trees will topple over the channel.</td><td>The channel illustrated between the rail corridor and the pond in the EMP and MSS has been replaced by a 3000mm storm sewer.</td></tr>
<tr><td>34</td><td>Stormwater Management Unit - March 1, 2019</td><td>Stormwater Management</td><td>6</td><td>It is also important to note how the ultimate pond will be constructed once the interim pond is in operation. No information has been provide to the timelines of the phasing and who will be expanding to the ultimate pond. The City will require a guarantee from multiple owners to ensure that future works will not impact negatively the operating pond. If there are no assurances of the construction staging, the interim pond will not be assumed by the City. The Owners will have to follow the ECA requirements and insure the level of service until such time the pond operation is assumed. Complete sediment removal is required for the facility and the first section of submerged pipe upstream from the proposed constructed channel connecting to the SWM facility. A cost estimate for the staging of construction should be provided to prevent any unwanted situations for all parties involved. We have seen in previous scenarios with similar designs where the facility was not properly maintained and development was held back until the deficiencies were addressed.</td><td>See Item No. 26.</td></tr>
<tr><td>35</td><td>Stormwater Management Unit - March 1, 2019</td><td>Stormwater Management</td><td>7</td><td>What are the quantity control requirements?</td><td>See Item No. 27.</td></tr>
<tr><td>36</td><td>Stormwater Management Unit - March 1, 2019</td><td>Stormwater Management</td><td>8</td><td>Who will be taking ownership of the tributary block?</td><td></td></tr>
</table>

<table>
<tr><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>37</td><td>Stormwater Management Unit - March 1, 2019</td><td>Stormwater Management</td><td>9</td><td>While LIDs are mentioned in the MSS, no information was provided in the servicing brief. Please elaborate on the existence of LIDs in the development.</td><td>The suitability of LIDs for the proposed development are evaluated in Paterson's Groundwater Infiltration Review memorandum dated June 21, 2019. The recommendations of the memo conclude that "...existing conditions at the subject site currently allow for only minimal volumes of recharge to occur. As such, the applicability of secondary infiltration measures is considered limited for Low Impact Development Measures (LIDs), such as rear yard catch basins and amended topsoil finishes. It should also be noted that previous attempts within the City of Ottawa to induce additional surface water infiltration in similarly low permeability soils have resulted in detrimental effects to both homeowners and their properties due to poorly maintained drainage systems."<br><br>McKinley Environmental Solutions' Low Impact Development Measures memorandum dated June 20, 2019 also avaluates the suitablility of LIDs. The recommendations of the memo concluded that ".... infiltration features (e.g. surface infiltration swales, ditches, etc.), may increase the likelihood that Black Legged Ticks will enter residential yards, particularly where those properties occur close to retained natural areas... Similarly, it is likely that such features will directly provide breeding habitat for mosquitos. The increased presence of Black Legged Ticks and/or mosquitos may have a detrimental effect on future homeowners and the community. It should be noted that infiltration features generally do not provide significant wildlife habitat values. Given their limited potential value to wildlife, coupled with their potential detrimental effects in terms of increasing the incidence of Black Legged Ticks and mosquitos, it is our professional opinion that the installation of infiltration features within the proposed development is unlikely to be beneficial to the natural features and functions of the Study Area. "</td></tr>
<tr><td>38</td><td>Stormwater Management Unit - March 1, 2019</td><td>Stormwater Management</td><td>10</td><td>Is the conceptual grading plan showing the potential grade raise for the subdivision? We would like to avoid submerged pipes and the potential of the channel to be used as extended TSS treatment.</td><td>The Conceptual Grading Plan (Drawing No. 1) does illustrate the proposed cut or fill depth between the centerline of road and the existing ground surface.<br>The proposed 3000mm storm sewer between the subdivision and pond will have standing water. Subdivision storm sewers upstream of MH 97, at the bottom of the subdivison storm sewer system, will not have standing water (sewer invert = 65.26; normal water level in pond = 64.80).</td></tr>
<tr><td>39</td><td>Stormwater Management Unit - March 1, 2019</td><td>Stormwater Management</td><td>11</td><td>Provide the following elevations for Pond 3 (we will require the extended detention as well), Shirley's Brook, the proposed channel and the tributary:<br><br>a. NWL<br>b. 2 year<br>c. 5 year<br>d. 10 year<br>e. 25 year<br>f. 100 year</td><td>Pond 3 elevations can be found within the Kanata North Community Pond 3 / Preliminary Stormwater Management Design (JFSA, Sept 2019), provided in Appendix E. The waterlevels for Shirley's Brook near the proposed Pond 3 outlet can be seen below. The channel is no longer being proposed, and the study area is not proposed to contribute any flows to the tributary.<br><br><table><tr><th>Station</th><th>Event</th><th>Water Level (m)</th></tr><tr><td>2199.535</td><td>2-Year</td><td>64.977</td></tr><tr><td>2199.535</td><td>5-Year</td><td>65.064</td></tr><tr><td>2199.535</td><td>10-Year</td><td>65.133</td></tr><tr><td>2199.535</td><td>25-Year</td><td>65.214</td></tr><tr><td>2199.535</td><td>50-Year</td><td>65.263</td></tr><tr><td>2199.535</td><td>100-Year</td><td>65.283</td></tr><tr><td>2199.535</td><td>Jul-79</td><td>65.323</td></tr></table></td></tr>
</table>

# Appendix B

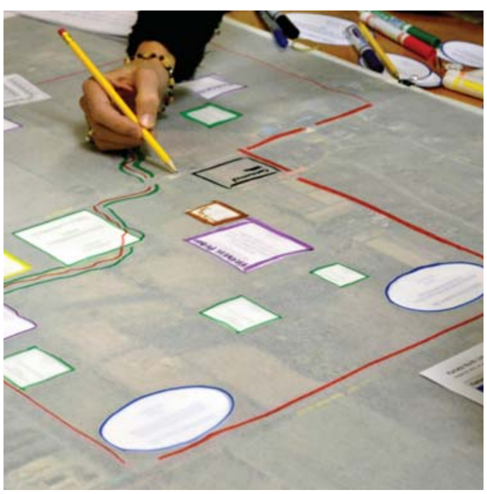
**Excerpts from Supporting Documents:**

- **Kanata North MSS (Novatech, June 2016)**
- **Infrastructure Master Plan (City of Ottawa, 2013)**
- **Development Charges Background Study (City of Ottawa, 2014)**

# KANATA NORTH
## COMMUNITY DESIGN PLAN

MASTER SERVICING STUDY REPORT

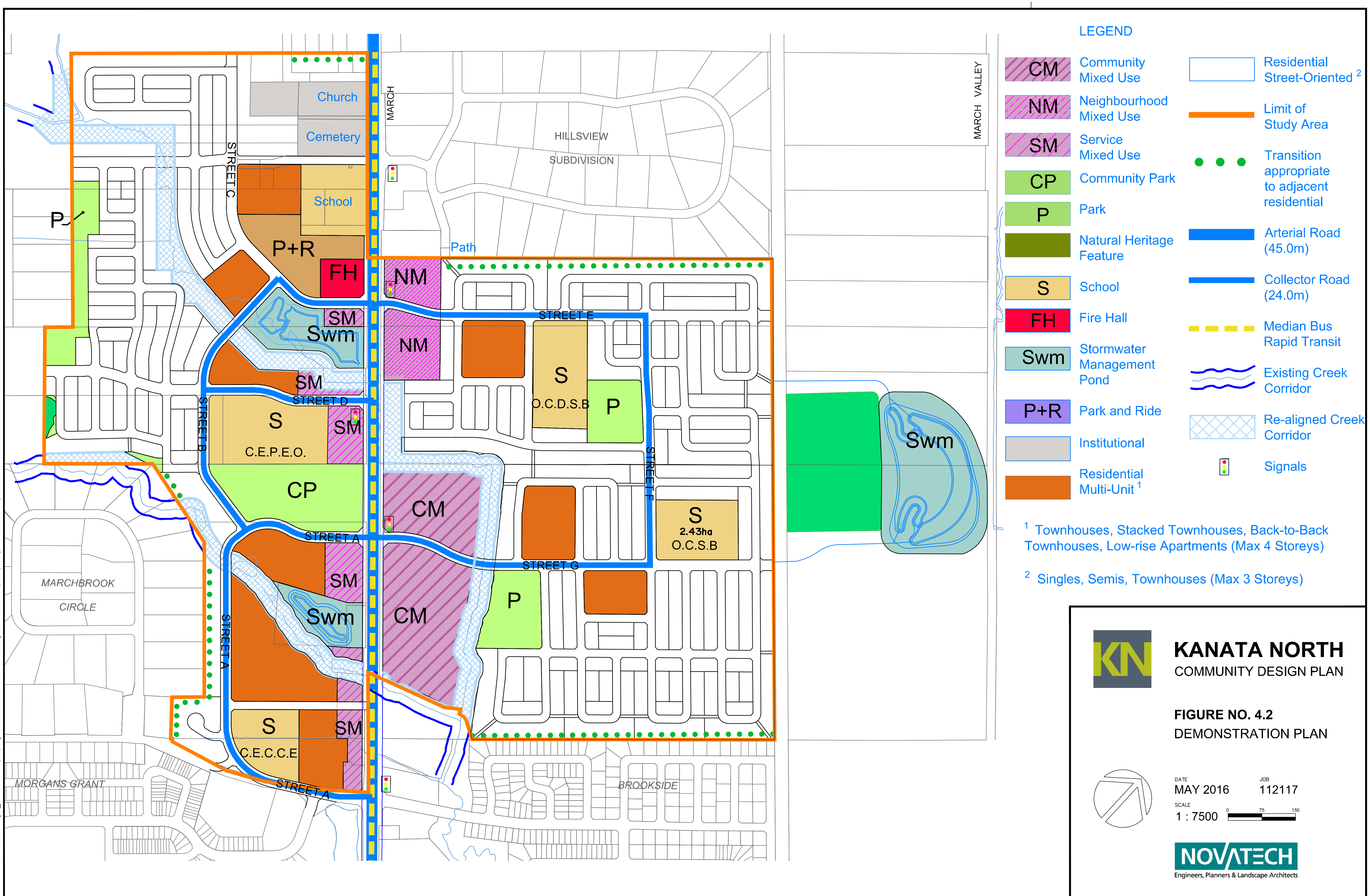





FINAL
JUNE 28, 2016

Ottawa

NOVATECH
Engineers, Planners & Landscape Architects




M:\2012\112117\CAD\Design_EMP\MEMO (CS)\Figure 9.1 Demonstration Plan.dwg, DEMO PLAN (MSS), May 26, 2016 - 3:56pm, tbrooks

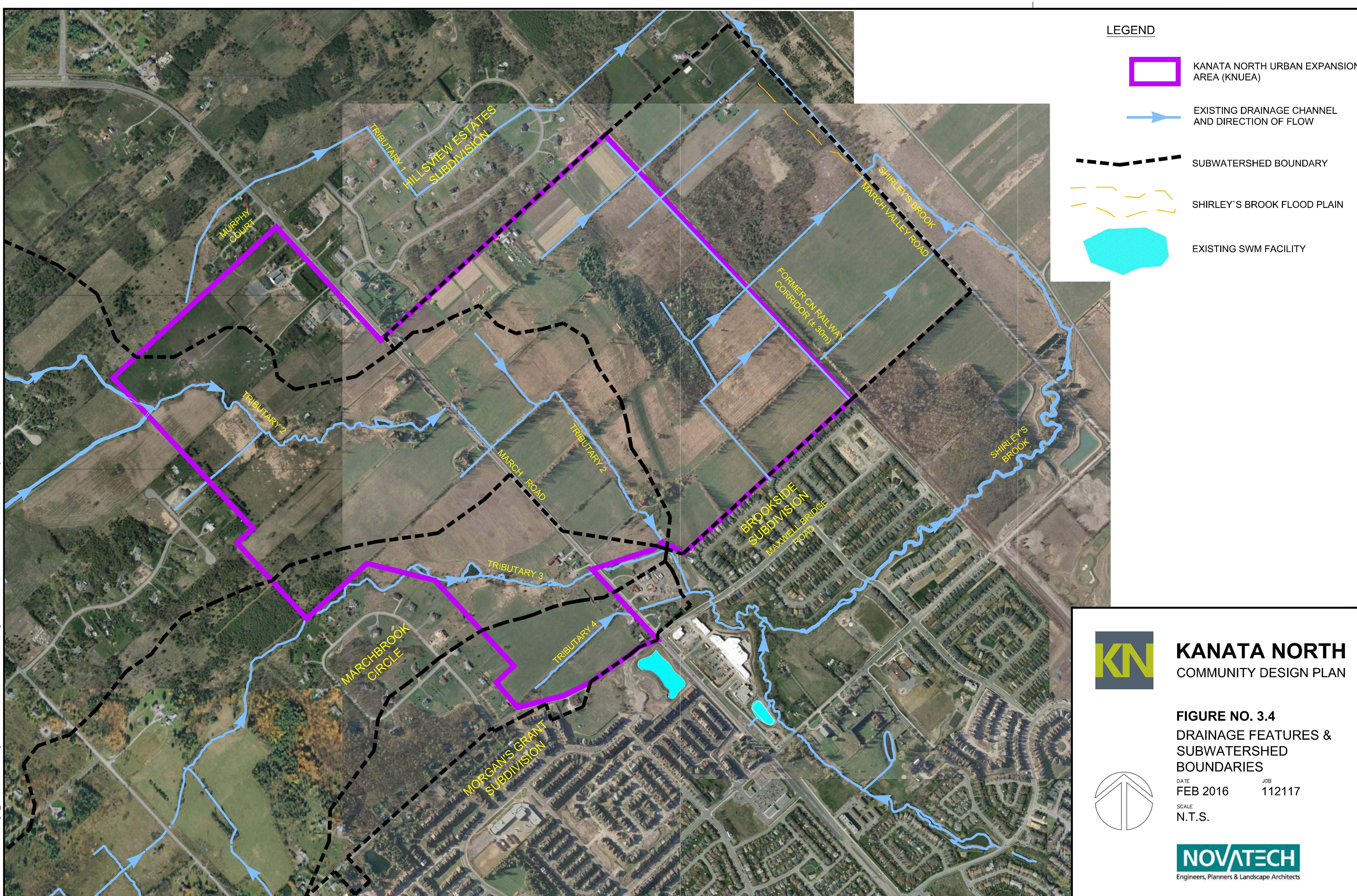
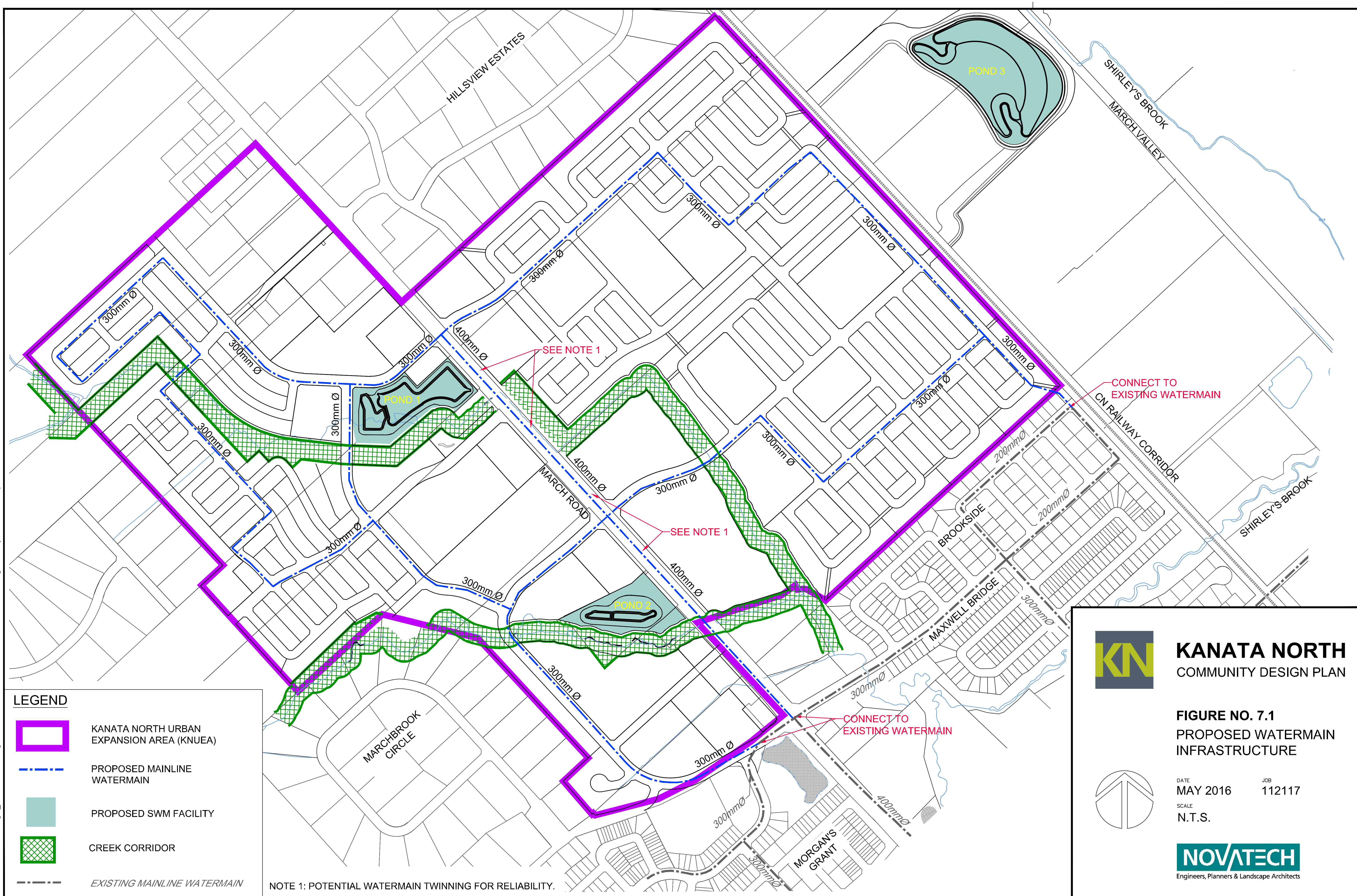


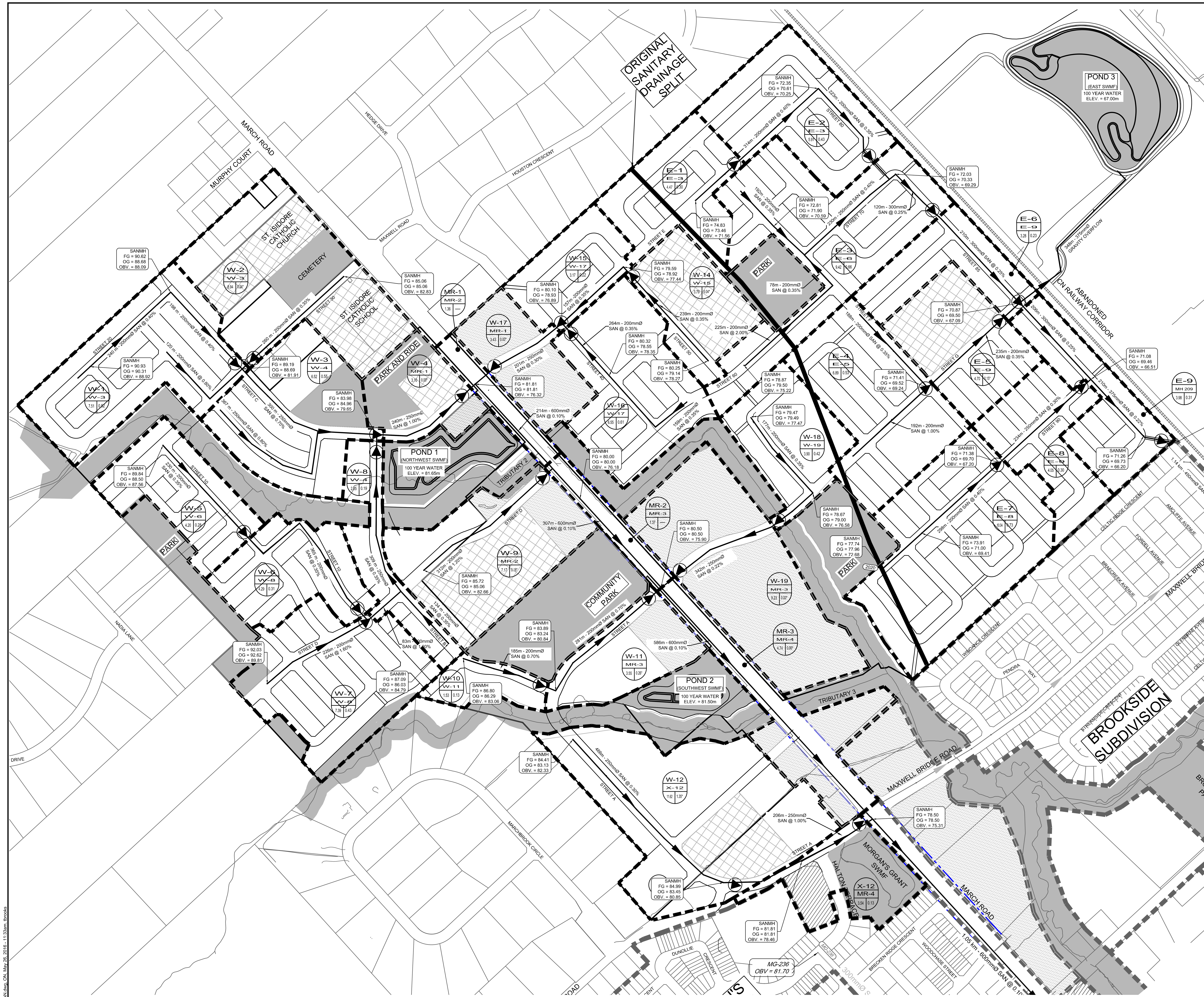

FIGURE NO. 3.4
DRAINAGE FEATURES & SUBWATERSHED BOUNDARIES

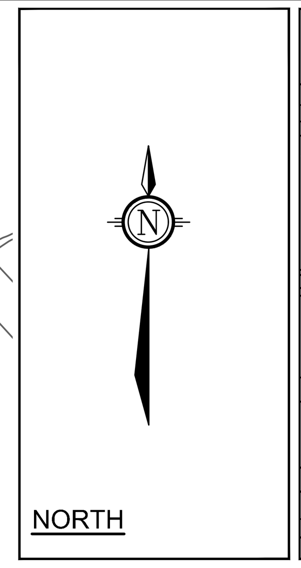
M:\2012\112117\CAD\Design_MSS\FIGURES\Figure 3.4 - DRAINAGE FEATURES.dwg, DRAINAGE FEAT, Feb 23, 2016 - 11:38am, lseely

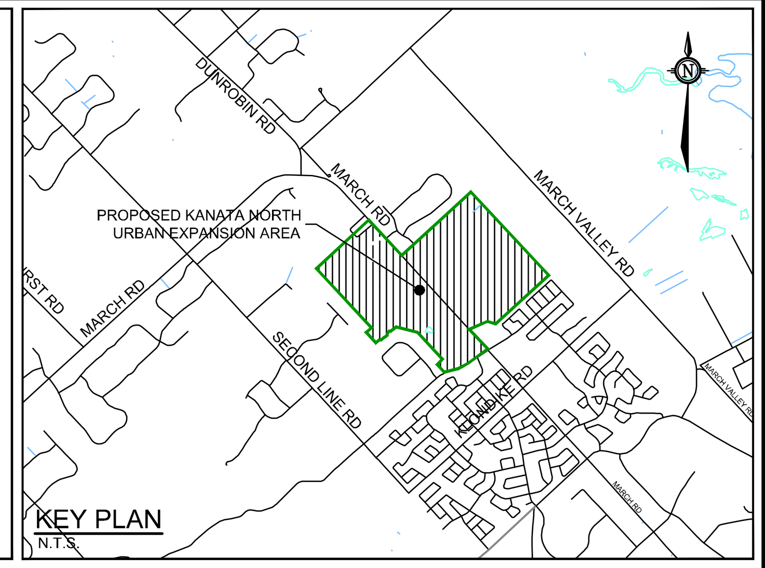



M:\2012\112117\CAD\Design_MSS\FIGURES\Figure 7.1 -PROP WATERMAIN INFRASTRUCTURE.dwg, 7.1, May 18, 2016 - 4:04pm, mhrehoriak

SHT11x17.DWG - 279mmx432mm








## LEGEND

E-2 — AREA ID
E-3 — OUTLET AREA
3.13 | 0.19 — EQUIVALENT POPULATION (THOUSANDS)
*PLUS ADDITIONAL NON-RESIDENTIAL FLOW
AREA IN HECTARES

PROPOSED DRAINAGE AREA

EXISTING DRAINAGE AREA

FLOW OUTLET

SANMH 106 — SAN ID
FG = 72.52 — PRELIMINARY FINISHED GROUND ELEVATION
OG = 69.52 — ORIGINAL GROUND ELEVATION
OBV. = 68.22 — PRELIMINARY OBVERT ELEVATION

PROPOSED SANITARY SEWER & FLOW DIRECTION

EXISING SANITARY SEWER & FLOW DIRECTION

LANDS TO BE SERVICED AND NOT PART OF STUDY AREA

LANDS WHICH DO NOT GENERATE SANITARY FLOWS

INSTIUTIONAL LANDS

COMMERCIAL LANDS

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 DRAFT MASTER SERVICING STUDY | MAY 20/16 | JLS |
| 2. | ISSUED WITH DRAFT MASTER SERVICING STUDY | APR 4/16 | JLS |
| 1. | ISSUED WITH DRAFT MASTER SERVICING STUDY | FEB 26/16 | JLS |

SCALE
1:3000
1:3000
0 30 60 90 120

DESIGN ARM / TB
CHECKED ARM
DRAWN TB
CHECKED CJR
APPROVED JLS

**FOR REVIEW ONLY**

NOVATECH
Engineers, Planners & Landscape Architects
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Website www.novatech-eng.com

LOCATION
KANATA NORTH URBAN EXPANSION AREA
COMMUNITY DESIGN PLAN

DRAWING NAME
ONSITE SANITARY
DRAINAGE AREA PLAN

PROJECT No. 112117-04
REV REV # 3
DRAWING No. 112117-SAN1

PLAN81.DWG - 1000mmx707mm

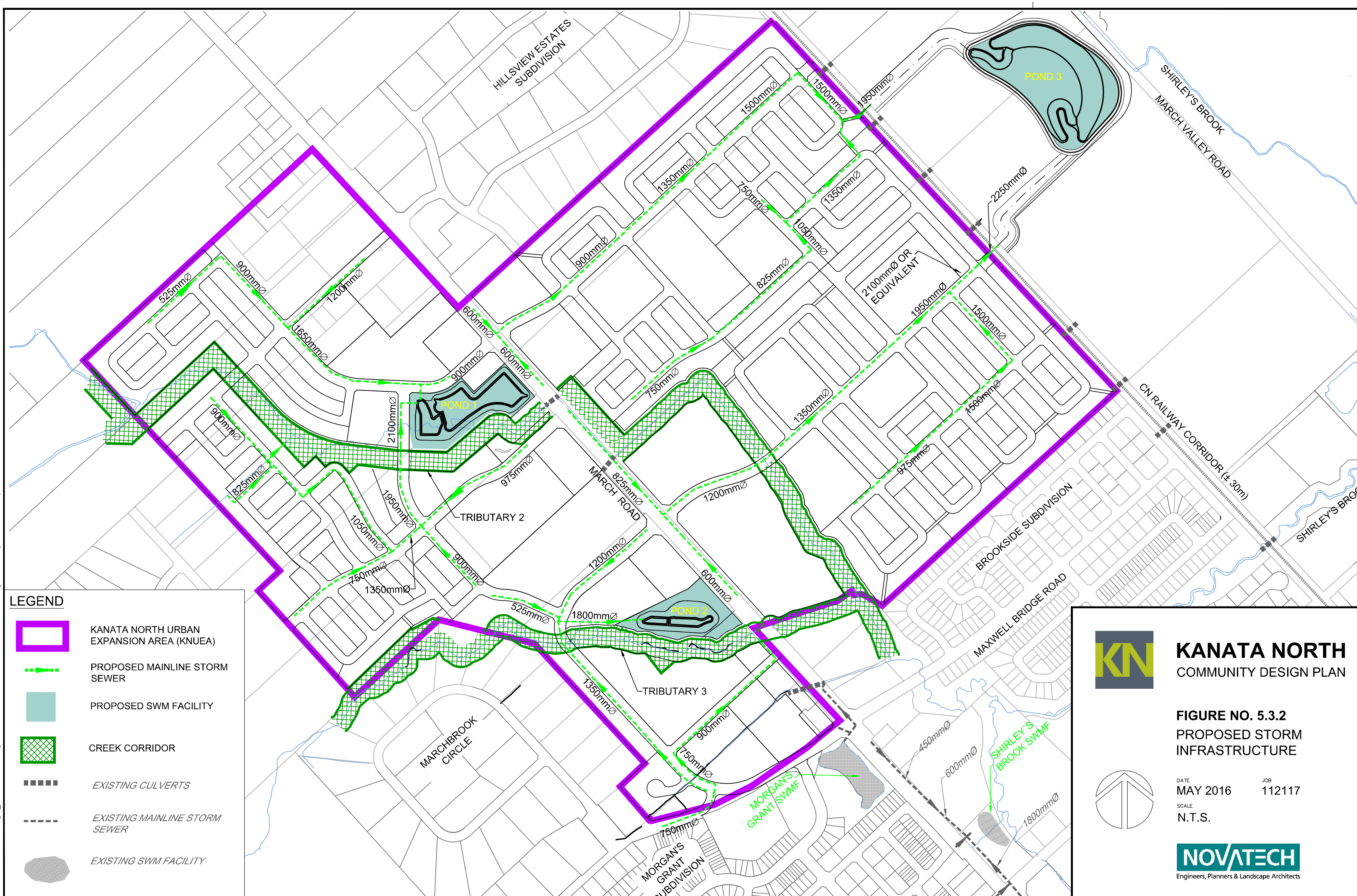
M:\2012\112117\CAD\Design_MSS\112117-SAN.dwg, ON, May 26, 2016 - 11:33am, tbrooks

**KANATA NORTH URBAN EXPANSION AREA**
**COMMUNITY DESIGN PLAN**

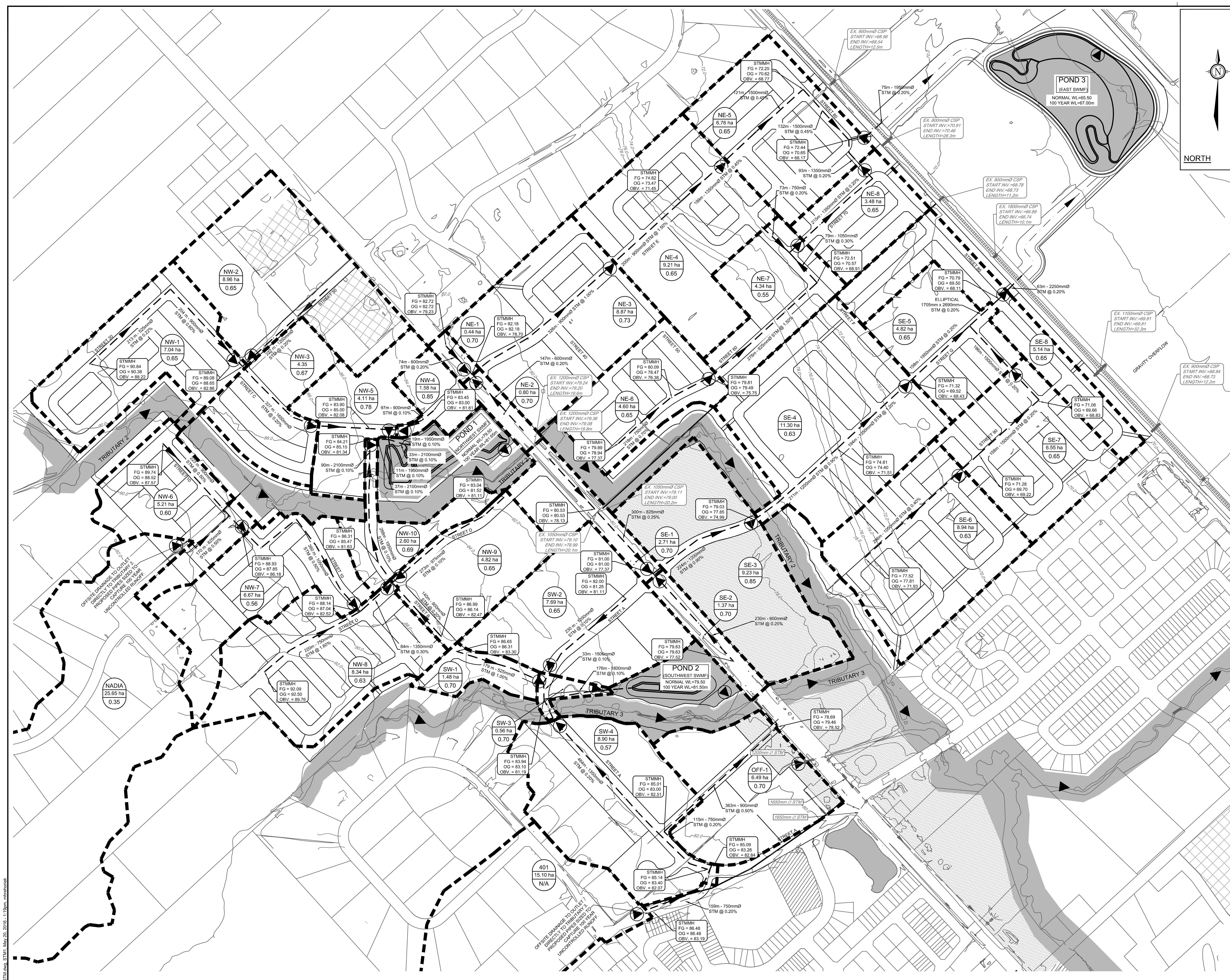
TABLE C-6b:
SANITARY SEWER DESIGN SHEET

NOVATECH
Engineers, Planners & Landscape Architects

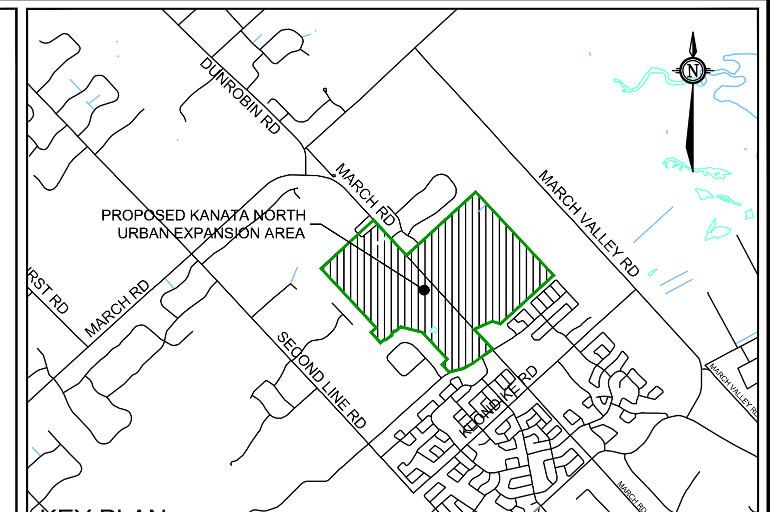
| LOCATION | | | | RESIDENTIAL AREA AND POPULATION | | | | | | | | | | ICI | | | | | | | | INFILTRATION | | | | FLOW | PIPE | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | Cumulative | | | | | IND | | | COMM | | INST | | | | | | | | | | | | | |
| Street | From Node | To Node | Total Area (ha) | Dwellings SFH 3.4 pers/ea | SD/TH 2.7 pers/ea | Density (Net ha) Low[3] 101 pers/ha | High[4] 161 per/ha | Pop. | Residential Area (ha) | Pop. New | Exist | Peak Factor | Peak Flow (l/s) | Area (ha) | Accu. Area (ha) | Peak Factor | Area (ha) | Accu. Area (ha) | Area (ha) | Accu. Area (ha) | Peak Flow (l/s) | Total Area (ha) | Accu. Area New (ha) | Exist | Infiltration Flow (l/s) | Total Flow (l/s) | Dia Act (mm) | Dia Nom (mm) | Slope (%) | Velocity (Full) (m/s) | Capacity (Full) (l/s) | Ratio Q/Qfull (%) |
| **EAST KNCDP** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| E-1 | E-1 | E-3 | 4.47 | | | 3.00 | | 303.0 | 3.00 | **303** | | 4.00 | 4.9 | | | | | | | | 0.0 | 4.47 | 4.47 | | 1.3 | 6.2 | 203 | 200 | 0.40 | 0.67 | 21.6 | 28% |
| E-2 | E-2 | E-3 | 5.91 | | | 4.29 | | 433.3 | 7.29 | **736** | | 3.88 | 11.6 | | | | | | | | 0.0 | 5.91 | 10.38 | | 2.9 | 14.5 | 203 | 200 | 0.35 | 0.62 | 20.2 | 72% |
| E-3 | E-3 | E-6 | 9.42 | | | 6.51 | | 657.5 | 13.80 | **1394** | | 3.70 | 20.9 | | | | | | | | 0.0 | 9.42 | 19.80 | | 5.5 | 26.4 | 254 | 250 | 0.40 | 0.77 | 39.2 | 67% |
| E-4 | E-4 | E-5 | 6.89 | | | 3.12 | 1.36 | 534.1 | 3.12 | **534** | | 3.96 | 8.6 | | | | | | | | 0.0 | 6.89 | 6.89 | | 1.9 | 10.5 | 203 | 200 | 1.00 | 1.05 | 34.2 | 31% |
| E-5 | E-5 | E-9 | 4.70 | | | 1.46 | | 147.5 | 4.58 | **682** | | 3.90 | 10.8 | | | | | | **2.29** | 2.29 | 2.0 | 4.70 | 11.59 | | 3.2 | 16.0 | 203 | 200 | 0.35 | 0.62 | 20.2 | 79% |
| E-6 | E-6 | E-9 | 3.28 | | | 2.32 | | 234.3 | 16.12 | **1628** | | 3.65 | 24.1 | | | | | | | | 0.0 | 3.28 | 23.08 | | 6.5 | 30.6 | 305 | 300 | 0.25 | 0.69 | 50.4 | 61% |
| E-7 | E-7 | E-8 | 10.04 | | | 7.21 | | 728.2 | 7.21 | **728** | | 3.88 | 11.5 | | | | | | | | 0.0 | 10.04 | 10.04 | | 2.8 | 14.3 | 203 | 200 | 0.40 | 0.67 | 21.6 | 66% |
| E-8 | E-8 | E-9 | 4.05 | | | 2.94 | | 296.9 | 10.15 | **1025** | | 3.79 | 15.8 | | | | | | | | 0.0 | 4.05 | 14.09 | | 3.9 | 19.7 | 254 | 250 | 0.30 | 0.67 | 33.9 | 58% |
| E-9 | E-9 | MH 209 | 3.98 | | | 3.06 | | 309.1 | 33.91 | **3644** | | 3.37 | 49.7 | | | | | | | 2.29 | 2.0 | 3.98 | 52.74 | | 14.8 | 66.5 | 381 | 375 | 0.22 | 0.75 | 85.7 | 78% |
| **Total Flows From East KNUEA** | | | **52.74** | | | | | **3644** | **33.91** | **3644** | | **3.37** | **49.7** | | | | | | | **2.29** | **1.99** | | **52.74** | | **14.77** | **66.49** | | | | | | |
| *X-1 (Brookside Subdivision)** | | *MH 209* | *32.80* | | | | | *2216.1* | *26.04* | | *2216* | *3.55* | *18.2* | | | | *6.76* | *6.76* | | | *2.3* | *32.80* | | *32.80* | *11.5* | *32.0* | | | | | | |
| | | | | *Population from Novatech #103106 Sanitary Sewer Design Sheet | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | *MH 209* | *MH 208* | | | | | | *0.0* | *59.95* | **3644** | *2216* | *3.18* | *63.3* | | | | | *6.76* | | *2.29* | *7.9* | *0.00* | **52.74** | *32.80* | *26.2* | *97.4* | 457 | 450 | 0.20 | 0.81 | 132.9 | 73% |
| | *MH 208* | *MH 207* | | | | | | *0.0* | *59.95* | **3644** | *2216* | *3.18* | *63.3* | | | | | *6.76* | | *2.29* | *7.9* | *0.00* | **52.74** | *32.80* | *26.2* | *97.4* | 457 | 450 | 0.20 | 0.81 | 132.9 | 73% |
| *X-2 (Brookside Subdivision)* | *MH 207* | *MH 206* | *3.12* | | *44* | | | *118.8* | *63.07* | **3644** | *2335* | *3.17* | *64.0* | | | | | *6.76* | | *2.29* | *7.9* | *3.12* | **52.74** | *35.92* | *27.3* | *99.2* | *457* | *450* | *0.20* | *0.81* | *132.9* | *75%* |
| *X-3 (Brookside Subdivision)*** | *MH 206* | *MH 205* | *9.81* | | *244* | | | *658.8* | *72.88* | **3644** | *2994* | *3.13* | *67.9* | | | | | *6.76* | | *2.29* | *7.9* | *9.81* | **52.74** | *45.73* | *30.8* | *106.5* | *457* | *450* | *0.21* | *0.83* | *136.2* | *78%* |
| | | | | **244 TH units = 107 Units from Novatech #103106 Sanitary Sewer Design Sheet, plus future 137 units North of Klondike and West of Marconi (5.67ha @ 65pers/ha) | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| X-13 (Future Industrial Lands) | Future | *MH 205* | 20.99 | | | | | | | | | | | 15.85 | 15.85 | 3.6 | | | | | 13.2 | 20.99 | **20.99** | | 5.9 | 19.1 | | | | | | |
| *Briar Ridge Pump Station Access Road* | *MH 205* | *MH 204* | | | | | | | *72.88* | **3644** | *2994* | *3.13* | *67.9* | | *15.85* | *3.6* | | *6.76* | | *2.29* | *21.1* | *0.00* | **73.73** | *45.73* | *36.6* | *125.6* | *457* | *450* | *0.20* | *0.81* | *132.9* | *94%* |
| *Briar Ridge Pump Station Access Road* | *MH 204* | *MH 203* | | | | | | | *72.88* | **3644** | *2994* | *3.13* | *67.9* | | *15.85* | *3.6* | | *6.76* | | *2.29* | *21.1* | *0.00* | **73.73** | *45.73* | *36.6* | *125.6* | *457* | *450* | *0.20* | *0.81* | *132.9* | *94%* |
| *Briar Ridge Pump Station Access Road* | *MH 203* | *MH 202* | | | | | | | *72.88* | **3644** | *2994* | *3.13* | *67.9* | | *15.85* | *3.6* | | *6.76* | | *2.29* | *21.1* | *0.00* | **73.73** | *45.73* | *36.6* | *125.6* | *457* | *450* | *0.25* | *0.91* | *148.6* | *85%* |
| *Briar Ridge Pump Station Access Road* | *MH 202* | *MH 201A* | | | | | | | *72.88* | **3644** | *2994* | *3.13* | *67.9* | | *15.85* | *3.6* | | *6.76* | | *2.29* | *21.1* | *0.00* | **73.73** | *45.73* | *36.6* | *125.6* | *457* | *450* | *0.26* | *0.92* | *151.6* | *83%* |
| *Briar Ridge Pump Station Access Road* | *MH 201A* | *MH 201* | | | | | | | *72.88* | **3644** | *2994* | *3.13* | *67.9* | | *15.85* | *3.6* | | *6.76* | | *2.29* | *21.1* | *0.00* | **73.73** | *45.73* | *36.6* | *125.6* | *457* | *450* | *0.25* | *0.91* | *148.6* | *85%* |
| *Briar Ridge Pump Station Access Road* | *MH 201* | *MH 200* | | | | | | | *72.88* | **3644** | *2994* | *3.13* | *67.9* | | *15.85* | *3.6* | | *6.76* | | *2.29* | *21.1* | *0.00* | **73.73** | *45.73* | *36.6* | *125.6* | *457* | *450* | *0.25* | *0.91* | *148.6* | *85%* |
| *Briar Ridge Pump Station Access Road* | *MH 200* | *EXMH1* | | | | | | | *72.88* | **3644** | *2994* | *3.13* | *67.9* | | *15.85* | *3.6* | | *6.76* | | *2.29* | *21.1* | *0.00* | **73.73** | *45.73* | *36.6* | *125.6* | *457* | *450* | *0.23* | *0.87* | *142.5* | *88%* |
| **RIDDELL VILLAGE (X-4)***** | | *EXMH1* | *42.42* | | | | | *3100* | | | *3100* | *3.43* | *24.6* | | | | | | *2.96* | *2.96* | *1.0* | *42.42* | | *42.42* | *14.8* | *40.5* | | | | | | |
| | | | | ***Population from Novatech #103106 Sanitary Sewer Design Sheet | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | *EXMH1* | *EXMH2* | | | | | | | *72.88* | **3644** | *6094* | *2.97* | *85.6* | | *15.85* | *3.6* | | *6.76* | | *5.25* | *23.6* | *0.00* | **73.73** | *88.15* | *51.5* | *160.8* | *457* | *450* | *0.30* | *0.99* | *162.8* | *99%* |
| | *EXMH2* | *EXMH4* | | | | | | | *72.88* | **3644** | *6094* | *2.97* | *85.6* | | *15.85* | *3.6* | | *6.76* | | *5.25* | *23.6* | *0.00* | **73.73** | *88.15* | *51.5* | *160.8* | *457* | *450* | *0.30* | *0.99* | *162.8* | *99%* |
| X-14 (Future Industrial Lands east of Marshes Golf Course) | *EXMH4* | *EXMH5* | 19.23 | | | | | | *72.88* | **3644** | *6094* | *2.97* | *85.6* | *19.23* | *35.08* | *3.1* | | *6.76* | | *5.25* | *35.6* | *19.23* | **92.96** | *88.15* | *56.9* | *178.1* | *457* | *450* | *0.44* | *1.20* | *197.2* | *90%* |
| | *EXMH5* | *PS* | | | | | | | *72.88* | **3644** | *6094* | *2.97* | *85.6* | | *35.08* | *3.1* | | *6.76* | | *5.25* | *35.6* | *0.00* | **92.96** | *88.15* | *56.9* | *178.1* | *457* | *450* | *0.40* | *1.14* | *188.0* | *95%* |
| **Briar Ridge Pump Station** | | | | | | | | | 72.88 | **3644** | *6094* | 2.97 | 85.6 | | 35.08 | 3.1 | | *6.76* | | 5.25 | 35.6 | 0.00 | **92.96** | *88.15* | 56.9 | 178.1 | | | | | | |
| **WEST KNUEA / MARCH ROAD** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| W-1 | W-1 | W-3 | 7.51 | | | 5.14 | | 519.1 | 5.14 | **519** | | 3.97 | 8.3 | | | | | | | | 0.0 | 7.51 | 7.51 | | 2.1 | 10.4 | 203 | 200 | 0.40 | 0.67 | 21.6 | 48% |
| | | | | | | | | | | | | | 0.0 | | | | | | | | | | | | | | | | | | | |
| W-2 | W-2 | W-3 | 8.94 | | | 2.36 | | 238.4 | 2.36 | **238** | | 4.00 | 3.9 | | | | | | **4.32** | 4.32 | 3.8 | 8.94 | 8.94 | | 2.5 | 10.1 | 203 | 200 | 0.35 | 0.62 | 20.2 | 50% |
| | | | | | | | | | | | | | 0.0 | | | | | | | | | | | | | | | | | | | |
| W-3 | W-3 | W-4 | 6.52 | | | 1.97 | 2.16 | 546.7 | 11.63 | **1304** | | 3.72 | 19.7 | | | | | | | | 0.0 | 6.52 | 22.97 | | 6.4 | 26.1 | 254 | 250 | 0.70 | 1.02 | 51.9 | 50% |
| W-5 | W-5 | W-6 | 4.20 | | | 2.74 | | 276.7 | 2.74 | **277** | | 4.00 | 4.5 | | | | | | | | 0.0 | 4.20 | 4.20 | | 1.2 | 5.7 | 203 | 200 | 0.35 | 0.62 | 20.2 | 28% |
| W-6 | W-6 | W-8 | 4.29 | | | 3.04 | | 307.0 | 5.78 | **584** | | 3.94 | 9.3 | | | | | | | | 0.0 | 4.29 | 8.49 | | 2.4 | 11.7 | 203 | 200 | 0.35 | 0.62 | 20.2 | 58% |
| | | | | | | | | | | | | | 0.0 | | | | | | | | | | | | | | | | | | | |
| W-7 | W-7 | W-8 | 7.39 | | | 4.24 | | 428.2 | 4.24 | **428** | | 4.00 | 6.9 | | | | | | | | 0.0 | 7.39 | 7.39 | | 2.1 | 9.0 | 203 | 200 | 1.60 | 1.33 | 43.2 | 21% |
| W-8 | W-8 | W-9 | 2.85 | | | 1.02 | 0.55 | 191.6 | 11.59 | **1204** | | 3.75 | 18.3 | | | | | | | | 0.0 | 2.85 | 18.73 | | 5.2 | 23.5 | 254 | 250 | 0.35 | 0.72 | 36.7 | 64% |
| W-4 | W-4 | MR-1 | 3.10 | | | | | 0.0 | 23.22 | **2508** | | 3.51 | 35.6 | | | | **0.35** | 0.35 | **0.83** | 5.15 | 4.8 | 3.10 | 26.07 | | 7.3 | 47.7 | 254 | 250 | 1.00 | 1.22 | 62.0 | 77% |
| | | | | | | | | | | | | | 0.0 | | | | | | | | | | | | | | | | | | | |
| W-14 | W-14 | W-15 | 3.79 | | | 0.36 | | 36.4 | 0.36 | **36** | | 4.00 | 0.6 | | | | | | **2.89** | 2.89 | 2.5 | 3.79 | 3.79 | | 1.1 | 4.2 | 203 | 200 | 0.35 | 0.62 | 20.2 | 21% |
| W-15 | W-15 | W-17 | 3.17 | | | 2.20 | | 222.2 | 2.56 | **259** | | 4.00 | 4.2 | | | | | | | | 0.0 | 3.17 | 6.96 | | 1.9 | 6.1 | 203 | 200 | 0.35 | 0.62 | 20.2 | 30% |



KANATA NORTH
COMMUNITY DESIGN PLAN
FIGURE NO. 5.3.2
PROPOSED STORM INFRASTRUCTURE
DATE MAY 2016
JOB 112117
SCALE N.T.S.
NOVATECH
Engineers, Planners & Landscape Architects
LEGEND
KANATA NORTH URBAN EXPANSION AREA (KNUEA)
PROPOSED MAINLINE STORM SEWER
PROPOSED SWM FACILITY
CREEK CORRIDOR
EXISTING CULVERTS
EXISTING MAINLINE STORM SEWER
EXISTING SWM FACILITY
HILLSVIEW ESTATES SUBDIVISION
POND 1
POND 2
POND 3
MARCH ROAD
TRIBUTARY 2
TRIBUTARY 3
SHIRLEY'S BROOK
MARCH VALLEY ROAD
CN RAILWAY CORRIDOR (± 30m)
BROOKSIDE SUBDIVISION
MAXWELL BRIDGE ROAD
MARCHBROOK CIRCLE
MORGAN'S GRANT SUBDIVISION
MORGAN'S GRANT SWMF
SHIRLEY'S BROOK SWMF
2100mmØ OR EQUIVALENT
1950mmØ
1500mmØ
1350mmØ
2250mmØ
1050mmØ
900mmØ
825mmØ
750mmØ
600mmØ
525mmØ
1200mmØ
1650mmØ
2100mmØ
975mmØ
1800mmØ
450mmØ




NORTH




KEY PLAN
N.T.S.

## LEGEND

- A-10 — AREA ID
- 1.14 ha — AREA IN HECTARES
- 0.40 — RUNOFF COEFFICIENT
- DRAINAGE AREA
- DRAINAGE AREA OUTLET
- STMMH — STM ID
- FG = 71.69 — FINISHED GROUND ELEVATION
- OG = 69.52 — ORIGINAL GROUND ELEVATION
- OBV. = 68.22 — OBVERT ELEVATION
- CREEK CORRIDOR
- PROPOSED OUTLET DITCH
- PROPOSED STORM SEWER & FLOW DIRECTION
- *EXISTING STORM SEWER & FLOW DIRECTION*

**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 DRAFT MASTER SERVICING STUDY | MAY 20/16 | JLS |
| 2. | ISSUED WITH DRAFT MASTER SERVICING STUDY | APR 4/16 | JLS |
| 1. | ISSUED WITH DRAFT MASTER SERVICING STUDY | FEB 26/16 | JLS |

SCALE 1:3000

1:3000
0 30 60 90 120

DESIGN ARM / TB
CHECKED ARM
DRAWN TB
CHECKED CJR
APPROVED JLS

**FOR REVIEW ONLY**

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Facsimile (613) 254-5867
Website www.novatech-eng.com

LOCATION
KANATA NORTH URBAN EXPANSION AREA
COMMUNITY DESIGN PLAN

DRAWING NAME
STORM DRAINAGE AREA PLAN
MINOR SYSTEM DRAINAGE

PROJECT No. 112117-04
REV REV # 3
DRAWING No. 112117-STM1

PLANB1.DWG - 1000mmx707mm


M:\2012\112117\CAD\Design_MSS\112117 - PRELIM GR.dwg, PRELIM GR, May 18, 2016 - 4:04pm, Brooks

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 DRAFT MASTER SERVICING STUDY | MAY 20/16 | JLS |
| 2. | ISSUED WITH DRAFT MASTER SERVICING STUDY | APR 4/16 | JLS |
| 1. | ISSUED WITH DRAFT MASTER SERVICING STUDY | FEB 26/16 | JLS |

SCALE 1:3000

1:3000
0 30 60 90 120

DESIGN: ARM / TB
CHECKED: ARM
DRAWN: TB
CHECKED: CJR
APPROVED: JLS

**FOR REVIEW ONLY**

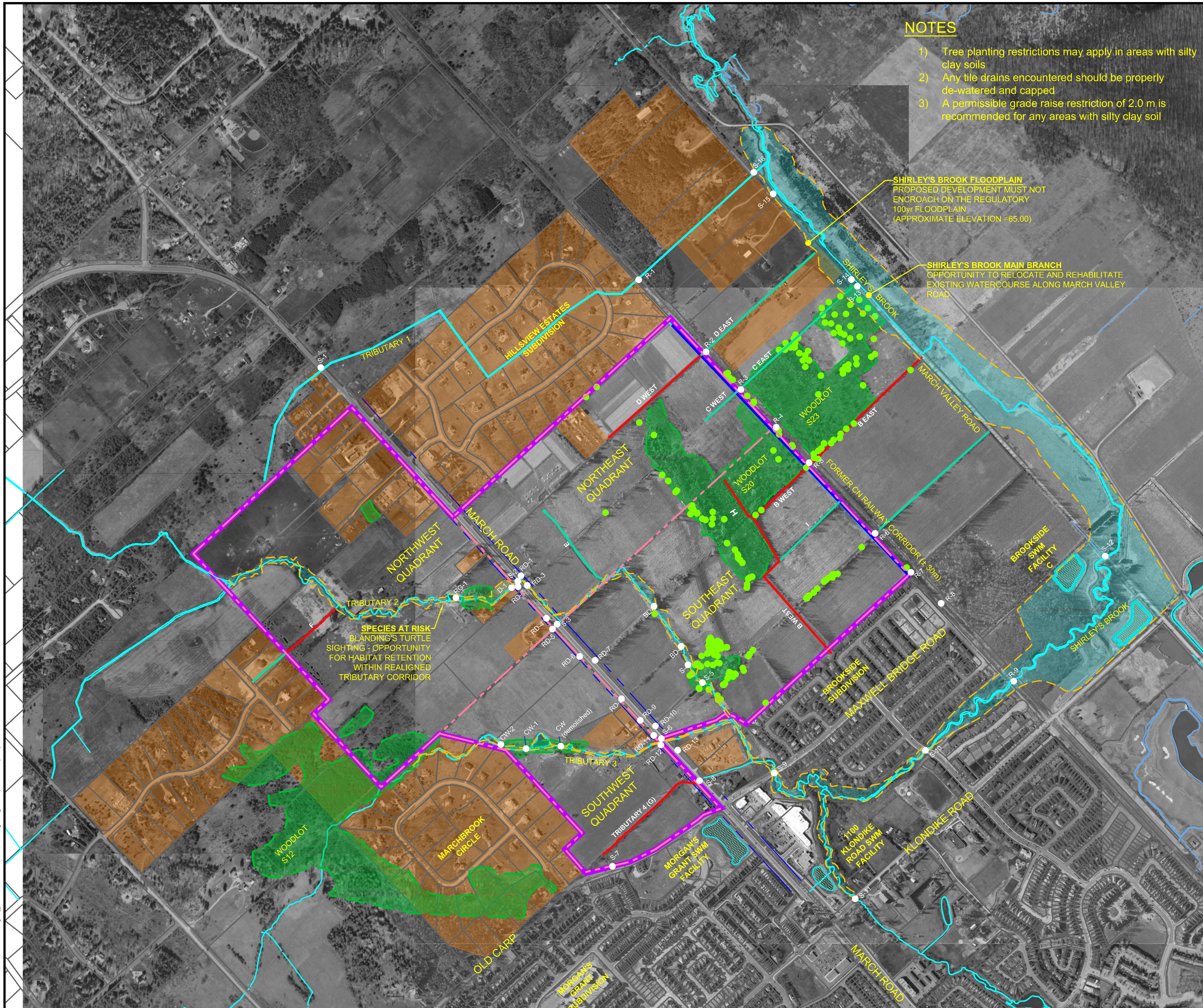
NOVATECH
Engineers, Planners & Landscape Architects
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Website www.novatech-eng.com

LOCATION
KANATA NORTH URBAN EXPANSION AREA
COMMUNITY DESIGN PLAN

DRAWING NAME
PRELIMINARY GRADING PLAN

PROJECT No. 112117-00
REV: REV # 3
DRAWING No. 112117-PGR

PLANB1.DWG - 1000mmx707mm




## LEGEND - GENERAL

KANATA NORTH URBAN EXPANSION AREA (KNUEA)

DRAINAGE CHANNEL

STUDY AREA QUADRANT BOUNDARY

## LEGEND - CONSTRAINTS

FLOODPLAIN BOUNDARY (APPROXIMATE - MVCA/ AECOM)

ADJACENT AREAS SERVICED BY WELLS

HYDRAULIC STRUCTURE ID
- BD BEAVER DAM
- CW CONCRETE WEIR
- D DRIVEWAY CULVERT
- R RAILWAY CULVERT
- RD ROADWAY CULVERT
- RG ROCK GABIAN BASKET
- S SHIRLEY'S BROOK CULVERT

HEADWATER DRAINAGE CHANNEL TO BE COMPENSATED

HEADWATER DRAINAGE CHANNEL NOT REQUIRING COMPENSATION OR MITIGATION

A DRAINAGE CHANNEL ID

## LEGEND - FEATURES

EXISTING SWM FACILITY

WOODED AREA

BUTTERNUT LOCATIONS (EXAMPLES)

# KANATA NORTH

COMMUNITY DESIGN PLAN

**FIGURE NO. 3.5**

EXISTING ENVIRONMENTAL INVENTORY

DATE APR 2016

JOB 112117

SCALE AS SHOWN

NOVATECH
Engineers, Planners & Landscape Architects

M:\2012\112117\CADD\Design_EMP\112117-ENV.dwg, Fig 3.5 (AERIAL), Apr 05, 2016 - 9:44am, tbrooks

SHT11X17.DWG - 279mmX432mm

Ottawa

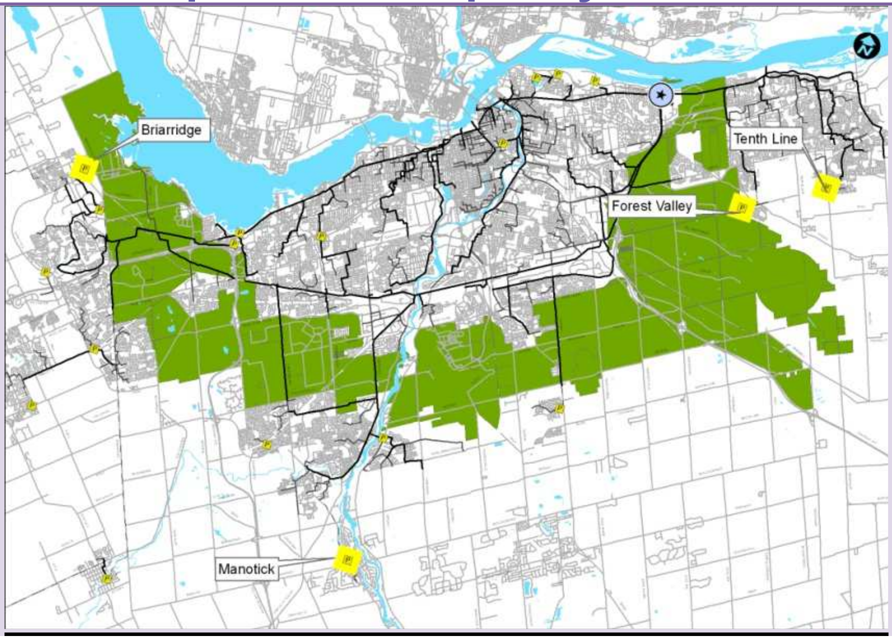
# Infrastructure Master Plan

November 2013

Building a Liveable Ottawa 2031

ottawa.ca
City services 3-1-1
613-580-2400
TTY 613-580-2401
@ottawacity

## Pump Station Capacity Increase




**Scope and Justification**

Capacity increases to the Manotick, Briarridge, Forest Valley and Tenth Line Pump Stations is needed to accommodate growth which is expected to occur within their catchment area. The proposed work will involve the replacement of existing pumps with larger ones.

**Timing**

2019 – 2031 Replace existing pumps.
(rate of development and flow monitoring will determine the exact timing).

**Action Item Funding**

Construction Cost Estimate = $0.9 M
Capital Cost Estimate* = $1.5 M (100% Development Charges, 0% Rate)
**Including construction cost, engineering, city internal costs and contingency allowance.*

**EA Requirements and Consultation**

This is Schedule A (pre-approved) Class EA project. No public consultation required before implementation.

**Follow Up Actions**

Monitor flows to the stations and rate of development in contributing areas.

# CITY OF OTTAWA 2014 DEVELOPMENT CHARGES BACKGROUND STUDY

**OFFICE CONSOLIDATION INCORPORATING BACKGROUND STUDY (APRIL 28, 2014) AS AMENDED BY:**

- **THE MAY 12 ADDENDUM AND PLANNING COMMITTEE REPORT 70A AS APPROVED BY COUNCIL ON JUNE 11, 2014**
- **THE AUGUST 7, 2014 AMENDMENT RE AFFORDABLE HOUSING;**
- **THE SEPTEMBER 22, 2015 SETTLEMENT AGREEMENT; AND**
- **THE MARCH 24, 2017 AMENDMENT (ROADS AND RELATED SERVICES ONLY)**

City of Ottawa in consultation with
Watson & Associates Economists Ltd.

PREPARED OCTOBER 27, 2017

**City of Ottawa**
**Area-Specific Development Charge Projects**
**Service Component - Sanitary Sewers**

| Item | Summary of Timing by Year(s) 2015-2031 | Increased Service Needs Attributable to Anticipated Development - 2015-2031 Project Description | Gross Capital Cost Estimate $000 | Benefit to Existing Development % | Less: Benefit to Existing Development $000 | Less: Grants, Subsidies & Contributions $000 | Less: Post Period Capacity $000 | Growth Cost $000 | Residential Share $000 | Non-residential Share $000 | Allocation of Expenditures by Area: Inside Greenbelt $000 | Allocation of Expenditures by Area: Outside Greenbelt $000 | Allocation of Expenditures by Area: Rural $000 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 10.0094 | 2017 | Tri-Township/March Ridge Collector Replacement | 8,800 | 59% | 5,192 | - | - | 3,608 | 3,211 | 397 | | 3,608 | |
| 10.0194 | 2015 | South Nepean Collector Phase 2 | 4,336 | 0% | - | - | - | 4,336 | 3,686 | 650 | | 4,336 | |
| 10.0294 | 2017-2018 | South Nepean Collector Phase 3 | 7,700 | 0% | - | - | - | 7,700 | 6,545 | 1,155 | | 7,700 | |
| 10.0394 | 2015-2024 | Kanata West Trunk Sewers | 9,962 | 0% | - | - | - | 9,962 | 8,866 | 1,096 | | 9,962 | |
| 10.0494 | 2015-2019 | Fernbank Collector Sewer - Front-ending Agreement | 2,000 | 0% | - | - | - | 2,000 | 1,780 | 220 | | 2,000 | |
| 10.0594 | 2018 | March Road Pumping Station Conversion | 4,781 | 53% | 2,534 | - | - | 2,247 | 2,000 | 247 | | 2,247 | |
| 10.5024 | 2022 | Signature Ridge Pump Station and Forcemain Expansion | 4,500 | 0% | - | - | - | 4,500 | 4,005 | 495 | | 4,500 | |
| 10.5034 | 2017 | Stittsville Pump Station Gravity Connection and Decommissioning | 1,500 | 70% | 1,050 | - | - | 450 | 401 | 50 | | 450 | |
| 10.5044 | 2022 | Acres Road Pump Station Upgrade | 3,900 | 0% | - | - | - | 3,900 | 3,471 | 429 | | 3,900 | |
| 10.5054 | 2016 | Stittsvile / Fernbank Interceptor Sewer | 5,959 | 10% | 596 | - | - | 5,363 | 4,773 | 590 | | 5,363 | |
| 10.5064 | 2028 | Conroy Road Collector Twinning | 1,900 | 0% | - | - | - | 1,900 | 1,615 | 285 | | 1,900 | |
| 10.5074 | 2019-2031 | Pump Stations Capacity Increase - Replacement | 1,500 | 0% | - | - | - | 1,500 | 1,290 | 210 | | 1,500 | |
| | 2018 | Area 6 Pumping Station | 3,300 | 0% | - | - | - | 3,300 | 2,838 | 462 | | 3,300 | |
| 10.5074 | 2015-2031 | O'Connor Flood Control Works | 58,000 | 90% | 52,200 | - | - | 5,800 | 4,118 | 1,682 | 5,800 | | |
| 10.5074 | 2028 | Rideau River Collector Upgrade | 1,800 | 0% | - | - | 1,620 | 180 | 128 | 52 | 180 | | |
| 10.5074 | 2028 | Rideau River Collector Twinning | 8,900 | 0% | - | - | 8,010 | 890 | 632 | 258 | 890 | | |
| 10.2004 | 2015-2022 | Wastewater System Renewal Program - Intensification Areas | 129,825 | 97% | 125,930 | - | - | 3,895 | 2,765 | 1,130 | 3,895 | | |
| 10.2004 | 2023-2031 | Wastewater System Renewal Program - Intensification Areas | 427,785 | 87% | 372,173 | - | - | 55,612 | 39,485 | 16,127 | 55,612 | | |
| | | | | | | | | | | | | | |
| | | **East Urban Community** | | | | | | | | | | | |
| 10.00X1 | 2017 | Neighbourhood 5 Sanitary Pumping Station Overflow | 500 | 0% | - | - | - | 500 | 410 | 90 | | 500 | |
| 10.00X2 | 2017 | Avalon South N4 Trunk Sewers | 633 | 0% | - | 439 | - | 194 | 159 | 35 | | 194 | |
| 10.00X3 | 2015 | Cumberland Trunk Sewers | 2,576 | 0% | - | 1,676 | - | 900 | 738 | 162 | | 900 | |
| 10.00X4 | 2016 | Neighbourhood 5 Trunk Sewer Oversizing | 817 | 0% | - | 757 | - | 60 | 49 | 11 | | 60 | |
| 10.00X5 | 2019-2021 | Orleans South Business Park | 1,522 | 0% | - | 1,329 | - | 193 | 158 | 35 | | 193 | |
| 10.00X6 | 2017-2018 | EUC Sanitary Sewer System | 1,837 | 0% | - | 1,425 | - | 412 | 338 | 74 | | 412 | |
| 10.00X7 | 2017-2019 | Cardinal Creek Sanitary Sewers | 894 | 0% | - | 521 | - | 373 | 306 | 67 | | 373 | |
| | | | | | | | | | | | | | |
| | | **South Urban Community** | | | | | | | | | | | |
| 10.00X8 | 2018 | SUC Nepean Sewer Oversizing North of Jock | 1,005 | 0% | - | 1,005 | - | 0 | 0 | 0 | | 0 | |
| 10.00X9 | 2015 | SUC Nepean Sewer Oversizing South of Jock | 5,042 | 0% | - | 4,627 | - | 415 | 365 | 50 | | 415 | |
| 10.00X10 | 2015 | Leitrim Sanitary Sewer System | 248 | 0% | - | 169 | - | 79 | 70 | 9 | | 79 | |
| 10.00X11 | 2016-2020 | Leitrim Sanitary Pump Station Expansion | 450 | 0% | - | - | - | 450 | 396 | 54 | | 450 | |
| 10.00X12 | 2020 | SUC Riverside South | 8,883 | 0% | - | 7,444 | - | 1,439 | 1,266 | 173 | | 1,439 | |
| | | | | | | | | | | | | | |
| | | **West Urban Community** | | | | | | | | | | | |
| 10.00X13 | 2018 | Kanata Lakes North | 727 | 0% | - | 721 | - | 6 | 5 | 1 | | 6 | |
| 10.00X14 | 2017 | Town Centre Sewer System | 552 | 0% | - | 218 | - | 334 | 294 | 40 | | 334 | |
| 10.00X17 | 2018-2019 | Jackson Trail Pumping Station and Sewer Oversizing | 200 | 0% | - | 100 | - | 100 | 88 | 12 | | 100 | |
| | | | | | | | | | | | | | |
| | | **Debt Payments** | | | | | | | | | | | |
| 10.4144 | 2015-2031 | Kanata West Pump Station & Forcemain - Debt Payments | 10,883 | 0% | - | - | - | 10,883 | 8,706 | 2,177 | | 10,883 | |
| 10.4244 | 2015-2031 | Kanata West Sewer Oversizing - Debt Payments | 71 | 0% | - | - | - | 71 | 57 | 14 | | 71 | |
| 10.1894 | 2015-2031 | Barrhaven South Oversizing (South of Jock River) - Debt Payments | 400 | 0% | - | - | - | 400 | 320 | 80 | | 400 | |
| 10.0194 | 2015-2031 | South Nepean Collector Phase 2 - Debt Payments | 427 | 0% | - | - | - | 427 | 342 | 85 | | 427 | |
| 10.2644 | 2015-2031 | North Kanata Sewer Phase 2 - Debt Payments | 256 | 0% | - | - | - | 256 | 205 | 51 | | 256 | |
| 10.0494 | 2015-2031 | Fernbank Sanitary Sewers - Debt Payments | 640 | 0% | - | - | - | 640 | 512 | 128 | | 640 | |
| 10.0594 | 2015-2031 | March Pump Station Conversion - Debt Payments | 142 | 0% | - | - | - | 142 | 114 | 28 | | 142 | |
| 10.2044 | 2015-2031 | Riverside South Community Trunk Oversizing - Debt Payments | 36 | 0% | - | - | - | 36 | 29 | 7 | | 36 | |
| 10.1794 | 2015-2031 | Barrhaven South Oversizing (North of Jock River) - Debt Payments | 33 | 0% | - | - | - | 33 | 26 | 7 | | 33 | |
| 10.1894 | 2015-2031 | Barrhaven South Oversizing (South of Jock River) - Debt Payments | 908 | 0% | - | - | - | 908 | 726 | 182 | | 908 | |
| | | | | | | | | | | | | | |
| 10.1AM4 | 2015 | Manotick Pump Station and Forcemain[1] | 13,000 | 48% | 6,240 | - | - | 6,760 | 5,746 | 1,014 | | | 6,760 |
| 10.1BM4 | 2015 | Stonebridge Sanitary Sewer Oversizing[1] | 97 | 48% | 47 | - | - | 50 | 43 | 8 | | | 50 |
| 10.20M4 | 2015 | Gravity Sanitary Sewer[1] | 2,300 | 32% | 736 | - | - | 1,564 | 1,329 | 235 | | | 1,564 |
| 10.30M4 | 2015 | Mahogany Pump Station + Forcemain[1] | 5,440 | 10% | 544 | - | - | 4,896 | 4,162 | 734 | | | 4,896 |
| 10.70M4 | 2015 | Sanitary Sewer Eastman[1] | 306 | 10% | 31 | - | | 275 | 234 | 41 | | | 275 |
| | | | | | | | | | | | | | |
| 10.508A4 | 2021 | Richmond Pump Station and Forcemain Expansion - Phase 1 [2] | 2,500 | 25% | 625 | - | - | 1,875 | 1,819 | 56 | | | 1,875 |
| 10.508B4 | 2025 | Richmond Pump Station and Forcemain Expansion - Phase 2 [2] | 27,500 | 25% | 6,875 | - | 4,125 | 16,500 | 16,005 | 495 | | | 16,500 |
| | | **Total** | **777,273** | | **574,772** | **20,431** | **13,755** | **168,315** | **136,625** | **31,689** | **66,377** | **70,017** | **31,921** |

**NOTES:**
[1] To be recovered within the boundaries of Rural Manotock
[2] To be recovered within the boundaries of the Village of Richmond (amended by Council, 2015)

H:\OTTAWA\2015 DC Hearing\[2017 July 25 City Gary 10 Project Temp

# Appendix C

## Sanitary Servicing Design

# SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

Ottawa

LICENSED PROFESSIONAL ENGINEER W. LIU 100167932 Sep 4, 2019 PROVINCE OF ONTARIO

| LOCATION: STREET | FROM M.H. | TO M.H. | RESIDENTIAL: AREA (ha) | UNITS | POP. | CUMULATIVE AREA (ha) | CUMULATIVE POP. | PEAK FACT. | PEAK FLOW (l/s) | COMM: AREA (ha) | COMM: ACCU. AREA (ha) | INSTIT: AREA (ha) | INSTIT: ACCU. AREA (ha) | PARK: AREA (ha) | PARK: ACCU. AREA (ha) | C+I+I: PEAK FLOW (l/s) | INFILTRATION: TOTAL AREA (ha) | INFILTRATION: ACCU. AREA (ha) | INFILT. FLOW (l/s) | TOTAL FLOW (l/s) | PIPE: DIST (m) | DIA (mm) | SLOPE (%) | CAP. (FULL) (l/s) | RATIO Q act/Q cap | VEL. (FULL) (m/s) | VEL. (ACT.) (m/s) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Trunk 2** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 69A | 70A | 0.06 | | 0 | 0.06 | 0 | | | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.06 | 0.06 | 0.02 | 0.02 | 40.0 | 200 | 0.65 | 26.44 | 0.00 | 0.84 | 0.12 |
| To Trunk 3, Pipe 70A - 71A | | | | | | 0.06 | 0 | | | | 0.00 | | 0.00 | | 0.00 | | | 0.06 | | | | | | | | | |
| | 52A | 55A | 3.46 | | 225 | 3.46 | 225 | 3.5 | 2.55 | | 0.00 | | 0.00 | 2.78 | 2.78 | 0.30 | 6.24 | 6.24 | 2.06 | 4.91 | 68.5 | 200 | 0.34 | 19.12 | 0.26 | 0.61 | 0.51 |
| | 55A | 59A | 1.36 | | 88 | 4.82 | 313 | 3.5 | 3.51 | | 0.00 | | 0.00 | | 2.78 | 0.30 | 1.36 | 7.60 | 2.51 | 6.31 | 71.0 | 200 | 0.34 | 19.12 | 0.33 | 0.61 | 0.55 |
| | | | 0.24 | | 16 | 5.06 | 329 | | | | 0.00 | | 0.00 | | 2.78 | | 0.24 | 7.84 | | | | | | | | | |
| | 59A | 62A | 1.28 | | 141 | 6.34 | 470 | 3.4 | 5.16 | | 0.00 | | 0.00 | | 2.78 | 0.30 | 1.28 | 9.12 | 3.01 | 8.47 | 66.0 | 250 | 0.25 | 29.73 | 0.28 | 0.61 | 0.52 |
| | | | 0.16 | | 11 | 6.50 | 481 | | | | 0.00 | | 0.00 | 0.40 | 3.18 | | 0.56 | 9.68 | | | | | | | | | |
| | 62A | 65A | 1.21 | | 133 | 7.71 | 614 | 3.3 | 6.65 | | 0.00 | | 0.00 | | 3.18 | 0.34 | 1.21 | 10.89 | 3.59 | 10.58 | 68.5 | 300 | 0.20 | 43.25 | 0.24 | 0.61 | 0.50 |
| | | | 0.28 | | 19 | 7.99 | 633 | | | | 0.00 | | 0.00 | | 3.18 | | 0.28 | 11.17 | | | | | | | | | |
| | 65A | 68A | 1.09 | | 120 | 9.08 | 753 | 3.3 | 8.06 | | 0.00 | | 0.00 | | 3.18 | 0.34 | 1.09 | 12.26 | 4.05 | 12.44 | 68.5 | 300 | 0.20 | 43.25 | 0.29 | 0.61 | 0.53 |
| | | | 0.26 | | 17 | 9.34 | 770 | | | | 0.00 | | 0.00 | | 3.18 | | 0.26 | 12.52 | | | | | | | | | |
| | 68A | 70A | 1.16 | | 127 | 10.50 | 897 | 3.3 | 9.49 | | 0.00 | | 0.00 | | 3.18 | 0.34 | 1.16 | 13.68 | 4.51 | 14.34 | 68.5 | 300 | 0.20 | 43.25 | 0.33 | 0.61 | 0.55 |
| To Trunk 3, Pipe 70A - 71A | | | | | | 10.50 | 897 | | | | 0.00 | | 0.00 | | 3.18 | | | 13.68 | | | | | | | | | |
| **Trunk 1** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 20A | 21A | 1.10 | | 72 | 1.10 | 72 | 3.6 | 0.85 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 1.10 | 1.10 | 0.36 | 1.21 | 76.0 | 200 | 1.34 | 37.97 | 0.03 | 1.21 | 0.54 |
| | 21A | 22A | 0.24 | | 16 | 1.34 | 88 | 3.6 | 1.03 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.24 | 1.34 | 0.44 | 1.47 | 55.5 | 200 | 2.24 | 49.09 | 0.03 | 1.56 | 0.68 |
| | 22A | 25A | 2.96 | | 195 | 4.30 | 283 | 3.5 | 3.18 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 2.96 | 4.30 | 1.42 | 4.60 | 70.0 | 200 | 1.19 | 35.78 | 0.13 | 1.14 | 0.78 |
| | | | 0.34 | | 23 | 4.64 | 306 | | | | 0.00 | | 0.00 | | 0.00 | | 0.34 | 4.64 | | | | | | | | | |
| | 25A | 28A | 1.31 | | 144 | 5.95 | 450 | 3.4 | 4.96 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 1.31 | 5.95 | 1.96 | 6.92 | 68.5 | 250 | 0.25 | 29.73 | 0.23 | 0.61 | 0.49 |
| | | | 0.33 | | 22 | 6.28 | 472 | | | | 0.00 | | 0.00 | | 0.00 | | 0.33 | 6.28 | | | | | | | | | |
| | 28A | 32A | 1.30 | | 143 | 7.58 | 615 | 3.3 | 6.66 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 1.30 | 7.58 | 2.50 | 9.16 | 72.5 | 250 | 0.43 | 39.00 | 0.23 | 0.79 | 0.64 |
| | | | 0.70 | | 46 | 8.28 | 661 | | | | 0.00 | 2.52 | 2.52 | | 0.00 | | 3.22 | 10.80 | | | | | | | | | |
| | 32A | 33A | 0.96 | | 106 | 9.24 | 767 | 3.3 | 8.20 | | 0.00 | | 2.52 | | 0.00 | 0.82 | 0.96 | 11.76 | 3.88 | 12.89 | 124.5 | 250 | 0.25 | 29.73 | 0.43 | 0.61 | 0.58 |
| | 33A | 34A | 0.78 | | 51 | 10.02 | 818 | 3.3 | 8.70 | | 0.00 | | 2.52 | | 0.00 | 0.82 | 0.78 | 12.54 | 4.14 | 13.66 | 124.5 | 250 | 0.28 | 31.47 | 0.43 | 0.64 | 0.62 |
| To Trunk 3, Pipe 34A - 40A | | | | | | 10.02 | 818 | | | | 0.00 | | 2.52 | | 0.00 | | | 12.54 | | | | | | | | | |
| **Trunk 3** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2170A | 9A | 21.50 | | 1390 | 21.50 | 1390 | 3.2 | 14.25 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 21.50 | 21.50 | 7.10 | 21.34 | 36.5 | 375 | 0.15 | 67.91 | 0.31 | 0.61 | 0.54 |
| To Trunk 3, Pipe 9A - 10A | | | | | | 21.50 | 1390 | | | | 0.00 | | 0.00 | | 0.00 | | | 21.50 | | | | | | | | | |
| **Trunk 3** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Contribution From Trunk 3, Pipe 2170A - 9A | | | | | | 21.50 | 1390 | | | | 0.00 | | 0.00 | | 0.00 | | 21.50 | 21.50 | | | | | | | | | |
| | | | 0.16 | | 11 | 21.66 | 1401 | | | | 0.00 | | 0.00 | | 0.00 | | 0.16 | 21.66 | | | | | | | | | |
| | 9A | 10A | 2.57 | | 167 | 24.23 | 1568 | 3.1 | 15.92 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 2.57 | 24.23 | 8.00 | 23.91 | 8.0 | 375 | 0.15 | 67.91 | 0.35 | 0.61 | 0.56 |
| | 10A | 14A | 0.89 | | 58 | 25.12 | 1626 | 3.1 | 16.46 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 0.89 | 25.12 | 8.29 | 24.75 | 128.0 | 375 | 0.26 | 89.40 | 0.28 | 0.81 | 0.69 |
| | 14A | 34A | 1.14 | | 77 | 26.26 | 1703 | 3.1 | 17.17 | | 0.00 | | 0.00 | | 0.00 | 0.00 | 1.14 | 26.26 | 8.67 | 25.84 | 72.5 | 375 | 0.17 | 72.29 | 0.36 | 0.65 | 0.60 |
| Contribution From Trunk 1, Pipe 33A - 34A | | | | | | 10.02 | 818 | | | | 0.00 | | 2.52 | | 0.00 | | 12.54 | 38.80 | | | | | | | | | |
| | 34A | 40A | 0.36 | | 23 | 36.64 | 2544 | 3.0 | 24.75 | | 0.00 | | 2.52 | | 0.00 | 0.82 | 0.36 | 39.16 | 12.92 | 38.49 | 73.5 | 375 | 0.15 | 67.91 | 0.57 | 0.61 | 0.63 |
| | | | 0.92 | | 60 | 37.56 | 2604 | | | | 0.00 | | 2.52 | | 0.00 | | 0.92 | 40.08 | | | | | | | | | |
| | 40A | 70A | 1.75 | | 114 | 39.31 | 2718 | 3.0 | 26.27 | | 0.00 | | 2.52 | | 0.00 | 0.82 | 1.75 | 41.83 | 13.80 | 40.89 | 68.5 | 375 | 0.15 | 67.91 | 0.60 | 0.61 | 0.64 |
| Contribution From Trunk 2, Pipe 68A - 70A | | | | | | 10.50 | 897 | | | | 0.00 | | 0.00 | | 3.18 | | 13.68 | 55.51 | | | | | | | | | |
| Contribution From Trunk 2, Pipe 69A - 70A | | | | | | 0.06 | 0 | | | | 0.00 | | 0.00 | | 0.00 | | 0.06 | 55.57 | | | | | | | | | |
| | 70A | 71A | 0.58 | | 64 | 50.45 | 3679 | 2.9 | 34.49 | | 0.00 | | 2.52 | | 3.18 | 1.16 | 0.58 | 56.15 | 18.53 | 54.17 | 88.0 | 450 | 0.12 | 98.76 | 0.55 | 0.62 | 0.63 |
| | 71A | 84A | 0.74 | | 81 | 51.19 | 3760 | 2.9 | 35.16 | | 0.00 | | 2.52 | | 3.18 | 1.16 | 0.74 | 56.89 | 18.77 | 55.10 | 96.0 | 450 | 0.12 | 98.76 | 0.56 | 0.62 | 0.64 |
| To Trunk 3, Pipe 84A - 85A | | | | | | 51.19 | 3760 | | | | 0.00 | | 2.52 | | 3.18 | | | 56.89 | | | | | | | | | |

DESIGN PARAMETERS

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

| | | |
|---|---|---|
| Designed: A.K. | PROJECT: Minto Kanata North | |
| Checked: W.L. | LOCATION: City of Ottawa | |
| Dwg. Reference: Sanitary Drainage Plan, Dwgs. No. | File Ref: 17-982 | Date: September 2019 — Sheet No. 1 of 2 |

982_SAN_Trunk_DesignSheet.xlsx

# SANITARY SEWER CALCULATION SHEET

Manning's n=0.013

Ottawa

| LOCATION | | | RESIDENTIAL AREA AND POPULATION | | | | | | | COMM | | INSTIT | | PARK | | C+I+I | INFILTRATION | | | | PIPE | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| STREET | FROM M.H. | TO M.H. | AREA (ha) | UNITS | POP. | CUMULATIVE AREA (ha) | CUMULATIVE POP. | PEAK FACT. | PEAK FLOW (l/s) | AREA (ha) | ACCU. AREA (ha) | AREA (ha) | ACCU. AREA (ha) | AREA (ha) | ACCU. AREA (ha) | PEAK FLOW (l/s) | TOTAL AREA (ha) | ACCU. AREA (ha) | INFILT. FLOW (l/s) | TOTAL FLOW (l/s) | DIST (m) | DIA (mm) | SLOPE (%) | CAP. (FULL) (l/s) | RATIO Q act/Q cap | VEL. (FULL) (m/s) | VEL. (ACT.) (m/s) |
| **Trunk 3** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Contribution From Trunk 3, Pipe 71A - 84A | | | | | | 51.19 | 3760 | | | | 0.00 | | 2.52 | | 3.18 | | 56.89 | 56.89 | | | | | | | | | |
| | | | 0.04 | | 0 | 51.23 | 3760 | | | | 0.00 | | 2.52 | | 3.18 | | 0.04 | 56.93 | | | | | | | | | |
| | | | 0.05 | | 0 | 51.28 | 3760 | | | | 0.00 | | 2.52 | | 3.18 | | 0.05 | 56.98 | | | | | | | | | |
| | | | 1.60 | | 175 | 52.88 | 3935 | | | | 0.00 | | 2.52 | | 3.18 | | 1.60 | 58.58 | | | | | | | | | |
| | 84A | 85A | 2.76 | | 181 | 55.64 | 4116 | 2.9 | 38.12 | | 0.00 | | 2.52 | | 3.18 | 1.16 | 2.76 | 61.34 | 20.24 | 59.52 | 53.5 | 450 | 0.12 | 98.76 | 0.60 | 0.62 | 0.65 |
| | 85A | 86A | | | | 55.64 | 4116 | 2.9 | 38.12 | | 0.00 | | 2.52 | | 3.18 | 1.16 | 0.00 | 61.34 | 20.24 | 59.52 | 58.0 | 450 | 0.12 | 98.76 | 0.60 | 0.62 | 0.65 |
| | 86A | 87A | | | | 55.64 | 4116 | 2.9 | 38.12 | | 0.00 | | 2.52 | | 3.18 | 1.16 | 0.00 | 61.34 | 20.24 | 59.52 | 120.0 | 450 | 0.12 | 98.76 | 0.60 | 0.62 | 0.65 |
| | 87A | 88A | | | | 55.64 | 4116 | 2.9 | 38.12 | | 0.00 | | 2.52 | | 3.18 | 1.16 | 0.00 | 61.34 | 20.24 | 59.52 | 17.5 | 450 | 0.12 | 98.76 | 0.60 | 0.62 | 0.65 |
| | 88A | 225A | | | | 55.64 | 4116 | 2.9 | 38.12 | | 0.00 | | 2.52 | | 3.18 | 1.16 | 0.00 | 61.34 | 20.24 | 59.52 | 5.0 | 450 | 0.12 | 98.76 | 0.60 | 0.62 | 0.65 |
| | 225A | 224A | 22.50 | | 1648 | 78.14 | 5764 | 2.7 | 51.36 | | 0.00 | | 2.52 | | 3.18 | 1.16 | 22.50 | 83.84 | 27.67 | 80.19 | 97.5 | 450 | 0.12 | 98.76 | 0.81 | 0.62 | 0.69 |
| | 224A | 209A | 0.22 | | 11 | 78.36 | 5775 | 2.7 | 51.45 | | 0.00 | | 2.52 | | 3.18 | 1.16 | 0.22 | 84.06 | 27.74 | 80.35 | 66.5 | 450 | 0.12 | 98.76 | 0.81 | 0.62 | 0.69 |
| | 209A | 208A | 9.05 | | 553 | 87.41 | 6328 | 2.7 | 55.76 | | 0.00 | | 2.52 | | 3.18 | 1.16 | 9.05 | 93.11 | 30.73 | 87.64 | 50.0 | 450 | 0.20 | 127.50 | 0.69 | 0.80 | 0.86 |
| | 208A | 207A | | | | 87.41 | 6328 | 2.7 | 55.76 | | 0.00 | | 2.52 | | 3.18 | 1.16 | 0.00 | 93.11 | 30.73 | 87.64 | 111.5 | 450 | 0.20 | 127.50 | 0.69 | 0.80 | 0.86 |

LICENSED PROFESSIONAL ENGINEER
W. LIU
100167932
PROVINCE OF ONTARIO

DESIGN PARAMETERS

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

| | |
|---|---|
| Designed: A.K. | PROJECT: Minto Kanata North |
| Checked: W.L. | LOCATION: City of Ottawa |
| Dwg. Reference: Sanitary Drainage Plan, Dwgs. No. | File Ref: 17-982 |
| Date: September 2019 | Sheet No 2 of 2 |



DSEL
david schaeffer engineering ltd

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Fax. (613) 836-7183
www.DSEL.ca


SANITARY SERVICING APPENDIX

MINTO KANATA NORTH

| | |
|---|---|
| PROJECT No. : | 17-982 |
| SCALE: | 1:2000 |
| DATE: | September 2019 |
| DRAWING No. | 3 |

# David Schaeffer Engineering Ltd.
# Briar Ridge Pumping Station Capacity Assessment

# Briar Ridge Pumping Station Capacity Assessment



| | | | | | | |
|---|---|---|---|---|---|---|
| Sept. 21, 2018 | A | Draft 1 | Jebran Iqbal | Peter Rüsch | Peter Rüsch | |
| | | | | | | |
| **Date** | **Rev.** | **Status** | **Prepared By** | **Checked By** | **Approved By** | **Approved By** |
| **HATCH** | | | | | | **Client** |

# Table of Contents

# 1. Introduction

Hatch has been retained by David Schaeffer Engineering Ltd (DSEL) for a capacity assessment of the Briar Ridge Pumping Station in the former city of Kanata, in Ottawa.

The purpose of this report is to:

- Provide a summary of the field investigation and relevant findings pertinent to the capacity[1] of the Briar Ridge Pumping Station; and
- Provide an analysis of SCADA data to confirm the pumping station capacity.
- Provide an overview of the present likely capacity and an upgrade path to reach the design capacity[2].

This report is submitted to David Schaeffer Engineering Ltd. for review and comments.

# 2. Methodology and Results

## 2.1 Briar Ridge Pumping Station Location & Introduction

The Briar Ridge pumping station is located at 960 Klondike Road in Kanata, Ottawa, accessible via an access road approximately 350 m northeast of Marconi Avenue. A location plan is attached in Appendix A of this report.

DSEL provided Hatch with a preliminary design report prepared by Cumming Cockburn Limited (CCL). A copy of this report is attached in Appendix B of this report. In line with the purpose of this assignment, Hatch did not review CCL's design, but confirmed performance relevant parameters of the station, in order to confirm the design capacity of the station.

## 2.2 Site Layout and General Arrangement of the PS & Forcemains

The general arrangement (plan and cross section) for this facility is attached in Appendix C. A short description of the Pumping Station is as follows:

- The Briar Ridge pumping station receives sewage at the east edge of the facility via a 450 mm gravity sewer to the wet well;
- The wet well is currently equipped with two Flygt submersible pumps (one duty, one standby) with space for a third for future installation at any time;
- 200 mm pump discharge lines run from the wet well to the PS control building;
- The PS control building, with controls and a standby generator on the main floor, and flow meters and pressure transducers in the basement; and
- The pump station discharges sewage west along Shirley's Brook Drive through two PVC SDR25 forcemains which are 200 mm and 300 mm in diameter.

[1] In the strict sense capacity means the maximum rate at which a pumping station can pump on a continuous basis.
[2] At the time of the visit to the pumping station only the 300 mmm forcemain was in use, data is extrapolated/theoretically calculated for the 200 mm forcemain.

## 2.3 Site Visit and Observations

Hatch visited the Briar Ridge Pumping Station on Tuesday, July 24, 2018, from 11:00 am to 1:30 pm. During this visit, the following was observed / confirmed:

- One pump was being operated at a time based on the inflow, with each pump alternating use[3];
- The pressure gauges for the pumps were defunct, but the pressure transducers were working; and
- Only one forcemain (300 mm) was in operation;

The following operational parameters were observed and / or reported by City staff[4]:

- Pressure and Flow readings for the PS would be made available from the SCADA system. City staff noted that SCADA data would be available in 10 s intervals, which would allow for the confirmation of total PS flows / determination of the fraction that a duty pump is running over an extended time period. Hatch has requested, and received SCADA data from the City of Ottawa. An e-mail exchange between the City of Ottawa and Hatch, is attached in Appendix H.

## 2.4 Site Survey and Confirmation of PS / Forcemain Elevations

The purpose of the survey Hatch conducted was to confirm key elevations pertaining to the pumping station, to correlate with the As-built drawings[5]. Hatch surveyed and confirmed the following elevations:

- The top of the Wet Well;
- The main floor level of the PS control building;
- The basement floor level of the PS control building;
- The elevation of the pressure transducers for both forcemains;
- The lid elevation of the discharge manhole;
- The pipe invert of the discharge MH directly below the lid;
- An estimate for the discharge pipe obvert was made based on the configuration in the discharge MH;

A summary of these elevations, and elevations taken from the as-built drawings, is provided below, detailed calculations and details of the survey shots are attached in Appendix D.

[3] Hatch recorded flow data only from pump 1 (RSP1) from the Miltronics display
[4] At the time of the pumping station visit.
[5] As-built drawings per definition, are based on the records from third parties, and may not be fully accurate.

| Label | Measured Elevation (m) | Design Elevation (m) |
|---|---|---|
| Wet Well Overflow | N/A | 60.6 |
| High High Alarm | N/A | 60.2 |
| High Level Alarm | N/A | 60.1 |
| 2nd Pump Starts | N/A | 60 |
| 1st Pump Starts | 59.77 | 59.8 |
| Pumps Stop | 58.59 | 58.6 |
| 300 mm Forcemain Outlet Manhole | 74.693 | 74.746 |
| 300 mm Forcemain Outlet Pipe Obvert | 72.293 | 72.765 |
| PS Metering Room Floor | 65.522 | 65.500 |
| Pressure Transducer 200 mm | 66.417 | - |
| Pressure Transducer 300 mm | 66.417 | - |

**Table 1: Elevations Summary**

## 2.5 Capacity of the Pumping Station

### *2.5.1 Approach*

Hatch has reviewed the pumping station performance from 4 different vantage points, to reduce the risk of any one measurement inaccuracy to cause a misrepresentation of the pumping station performance. These following vantage points were selected:

- Record pump flow rates and wet well water levels in 10s intervals from pump start to pump stop by reading from the Miltronics displays;
- Record wet well water levels in 10s intervals from pump start to pump stop by using a laser level during pump operation;
- Determine theoretical performance of the pumping station, i.e. can the system curve and intersection of the pump curve and system curve be re-created as per the preliminary design report; and
- Perform SCADA data analysis to confirm the duty point of the pumping station.

Hatch furthermore located the MOE Certificate of approval to confirm the key operating parameters that were submitted to the MOE at the time of obtaining approval. Ultimately, at least 3 of these vantage points would confirm the actual capacity of the pumping station, provided there is a plausible explanation for the 4$^{th}$ point not matching the results of the other points.

### *2.5.2 MOE Certificate of Approval for the Pumping Station.*

Hatch obtained the MOE Certificate of Approval for the PS, attached in Appendix E. In this certificate the following is noted:

- Initial Design Peak Flow Capacity of 53 L/s[6], with 1 duty and 1 standby pump.
- Single Pump Capacity of 55 L/s @ 23 m TDH

[6] This capacity appears to be based on both forcemains being operational.

### 2.5.3 *Existing Pump Models / Pump Numbers*

The pumping station is equipped with 2 identical Flygt CP 3201.180 Pumps. A pump curve, taken from the reviewed shop drawings is attached in Appendix F of this report. Space for a third pump is available in the wet well, and could be installed at any given stage.

### 2.5.4 *Derived System Curve and Theoretical Duty Point for the 300 mm Forcemain*

Based on the information gathered and as-built drawings, Hatch derived a system curve for the pumping station, attached in Appendix G of this report. Hatch has noted the duty point taken from the preliminary design report on this curve, and denoted it “Duty Point”. This system curve matches the system curve in the preliminary design report very closely, with observed differences most likely with the operational levels in the wet well and in the interpretation of local losses.

*Based on this theoretical analysis it would appear as if the pumping station, when operated as intended, will reach the design capacity (Flow) as noted in the MOE Certificate of Approval*

### 2.5.5 *Pump Performance, SCADA Data Analysis and Capacity Summary*

The duty point noted in the pump curve provided by Flygt is located at the Best Efficiency Point (BEP) @ 60.9 L/s with a head of 22.5m. This pump curve, intended as the average expected performance of the pump was overlaid with the derived system curve, the recorded pump flow data, and the pump flows from the SCADA data. The lower range of expected operation shown on Flygt’s curve was also plotted. These curves were compared to verify and determine the actual duty point of the system, as well as the flow rate of the pump in comparison to the manufacturer’s data.

It has to be noted that this point is somewhat speculative based on the shop drawing pump curve. Alternatively, it is feasible that the impellor of the pump has worn somewhat, reducing flow and head, and (again speculative) at the published efficiency this would result in a feasible operating point of ~ 69.7 L/s. The plotted system and pump curves can be seen in Appendix G.

Hatch has analysed the flow data for the flow meter for the 300 mm forcemain. To verify the recorded observed data, Hatch has extracted a subset of the data for the time noted in July 24, 2018 (from 12:06:40 pm to 1:05:00 pm) to review the capacity for each of the pumps, this dataset is attached in Appendix H of this report. The findings are summarised below:

- Observed capacity of the pump running at the time of observation (RSP1) appears to be ~70 L/s;
- The alternate pump (RSP2) capacity under the same operating conditions appears be ~66 L/s.[7]

Hatch has received (refer to Appendix I) a table of a capacity analysis completed by NOVATECH in 2016, using the certificate of approval, theoretical data from the pre-design report, and extracted SCADA information from various years for both typical use and storm events. This table confirms the following performance for the design and calculates the available capacity for the final CCL ultimate design:

---

[7] RSP2 was not recorded during the site visit, but is assumed to run at similar capacity as, if not slightly less than, RSP1, confirmed with the SCADA information.

- Rated Pump Capacity (2 pumps), 200 & 300 mm forcemain: 55 L/s[8]
- Ultimate Design at Build-Out Capacity (3 pumps), 200 & 300 mm forcemain: 183 L/s[9]

While on site, Hatch made the following observations:

- The pump flow rate that was being reached by RSP1 was ~70 L/s, notably higher than the installed design noted in the certificate of approval and the capacity analysis by NOVATECH. Likely, this is due to the increased inflow over time.
- The pump head identified by Flygt @ 70 L/s would be in the operational range of 17.15 m – 19.63 m. On site, the head that was recorded @ ~70 L/s was in the range of 15.33 m – 16.25 m. The reduction in capacity points to wear of the pumps in the timeframe between 2001 (installation) and 2018. The reduction in capacity is approximately in the order of 11%-18%.

Given the uncertainties / inconsistencies in the data findings, Hatch is of the opinion that the current confirmed duty point, or firm capacity of the pumping station (single duty pump, and single standby pump) is 70 L/s, when operating with the 300 mm forcemain. Likewise[10] a similar reduction in pump capacity is assumed for the operating point for each pump with the 200 mm forcemain, approximately at 52 L/s.

With both forcemains in operation, the theoretical duty point with the current pumps would be at approximately 80 L/s.

As such it appears that the pumping station, provided that the current pumps are replaced and a third pump is added to the station, will reach the intended design capacity of 183 L/s with both forcemains in operation.

### *2.5.6 Forcemain Velocities, Forcemain Redundancy and Transients*

At the confirmed duty point, the forcemain velocity has been calculated at 0.95 m/s. This is based on a 300 mm nominal diameter PVC DR 25 forcemain, ID 308 mm. This velocity is within the range required by the MOE (between 0.6 m/s – 1.1 m/s cleansing velocities, with maximum velocity of 3 m/s). For the 200 mm nominal diameter PVC DR 25 forcemain, ID 212 mm, the velocity is calculated to be ~1.47 m/s at the duty point of 52 L/s. The preliminary design report (section 2.4) the target design velocity design criteria are between 1.1 m/s and 2.5 m/s. The flow velocity for the 300 mm is less than the targeted range in the pre-design report, but matches up to what should be expected by the graph showing velocities at various flow rates for different sized forcemains in the pre-design report.

In the SCADA data analysis, there do not appear to be transients on pump shutdown, as the flow records indicate that, on pump shutdown, the flows are reduced to zero and stay at zero and do not fluctuate and there are no negative pressures found that would be indicative of transients.

[8] Data obtained from MOE Certificate of Approval
[9] Data obtained from CCL "Briarridge Sanitary Pumping Station Pre-Design Report, City of Kanata"
[10] Hatch notes that test were not conducted with the 200 mm forcemain. Hence the result in somewhat speculative, but would be a fair indication of a likely capacity.

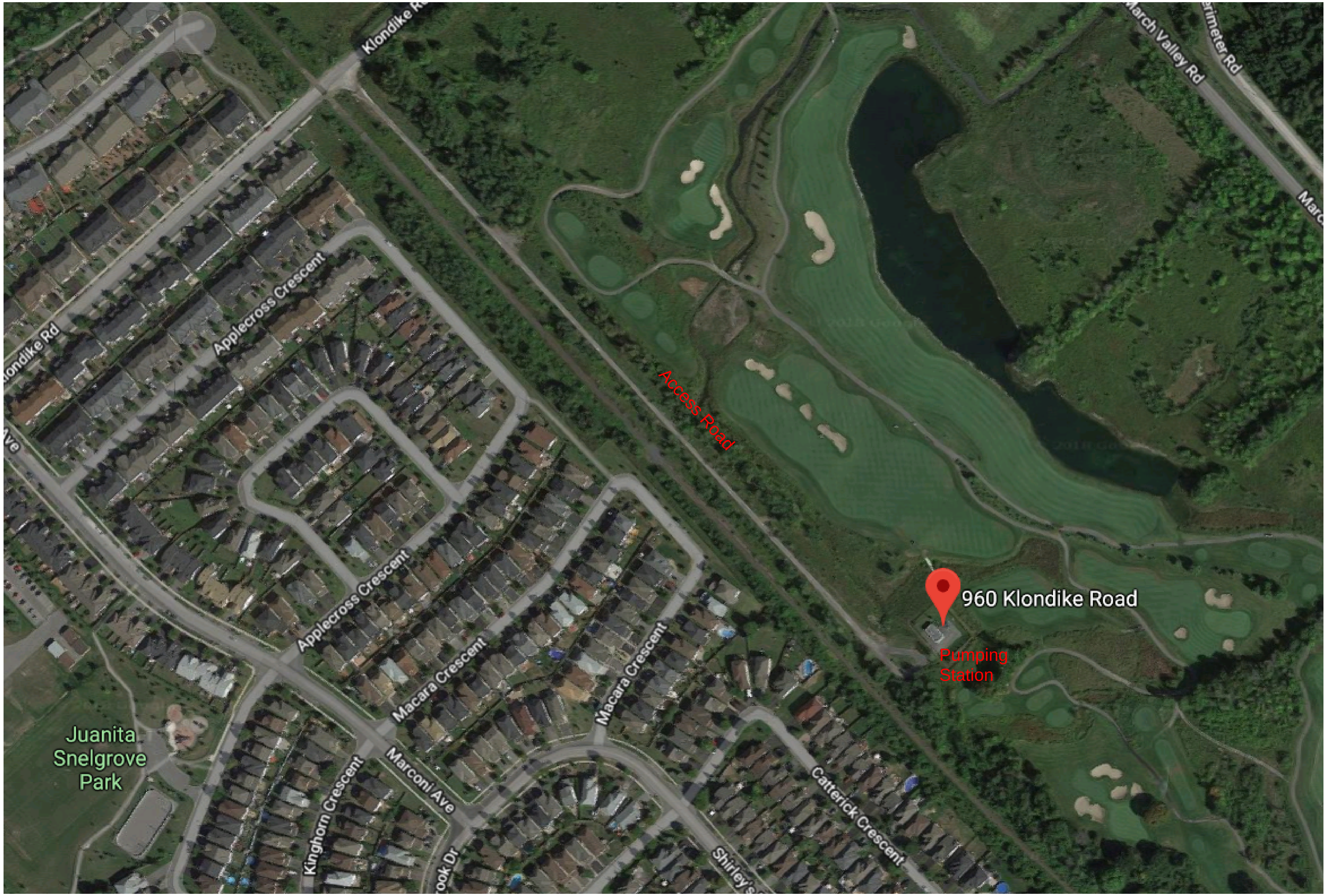
During the site visit, Hatch did not note any transient typical noises on pump shutdown, apart from normal ball valve shutdown. These reasons are a good indication that pressures are not excessive when a single pump is used in combination with the 300 mm forcemain.

# 3. Recommendations

Hatch recommends that the following be undertaken:

- A pump test should be undertaken when servicing a pump. This would confirm the pump performance. Since the pumps do not appear to have been replaced since they were first installed in 2001, they will most likely need to be replaced depending on the results of a pump test, due to the not insignificant reduction of pump performance.
- At this stage, the pumping station is nearing the 20 year intended pumping requirement phase (indicated in the pre-design report), meaning the pumping station capacity should currently be at 61 L/s. As determined by the analysis, the pumps are currently pumping at ~70 L/s. Based on the observances and calculations of the current and expected flows, the current pumps should be replaced and a third pump may be added alongside the replacement of the current pumps to service the expected future flows.

# APPENDIX A: LOCATION PLAN


Klondike Rd
March Valley Rd
Perimeter Rd
Klondike Rd
Applecross Crescent
Access Road
960 Klondike Road
Pumping Station
Applecross Crescent
Macara Crescent
Macara Crescent
Juanita Snelgrove Park
Marconi Ave
Kinghorn Crescent
Catterick Crescent

# APPENDIX B: CCL PRE-DESIGN REPORT

IBI GROUP
400–333 Preston Street
Ottawa ON K1S 5N4 Canada
tel 613 225 1311 fax 613 225 9868
ibigroup.com

# Transmittal

| To/Attention | Company/Address | Telephone No |
|---|---|---|
| Mr. Matt Wingate | DSEL<br>120 Iber Road<br>Suite 103<br>Ottawa, Ontario<br>K2S 1E9 | (613) 836-0856 |

**cc**

| | | | |
|---|---|---|---|
| **Delivery** | By Courier | **No of Copies** | 1 |
| **From** | Jim Moffatt | | |
| **Sent By** | | | |
| **Date** | May 7, 2018 | | |
| **Project No** | 3345-LD | | |
| **Subject** | Briarridge Sanitary Pumping Station – Pre-Design Report, City of Kanata | | |

## Comments

Please find enclosed one copy of the above mentioned report.

Regards,

**IBI GROUP**

James I. Moffatt, P. Eng.
Associate

JIM/ks
Encl.

D:\Users\Karen.Suprunchuk\Desktop\Guys Folders\Jim\CTB_mwingate_2018-05-07.docx\2018-05-07\KS

# BRIARRIDGE SANITARY PUMPING STATION
# PRE-DESIGN REPORT
# CITY OF KANATA

Project 3345-LD

Prepared for

**TENTH LINE DEVELOPMENT INC.**

Prepared by


**CUMMING COCKBURN LIMITED**
1770 Woodward Drive
Ottawa, Ontario
K2C 0P8



MARCH 2001

Revised June 2001

# TABLE OF CONTENTS



**APPENDICES**

## CLARIFICATION

On January 1, 2001, the former Regional Municipality of Ottawa-Carleton and eleven local Cities and Townships covering the total geographic area of the former Region were amalgamated under provincial legislation as the City of Ottawa. Included in the amalgamation was the former City of Kanata where the Briarridge Pumping Station will be located.

The draft of this report was prepared and submitted for comments/approval prior to the date of municipal amalgamation. Consequently, this report contains numerous references to the former municipalities both in the report text and Figures. For continuity the references to the former municipalities in this report remain unchanged.

# 1.0 INTRODUCTION

## 1.1 Background

In 1990 a group of landowners in the area north of the South March community in the City of Kanata applied to the City of Kanata and the Regional Municipality of Ottawa-Carleton to amend their respective Official Plans to permit urban development. In response to this the City completed a concept plan that dealt with land use, development, transportation environment and infrastructure issues. That study was the basis for the Regional Official Plan Amendment 41 (ROPA 41) that was adopted by Regional Council in March 1994.

The Ministry of Municipal Affairs refused to approve ROPA 41 and the issue was referred to the Ontario Municipal Board (OMB). Following the hearing in July 1995, the OMB approved ROPA 41 in January 1996. The approval set several requirements that had to be met before urban development could proceed in the area called Kanata North Urban Expansion Area (KNUEA). Those requirements were incorporated with the Regional Official Plan (ROP).

One of the key requirements was the preparation of a study that addressed the various matters set out in the ROP policies. To that end, in 1998, the City of Kanata completed a study[1] which addressed the necessary issues and also recommended a concept plan for the study area. Figure 1 attached is the concept plan recommended in the 1998 Kanata study.

With regard to the ability of current and future municipal infrastructure to meet the demands of the KNUEA the following paragraph is extracted from the 1998 study.

> *"A report was prepared for Phase One, using a very aggressive growth rate to determine the impact of the "worst-case" scenario on transportation and infrastructure requirements. The only specific additional unplanned item that arose in this scenario was for March Road to be widened to six lanes instead of the planned four lanes. There was also a contributory impact on Terry Fox Drive. In subsequent planning analysis, a more conservative and realistic growth rate was used and no additional unplanned facilities were required. The proposed plan has been designed to conform to Regional Master Plans for Infrastructure".*

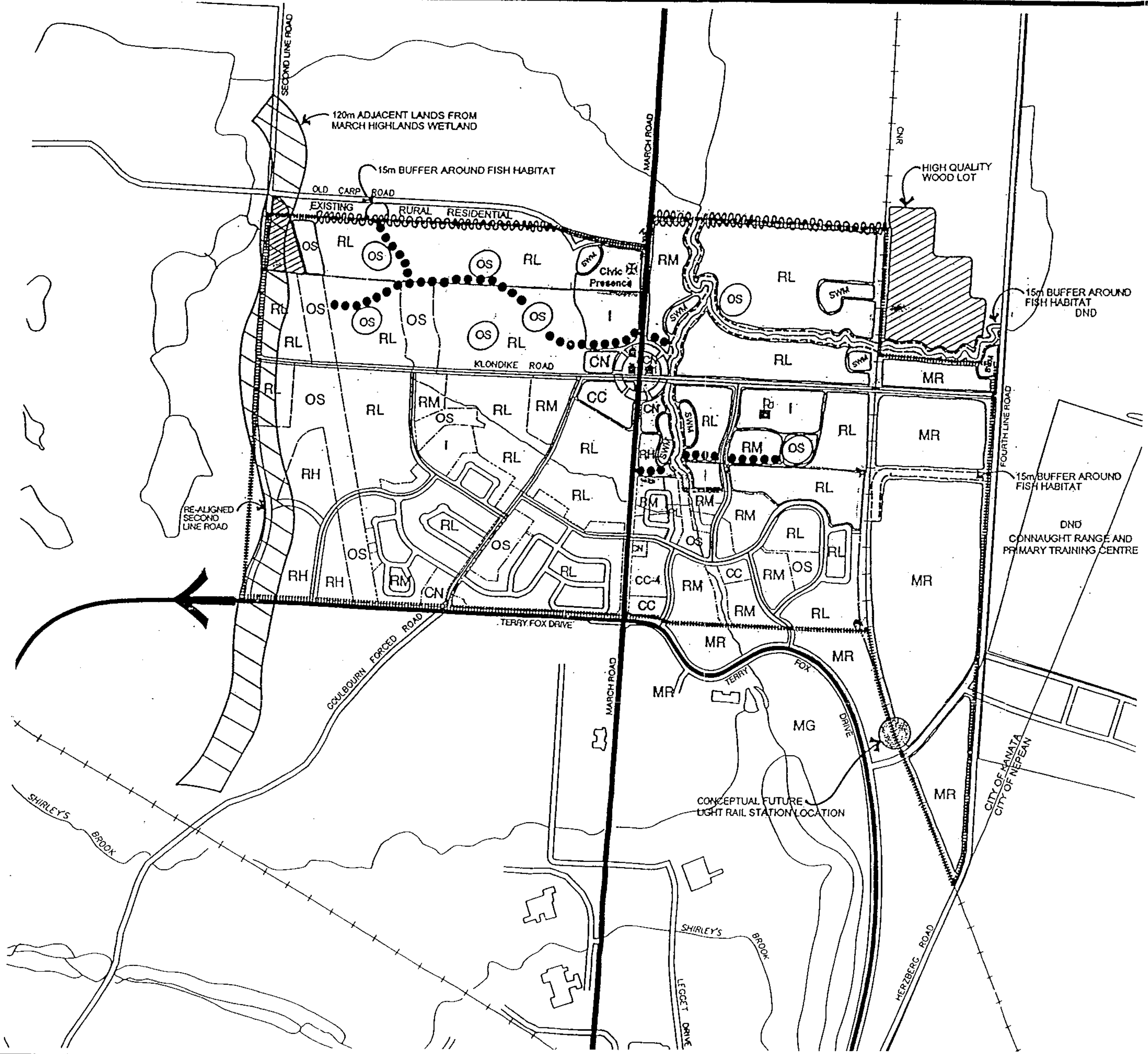
Subsequent to completion of the 1998 study and concept plan under Regional Official Plan Amendment 8, the Region adopted the plan and the City of Kanata is presently preparing a local Official Plan Amendment in accordance with the 1998 concept plan.

## 1.2 Briarridge Drainage Area

Both the Marchwood Trunk and the East March Trunk provide the necessary sanitary wastewater outlet for the South March community and the Kanata North Urban Expansion Area.

---

1 Kanata North Urban Expansion Area Study Concept Plan




# KANATA NORTH URBAN EXPANSION STUDY

Study Area Boundary
Existing Urban Area Boundary

## LEGEND:

**Urban Land Use Designations**
- RL Low Density Residential
- RM Medium Density Residential
- RH High Density Residential
- OS Park and Open Space
- CC Community Commercial
- CN Neighbourhood Commercial
- I Institutional
- MG General Industrial
- MR Restricted Industrial

**Roads**
- Major Arterial
- Neighbourhood Collector
- Local Street

**Heritage Resources**
- Building of Heritage Interest
- Heritage Precinct

**Community Facilities**
- School Site (Conceptual Location)
- Fire Station (Conceptual Location)
- Civic Presence (Conceptual Location)

**Environmental Resources**
- High Quality Wood Lot
- Rural/Urban Buffer
- Fish Habitat
- 120m Adjacent Land to South March Highlands Wetland Complex
- Storm Water Management Facility

**Park and Open Spaces**
- Conceptual Park Location
- Linkage

## CONCEPT PLAN

BRIARRIDGE SANITARY PUMPING STATION PRE-DESIGN REPORT
CITY OF KANATA

Cumming Cockburn Limited
Consulting Engineers, Planners, and Environmental Scientists

SOUTH MARCH AND KANATA NORTH CONCEPT PLAN

DATE NOV. 2000 | FIGURE 1

Figure 2, which was extracted from the 1998 report, shows the South March and KNUEA areas together with the two outlet sewers. Wastewater flows from the South March community west of March Road will be directed to the Marchwood Trunk. All the wastewater from the Kanata North Urban Expansion Area will be directed to the East March Trunk.

Most of the area east of March Road, including all lands north of Klondike Road and east of the Ottawa Central Railway (OCR) railway track are tributary to the proposed Briarridge Pumping Station. Figure 3 shows the detailed tributary area together with the proposed pumping station location and EMT sewer location.

The total gross area tributary to the proposed pumping station is about 179 ha. Allowing for lands adjacent to Shirley's Brook as open space and the proposed golf course in the Kanata Research Park, the net drainage area to the station is about 128 ha.

Development of a small portion of the drainage area was completed in the mid 1990's along Helmsdale Drive. That development consists of 88 townhouse units in the medium density residential area in the south of the drainage area immediately east of Shirley's Brook. Flows from that area drain to a temporary lift station on Helmsdale Road. That station, which discharges into the terminus of the EMT sewer, will be decommissioned upon completion of the Briarridge Pumping Station.

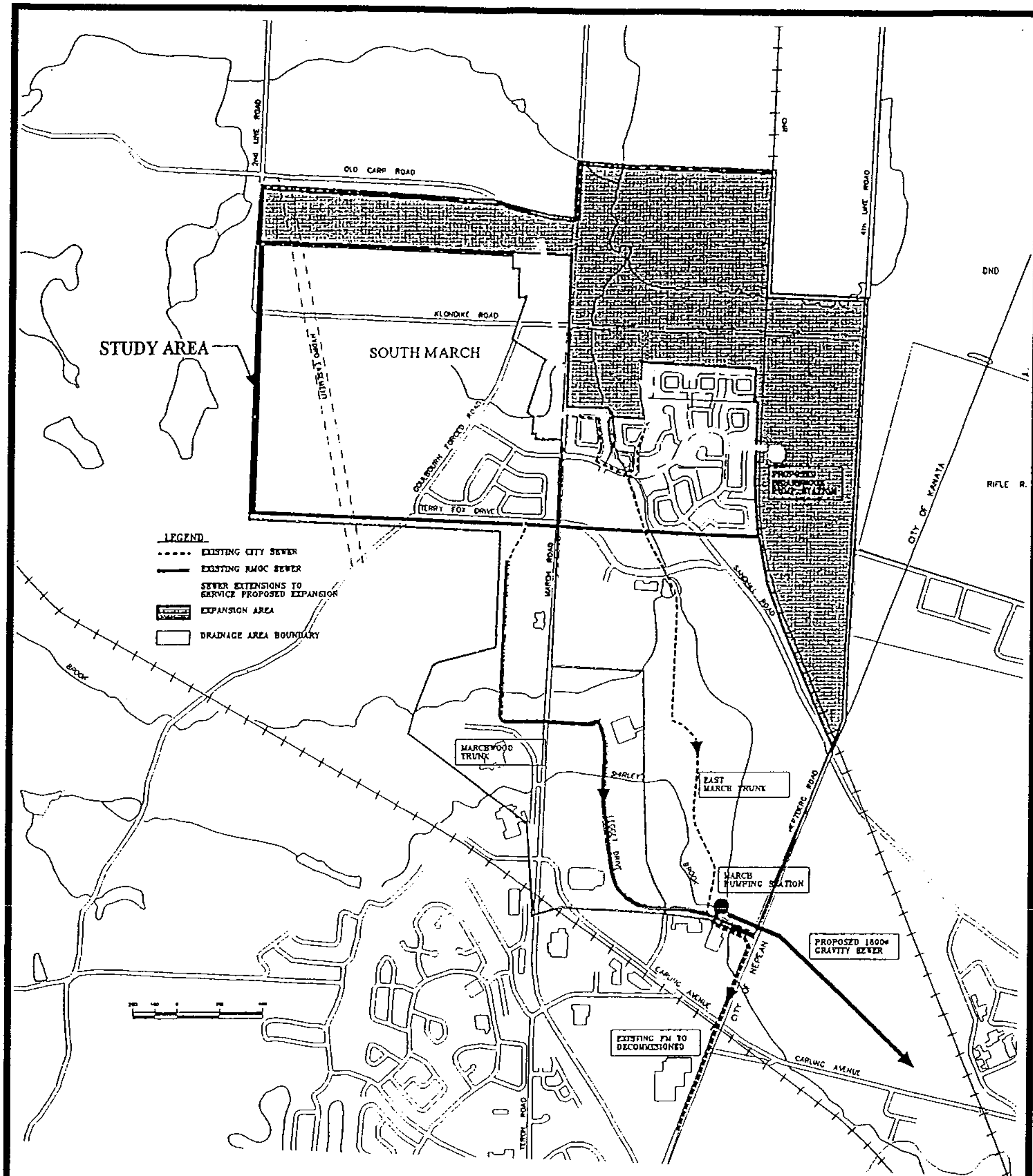
In accordance with the adopted concept plan, the lands in the pumping station drainage area will be low or medium density residential, (with one elementary school) or restricted industrial. All lands east of the OCR tracks will be industrial and those west of the tracks will be residential.

### 1.3 Purpose of Report

This brief or pre-design report is completed to provide the affected approval agencies and eventual station owners and operators with a blue print for the station and forcemain upon which final design and construction will be based.

This report will detail expected wastewater flow rates from inception to build out. It will establish a plan to collect and discharge those flows from early developments to build out. The plan will address the issues of initial low flows and resultant velocities and resident times both in the station and forcemain.

The City of Ottawa (former Region) will eventually own and operate the station and much of the criteria discussed herein will be based on design guidelines and operating procedures used by the former Region.

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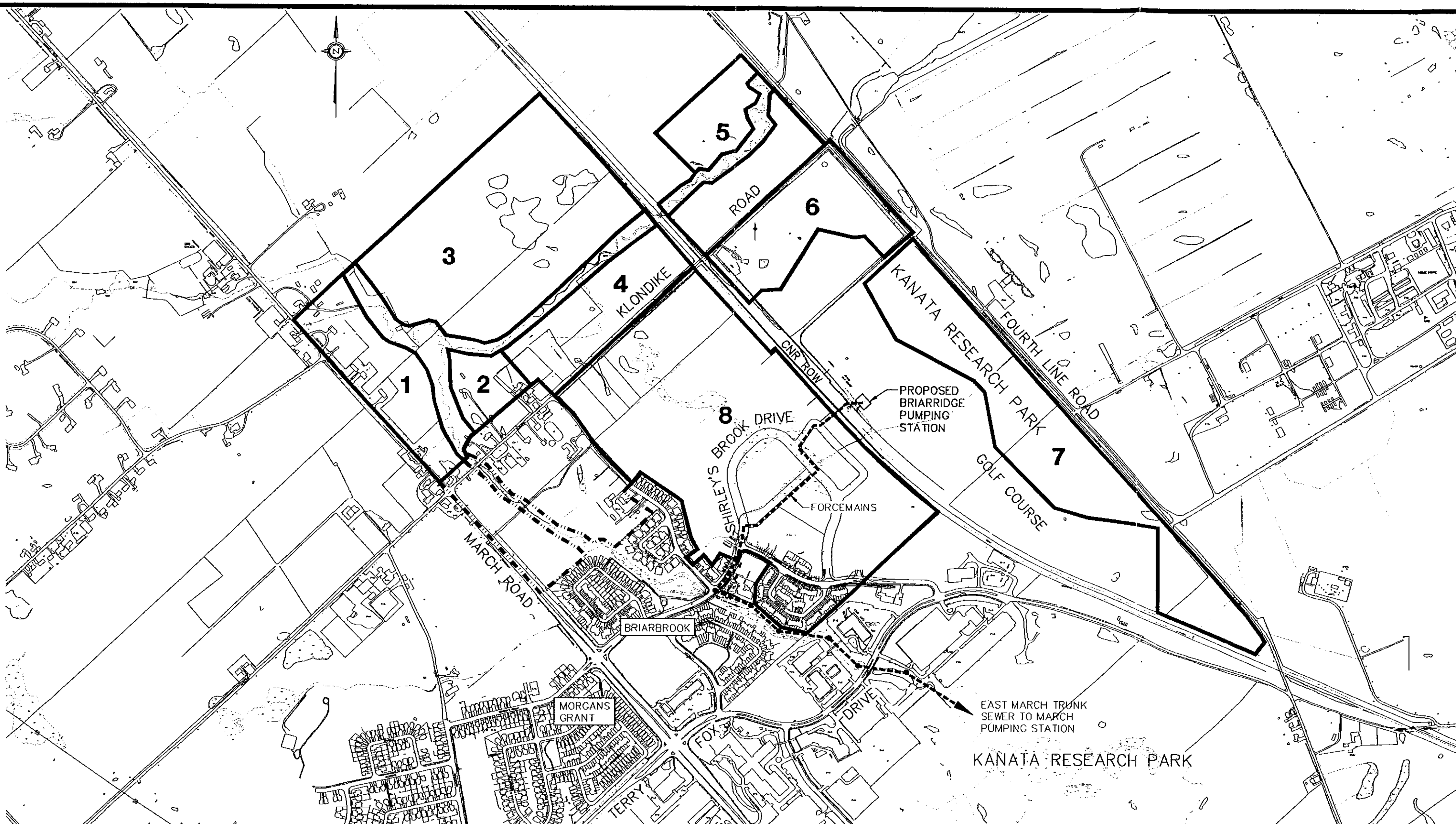
SOUTH MARCH AND KANATA NORTH OULET SANITARY SEWERS

| | |
|---|---|
| DATE NOV. 2000 | FIGURE 2 |




LEGEND:

**7** DRAINAGE AREAS

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SANITARY DRAINAGE AREAS

DATE NOV. 2000 | FIGURE 3

## 2.0 HYDRAULIC ANALYSIS

### 2.1 Flow Projections

The total area of both the South March community and the Kanata North Urban Expansion Area is about 414 ha (refer to Appendix "A" Development Capacity Analysis reproduced from the 1998 report). That report, which mirrors closely Regional projections, estimates that there were 938 housing units in the South March community in 1998 and predicts there will be a total of 3121 units by 2021 and 4290 units at build out. The report also estimates that the build out population will be 14290 which equates to 3.33 people per unit.

The 1998 study also included information and predictions concerning housing densities and general rates of development. These are:

- Low density residential — 17 to 25 units per hectare
- Medium density residential — 15 to 35 units per hectare
- Development rate — 94 units per year

With regard to development rates for industrial lands within the Briarridge Pumping Station drainage area, a development rate similar to projected residential units is assumed.

The following design criteria was also used:

**<u>Design</u>**

| | | |
|---|---|---|
| Flow per capita | 350 l/d | |
| Peaking factor | Harmon = | p in 1000's |
| Industrial | 35,000 l/ha/d | |
| Industrial peaking factor | MOE guidelines | (see Appendix "B") |
| Infiltration | 0.28 l/ha/s | |

The Region has also asked that monitored flow rates also be evaluated for the Briarridge Pumping Station drainage area. These flows are:

**<u>Monitored</u>**

| | | |
|---|---|---|
| Flow per capita | 300 l/d | |
| Peaking factor | Modified Harmon = | p in 1000's |
| Industrial | 15,000 l/ha/d | |
| Industrial peaking | 2.0 | |
| Infiltration: | | |
| DW Inflow | 0.05 l/ha/s | |
| WW Event (typ) | 0.15 to 0.20 l/ha/s | |
| WW Event (large) | 0.28 l/ha/s | |
| WW Event (rare) | 0.30 to 0.50 l/ha/s | |

The Region has completed extensive flow monitoring throughout the region. Results of the monitoring indicate that during most times flows less than those predicted by the standard MOE design criteria occur. Therefore the Region asked that the pumping system proposed for Briarridge include its findings. The Region provided the pertinent monitored criteria noted above which is based on its extensive monitoring program.

Based on the above information and criteria, Table 1 summarizes the expected flow projections from 2001 to build out. The detailed calculations are included in Appendix "B". An inflow and infiltration rate of 0.28 l/s/ha was used to calculate the monitored annual peak flow and a rate of 0.50 l/s/ha was used to calculate the monitored rare event

**TABLE 1**

| | Estimated Flows (l/s) | | | | | |
|---|---|---|---|---|---|---|
| | 2001 | | | 2011 | | |
| | Design Peaked | Monitored Annual Peak | Monitored Rare Event | Design Peaked | Monitored Annual Peak | Monitore d Rare Event |
| Residential | 5.64 | 3.81 | 4.56 | 35.65 | 24.67 | 30.59 |
| Industrial | — | — | — | 64.35 | 18.05 | 26.81 |
| **TOTAL** | **5.64** | **3.81** | **4.56** | **100.00** | **42.72** | **57.40** |
| | 2021 | | | Build Out | | |
| | Design Peaked | Monitored Annual Peak | Monitored Rare Event | Design Peaked | Monitored Annual Peak | Monitore d Rare Event |
| Residential | 49.98 | 34.85 | 43.38 | 65.01 | 45.62 | 56.99 |
| Industrial | 88.85 | 26.95 | 40.03 | 108.79 | 34.40 | 51.09 |
| **TOTAL** | **138.83** | **61.80** | **83.41** | **173.80** | **80.02** | **108.08** |

The design of the station will consider both the peak design flow projections which will be the maximum peak wet weather flow predicted by tradition MOE design guidelines. The station design will also consider the monitored peak annual wet weather flow rate. This rate is the expected wet weather event that traditionally will be expected to occur during the spring snow melt. Thus the hydraulic design of the station will consider station operation under both these events to buildout. The third column in Table 1 was included to show that the predicted monitored extreme or rare event was still less than the flows predicted by MOE design criteria.

Landowners for drainage areas 2, 3 and 4 have petitioned the Region to change the current residential land use in those areas to restricted industrial. A supplementary design sheet was completed assuming that the above three areas developed with industrial uses as opposed to residential, and the resultant estimated flows were found to be less than 5% higher than residential uses. Therefore to be slightly conservative the flow calculations given in this report assume that drainage areas 2, 3 and 4 develop as industrial uses and not residential.

## 2.2 Changes to Drainage Area

Most of the tributary drainage areas to the Briarridge station are proposed light industrial uses. A portion of these include Areas 6 & 7 as shown on Figure 3. Those two areas will be developed around a portion of a proposed golf course between the railroad and Fourth Line Road. In terms of sanitary flows tributary to the station, the golf course development will have negligible impact.

In the unlikely event that the approximately 20 hectare area taken up by the golf course in this area should development as an industrial park, similar to Areas 6 & 7 a sensitivity analysis on tributary flows to the station was completed. A detailed design sheet describing that event is included in Appendix B.

Without any contributary flows from the golf course the estimated peak flow to the station is 174 l/s. The peak flow will increase to 199 l/s if the area taken up by the golf course should develop as light industrial. Since the golf course is presently under construction it is unlikely it will develop as light industrial in the foreseeable future. In the improbable event it does, then additional pumping capability in the Briarridge station may have to be reviewed at that time as well as available outlet sewer capacity. The initial design of the Briarridge station does not allow for flows from the area taken up by the golf course.

## 2.3 Forcemain Sizing

The Region has stipulated that as owners and operators of the proposed Briarridge Pumping Station, it requires a dual forcemain design. Also, although a small portion of the Briarridge Pumping Station drainage area is developed (88 townhouse units over 3.37 ha) the forcemain and pumping capabilities should consider the fact that full development of the drainage area could take a generation or more.

The station and forcemain are to be designed to enable optimum performance for the 20 year design period including the initial low flow period. The pumping station is also designed to accommodate build-out design peak flows. These two conditions and resultant infrastructure must be considered for a staged development covering 128 ha.

The following conditions and assumptions were considered in the pre-design of the station and forcemains.

- Pumping capacity should be staged to match the 10 year, 20 year and build-out estimated flows.

- To provide added protection against basement flooding by wastewater, an emergency overflow to an existing outlet storm ditch will be constructed. The overflow is a "last resort" level of protection since the station will have sufficient firm pumping capacity powered from the local electrical grid. Additionally the station is proposed to include an emergency back up diesel generator. The level of protection proposed to be provided by the overflow is the annual wet weather monitored event equivalent to about 80 l/s.

- The Ministry of Environment stipulates that the firm station capacity is the available pumping capacity when the largest installed pump is out service. Thus the firm pumping capacity for the Briarridge Pumping Station will be:

  | | |
  |---|---|
  | 10 year | 100 l/s |
  | 20 year | 136 l/s |
  | Build Out | 174 l/s |

  The firm capacity can take advantage of both forcemains.

- Simultaneous failure of a pump and forcemain is assumed to be of minimal probability. If a forcemain is out of service, the capacity of the station may be based on all installed pumps being in service. The station installed capacity (all pumps in service) when pumping through the smallest forcemain is to be greater than or equal to the Monitored Annual Peak Flow indicated in Table 1. For the Briarridge Pumping Station these pumping requirements are:

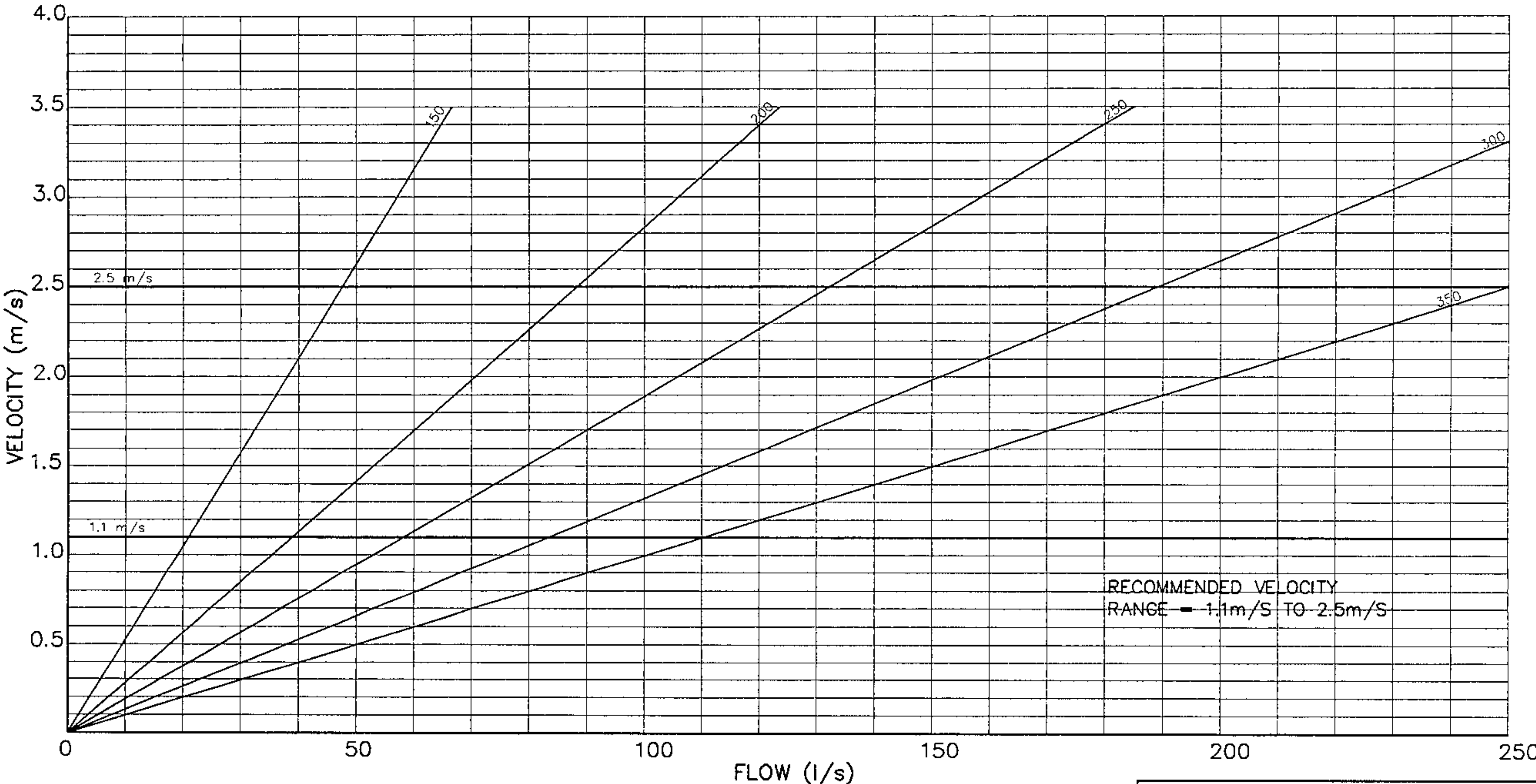
  | | |
  |---|---|
  | 10 year | 43 l/s |
  | 20 year | 61 l/s |
  | Build Out | 80 l/s |

  For purposes of further evaluation the forcemain material considered in this report is equivalent to PVC DR 25. At the time of final design other materials such as Ductile Iron or High Density Polyethylene (HDPE) or another class of PVC material could also be considered.

## 2.4 Forcemain Velocities

The typical recommended minimum cleansing velocity for forcemains is 0.80 m/s. Velocities below that limit lack the re-suspension ability to cleanse the mains and operational difficulties arise. To ensure cleansing velocities are adequately achieved for the Briarridge Pumping Station it is assumed that the minimum design velocity will be 1.10 m/s. Because the Briarridge forcemain will discharge directly to a gravity sewer, a maximum operational velocity of 2.5 m/s will be a target. Infrequent events, which may result in slightly higher velocities, can be tolerated. Energy consumption needed for large velocities should be avoided.

Thus for the Briarridge Pumping Station the minimum and maximum design velocity criteria will be 1.1 m/s and 2.5 m/s respectively. Figure 4 shows the velocity characteristics for several size forcemains over a range of flows.

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FORCEMAIN VELOCITIES

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FIGURE 4

The two forcemains can be sized to handle the 20 year or build out design flow ranges. Sizing the two forcemains to handle the 20 year design flow range enables the smallest forcemain's diameter, volume and retention time to be reduced. However, consideration must also be given to the build out flow ranges when sizing the two forcemains.

### 2.4.1 20 Year Design Approach

The smallest forcemain is to convey the 20 year Monitored Annual Peak event flow of 61 l/s, if the second main is out of service. Figure 4, indicates that the smallest forcemain with a velocity less than 2.5 m/s at 61 l/s is 200 mm ø.

The diameter of the second forcemain is dependent upon that of the smallest forcemain. The expected flow for the 20 year peak design will be 136 l/s. At the maximum design velocity of 2.5 m/s, the required total forcemain area will be 0.054 $m^2$ for two forcemains. The total cross sectional area of a 200 mm ø and 150 mm ø forcemain is 0.056 $m^2$. However a 150 mm ø forcemain cannot convey the 20 year Monitored Annual Peak event flow of 61 l/s. Therefore the minimum size of the second forcemain must be 200 mm ø.

Thus the two forcemains must be able to convey the 20 year design peak flow of 136 l/s. Also all installed pumps discharging to the smallest forcemain must deliver a minimum flow of 61 l/s.

For the 20 year design, the forcemain (F/M) alternatives given further evaluation are:

| | |
|---|---|
| F/M Alternative 1 | 200 and 200 mm ø |
| F/M Alternative 2 | 200 and 250 mm ø |
| F/M Alternative 3 | 200 and 300 mm ø |

### 2.4.2 Build Out Design Approach

The smallest forcemain must convey the build-out Monitored Annual Peak event flow of 80 l/s if the second forcemain is out of service. The smallest standard pipe diameter which can satisfy the 2.5 m/s maximum velocity criteria is 200 mm ø.

Both forcemains must be capable of conveying the build out design peak flow of 174 l/s. The minimum required cross sectional area at the design velocity of 2.5 m/s would therefore be 0.068 $m^2$. Two 200 mm ø forcmains have a total area of 0.070 $m^2$.

With the largest pump out of service, the two forcemains must be able to convey the build-out design peak flow of 174 l/s. Also all installed pumps discharging to the smallest forcemain are to convey a flow of 80 l/s.

For the build-out design the following forcemain alternatives were given further consideration.

| | |
|---|---|
| F/M Alternative 4 | 250 and 250 mm ø |
| F/M Alternative 5 | 250 and 300 mm ø |

## 3.0 PUMPING EQUIPMENT AND FORCEMAIN SELECTION

### 3.1 Station Head and System Curves

Figure 3 shows the proposed location of the Briarridge Pumping Station and discharge forcemains. The average static lift for the station will be about 13.37 metres. The outlet elevation at the end of the East March Trunk is 72.77 metres. The approximate storage limits in the station wet well will be between 58.4 m and 60.4 m.

Based on an average static lift of 13.37 m some preliminary system curves are shown in Figure 5.

In 1994 Coscan Development Corporation had started preliminary design on the Briarridge Pumping Station (then called the Briarbrook Pumping Station). Some of the design assumptions implemented at that time are proposed to be employed in the design of the Briarridge Pumping Station.

In 1994, a pre-fabricated fibre reinforced plastic (FRP) wet well c/w ITT Flygt submersible pumps was proposed. The Region has successfully used this application for at least two recent applications (1996 River Road and 1998 Hemlock) and were involved in discussions during the preliminary design of the Briarbrook Pumping Station.

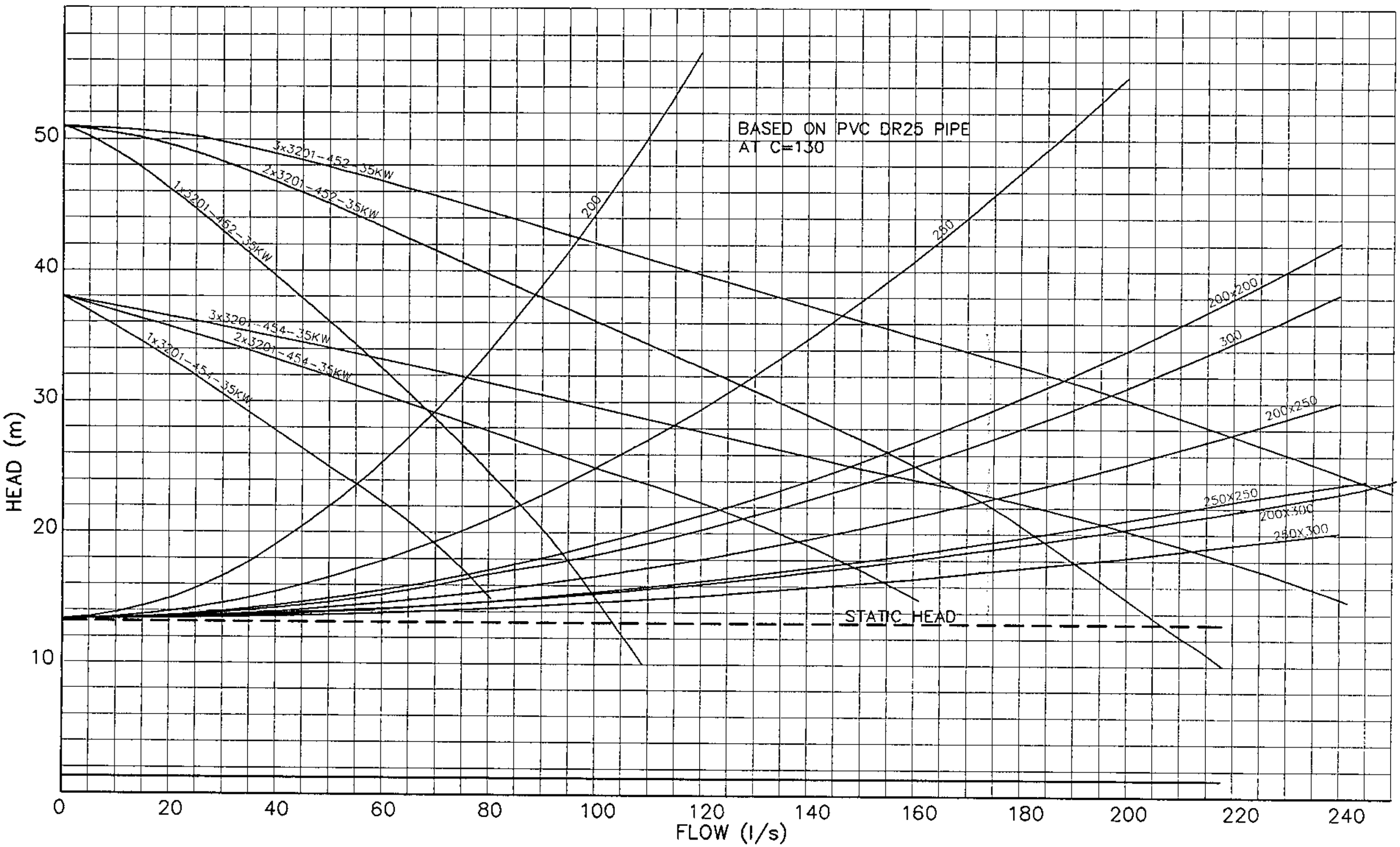
The proposed duty pumps will be constant speed. The Briarridge Pumping Station is not a large station and constant speed driven pumps can be easily upgraded through the build out period to match changing flow conditions. A combination of impeller changes, pump changes or additional pumps can adequately match the flow sizes to build out conditions. It should be recognized that a normal pump life is about 20 years. It is likely that at the end of the life of the initial pump installation, larger pumps if deemed necessary at that time could be installed.

It is recommended that a 3.66 m ø (12 foot) fibre reinforced plastic (FRP) wet well using submersible constant speed sewage pumps be installed in the Briarridge Pumping Station.

### 3.2 Pump Selection

All the calculated pumping rates hereafter are based on submersible pumps by ITT Flygt. The following section examines pumps in combination with the previously identified dual forcemain alternatives and system curves. In particular, one pump model seems to be well suited for the analysis; the C3201 35kW unit at 1755 rpm and 452 impeller. A pump curve is also included for impeller 454. That impeller may be a better selection during the early years of operation. The manufacturers hydraulic and electrical performance pump curves for these models are included in Appendix "C".

The C3201 pump curves for one, two and three units in a parallel operation are superimposed on the single and dual forcemain alternative system curves as shown in Figure 5. These figures indicate the estimated discharge capacity and duty points for the various possible operating conditions.

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SYSTEM CURVES

DATE NOV. 2000

FIGURE 5

Table 2 which was developed from the values in Figure 5 for the 452 impeller, presents the maximum pumping capacities for the various alternative forcemain configurations.

**TABLE 2**
**PUMPING CAPACITIES WITH ALTERNATIVE FM'S**

| | **20 YEAR DESIGN** | | | **BUILD-OUT DESIGN** | |
|---|---|---|---|---|---|
| **ALTERNATIVES** | **1** | **2** | **3** | **4** | **5** |
| **Pumping Capacity in Dedicated Forcemain** | | | | | |
| **Forcemain A (mmø)** | **200** | **200** | **200** | **250** | **250** |
| 1. Pump | 69 | 69 | 69 | 86 | 86 |
| 2. Pumps | 88 | 88 | 88 | 127 | 127 |
| 3. Pumps (1) | 97 | 97 | 97 | 147 | 147 |
| **Forcemain B (mmø)** | **200** | **250** | **300** | **250** | **300** |
| 1. Pump | 69 | 86 | 95 | 86 | 95 |
| 2. Pumps | 88 | 127 | 155 | 127 | 155 |
| 3. Pumps | 97 | 147 | 197 | 147 | 197 |
| Firm Capacity (2) | 155 | 173 | 183 | 182 | 190 |
| Installed Capacity | 188 | 220 | 247 | 244 | "265 |
| **Pumping Capacity in Combined Forcemains** | | | | | |
| **Forcemain A&B** | **200+200** | **200+250** | **200+300** | **250+250** | **250+300** |
| 1. Pump | 94 | 97 | 99 | 99 | 101 |
| 2. Pumps | 155 | 173 | 183 | 182 | 190 |
| 3. Pumps | 188 | 220 | 247 | 244 | "265 |

| | Small F/M | Both FM's |
|---|---|---|
| Notes: | (1) 20 yr installed (monitored) cap. = 61 l/s | 20 yr F/M Cap. (Design) = 136 l/s |
| | (2) B/O installed (monitored) cap. = 80 l/s | B/O F/M Cap. (Design) = 174 l/s |

For the build-out design approach, the pump/forcemain combination must deliver 174 l/s. From Table 2 alternatives 3, 4 and 5 will provide the required capacity to meet that criteria. Before making a final decision on the preferred forcemain design some consideration to the issue of low flows, system retention times and resultant impacts should be considered.

### 3.3 Low Flow Impacts and Mitigation

Hydrogen sulfide ($H_2S$) gas suppression and mitigation has direct bearing on the evaluation of the forcemain alternatives. $H_2S$ forms in domestic wastewater under anerobic conditions (i.e. no oxygen environment). The opportunities for such events in the Briarridge Pumping Station will be in the wet well and in the forcemain. The longer the wastewater is held in anerobic conditions (retention time) the greater the concentration of sulfide in the wastewater which is discharged from the forcemain. There are three ways to address this potential problem:

- minimize retention times in wet wells and forcemain;
- suppress sulfide formation in wet wells and forcemains by oxygenation or chemical addition; and
- mitigate the negative impacts of $H_2S$ released in the downstream sewers.

### 3.4 Reducing Retention Times

Wet well retention times are typically short as compared to forcemain retention times. This will be the case with the Briarridge Pumping Station. Wet well retention times can be kept to a minimum by shortening the distance between normal "pump-on" elevation and "pump-off" elevation. Mixers can also be added to a wet well to provide oxygenation.

Forcemain retention time can be reduced by discharging through a smaller forcemain during early years of development. Thus there would be an advantage to using a smaller forcemain, given a choice, to lessen the possibility of $H_2S$ formation.

Anerobic reactions that play a role in the formation of hydrogen sulfide are relatively slow. They require hours (6-7 hrs) to happen under optimal environmental conditions (e.g. a temperature range of $30\text{-}35^{N}$ C, the presence of suitable nutrients, etc.). At lower temperatures (e.g. $10\text{-}15^{N}$ C) these reactions may require weeks or even months. However, the conversion of $H_2S$ to sulphuric acid is quite rapid and may occur in seconds.

Table 3 shows expected retention times in a 200 mm diameter forcemain for the Briarridge station. Even with early low flows of 1 l/s the expected maximum retention in the forcemain can be controlled to about 7.5 hours. It is reasonable to expect initial dry weather flows to the Briarridge station will be at least 1 l/s. Measured dry weather average flows to the current station were in the 0.7 l/s range.

It is therefore unlikely that problems arising from the formation of sulfuric acid resulting from hydrogen sulfide in the forcemain will happen for the Briarridge station since the optimum environment will not exist. However, to be safe in this regard, allowances in the proposed control building will be provided for the future addition of hydrogen sulfide suppression appurtenances such as storage, pumps, electrical, plumbing, etc.

### 3.5 Selected Forcemains

Alternatives 3, 4 and 5 meet the design criteria established for this report. It is recommended that the 200 mm and 300 mm diameter forcemains be constructed for the Briarridge station.

Alternative 4 (2 x 250mm forcemain) offers no flexibility for initial low flow periods or energy efficiency in later years of development. Alternative 5 will offer the largest flow capability but will be less effective in early years of development in terms of forcemain retention times. Alternative 3 combines the best option for the initial development period and build out condition. At a firm capacity of about 183 l/s it has some flexibility for increases in development trends for the catchment area.

### 3.6 Existing Conditions

As stated earlier, a portion of the Briarridge Pumping Station drainage area has already developed. Part of that development included a short section of Shirley's Brook Drive in which the ultimate forcemain from the Briarridge Pumping Station was to be located. In order to eliminate the need to re-excavate about 165 metres of Shirley's Brook Drive, a ductile iron forcemain was constructed. That forcemain includes a 15m length of 400 mm ø pipe and 150 m of 350 mm ø pipe. The discharge forcemain from the existing temporary pumping station runs parallel with that forcemain. It is therefore proposed to connect the larger Briarridge forcemain to the existing 350 mm ø pipe but construct the smaller forcemain in the existing south boulevard of Shirley's Brook Drive. That boulevard is 7.5 m wide and should provide sufficient room to accommodate the new pipe.

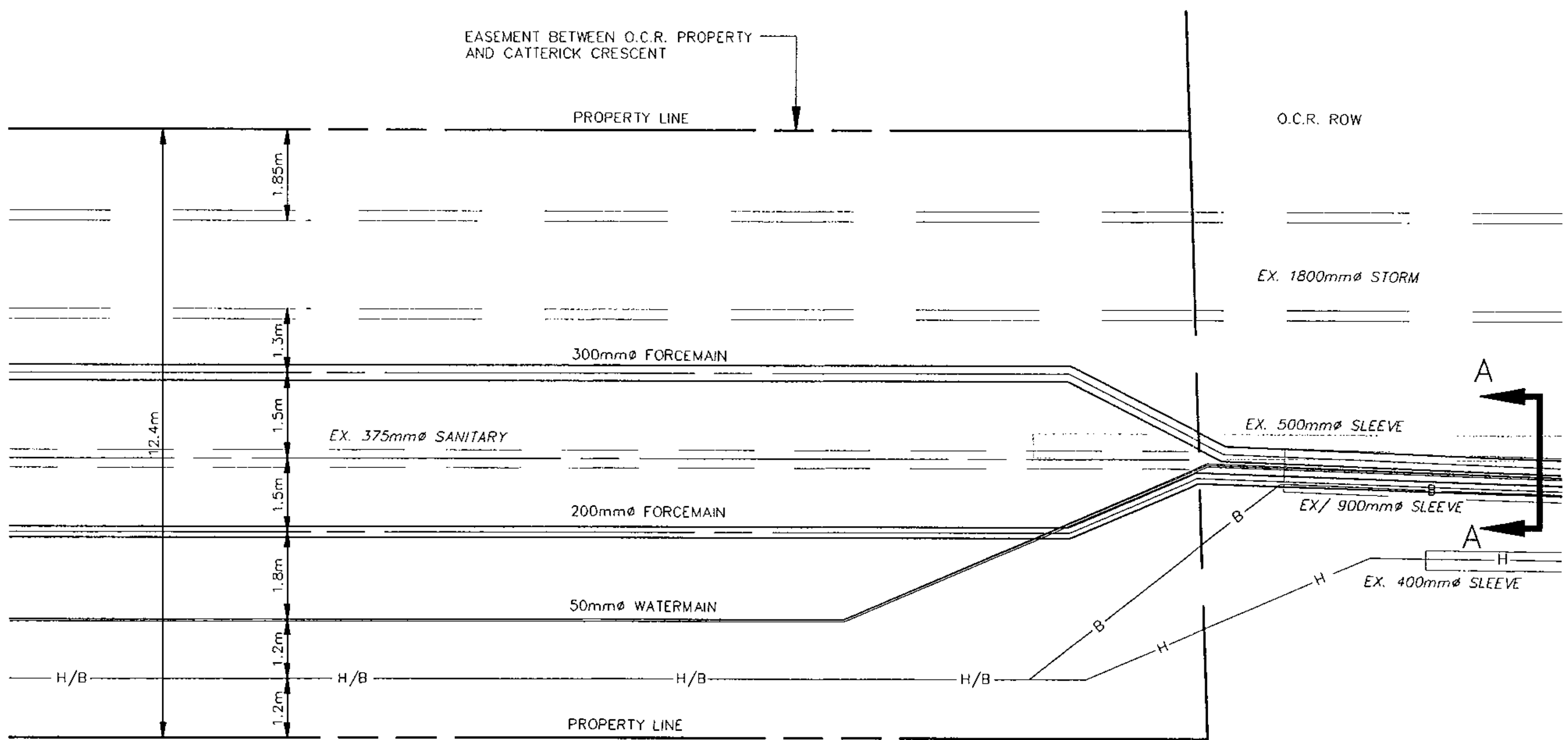
Both storm and sanitary sewer outlets from some of the area tributary to the Briarridge Pumping Station have to cross under the OCR tracks. In anticipation of further development in South March, in the early 1990's several steel casings were constructed under the tracks. These casings were designed to carry the necessary future infrastructure to develop the Briarridge Pumping Station including, utility supply, sanitary sewer and forcemain. A separate 1800 mm ø storm sewer was also constructed under the tracks at that time.

One of those casings (900 mm ø) was sized to carry a water supply, forcemain and bell ducts. Figure 6 attached shows the proposed forcemain, watermain and bell duct configuration within the steel casing as well as the plan location for all infrastructure from the railway tracks to the nearest subdivision street Catterick Crescent.

### 3.7 Recommended Pumps and Forcemain

The recommended forcemain combination is 200 mm and 300 mm diameter. Each forcemain will be approximately 750 m long.

Two 35 kW pumps could be installed initially (one pump firm capacity) and a third pump added in the future when necessary (approximately 20 years) to provide the ultimate firm capacity. For the CP3201 model pumps, the 452 impeller (330 mm) must be used to provide ultimate firm capacity.

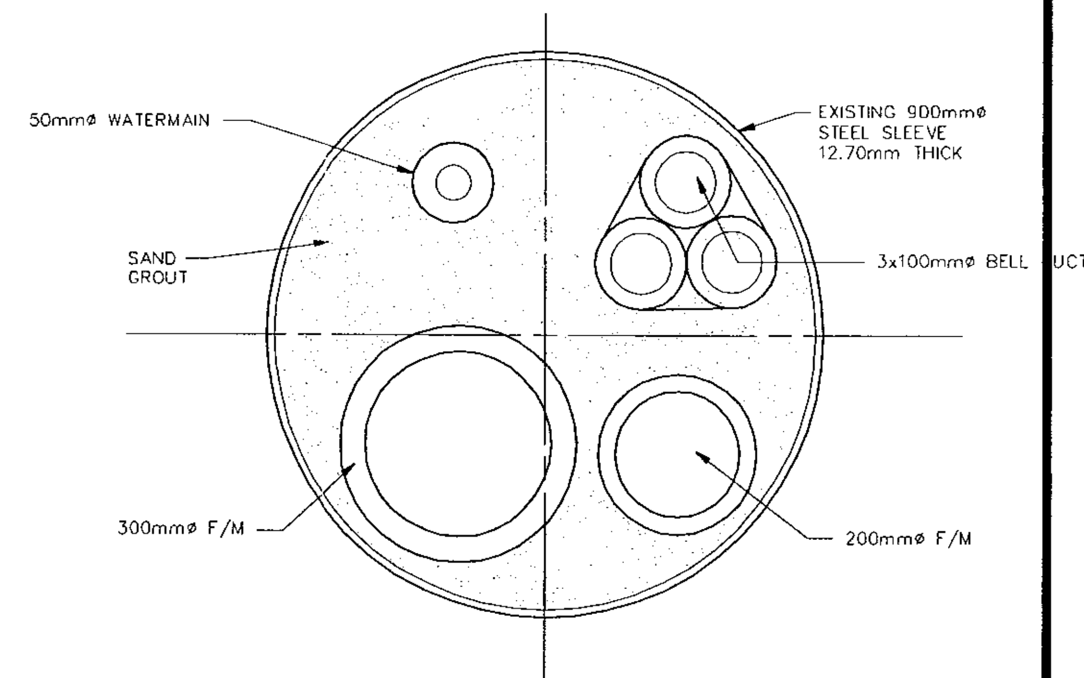



## PLAN VIEW
N.T.S.

LEGEND:

H – HYDRO

B – BELL




## SECTION A–A PROPOSED CROSSING
## 900mmø CASING
N.T.S.

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CNR CROSSING DETAIL

| DATE NOV. 2000 | FIGURE 6 |
|---|---|

However, it is recommended that initially, a smaller 454 impeller (281 mm) be installed in the pumps. Using a 200 mm ø forcemain that impeller will pump about 55 l/s at a velocity of 1.5 m/s. The reason for initially fitting the pumps with smaller impellers is to reduce the peak electrical demand and power costs of the pumps, and to increase their running time versus off time.

### 3.8 External Forcemain

A preliminary plan and profile of the proposed forcemains is shown in Figure 7. It is proposed that the two forcemains be installed at identical elevations with a lateral separation of 1.0m. Because the forcemains are being installed in an urban roadway cross section, they are subject to some location restrictions. It is proposed to install both mains at the same time since it will be expensive to install the second forcemain in the future when the subdivision has been built out.

It is proposed to install both forcemains in the existing 900 mm ø steel casing under the OCR tracks. The forcemains will then be routed along the Catterick Crescent boulevard to Shirley's Brook Drive (south). In Shirley's Brook Drive (south) the forcemains can be located under the roadway asphalt surface.

The forcemain is then proposed to cross Shirley's Brook Drive south and be constructed through a future park land to Shirley's Brook Drive north. From there the larger forcemain can be constructed under the roadway asphalt in Shirley's Brook Drive north to the existing 350 mmø outlet and the smaller one along the south Boulevard ultimately discharging to the existing gravity sewer at a new manhole.

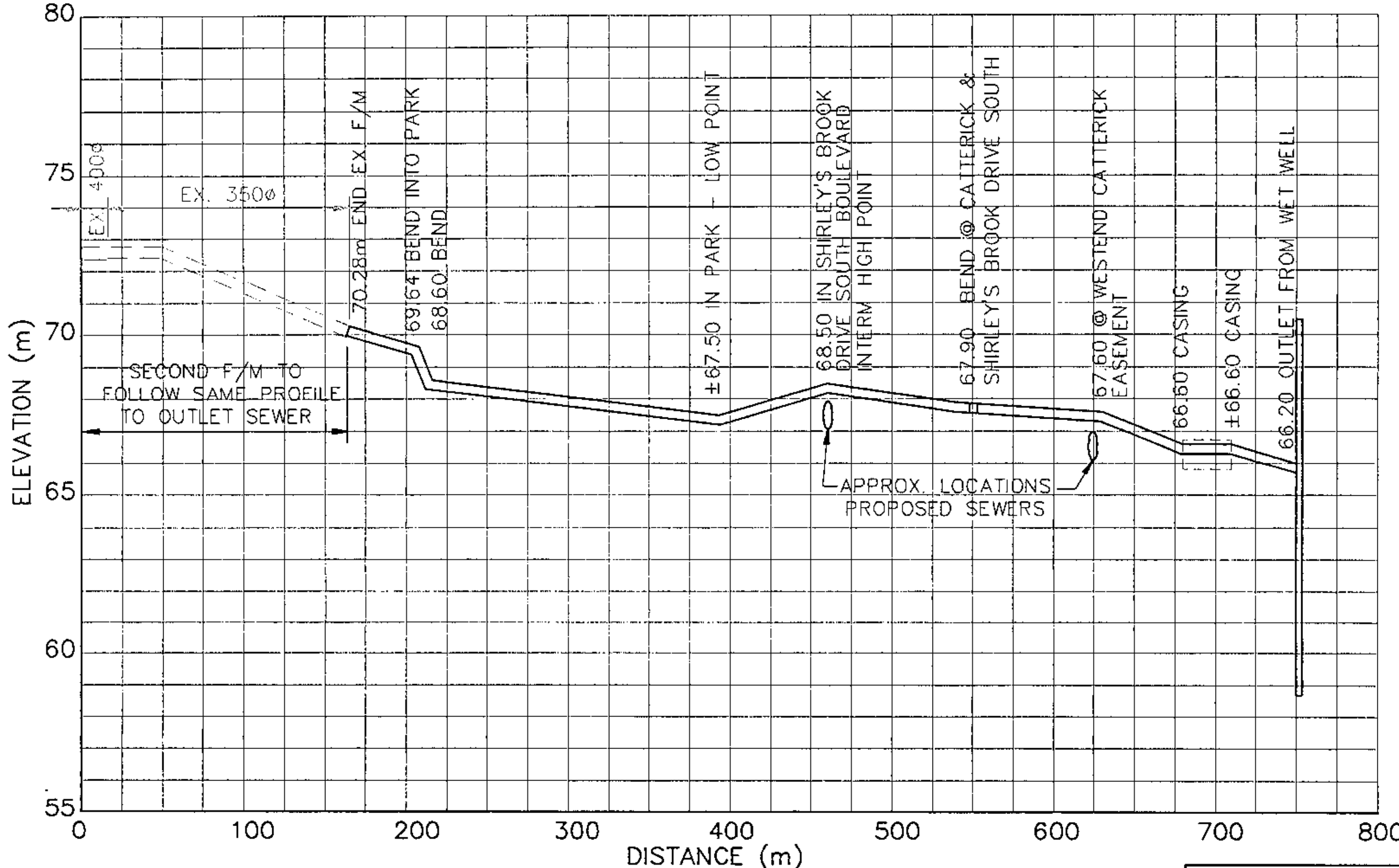
Vertically, the forcemains will have an intermediate high point near Shirley's Brook Drive south and low point in the park area. The saw tooth profile pattern is unavoidable because of conflicts with subdivision sewers. An air release valve complete with chamber will be required at the high point and a drain out chamber will be required at the low point. Cover over the forcemain will be about 2.0 m.

## 4.0 GENERAL STATION ARRANGEMENT AND EQUIPMENT

### 4.1 Pump Station Layout

As stated earlier, some work had already been completed in 1994 regarding the design of the Briarridge Pumping Station. With regard to the wet well, capacity for three pumps in a 3600 mm ø (12 foot) fibre reinforced plastic (FRP) wet well was designed. The same arrangement is proposed at this time. The wet well will be a permanent undivided FRP with two pumps initially installed and full provision for a third pump. Such a well would be almost identical to ones presently existing in two other Regional stations.

Figure 8 shows the proposed initial arrangement for the wet well in both elevation and plan view. The well will be equipped with a manually removed trash rack at the sewer inlet. The well is also proposed to be fitted with an emergency overflow pipe discharging to a nearby drainage ditch. That ditch is part of the storm outlet system for surrounding lands and is tributary to a treatment facility east of Fourth Line Road.

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FORCEMAIN PROFILES

DATE NOV. 2000 | FIGURE 7

The expected 1:100 year flood level in the ditch is 67.0 metres. The lowest residential basement will be about 67.50m. Therefore there is a narrow window for construction of an overflow. The overflow should be fitted with a back water valve and gate valve. The overflow issue will have to be reviewed by the Ministry of Environment.

### 4.2 Building Layout

The control building will include three separate work areas for the Briarridge Pumping Station. One room will be the generator room in which will be installed the back-up power generator, louvers and fuel supply. The second room will include the power supply, motor controls, PLC panels, working space and washroom. The third room will be the chemical room. This room will provide the station operators with the space and ability to add a $H_2S$ suppression system in the future if warranted.

Part of the station system design will include flow meters, pressure transmitters and by-pass connection. Instead of constructing these appurtenances in separate chambers, a basement will be provided below the building control room for easy operational access and control. A typical arrangement is shown in Figure 9. Final layout details can be confirmed at the design stage.

## 5.0 ELECTRICAL REQUIREMENTS

### 5.1 Main Power Supply

The electrical power supply to the pumping station has been assumed to be 600 volt, 3 phase, 60 Hertz. Major pieces of equipment will operate on 600 V 3 pH 60 Hz power supply. A lighting transformer and lighting panel will be provided. Power available from the lighting panel will be either 110 volt or 240 volt single phase 60 Hertz. All lighting and outlets and minor pieces of equipment will be operated from this power source.

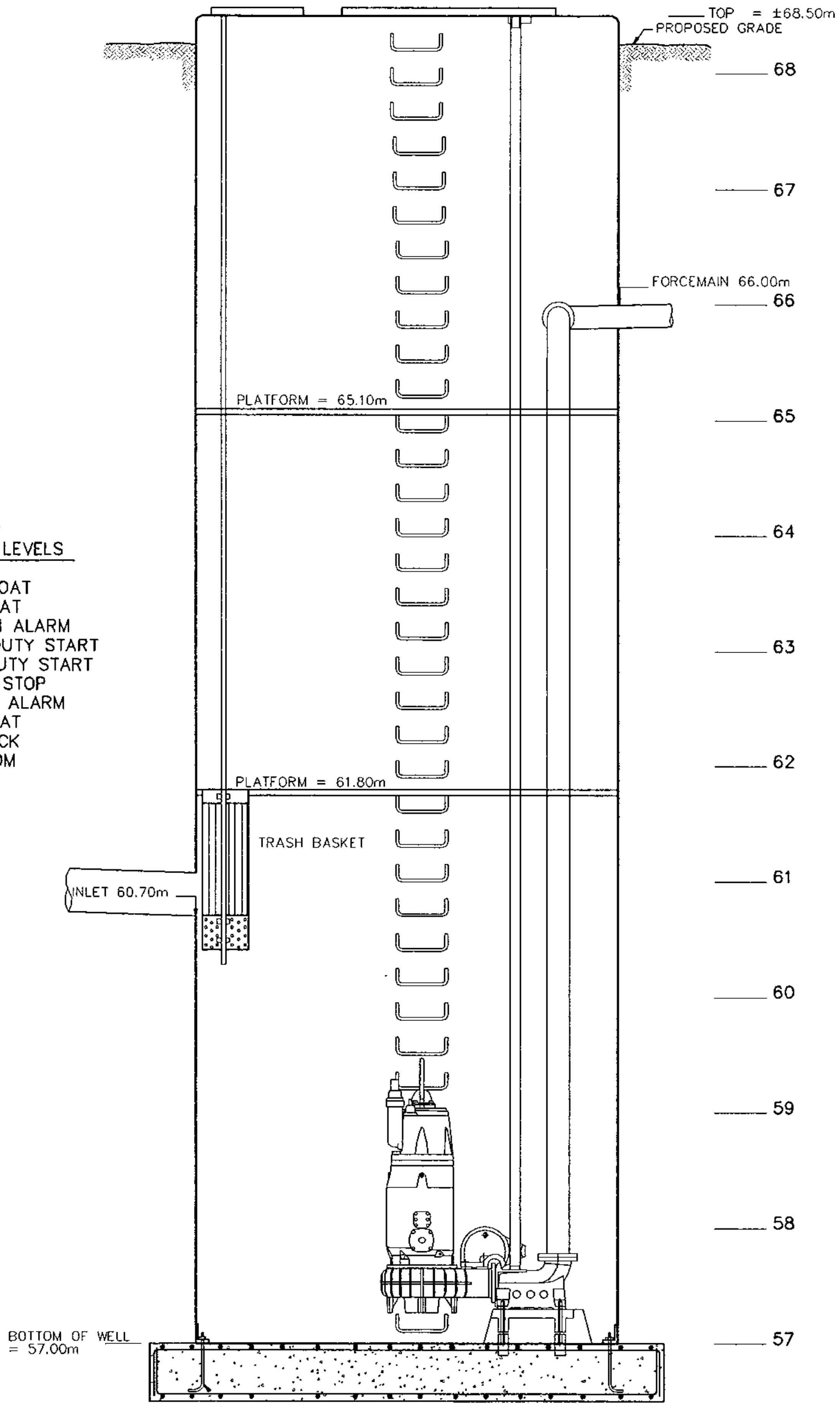
### 5.2 Electrical Systems

Motor starters and/or breakers will be contained in a modular motor control centre (MCC) with sections for incoming supply, main breakers, etc. A separate process metering control panel will be provided adjacent to the MCC section in which will be mounted the independent wet well level indicators, magnetic flow indicator readings and any other necessary process indicators. Reduced voltage (auto transformer) starting will be provided in order to minimize the "in-rush" or "start-up" current and thereby reduce the size of emergency generator required. Deceleration or "ramp-down" stops will also be included.

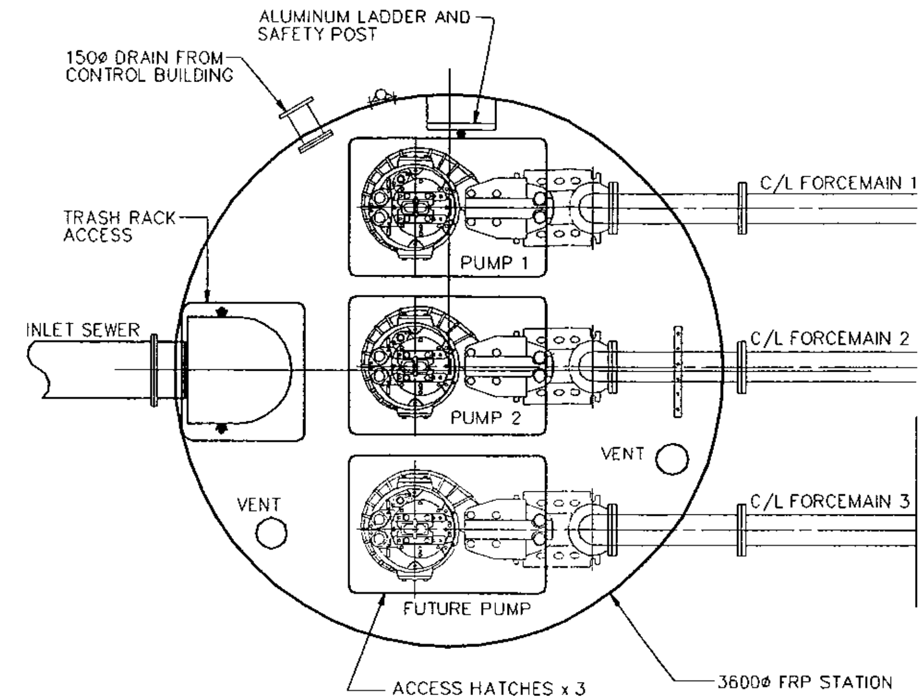
Wiring to all fixtures and equipment will be through conduits which will be exposed to view. Since the wet well is an area in which an explosive gas mixture could be present, conduit, wiring and fixtures in this area will be provided to comply with Ontario Hydro regulations for areas classified as Class 1, Group D, Division 1 areas.

PROPOSED ALARM/DUTY LEVELS

| | |
|---|---|
| 61.10 | HH FLOAT |
| 61.00 | H FLOAT |
| 60.80 | PLC H ALARM |
| 60.70 | 2nd DUTY START |
| 60.40 | 1st DUTY START |
| 58.40 | DUTY STOP |
| 58.10 | PLC L ALARM |
| 57.90 | L FLOAT |
| 57.60 | AIRLOCK |
| 57.00 | BOTTOM |




ELEVATION
N.T.S.



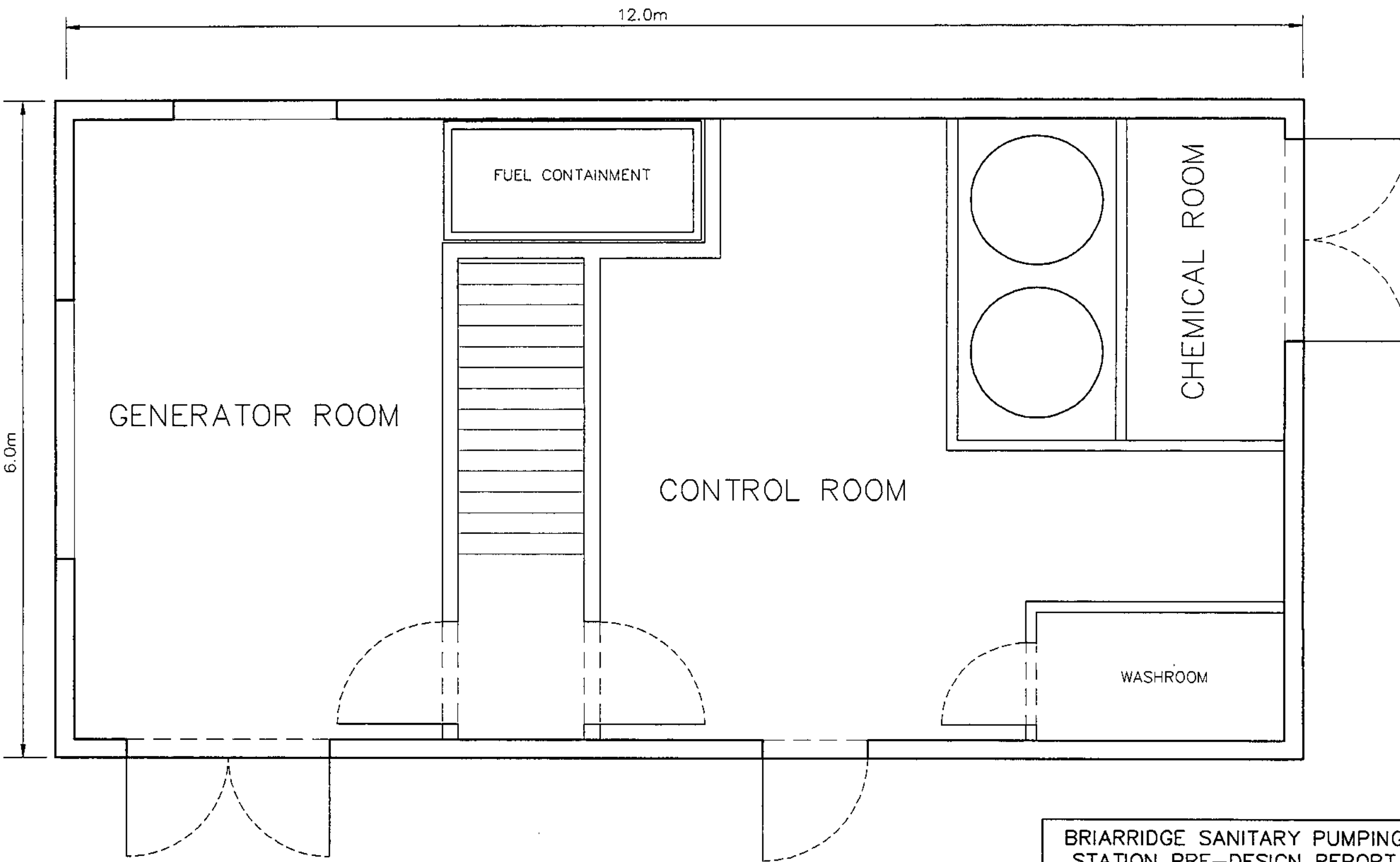

PLAN
SCALE N.T.S.

BRIARRIDGE SANITARY PUMPING STATION PRE-DESIGN REPORT
CITY OF KANATA

Cumming Cockburn Limited
Consulting Engineers, Planners, and Environmental Scientists

WET WELL

DATE NOV. 2000 | FIGURE 8




BRIARRIDGE SANITARY PUMPING STATION PRE-DESIGN REPORT
CITY OF KANATA

Cumming Cockburn Limited
Consulting Engineers, Planners, and Environmental Scientists

CONTROL BUILDING LAYOUT

DATE NOV. 2000

FIGURE 9

## 5.3 Emergency Power Supply

An emergency diesel driven generator will be installed to provide standby power sufficient to start two pumps and all ancillary equipment deemed to be necessary to be operated during emergency situations. Tentative sizing is for a 125 kW generator powered by a diesel driven engine. The sizing of the generator set will be reviewed and confirmed during final design.

Diesel generator controls and starting system will be direct current operated. A battery rack will be provided to start the generator. A trickling battery charger will be provided to maintain a full charge in the battery rack at all times.

An automatic transfer switch will be provided to control the diesel generator set. A loss of incoming power to controls will start the emergency generator. The generator set will be allowed to come to full speed prior to any loads being put on it. Upon resumption of main power feed, all equipment will be shut down prior to switching back to the main feed. After the transfer switch to the main power feed, the generator will be operated for a recommended "cool down" period.

As noted in a previous section, the motors for the pumps are anticipated to be 35 kW (47 Hp). With motors of this size, it is recommended that the temperature of the motor windings be monitored by temperature sensors or thermistors. If any of the motors windings become too warm, the thermistor will fail, shut down the operating pump and provide an alarm to the PLC and thereby the generator station alarm.

## 5.4 Instrumentation and Controls

Pumping station operation will be controlled in automatic mode by a programmable logic controller (PLC) at the pumping station. Manual control of the pumps will also be provided for start-up and maintenance. The wet well will be equipped with dual ultrasonic level controls and back up float controls.

The PLC will monitor the wet well liquid level, and stop the pumps on this basis. The wet well level will be indicated on a control panel at the pumping station.

The discharge flow from the pumps will be measured by magnetic flow meters complete with a wall mounted display in the control building.

The PLC system can also monitor numerous alarm points. The detailed requirements of the telemetering system will be determined during final design. Expansion of the PLC, to provide additional information, can be achieved by expanding the PLC with additional electronic output expansion modules. These additional outputs can be "telemetered" to a remote monitoring station from the PLC at a later date as part of the installation of a Supervisory Control and Data Acquisition (SCADA) expansion.

## 6.0 SITE REQUIREMENTS

### 6.1 Location and Access

The proposed pumping station site is shown on Figure 3. Access will be from a gravel road from Klondike Road parallel to the OCR rail line. The site detail plan is shown in Figure 10. The site will be located on a 26 m x 35 m easement within the Kanata Research Park golf course.

The site will be equipped to the owners requirements concerning lighting, fencing, windows and general security.

A proposed flow chart for the Briarridge Pumping Station is included in Figure 11. Flow will enter the site from up to three different locations and be directed to an inlet manhole prior to discharge into the wet well. It is proposed to install either a sluice gate on the outlet from the inlet manhole or a line valve on the wet well inlet sewer. That isolation device will assist operations during by-pass periods.

As stated earlier, the forcemain control appurtenances such as valves, meters, and by-pass connections will be located in the building basement. Discharge from the wet well will enter the building in three separate lines and connect to a common header which will discharge into the two forcemains.

Appropriate isolation and valving (including check and gate valves) will be provided for operational flow control, metering and by-pass isolation.

### 6.2 Soil Conditions

Two boreholes taken in the vicinity of the station indicate that bedrock near the 63 m elevation is immediately overlaid with a thin layer of glacial till and then 4 to 5 metres of very stiff to weathered clay.

A geotechnical report was completed in 1994 by John D. Paterson and Associates Ltd. (report no. SG264-94). The report includes recommendations for municipal services construction, including soil bearing information for the control building and wet well. In particular the report provides design guidelines for the wet well including earth pressure and buoyancy criteria.

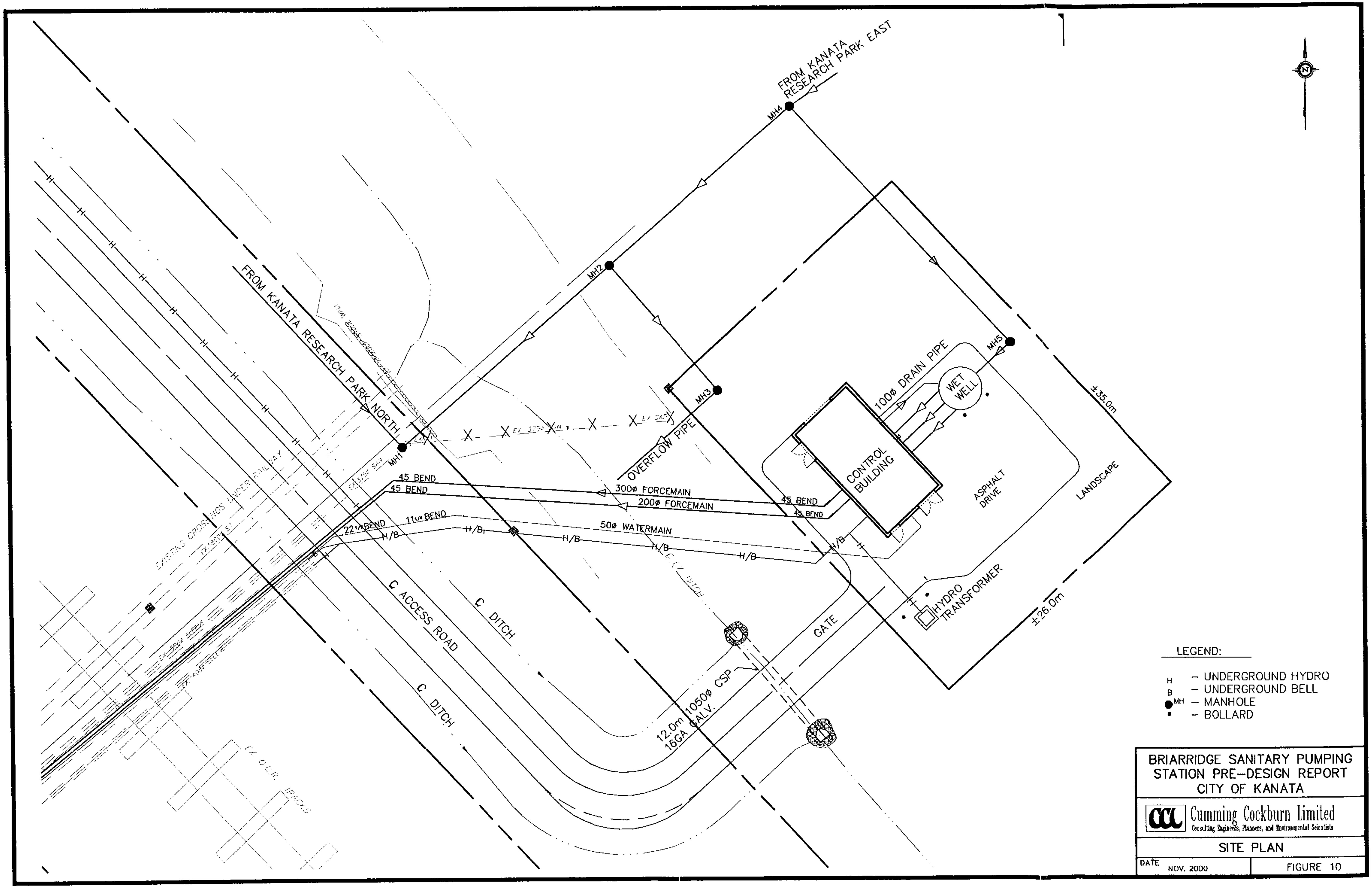
It is expected that about half of the wet well excavation will be in solid rock. This rock will have to be removed by blasting. The report will also include guidelines for rock anchor design for the wet well. Soil bearing pressure for the control building and wet well are provided.

### 6.3 Landscape Architecture

The exterior treatment and arrangement of the pumping station site will be done in such a manner to allow for ease of access and mobility of both vehicles and operation personnel. The landscape treatment should be durable and require very little maintenance, and the type of grass selected should require minimal maintenance.

It is recommended that vehicular access to and around the station be on a paved surface. Asphalt surfaces should also be provided for necessary pedestrian movement of operation personnel.

LICENSED PROFESSIONAL ENGINEER
J. I. MOFFATT
PROVINCE OF ONTARIO

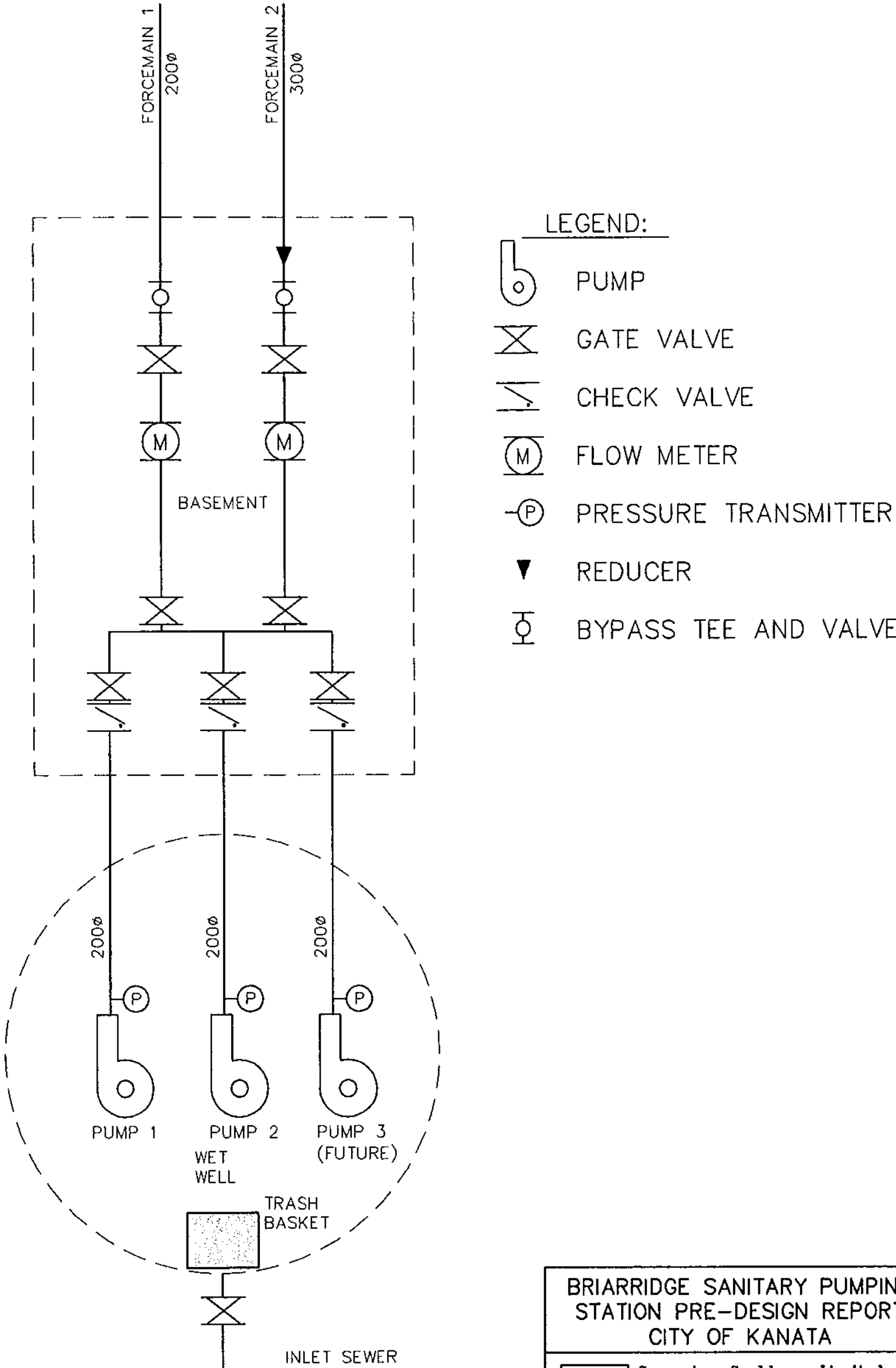



BRIARRIDGE SANITARY PUMPING STATION PRE–DESIGN REPORT
CITY OF KANATA

Cumming Cockburn Limited
Consulting Engineers, Planners, and Environmental Scientists

SITE PLAN

DATE NOV. 2000 | FIGURE 10




BRIARRIDGE SANITARY PUMPING STATION PRE-DESIGN REPORT
CITY OF KANATA

Cumming Cockburn Limited
Consulting Engineers, Planners, and Environmental Scientists

FLOW DIAGRAM

DATE NOV. 2000

FIGURE 11

# APPENDIX "A"

## DEVELOPMENT CAPACITY ANALYSIS

## SOUTH MARCH COMMUNITY (INCLUDING KANATA NORTH URBAN EXPANSION AREA) DEVELOPMENT CAPACITY ANALYSIS

| | RESIDENTIAL | | | INSTITUTIONAL | | | COMMERCIAL | | | ENVIRONMENTAL | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low Resid. | Med. Resid. | High Resid. | Schools | Civic Pres. | Churc | Commun | N'hood | Busines Park | Open Space/ Parks | SWM | Woodlot | Ravines | EIS/ Wetland | Other (Roads/ Railway) | |
| Land Area | 174.3 | 31.57 | 12.81 | 5.36 | 8.01 | 1.24 | 4.83 | 6.97 | 52.8 | 36.84 | 5.77 | 0.97 | 10.18 | 15.85 | 46.22 | 413.72 |
| Bldg. Area | | | | | 4182 | | 12075 | 17425 | 139115 | | | | | | | 172797 |
| Jobs | | | | 100 | 90 | 10 | 325 | 469 | 2994 | | | | | | | 3988 |
| Units | 2545 | 1105 | 640 | | | | | | | | | | | | | 4290 |

### HOUSING PROJECTIONS

| South March-Current (30/06/98) | South March (excluding KNUEA) 2021/Buildout | South March (incl. KNUEA) 2021/ Buildout |
|---|---|---|
| 938 | 3121/3121 | 3121/4290 |

### EMPLOYMENT PROJECTIONS

| | South March-Current (30/06/98 | South March (excluding KNUEA) 2021 | South March (incl. KNUEA) 2021 |
|---|---|---|---|
| Commercial | 90 | 612 | 779 |
| Business Park | | | 2994 |
| Other | | 129 | 215 |
| TOTAL | 90 | 741 | 3988 |

Note: All land areas are expressed in hectares and Building Areas are expressed in square metres. (1 square metre = 10.76 square feet)

Note: Building area calculations only apply to Commercial and Business Park lands.

Note: The assumed rate of growth in the entire South March community (including the current South March community and the KNUEA) is 94 units per year (historical growth rate of the South March community since its initial development).

# APPENDIX "B"

## INDUSTRIAL PEAKING FACTORS AND DESIGN FLOW CALCULATIONS

SANITARY FLOW CALCULATIONS TO BUILDOUT
BRIARRIDGE PUMPING STATION

Project: 3345-LD-03
Date: Nov. 22, 2000
File: Buildout2

( MONITORED = RESIDENTIAL PEAKED WITH HARMON/INDUSTRIAL PEAKED AT 1.0 )

**2001**

| | UNITS | AREA | POPN | DESIGN (l/s) AVG W/O I/I | DESIGN (l/s) PEAK | MONITORED (l/s) AVG DWF W/O I/I | AVG DWF | PK DWF | ANN. WWF | RARE WWF |
|---|---|---|---|---|---|---|---|---|---|---|
| RESIDENTIAL | 88 | 3.37 | 290 | 1.17 | 5.64 | 1.01 | 1.18 | 3.04 | 3.81 | 4.56 |
| INDUSTRIAL | | 0 | 0 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0 |
| TOTALS | 88 | 3.37 | 290 | 1.17 | 5.64 | 1.01 | 1.18 | 3.04 | 3.81 | 4.56 |

**2011**

| | UNITS | AREA | POPN | DESIGN (l/s) AVG W/O I/I | DESIGN (l/s) PEAK | MONITORED (l/s) AVG DWF W/O I/I | AVG DWF | PK DWF | ANN. WWF | RARE WWF |
|---|---|---|---|---|---|---|---|---|---|---|
| RESIDENTIAL | 584 | 26.9 | 1929 | 7.81 | 35.65 | 6.70 | 8.04 | 18.48 | 24.67 | 30.59 |
| INDUSTRIAL | | 39.8 | | 16.12 | 64.35 | 6.91 | 8.90 | 8.90 | 18.05 | 26.81 |
| TOTALS | 584 | 66.7 | 1929 | 23.94 | 100.00 | 13.61 | 16.94 | 27.38 | 42.72 | 57.40 |

**2021**

| | UNITS | AREA | POPN | DESIGN (l/s) AVG W/O I/I | DESIGN (l/s) PEAK | MONITORED (l/s) AVG DWF W/O I/I | AVG DWF | PK DWF | ANN. WWF | RARE WWF |
|---|---|---|---|---|---|---|---|---|---|---|
| RESIDENTIAL | 843 | 38.8 | 2783 | 11.27 | 49.98 | 9.66 | 9.66 | 25.92 | 34.85 | 43.38 |
| INDUSTRIAL | | 57.45 | 0 | 23.27 | 85.90 | 9.97 | 12.85 | 12.85 | 26.06 | 38.70 |
| TOTALS | 843 | 96.25 | 2783 | 34.55 | 135.89 | 19.64 | 22.51 | 38.77 | 60.91 | 82.08 |

**BUILDOUT**

| | UNITS | AREA | POPN | DESIGN (l/s) AVG W/O I/I | DESIGN (l/s) PEAK | MONITORED (l/s) AVG DWF W/O I/I | AVG DWF | PK DWF | ANN. WWF | RARE WWF |
|---|---|---|---|---|---|---|---|---|---|---|
| RESIDENTIAL | 1124 | 51.7 | 3710 | 15.03 | 65.01 | 12.88 | 12.88 | 33.73 | 45.62 | 56.99 |
| INDUSTRIAL | | 75.84 | | 30.72 | 108.79 | 13.17 | 16.96 | 16.96 | 34.40 | 51.09 |
| TOTALS | 1124 | 127.54 | 3710 | 45.75 | 173.80 | 26.05 | 29.84 | 50.69 | 80.02 | 108.08 |

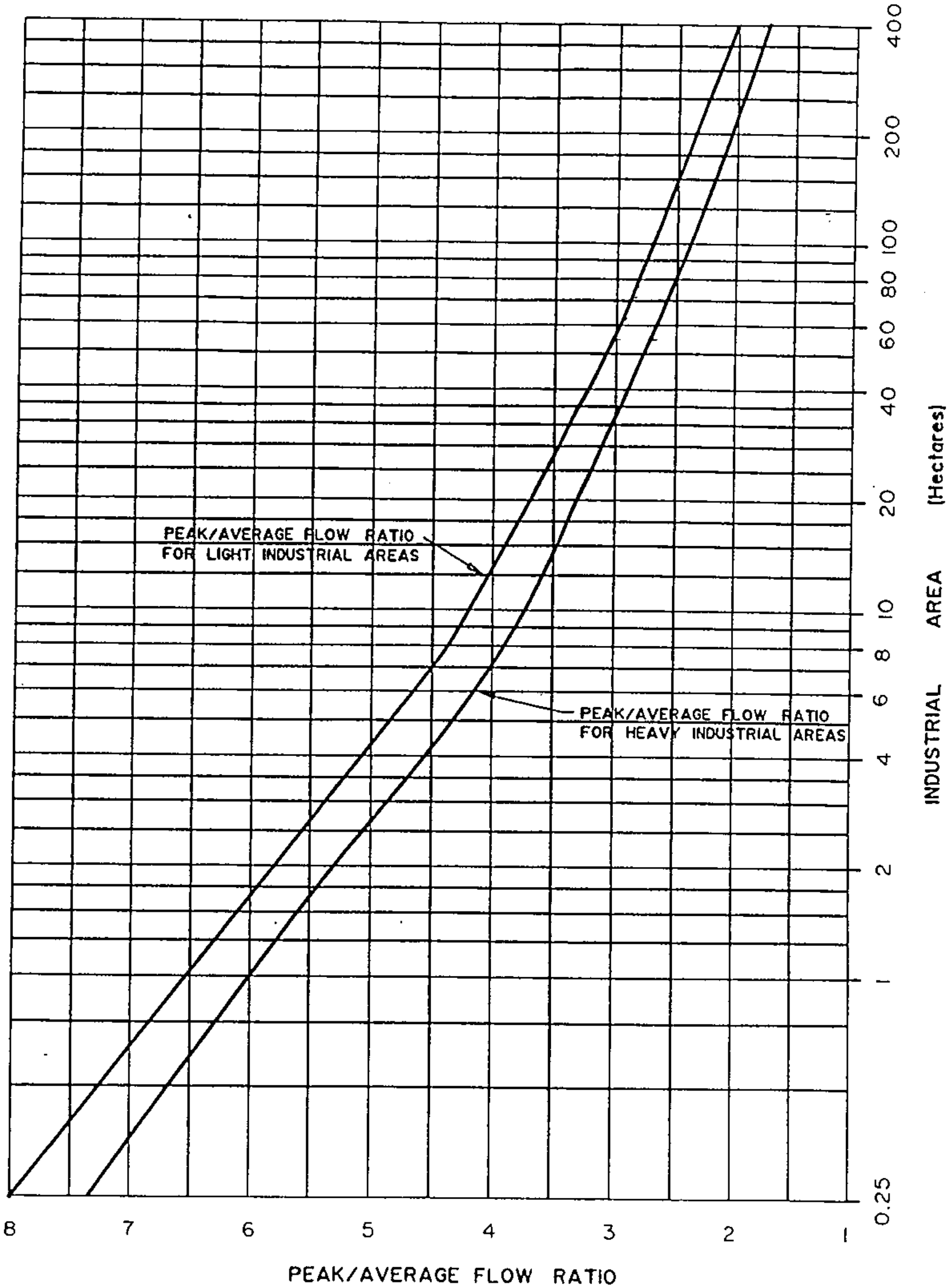
Revision No. 1: Jan. 24, 2001
Revision No. 2: June 20, 2001

## UNIT SANITARY FLOWS

| SOURCE | Monitored | | Design |
|---|---|---|---|
| **Residential (Lpcd)** | | | |
| Average | 300 | | 350 |
| Peak Factor | Harmon (K=0.6) | | Harmon (K=1.0) |
| Unit Population | 3.3 ppu | | |
| **ICI (L/ha/d)** | | | |
| Industrial Average | 15000 | | 35000 |
| Peak Factor | 1 (non-coincident peak) | | MOE Guidelines |
| **Inflow/Infiltration (L/ha/s)** | | | |
| Dry Weather Inflow (Low) | 0.05 | 0.08 | |
| Wet Weather Event (Typ) | 0.15 | 0.20 | 0.28 |
| Wet Weather Event (Large) | 0.28 | | |
| Wet Weather Event (Rare) | 0.30 | 0.50 | |

Inflow/Infiltration Allowances Used For Monitored Events Are:

Annual Peak Flow = 0.28 l/s
Rare Event = 0.50 l/s




| | | |
|---|---|---|
| Regional Municipality of Ottawa - Carleton Environmental Services Department | SECTION 7 - SANITARY SEWER DESIGN | APPENDIX E |
| | TYPICAL INDUSTRIAL SEWAGE FLOW PEAKING FACTORS | Date: JUNE 1991 |
| | | Rev.: |
| **DESIGN GUIDELINES** | | Figure: 1 |

# SANITARY SEWER DESIGN SHEET

CUMMING COCKBURN
1770 WOODWARD DRIVE
OTTAWA, ONTARIO
K2C OP8

PROJECT : BRIARBROOK PUMPING STATION
CITY OF KANATA
DEVELOPER : TENTH LINE DEVELOPMENT INC.

AREAS 2,3,&4 AS INDUSTRIAL

| LOCATION | | | RESIDENTIAL | | | INDUSTRIAL | | | TOTAL | PEAK FLOWS (l/s) | | | | | INFILTRATION | | | PEAK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | RESIDENTIAL | | INDUSTRIAL | | | | | | |
| AREA | FROM MH | TO MH | POPN | | AVG FLOW (l/s) | AREA | | AVG FLOW (l/s) | AVG FLOW (l/s) | PK FACT | FLOW | PK FACT | FLOW | TOTAL FLOW | AREA (Ha) | | FLOW (l/s) | WET W. FLOW (l/s) |
| AREA 1 (Residential) | | | 610 | | 2.47 | | | | 2.47 | | | | | | 6.10 | | | |
| AREA 2 (L. Industrial) | | | | | | 3.10 | | 1.26 | 1.26 | | | | | | 3.10 | | | |
| AREA 3 (L. Industrial) | | | | | | 27.50 | | 11.14 | 11.14 | | | | | | 27.50 | | | |
| AREA 4 (L. Industrial) | | | | | | 7.00 | | 2.84 | 2.84 | | | | | | 7.00 | | | |
| AREA 5 (L. Industrial) | | | | | | 10.10 | | 4.09 | 4.09 | | | | | | 10.10 | | | |
| AREA 6 (L. Industrial) | | | | | | 9.50 | | 3.85 | 3.85 | | | | | | 9.50 | | | |
| AREA 7 (L. Industrial) | | | | | | 18.64 | | 7.55 | 7.55 | | | | | | 18.64 | | | |
| AREA 8 (Residential) | | | 3100 | | 12.56 | | | 0.00 | 12.56 | | | | | | 45.57 | | | |
| TOTAL FLOW | | | 3710 | | 15.03 | 75.84 | | 30.72 | 45.75 | 3.36 | 50.53 | 2.85 | 87.56 | 138.09 | 127.51 | | 35.70 | 173.79 |

Average Flows
Residential Flow/Capita = 0.0042 l/s
Industrial Flow = 35000 l/Ha/d
Infiltration Allowance = 0.28 l/Ha/s

Note: Information for Area 8 Taken From Recent MOE Application
Population Projections: Area 1 = Medium Res. = 100 p/Ha.

Date: October 16, 2000
File: SanFlow
Project: 3345-LD-03

Revision No. 1: June 20, 2001

Peaking Factors
Residential = **Harmon Formula** = **1+14/(4+P^0.5) Max. of 4.0** **where P is population in thousands**
Industrial **MOE Guidelines**

# SANITARY SEWER DESIGN SHEET

CUMMING COCKBURN
1770 WOODWARD DRIVE
OTTAWA, ONTARIO
K2C OP8

PROJECT : BRIARBROOK PUMPING STATION
CITY OF KANATA
DEVELOPER : TENTH LINE DEVELOPMENT INC.

| LOCATION | | | RESIDENTIAL | | | INDUSTRIAL | | | TOTAL | PEAK FLOWS (l/s) | | | | | INFILTRATION | | | PEAK | PROPOSED SEWER | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | RESIDENTIAL | | INDUSTRIAL | | | | | | | | | | | | |
| AREA | FROM MH | TO MH | POPN INCREM | POPN TOTAL | AVG FLOW (l/s) | AREA INCREM | AREA TOTAL | AVG FLOW (l/s) | AVG FLOW (l/s) | PK FACT | FLOW | PK FACT | FLOW | TOTAL FLOW | AREA INCREM (Ha) | AREA TOTAL (Ha) | FLOW (l/s) | WET W. FLOW (l/s) | CAP l/s | VEL m/s | LGTH. (m) | PIPE (mm) | GRADE % | TYPE PIPE |
| Gravity Sewers | | | | | | | | | | | | | | | | | | | | | | | | |
| AREA 8 (Residential) | | 1 | 3100 | 3100 | 12.56 | | | | 12.56 | 3.43 | 43.08 | | | | 45.57 | 45.57 | 12.76 | 12.76 | *146.39* | *1.28* | | *375* | *0.64* | *CONC* |
| AREAS 2 to 6 (Indust.) AREA 1 (Residential) | | 1 | 610 | 610 | 2.47 | 57.20 | 57.20 | 23.17 | 25.64 | 3.93 | 9.71 | 3.00 | 69.51 | 79.22 | 63.30 | 63.30 | 17.72 | 96.94 | 139.55 | 0.85 | 8.0 | 450 | 0.22 | CONC |
| | 1 | 4 | 0 | 3710 | 15.03 | 0.00 | 57.20 | 23.17 | 38.20 | 3.36 | 50.53 | 3.00 | 69.51 | 120.05 | 0.00 | 108.87 | 30.48 | 150.53 | 162.86 | 0.99 | 44.0 | 450 | 0.30 | CONC |
| AREA 7 (Industrial) | | 4 | 0 | 0 | 0.00 | 18.64 | 18.64 | 7.55 | 7.55 | 0.00 | 0.00 | 3.75 | 28.32 | 28.32 | 18.64 | 18.64 | 5.22 | 33.54 | 34.00 | 0.67 | 5.0 | 250 | 0.30 | PVC |
| | 4 | INLET | 0 | 3710 | 15.03 | 0.00 | 75.84 | 30.72 | 45.75 | 3.36 | 50.53 | 2.85 | 87.56 | 138.09 | 0.00 | 127.51 | 35.70 | 173.79 | 188.14 | 1.15 | 31.5 | 450 | 0.40 | CONC |
| Overflow Sewer | | | | | | | | | | | | | | | | | | | | | | | | |
| | 2 | Outlet | | Level of Protection is Annual Wet Weather Flow = 80 l/s. | | | | | | | | | | | | | | | 87.34 | 1.20 | 31.5 | 300 | 0.75 | PVC |

Average Flows
Residential Flow/Capita = 350 l/c/d
Industrial Flow = 35000 l/Ha/d
Infiltration Allowance = 0.28 l/Ha/s

Notes:
1. Information for Area 8 Taken From Recent MOE Application
Population Projections:
2. Area 1 = Medium Res. = 100 p/Ha.

Date: October 16, 2000
File: SanFlow
Project: 3345-LD-03

Revision No. 1: June 20, 2001

Peaking Factors
Residential = Harmon Formula = 1+14/(4+P^0.5) Max. of 4.0 where P is population in thousands
Industrial MOE Guidelines

# SANITARY SEWER DESIGN SHEET

CUMMING COCKBURN
1770 WOODWARD DRIVE
OTTAWA, ONTARIO
K2C OP8

PROJECT : BRIARBROOK PUMPING STATION
CITY OF KANATA
DEVELOPER : TENTH LINE DEVELOPMENT INC.

AREAS 2,3,&4 AS INDUSTRIAL AND
ADD GOLF COURSE AS INDUSTRIAL

| LOCATION | | | RESIDENTIAL | | | INDUSTRIAL | | | TOTAL | PEAK FLOWS (l/s) | | | | | INFILTRATION | | | PEAK |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AREA | FROM MH | TO MH | POPN | | AVG FLOW (l/s) | AREA | | AVG FLOW (l/s) | AVG FLOW (l/s) | RESIDENTIAL PK FACT | RESIDENTIAL FLOW | INDUSTRIAL PK FACT | INDUSTRIAL FLOW | TOTAL FLOW | AREA (Ha) | | FLOW (l/s) | WET W. FLOW (l/s) |
| AREA 1 (Residential) | | | 610 | | 2.47 | | | | 2.47 | | | | | | 6.10 | | | |
| AREA 2 (L. Industrial) | | | | | | 3.10 | | 1.26<br>2.75 | 1.26 | | | | | | 3.10 | | | |
| AREA 3 (L. Industrial) | | | | | | 27.50 | | 11.14 | 11.14 | | | | | | 27.50 | | | |
| AREA 4 (L. Industrial) | | | | | | 7.00 | | 2.84 | 2.84 | | | | | | 7.00 | | | |
| AREA 5 (L. Industrial) | | | | | | 10.10 | | 4.09 | 4.09 | | | | | | 10.10 | | | |
| AREA 6 (L. Industrial) | | | | | | 9.50 | | 3.85 | 3.85 | | | | | | 9.50 | | | |
| AREA 7 (L. Industrial) | | | | | | 18.64 | | 7.55 | 7.55 | | | | | | 18.64 | | | |
| GOLF COURSE | | | | | | 20.00 | | 8.10 | 8.10 | | | | | | 20.00 | | | |
| AREA 8 (Residential) | | | 3100 | | 12.56 | | | 0.00 | 12.56 | | | | | | 45.57 | | | |
| TOTAL FLOW | | | 3710 | | 15.03 | 95.84 | | 38.82 | 53.85 | 3.36 | 50.53 | 2.75 | 106.77 | 157.30 | 147.51 | | 41.30 | 198.60 |

Average Flows
Residential Flow/Capita = **0.0042** l/s
Industrial Flow = **35000** l/Ha/d
Infiltration Allowance = **0.28** l/Ha/s

Note: Information for Area 8 Taken From Recent MOE Application
Population Projections: Area 1 = Medium Res. = 100 p/Ha.

Date: March 06, 2001
File: SanFlow
Project: 3345-LD-03

Revision No. 1: June 20, 2001

Peaking Factors
Residential = **Harmon Formula** = **1+14/(4+P^0.5) Max. of 4.0** **where P is population in thousands**
Industrial **MOE Guidelines**

# APPENDIX "C"

## ITT FLYGT PERFORMANCE CURVES

| FLYGT | PERFORMANCE CURVE | PRODUCT<br>CP3201.180 | TYPE<br>HT |
|---|---|---|---|
| DATE<br>2001-06-29 | PROJECT | CURVE NO<br>63-452-00-5350 | ISSUE<br>2 |

| | 1/1-LOAD | 3/4-LOAD | 1/2-LOAD |
|---|---|---|---|
| MOTOR COS PHI | 0.90 | 0.88 | 0.82 |
| MOTOR EFFICIENCY | 87.0 % | 87.5 % | 86.5 % |
| GEAR EFFICIENCY | --- | --- | --- |

| | | |
|---|---|---|
| MOTOR SHAFT POWER ..... | 35 | kW |
| STARTING CURRENT ... | 288 | A |
| RATED CURRENT ... | 43 | A |
| RATED SPEED ..... | 1755 | rpm |
| TOT.MOM.OF INERTIA ... | 0.58 | kgm2 |
| NO. OF BLADES | 1 | |

COMMENTS

INLET/OUTLET: - /150 mm

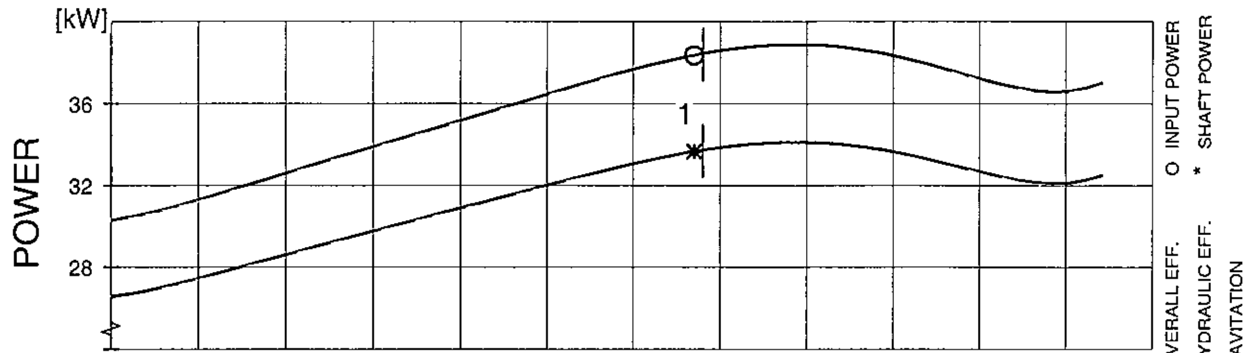
IMP. THROUGHLET: 77 mm

IMPELLER DIAMETER: 330 mm

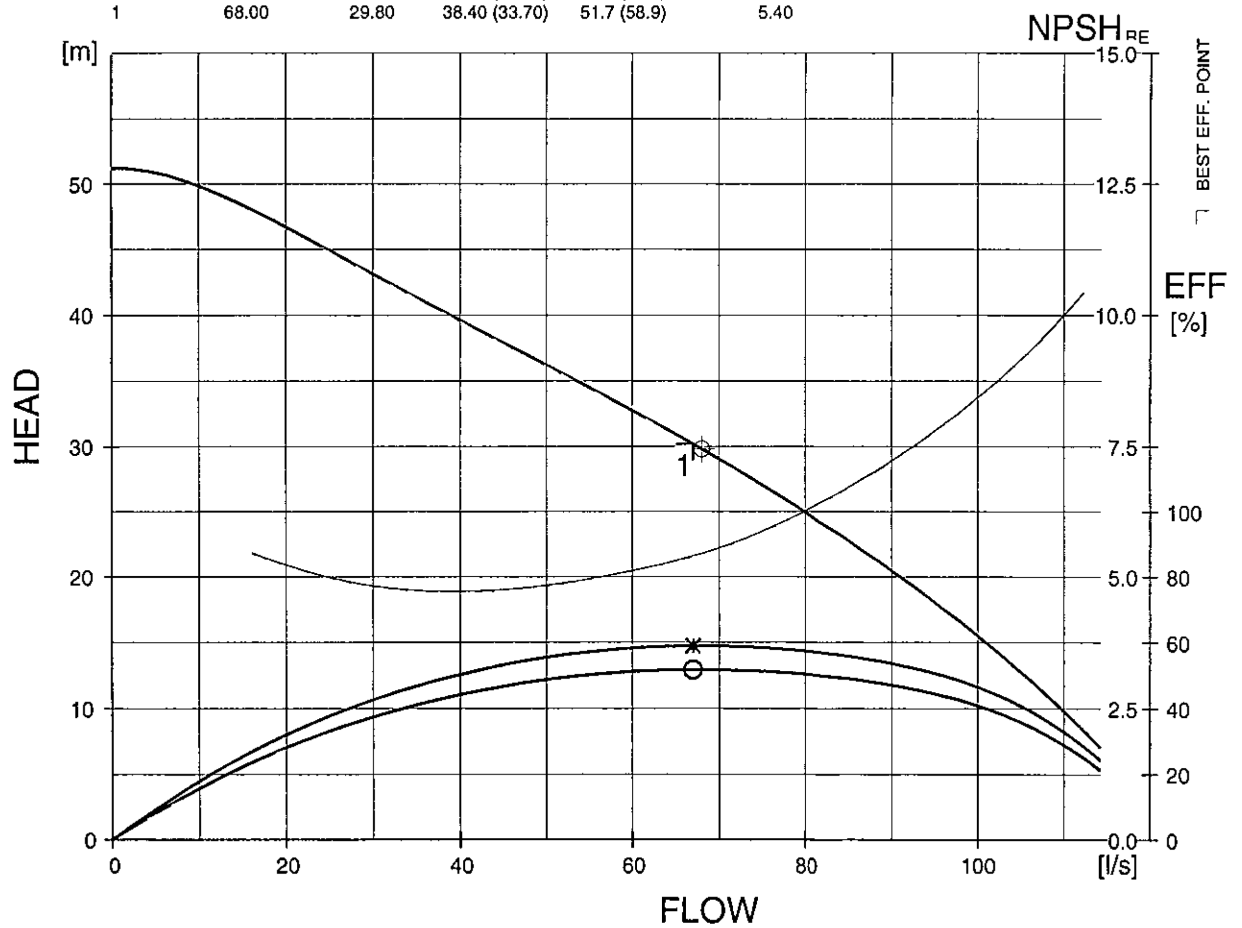
| MOTORTYPE | STATOR | REV |
|---|---|---|
| 27-26-4AA | 52D | 10 |

| FREQ. | PHASES | VOLTAGE | POLES |
|---|---|---|---|
| 60 Hz | 3 | 600 V | 4 |

| GEARTYPE | RATIO |
|---|---|
| --- | --- |




| DUTY-POINT: | FLOW[l/s] | HEAD[m] | POWER[kW] | EFF[%] | NPSH[m] | GUARANTY |
|---|---|---|---|---|---|---|
| B.E.P.: | 66.98 | 30.20 | 38.35 (33.67) | 51.7 (58.9) | 5.39 | |
| 1 | 68.00 | 29.80 | 38.40 (33.70) | 51.7 (58.9) | 5.40 | |




FLYPS 2.0 (1118)

Performance with clear water and rating data at 40 °C

FLYGT CURVE

# PERFORMANCE CURVE

| PRODUCT | TYPE |
|---|---|
| CP3201.180 | HT |

| DATE | PROJECT | CURVE NO | ISSUE |
|---|---|---|---|
| 2001-06-29 | | 63-454-00-2350 | 2 |

| | 1/1-LOAD | 3/4-LOAD | 1/2-LOAD |
|---|---|---|---|
| MOTOR COS PHI | 0.90 | 0.88 | 0.82 |
| MOTOR EFFICIENCY | 87.0 % | 87.5 % | 86.5 % |
| GEAR EFFICIENCY | --- | --- | --- |

| | | |
|---|---|---|
| MOTOR SHAFT POWER ..... | 35 | kW |
| STARTING CURRENT ... | 288 | A |
| RATED CURRENT ... | 43 | A |
| RATED SPEED ..... | 1755 | rpm |
| TOT.MOM.OF INERTIA ... | 0.33 | kgm2 |
| NO. OF BLADES | 1 | |

COMMENTS

INLET/OUTLET: - /150 mm

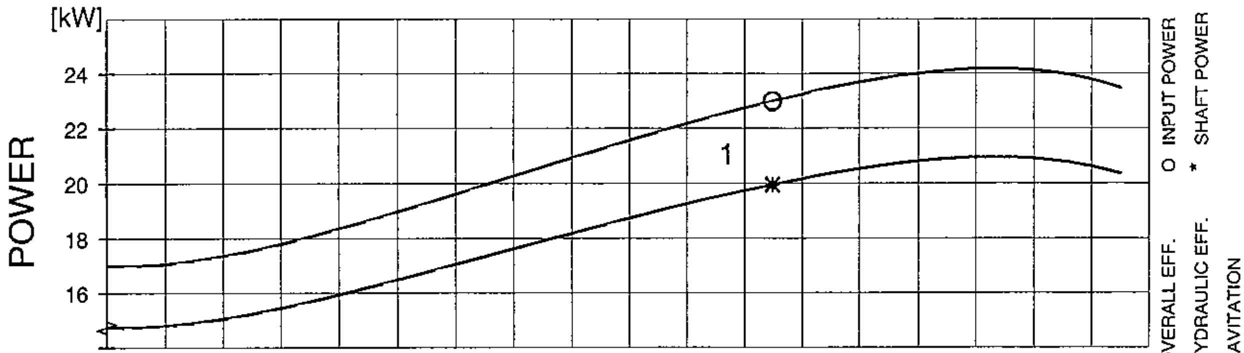
IMP. THROUGHLET: 76 mm

IMPELLER DIAMETER: 281 mm

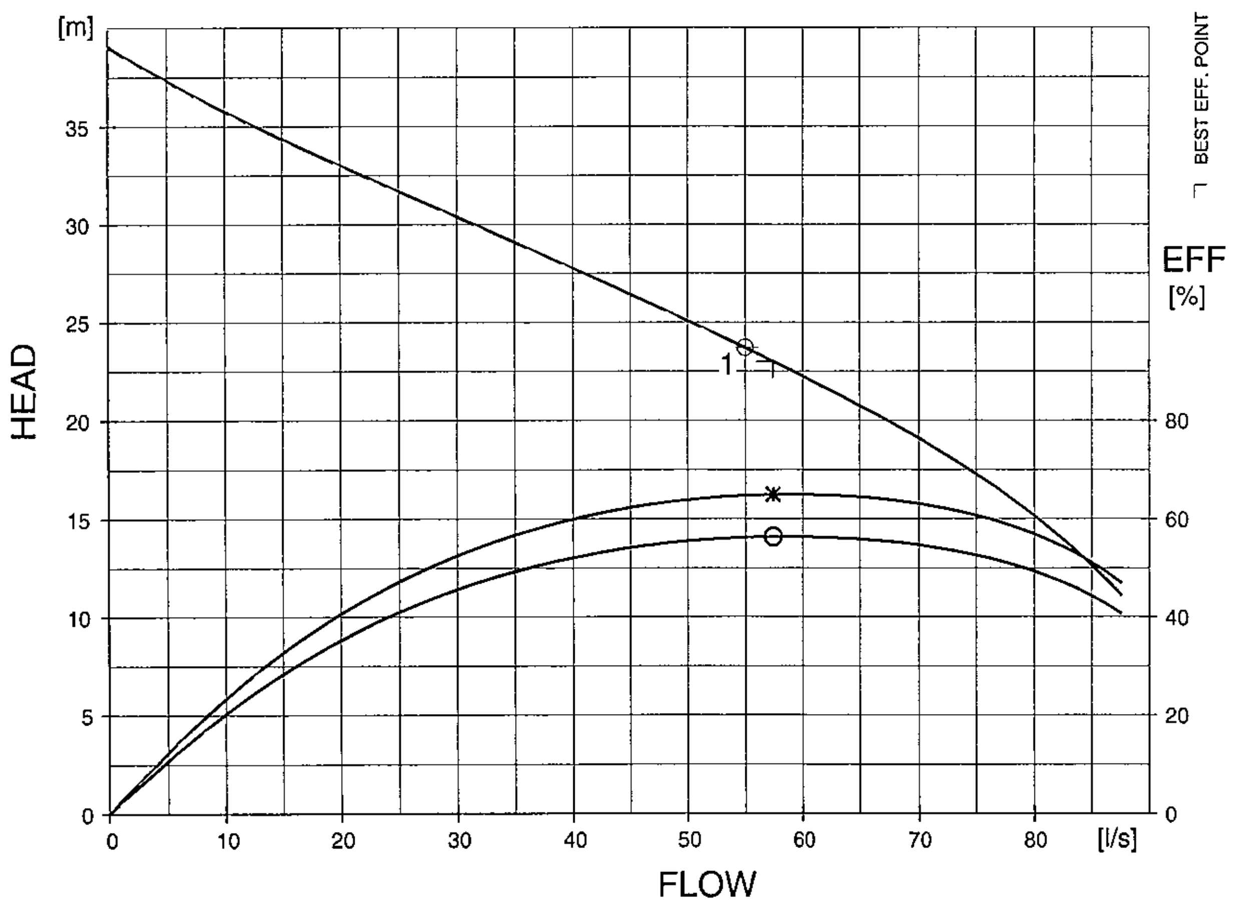
| MOTORTYPE | STATOR | REV |
|---|---|---|
| 27-26-4AA | 52D | 10 |

| FREQ. | PHASES | VOLTAGE | POLES |
|---|---|---|---|
| 60 Hz | 3 | 600 V | 4 |

| GEARTYPE | RATIO |
|---|---|
| --- | --- |




| DUTY-POINT: | FLOW[l/s] | HEAD[m] | POWER[kW] | EFF[%] | GUARANTY |
|---|---|---|---|---|---|
| B.E.P.: | 57.42 | 22.99 | 22.99 (19.95) | 56.3 (64.9) | --- |
| 1 | 55.00 | 23.70 | 22.70 (19.70) | 56.2 (64.7) | |

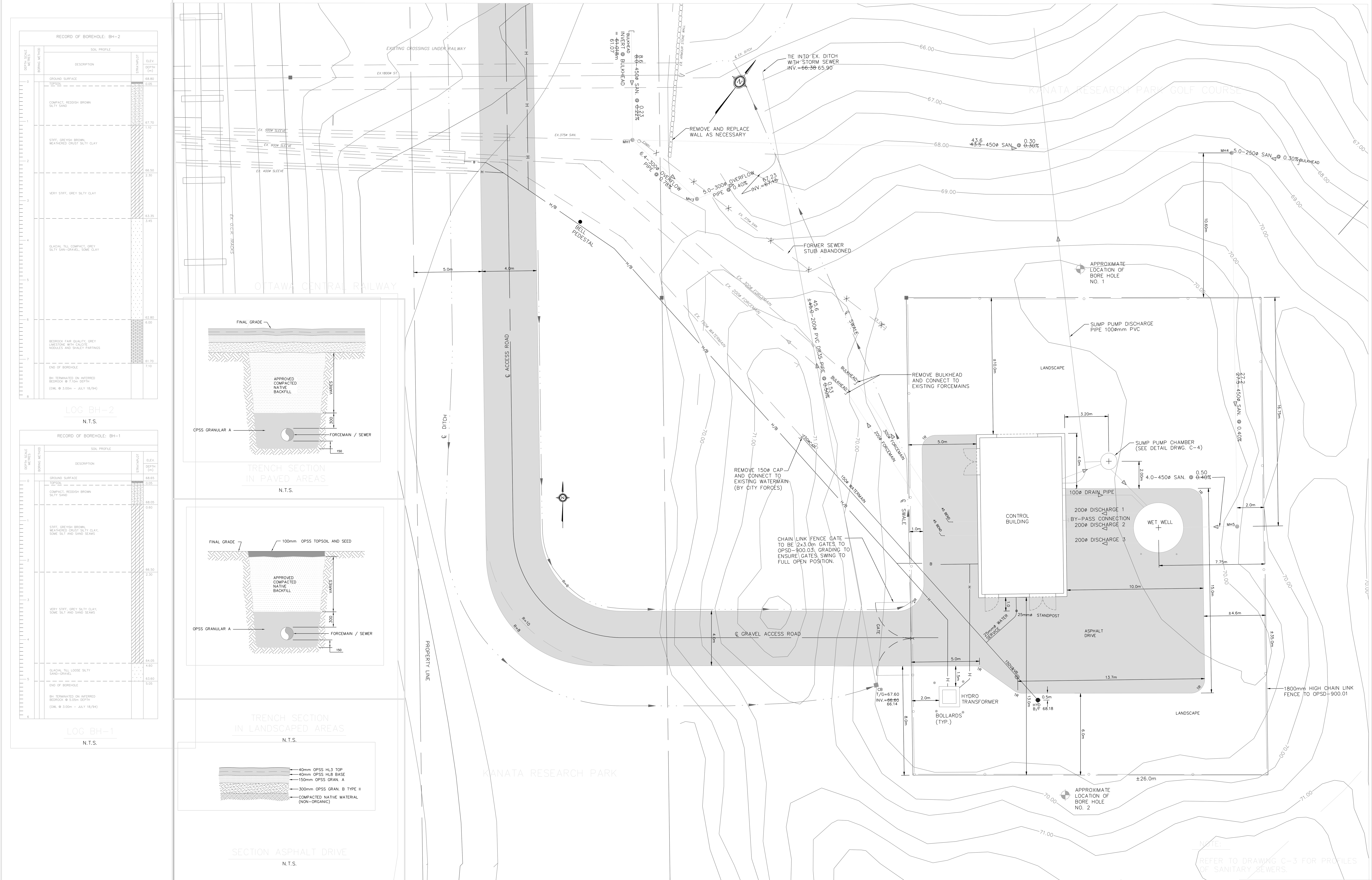



FLYPS 2.0 (1118)

Performance with clear water and rating data at 40 °C

CURVE

# APPENDIX C: GENERAL ARRANGEMENT




| No. | DATE | REVISIONS | BY | No. | DATE | REVISIONS | BY |
|---|---|---|---|---|---|---|---|
| 0. | 01:03:19 | ISSUED FOR APPROVAL | D.P.S. | 5. | 02:12:20 | AS-BUILT | |
| 1. | 01:07:03 | GENERAL REVISIONS | D.P.S. | | | | |
| 2. | 01:08:24 | ISSUED FOR CLIENT REVIEW | D.P.S. | | | | |
| 3. | 01:11:14 | REVISED AS PER CITY COMMENTS | D.P.S. | | | | |
| 4. | 02:01:21 | GENERAL REVISIONS | D.P.S. | | | | |

LICENSED PROFESSIONAL ENGINEER
J. I. MOFFATT
01:03:19
PROVINCE OF ONTARIO

SCALES
1:125

Cumming Cockburn Limited
Consulting Engineers, Planners, and Environmental Scientists
Hull, Ottawa, Kingston, Toronto, Waterloo, London

DESIGN J.I.M.
CHECKED J.I.M.
DRAWN D.S./CAD
CHECKED J.I.M.
APPROVED J.I.M.

CITY OF KANATA
DEPARTMENT OF ENGINEERING

# BRIARRIDGE PUMPING STATION AND FORCEMAINS
TENTH LINE DEVELOPMENT INC.

SITE PLAN

PROJ. No. 3345-LD
CONT. No.
DATED MARCH 2001
DWG. No. C-1

# APPENDIX D: SURVEY DATA AND CALCULATIONS

**RAW SURVEY DATA**

| | | | | |
|---|---|---|---|---|
| PRS87429907110 | 5025195.07 | 449919.056 | 95.23 | |
| 1 | 5023046.9 | 428082.37 | 68.049 | CP1 |
| 2 | 5023033.86 | 428074.738 | 67.656 | CP2 |
| 3 | 5023049.53 | 428080.497 | 68.549 | WETWELLTOP |
| 4 | 5023032.87 | 428077.856 | 67.697 | CP3 |
| 5 | 5022545.34 | 427666.298 | 74.695 | FM1 |
| 6 | 5022545.95 | 427666.63 | 74.69 | FM1 |
| 7 | 5022545.24 | 427666.884 | 74.694 | FM1 |
| 8 | 5022542.08 | 427675.15 | 74.701 | FM2 |
| 9 | 5022541.62 | 427674.735 | 74.698 | FM2 |
| 10 | 5022542.13 | 427674.368 | 74.671 | FM2 |

Basement Floor Elevation: 65.522m *Determined from traverse started at CP3 +/-4.8cm

Height Of Pressure Gauge (Measured From Bottom of Floor): .895m

Elevation of Pressure Gauge : 65.522m+.895m = 66.417 m

Elevation of CP3 determined from closing loop: 67.745

Error: 67.745m-67.697m = .048m

## Recorded Data

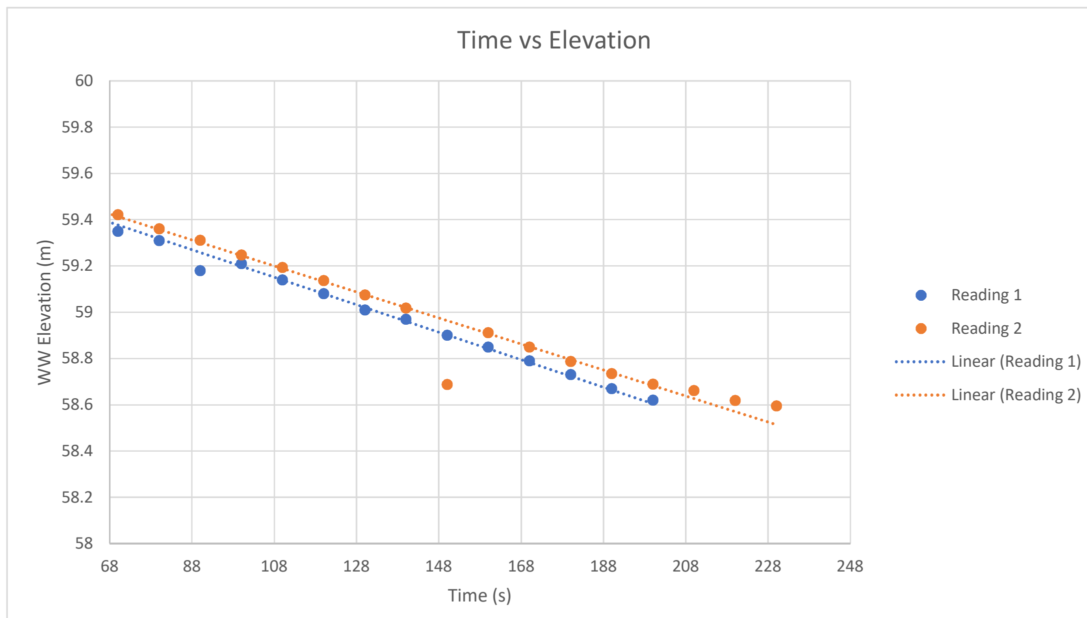
Reading 1 — Start 12:07 PM — Stop 12:10 PM

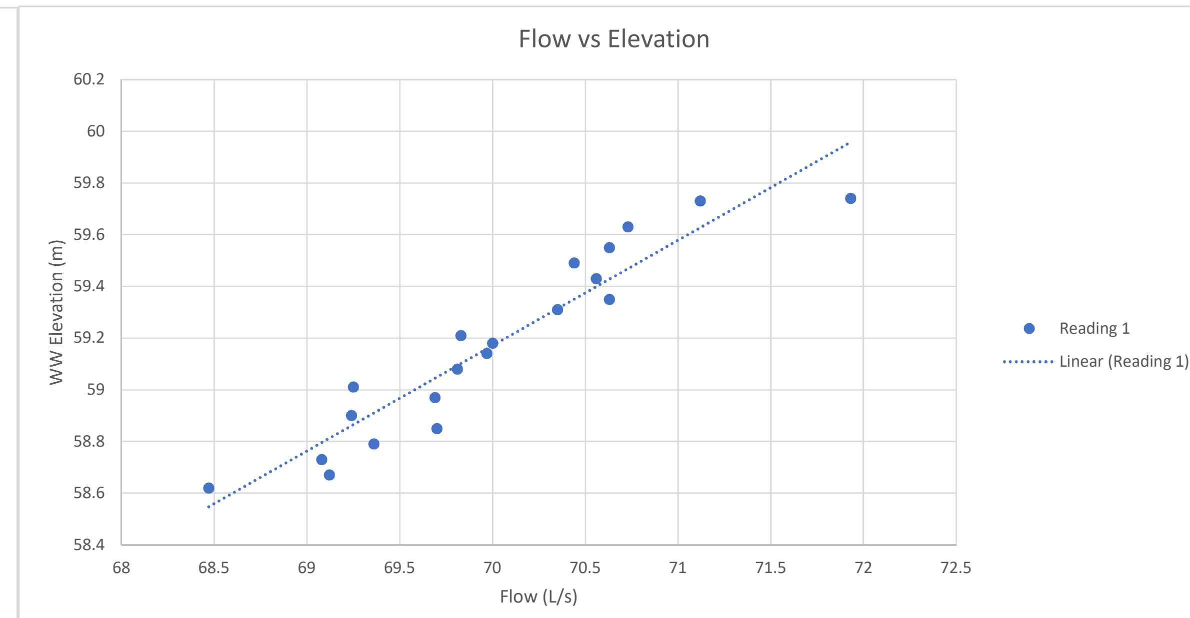
| t (s) | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Milltronics flow reading, Q (L/s) | 26.54 | 71.93 | 71.12 | 70.73 | 70.63 | 70.44 | 70.56 | 70.63 | 70.35 | 70 | 69.83 | 69.97 | 69.81 | 69.25 | 69.69 | 69.24 | 69.7 | 69.36 | 69.08 | 69.12 | 68.47 | 50 |
| h (m) | 2.81 | 2.78 | 2.77 | 2.67 | 2.59 | 2.53 | 2.47 | 2.39 | 2.35 | 2.22 | 2.25 | 2.18 | 2.12 | 2.05 | 2.01 | 1.94 | 1.89 | 1.83 | 1.77 | 1.71 | 1.66 | 1.63 |
| True WW Elevs (m) | 59.77 | 59.74 | 59.73 | 59.63 | 59.55 | 59.49 | 59.43 | 59.35 | 59.31 | 59.18 | 59.21 | 59.14 | 59.08 | 59.01 | 58.97 | 58.9 | 58.85 | 58.79 | 58.73 | 58.67 | 58.62 | 58.59 |

Reading 2 — Start 1:00 PM Approximated — Stop 1:05 PM Approxima

| t (s) | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d (laser reading)(m) | 8.739 | 8.8 | 8.84 | 8.89 | 8.95 | 9.005 | 9.06 | 9.127 | 9.189 | 9.238 | 9.302 | 9.356 | 9.412 | 9.475 | 9.531 | 9.861 | 9.637 | 9.7 | 9.762 | 9.815 | 9.86 | 9.888 | 9.931 | 9.954 |
| True WW Elevs (m) | 59.81 | 59.749 | 59.709 | 59.659 | 59.599 | 59.544 | 59.489 | 59.422 | 59.36 | 59.311 | 59.247 | 59.193 | 59.137 | 59.074 | 59.018 | 58.688 | 58.912 | 58.849 | 58.787 | 58.734 | 58.689 | 58.661 | 58.618 | 58.595 |
| Calculated Depth, h (m) | 2.85 | 2.789 | 2.749 | 2.699 | 2.639 | 2.584 | 2.529 | 2.462 | 2.4 | 2.351 | 2.287 | 2.233 | 2.177 | 2.114 | 2.058 | 1.728 | 1.952 | 1.889 | 1.827 | 1.774 | 1.729 | 1.701 | 1.658 | 1.635 |

| | |
|---|---|
| Milltronics Pump Stop Reading (m) | 1.62 |
| Top of WW to Fluid Level @ Pump Stop (m) | 9.969 |
| Top of WW Elev (m) | 68.549 |
| Fluid level Elevation @ Pump Stop (m) | 58.58 |
| Bottom of WW (m) | 56.96 |
| Surveyed WW Height | 11.589 |
| As-Built WW Bottom (m) | 57.00 |
| As-Built Top of WW (m) | 68.35 |
| As-Built WW Height (m) | 11.35 |
| WW Bottom Error (m) | 0.04 |
| WW Height Error (m) | 0.24 |
| Ultrasonic Level Sensor Elev (m) | 61.8 |
| Pressure Transducer Elev (m) | 66.417 |
| | |
| Pump Start Height (m) | 2.81 |
| Pump Start Elevation (m) | 59.77 |
| Pump Stop Height (m) | 1.63 |
| Pump Stop Elevation (m) | 58.59 |
| | |
| Static Head (m) | 12.52 |




SCADA Data

Start 12:06 PM — Stop 12:10 PM

| t (s) | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 | 200 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RSP1, Q (L/s) | 69.2 | 69.2 | 70.5 | 70.5 | 70.5 | 70.5 | 70.5 | 70.5 | 70.5 | 70.5 | 70.5 | 69.5 | 69.5 | 69.5 | 69.5 | 69.5 | 69.5 | 69.5 | 68.5 | 38.4 | 38.4 |
| h (m) | 2.76 | 2.76 | 2.5 | 2.47 | 2.37 | 2.31 | 2.26 | 2.21 | 2.16 | 2.06 | 2.06 | 1.95 | 1.83 | 1.78 | 1.78 | 1.72 | 1.72 | 1.67 | 1.57 | 1.57 | 1.57 |
| True WW Elevs (m) | 59.72 | 59.72 | 59.46 | 59.43 | 59.33 | 59.27 | 59.22 | 59.17 | 59.12 | 59.02 | 59.02 | 58.91 | 58.79 | 58.74 | 58.74 | 58.68 | 58.68 | 58.63 | 58.53 | 58.53 | 58.53 |
| Pressure (kPa) | 91 | 91 | 92.8 | 92.8 | 92.8 | 92.8 | 92.8 | 92.8 | 92.8 | 92.8 | 92.8 | 92.8 | 91.8 | 91.8 | 91.8 | 91.8 | 91.8 | 91.8 | 91.8 | 0 | 0 |
| Pressure Head (m) | 9.28 | 9.28 | 9.47 | 9.47 | 9.47 | 9.47 | 9.47 | 9.47 | 9.47 | 9.47 | 9.47 | 9.47 | 9.36 | 9.36 | 9.36 | 9.36 | 9.36 | 9.36 | 9.36 | 0.00 | 0.00 |
| Pressure Head Correction (m) | 2.58 | 2.58 | 2.51 | 2.48 | 2.38 | 2.32 | 2.27 | 2.22 | 2.17 | 2.07 | 2.07 | 1.96 | 1.74 | 1.69 | 1.69 | 1.63 | 1.63 | 1.58 | 1.48 | -7.89 | -7.89 |
| Pressure Head WW Elevs (m) | 59.54 | 59.54 | 59.47 | 59.44 | 59.34 | 59.28 | 59.23 | 59.18 | 59.13 | 59.03 | 59.03 | 58.92 | 58.70 | 58.65 | 58.65 | 58.59 | 58.59 | 58.54 | 58.44 | 49.07 | 49.07 |

Start 1:01 PM — Stop 1:05 PM

| t (s) | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 | 160 | 170 | 180 | 190 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| RSP1, Q (L/s) | 62 | 69.6 | 69.6 | 69.6 | 69.6 | 69.6 | 69.6 | 69.6 | 69.6 | 68.6 | 68.6 | 68.6 | 68.6 | 68.6 | 68.6 | 68 | 68 | 68 | 68 | 68 |
| h (m) | 2.72 | 2.72 | 2.62 | 2.6 | 2.53 | 2.53 | 2.43 | 2.37 | 2.32 | 2.26 | 2.17 | 2.08 | 2.08 | 1.94 | 1.94 | 1.81 | 1.71 | 1.71 | 1.6 | 1.6 |
| True WW Elevs (m) | 59.68 | 59.68 | 59.58 | 59.56 | 59.49 | 59.49 | 59.39 | 59.33 | 59.28 | 59.22 | 59.13 | 59.04 | 59.04 | 58.9 | 58.9 | 58.77 | 58.67 | 58.67 | 58.56 | 58.56 |
| Pressure (kPa) | 101 | 92.2 | 92.2 | 93.7 | 92.4 | 92.4 | 92.4 | 92.4 | 92.4 | 92.4 | 92.4 | 92.4 | 91.1 | 91.1 | 91.1 | 91.2 | 91.2 | 91.2 | 91.2 | 22.3 |
| Pressure Head (m) | 10.30 | 9.40 | 9.40 | 9.56 | 9.42 | 9.42 | 9.42 | 9.42 | 9.42 | 9.42 | 9.42 | 9.42 | 9.29 | 9.29 | 9.29 | 9.30 | 9.30 | 9.30 | 9.30 | 2.27 |
| | 3.56 | 2.67 | 2.57 | 2.70 | 2.50 | 2.50 | 2.40 | 2.34 | 2.29 | 2.23 | 2.14 | 2.05 | 1.91 | 1.77 | 1.77 | 1.66 | 1.56 | 1.56 | 1.45 | -5.58 |
| True WW Elevs (m) | 60.52 | 59.63 | 59.53 | 59.66 | 59.46 | 59.46 | 59.36 | 59.30 | 59.25 | 59.19 | 59.10 | 59.01 | 58.87 | 58.73 | 58.73 | 58.62 | 58.52 | 58.52 | 58.41 | 51.38 |
| | 11.77 | 12.67 | 12.77 | 12.63 | 12.84 | 12.84 | 12.94 | 13.00 | 13.05 | 13.11 | 13.20 | 13.29 | 13.42 | 13.56 | 13.56 | 13.68 | 13.78 | 13.78 | 13.89 | |
| | | 15.48 | 15.58 | 15.45 | 15.65 | 15.65 | 15.75 | 15.81 | 15.86 | 15.92 | 16.01 | 16.10 | 16.23 | 16.37 | 16.37 | 16.49 | 16.59 | 16.59 | 16.70 | |

ted

## Discharge Manholes

| | | |
|---|---|---|
| **MH1 (Center of Sandhill and Shirley's Brook Intersection) 300 mm FM Discharge** | | |
| Angle Reading (Rim to FM Invert) (m) | 3 | |
| MH diameter (m) | 1.2 | |
| FM diameter (m) | 0.35 | 300 mm installed into existing 350 mm FM, discharging i |
| Invert (ground to FM Invert) (m) | 2.750 | |
| Obvert (ground to FM Obvert) (m) | 2.400 | |
| Reading Angle (degrees) | 24 | |
| Top of MH1 elevation (m) | 74.693 | |
| Actual Invert Elevation (m) | 71.943 | |
| Actual Obvert Elevation (m) | 72.293 | |
| | | |
| **MH2 (East of Intersection) 200 mm FM Discharge** | | |
| Top of MH2 elevation (m) | 74.69 | |
| FM diameter (m) | 0.2 | |
| MH diameter (m) | 1.5 | |
| As-built Obvert Elevation (m) | 72.765 | |
| Invert Elevation (m) | 72.565 | |
| | | |
| Low Level Elevation (m) | 58.59 | |
| As-Built FM Discharge Elevation (m) | 66.1 | |
| | | |
| Suction Head (m) | 7.51 | |
| Discharge Head 200mm FM (m) | 6.665 | |
| Discharge Head 300mm FM (m) | 6.193 | |
| | | |
| Static Head 200mm FM (m) | 14.175 | |
| Static Head 300mm FM (m) | 13.703 | |

nto MH1

# APPENDIX E: CERTIFICATE OF APPROVAL

**CONTENT COPY OF ORIGINAL**

Ministry of the Environment | Ministère de l'Environnement | Ontario

CERTIFICATE OF APPROVAL
MUNICIPAL AND PRIVATE SEWAGE WORKS
NUMBER 3079-4ZVRAG

Tenth Line Development Inc.
210 Gladstone Avenue, Suite 2001
Ottawa, Ontario
K2P 0Y6

Site Location: Briarridge Sewage Pumping Station
Lots 9 and 10, Concession IV
Ottawa City, (Ward 4 - Kanata), Ontario

*You have applied in accordance with Section 53 of the Ontario Water Resources Act for approval of:*

a sanitary sewage pumping station having an initial design peak flow capacity of 53 litres per second, to be constructed to serve the Briarridge Subdivision and surrounding drainage area of approximately 128 hectares, located approximately 130 metres north-east of Catterick Crescent, in the City of Ottawa, consisting of:

**SEWAGE PUMPING STATION**

a 3.66 metres diameter by approximately 11 metres depth, fiber reinforced plastic (FRP) wet well, equipped with two (2) submersible pumps (one duty, one standby), each rated at 55 litres per second at a total dynamic head of 23 metres, complete with piping, fittings, valves, by-pass connection, level controls, power supply, and a remote control building of 72 square metres floor area, complete with control room, chemical room, valve room and generator room, housing a 125 kilowatts rated standby power diesel generator set, telemetry system for remote station status indication, and all other items necessary to have a complete and operable pumping station;

**SANITARY FORCEMAIN AND OVERFLOW PIPE**

external piping consisting of a 300 millimetre diameter emergency overflow pipe from the pumping station to the nearby ditch to the west of the pumping station, and dual forcemains (200 millimetre and 300 millimetre diameter) from the pumping station, through the golf course access easement and railway corridor, along Block 24, Catterick Crescent, Shirley's Brook Drive (south), through the park area (Block 17) and Shirley's Brook Drive (north) for connection to the existing capped forcemain east of Helmsdale Road (for 300 millimetre diameter) and the existing trunk sanitary sewer at Sandhill Road (for 200 millimetre diameter); and

**SANITARY SEWERS**

to be constructed in the railway corridor, the pumping station access road, the golf course access easement and the pumping station site;

all in accordance with the application from Tenth Line Developments, dated March 20, 2001, including final plans, specifications, hydraulic design data sheets and "Briarridge Sanitary Pumping Station Pre-Design Report, City of Kanata", prepared by Cumming Cockburn Ltd., Consulting Engineers.

*For the purpose of this Certificate of Approval and the terms and conditions specified below, the following definitions apply:*

1. "Certificate" means this entire Certificate of Approval document, issued in accordance with Section 53 of the *Ontario Water Resources Act*;

2. "Director" means any Ministry employee appointed by the Minister pursuant to Section 5 of the *Ontario Water Resources*

*Act*;

3. "Environmental Appeal Board" means the Environmental Review Tribunal established pursuant to the Environmental Review Tribunal Act;

4. "Ministry" means the Ontario Ministry of the Environment;

5. "Owner" means Tenth Line Development Inc.; and

6. "works" means the sewage works described in the Owner's application, this Certificate and in the supporting documentation referred to herein, to the extent approved by this Certificate.

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

**TERMS AND CONDITIONS**

**GENERAL CONDITIONS**

1. Except as otherwise provided by these Conditions, the Owner shall design, build, install, operate and maintain the works in accordance with the description given in this Certificate, the application for approval of the works and the submitted supporting documents and plans and specifications as listed in this Certificate.

2. Where there is a conflict between a provision of any submitted document referred to in this Certificate and the Conditions of this Certificate, the Conditions in this Certificate shall take precedence, and where there is a conflict between the listed submitted documents, the document bearing the most recent date shall prevail.

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

Conditions No. 1 and No. 2 are imposed to ensure that the works are built and operated in the manner in which they were described for review and upon which approval was granted. These conditions are also included to emphasize the precedence of Conditions in the Certificate and the practice that the Approval is based on the most current document, if several conflicting documents are submitted for review.

*In accordance with Section 100 of the Ontario Water Resources Act, R.S.O. 1990, Chapter 0.40, as amended, you may by written notice served upon me and the Environmental Appeal Board within 15 days after receipt of this Notice, require a hearing by the Board. Section 101 of the Ontario Water Resources Act, R.S.O. 1990, Chapter 0.40, provides that the Notice requiring the hearing shall state:*

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

*The Notice should also include:*

3. The name of the appellant;
4. The address of the appellant;
5. The Certificate of Approval number;
6. The date of the Certificate of Approval;
7. The name of the Director;
8. The municipality within which the works are located;

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

*This Notice must be served upon:*

The Secretary*
Environmental Appeal Board
2300 Yonge St., 12th Floor
P.O. Box 2382
Toronto, Ontario
M4P 1E4

AND

The Director
Section 53, *Ontario Water Resources Act*
Ministry ofthe Environment
2 St. Clair Avenue West, Floor 12A
Toronto, Ontario
M4V 1L5

*** Further information on the Environmental Appeal Board's requirements for an appeal can be obtained directly from the Board at: Tel: (416) 314-4600, Fax: (416) 314-4506 or www.ert.gov.on.ca**

*The above noted sewage works are approved under Section 53 of the Ontario Water Resources Act.*

DATED AT TORONTO this 24th day of August, 2001

Yvonne Hall, P.Eng.
Director
Section 53, *Ontario Water Resources Act*

KC/
c: District Manager, MOE Ottawa District Office
Jim Moffatt, P. Eng., Cumming Cockburn Limited
P. Pagé, City Clerk & Director, Secretariat Services, The Corporation of the City of Ottawa
R. Phillips, Interim Coordinator - Ottawa West, The Corporation of the City of Ottawa
C. Goulet, P.Eng., MOE Ottawa District Office

# APPENDIX F: PUMP CURVE

FLYGT

# Performance Curve

| Product | Type |
|---|---|
| CP3201.180 | HT |

| Date | Project | Curve No | Issue |
|---|---|---|---|
| 2018-08-01 | | 63-454-00-2350 | 8 |

| | 1/1-Load | 3/4-Load | 1/2-Load |
|---|---|---|---|
| Power Factor | 0.90 | 0.88 | 0.82 |
| Efficiency | 87.0 % | 87.5 % | 86.5 % |
| Motor Data | --- | --- | --- |

| | | |
|---|---|---|
| Rated Power ... | 47 ( 35.05 kW) | hp |
| Starting Current ... | 288 | A |
| Rated Current ... | 43 | A |
| Rated Speed ... | 1755 | rpm |
| Tot. Mom. of Inertia ... | 0.33 | kgm2 |
| No. of Blades | 1 | |

Comments

Inlet/Outlet: -/150 mm

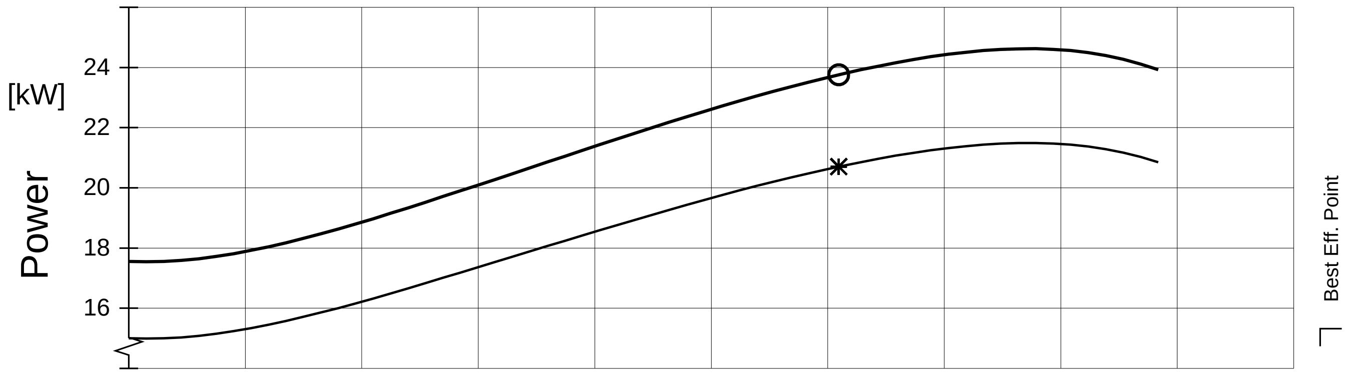
Imp. Throughlet: 76 mm

Impeller Diameter: 281 mm

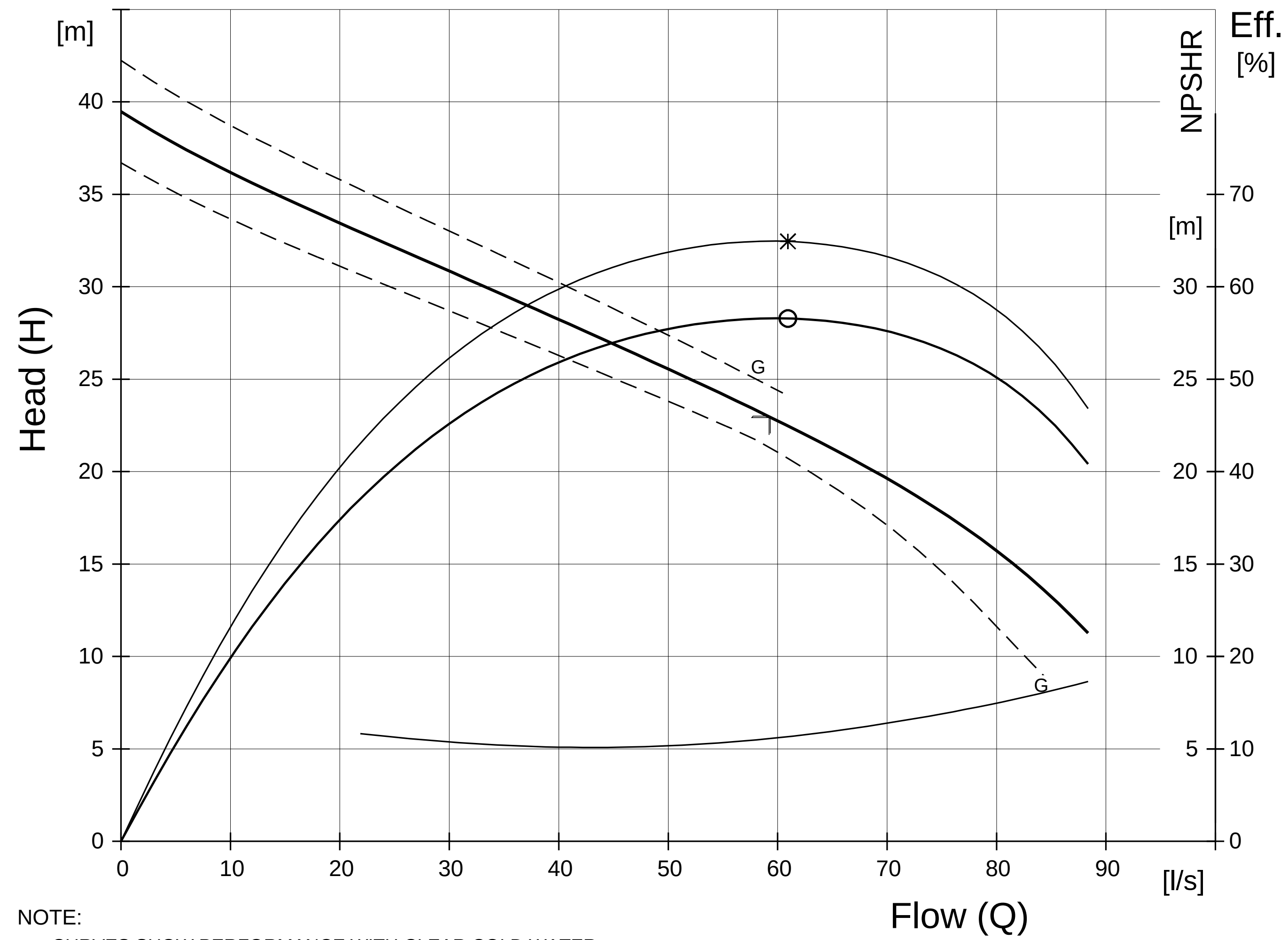
| Motor # | Stator | Rev |
|---|---|---|
| 27-26-4AA | 52D | 11 |

| Freq. | Phases | Voltage | Poles |
|---|---|---|---|
| 60 Hz | 3 | 600 V | 4 |

| Geartype | Ratio |
|---|---|
| --- | --- |




| Duty-Point | Flow [l/s] | Head [m] | Power [kW] | Eff. [%] | NPSHR[m] |
|---|---|---|---|---|---|
| B.E.P. | 60.9 | 22.5 | 23.8 ( 20.8) * | 56.6 (64.9) * | 5.7 |




NOTE:

CURVES SHOW PERFORMANCE WITH CLEAR COLD WATER

* : Pump EFFICIENCY/Shaft POWER

O : Overall EFFICIENCY/Input POWER

NPSHR = NPSH3 + min. operational margin

Guarantee between limits (G) acc. to

ISO 9906:2012 & ANSI/HI 11.6:2012 / grade 3B-

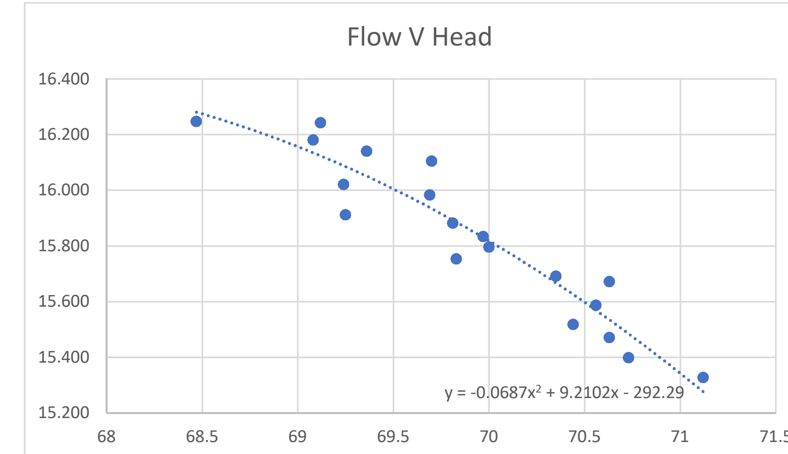
unix AUTHOR: SAMALSA SACU (rev:8.1)

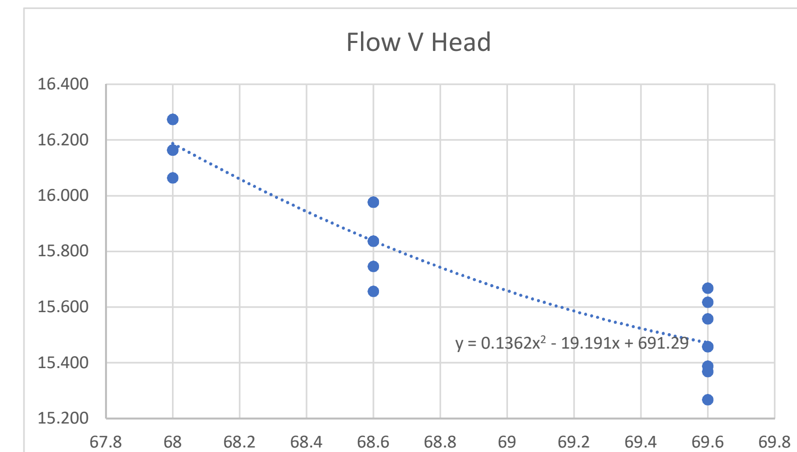
| Flygt CP 3201.190, 35 kW, 600V | 1755 RPM | 47 HP | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Actual Data | | | | | | | | | | | |
| Flow Rate, Q (L/s) | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 88.37 | 0.921 |
| Head, h (m) | 39.472 | 36.186 | 33.433 | 30.849 | 28.227 | 25.553 | 22.738 | 19.628 | 15.718 | 12.13 | |
| Reduced Head | 36.71 | 33.76 | 31.11 | 28.69 | 26.29 | 23.8 | 21.05 | 17.15 | 11.62 | - | |

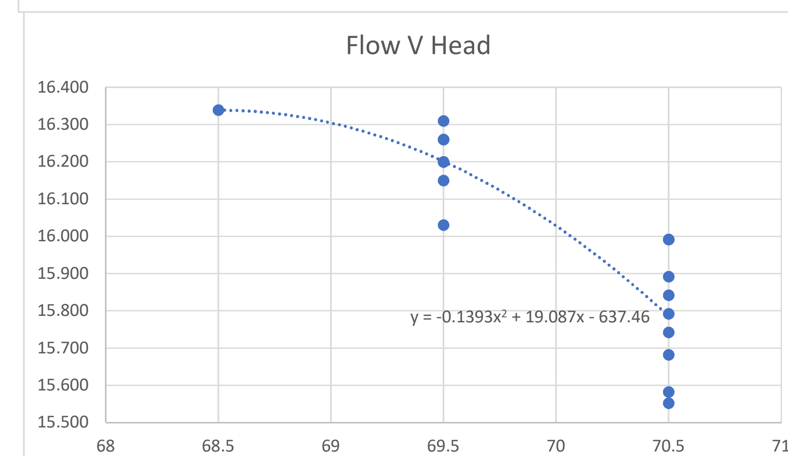
| | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Recorded data 1 | | | | | | | | | | | | | | | | | | | | |
| **MiniCAS Reading, Q (L/s)** | | **71.12** | **70.73** | **70.63** | **70.44** | **70.56** | **70.63** | **70.35** | **70** | **69.83** | **69.97** | **69.81** | **69.25** | **69.69** | **69.24** | **69.7** | **69.36** | **69.08** | **69.12** | **68.47** |
| 300 mm FM Static Head (m) | 12.553 | 12.563 | 12.663 | 12.743 | 12.803 | 12.863 | 12.943 | 12.983 | 13.113 | 13.083 | 13.153 | 13.213 | 13.283 | 13.323 | 13.393 | 13.443 | 13.503 | 13.563 | 13.623 | 13.673 |
| 200 mm FM Static Head (m) | 13.025 | 13.035 | 13.135 | 13.215 | 13.275 | 13.335 | 13.415 | 13.455 | 13.585 | 13.555 | 13.625 | 13.685 | 13.755 | 13.795 | 13.865 | 13.915 | 13.975 | 14.035 | 14.095 | 14.145 |
| Wet Well Elevation (m) | 59.740 | 59.730 | 59.630 | 59.550 | 59.490 | 59.430 | 59.350 | 59.310 | 59.180 | 59.210 | 59.140 | 59.080 | 59.010 | 58.970 | 58.900 | 58.850 | 58.790 | 58.730 | 58.670 | 58.620 |
| 300 mm Pipe Area (m2) | 0.071 | | | | | | | | | | | | | | | | | | | |
| 300 mm Velocity (m/s) | 0.000 | 1.006 | 1.001 | 0.999 | 0.997 | 0.998 | 0.999 | 0.995 | 0.990 | 0.988 | 0.990 | 0.988 | 0.980 | 0.986 | 0.980 | 0.986 | 0.981 | 0.977 | 0.978 | 0.969 |
| Friction Losses (m) | 0.000 | 2.248 | 2.225 | 2.219 | 2.208 | 2.215 | 2.219 | 2.203 | 2.183 | 2.173 | 2.181 | 2.172 | 2.140 | 2.165 | 2.139 | 2.165 | 2.146 | 2.130 | 2.132 | 2.095 |
| Local Losses (m) | 0.000 | 0.516 | 0.510 | 0.509 | 0.506 | 0.508 | 0.509 | 0.505 | 0.500 | 0.497 | 0.499 | 0.497 | 0.489 | 0.495 | 0.489 | 0.496 | 0.491 | 0.487 | 0.487 | 0.478 |
| Static Lift | 12.553 | 12.563 | 12.663 | 12.743 | 12.803 | 12.863 | 12.943 | 12.983 | 13.113 | 13.083 | 13.153 | 13.213 | 13.283 | 13.323 | 13.393 | 13.443 | 13.503 | 13.563 | 13.623 | 13.673 |
| **Total Dynamic Head (m)** | | **15.327** | **15.398** | **15.471** | **15.517** | **15.586** | **15.671** | **15.691** | **15.795** | **15.753** | **15.833** | **15.882** | **15.912** | **15.983** | **16.021** | **16.104** | **16.140** | **16.180** | **16.242** | **16.246** |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCADA Reading 1 | | | | | | | | | | | | | | | | | | | |
| Flow Rate, Q (L/s) | **69.6** | **69.6** | **69.6** | **69.6** | **69.6** | **69.6** | **69.6** | **69.6** | **68.6** | **68.6** | **68.6** | **68.6** | **68.6** | **68.6** | **68** | **68** | **68** | **68** | **68** |
| 300 mm FM Static Head (m) | 12.613 | 12.713 | 12.733 | 12.803 | 12.803 | 12.903 | 12.963 | 13.013 | 13.073 | 13.163 | 13.253 | 13.253 | 13.393 | 13.393 | 13.523 | 13.623 | 13.623 | 13.733 | 13.733 |
| 200 mm FM Static Head (m) | 13.045 | 13.305 | 13.335 | 13.435 | 13.495 | 13.545 | 13.595 | 13.645 | 13.745 | 13.745 | 13.855 | 13.975 | 14.025 | 14.025 | 14.085 | 14.085 | 14.135 | 14.235 | 14.235 |
| Wet Well Elevation (m) | 59.680 | 59.580 | 59.560 | 59.490 | 59.490 | 59.390 | 59.330 | 59.280 | 59.220 | 59.130 | 59.040 | 59.040 | 58.900 | 58.900 | 58.770 | 58.670 | 58.670 | 58.560 | 58.560 |
| 300 mm Pipe Area (m2) | 0.071 | | | | | | | | | | | | | | | | | | |
| 300 mm Velocity (m/s) | 0.985 | 0.985 | 0.985 | 0.985 | 0.985 | 0.985 | 0.985 | 0.985 | 0.970 | 0.970 | 0.970 | 0.970 | 0.970 | 0.970 | 0.962 | 0.962 | 0.962 | 0.962 | 0.962 |
| Friction Losses (m) | 2.160 | 2.160 | 2.160 | 2.160 | 2.160 | 2.160 | 2.160 | 2.160 | 2.102 | 2.102 | 2.102 | 2.102 | 2.102 | 2.102 | 2.069 | 2.069 | 2.069 | 2.069 | 2.069 |
| Local Losses (m) | 0.494 | 0.494 | 0.494 | 0.494 | 0.494 | 0.494 | 0.494 | 0.494 | 0.480 | 0.480 | 0.480 | 0.480 | 0.480 | 0.480 | 0.472 | 0.472 | 0.472 | 0.472 | 0.472 |
| Static Lift | 12.613 | 12.713 | 12.733 | 12.803 | 12.803 | 12.903 | 12.963 | 13.013 | 13.073 | 13.163 | 13.253 | 13.253 | 13.393 | 13.393 | 13.523 | 13.623 | 13.623 | 13.733 | 13.733 |
| **300 mm Total Dynamic Head (m)** | **15.267** | **15.367** | **15.387** | **15.457** | **15.457** | **15.557** | **15.617** | **15.667** | **15.656** | **15.746** | **15.836** | **15.836** | **15.976** | **15.976** | **16.063** | **16.163** | **16.163** | **16.273** | **16.273** |

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCADA Reading 2 | | | | | | | | | | | | | | | | | | | |
| **Flow Rate, Q (L/s)** | **69.2** | **69.2** | **70.5** | **70.5** | **70.5** | **70.5** | **70.5** | **70.5** | **70.5** | **70.5** | **70.5** | **69.5** | **69.5** | **69.5** | **69.5** | **69.5** | **69.5** | **69.5** | **68.5** |
| Wet Well Elevation (m) | 59.72 | 59.72 | 59.46 | 59.43 | 59.33 | 59.27 | 59.22 | 59.17 | 59.12 | 59.02 | 59.02 | 58.91 | 58.79 | 58.74 | 58.74 | 58.68 | 58.68 | 58.63 | 58.53 |
| 300 mm Pipe Area (m2) | 0.071 | | | | | | | | | | | | | | | | | | |
| 300 mm Velocity (m/s) | 0.979 | 0.979 | 0.997 | 0.997 | 0.997 | 0.997 | 0.997 | 0.997 | 0.997 | 0.997 | 0.997 | 0.983 | 0.983 | 0.983 | 0.983 | 0.983 | 0.983 | 0.983 | 0.969 |
| Friction Losses (m) | 2.137 | 2.137 | 2.212 | 2.212 | 2.212 | 2.212 | 2.212 | 2.212 | 2.212 | 2.212 | 2.212 | 2.154 | 2.154 | 2.154 | 2.154 | 2.154 | 2.154 | 2.154 | 2.097 |
| Local Losses (m) | 0.488 | 0.488 | 0.507 | 0.507 | 0.507 | 0.507 | 0.507 | 0.507 | 0.507 | 0.507 | 0.507 | 0.493 | 0.493 | 0.493 | 0.493 | 0.493 | 0.493 | 0.493 | 0.479 |
| Static Lift | 12.573 | 12.573 | 12.833 | 12.863 | 12.963 | 13.023 | 13.073 | 13.123 | 13.173 | 13.27 | 13.27 | 13.38 | 13.5 | 13.55 | 13.55 | 13.61 | 13.61 | 13.66 | 13.76 |
| **300 mm Total Dynamic Head (m)** | | | **15.552** | **15.582** | **15.682** | **15.742** | **15.792** | **15.842** | **15.892** | **15.992** | **15.992** | **16.030** | **16.150** | **16.200** | **16.200** | **16.260** | **16.260** | **16.310** | **16.338** |



# APPENDIX G: SYSTEM CURVE

### System Curve 200 mm FM Determination of Briarridge PS

| | | |
|---|---|---|
| Elevation at HP | 72.765 m (obvert) | |
| Forcemain Length | 750 m | |
| Forcemain Inner Diameter | 212 mm | (Nominal Diameter = 200mm, PVC DR25) |
| Sump Max Level | 59.77 m | |
| Sump Min Level | 58.59 m | |
| Sump Intermediate Level | 59.18 m | |

| | | |
|---|---|---|
| Elevation at HP | 72.293 m (As-Built Obvert) | |
| Forcemain Length | 750 m | |
| Forcemain Inner Diameter | 308 mm | (Nominal Diameter = 300mm, PVC DR25) |

Equivalent FM

| | | |
|---|---|---|
| Elevation at HP | 72.293 m | |
| Forcemain Length | 750 m | |
| EQ FM Inner Diameter | **347.52** mm | (Nominal Diameter = 350 mm) |

| FM1 | FM2 | Equivalent |
|---|---|---|
| 0.061 | 0.163 | 0.225 |
| HW - C | 130 | |

**200 mm FM**

| Flow (l/s): | Velocity (m/s): | Friction Losses: HW-C 100 | 115 | 130 | Local Losses: k= 15 | System Curve Max | Ave | Min |
|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 0 | 0 | 0 | 0 | 14.175 | 13.585 | 12.995 |
| 0.75 | 0.0212471 | 0.004915 | 0.0038 | 0.0030232 | 0.000345137 | 14.18026 | 13.58914 | 12.99837 |
| 1.50 | 0.0424942 | 0.017742 | 0.0137 | 0.0109136 | 0.001380548 | 14.19412 | 13.60008 | 13.00729 |
| 2.25 | 0.0637413 | 0.037593 | 0.029 | 0.0231254 | 0.003106233 | 14.2157 | 13.61713 | 13.02123 |
| 3.00 | 0.0849884 | 0.064047 | 0.0494 | 0.0393981 | 0.005522193 | 14.24457 | 13.63996 | 13.03992 |
| 3.75 | 0.1062355 | 0.096822 | 0.0747 | 0.0595597 | 0.008628426 | 14.28045 | 13.66837 | 13.06319 |
| 4.50 | 0.127482599 | 0.135712 | 0.1048 | 0.0834826 | 0.012424934 | 14.32314 | 13.70219 | 13.09091 |
| 5.25 | 0.148729699 | 0.180553 | 0.1394 | 0.1110661 | 0.016911715 | 14.37246 | 13.74129 | 13.12298 |
| 6.00 | 0.169976799 | 0.23121 | 0.1785 | 0.1422272 | 0.022088771 | 14.4283 | 13.78557 | 13.15932 |
| 6.75 | 0.191223899 | 0.287568 | 0.222 | 0.1768957 | 0.027956101 | 14.49052 | 13.83494 | 13.19985 |
| 7.50 | 0.212470999 | 0.349529 | 0.2698 | 0.2150107 | 0.034513704 | 14.55904 | 13.88933 | 13.24452 |
| 8.25 | 0.233718099 | 0.417006 | 0.3219 | 0.2565189 | 0.041761582 | 14.63377 | 13.94867 | 13.29328 |
| 9.00 | 0.254965199 | 0.489922 | 0.3782 | 0.3013726 | 0.049699734 | 14.71462 | 14.01289 | 13.34607 |
| 9.75 | 0.276212299 | 0.568207 | 0.4386 | 0.3495289 | 0.058328161 | 14.80153 | 14.08195 | 13.40286 |
| 10.50 | 0.297459399 | 0.651797 | 0.5032 | 0.400949 | 0.067646861 | 14.89444 | 14.1558 | 13.4636 |
| 11.25 | 0.318706499 | 0.740635 | 0.5717 | 0.4555972 | 0.077655835 | 14.99329 | 14.23439 | 13.52825 |
| 12.00 | 0.339953599 | 0.834667 | 0.6443 | 0.5134407 | 0.088355084 | 15.09802 | 14.31767 | 13.5968 |
| 12.75 | 0.361200699 | 0.933844 | 0.7209 | 0.574449 | 0.099744606 | 15.20859 | 14.40562 | 13.66919 |
| 13.50 | 0.382447798 | 1.038121 | 0.8014 | 0.6385939 | 0.111824403 | 15.32495 | 14.4982 | 13.74542 |
| 14.25 | 0.403694898 | 1.147453 | 0.8858 | 0.7058489 | 0.124594473 | 15.44705 | 14.59537 | 13.82544 |
| 15.00 | 0.424941998 | 1.2618 | 0.974 | 0.7761892 | 0.138054818 | 15.57486 | 14.6971 | 13.90924 |
| 15.75 | 0.446189098 | 1.381126 | 1.0662 | 0.8495916 | 0.152205437 | 15.70833 | 14.80336 | 13.9968 |
| 16.50 | 0.467436198 | 1.505393 | 1.1621 | 0.9260338 | 0.16704633 | 15.84744 | 14.91413 | 14.08808 |
| 17.25 | 0.488683298 | 1.634568 | 1.2618 | 1.0054952 | 0.182577497 | 15.99215 | 15.02938 | 14.18307 |
| 18.00 | 0.509930398 | 1.768619 | 1.3653 | 1.0879559 | 0.198798938 | 16.14242 | 15.14908 | 14.28175 |
| 18.75 | 0.531177498 | 1.907515 | 1.4725 | 1.1733969 | 0.215710653 | 16.29823 | 15.27321 | 14.38411 |
| 19.50 | 0.552424598 | 2.051227 | 1.5834 | 1.2618005 | 0.233312642 | 16.45954 | 15.40175 | 14.49011 |
| 20.25 | 0.573671698 | 2.199727 | 1.6981 | 1.3531494 | 0.251604906 | 16.62633 | 15.53468 | 14.59975 |
| 21.00 | 0.594918798 | 2.352989 | 1.8164 | 1.4474272 | 0.270587443 | 16.79858 | 15.67197 | 14.71301 |
| 21.75 | 0.616165898 | 2.510986 | 1.9383 | 1.5446182 | 0.290260255 | 16.97625 | 15.81361 | 14.82988 |
| 22.50 | 0.637412997 | 2.673694 | 2.064 | 1.6447073 | 0.31062334 | 17.15932 | 15.95957 | 14.95033 |
| 23.25 | 0.658660097 | 2.84109 | 2.1932 | 1.74768 | 0.3316767 | 17.34777 | 16.10985 | 15.07436 |
| 24.00 | 0.679907197 | 3.013151 | 2.326 | 1.8535223 | 0.353420334 | 17.54157 | 16.26441 | 15.20194 |
| 24.75 | 0.701154297 | 3.189855 | 2.4624 | 1.9622208 | 0.375854242 | 17.74071 | 16.42325 | 15.33308 |
| 25.50 | 0.722401397 | 3.371181 | 2.6024 | 2.0737625 | 0.398978424 | 17.94516 | 16.58635 | 15.46774 |
| 26.25 | 0.743648497 | 3.557109 | 2.7459 | 2.1881348 | 0.42279288 | 18.1549 | 16.75369 | 15.60593 |
| 27.00 | 0.764895597 | 3.747618 | 2.893 | 2.3053257 | 0.44729761 | 18.36992 | 16.92526 | 15.74762 |
| 27.75 | 0.786142697 | 3.942691 | 3.0435 | 2.4253233 | 0.472492615 | 18.59018 | 17.10104 | 15.89282 |
| 28.50 | 0.807389797 | 4.142308 | 3.1976 | 2.5481165 | 0.498377893 | 18.81569 | 17.28102 | 16.04149 |
| 29.25 | 0.828636897 | 4.346451 | 3.3552 | 2.673694 | 0.524953445 | 19.0464 | 17.46518 | 16.19365 |
| 30.00 | 0.849883997 | 4.555103 | 3.5163 | 2.8020453 | 0.552219272 | 19.28232 | 17.65352 | 16.34926 |
| 30.75 | 0.871131097 | 4.768248 | 3.6808 | 2.93316 | 0.580175373 | 19.52342 | 17.84601 | 16.50834 |
| 31.50 | 0.892378196 | 4.985869 | 3.8488 | 3.067028 | 0.608821747 | 19.76969 | 18.04265 | 16.67085 |
| 32.25 | 0.913625296 | 5.207949 | 4.0203 | 3.2036395 | 0.638158396 | 20.02111 | 18.24342 | 16.8368 |
| 33.00 | 0.934872396 | 5.434474 | 4.1951 | 3.3429849 | 0.668185319 | 20.27766 | 18.44831 | 17.00617 |
| 33.75 | 0.956119496 | 5.665428 | 4.3734 | 3.4850549 | 0.698902516 | 20.53933 | 18.65731 | 17.17896 |
| 34.50 | 0.977366596 | 5.900797 | 4.5551 | 3.6298406 | 0.730309987 | 20.80611 | 18.87041 | 17.35515 |
| 35.25 | 0.998613696 | 6.140566 | 4.7402 | 3.7773331 | 0.762407732 | 21.07797 | 19.0876 | 17.53474 |
| 36.00 | 1.019860796 | 6.384721 | 4.9287 | 3.9275238 | 0.795195752 | 21.35492 | 19.30886 | 17.71772 |
| 36.75 | 1.041107896 | 6.633249 | 5.1205 | 4.0804043 | 0.828674045 | 21.63692 | 19.53419 | 17.90408 |
| 37.50 | 1.062354996 | 6.886136 | 5.3157 | 4.2359664 | 0.862842612 | 21.92398 | 19.76358 | 18.09381 |
| 38.25 | 1.083602096 | 7.143369 | 5.5143 | 4.394202 | 0.897701454 | 22.21607 | 19.99701 | 18.2869 |
| 39.00 | 1.104849196 | 7.404936 | 5.7162 | 4.5551035 | 0.93325057 | 22.51319 | 20.23447 | 18.48335 |
| 39.75 | 1.126096295 | 7.670825 | 5.9215 | 4.718663 | 0.969489959 | 22.81531 | 20.47596 | 18.68315 |
| 40.50 | 1.147343395 | 7.941022 | 6.13 | 4.8848732 | 1.006419623 | 23.12244 | 20.72147 | 18.88629 |

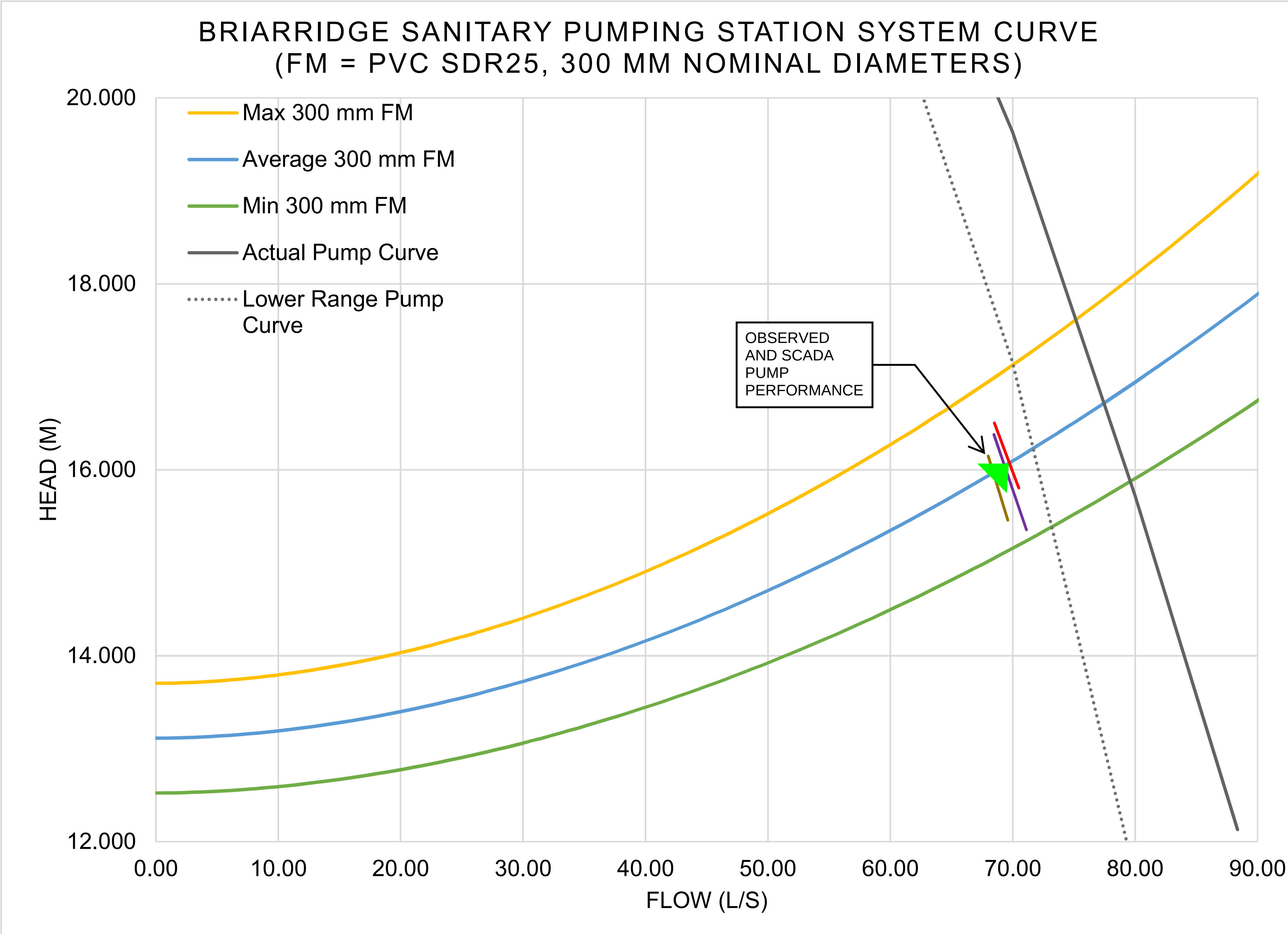
**300 mm FM**

| Flow (l/s): | Velocity (m/s): | Friction Losses: HW-C 110 | 120 | 130 | Local Losses: k= 10 | System Curve Max | Ave | Min |
|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 0 | 0 | 0 | 0 | 13.703 | 13.113 | 12.523 |
| 0.75 | 0.010066302 | 0.000668 | 0.000569 | 0.00049 | 5.16465E-05 | 13.704 | 13.114 | 12.524 |
| 1.50 | 0.020132604 | 0.002412 | 0.002053 | 0.00177 | 0.000206586 | 13.706 | 13.115 | 12.525 |
| 2.25 | 0.030198906 | 0.005111 | 0.00435 | 0.003751 | 0.000464818 | 13.709 | 13.118 | 12.527 |
| 3.00 | 0.040265207 | 0.008707 | 0.007411 | 0.00639 | 0.000826344 | 13.713 | 13.121 | 12.530 |
| 3.75 | 0.050331509 | 0.013162 | 0.011203 | 0.00966 | 0.001291162 | 13.717 | 13.125 | 12.534 |
| 4.50 | 0.060397811 | 0.018449 | 0.015703 | 0.01354 | 0.001859274 | 13.723 | 13.131 | 12.538 |
| 5.25 | 0.070464113 | 0.024545 | 0.020892 | 0.018013 | 0.002530678 | 13.730 | 13.136 | 12.544 |
| 6.00 | 0.080530415 | 0.031431 | 0.026753 | 0.023067 | 0.003305376 | 13.738 | 13.143 | 12.549 |
| 6.75 | 0.090596717 | 0.039093 | 0.033274 | 0.02869 | 0.004183366 | 13.746 | 13.150 | 12.556 |
| 7.50 | 0.100663018 | 0.047516 | 0.040444 | 0.034872 | 0.00516465 | 13.756 | 13.159 | 12.563 |
| 8.25 | 0.11072932 | 0.056689 | 0.048252 | 0.041604 | 0.006249226 | 13.766 | 13.168 | 12.571 |
| 9.00 | 0.120795622 | 0.066601 | 0.056689 | 0.048878 | 0.007437096 | 13.777 | 13.177 | 12.579 |
| 9.75 | 0.130861924 | 0.077243 | 0.065747 | 0.056689 | 0.008728258 | 13.789 | 13.187 | 12.588 |
| 10.50 | 0.140928226 | 0.088607 | 0.075419 | 0.065028 | 0.010122714 | 13.802 | 13.199 | 12.598 |
| 11.25 | 0.150994528 | 0.100684 | 0.085699 | 0.073892 | 0.011620462 | 13.815 | 13.210 | 12.609 |
| 12.00 | 0.16106083 | 0.113467 | 0.096579 | 0.083273 | 0.013221504 | 13.830 | 13.223 | 12.619 |
| 12.75 | 0.171127131 | 0.126949 | 0.108055 | 0.093168 | 0.014925838 | 13.845 | 13.236 | 12.631 |
| 13.50 | 0.181193433 | 0.141124 | 0.120121 | 0.103571 | 0.016733466 | 13.861 | 13.250 | 12.643 |
| 14.25 | 0.191259735 | 0.155987 | 0.132771 | 0.114479 | 0.018644386 | 13.878 | 13.264 | 12.656 |
| 15.00 | 0.201326037 | 0.171532 | 0.146003 | 0.125887 | 0.0206586 | 13.895 | 13.280 | 12.670 |
| 15.75 | 0.211392339 | 0.187753 | 0.15981 | 0.137792 | 0.022776106 | 13.914 | 13.296 | 12.684 |
| 16.50 | 0.221458641 | 0.204647 | 0.174189 | 0.15019 | 0.024996906 | 13.933 | 13.312 | 12.698 |
| 17.25 | 0.231524943 | 0.222207 | 0.189136 | 0.163077 | 0.027320998 | 13.953 | 13.329 | 12.713 |
| 18.00 | 0.241591244 | 0.24043 | 0.204647 | 0.176451 | 0.029748384 | 13.973 | 13.347 | 12.729 |
| 18.75 | 0.251657546 | 0.259312 | 0.220718 | 0.190309 | 0.032279062 | 13.995 | 13.366 | 12.746 |
| 19.50 | 0.261723848 | 0.278848 | 0.237347 | 0.204647 | 0.034913034 | 14.017 | 13.385 | 12.763 |
| 20.25 | 0.27179015 | 0.299036 | 0.25453 | 0.219462 | 0.037650298 | 14.040 | 13.405 | 12.780 |
| 21.00 | 0.281856452 | 0.319871 | 0.272264 | 0.234753 | 0.040490856 | 14.063 | 13.426 | 12.798 |
| 21.75 | 0.291922754 | 0.341349 | 0.290546 | 0.250516 | 0.043434706 | 14.088 | 13.447 | 12.817 |
| 22.50 | 0.301989055 | 0.363468 | 0.309372 | 0.266749 | 0.04648185 | 14.113 | 13.469 | 12.836 |
| 23.25 | 0.312055357 | 0.386224 | 0.328742 | 0.283449 | 0.049632286 | 14.139 | 13.491 | 12.856 |
| 24.00 | 0.322121659 | 0.409614 | 0.348651 | 0.300616 | 0.052886016 | 14.166 | 13.515 | 12.877 |
| 24.75 | 0.332187961 | 0.433636 | 0.369097 | 0.318245 | 0.056243038 | 14.193 | 13.538 | 12.897 |
| 25.50 | 0.342254263 | 0.458286 | 0.390079 | 0.336335 | 0.059703354 | 14.221 | 13.563 | 12.919 |
| 26.25 | 0.352320565 | 0.483561 | 0.411592 | 0.354885 | 0.063266962 | 14.250 | 13.588 | 12.941 |
| 27.00 | 0.362386867 | 0.50946 | 0.433636 | 0.373892 | 0.066933864 | 14.279 | 13.614 | 12.964 |
| 27.75 | 0.372453168 | 0.535978 | 0.456208 | 0.393354 | 0.070704058 | 14.310 | 13.640 | 12.987 |
| 28.50 | 0.38251947 | 0.563115 | 0.479305 | 0.413269 | 0.074577546 | 14.341 | 13.667 | 13.011 |
| 29.25 | 0.392585772 | 0.590866 | 0.502927 | 0.433636 | 0.078554326 | 14.372 | 13.694 | 13.035 |
| 30.00 | 0.402652074 | 0.619231 | 0.52707 | 0.454453 | 0.0826344 | 14.405 | 13.723 | 13.060 |
| 30.75 | 0.412718376 | 0.648206 | 0.551733 | 0.475718 | 0.086817766 | 14.438 | 13.752 | 13.086 |
| 31.50 | 0.422784678 | 0.67779 | 0.576914 | 0.497429 | 0.091104426 | 14.472 | 13.781 | 13.112 |
| 32.25 | 0.432850979 | 0.70798 | 0.602611 | 0.519586 | 0.095494378 | 14.506 | 13.811 | 13.138 |
| 33.00 | 0.442917281 | 0.738775 | 0.628822 | 0.542186 | 0.099987624 | 14.542 | 13.842 | 13.165 |
| 33.75 | 0.452983583 | 0.770171 | 0.655545 | 0.565227 | 0.104584162 | 14.578 | 13.873 | 13.193 |
| 34.50 | 0.463049885 | 0.802167 | 0.68278 | 0.58871 | 0.109283994 | 14.614 | 13.905 | 13.221 |
| 35.25 | 0.473116187 | 0.834762 | 0.710523 | 0.612631 | 0.114087118 | 14.652 | 13.938 | 13.250 |
| 36.00 | 0.483182489 | 0.867953 | 0.738775 | 0.63699 | 0.118993536 | 14.690 | 13.971 | 13.279 |
| 36.75 | 0.493248791 | 0.901739 | 0.767532 | 0.661785 | 0.124003246 | 14.729 | 14.005 | 13.309 |
| 37.50 | 0.503315092 | 0.936117 | 0.796793 | 0.687015 | 0.12911625 | 14.768 | 14.039 | 13.339 |
| 38.25 | 0.513381394 | 0.971086 | 0.826558 | 0.712679 | 0.134332546 | 14.808 | 14.074 | 13.370 |
| 39.00 | 0.523447696 | 1.006644 | 0.856823 | 0.738775 | 0.139652136 | 14.849 | 14.109 | 13.401 |
| 39.75 | 0.533513998 | 1.042789 | 0.887589 | 0.765302 | 0.145075018 | 14.891 | 14.146 | 13.433 |
| 40.50 | 0.5435803 | 1.07952 | 0.918854 | 0.792259 | 0.150601194 | 14.933 | 14.182 | 13.466 |

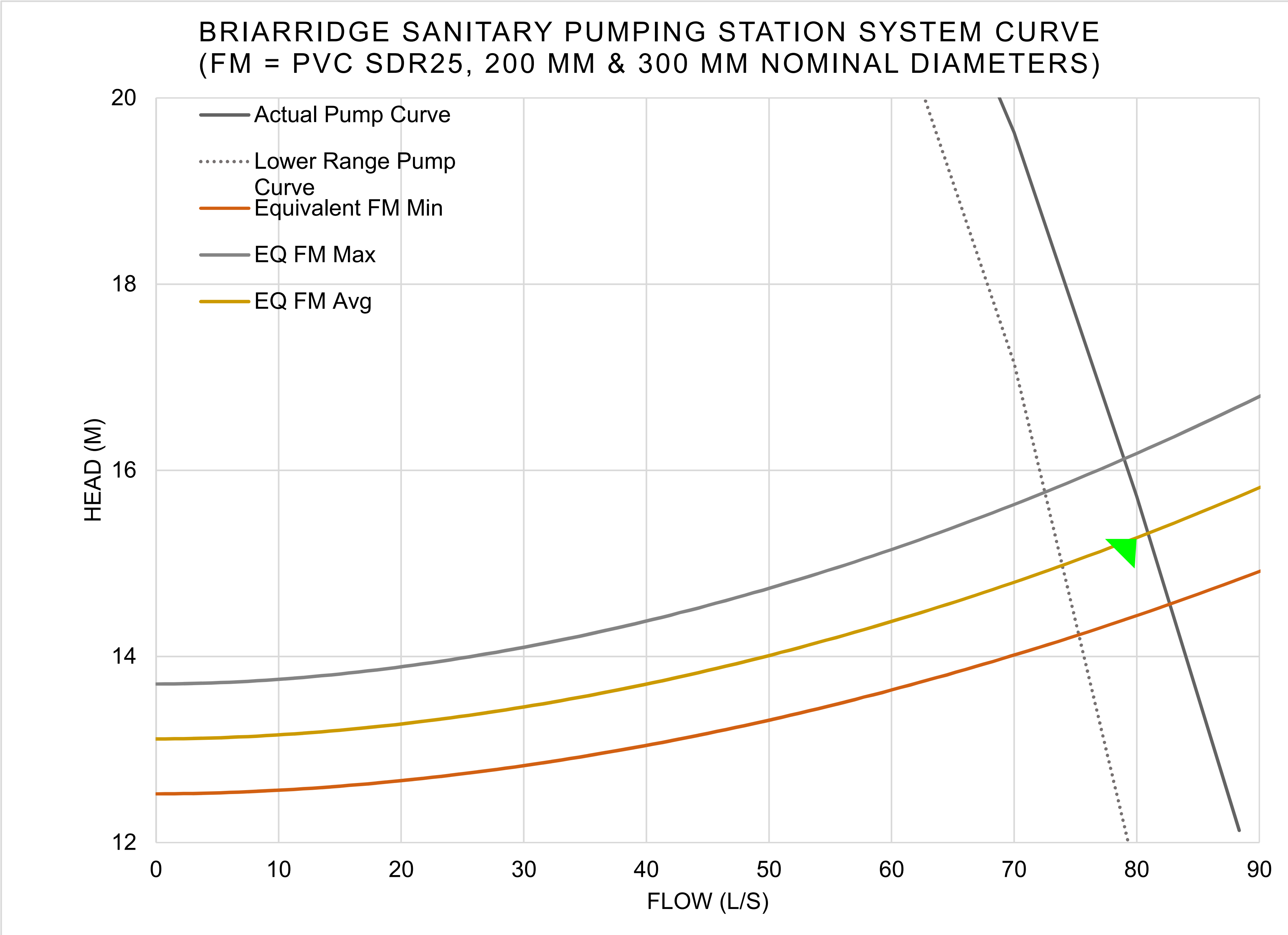
**Equivalent FM**

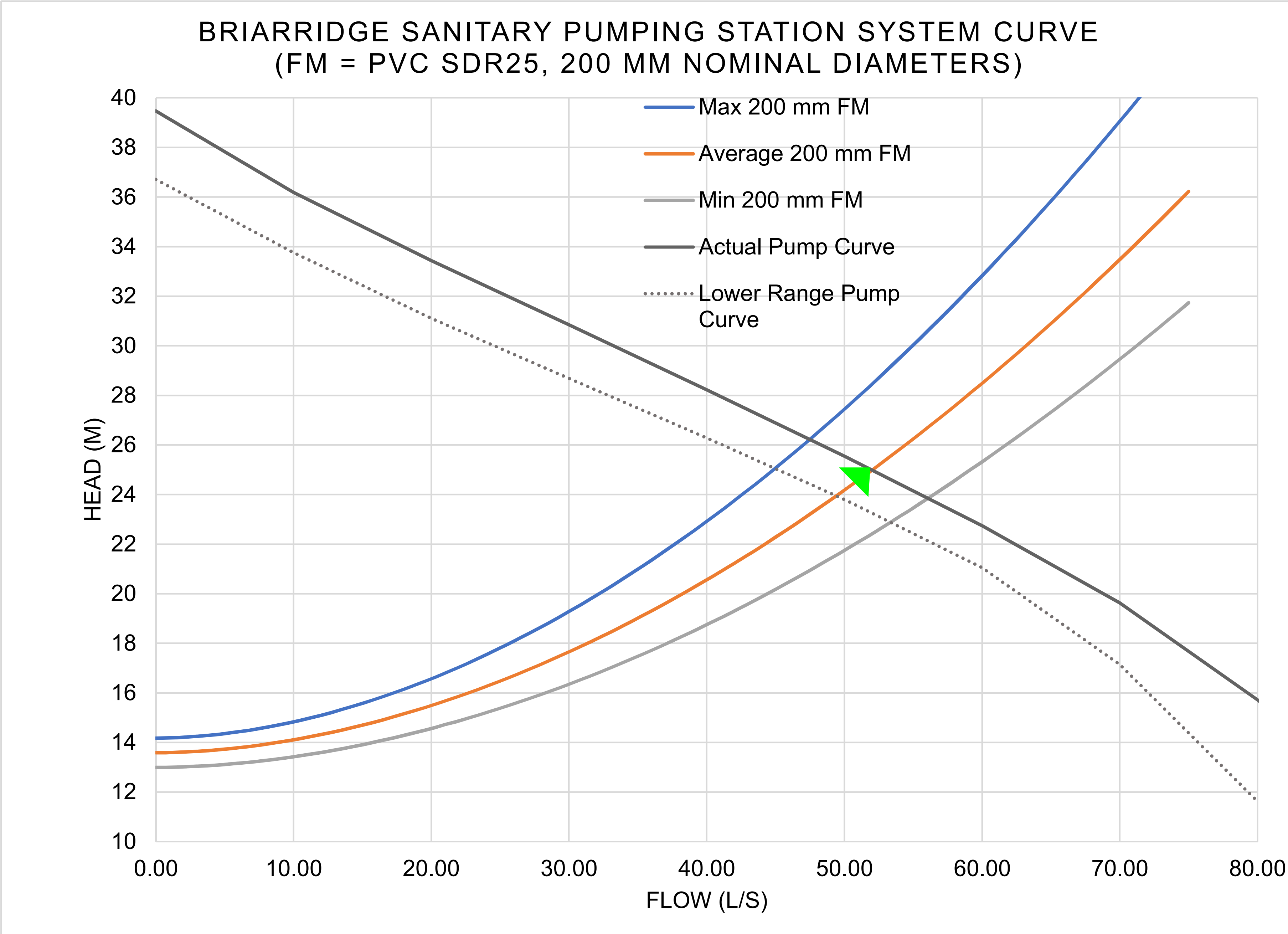
| Flow (l/s): | Velocity (m/s): | Friction Losses: HW-C 110 | 120 | 130 | Local Losses: k= 10 | System Curve Max | Ave | Min |
|---|---|---|---|---|---|---|---|---|
| 0.00 | 0 | 0 | 0 | 0 | 0 | 13.703 | 13.113 | 12.523 |
| 0.75 | 0.007906996 | 0.000371 | 0.000316 | 0.000272 | 3.18657E-05 | 13.703 | 13.113 | 12.523 |
| 1.50 | 0.015813993 | 0.00134 | 0.00114 | 0.000983 | 0.000127463 | 13.704 | 13.114 | 12.524 |
| 2.25 | 0.023720989 | 0.002839 | 0.002416 | 0.002083 | 0.000286792 | 13.706 | 13.116 | 12.525 |
| 3.00 | 0.031627986 | 0.004836 | 0.004117 | 0.003549 | 0.000509852 | 13.708 | 13.118 | 12.527 |
| 3.75 | 0.039534982 | 0.007311 | 0.006223 | 0.005366 | 0.000796644 | 13.711 | 13.120 | 12.529 |
| 4.50 | 0.047441978 | 0.010248 | 0.008723 | 0.007521 | 0.001147167 | 13.714 | 13.123 | 12.532 |
| 5.25 | 0.055348975 | 0.013634 | 0.011605 | 0.010006 | 0.001561422 | 13.718 | 13.126 | 12.535 |
| 6.00 | 0.063255971 | 0.017459 | 0.014861 | 0.012813 | 0.002039408 | 13.722 | 13.130 | 12.538 |
| 6.75 | 0.071162968 | 0.021715 | 0.018483 | 0.015937 | 0.002581125 | 13.727 | 13.134 | 12.542 |
| 7.50 | 0.079069964 | 0.026394 | 0.022466 | 0.019371 | 0.003186575 | 13.733 | 13.139 | 12.546 |
| 8.25 | 0.08697696 | 0.03149 | 0.026803 | 0.02311 | 0.003855755 | 13.738 | 13.144 | 12.550 |
| 9.00 | 0.094883957 | 0.036996 | 0.03149 | 0.027151 | 0.004588667 | 13.745 | 13.149 | 12.555 |
| 9.75 | 0.102790953 | 0.042907 | 0.036521 | 0.03149 | 0.005385311 | 13.751 | 13.155 | 12.560 |
| 10.50 | 0.11069795 | 0.049219 | 0.041894 | 0.036122 | 0.006245686 | 13.758 | 13.161 | 12.565 |
| 11.25 | 0.118604946 | 0.055928 | 0.047604 | 0.041045 | 0.007169793 | 13.766 | 13.168 | 12.571 |
| 12.00 | 0.126511942 | 0.063029 | 0.053648 | 0.046257 | 0.008157631 | 13.774 | 13.175 | 12.577 |
| 12.75 | 0.134418939 | 0.070518 | 0.060023 | 0.051753 | 0.0092092 | 13.783 | 13.182 | 12.584 |
| 13.50 | 0.142325935 | 0.078392 | 0.066725 | 0.057532 | 0.010324501 | 13.792 | 13.190 | 12.591 |
| 14.25 | 0.150232932 | 0.086648 | 0.073752 | 0.063591 | 0.011503534 | 13.801 | 13.198 | 12.598 |
| 15.00 | 0.158139928 | 0.095283 | 0.081102 | 0.069928 | 0.012746298 | 13.811 | 13.207 | 12.606 |
| 15.75 | 0.166046924 | 0.104294 | 0.088771 | 0.076541 | 0.014052794 | 13.821 | 13.216 | 12.614 |
| 16.50 | 0.173953921 | 0.113677 | 0.096759 | 0.083428 | 0.015423021 | 13.832 | 13.225 | 12.622 |
| 17.25 | 0.181860917 | 0.123432 | 0.105061 | 0.090586 | 0.016856979 | 13.843 | 13.235 | 12.630 |
| 18.00 | 0.189767914 | 0.133555 | 0.113677 | 0.098015 | 0.018354669 | 13.855 | 13.245 | 12.639 |
| 18.75 | 0.19767491 | 0.144043 | 0.122605 | 0.105713 | 0.019916091 | 13.867 | 13.256 | 12.649 |
| 19.50 | 0.205581906 | 0.154895 | 0.131842 | 0.113677 | 0.021541244 | 13.879 | 13.266 | 12.658 |
| 20.25 | 0.213488903 | 0.166109 | 0.141387 | 0.121907 | 0.023230128 | 13.892 | 13.278 | 12.668 |
| 21.00 | 0.221395899 | 0.177682 | 0.151238 | 0.130401 | 0.024982744 | 13.906 | 13.289 | 12.678 |
| 21.75 | 0.229302896 | 0.189613 | 0.161393 | 0.139157 | 0.026799092 | 13.919 | 13.301 | 12.689 |
| 22.50 | 0.237209892 | 0.2019 | 0.171851 | 0.148174 | 0.028679171 | 13.934 | 13.314 | 12.700 |
| 23.25 | 0.245116888 | 0.21454 | 0.18261 | 0.157451 | 0.030622981 | 13.948 | 13.326 | 12.711 |
| 24.00 | 0.253023885 | 0.227533 | 0.193669 | 0.166986 | 0.032630523 | 13.963 | 13.339 | 12.723 |
| 24.75 | 0.260930881 | 0.240877 | 0.205027 | 0.176779 | 0.034701796 | 13.979 | 13.353 | 12.734 |
| 25.50 | 0.268837877 | 0.254569 | 0.216682 | 0.186828 | 0.036836801 | 13.994 | 13.367 | 12.747 |
| 26.25 | 0.276744874 | 0.268609 | 0.228632 | 0.197132 | 0.039035538 | 14.011 | 13.381 | 12.759 |
| 27.00 | 0.28465187 | 0.282996 | 0.240877 | 0.20769 | 0.041298006 | 14.027 | 13.395 | 12.772 |
| 27.75 | 0.292558867 | 0.297726 | 0.253415 | 0.218501 | 0.043624205 | 14.044 | 13.410 | 12.785 |
| 28.50 | 0.300465863 | 0.3128 | 0.266245 | 0.229563 | 0.046014136 | 14.062 | 13.425 | 12.799 |
| 29.25 | 0.308372859 | 0.328215 | 0.279367 | 0.240877 | 0.048467798 | 14.080 | 13.441 | 12.812 |
| 30.00 | 0.316279856 | 0.343971 | 0.292778 | 0.25244 | 0.050985192 | 14.098 | 13.457 | 12.826 |
| 30.75 | 0.324186852 | 0.360067 | 0.306478 | 0.264253 | 0.053566318 | 14.117 | 13.473 | 12.841 |
| 31.50 | 0.332093849 | 0.3765 | 0.320465 | 0.276313 | 0.056211174 | 14.136 | 13.490 | 12.856 |
| 32.25 | 0.340000845 | 0.39327 | 0.334739 | 0.28862 | 0.058919763 | 14.155 | 13.507 | 12.871 |
| 33.00 | 0.347907841 | 0.410376 | 0.349299 | 0.301174 | 0.061692083 | 14.175 | 13.524 | 12.886 |
| 33.75 | 0.355814838 | 0.427816 | 0.364143 | 0.313974 | 0.064528134 | 14.195 | 13.542 | 12.902 |
| 34.50 | 0.363721834 | 0.445589 | 0.379272 | 0.327017 | 0.067427917 | 14.216 | 13.560 | 12.917 |
| 35.25 | 0.371628831 | 0.463695 | 0.394683 | 0.340305 | 0.070391431 | 14.237 | 13.578 | 12.934 |
| 36.00 | 0.379535827 | 0.482132 | 0.410376 | 0.353836 | 0.073418677 | 14.259 | 13.597 | 12.950 |
| 36.75 | 0.387442823 | 0.500899 | 0.42635 | 0.367609 | 0.076509654 | 14.280 | 13.616 | 12.967 |
| 37.50 | 0.39534982 | 0.519996 | 0.442604 | 0.381624 | 0.079664363 | 14.303 | 13.635 | 12.984 |
| 38.25 | 0.403256816 | 0.53942 | 0.459138 | 0.39588 | 0.082882803 | 14.325 | 13.655 | 13.002 |
| 39.00 | 0.411163813 | 0.559172 | 0.47595 | 0.410376 | 0.086164975 | 14.348 | 13.675 | 13.020 |
| 39.75 | 0.419070809 | 0.57925 | 0.49304 | 0.425111 | 0.089510878 | 14.372 | 13.696 | 13.038 |
| 40.50 | 0.426977805 | 0.599654 | 0.510406 | 0.440085 | 0.092920513 | 14.396 | 13.716 | 13.056 |

| | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 41.25 | 1.168590495 | 8.215516 | 6.3419 | 5.0537267 | 1.044039561 | 23.43456 | 20.97098 | 19.09277 | 0.553646602 | 1.116836 | 0.950615 | 0.819644 | 0.156230662 | 14.976 | 14.220 | 13.499 | 0.434884802 | 0.620382 | 0.528049 | 0.455297 | 0.096393879 | 14.420 | 13.737 | 13.075 |
| 42.00 | 1.189837595 | 8.494296 | 6.5571 | 5.2252164 | 1.082349773 | 23.75165 | 21.2245 | 19.30257 | 0.563712904 | 1.154734 | 0.982873 | 0.847458 | 0.161963424 | 15.020 | 14.258 | 13.532 | 0.442791798 | 0.641433 | 0.545968 | 0.470747 | 0.099930977 | 14.444 | 13.759 | 13.094 |
| 42.75 | 1.211084695 | 8.777349 | 6.7757 | 5.3993352 | 1.121350259 | 24.0737 | 21.482 | 19.51569 | 0.573779205 | 1.193212 | 1.015625 | 0.875697 | 0.167799478 | 15.064 | 14.296 | 13.566 | 0.450698795 | 0.662808 | 0.564161 | 0.486434 | 0.103531806 | 14.469 | 13.781 | 13.113 |
| 43.50 | 1.232331795 | 9.064666 | 6.9974 | 5.5760762 | 1.161041019 | 24.40071 | 21.74348 | 19.73212 | 0.583845507 | 1.232271 | 1.04887 | 0.904362 | 0.173738826 | 15.109 | 14.336 | 13.601 | 0.458605791 | 0.684504 | 0.582628 | 0.502357 | 0.107196367 | 14.495 | 13.803 | 13.133 |
| 44.25 | 1.253578895 | 9.356234 | 7.2225 | 5.7554327 | 1.201422053 | 24.73266 | 22.00894 | 19.95185 | 0.593911809 | 1.271907 | 1.082608 | 0.933451 | 0.179781466 | 15.155 | 14.375 | 13.636 | 0.466512787 | 0.706521 | 0.601369 | 0.518515 | 0.110924659 | 14.520 | 13.825 | 13.152 |
| 45.00 | 1.274825995 | 9.652043 | 7.4509 | 5.9373981 | 1.242493362 | 25.06954 | 22.27836 | 20.17489 | 0.603978111 | 1.31212 | 1.116836 | 0.962963 | 0.1859274 | 15.201 | 14.416 | 13.672 | 0.474419784 | 0.728859 | 0.620382 | 0.534909 | 0.114716683 | 14.547 | 13.848 | 13.173 |
| 45.75 | 1.296073095 | 9.952083 | 7.6825 | 6.1219659 | 1.284254944 | 25.41134 | 22.55174 | 20.40122 | 0.614044413 | 1.352908 | 1.151553 | 0.992898 | 0.192176626 | 15.248 | 14.457 | 13.708 | 0.48232678 | 0.751516 | 0.639667 | 0.551537 | 0.118572438 | 14.573 | 13.871 | 13.193 |
| 46.50 | 1.317320195 | 10.25634 | 7.9174 | 6.3091298 | 1.326706801 | 25.75805 | 22.82906 | 20.63084 | 0.624110715 | 1.39427 | 1.186759 | 1.023253 | 0.198529146 | 15.296 | 14.498 | 13.745 | 0.490233777 | 0.774492 | 0.659223 | 0.568398 | 0.122491924 | 14.600 | 13.895 | 13.214 |
| 47.25 | 1.338567295 | 10.56481 | 8.1555 | 6.4988835 | 1.369848931 | 26.10966 | 23.11033 | 20.86373 | 0.634177016 | 1.436204 | 1.222452 | 1.054029 | 0.204984958 | 15.344 | 14.540 | 13.782 | 0.498140773 | 0.797785 | 0.67905 | 0.585494 | 0.126475143 | 14.627 | 13.919 | 13.235 |
| 48.00 | 1.359814395 | 10.87748 | 8.3968 | 6.6912209 | 1.413681336 | 26.46617 | 23.39552 | 21.0999 | 0.644243318 | 1.478709 | 1.258631 | 1.085223 | 0.211544064 | 15.393 | 14.583 | 13.820 | 0.506047769 | 0.821396 | 0.699147 | 0.602822 | 0.130522092 | 14.655 | 13.943 | 13.256 |
| 48.75 | 1.381061494 | 11.19434 | 8.6414 | 6.8861359 | 1.458204015 | 26.82755 | 23.68465 | 21.33934 | 0.65430962 | 1.521784 | 1.295295 | 1.116836 | 0.218206462 | 15.443 | 14.627 | 13.858 | 0.513954766 | 0.845323 | 0.719513 | 0.620382 | 0.134632773 | 14.683 | 13.967 | 13.278 |
| 49.50 | 1.402308594 | 11.51539 | 8.8893 | 7.0836227 | 1.503416968 | 27.1938 | 23.97769 | 21.58204 | 0.664375922 | 1.565427 | 1.332443 | 1.148865 | 0.224972154 | 15.493 | 14.670 | 13.897 | 0.521861762 | 0.869566 | 0.740147 | 0.638174 | 0.138807186 | 14.711 | 13.992 | 13.300 |
| 50.25 | 1.423555694 | 11.8406 | 9.1403 | 7.2836755 | 1.549320195 | 27.56492 | 24.27464 | 21.828 | 0.674442224 | 1.609637 | 1.370073 | 1.181311 | 0.231841138 | 15.544 | 14.715 | 13.936 | 0.529768759 | 0.894124 | 0.76105 | 0.656197 | 0.14304533 | 14.740 | 14.017 | 13.322 |
| 51.00 | 1.444802794 | 12.16997 | 9.3946 | 7.4862885 | 1.595913696 | 27.94089 | 24.57549 | 22.0772 | 0.684508526 | 1.654413 | 1.408185 | 1.214172 | 0.238813416 | 15.596 | 14.760 | 13.976 | 0.537675755 | 0.918996 | 0.782221 | 0.67445 | 0.147347206 | 14.769 | 14.043 | 13.345 |
| 51.75 | 1.466049894 | 12.5035 | 9.652 | 7.6914562 | 1.643197471 | 28.3217 | 24.88024 | 22.32965 | 0.694574828 | 1.699754 | 1.446777 | 1.247447 | 0.245888986 | 15.649 | 14.806 | 14.016 | 0.545582751 | 0.944182 | 0.803658 | 0.692934 | 0.151712813 | 14.799 | 14.068 | 13.368 |
| 52.50 | 1.487296994 | 12.84117 | 9.9127 | 7.899173 | 1.69117152 | 28.70734 | 25.18888 | 22.58534 | 0.704641129 | 1.745658 | 1.485849 | 1.281136 | 0.25306785 | 15.702 | 14.852 | 14.057 | 0.553489748 | 0.969681 | 0.825362 | 0.711648 | 0.156142151 | 14.829 | 14.095 | 13.391 |
| 53.25 | 1.508544094 | 13.18298 | 10.177 | 8.1094335 | 1.739835844 | 29.09782 | 25.5014 | 22.84427 | 0.714707431 | 1.792124 | 1.525399 | 1.315237 | 0.260350006 | 15.755 | 14.899 | 14.099 | 0.561396744 | 0.995492 | 0.847332 | 0.73059 | 0.160635221 | 14.859 | 14.121 | 13.414 |
| 54.00 | 1.529791194 | 13.52891 | 10.444 | 8.3222324 | 1.789190441 | 29.4931 | 25.8178 | 23.10642 | 0.724773733 | 1.839151 | 1.565427 | 1.34975 | 0.267735456 | 15.810 | 14.946 | 14.140 | 0.569303741 | 1.021615 | 0.869566 | 0.749762 | 0.165192023 | 14.890 | 14.148 | 13.438 |
| 54.75 | 1.551038294 | 13.87896 | 10.714 | 8.5375644 | 1.839235313 | 29.8932 | 26.13806 | 23.3718 | 0.734840035 | 1.886737 | 1.605932 | 1.384674 | 0.275224198 | 15.865 | 14.994 | 14.183 | 0.577210737 | 1.048048 | 0.892066 | 0.769161 | 0.169812556 | 14.921 | 14.175 | 13.462 |
| 55.50 | 1.572285394 | 14.23313 | 10.987 | 8.7554243 | 1.889970458 | 30.2981 | 26.46219 | 23.64039 | 0.744906337 | 1.934883 | 1.646912 | 1.420008 | 0.282816234 | 15.921 | 15.043 | 14.226 | 0.585117733 | 1.074792 | 0.914829 | 0.788789 | 0.174496821 | 14.952 | 14.202 | 13.486 |
| 56.25 | 1.593532494 | 14.59139 | 11.264 | 8.9758072 | 1.941395878 | 30.70778 | 26.79018 | 23.9122 | 0.754972639 | 1.983586 | 1.688366 | 1.455751 | 0.290511562 | 15.977 | 15.092 | 14.269 | 0.59302473 | 1.101846 | 0.937856 | 0.808643 | 0.179244817 | 14.984 | 14.230 | 13.511 |
| 57.00 | 1.614779594 | 14.95374 | 11.544 | 9.1987079 | 1.993511572 | 31.12225 | 27.12201 | 24.18722 | 0.765038941 | 2.032845 | 1.730294 | 1.491903 | 0.298310184 | 16.034 | 15.142 | 14.313 | 0.600931726 | 1.129208 | 0.961147 | 0.828725 | 0.184056544 | 15.016 | 14.258 | 13.536 |
| 57.75 | 1.636026693 | 15.32018 | 11.826 | 9.4241215 | 2.04631754 | 31.5415 | 27.45769 | 24.46544 | 0.775105242 | 2.08266 | 1.772695 | 1.528462 | 0.306212098 | 16.092 | 15.192 | 14.358 | 0.608838723 | 1.15688 | 0.9847 | 0.849032 | 0.188932003 | 15.049 | 14.287 | 13.561 |
| 58.50 | 1.657273793 | 15.6907 | 12.112 | 9.6520432 | 2.099813781 | 31.96551 | 27.79721 | 24.74686 | 0.785171544 | 2.133029 | 1.815567 | 1.565427 | 0.314217306 | 16.150 | 15.243 | 14.403 | 0.616745719 | 1.184859 | 1.008514 | 0.869566 | 0.193871194 | 15.082 | 14.315 | 13.586 |
| 59.25 | 1.678520893 | 16.06529 | 12.402 | 9.8824682 | 2.154000298 | 32.39429 | 28.14055 | 25.03147 | 0.795237846 | 2.183951 | 1.858911 | 1.602799 | 0.322325806 | 16.209 | 15.294 | 14.448 | 0.624652715 | 1.213145 | 1.032591 | 0.890326 | 0.198874116 | 15.115 | 14.344 | 13.612 |
| 60.00 | 1.699767993 | 16.44394 | 12.694 | 10.115392 | 2.208877088 | 32.82781 | 28.48773 | 25.31927 | 0.805304148 | 2.235425 | 1.902724 | 1.640576 | 0.3305376 | 16.269 | 15.346 | 14.494 | 0.632559712 | 1.241738 | 1.056928 | 0.91131 | 0.203940769 | 15.149 | 14.374 | 13.638 |
| 60.75 | 1.721015093 | 16.82664 | 12.989 | 10.350809 | 2.264444152 | 33.26608 | 28.83872 | 25.61025 | 0.81537045 | 2.287451 | 1.947006 | 1.678757 | 0.338852686 | 16.329 | 15.399 | 14.541 | 0.640466708 | 1.270637 | 1.081526 | 0.932519 | 0.209071154 | 15.183 | 14.404 | 13.665 |
| 61.50 | 1.742262193 | 17.21339 | 13.288 | 10.588716 | 2.32070149 | 33.70909 | 29.19353 | 25.90442 | 0.825436752 | 2.340027 | 1.991757 | 1.717343 | 0.347271066 | 16.390 | 15.452 | 14.588 | 0.648373705 | 1.299842 | 1.106385 | 0.953952 | 0.214265271 | 15.217 | 14.434 | 13.691 |
| 62.25 | 1.763509293 | 17.60418 | 13.589 | 10.829108 | 2.377649103 | 34.15683 | 29.55215 | 26.20176 | 0.835503053 | 2.393151 | 2.036975 | 1.756331 | 0.355792738 | 16.452 | 15.506 | 14.635 | 0.656280701 | 1.329352 | 1.131503 | 0.97561 | 0.219523118 | 15.252 | 14.464 | 13.718 |
| 63.00 | 1.784756393 | 17.999 | 13.894 | 11.07198 | 2.435286989 | 34.60929 | 29.91456 | 26.50227 | 0.845569355 | 2.446824 | 2.08266 | 1.795721 | 0.364417704 | 16.514 | 15.560 | 14.683 | 0.664187697 | 1.359166 | 1.15688 | 0.99749 | 0.224844698 | 15.287 | 14.495 | 13.745 |
| 63.75 | 1.806003493 | 18.39785 | 14.202 | 11.317328 | 2.49361515 | 35.06646 | 30.28078 | 26.80594 | 0.855635657 | 2.501044 | 2.12881 | 1.835513 | 0.373145962 | 16.577 | 15.615 | 14.732 | 0.672094694 | 1.389284 | 1.182515 | 1.019594 | 0.230230009 | 15.323 | 14.526 | 13.773 |
| 64.50 | 1.827250593 | 18.80071 | 14.513 | 11.565148 | 2.552633584 | 35.52834 | 30.65079 | 27.11278 | 0.865701959 | 2.555811 | 2.175426 | 1.875706 | 0.381977514 | 16.641 | 15.670 | 14.781 | 0.68000169 | 1.419706 | 1.208409 | 1.041921 | 0.235679051 | 15.358 | 14.557 | 13.801 |
| 65.25 | 1.848497693 | 19.20759 | 14.827 | 11.815435 | 2.612342293 | 35.99493 | 31.02459 | 27.42278 | 0.875768261 | 2.611122 | 2.222505 | 1.916299 | 0.390912358 | 16.705 | 15.726 | 14.830 | 0.687908687 | 1.450431 | 1.234561 | 1.064469 | 0.241191825 | 15.395 | 14.589 | 13.829 |
| 66.00 | 1.869744793 | 19.61847 | 15.144 | 12.068185 | 2.672741276 | 36.46621 | 31.40216 | 27.73593 | 0.885834563 | 2.666978 | 2.270048 | 1.957292 | 0.399950496 | 16.770 | 15.783 | 14.880 | 0.695815683 | 1.481458 | 1.26097 | 1.08724 | 0.246768331 | 15.431 | 14.621 | 13.857 |
| 66.75 | 1.890991892 | 20.03334 | 15.465 | 12.323394 | 2.733830533 | 36.94217 | 31.78351 | 28.05222 | 0.895900865 | 2.723377 | 2.318053 | 1.998683 | 0.409091926 | 16.835 | 15.840 | 14.931 | 0.703722679 | 1.512786 | 1.287636 | 1.110232 | 0.252408567 | 15.468 | 14.653 | 13.886 |
| 67.50 | 1.912238992 | 20.45221 | 15.788 | 12.581058 | 2.795610064 | 37.42282 | 32.16864 | 28.37167 | 0.905967166 | 2.780319 | 2.36652 | 2.040473 | 0.41833665 | 16.902 | 15.898 | 14.982 | 0.711629676 | 1.544417 | 1.314559 | 1.133445 | 0.258112536 | 15.506 | 14.686 | 13.915 |
| 68.25 | 1.933486092 | 20.87506 | 16.114 | 12.841173 | 2.858079869 | 37.90814 | 32.55753 | 28.69425 | 0.916033468 | 2.837803 | 2.415449 | 2.08266 | 0.427684666 | 16.968 | 15.956 | 15.033 | 0.719536672 | 1.576348 | 1.341738 | 1.15688 | 0.263880236 | 15.543 | 14.719 | 13.944 |
| 69.00 | 1.954733192 | 21.30189 | 16.444 | 13.103735 | 2.921239948 | 38.39813 | 32.95018 | 29.01998 | 0.92609977 | 2.895827 | 2.464837 | 2.125244 | 0.437135976 | 17.036 | 16.015 | 15.085 | 0.727443668 | 1.608579 | 1.369172 | 1.180534 | 0.269711667 | 15.581 | 14.752 | 13.973 |
| 69.75 | 1.975980292 | 21.73269 | 16.776 | 13.36874 | 2.985090302 | 38.89278 | 33.34658 | 29.34883 | 0.936166072 | 2.954391 | 2.514685 | 2.168224 | 0.446690578 | 17.104 | 16.074 | 15.138 | 0.735350665 | 1.64111 | 1.396861 | 1.204409 | 0.27560683 | 15.620 | 14.785 | 14.003 |
| 70.50 | 1.997227392 | 22.16746 | 17.112 | 13.636184 | 3.049630929 | 39.39209 | 33.74674 | 29.68081 | 0.946232374 | 3.013494 | 2.564991 | 2.2116 | 0.456348474 | 17.173 | 16.134 | 15.191 | 0.743257661 | 1.673941 | 1.424806 | 1.228503 | 0.281565724 | 15.659 | 14.819 | 14.033 |
| 71.25 | 2.018474492 | 22.60618 | 17.451 | 13.906062 | 3.114861831 | 39.89605 | 34.15064 | 30.01592 | 0.956298676 | 3.073135 | 2.615756 | 2.25537 | 0.466109662 | 17.242 | 16.195 | 15.244 | 0.751164658 | 1.70707 | 1.453005 | 1.252817 | 0.28758835 | 15.698 | 14.854 | 14.063 |
| 72.00 | 2.039721592 | 23.04886 | 17.793 | 14.178372 | 3.180783006 | 40.40464 | 34.55829 | 30.35416 | 0.966364977 | 3.133314 | 2.666978 | 2.299535 | 0.475974144 | 17.312 | 16.256 | 15.299 | 0.759071654 | 1.740498 | 1.481458 | 1.27735 | 0.293674707 | 15.737 | 14.888 | 14.094 |
| 72.75 | 2.060968692 | 23.49548 | 18.137 | 14.45311 | 3.247394456 | 40.91788 | 34.96967 | 30.6955 | 0.976431279 | 3.194029 | 2.718657 | 2.344094 | 0.485941918 | 17.383 | 16.318 | 15.353 | 0.76697865 | 1.774224 | 1.510164 | 1.302101 | 0.299824796 | 15.777 | 14.923 | 14.125 |
| 73.50 | 2.082215792 | 23.94605 | 18.485 | 14.730271 | 3.31469618 | 41.43574 | 35.38478 | 31.03997 | 0.986497581 | 3.255279 | 2.770791 | 2.389045 | 0.496012986 | 17.454 | 16.380 | 15.408 | 0.774885647 | 1.808248 | 1.539124 | 1.327071 | 0.306038617 | 15.817 | 14.958 | 14.156 |
| 74.25 | 2.103462892 | 24.40054 | 18.836 | 15.009853 | 3.382688178 | 41.95823 | 35.80362 | 31.38754 | 0.996563883 | 3.317065 | 2.823381 | 2.43439 | 0.506187346 | 17.526 | 16.443 | 15.464 | 0.782792643 | 1.842569 | 1.568337 | 1.352259 | 0.312316168 | 15.858 | 14.994 | 14.188 |
| 75.00 | 2.124709991 | 24.85897 | 19.19 | 15.291851 | 3.45137045 | 42.48534 | 36.22618 | 31.73822 | 1.006630185 | 3.379384 | 2.876425 | 2.480126 | 0.516465 | 17.599 | 16.506 | 15.520 | 0.79069964 | 1.877186 | 1.597802 | 1.377665 | 0.318657452 | 15.899 | 15.029 | 14.219 |
| 76.00 | 2.153039458 | 25.47631 | 19.666 | 15.671601 | 3.544020572 | 43.19533 | 36.79538 | 32.21062 | 1.020051921 | 3.463306 | 2.947857 | 2.541716 | 0.530329216 | 17.697 | 16.591 | 15.595 | 0.801242302 | 1.923803 | 1.637481 | 1.411877 | 0.327211634 | 15.954 | 15.078 | 14.262 |
| 77.00 | 2.181368925 | 26.1006 | 20.148 | 16.055632 | 3.637897848 | 43.9135 | 37.37118 | 32.68853 | 1.033473656 | 3.548174 | 3.020094 | 2.604001 | 0.544377064 | 17.796 | 16.677 | 15.671 | 0.811784963 | 1.970946 | 1.677607 | 1.446475 | 0.335879117 | 16.010 | 15.126 | 14.305 |
| 78.00 | 2.209698391 | 26.73184 | 20.636 | 16.443937 | 3.733002278 | 44.63984 | 37.95357 | 33.17194 | 1.046895392 | 3.633986 | 3.093135 | 2.666978 | 0.558608544 | 17.896 | 16.765 | 15.749 | 0.822327625 | 2.018613 | 1.71818 | 1.481458 | 0.3446599 | 16.066 | 15.176 | 14.349 |
| 79.00 | 2.238027858 | 27.37002 | 21.128 | 16.836506 | 3.829333862 | 45.37435 | 38.54254 | 33.66084 | 1.060317128 | 3.720741 | 3.166978 | 2.730647 | 0.573023655 | 17.997 | 16.853 | 15.827 | 0.832870287 | 2.066804 | 1.759198 | 1.516825 | 0.353553983 | 16.123 | 15.226 | 14.393 |
| 80.00 | 2.266357324 | 28.01511 | 21.626 | 17.233332 | 3.9268926 | 46.117 | 39.13808 | 34.15522 | 1.073738864 | 3.808437 | 3.241622 | 2.795007 | 0.587622399 | 18.099 | 16.942 | 15.906 | 0.843412949 | 2.115517 | 1.800662 | 1.552575 | 0.362561367 | 16.181 | 15.276 | 14.438 |
| 81.00 | 2.294686791 | 28.66711 | 22.129 | 17.634407 | 4.025678492 | 46.86779 | 39.74018 | 34.65509 | 1.0871606 | 3.897071 | 3.317065 | 2.860056 | 0.602404775 | 18.202 | 17.032 | 15.985 | 0.853955611 | 2.164752 | 1.842569 | 1.588709 | 0.371682052 | 16.239 | 15.327 | 14.483 |
| 82.00 | 2.323016257 | 29.32601 | 22.638 | 18.039722 | 4.125691538 | 47.6267 | 40.34882 | 35.16041 | 1.100582335 | 3.986643 | 3.393305 | 2.925792 | 0.617370783 | 18.307 | 17.124 | 16.066 | 0.864498273 | 2.214507 | 1.884919 | 1.625224 | 0.380916036 | 16.298 | 15.379 | 14.529 |
| 83.00 | 2.351345724 | 29.99178 | 23.152 | 18.449271 | 4.226931738 | 48.39372 | 40.96401 | 35.6712 | 1.114004071 | 4.07715 | 3.470342 | 2.992216 | 0.632520423 | 18.413 | 17.216 | 16.148 | 0.875040935 | 2.264782 | 1.927712 | 1.662121 | 0.390263322 | 16.358 | 15.431 | 14.575 |
| 84.00 | 2.37967519 | 30.66443 | 23.671 | 18.863046 | 4.329399092 | 49.16883 | 41.58572 | 36.18745 | 1.127425807 | 4.168591 | 3.548174 | 3.059324 | 0.647853695 | 18.519 | 17.309 | 16.230 | 0.885583596 | 2.315576 | 1.970946 | 1.699399 | 0.399723907 | 16.418 | 15.484 | 14.622 |
| 85.00 | 2.408004657 | 31.34394 | 24.196 | 19.28104 | 4.4330936 | 49.95203 | 42.21396 | 36.70913 | 1.140847543 | 4.260965 | 3.626799 | 3.127117 | 0.663370599 | 18.627 | 17.403 | 16.313 | 0.896126258 | 2.366888 | 2.014621 | 1.737056 | 0.409297793 | 16.479 | 15.537 | 14.669 |
| 86.00 | 2.436334124 | 32.03029 | 24.726 | 19.703244 | 4.538015261 | 50.7433 | 42.8487 | 37.23626 | 1.154269279 | 4.354269 | 3.706217 | 3.195592 | 0.679071135 | 18.736 | 17.498 | 16.398 | 0.90666892 | 2.418717 | 2.058736 | 1.775093 | 0.41898498 | 16.541 | 15.591 | 14.717 |
| 87.00 | 2.46466359 | 32.72347 | 25.261 | 20.129651 | 4.644164077 | 51.54263 | 43.48995 | 37.76882 | 1.167691014 | 4.448501 | 3.786425 | 3.26475 | 0.694955303 | 18.846 | 17.594 | 16.483 | 0.917211582 | 2.471061 | 2.10329 | 1.813509 | 0.428785467 | 16.603 | 15.645 | 14.765 |
| 88.00 | 2.492993057 | 33.42347 | 25.801 | 20.560255 | 4.751540046 | 52.35001 | 44.1377 | 38.3068 | 1.18111275 | 4.543662 | 3.867422 | 3.334588 | 0.711023103 | 18.958 | 17.691 | 16.569 | 0.927754244 | 2.523921 | 2.148282 | 1.852303 | 0.438699254 | 16.666 | 15.700 | 14.814 |
| 89.00 | 2.521322523 | 34.13029 | 26.347 | 20.995049 | 4.86014317 | 53.16543 | 44.79192 | 38.85019 | 1.194534486 | 4.639748 | 3.949208 | 3.405105 | 0.727274535 | 19.070 | 17.789 | 16.655 | 0.938296906 | 2.577295 | 2.193713 | 1.891474 | 0.448726342 | 16.729 | 15.755 | 14.863 |
| 90.00 | 2.54965199 | 34.8439 | 26.898 | 21.434024 | 4.969973447 | 53.98888 | 45.45263 | 39.399 | 1.207956222 | 4.736758 | 4.03178 | 3.476301 | 0.743709599 | 19.183 | 17.888 | 16.743 | 0.948839568 | 2.631183 | 2.23958 | 1.931022 | 0.45886673 | 16.793 | 15.811 | 14.913 |
| 91.00 | 2.577981456 | 35.56431 | 27.454 | 21.877176 | 5.081030879 | 54.82034 | 46.1198 | 39.95321 | 1.221377958 | 4.834691 | 4.115137 | 3.548174 | 0.760328295 | 19.298 | 17.988 | 16.832 | 0.959382229 | 2.685583 | 2.285884 | 1.970946 | 0.469120419 | 16.858 | 15.868 | 14.963 |
| 92.00 | 2.606310923 | 36.29148 | 28.015 | 22.324495 | 5.193315464 | 55.6598 | 46.79343 | 40.51281 | 1.234799693 | 4.933546 | 4.199279 | 3.620723 | 0.777130623 | 19.414 | 18.089 | 16.921 | 0.969924891 | 2.740494 | 2.332623 | 2.011245 | 0.479487408 | 16.923 | 15.925 | 15.014 |
| 93.00 | 2.634640389 | 37.02543 | 28.582 | 22.775977 | 5.306827203 | 56.50726 | 47.4735 | 41.0778 | 1.248221429 | 5.03332 | 4.284203 | 3.693947 | 0.794116583 | 19.530 | 18.191 | 17.011 | 0.980467553 | 2.795917 | 2.379797 | 2.05192 | 0.489967698 | 16.989 | 15.983 | 15.065 |
| 94.00 | 2.662969856 | 37.76613 | 29.153 | 23.231614 | 5.421566096 | 57.36269 | 48.16002 | 41.64818 | 1.261643165 | 5.134012 | 4.36991 | 3.767845 | 0.811286175 | 19.648 | 18.294 | 17.102 | 0.991010215 | 2.85185 | 2.427405 | 2.092969 | 0.500561288 | 17.055 | 16.041 | 15.117 |
| 95.00 | 2.691299323 | 38.51357 | 29.73 | 23.691399 | 5.537532143 | 58.2261 | 48.85298 | 42.22393 | 1.275064901 | 5.235621 | 4.456396 | 3.842416 | 0.828639399 | 19.767 | 18.398 | 17.194 | 1.001552877 | 2.908292 | 2.475447 | 2.134392 | 0.511268178 | 17.123 | 16.100 | 15.169 |
| 96.00 | 2.719628789 | 39.26775 | 30.313 | 24.155327 | 5.654725344 | 59.09747 | 49.55235 | 42.80505 | 1.288486637 | 5.338145 | 4.543662 | 3.917658 | 0.846176255 | 19.887 | 18.503 | 17.287 | 1.012095539 | 2.965242 | 2.523921 | 2.176188 | 0.522088369 | 17.190 | 16.159 | 15.221 |
| 97.00 | 2.747958256 | 40.02865 | 30.9 | 24.62339 | 5.773145699 | 59.97679 | 50.25815 | 43.39154 | 1.301908372 | 5.441584 | 4.631705 | 3.993572 | 0.863896743 | 20.008 | 18.609 | 17.380 | 1.022638201 | 3.0227 | 2.572828 | 2.218356 | 0.53302186 | 17.259 | 16.219 | 15.274 |



BRIARRIDGE SANITARY PUMPING STATION SYSTEM CURVE
(FM = PVC SDR25, 300 MM NOMINAL DIAMETERS)
Max 300 mm FM
Average 300 mm FM
Min 300 mm FM
Actual Pump Curve
Lower Range Pump Curve
OBSERVED AND SCADA PUMP PERFORMANCE
HEAD (M)
20.000
18.000
16.000
14.000
12.000
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
FLOW (L/S)


BRIARRIDGE SANITARY PUMPING STATION SYSTEM CURVE
(FM = PVC SDR25, 200 MM & 300 MM NOMINAL DIAMETERS)
Actual Pump Curve
Lower Range Pump Curve
Equivalent FM Min
EQ FM Max
EQ FM Avg
HEAD (M)
20
18
16
14
12
0
10
20
30
40
50
60
70
80
90
FLOW (L/S)



BRIARRIDGE SANITARY PUMPING STATION SYSTEM CURVE
(FM = PVC SDR25, 200 MM NOMINAL DIAMETERS)
Max 200 mm FM
Average 200 mm FM
Min 200 mm FM
Actual Pump Curve
Lower Range Pump Curve
HEAD (M)
FLOW (L/S)
40
38
36
34
32
30
28
26
24
22
20
18
16
14
12
10
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00

# APPENDIX H: SCADA DATA EMAIL & SAMPLE SCADA DATA

## Iqbal, Jebran

| | |
|---|---|
| **From:** | Rusch, Peter |
| **Sent:** | Friday, September 14, 2018 1:25 PM |
| **To:** | Iqbal, Jebran |
| **Subject:** | FW: Request for Information for Briar Ridge Pumping Station |
| **Attachments:** | briar_storm_event.xlsx; Briar_scada_16-30.xlsx |

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**From:** Gauthier, Sebastien <sebastien.gauthier@ottawa.ca>
**Sent:** Friday, August 17, 2018 8:47 AM
**To:** Rusch, Peter <peter.rusch@hatch.com>
**Subject:** RE: Request for Information for Briar Ridge Pumping Station

Good morning,

My apologies for the wait.
Attached is the SCADA data you had requested.

Regards,

Sebastien

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**From:** Rusch, Peter <peter.rusch@hatch.com>
**Sent:** Friday, August 17, 2018 8:39 AM
**To:** Gauthier, Sebastien <sebastien.gauthier@ottawa.ca>
**Cc:** Zaknoun, Hasnaa <hasnaa.zaknoun@ottawa.ca>; Iqbal, Jebran <jebran.iqbal@hatch.com>
**Subject:** RE: Request for Information for Briar Ridge Pumping Station

Good morning & Happy Friday!

We have, in the meantime been able to obtain pump curves from the manufacturer.

We would appreciate an update on the status of the SCADA data request.

Kind regards,

Peter

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**From:** Gauthier, Sebastien <sebastien.gauthier@ottawa.ca>
**Sent:** Friday, August 17, 2018 8:35 AM
**To:** Rusch, Peter <peter.rusch@hatch.com>
**Cc:** Zaknoun, Hasnaa <hasnaa.zaknoun@ottawa.ca>
**Subject:** RE: Request for Information for Briar Ridge Pumping Station

We have not been able to locate any such pump curves for this particular station. We will continue trying to locate them. If and when we find them they will be sent immediately.

Sebastien Gauthier
Engineering Stdt II - Union 40hrs
Public Works & Enviro Services Dept.
Wastewater Collection Proc. Eng. Unit
GREEN'S CREEK DR, 800
ext. 22608

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**From:** Zaknoun, Hasnaa
**Sent:** Friday, August 10, 2018 10:29 AM
**To:** Gauthier, Sebastien <sebastien.gauthier@ottawa.ca>
**Subject:** FW: Request for Information for Briar Ridge Pumping Station

Just following up on the pump curves, have you sent them?

Hasnaa Zaknoun

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**From:** Rusch, Peter <peter.rusch@hatch.com>
**Sent:** Wednesday, August 01, 2018 2:22 PM
**To:** Zaknoun, Hasnaa <hasnaa.zaknoun@ottawa.ca>; Procyshen, Douglas <Douglas.Procyshen@ottawa.ca>
**Cc:** Laberge, Scott <Scott.Laberge@ottawa.ca>; Gauthier, Sebastien <sebastien.gauthier@ottawa.ca>; Iqbal, Jebran <jebran.iqbal@hatch.com>
**Subject:** RE: Request for Information for Briar Ridge Pumping Station

Hi Doug and Hasnaa:

Firstly: thank you for arranging access for us last week at the pumping station, we have reviewed the information we have gathered and seems that we have collected all the data that we required from the field visit.

We would like to obtain the following info:

While we have asked Flygt for the actual pump curves based on when the pumps were sold, we have not received them as yet.
Does the City have the actual curves – and were there pump tests done for these pumps? If so, we would appreciate a copy of both.
Was there an issue with one of the pumps initially? As per the information we have from Flygt, it appears that the pumps were manufactured in different years, although it is not known to us when in the years.
There was We (read I) missed that the station was set to have one of the pumps run only , and hence I need a bit more extensive SCADA data – as detailed below.

SCADA data:
We request the following SCADA data for the pumping station for two weeks, starting with Monday, July 16, 2018 at midnight, and ending on Sunday, July 29, at midnight.
Since we do not know if both pumps were used in this timeframe, we also request a similar SCADA data set for when the other pump is running.
Thirdly, we are requesting a SCADA data set for say 72 h, starting just before a heavy rainfall event in the catchment of the PS.

Scott:

We noticed in the station that the stairs down to the basement were rather slippery – this may be something that may require attending to.

Kind regards,

Peter

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**From:** Zaknoun, Hasnaa <hasnaa.zaknoun@ottawa.ca>
**Sent:** Tuesday, June 26, 2018 4:41 PM
**To:** Gammie, Colleen <colleen.gammie@hatch.com>
**Cc:** Laberge, Scott <Scott.Laberge@ottawa.ca>; Rusch, Peter <peter.rusch@hatch.com>; Gauthier, Sebastien <sebastien.gauthier@ottawa.ca>; Procyshen, Douglas <Douglas.Procyshen@ottawa.ca>
**Subject:** RE: Request for Information for Briar Ridge Pumping Station

Hello Colleen,
I just forwarded you the as-built drawings for this station. As for the SCADA data, I need you to be a bit more specific as to what exactly you need.
Please contact Doug (CCed) for coordinating access to the station.
Thanks

Hasnaa Zaknoun

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**From:** Gammie, Colleen <colleen.gammie@hatch.com>
**Sent:** Tuesday, June 26, 2018 8:52 AM
**To:** Zaknoun, Hasnaa <hasnaa.zaknoun@ottawa.ca>
**Cc:** Laberge, Scott <Scott.Laberge@ottawa.ca>; Rusch, Peter <peter.rusch@hatch.com>
**Subject:** RE: Request for Information for Briar Ridge Pumping Station

Good morning Hasnaa,

Following up on the request below. Please give me a call if you have any questions.

Thank you,

Colleen Gammie, EIT
Project Associate / Infrastructure

**Tel: +1 289 288-2705**
5035 South Service Road, Sixth Floor, Burlington
Ontario Canada L7L 6M9

HATCH

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**From:** Gammie, Colleen
**Sent:** Thursday, June 14, 2018 9:53 AM
**To:** 'hasnaa.zaknoun@ottawa.ca' <hasnaa.zaknoun@ottawa.ca>
**Cc:** 'Scott.Laberge@ottawa.ca' <Scott.Laberge@ottawa.ca>
**Subject:** Request for Information for Briar Ridge Pumping Station

Good morning Hasnaa,

Hatch has been retained by David Schaeffer Engineering Ltd. on behalf of Minto to perform investigations into the pumping capacity of (and an evaluation of inflow into) the Briar Ridge Pump Station (BRPS), situated in the west end of the City of Ottawa (Kanata). As part of the capacity confirmation we would like to determine the peak hourly inflow rate from SCADA data.

Hatch is requesting the following information from the City of Ottawa, at your earliest convenience:

- As-built drawings for the layout of the pumping station, including forcemain, in either PDF of Tiff
- Available SCADA information (and format)

Hatch would like to visit the site as early as next week to confirm layout and certain elevations as part of our work, and would like to coordinate with the City of Ottawa to facilitate entry into the station building and opening of maintenance holes and other necessary structures.

Please let me know if this is possible at your earliest convenience.

Thank you,

Colleen Gammie, EIT
Project Associate / Infrastructure

**Tel: +1 289 288-2705**
5035 South Service Road, Sixth Floor, Burlington
Ontario Canada L7L 6M9

HATCH

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| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | OPSCP1.V | OPSCP1.WW | OPSCP1.F | OPSCP1.F | OPSCP1.WW0 | OPSCP1.WW02FIAAACTBRIA.F_CV |
| | Description | BRIA: WET | BRIA: FIT1 D | BRIA: RSF | BRIA: RSF | BRIA: PIT1 DIS | BRIA: FIT2 DISCHARGE FLOW ACTUAL (F_CV) |
| | Data Type | DoubleFloa | DoubleFloat | DoubleFloa | DoubleFloa | DoubleFloat | DoubleFloat |
| | Hi Engineering | 327.67 | 3,277 | 1 | 1 | 3,277 | 3,277 |
| | Lo Engineering | 0 | 0 | 0 | 0 | 0 | 0 |
| | Eng Units | M | L/S | N/A | N/A | KPA | L/S |
| | | | | | | | |
| | | WW level | Flow 300mm | RSP1 | RSP2 | Pressure kPa | Flow 200mm FM l/s |
| TimeStamp | Time Zone | OPSCP1.V | OPSCP1.WW | OPSCP1.F | OPSCP1.F | OPSCP1.WW0 | OPSCP1.WW02FIAAACTBRIA.F_CV |
| 7/24/2018 12:06 | GMT-4.0 | 2.76 | 69.2 | 1 | 0 | 91 | 0 |
| 7/24/2018 12:07 | GMT-4.0 | 2.76 | 69.2 | 1 | 0 | 91 | 0 |
| 7/24/2018 12:07 | GMT-4.0 | <No Data> | <No Data> | <No Data> | <No Data> | <No Data> | <No Data> |
| 7/24/2018 12:07 | GMT-4.0 | <No Data> | <No Data> | <No Data> | <No Data> | <No Data> | <No Data> |
| 7/24/2018 12:07 | GMT-4.0 | 2.5 | 70.5 | 1 | 0 | 92.8 | 0 |
| 7/24/2018 12:07 | GMT-4.0 | 2.47 | 70.5 | 1 | 0 | 92.8 | 0 |
| 7/24/2018 12:07 | GMT-4.0 | 2.37 | 70.5 | 1 | 0 | 92.8 | 0 |
| 7/24/2018 12:08 | GMT-4.0 | 2.31 | 70.5 | 1 | 0 | 92.8 | 0 |
| 7/24/2018 12:08 | GMT-4.0 | 2.26 | 70.5 | 1 | 0 | 92.8 | 0 |
| 7/24/2018 12:08 | GMT-4.0 | 2.21 | 70.5 | 1 | 0 | 92.8 | 0 |
| 7/24/2018 12:08 | GMT-4.0 | 2.16 | 70.5 | 1 | 0 | 92.8 | 0 |
| 7/24/2018 12:08 | GMT-4.0 | 2.06 | 70.5 | 1 | 0 | 92.8 | 0 |
| 7/24/2018 12:08 | GMT-4.0 | 2.06 | 70.5 | 1 | 0 | 92.8 | 0 |
| 7/24/2018 12:09 | GMT-4.0 | 1.95 | 69.5 | 1 | 0 | 92.8 | 0 |
| 7/24/2018 12:09 | GMT-4.0 | 1.83 | 69.5 | 1 | 0 | 91.8 | 0 |
| 7/24/2018 12:09 | GMT-4.0 | 1.78 | 69.5 | 1 | 0 | 91.8 | 0 |
| 7/24/2018 12:09 | GMT-4.0 | 1.78 | 69.5 | 1 | 0 | 91.8 | 0 |
| 7/24/2018 12:09 | GMT-4.0 | 1.72 | 69.5 | 1 | 0 | 91.8 | 0 |
| 7/24/2018 12:09 | GMT-4.0 | 1.72 | 69.5 | 1 | 0 | 91.8 | 0 |
| 7/24/2018 12:10 | GMT-4.0 | 1.67 | 69.5 | 1 | 0 | 91.8 | 0 |
| 7/24/2018 12:10 | GMT-4.0 | 1.57 | 68.5 | 0 | 0 | 91.8 | 0 |
| 7/24/2018 12:10 | GMT-4.0 | 1.57 | 38.4 | 0 | 0 | 0 | 0 |
| 7/24/2018 12:10 | GMT-4.0 | 1.57 | 38.4 | 0 | 0 | 0 | 0 |
| 7/24/2018 12:10 | GMT-4.0 | 1.57 | 0 | 0 | 0 | 21 | 0 |
| 7/24/2018 12:10 | GMT-4.0 | 1.57 | 0 | 0 | 0 | 22.4 | 0 |

# APPENDIX I: BRIAR RIDGE PUMP STATION CAPACITY TABLE (ATTRIBUTED TO NOVATECH)

**KANATA NORTH URBAN EXPANSION AREA**

**COMMUNITY DESIGN PLAN**

## Table C-4: Briar Ridge Pump Station (BRPS) - Capacity Analysis

**PROJECT :** 112117
**DESIGNED BY:** ARM
**CHECKED BY:** CJR
**DATE:** Mar-16

NOVATECH
Engineers, Planners & Landscape Architects

## Design Data

| | Design Area (ha) | Theoretical Peak Flow (L/s) | Forcemains (mm) | No. of Pumps (Qty) | Pump Impellers Model | Pump Impellers Dia (mm) | Rated Capacity (L/s) |
|---|---|---|---|---|---|---|---|
| Installed Design * | 128 | 53 | 200 & 300 | 2 | 454 | 281 | 55 |
| Ultimate Design at Build-Out ** | 128 | 173.8 | 200 & 300 | 3 | 452 | 330 | 183 |

*Installed Design approved per MOE Certificate of Approval 3079-4ZVRAG, dated August 24, 2001
**Refer to Cumming Cockburn Limited "Briarridge Sanitary Pumping Station Pre-Design Report, City of Kanata" June, 2001

## Existing (Current) Flows

Based on existing conditions (as determined by monitored data provided by the City & aerial imagery) and full build out of existing design drainage area.

| | BRPS Observed Flows (Per City of Ottawa SCADA) | | | | | | | | Theoretical Design Flows (Build out of design drainage area) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Note | Date | Max observed Inflow | Peak I/I | Avg DWF | Peak DWF | Peak I/I + Peak DWF | Units | Total Area | I/I | Population | | | | | ICI | | | | Total |
| | | | | | | | | **** | 0.28 L/s/ha | Area | Pop | Avg | PF | Peak | Area | Avg | PF | Peak | |
| | | (L/s) | (L/s) | | (L/s) | (L/s) | (Qty) | (ha) | (L/s) | | (pers) | (L/s) | | (L/s) | (ha) | (L/s) | | (L/s) | (L/s) |
| **BRPS Pump Station Observed Flows** | | | | | | | | | | | | | | | | | | | |
| Typical | Winter-16 | 23.3 | 4.43 | 11.1 | 18.9 *** | 23.3 | | | | | | | | | | | | | |
| Typical | Jan-15 to Dec-15 | 29.9 | 12.56 | 10.2 | 17.3 *** | 29.9 | | | | | | | | | | | | | |
| Event | Jun-14 | 37.3 | 20.64 | 9.8 | 16.7 *** | 37.3 | | | | | | | | | | | | | |
| Typical | Winter -14 | 27.1 | 9.25 | 10.5 | 17.9 *** | 27.1 | | | | | | | | | | | | | |
| Event | Apr-13 | 23.1 | 12.6 | | 18.7 | 31.3 | | | | | | | | | | | | | |
| Typical | Jan-13 | | | 10.9 | 17.5 | | 1131 | 81.1 | 22.72 | | 3442 | 13.94 | 3.39 | 47.28 | 8.68 | 3.52 | 1.5 | 5.27 | 75.28 |
| Event | Apr-11 | 31.9 | 23 | | 18.7 | 41.7 | | | | | | | | | | | | | |
| Event | Jul-09 | 43.7 | 34.7 | | 12.9 | 47.6 | | | | | | | | | | | | | |
| Event | Sep-04 | 43.4 | 41.1 | | 4.8 | 45.9 | 261 | 18.7 | 5.24 | | 759 | 3.07 | 3.87 | 11.91 | | 0.00 | 1.5 | 0.00 | 17.15 |
| | *** Note: Peaking factor of approximately 1.7 based on monitored SCADA data | | | | | | | | | | | | | | | | | | |
| | ****Note: Total Area based on aerial imagery corresponding with date of SCADA information used to calculate design I/I | | | | | | | | | | | | | | | | | | |
| **Full Buildout of Design Drainage Area** | | | | | | | | | | | | | | | | | | | |
| Future Flows - Full Buildout of Design Drainage Area | | | | | | | | 49.4 | 13.84 | 10.45 | 680 | 2.75 | 3.32 | 9.15 | 32.32 | 13.09 | 3.3 | 43.21 | 66.20 |
| Existing Flows - Observed as of March 2016 | | | | | | | | 81.1 | 22.72 | | | | | 18.87 | | | | | 41.59 |
| | | | | | | | | | | | | | | | **Total Flows Tributary to BRPS on Full Buildout =** | | | | **107.79** |

Based on 65pers/ha of undeveloped residential area

## Distribution of Total Flows on Full Buildout

| Note | Condition | Existing Flows | | | | Total Area | I/I | Population | | | | | ICI | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Peak DWF | Developed Area | | | | | | | | | | | | | |
| | | | Pro-Rated | | | * | 0.28 L/s/ha | Area | Pop | Avg | PF | Peak | Area | Avg | PF | Peak | |
| | | | (L/s) | (ha) | | (ha) | (L/s) | | (pers) | (L/s) | | (L/s) | (ha) | (L/s) | | (L/s) | (L/s) |
| Klondike Road West | Existing | | 9.29 | 39.95 | | 49.02 | 13.73 | 9.07 | 590 | 2.39 | 3.32 | 7.94 | | | | | 30.95 |
| Klondike Road East | Future | | | | | 19.18 | 5.37 | | | | | | 14.18 | 5.74 | 3.3 | 18.956 | 24.33 |
| March Valley Road Industrial | Future | | | | | 19.80 | 5.54 | | | | | | 18.14 | 7.35 | 3.3 | 24.25 | 29.79 |
| Shirleys Brook Residential | Existing | | 9.58 | 41.19 | | 42.57 | 11.92 | 1.38 | 90 | 0.36 | 3.32 | 1.21 | | | | | 22.71 |
| **Total** | | | 18.87 | 81.14 | | **130.57** | **36.56** | 10.45 | 680 | 2.75 | | **9.15** | 32.32 | 13.09 | | **43.21** | **107.78** |

*Excluding Park and Open Space

## Available Capacity

Assuming BRPS is upgraded from MOE approved capacity to CCL ultimate design.

| | Flow (L/s) | |
|---|---|---|
| Ultimate Constructed Capacity (per CCL 2001 Report) | 183 | |
| Total Flows on Full Buildout of drainage area | 107.79 | - |
| 2031 Design Flows (per 2013 IMP, including some KNUEA flow) | - | 80 |
| Available Capacity within Original BRPS Design Parameters | **75.21** | **103.00** |

**DESIGN PARAMETERS**

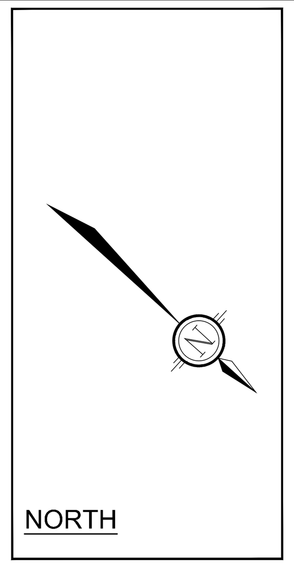
| | | | |
|---|---|---|---|
| Average Daily Flow (Future)= | 350 L/cap/day | Industrial Peak Factor = | per MOE graph |
| Indust/Comm/Inst Flow = | 35000 L/ha/day | Max Res Peak Factor= | 4 |
| Extraneous Flow = | 0.28 L/s/ha | Comm/Inst Peak Factor= | 1.5 |

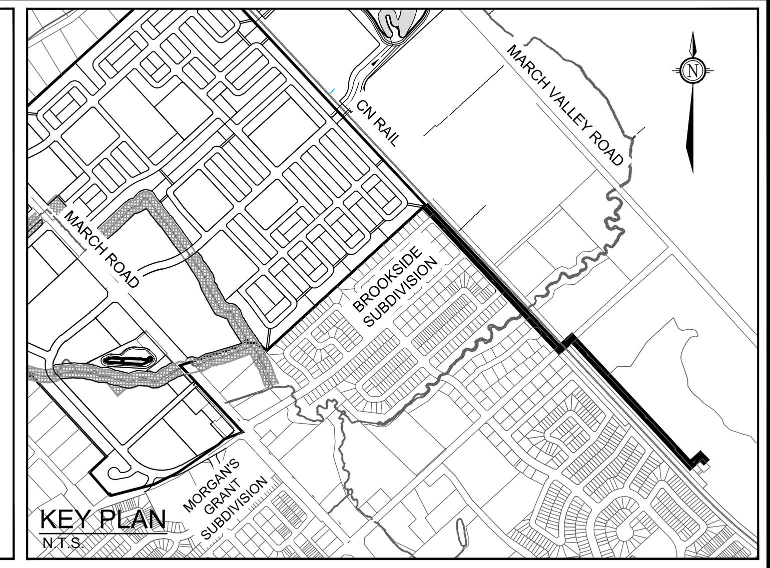
PREPARED BY: NOVATECH
2016-04-01

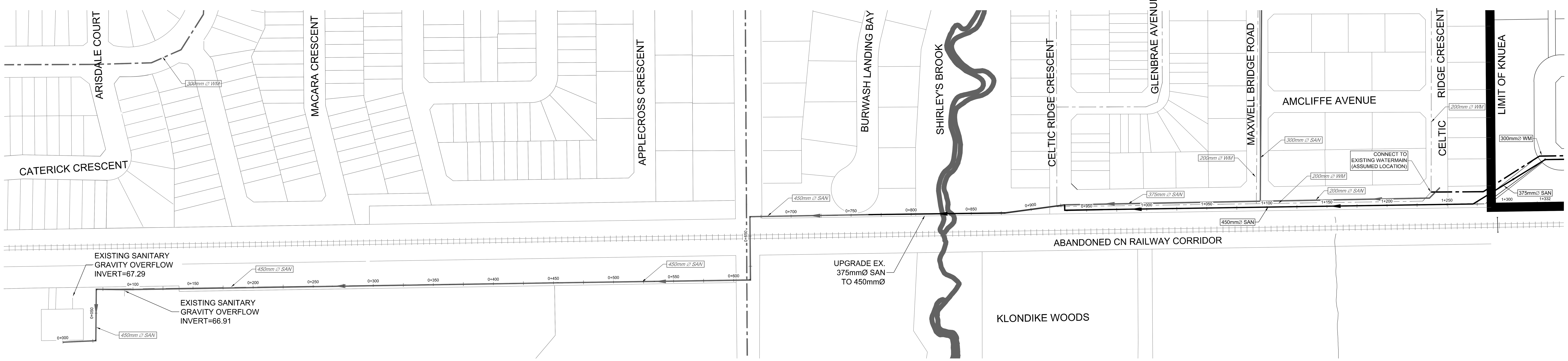
\\novatech2008\nova2\2012\112117\DATA\Calculations\Sewer Calcs\SAN\BRPS\201603-BRPS-Flow calcs.xlsx

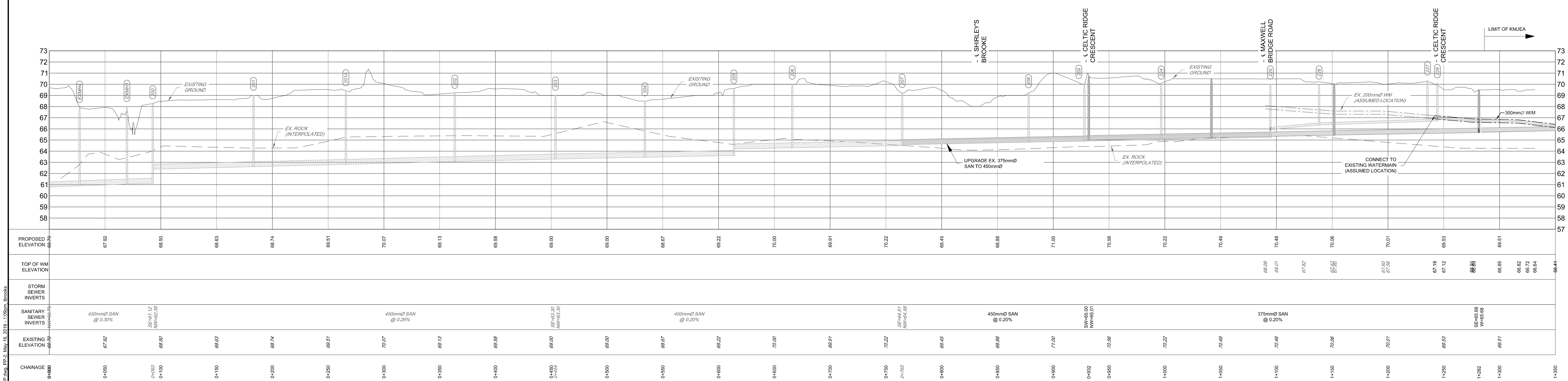
## LEGEND

- PROPOSED STORM SEWER & FLOW DIRECTION (PLAN VIEW)
- PROPOSED STORM SEWER (PROFILE VIEW)
- EXISTING STORM SEWER & FLOW DIRECTION (PLAN VIEW)
- EXISTING STORM SEWER (PROFILE VIEW)
- PROPOSED SANITARY SEWER & FLOW DIRECTION (PLAN VIEW)
- PROPOSED SANITARY SEWER (PROFILE VIEW)
- EXISTING SANITARY SEWER & FLOW DIRECTION (PLAN VIEW)
- EXISTING SANITARY SEWER (PROFILE VIEW)
- PROPOSED WATERMAIN (PLAN VIEW)
- PROPOSED WATERMAIN (PROFILE VIEW)
- EXISTING WATERMAIN (PLAN VIEW)
- EXISTING WATERMAIN (PROFILE VIEW)




M:\2012\112117\CAD\Design_MSS\112117-PP.dwg, PP-2, May 16, 2016 - 1:09pm, Brooks

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 DRAFT MASTER SERVICING STUDY | MAY 20/16 | JLS |
| 2. | ISSUED WITH DRAFT MASTER SERVICING STUDY | APR 4/16 | JLS |
| 1. | ISSUED WITH DRAFT MASTER SERVICING STUDY | FEB 26/16 | JLS |

SCALE: 1:1500

1:1500 — 0 15 30 45 60

DESIGN: ARM / TB
CHECKED: ARM
DRAWN: TB
CHECKED: CJR
APPROVED: JLS

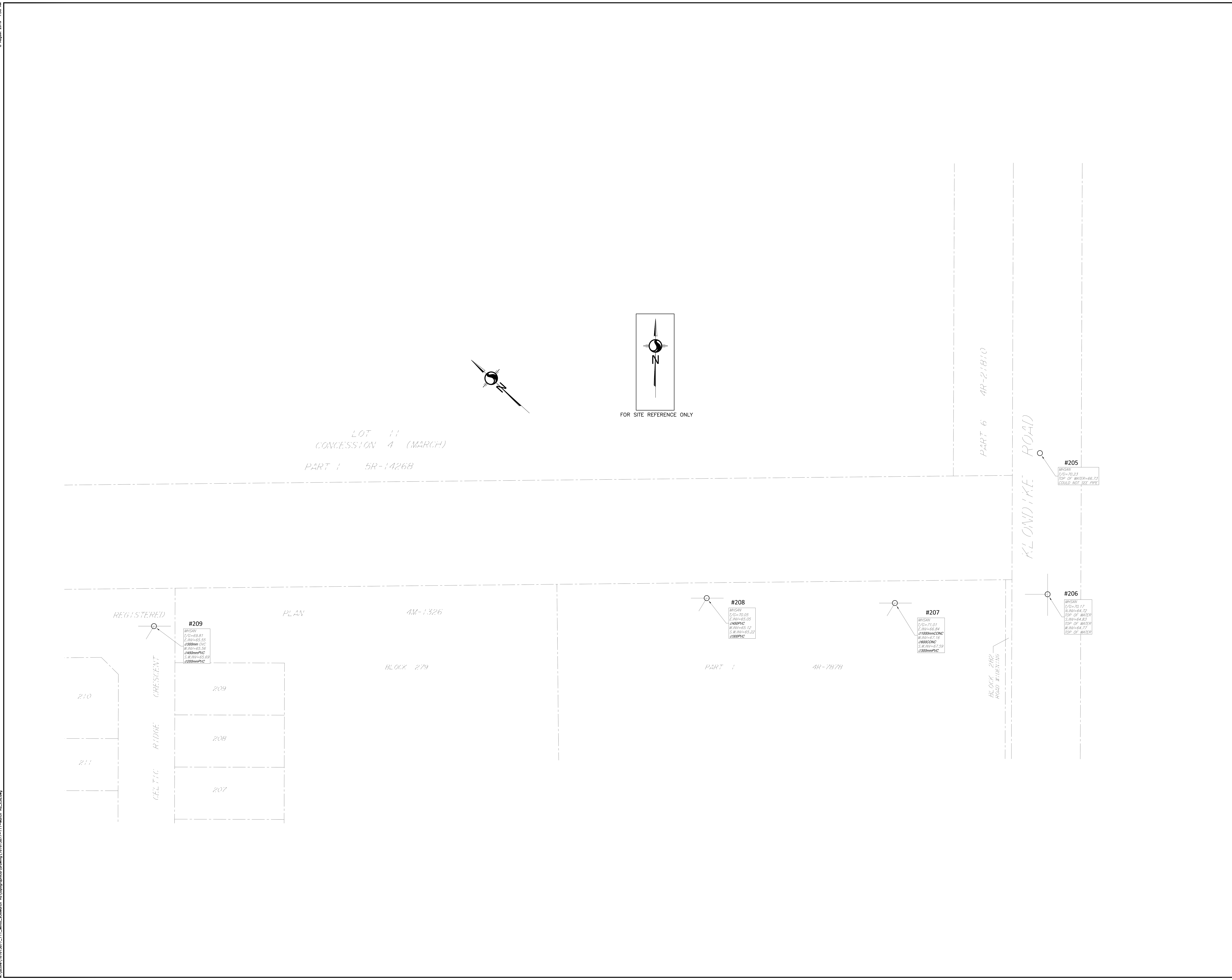
**FOR REVIEW ONLY**

NOVATECH
Engineers, Planners & Landscape Architects
Suite 200, 240 Michael Cowpland Drive
Ottawa, Ontario, Canada K2M 1P6
Telephone (613) 254-9643
Facsimile (613) 254-5867
Website www.novatech-eng.com

LOCATION
KANATA NORTH URBAN EXPANSION AREA
COMMUNITY DESIGN PLAN

DRAWING NAME
KNUEA TO BRIAR RIDGE
PUMP STATION
PLAN AND PROFILE

PROJECT No. 112117-04
REV: REV # 3
DRAWING No. 112117-PP2





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




TOPOGRAPHIC SKETCH of

# MINTO KANATA NORTH
# 936 MARCH ROAD
# CITY OF OTTAWA

Scale 1:500

10 0 10 20 30 METRES

**METRIC CONVERSION**

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

**VERTICAL DATUM NOTE**

ELEVATIONS ARE REFERRED TO THE CANADIAN GEODETIC VERTICAL DATUM (CGVD-1928 : 1978) AND ARE DERIVED FROM BENCHMARK MONUMENT No. 00119833012, HAVING A PUBLISHED ELEVATION OF 70.191 METRES.

**HORIZONTAL DATUM NOTE**

PROJECTION: UNIVERSAL TRANSVERSE MERCATOR (MTM, ZONE 9, CM76°30'W)
DATUM: NAD 83 (ORIGINAL)

DISTANCES ON THIS PLAN MAY BE CONVERTED TO GROUND DISTANCES BY DIVIDING BY A COMBINED SCALE FACTOR OF 0.99991802.

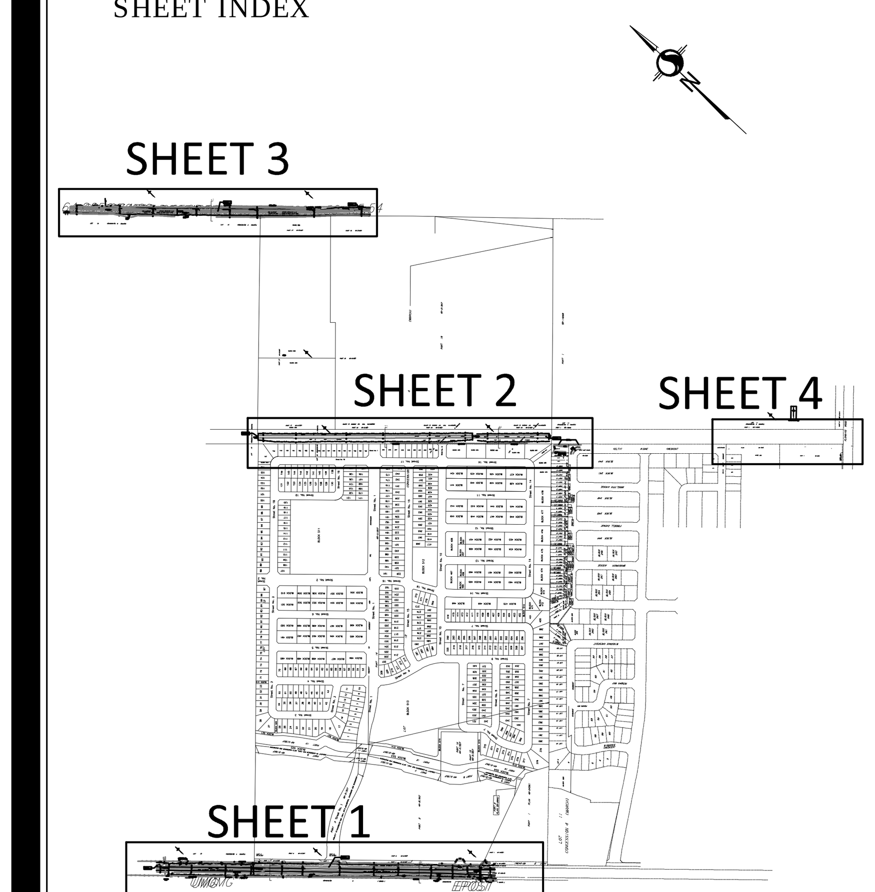
**UTILITY NOTES**

1. THIS DRAWING CANNOT BE ACCEPTED AS ACKNOWLEDGING ALL OF THE UNDERGROUND UTILITIES AND IT WILL THE RESPONSIBILITY OF THE USER TO CONTACT THE RESPECTIVE AUTHORITIES FOR CONFIRMATION OR LOCATION.
2. BEFORE ANY WORK INVOLVING PROBING, EXCAVATING, ETC. A FIELD LOCATION OF UNDERGROUND PLANT BY THE PERTINENT UTILITY AUTHORITY IS MANDATORY.

**LEGEND**

| | | | |
|---|---|---|---|
| ES | | DENOTES | EDGE OF SHOULDER |
| EP | | " | EDGE OF PAVEMENT |
| PM | | " | PAINT MARKINGS |
| CL | | " | CENTERLINE |
| DI | | " | DITCH |
| TB | | " | TOP OF BANK |
| BB | | " | BOTTOM OF BANK |
| EGR | | " | EDGE OF GRAVEL |
| | | " | TREE DECIDUOUS |
| | *MHSAN* | " | MAINTENANCE HOLE SANITARY |
| | *MHSTM* | " | MAINTENANCE HOLE STORM |
| | *SN* | " | SIGN |
| | *LS* | " | LIGHT STANDARD |
| | *AN* | " | ANCHOR |
| | *MB* | " | MAILBOX |
| | *POST* | " | POST |
| | *BOL* | " | BOLLARD |

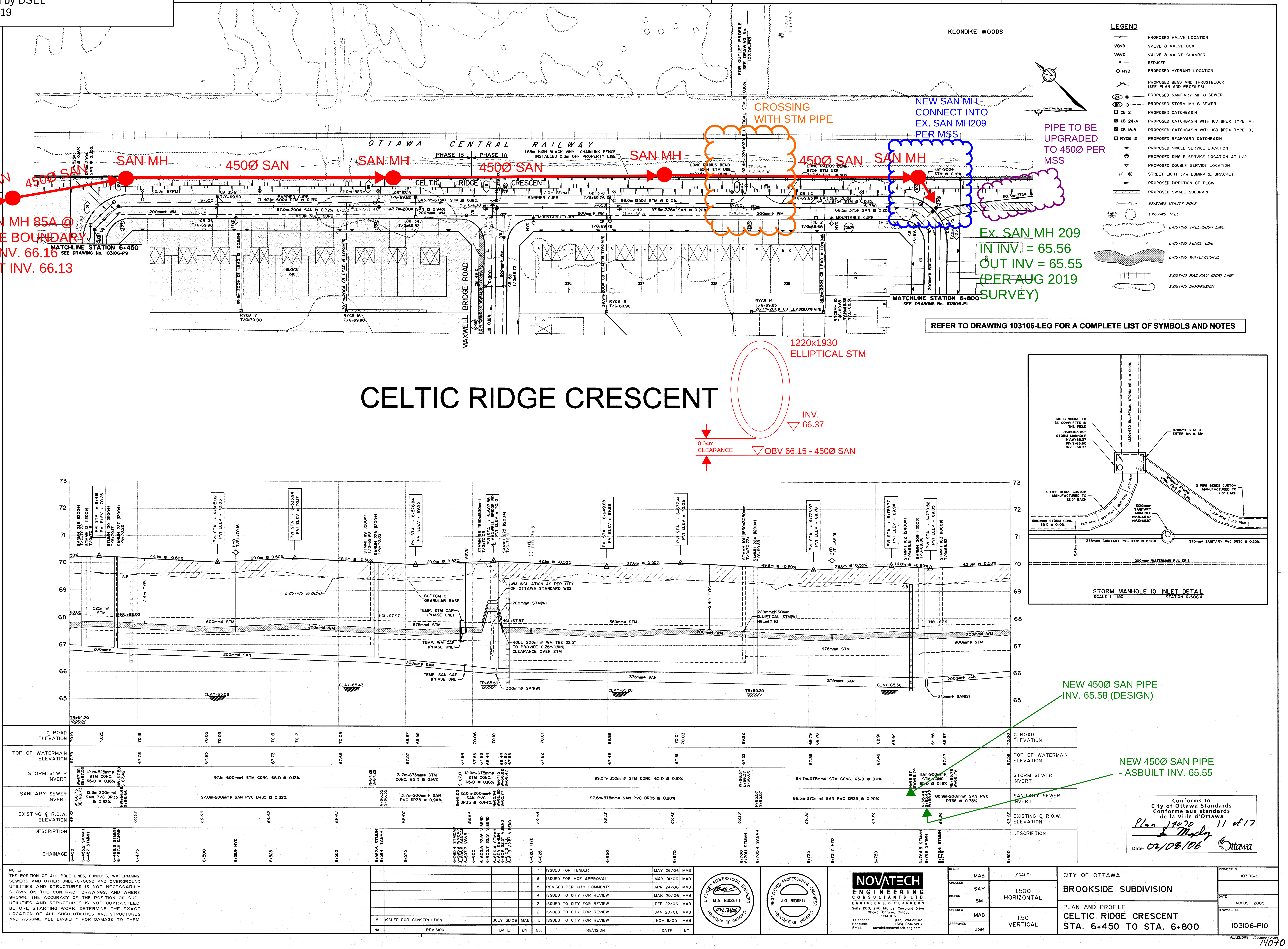
SHEET INDEX




SHEET 4 OF 4

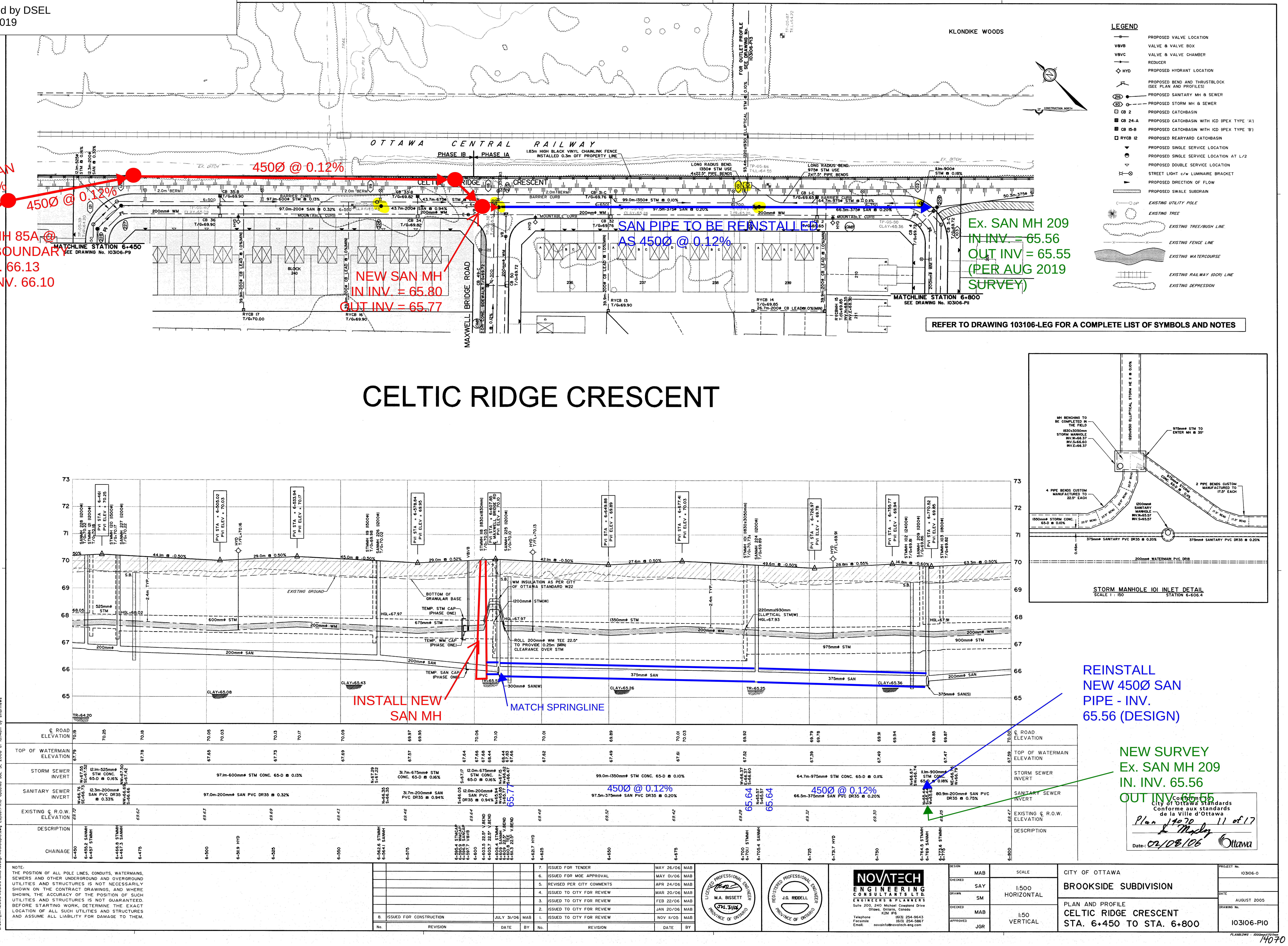
DRAWN: * CHECKED: * PM: * FIELD: * PROJECT No.: 161600000

MSS CONCEPT MARKUP
Prepared by DSEL
SEPT 2019



AUG 2019 SURVEY MARKUP

Prepared by DSEL
SEPT 2019




## LEGEND

| | |
|---|---|
| 3 | AREA I.D. |
| 10.5 | AREA IN HECTARES |
| RES | LANDUSE TYPE: RES = RESIDENTIAL, IND = LIGHT INDUSTRIAL |
| 500 | POPULATION ESTIMATE |
| (thick line) | SANITARY DRAINAGE AREA BOUNDARY |

## NOTES:

1. SANITARY DRAINAGE AREAS AND POPULATION VALUES DEPICTED ON THIS DRAWING WERE TAKEN FROM THE "BRIAR RIDGE SANITARY PUMP STATION PRE-DESIGN REPORT" BY CCL (REPORT No. xxxxxxx). THE BOUNDARY LINES ON THIS PLAN HAVE BEEN APPROXIMATED FROM THAT REPORT. PRECISE BOUNDARY LOCATIONS SHOULD BE TAKEN FROM THE APPROVED PUMPING STATION REPORT.

2. AREA No.1 AS BOUNDED HAS A LAND AREA OF 9.0ha. A SIZEABLE PORTION IS ATTRIBUTED TO FUTURE STORMWATER MANAGEMENT FACILITY 'A' WHICH HAS YET TO BE DESIGNED. THE BALANCE OF THE LAND AREA IS ATTRIBUTED TO RESIDENTIAL AND ROADWAY USES. THE DEVELOPMENT AREA=6.10ha WITH POPULATION 610 IS TAKEN DIRECTLY FROM THE "BRIAR RIDGE SANITARY PUMP STATION PRE-DESIGN REPORT".

3. AREA No.2 CURRENTLY EXCLUDES A SMALL PARCEL OF LAND (±1.1ha) ON THE NORTH SIDE OF KLONDIKE ROAD BETWEEN SANDHILL ROAD AND SHIRLEY'S BROOK. THE CITY OF OTTAWA MAY CHOOSE TO EXPLORE SERVICING THIS PARCEL WITH A CONNECTION TO A FUTURE SANITARY SEWER WITHIN KLONDIKE ROAD. RESIDUAL FREE FLOW CAPACITY APPEARS TO EXIST IN THE SANITARY SEWER LINES TO THE PUMP STATION.

4. FOR AREAS No. 3, No. 5 AND No.6 THE POPULATION AND AREA VALUES HAVE BEEN UPDATED FROM THE NOVEMBER 2000 CCL REPORT "BRIAR RIDGE SANITARY PUMP STATION PRE-DESIGN REPORT" TO REFLECT THE LATEST LANDUSE PLANS.

5. ALL PIPE DISTANCES AND SLOPE VALUES IDENTIFIED ON THIS PLAN ARE NOMINAL.

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 | No. | REVISION | DATE | BY |
|---|---|---|---|---|---|---|---|
| | | | | 7. | ISSUED TO CLIENT | OCT 10/06 | MAB |
| | | | | 6. | ISSUED FOR CONSTRUCTION | AUG 17/06 | MAB |
| | | | | 5. | ISSUED WITH MOE APPLICATION | AUG 08/06 | MAB |
| | | | | 4. | ISSUED FOR TENDER | MAY 26/06 | MAB |
| | | | | 3. | ISSUED FOR MOE APPROVAL | MAY 01/06 | MAB |
| 9. | AS-BUILT | JAN 16/14 | MAB | 2. | REVISED PER CITY COMMENTS | APR 24/06 | MAB |
| 8. | ISSUED FOR MOE APPROVAL | NOV 09/06 | MAB | 1. | ISSUED TO CITY FOR REVIEW | MAR 20/06 | MAB |

LICENSED PROFESSIONAL ENGINEER — M.A. BISSETT — PROVINCE OF ONTARIO

REGISTERED PROFESSIONAL ENGINEER — J.G. RIDDELL — PROVINCE OF ONTARIO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K2M 1P6
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Facsimile (613) 254-5867
Email: novainfo@novatech-eng.com


| | |
|---|---|
| DESIGN | MAB |
| CHECKED | SAY |
| DRAWN | SM |
| CHECKED | MAB |
| APPROVED | JGR |

SCALE 1:2000

CITY OF OTTAWA

BROOKSIDE SUBDIVISION

BRIAR RIDGE PUMP STATION
SANITARY DRAINAGE PLAN

PROJECT No. 103106-0

DATE AUGUST 2005

DRAWING No. 103106-SANI

# BROOKSIDE SUBDIVISION
# SANITARY SEWER DESIGN SHEET

| LOCATION: Street | LOCATION: From Node | LOCATION: To Node | RESIDENTIAL: Area (ha) | Dwellings: SFH | Dwellings: TH | Pop. | Cumulative Area (ha) | Cumulative Pop. | Peak Factor | Peak Flow (l/s) | IND: Area (ha) | IND: Accu. Area (ha) | IND: Peak Factor | INST: Area (ha) | INST: Accu. Area (ha) | ICI: Peak Flow (l/s) | INFILTRATION: Total Area (ha) | INFILTRATION: Accu. Area (ha) | Infiltration Flow (l/s) | FLOW: Total Flow (l/s) | PIPE: Length (m) | Dia Act (mm) | Dia Nom (mm) | Slope (%) | Velocity (Full) (m/s) | Capacity (Full) (l/s) | Ratio Q/Qfull (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Area 1 - March Road** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Offsite | MH 261 | 6.10 | | | 610 | 6.10 | 610.0 | 3.93 | 9.7 | | | | | | | 6.1 | 6.1 | 1.7 | 11.4 | | | | | | | |
| | MH 261 | MH 260 | 0.19 | | | | 6.29 | 610.0 | 3.93 | 9.7 | | | | | | | 0.2 | 6.3 | 1.8 | 11.5 | 92.0 | 203 | 200 | 0.33 | 0.61 | 19.6 | 58% |
| | MH 260 | MH 259 | 0.17 | | | | 6.46 | 610.0 | 3.93 | 9.7 | | | | | | | 0.2 | 6.5 | 1.8 | 11.5 | 71.0 | 203 | 200 | 1.13 | 1.12 | 36.3 | 32% |
| | MH 259 | MH 258 | 0.13 | | | | 6.59 | 610.0 | 3.93 | 9.7 | | | | | | | 0.1 | 6.6 | 1.8 | 11.6 | 54.4 | 203 | 200 | 0.37 | 0.64 | 20.8 | 56% |
| **Area 3 - Brookside Subdivision** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Maxwell Bridge Rd | MH 258 | MH 256 | 0.24 | 3 | | 10.2 | 6.83 | 620.2 | 3.92 | 9.9 | | | | | | | 0.2 | 6.8 | 1.9 | 11.8 | 42.6 | 203 | 200 | 2.35 | 1.62 | 52.4 | 22% |
| Windance Cres | MH 249 | MH 257 | 0.47 | 7 | | 23.8 | 0.47 | 23.8 | 4.00 | 0.4 | | | | | | | 0.5 | 0.5 | 0.1 | 0.5 | 54.7 | 203 | 200 | 2.00 | 1.49 | 48.3 | 1% |
| | MH 257 | MH 256 | 0.37 | 5 | | 17.0 | 0.84 | 40.8 | 4.00 | 0.7 | | | | | | | 0.4 | 0.8 | 0.2 | 0.9 | 51.5 | 203 | 200 | 0.82 | 0.95 | 31.0 | 3% |
| Maxwell Bridge Rd | MH 256 | MH 255 | 0.60 | 9 | | 30.6 | 8.27 | 691.6 | 3.90 | 10.9 | | | | | | | 0.6 | 8.3 | 2.3 | 13.2 | 80.5 | 203 | 200 | 1.11 | 1.11 | 36.0 | 37% |
| | MH 255 | MH 250 | 0.38 | 6 | | 20.4 | 8.65 | 712 | 3.89 | 11.2 | | | | | | | 0.4 | 8.7 | 2.4 | 13.6 | 56.4 | 203 | 200 | 1.35 | 1.22 | 39.7 | 34% |
| Pendra Way | MH 246 | MH 254 | 0.44 | 7 | | 23.8 | 0.44 | 23.8 | 4.00 | 0.4 | | | | | | | 0.4 | 0.4 | 0.1 | 0.5 | 52.0 | 203 | 200 | 0.90 | 1.00 | 32.4 | 2% |
| | MH 254 | MH 253 | 0.22 | 2 | | 6.8 | 0.66 | 30.6 | 4.00 | 0.5 | | | | | | | 0.2 | 0.7 | 0.2 | 0.7 | 11.5 | 203 | 200 | 0.61 | 0.82 | 26.7 | 3% |
| | MH 253 | MH 252 | 0.00 | | | 0.0 | 0.66 | 30.6 | 4.00 | 0.5 | | | | | | | 0.0 | 0.7 | 0.2 | 0.7 | 35.2 | 203 | 200 | 0.57 | 0.80 | 25.8 | 3% |
| | MH 252 | MH 251 | 0.11 | 1 | | 3.4 | 0.77 | 34.0 | 4.00 | 0.6 | | | | | | | 0.1 | 0.8 | 0.2 | 0.8 | 10.6 | 203 | 200 | 0.66 | 0.86 | 27.8 | 3% |
| | MH 251 | MH 250 | 0.54 | 9 | | 30.6 | 1.20 | 61.2 | 4.00 | 1.0 | | | | | | | 0.5 | 1.2 | 0.3 | 1.3 | 67.8 | 203 | 200 | 0.60 | 0.82 | 26.5 | 5% |
| Maxwell Bridge Rd | MH 250 | MH 242 | 0.42 | 6 | | 20.4 | 10.27 | 793.6 | 3.86 | 12.4 | | | | | | | 0.4 | 10.3 | 2.9 | 15.3 | 82.0 | 203 | 200 | 0.80 | 0.94 | 30.6 | 50% |
| Windance Cres | MH 249 | MH 248 | 0.15 | 2 | | 6.8 | 0.15 | 6.8 | 4.00 | 0.1 | | | | | | | 0.2 | 0.2 | 0.0 | 0.2 | 20.2 | 203 | 200 | 1.00 | 1.05 | 34.2 | 0% |
| | MH 248 | MH 247 | 0.23 | 2 | | 6.8 | 0.38 | 13.6 | 4.00 | 0.2 | | | | | | | 0.2 | 0.4 | 0.1 | 0.3 | 13.1 | 203 | 200 | 2.30 | 1.60 | 51.8 | 1% |
| | MH 247 | MH 246 | 0.49 | 6 | | 20.4 | 0.87 | 34.0 | 4.00 | 0.6 | | | | | | | 0.5 | 0.9 | 0.2 | 0.8 | 81.5 | 203 | 200 | 2.90 | 1.80 | 58.2 | 1% |
| | MH 246 | MH 245 | 0.94 | 14 | | 47.6 | 1.81 | 81.6 | 4.00 | 1.3 | | | | | | | 0.9 | 1.8 | 0.5 | 1.8 | 123.0 | 203 | 200 | 1.20 | 1.15 | 37.4 | 5% |
| | MH 245 | MH 244 | 0.20 | | 3 | 8.1 | 2.01 | 89.7 | 4.00 | 1.5 | | | | | | | 0.2 | 2.0 | 0.6 | 2.0 | 11.2 | 203 | 200 | 0.36 | 0.63 | 20.5 | 10% |
| | MH 244 | MH 243 | 0.18 | | 5 | 13.5 | 2.19 | 103.2 | 4.00 | 1.7 | | | | | | | 0.2 | 2.2 | 0.6 | 2.3 | 29.8 | 203 | 200 | 0.34 | 0.61 | 19.9 | 11% |
| | MH 243 | MH 242 | 0.79 | 7 | 12 | 56.2 | 2.80 | 145.9 | 4.00 | 2.4 | | | | | | | 0.8 | 2.8 | 0.8 | 3.1 | 108.0 | 203 | 200 | 0.32 | 0.60 | 19.3 | 16% |
| Maxwell Bridge Rd | MH 242 | MH 240 | 0.39 | 5 | | 17.0 | 13.46 | 956.5 | 3.81 | 14.8 | | | | | | | 0.4 | 13.5 | 3.8 | 18.5 | 82.0 | 254 | 250 | 0.38 | 0.75 | 38.2 | 49% |
| Celtic Ridge Cres | MH 233 | MH 241 | 0.63 | | 20 | 54.0 | 0.63 | 54.0 | 4.00 | 0.9 | | | | | | | 0.6 | 0.6 | 0.2 | 1.1 | 73.3 | 203 | 200 | 0.33 | 0.61 | 19.6 | 5% |
| | MH 241 | MH 240 | 0.45 | | 13 | 35.1 | 1.08 | 89.1 | 4.00 | 1.4 | | | | | | | 0.5 | 1.1 | 0.3 | 1.7 | 63.7 | 203 | 200 | 1.21 | 1.16 | 37.6 | 5% |
| Maxwell Bridge Rd | MH 240 | MH 238 | 0.40 | | 9 | 24.3 | 14.94 | 1069.9 | 3.78 | 16.4 | | | | | | | 0.4 | 14.9 | 4.2 | 20.6 | 82.0 | 254 | 250 | 0.24 | 0.60 | 30.4 | 68% |
| Celtic Ridge Cres | MH 233 | MH 232 | 0.19 | | 3 | 8.1 | 0.19 | 8.1 | 4.00 | 0.1 | | | | | | | 0.2 | 0.2 | 0.1 | 0.2 | 12.4 | 203 | 200 | 0.65 | 0.85 | 27.6 | 1% |
| | MH 232 | MH 231 | 0.46 | | 12 | 32.4 | 0.65 | 40.5 | 4.00 | 0.7 | | | | | | | 0.5 | 0.7 | 0.2 | 0.8 | 73.3 | 203 | 200 | 0.40 | 0.67 | 21.6 | 4% |
| Celtic Ridge Cres | MH 230 | MH 231 | 0.41 | | 11 | 29.7 | 0.41 | 29.7 | 4.00 | 0.5 | | | | | | | 0.4 | 0.4 | 0.1 | 0.6 | 82.1 | 203 | 200 | 0.33 | 0.61 | 19.6 | 3% |
| Braecreek Ave | MH 231 | MH 239 | 0.92 | | 28 | 75.6 | 1.98 | 145.8 | 4.00 | 2.4 | | | | | | | 0.9 | 2.0 | 0.6 | 2.9 | 120.0 | 203 | 200 | 0.33 | 0.61 | 19.6 | 15% |
| | MH 239 | MH 238 | 0.17 | | 4 | 10.8 | 2.15 | 156.6 | 4.00 | 2.5 | | | | | | | 0.2 | 2.2 | 0.6 | 3.1 | 27.4 | 203 | 200 | 1.82 | 1.42 | 46.1 | 7% |
| Maxwell Bridge Rd | MH 238 | MH 236 | 0.42 | | 13 | 35.1 | 17.51 | 1261.6 | 3.73 | 19.1 | | | | | | | 0.4 | 17.5 | 4.9 | 24.0 | 82.0 | 254 | 250 | 0.24 | 0.60 | 30.4 | 79% |
| Fordell Ave | MH 230 | MH 237 | 0.86 | | 30 | 81.0 | 0.86 | 81.0 | 4.00 | 1.3 | | | | | | | 0.9 | 0.9 | 0.2 | 1.6 | 110.0 | 203 | 200 | 0.32 | 0.60 | 19.3 | 8% |
| | MH 237 | MH 236 | 0.23 | | 6 | 16.2 | 1.09 | 97.2 | 4.00 | 1.6 | | | | | | | 0.2 | 1.1 | 0.3 | 1.9 | 39.1 | 203 | 200 | 2.30 | 1.60 | 51.8 | 4% |

# BROOKSIDE SUBDIVISION
# SANITARY SEWER DESIGN SHEET

| LOCATION | | | RESIDENTIAL AREA AND POPULATION | | | | | | | | IND | | | INST | | ICI | INFILTRATION | | | FLOW | PIPE | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Street | From Node | To Node | Area (ha) | Dwellings SFH | Dwellings TH | Pop. | Cumulative Area (ha) | Cumulative Pop. | Peak Factor | Peak Flow (l/s) | Area (ha) | Accu. Area (ha) | Peak Factor | Area (ha) | Accu. Area (ha) | Peak Flow (l/s) | Total Area (ha) | Accu. Area (ha) | Infiltration Flow (l/s) | Total Flow (l/s) | Length (m) | Dia Act (mm) | Dia Nom (mm) | Slope (%) | Velocity (Full) (m/s) | Capacity (Full) (l/s) | Ratio Q/Qfull (%) |
| Maxwell Bridge Rd | MH 236 | MH 234 | 0.39 | | 12 | 32.4 | 18.99 | 1391.2 | 3.70 | 20.9 | | | | | | | 0.4 | 19.0 | 5.3 | 26.2 | 82.0 | 305 | 300 | 0.24 | 0.68 | 49.4 | 53% |
| Arncliffe Ave | MH 229 | MH 235 | 0.87 | | 30 | 81.0 | 0.87 | 81.0 | 4.00 | 1.3 | | | | | | | 0.9 | 0.9 | 0.2 | 1.6 | 120.0 | 203 | 200 | 0.33 | 0.61 | 19.6 | 8% |
| | MH 235 | MH 234 | 0.22 | | 6 | 16.2 | 1.09 | 97.2 | 4.00 | 1.6 | | | | | | | 0.2 | 1.1 | 0.3 | 1.9 | 29.3 | 203 | 200 | 2.90 | 1.80 | 58.2 | 3% |
| Maxwell Bridge Rd | MH 234 | MH 225 | 0.26 | | 6 | 16.2 | 20.34 | 1504.6 | 3.68 | 22.4 | | | | | | | 0.3 | 20.3 | 5.7 | 28.1 | 79.8 | 305 | 300 | 0.25 | 0.69 | 50.4 | 56% |
| Celtic Ridge Cres | MH 230 | MH 229 | 0.43 | | 12 | 32.4 | 0.43 | 32.4 | 4.00 | 0.5 | | | | | | | 0.4 | 0.4 | 0.1 | 0.6 | 81.9 | 203 | 200 | 0.32 | 0.60 | 19.3 | 3% |
| | MH 229 | MH 228 | 0.38 | | 11 | 29.7 | 0.81 | 62.1 | 4.00 | 1.0 | | | | | | | 0.4 | 0.8 | 0.2 | 1.2 | 70.3 | 203 | 200 | 0.33 | 0.61 | 19.6 | 6% |
| | MH 228 | MH 227 | 0.10 | | 0 | 0.0 | 0.91 | 62.1 | 4.00 | 1.0 | | | | | | | 0.1 | 0.9 | 0.3 | 1.3 | 12.3 | 203 | 200 | 0.33 | 0.61 | 19.6 | 6% |
| | MH 227 | MH 226 | 0.46 | | 13 | 35.1 | 1.37 | 97.2 | 4.00 | 1.6 | | | | | | | 0.5 | 1.4 | 0.4 | 2.0 | 97.0 | 203 | 200 | 0.32 | 0.60 | 19.3 | 10% |
| | MH 226 | MH 225 | 0.21 | | 5 | 13.5 | 1.58 | 110.7 | 4.00 | 1.8 | | | | | | | 0.2 | 1.6 | 0.4 | 2.2 | 43.7 | 203 | 200 | 0.94 | 1.02 | 33.1 | 7% |
| Celtic Ridge Cres | MH 225 | MH 224 | 0.58 | | 12 | 32.4 | 22.50 | 1647.7 | 3.65 | 24.4 | | | | | | | 0.6 | 22.5 | 6.3 | 30.7 | 97.5 | 381 | 375 | 0.20 | 0.72 | 81.7 | 38% |
| | MH 224 | MH 209 | 0.22 | | 4 | 10.8 | 22.72 | 1658.5 | 3.65 | 24.5 | | | | | | | 0.2 | 22.7 | 6.4 | 30.9 | 66.5 | 381 | 375 | 0.20 | 0.72 | 81.7 | 38% |
| Streamside Cres | MH 217 | MH 218 | 0.26 | 2 | | 6.8 | 0.26 | 6.8 | 4.00 | 0.1 | | | | | | | 0.3 | 0.3 | 0.1 | 0.2 | 12.4 | 203 | 200 | 1.00 | 1.05 | 34.2 | 1% |
| | MH 218 | MH 219 | 0.96 | 20 | | 68.0 | 1.22 | 74.8 | 4.00 | 1.2 | | | | | | | 1.0 | 1.2 | 0.3 | 1.6 | 120.0 | 203 | 200 | 0.80 | 0.94 | 30.6 | 5% |
| | MH 219 | MH 220 | 0.62 | 11 | | 37.4 | 1.84 | 112.2 | 4.00 | 1.8 | | | | | | | 0.6 | 1.8 | 0.5 | 2.3 | 77.8 | 203 | 200 | 0.32 | 0.60 | 19.3 | 12% |
| Glenbrae Ave | MH 220 | MH 221 | 0.96 | | 28 | 75.6 | 2.80 | 187.8 | 4.00 | 3.0 | | | | | | | 1.0 | 2.8 | 0.8 | 3.8 | 118.9 | 203 | 200 | 0.32 | 0.60 | 19.3 | 20% |
| | MH 221 | MH 222 | 1.04 | | 33 | 89.1 | 3.84 | 276.9 | 4.00 | 4.5 | | | | | | | 1.0 | 3.8 | 1.1 | 5.6 | 119.0 | 203 | 200 | 0.32 | 0.60 | 19.3 | 29% |
| | MH 222 | MH 223 | 0.20 | | 3 | 8.1 | 4.04 | 285.0 | 4.00 | 4.6 | | | | | | | 0.2 | 4.0 | 1.1 | 5.7 | 12.9 | 203 | 200 | 0.39 | 0.66 | 21.3 | 27% |
| | MH 223 | MH 210 | 0.22 | | 4 | 10.8 | 4.26 | 295.8 | 4.00 | 4.8 | | | | | | | 0.2 | 4.3 | 1.2 | 6.0 | 72.9 | 203 | 200 | 0.33 | 0.61 | 19.6 | 30% |
| Streamside Cres | MH 217 | MH 216 | 0.37 | 5 | | 17.0 | 0.37 | 17.0 | 4.00 | 0.3 | | | | | | | 0.4 | 0.4 | 0.1 | 0.4 | 40.1 | 203 | 200 | 0.65 | 0.85 | 27.6 | 1% |
| | MH 216 | MH 215 | 0.17 | 2 | | 6.8 | 0.54 | 23.8 | 4.00 | 0.4 | | | | | | | 0.2 | 0.5 | 0.2 | 0.5 | 13.6 | 203 | 200 | 0.65 | 0.85 | 27.6 | 2% |
| | MH 215 | MH 214 | 0.17 | 2 | | 6.8 | 0.71 | 30.6 | 4.00 | 0.5 | | | | | | | 0.2 | 0.7 | 0.2 | 0.7 | 31.6 | 203 | 200 | 0.50 | 0.75 | 24.2 | 3% |
| | MH 214 | MH 213 | 1.02 | 18 | | 61.2 | 1.73 | 91.8 | 4.00 | 1.5 | | | | | | | 1.0 | 1.7 | 0.5 | 2.0 | 119.0 | 203 | 200 | 0.90 | 1.00 | 32.4 | 6% |
| | MH 213 | MH 212 | 0.50 | 7 | | 23.8 | 2.23 | 115.6 | 4.00 | 1.9 | | | | | | | 0.5 | 2.2 | 0.6 | 2.5 | 56.5 | 203 | 200 | 0.32 | 0.60 | 19.3 | 13% |
| Celtic Ridge Cres | MH 212 | MH 211 | 1.04 | 16 | | 54.4 | 3.27 | 170.0 | 4.00 | 2.8 | | | | | | | 1.0 | 3.3 | 0.9 | 3.7 | 124.9 | 203 | 200 | 0.32 | 0.60 | 19.3 | 19% |
| | MH 211 | MH 210 | 0.94 | 16 | | 54.4 | 4.21 | 224.4 | 4.00 | 3.6 | | | | | | | 0.9 | 4.2 | 1.2 | 4.8 | 122.0 | 203 | 200 | 0.33 | 0.61 | 19.6 | 25% |
| Celtic Ridge Cres | MH 210 | MH 209 | 0.58 | 11 | | 37.4 | 9.05 | 557.6 | 3.95 | 8.9 | | | | | | | 0.6 | 9.1 | 2.5 | 11.5 | 80.9 | 203 | 200 | 0.75 | 0.91 | 29.6 | 39% |
| Easement | MH 209 | MH 208 | 0.06 | | | 0.0 | 31.83 | 2216.1 | 3.55 | 31.9 | | | | | | | 0.1 | 31.8 | 8.9 | 40.8 | 50.3 | 381 | 375 | 0.20 | 0.72 | 81.7 | 50% |
| | MH 208 | MH 207 | 0.24 | | | 0.0 | 32.07 | 2216.1 | 3.55 | 31.9 | | | | | | | 0.2 | 32.1 | 9.0 | 40.9 | 111.6 | 381 | 375 | 0.20 | 0.72 | 81.7 | 50% |
| **Area 4a - Phase 2 Lands** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | MH 273 | MH 272 | 0.57 | | 9 | 24.3 | 0.57 | 24.3 | 4.00 | 0.4 | | | | | | | 0.6 | 0.6 | 0.2 | 0.6 | 66.0 | 203 | 200 | 0.65 | 0.85 | 27.6 | 2% |
| | MH 272 | MH 271 | 0.92 | | 16 | 43.2 | 1.49 | 67.5 | 4.00 | 1.1 | | | | | | | 0.9 | 1.5 | 0.4 | 1.5 | 90.2 | 203 | 200 | 0.40 | 0.67 | 21.6 | 7% |
| | MH 271 | MH 270 | 1.06 | | 19 | 51.3 | 2.55 | 118.8 | 4.00 | 1.9 | | | | | | | 1.1 | 2.6 | 0.7 | 2.6 | 113.0 | 203 | 200 | 0.40 | 0.67 | 21.6 | 12% |
| | MH 270 | MH 207 | 0.00 | | 0 | 0.0 | 2.55 | 118.8 | 4.00 | 1.9 | | | | | | | 0.0 | 2.6 | 0.7 | 2.6 | 16.0 | 254 | 250 | 0.32 | 0.69 | 35.1 | 8% |
| Easement | MH 207 | MH 206 | 0.22 | | | 0.0 | 34.84 | 2240.4 | 3.55 | 32.2 | | | | | | | 0.2 | 34.8 | 9.8 | 41.9 | 100.0 | 457 | 450 | 0.20 | 0.81 | 132.9 | 32% |
| **Area 2** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | Area 2 | MH 266 | 3.10 | | | 202 | 3.10 | 202.0 | 4.00 | 3.3 | | | | | | | 3.1 | 3.1 | 0.9 | 4.1 | - | 203 | 200 | 0.32 | 0.60 | 19.3 | 21% |
| **Klondike Road & Area 4b** | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | MH 266 | MH 265 | 0.24 | | | | 3.34 | 202.0 | 4.00 | 3.3 | | | | | | | 0.2 | 3.3 | 0.9 | 4.2 | 93.7 | 203 | 200 | 0.32 | 0.60 | 19.3 | 22% |
| | Park | MH 265 | 1.89 | | | | 1.89 | 0.0 | 4.00 | 0.0 | | | | | | | 1.9 | 1.9 | 0.5 | 0.5 | 13.0 | 203 | 200 | 0.32 | 0.60 | 19.3 | 3% |
| | MH 265 | MH 264 | 0.31 | | | | 5.54 | 202.0 | 4.00 | 3.3 | | | | | | | 0.3 | 5.5 | 1.6 | 4.8 | 120.0 | 203 | 200 | 0.32 | 0.60 | 19.3 | 25% |

# Appendix D

**Stormwater Servicing Design**

# STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

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

Manning 0.013

Ottawa

| LOCATION | | | AREA (Ha) | | | | | | | | | | | | | | | | FLOW | | | | | | SEWER DATA | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2 YEAR | | | | 5 YEAR | | | | 10 YEAR | | | | 100 YEAR | | | | Time of | Intensity | Intensity | Intensity | Intensity | Peak Flow | DIA. (mm) | DIA. (mm) | TYPE | SLOPE | LENGTH | CAPACITY | VELOCITY | TIME OF | RATIO |
| | | | AREA | R | Indiv. | Accum. | AREA | R | Indiv. | Accum. | AREA | R | Indiv. | Accum. | AREA | R | Indiv. | Accum. | Conc. | 2 Year | 5 Year | 10 Year | 100 Year | | | | | | | | | | |
| Location | From Node | To Node | (Ha) | | 2.78 AC | 2.78 AC | (Ha) | | 2.78 AC | 2.78 AC | (Ha) | | 2.78 AC | 2.78 AC | (Ha) | | 2.78 AC | 2.78 AC | (min) | (mm/h) | (mm/h) | (mm/h) | (mm/h) | Q (l/s) | (actual) | (nominal) | | (%) | (m) | (l/s) | (m/s) | LOW (min) | Q/Q full |
| **Trunk 2** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 12.38 | | | | | | | | | | | | | | |
| | | | | | 0.00 | 0.00 | 2.78 | 0.40 | 3.09 | 3.09 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | 53 | 54 | 3.50 | 0.65 | 6.32 | 6.32 | | | 0.00 | 3.09 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 12.38 | 68.73 | 93.10 | 109.08 | 159.37 | 722 | 900 | 900 | CONC | 0.30 | 74.5 | 991.5483 | 1.5586 | 0.7966 | 0.729 |
| | | | | | 0.00 | 6.32 | 0.00 | 0.00 | 0.00 | 3.09 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 15.24 | | | | | | | | | | | | | | |
| | 54 | 58 | 3.75 | 0.65 | 6.78 | 13.10 | | | 0.00 | 3.09 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 15.24 | 61.20 | 82.79 | 96.94 | 141.56 | 1058 | 975 | 975 | CONC | 0.50 | 71.5 | 1584.6640 | 2.1225 | 0.5615 | 0.667 |
| | | | | | 0.00 | 13.10 | 0.00 | 0.00 | 0.00 | 3.09 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 12.27 | | | | | | | | | | | | | | |
| | 58 | 61 | 1.66 | 0.70 | 3.23 | 16.33 | | | 0.00 | 3.09 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 15.80 | 59.94 | 81.05 | 94.90 | 138.57 | 1229 | 1050 | 1050 | CONC | 0.35 | 65.5 | 1615.5188 | 1.8657 | 0.5851 | 0.761 |
| | | | | | 0.00 | 16.33 | 0.00 | 0.00 | 0.00 | 3.09 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 12.37 | | | | | | | | | | | | | | |
| | | | 0.15 | 0.65 | 0.27 | 16.60 | | | 0.00 | 3.09 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | | | | | 0.00 | 16.60 | 0.40 | 0.40 | 0.44 | 3.54 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | 61 | 64 | 1.23 | 0.70 | 2.39 | 19.00 | | | 0.00 | 3.54 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 16.39 | 58.67 | 79.33 | 92.88 | 135.59 | 1395 | 1200 | 1200 | CONC | 0.20 | 68.5 | 1743.5652 | 1.5417 | 0.7405 | 0.800 |
| | | | | | 0.00 | 19.00 | 0.00 | 0.00 | 0.00 | 3.54 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 12.39 | | | | | | | | | | | | | | |
| | | | 0.29 | 0.65 | 0.52 | 19.52 | | | 0.00 | 3.54 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | 64 | 67 | 1.10 | 0.70 | 2.14 | 21.66 | | | 0.00 | 3.54 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 17.13 | 57.16 | 77.26 | 90.44 | 132.02 | 1511 | 1200 | 1200 | CONC | 0.25 | 68.5 | 1949.3651 | 1.7236 | 0.6624 | 0.775 |
| | | | | | 0.00 | 21.66 | 0.00 | 0.00 | 0.00 | 3.54 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 12.39 | | | | | | | | | | | | | | |
| | | | 0.25 | 0.65 | 0.45 | 22.11 | | | 0.00 | 3.54 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | 67 | 75 | 1.16 | 0.70 | 2.26 | 24.37 | | | 0.00 | 3.54 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 17.79 | 55.88 | 75.50 | 88.38 | 129.00 | 1629 | 1200 | 1200 | CONC | 0.30 | 68.5 | 2135.4225 | 1.8881 | 0.6047 | 0.763 |
| To Trunk 3, Pipe 75 - 82 | | | | | | 24.37 | | | | 3.54 | | | | 0.00 | | | | 0.00 | 18.40 | | | | | | | | | | | | | | |
| **Trunk 3** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 15.05 | | | | | | | | | | | | | | |
| | 88 | 89 | 2.62 | 0.65 | 4.73 | 4.73 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 15.05 | 61.64 | 83.39 | 97.65 | 142.60 | 292 | 750 | 750 | CONC | 0.15 | 68.0 | 431.1703 | 0.9760 | 1.1612 | 0.677 |
| | 89 | 90 | 0.14 | 0.65 | 0.25 | 4.99 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 16.21 | 59.04 | 79.83 | 93.47 | 136.46 | 294 | 750 | 750 | CONC | 0.15 | 13.5 | 431.1703 | 0.9760 | 0.2305 | 0.683 |
| | 90 | 91 | 0.38 | 0.65 | 0.69 | 5.67 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 16.44 | 58.56 | 79.16 | 92.68 | 135.31 | 332 | 750 | 750 | CONC | 0.15 | 68.0 | 431.1703 | 0.9760 | 1.1612 | 0.771 |
| | 91 | 96 | 0.35 | 0.65 | 0.63 | 6.31 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 17.61 | 56.23 | 75.99 | 88.95 | 129.83 | 355 | 750 | 750 | CONC | 0.20 | 66.0 | 497.8726 | 1.1270 | 0.9761 | 0.712 |
| | | | | | 0.00 | 6.31 | 0.00 | 0.00 | 0.00 | 0.00 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 13.11 | | | | | | | | | | | | | | |
| | 96 | 97 | 1.04 | 0.65 | 1.88 | 8.19 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 18.58 | 54.43 | 73.53 | 86.06 | 125.59 | 446 | 825 | 825 | CONC | 0.20 | 72.5 | 641.9463 | 1.2009 | 1.0062 | 0.694 |
| To Trunk 1, Pipe 97 - 98TEE | | | | | | 8.19 | | | | 0.00 | | | | 0.00 | | | | 0.00 | 19.59 | | | | | | | | | | | | | | |
| Contribution From Trunk 2, Pipe 67 - 75 | | | | | | 24.37 | | | | 3.54 | | | | 0.00 | | | | 0.00 | 18.40 | | | | | | | | | | | | | | |
| | | | | | 0.00 | 24.37 | 0.00 | 0.00 | 0.00 | 3.54 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 17.86 | | | | | | | | | | | | | | |
| | | | 0.18 | 0.65 | 0.33 | 24.69 | | | 0.00 | 3.54 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | 75 | 82 | 2.61 | 0.70 | 5.08 | 29.77 | | | 0.00 | 3.54 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 18.40 | 54.76 | 73.98 | 86.59 | 126.38 | 1892 | 1500 | 1500 | CONC | 0.15 | 62.5 | 2737.7609 | 1.5493 | 0.6724 | 0.691 |
| | | | | | 0.00 | 29.77 | 0.00 | 0.00 | 0.00 | 3.54 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 14.80 | | | | | | | | | | | | | | |
| | | | 0.93 | 0.65 | 1.68 | 31.45 | | | 0.00 | 3.54 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | 82 | 97 | 1.67 | 0.65 | 3.02 | 34.47 | | | 0.00 | 3.54 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | 19.07 | 53.58 | 72.37 | 84.69 | 123.59 | 2103 | 1500 | 1500 | CONC | 0.15 | 73.5 | 2737.7609 | 1.5493 | 0.7907 | 0.768 |
| To Trunk 1, Pipe 97 - 98TEE | | | | | | 34.47 | | | | 3.54 | | | | 0.00 | | | | 0.00 | 19.86 | | | | | | | | | | | | | | |
| **Trunk 1** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| | | | | | 0.00 | 0.00 | 0.15 | 0.65 | 0.27 | 0.27 | | | 0.00 | 0.00 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | | | | | 0.00 | 0.00 | | | 0.00 | 0.27 | 1.39 | 0.65 | 2.51 | 2.51 | | | 0.00 | 0.00 | 16.19 | | | | | | | | | | | | | | |
| | 7 | 8 | | | 0.00 | 0.00 | | | 0.00 | 0.27 | 2.47 | 0.65 | 4.46 | 6.98 | | | 0.00 | 0.00 | 16.19 | 59.09 | 79.90 | 93.55 | 136.58 | 674 | 900 | 900 | CONC | 0.25 | 80.5 | 905.1556 | 1.4228 | 0.9430 | 0.745 |
| | 8 | 9 | | | 0.00 | 0.00 | 0.14 | 0.65 | 0.25 | 0.52 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 17.13 | 57.15 | 77.24 | 90.43 | 132.00 | 671 | 900 | 900 | CONC | 0.40 | 54.5 | 1144.9413 | 1.7997 | 0.5047 | 0.586 |
| | 9 | 10 | | | 0.00 | 0.00 | 0.15 | 0.65 | 0.27 | 0.80 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 17.64 | 56.17 | 75.90 | 88.85 | 129.69 | 680 | 900 | 900 | CONC | 0.85 | 56.5 | 1669.0244 | 2.6235 | 0.3589 | 0.407 |
| | | | | | 0.00 | 0.00 | 0.22 | 0.65 | 0.40 | 1.19 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | | | | | 0.00 | 0.00 | 3.67 | 0.85 | 8.67 | 9.86 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | 10 | 11 | | | 0.00 | 0.00 | 5.68 | 0.85 | 13.42 | 23.29 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 18.00 | 55.49 | 74.98 | 87.77 | 128.10 | 2358 | 1350 | 1350 | CONC | 0.35 | 87.5 | 3157.6496 | 2.2060 | 0.6611 | 0.747 |
| | 11 | 12 | | | 0.00 | 0.00 | 0.44 | 0.65 | 0.80 | 24.08 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 18.66 | 54.30 | 73.34 | 85.84 | 125.28 | 2365 | 1350 | 1350 | CONC | 0.60 | 76.0 | 4134.3338 | 2.8883 | 0.4385 | 0.572 |
| | 12 | 20 | | | 0.00 | 0.00 | 0.24 | 0.65 | 0.43 | 24.52 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 19.10 | 53.53 | 72.30 | 84.62 | 123.48 | 2363 | 1350 | 1350 | CONC | 0.60 | 53.0 | 4134.3338 | 2.8883 | 0.3058 | 0.571 |
| | | | | | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 24.52 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 13.01 | | | | | | | | | | | | | | |
| | | | | | 0.00 | 0.00 | 0.23 | 0.65 | 0.42 | 24.93 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | 20 | 23 | 2.37 | 0.65 | 4.28 | 4.28 | | | 0.00 | 24.93 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 19.40 | 53.01 | 71.59 | 83.79 | 122.26 | 2596 | 1350 | 1350 | CONC | 0.60 | 70.0 | 4134.3338 | 2.8883 | 0.4039 | 0.628 |
| | | | | | 0.00 | 4.28 | 0.00 | 0.00 | 0.00 | 24.93 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 11.41 | | | | | | | | | | | | | | |
| | | | | | 0.00 | 4.28 | 0.34 | 0.65 | 0.61 | 25.55 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | 23 | 26 | 1.30 | 0.70 | 2.53 | 6.81 | | | 0.00 | 25.55 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 19.81 | 52.35 | 70.68 | 82.71 | 120.69 | 2739 | 1350 | 1350 | CONC | 0.45 | 68.5 | 3580.4381 | 2.5014 | 0.4564 | 0.765 |

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

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

LICENSED PROFESSIONAL ENGINEER
W. LIU
100167932
Sep 4, 2019
PROVINCE OF ONTARIO

| Designed: | PROJECT: | | |
|---|---|---|---|
| A.K. | Minto Kanata North | | |
| Checked: | LOCATION: | | |
| W.L. | City of Ottawa | | |
| Dwg. Reference: | File Ref: 17-982 | Date: Sep 2019 | Sheet No. SHEET 1 OF 2 |

982_STM_Trunk_Designsheet.xlsx

# STORM SEWER CALCULATION SHEET (RATIONAL METHOD)

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

Ottawa

| | LOCATION | | AREA (Ha) | | | | | | | | | | | | | | | | FLOW | | | | | | SEWER DATA | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 2 YEAR | | | | 5 YEAR | | | | 10 YEAR | | | | 100 YEAR | | | | Time of Conc. | Intensity 2 Year | Intensity 5 Year | Intensity 10 Year | Intensity 100 Year | Peak Flow | DIA. (mm) | DIA. (mm) | TYPE | SLOPE | LENGTH | CAPACITY | VELOCITY | TIME OF | RATIO |
| Location | From Node | To Node | AREA (Ha) | R | Indiv. 2.78 AC | Accum. 2.78 AC | AREA (Ha) | R | Indiv. 2.78 AC | Accum. 2.78 AC | AREA (Ha) | R | Indiv. 2.78 AC | Accum. 2.78 AC | AREA (Ha) | R | Indiv. 2.78 AC | Accum. 2.78 AC | (min) | (mm/h) | (mm/h) | (mm/h) | (mm/h) | Q (l/s) | (actual) | (nominal) | | (%) | (m) | (l/s) | (m/s) | LOW (min) | Q/Q full |
| | | | | | 0.00 | 6.81 | 0.00 | 0.00 | 0.00 | 25.55 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 11.48 | | | | | | | | | | | | | | |
| | | | | | 0.00 | 6.81 | 0.35 | 0.65 | 0.63 | 26.18 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | 26 | 30 | 1.30 | 0.70 | 2.53 | 9.34 | | | 0.00 | 26.18 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 20.26 | 51.61 | 69.68 | 81.54 | 118.97 | 2875 | 1500 | 1500 | CONC | 0.30 | 78.5 | 3871.7786 | 2.1910 | 0.5971 | 0.743 |
| | | | | | 0.00 | 9.34 | 0.00 | 0.00 | 0.00 | 26.18 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 12.85 | | | | | | | | | | | | | | |
| | | | 0.11 | 0.65 | 0.20 | 9.54 | | | 0.00 | 26.18 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | | | | | 0.00 | 9.54 | 0.39 | 0.65 | 0.70 | 26.88 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | 30 | 31 | | | 0.00 | 9.54 | 0.96 | 0.70 | 1.87 | 28.75 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 20.86 | 50.69 | 68.42 | 80.06 | 116.80 | 3009 | 1500 | 1500 | CONC | 0.35 | 83.0 | 4181.9989 | 2.3665 | 0.5845 | 0.720 |
| | | | | | 0.00 | 9.54 | 0.42 | 0.65 | 0.76 | 29.51 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | | | | | | | | | | | | | | | |
| | 31 | 32 | | | 0.00 | 9.54 | 2.52 | 0.65 | 4.55 | 34.06 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 21.44 | 49.82 | 67.23 | 78.66 | 114.75 | 3314 | 1500 | 1500 | CONC | 0.35 | 83.0 | 4181.9989 | 2.3665 | 0.5845 | 0.792 |
| | 32 | 97 | | | 0.00 | 9.54 | 0.56 | 0.65 | 1.01 | 35.08 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 22.03 | 48.98 | 66.09 | 77.32 | 112.79 | 3325 | 1500 | 1500 | CONC | 0.60 | 83.0 | 5475.5219 | 3.0985 | 0.4465 | 0.607 |
| Contribution From Trunk 3, Pipe 82 - 97 | | | | | | 34.47 | | | | 3.54 | | | | 0.00 | | | | 0.00 | 19.86 | | | | | | | | | | | | | | |
| Contribution From Trunk 3, Pipe 96 - 97 | | | | | | 8.19 | | | | 0.00 | | | | 0.00 | | | | 0.00 | 19.59 | | | | | | | | | | | | | | |
| | 97 | 98TEE | | | 0.00 | 52.20 | 0.07 | 0.65 | 0.13 | 38.74 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 22.48 | 48.36 | 65.25 | 76.33 | 111.34 | 5584 | 3000 | 3000 | CONC | 0.10 | 92.5 | 14193.7303 | 2.0080 | 0.7678 | 0.393 |
| | 98TEE | 990TEE | | | 0.00 | 52.20 | | | 0.00 | 38.74 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 23.24 | 47.34 | 63.85 | 74.70 | 108.93 | 5466 | 3000 | 3000 | CONC | 0.10 | 13.0 | 14193.7303 | 2.0080 | 0.1079 | 0.385 |
| | 990TEE | 99TEE | | | 0.00 | 52.20 | | | 0.00 | 38.74 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 23.35 | 47.20 | 63.66 | 74.47 | 108.61 | 5449 | 3000 | 3000 | CONC | 0.10 | 25.0 | 14193.7303 | 2.0080 | 0.2075 | 0.384 |
| | 99TEE | 100TEE | | | 0.00 | 52.20 | | | 0.00 | 38.74 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 23.56 | 46.93 | 63.30 | 74.04 | 107.98 | 5418 | 3000 | 3000 | CONC | 0.10 | 23.0 | 14193.7303 | 2.0080 | 0.1909 | 0.382 |
| | 100TEE | 101TEE | | | 0.00 | 52.20 | | | 0.00 | 38.74 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 23.75 | 46.69 | 62.97 | 73.66 | 107.41 | 5390 | 3000 | 3000 | CONC | 0.10 | 98.5 | 14193.7303 | 2.0080 | 0.8176 | 0.380 |
| To Trunk 1, Pipe 101TEE - 1001TEE | | | | | | 52.20 | | | | 38.74 | | | | 6.98 | | | | 0.00 | 24.57 | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| **Trunk 1** | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Contribution From Trunk 1, Pipe 100TEE - 101TEE | | | | | | 52.20 | | | | 38.74 | | | | 6.98 | | | | 0.00 | 24.57 | | | | | | | | | | | | | | |
| | 101TEE | 1001TEE | | | 0.00 | 52.20 | | | 0.00 | 38.74 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 24.57 | 45.68 | 61.60 | 72.05 | 105.05 | 5273 | 3000 | 3000 | CONC | 0.10 | 10.0 | 14193.7303 | 2.0080 | 0.0830 | 0.372 |
| | 1001TEE | 103 | | | 0.00 | 52.20 | | | 0.00 | 38.74 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 24.65 | 45.58 | 61.46 | 71.89 | 104.82 | 5262 | 3000 | 3000 | CONC | 0.10 | 28.0 | 14193.7303 | 2.0080 | 0.2324 | 0.371 |
| | 103 | 102 | | | 0.00 | 52.20 | | | 0.00 | 38.74 | | | 0.00 | 6.98 | | | 0.00 | 0.00 | 24.88 | 45.31 | 61.08 | 71.45 | 104.17 | 5230 | 3000 | 3000 | CONC | 0.10 | 13.0 | 14193.7303 | 2.0080 | 0.1079 | 0.368 |

LICENSED PROFESSIONAL ENGINEER
W. LIU
100167932
SEP 4, 2019
PROVINCE OF ONTARIO

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

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

| | | | |
|---|---|---|---|
| Designed: A.K. | PROJECT: Minto Kanata North | | |
| Checked: W.L. | LOCATION: City of Ottawa | | |
| Dwg. Reference: | File Ref: 17-982 | Date: Sep 2019 | Sheet No. SHEET 2 OF 2 |


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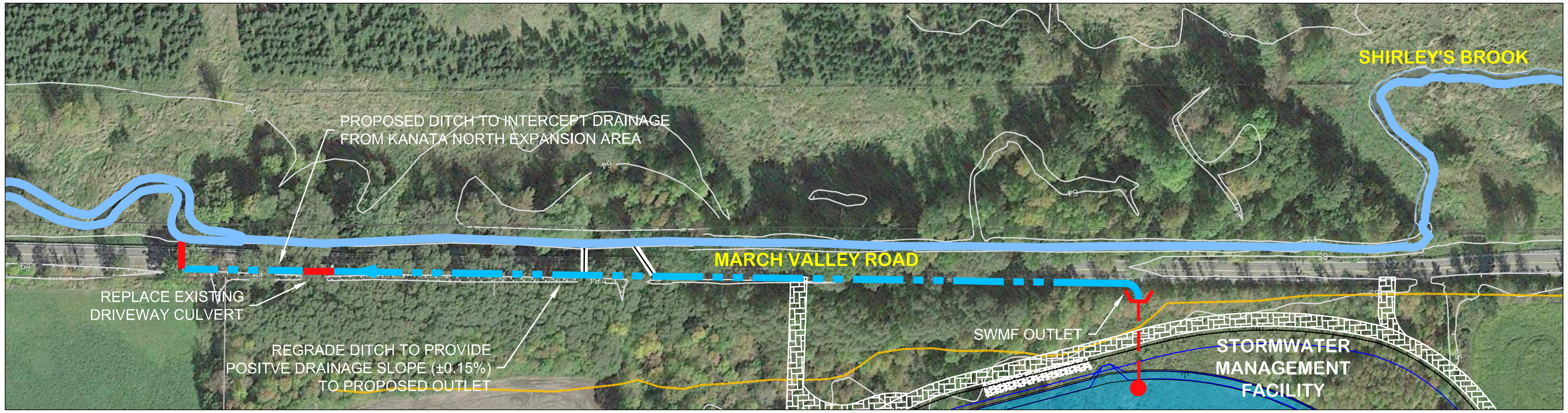
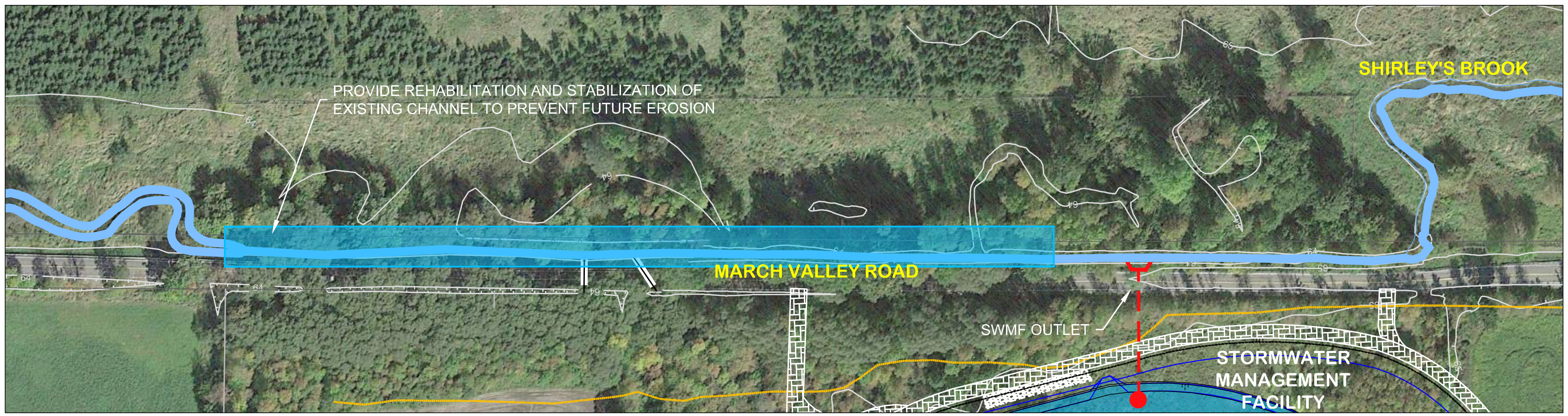
# STORM SERVICING APPENDIX
# MINTO KANATA NORTH

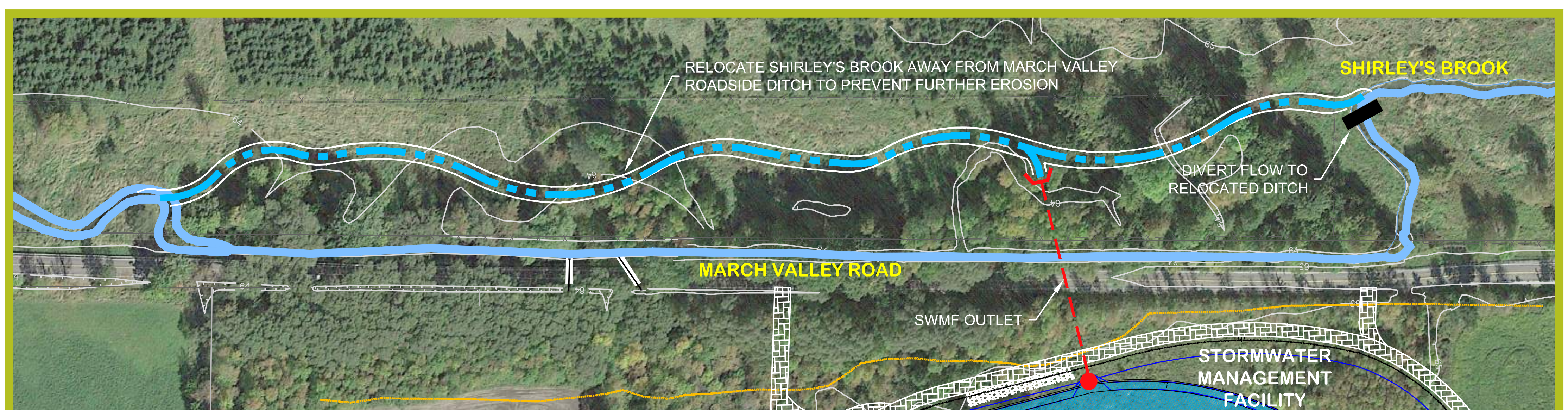
| | |
|---|---|
| PROJECT No. : | 17-982 |
| SCALE: | 1:2000 |
| DATE: | September 2019 |
| DRAWING No. | 2 |




OPTION 1: UPGRADE ROAD-SIDE DITCH SOUTH OF MARCH VALLEY ROAD TO INTERCEPT DRAINAGE FROM PROPOSED SWMF




OPTION 2: REHABILITATE SHIRLEY'S BROOK ALONG MARCH VALLEY ROAD DOWNSTREAM OF SWM FACILITY OUTLET




OPTION 3: REALIGN SHIRLEY'S BROOK THROUGH WOODED AREA, AWAY FROM MARCH VALLEY ROAD (PREFERRED)

## LEGEND

- KNUEA
- EXISTING DRAINAGE CHANNEL
- PROPOSED DRAINAGE CHANNEL

**KANATA NORTH**
COMMUNITY DESIGN PLAN

**FIGURE NO. 6.5**
SHIRLEY'S BROOK REALIGNMENT ALTERNATIVES

| DATE | JOB |
|---|---|
| MAY 2016 | 112117 |

SCALE
1:2000 (0 20m 40m 80m)

NOVATECH
Engineers, Planners & Landscape Architects

M:\2012\112117\CAD\Design_EMP\Figure 6.5 Shirley's Brook Options.dwg, Figure 6.5, May 18, 2016 - 5:15pm, kbanks

**re:** **Groundwater Infiltration Review**
**Proposed Mixed-Use Development**
**936 March Road - Ottawa**

**to:** Minto Communities 2559688 - **Ms. Beth Henderson** - bhenderson@minto.com

**date:** June 21, 2019

**file:** PG4554-MEMO.01R

---

Paterson Group (Paterson) has prepared the current memorandum report to provide a review of the hydrogeological characteristics in support of groundwater infiltration recommendations for the aforementioned site.

## Background Information

It is currently understood that the proposed mixed-use development consists of a mixture of single family and townhouse style residential dwellings, a school located in the central portion of the site and future commercial developments to be located at the western end of the site fronting onto March Road. It is also understood that the development will be serviced by municipal infrastructure that outlets to a stormwater management pond.

Multiple geotechnical and environmental investigations were completed for the proposed development, as part of which a total of 41 boreholes and 17 test pits were advanced to a maximum depth of 7.5 m. The results of the investigations indicated that, in general, the subsurface profile at the test hole locations consisted of topsoil overlying a layer of hard to firm brown silty clay that became grey with depth. This was typically underlain by a till deposit composed of a silty sand/silty clay matrix with gravel, cobbles and boulders. A deposit of silty sand was noted above the silty clay layer at borehole locations within the central portion of the site. Where encountered, the silty sand deposit was typically 0.5 to 1.5 m in thickness.

Practical refusal to augering was encountered on the inferred bedrock surface at depths ranging from approximately 1.3 m on the western portion of the site to approximately 7.8 m at the eastern boundary of the site. Based on available geological mapping, the site is located in an area where bedrock in the western portion of the site consists of interbedded sandstone and dolomite of the March formation, while bedrock in the eastern portion of the site consists of dolomite of the Oxford formation. Overburden thickness in the area is expected to range from 3 to 10 m.

# Hydrogeological Setting

The subject site is located within the Shirley's Brook subwatershed of the Ottawa West watershed. The only surface water feature identified within the study area is an unnamed tributary to Shirley's Brook, which transects the site in a northwest to southeast direction.

### Hydraulic Conductivity

Hydraulic conductivity testing was not completed as part of the various investigations for the proposed development. The hydraulic conductivity values were conservatively estimated based upon previous experience at similar sites in the area, information obtained from the results of the geotechnical field program and typical published values for similar stratigraphy. The values are interpreted to be approximately $1.0 \times 10^{-7}$ to $1.0 \times 10^{-10}$ m/sec for silty clay and $1.0 \times 10^{-6}$ to $1.0 \times 10^{-12}$ m/sec for limestone/dolomite bedrock.

### Water Levels and Flow Directions

Water levels within the flexible piezometers installed within the boreholes ranged from 0.8 to 4.4 m depth. It should be noted that groundwater levels may have been influenced by surface water infiltrating the backfilled boreholes. Subsequently, groundwater level readings within the piezometers can be influenced by perched water in the backfill material within the borehole. As such, long-term groundwater levels are also estimated based on other factors such as colour, moisture levels and consistency of the recovered soil samples. Based on these observations, the long-term groundwater level at the subject site is expected to range from 2.5 to 4.5 m depth.

Based on the recovered water levels, shallow groundwater flow is expected to reflect local topography. The regional groundwater flow direction is expected to trend eastward towards Shirley's Bay and the Ottawa River, located approximately 2.2 km east of the proposed development.

### Groundwater Recharge and Discharge

In general, groundwater will follow the path of least resistance from areas of higher hydraulic head to areas of lower hydraulic head. While upward and downward hydraulic gradients may be indicative of discharge and recharge, respectively, other factors must be considered.

Based on the hydraulic conductivity estimates obtained from previous studies and published literature, the silty clay overburden is generally considered to act as a confining layer. It is our interpretation that groundwater will generally flow laterally through the upper layer of topsoil/weathered brown silty clay, as opposed to vertically upwards or downwards through overburden soils with lower hydraulic conductivity such as the grey silty clay. While small amounts of groundwater recharge and discharge could potentially take place on a localized scale where overburden thickness is minimal and/or contains silty sand near surface, neither the topographical or geological conditions are suitable for recharge or discharge to be occurring on a large scale at the subject site.

## Recommendations

As previously discussed, existing conditions at the subject site currently allow for only minimal volumes of recharge to occur. As such, the applicability of secondary infiltration measures is considered limited for Low Impact Development Measures (LIDs), such as rear yard catch basins and amended topsoil finishes. It should also be noted that previous attempts within the City of Ottawa to induce additional surface water infiltration in similarly low permeability soils have resulted in detrimental effects to both homeowners and their properties due to poorly maintained drainage systems.

While some loss of infiltration can be expected as a result of impervious surfaces, such as rooftops and roadways, directing drainage to municipal services, the majority of the existing infiltration potential is expected to be maintained through urban lawns and landscaped areas.

We trust that this information satisfies your requirements.

Best Regards,

**Paterson Group Inc.**

LICENSED PROFESSIONAL ENGINEER
June 21, 2019
D. J. GILBERT
100116130
PROVINCE OF ONTARIO

Michael Laflamme, P.Geo.

David J. Gilbert, P.Eng.

**Paterson Group Inc.**

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Minto Communities
180 Kent Street, Suite 200
Ottawa, ON, K1P 0B6

June 20th, 2019

Attn: Beth Henderson, Senior Land Development Manager

RE: Minto Kanata North Development (936 March Road)
Memorandum – Low Impact Development Measures (LIDs)

## 1.0 INTRODUCTION AND BACKGROUND

McKinley Environmental Solutions (MES) was previously retained by Minto Communities to prepare a Combined Environmental Impact Statement (EIS) and Tree Conservation Report (TCR) to support the development of the Southeast Quadrant of the Kanata North Urban Expansion Area (KNUEA), which includes the property at 936 March Road, Ottawa, Ontario (the Study Area). The Combined EIS and TCR is entitled *Minto Communities and 2559688 Ontario Inc. Kanata North Development (936 March Road) Combined Environmental Impact Statement & Tree Conservation Report (Revised)* dated May 2019. The 936 March Road property is proposed to be developed as a future subdivision, which will include a mixture of residential, commercial, and institutional uses. Refer to the Combined EIS and TCR for additional detail.

As part of the Combined EIS and TCR, MES conducted extensive natural heritage surveys throughout the Study Area in 2017, 2018 and 2019. During these surveys, MES observed that Black Legged Ticks are common within the undeveloped portions of the Study Area, including in Woodlot S-20, Woodlot S-23, and within riparian vegetation surrounding the North Tributary of Shirley's Brook. During a typical Site visit, MES staff would typically encounter anywhere between one (1) and five (5) Black Legged Ticks each day. Ottawa Public Health has documented a high incidence of Lyme Disease within Black Legged Ticks in the Ottawa area (Ottawa Public Health 2019). Mosquitos are also common throughout the Study Area.

## 2.0 LOW IMPACT DEVELOPMENT MEASURES

Section 4.2.4 of the Combined EIS and TCR notes that "*Mitigation measures pertaining to the hydrological functions of the Ephemeral Farm Drainage Channels will be addressed by the stormwater management and servicing studies. The stormwater management and servicing studies will also consider Low Impact Development (LID) options, in order to mitigate impacts to the water balance of the Study Area.*"

MES has reviewed the *Memorandum - Groundwater Infiltration Review – Proposed Mixed Use Development – 936 March Road – Ottawa* (prepared by Paterson Group - June 2019). Paterson Group (2019) note that existing conditions at the subject site currently allow for only minimal volumes of recharge to occur. As such, they conclude that the applicability of secondary infiltration measures is considered limited for Low Impact Development Measures (LIDs). Paterson Group (2019) further note that previous attempts within the City of Ottawa to induce additional surface water infiltration in similarly low permeability soils have resulted in detrimental effects to both homeowners and their properties due to poorly maintained drainage systems. Lastly, Paterson Group (2019) note that while some loss of infiltration can be expected as a result of impervious surfaces, the majority of the existing infiltration potential is expected to be maintained through urban lawns and landscaped areas.

It is our opinion that in situations where low permeability soils exist and drainage problems are anticipated, the pooling of surface water associated with infiltration features (e.g. surface infiltration swales, ditches, etc.) may have a detrimental impact on the future homeowners and community by increasing the risk/incidence of mosquitos and Black Legged Ticks. While Black Legged Ticks are unlikely to directly breed within infiltration features, the presence of such features may increase the likelihood that Black Legged Ticks will occur within residential yards. The growth of vegetation and accumulation of moisture associated within infiltration features increases the likelihood that Black Legged Ticks, and associated host animals (e.g. mice, voles, deer, etc.), may enter residential yards, particularly where those properties occur close to retained natural features. Per the Combined EIS and TCR, the future development is intended to include a retained corridor 40 m wide surrounding the North Tributary of Shirley's Brook, as well as a retained portion of Woodlot S-23. Black Legged Ticks are currently common in both areas. Ottawa Public Health recommends that homeowners remove brush from yard edges and cut their grass regularly, in order to reduce the likelihood of Black Legged Ticks entering their yard (Ottawa Public Health).

Mosquitos are capable of breeding in very shallow ephemeral pools, including in ditches and infiltration swales that are not permanently hydrated (CWF 2019). The pooling of surface water associated with infiltration features (e.g. surface infiltration swales, ditches, etc.) is hence likely to directly provide mosquito breeding habitat, which will likely increase the population of mosquitos within the future residential area.

# 3.0 RECOMMENDATIONS AND CLOSURE

As described above, it is our professional opinion that infiltration features (e.g. surface infiltration swales, ditches, etc.), may increase the likelihood that Black Legged Ticks will enter residential yards, particularly where those properties occur close to retained natural areas (e.g. the 40 m corridor surrounding the North Tributary and the retained portion of Woodlot S-23). Similarly, it is likely that such features will directly provide breeding habitat for mosquitos. The increased presence of Black Legged Ticks and/or mosquitos may have a detrimental effect on future homeowners and the community.

It should be noted that infiltration features (e.g. surface infiltration swales, ditches, etc.) generally do not provide significant wildlife habitat values. Given their limited potential value to wildlife, coupled with their potential detrimental effects in terms of increasing the incidence of Black Legged Ticks and mosquitos, it is our professional opinion that the installation of infiltration features within the proposed development is unlikely to be beneficial to the natural features and functions of the Study Area.

We trust that the above information is sufficient; should you have any questions or require further information, please do not hesitate to contact the undersigned, at your convenience.

Sincerely,

Dr. Andrew McKinley, EP, RP Bio.

References:

Canadian Wildlife Federation (CWF) (2019) Hinterland Who's Who – Mosquito. Retrieved June 20th, 2019 from <http://www.hww.ca/en/wildlife/invertebrates/mosquito.html>

Ottawa Public Health (2019) Lyme Disease. Retrieved June 20th, 2019 from <http://www.ottawa publichealth.ca/en/public-health-topics/lyme-disease.aspx#How-can-I-reduce-the-number-of-blacklegged-ticks-around-my-home>


McKINLEY ENVIRONMENTAL SOLUTIONS
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# Appendix E

**SWM Pond 3 Design & Kanata North Community Pond 3 / Preliminary Stormwater Management Design (JFSA, Sept 2019)**

| | |
|---|---|
| Date: | Sep, 2019 |
| File: | 17-982 |

# Minto Kanata North
# OTTAWA
# Calculation of Pond 3 Forebay Size



**Settling Criteria**

From the SWMP Manual, the required length for settling is as follows:

$$L_{min} = \left(\frac{r\,Q_p}{V_s}\right)^{0.5}$$

where:
- r = length to width ratio
- $Q_p$ = peak outflow during design quality storm
- $V_s$ = settling velocity

Input:

| | | |
|---|---|---|
| r = | 10.0 | |
| $Q_p$ = | 0.025 | $m^3/s$ |
| $V_s$ = | 0.0003 | m/s |

$L_{min}$ = 28.9 m

**Dispersion Criteria**

From the SWMP Manual, the required length for dispersion is as follows:

$$L_{min} = \frac{8\,Q}{d\,V_f}$$

where:
- Q = Maximum inflow (10 YR)
- d = depth of permanent pool
- $V_f$ = desired final velocity

Input:

| | | | |
|---|---|---|---|
| Q = | 6.99 | $m^3/s$ | (10 YR estimated) |
| d = | 1.5 | m | |
| Vf = | 0.5 | m/s | |

$L_{min}$ = 74.6 m

The minimum forebay length is determined by the larger of the settling or dispersion criteria.

Minimum Length of Forebay Required 74.6 m

**Minimum Length of Forebay Provided 140.0 m**

Date: September, 2019
File: 17-982

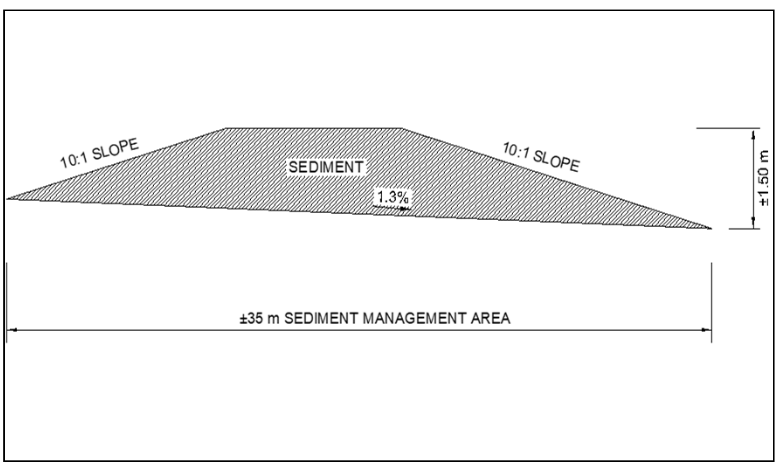
# Minto Kanata North
# City of Ottawa
# SWM Pond 3
# Sediment Management Area

As per Table 6.3 in the MOE SWMP Manual, the annual sediment loading for this catchments will be 2.68 $m^3$/ha

| Table 6.3 Annual Sediment Loadings | | | |
|---|---|---|---|
| Catchement Imperviousness | Annual Loading (kg/ha) | Wet Density (kg/$m^3$) | Annual Loading ($m^3$/ha) |
| 35% | 770 | 1230 | 0.6 |
| 55% | 2300 | 1230 | 1.9 |
| 70% | 3495 | 1230 | 2.8 |
| 85% | 4680 | 1230 | 3.8 |

Interpolate for Catchement Imperviousness of 66% - Annual Loading = 2.68 $m^3$/ha
Total Drainage Area = 118.1 ha

**Sediment Drying Volume = min 10 yrs accumulation x annual loading x drainage area**
**Sediment Drying Volume = (10)*(2.68)* 118.1**
**= 3165 $m^3$**




**Provided Sediment Drying Area Capacity = 3744 $m^3$**

BaseArea= 7290 $m^2$

J.F. Sabourin and Associates Inc.
WATER RESOURCES AND ENVIRONMENTAL CONSULTANTS
52 Springbrook Drive
Ottawa (Stittsville), ON K2S 1B9
TEL: (613) 836- 3884
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WEB: www.jfsa.com

September 11, 2019

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

**Attention:** **Mr. Matt Wingate, P.Eng.**

**Subject:** **Kanata North Community Pond 3 / Preliminary Stormwater Management Design**

*our file: 1808-19*

As requested by your office, we have evaluated, based on the available information as described below, the quantity control targets and preliminary stage-storage-discharge relationship for Kanata North Stormwater Management (SWM) Pond 3, as well as preliminary hydraulic gradeline results for the storm sewer servicing the drainage area to Pond 3.

## STORMWATER MANAGEMENT REQUIREMENTS

The Kanata North Community is serviced by Ponds 1 and 2 discharging to tributaries of Shirley's Brook, and Pond 3 discharging to the main branch of Shirley's Brook. Quality, erosion and quantity control targets for these ponds were initially set in the June 2016 *Kanata North Community Design Plan Environmental Management Plan Report* by Novatech. As per the June 2016 *Environmental Management Plan (EMP)*, an enhanced level of quality control (80% TSS removal) is required for the ponds. No additional erosion control requirements were identified in the June 2016 *EMP*. 2-, 5- and 100-year quantity control target release rates for Ponds 1, 2 and 3 were set based on the 24-hour SCS Type II design storm distribution. The June 2016 design of Pond 3 is presented in Table 1 below based on a post-development drainage area of 106.8 ha at 71% imperviousness.

**Table 1: SWM Pond 3 Requirements - June 2016 EMP**

| Pond Component | Unit Outflow (2) ($m^3$/s/ha) | Pond Outflow (3) ($m^3$/s) | Required Storage ($m^3$) |
|---|---|---|---|
| Permanent Pool (1) | N/A | N/A | 19927 |
| Quality Control | N/A | 0.058 | 16100 |
| 2yr/24hr SCS | 0.0021 | 0.220 | 25150 |
| 5yr/24hr SCS | 0.0038 | 0.402 | 34880 |
| 100yr/24hr SCS | 0.0098 | 1.045 | 61150 |

(1) Permanent Pool as per MOE requirements for enhanced protection.
(2) Unit outflows calculated based on target outflows and post-development drainage area of 106.8 ha.
(3) Quantity control outflows and volumes as per June 2016 *EMP*.

The June 2016 *EMP* demonstrated that post-development flows on the tributaries of Shirley's Brook downstream of Ponds 1 and 2 would not exceed pre-development levels based on SWMHYMO modelling; however, the model did not extend to include the main branch of Shirley's Brook downstream of Ponds 1, 2 and 3. As such, Novatech has combined the Kanata North pre- and post-development conditions SWMHYMO models with the larger existing conditions SWMHYMO model of Shirley's Brook prepared by AECOM in the April 2015 *Shirley's Brook and Watt's Creek Phase 2 Stormwater Management Study*, with the latest version of this combined model provided to

JFSA on August 20, 2019. Note that other modifications to the modelling of Kanata North, including the design of Pond 2, were also made by Novatech at this time; however, the Pond 3 design remained as per the June 2016 *EMP*. Note also that the SWMHYMO model has been converted from a single event model to a continuous model to facilitate its use for a continuous erosion analysis, as well as for comparing 2- to 100-year pre- and post-development flows for the 24-hour SCS Type II design storms.

Drainage plans for the pre- and post-development conditions Kanata North SWMHYMO models by Novatech and the existing conditions Shirley's Brook SWMHYMO model by AECOM are presented in Attachment A. The existing conditions Shirley's Brook drainage plan has been marked up to show the approximate locations of Kanata North Ponds 1, 2 and 3, and of key nodes along the main branch of the watercourse. The pre- and post-development flows at these key nodes are summarized in Table 2.

**Table 2: Peak flows at Key Nodes on the Main Branch of Shirley's Brook (Ponds 1-3 In Place) (1)**

| Event | Condition | Flow ($m^3/s$) | | | | |
|---|---|---|---|---|---|---|
| | | SFP12 | SB-5A (1) | SB-5A (2) | SFP13 | SB-OR |
| 2-Yr | Pre-Development | 5.519 | 5.367 | 5.352 | 6.173 | 6.858 |
| | Post-Development | 5.625 | 5.476 | 5.461 | 6.282 | 6.985 |
| | *Post-Dev - Pre-Dev* | *0.106* | *0.109* | *0.109* | *0.109* | *0.127* |
| 5-Yr | Pre-Development | 8.468 | 8.192 | 8.162 | 9.359 | 10.726 |
| | Post-Development | 8.780 | 8.491 | 8.467 | 9.659 | 11.055 |
| | *Post-Dev - Pre-Dev* | *0.312* | *0.299* | *0.305* | *0.300* | *0.329* |
| 10-Yr | Pre-Development | 10.801 | 10.581 | 10.521 | 12.000 | 13.738 |
| | Post-Development | 11.268 | 11.051 | 10.985 | 12.463 | 14.205 |
| | *Post-Dev - Pre-Dev* | *0.467* | *0.470* | *0.464* | *0.463* | *0.467* |
| 25-Yr | Pre-Development | 14.042 | 13.716 | 13.603 | 15.469 | 17.571 |
| | Post-Development | 14.692 | 14.351 | 14.237 | 16.104 | 18.208 |
| | *Post-Dev - Pre-Dev* | *0.650* | *0.635* | *0.634* | *0.635* | *0.637* |
| 50-Yr | Pre-Development | 16.853 | 16.403 | 16.237 | 18.434 | 20.867 |
| | Post-Development | 17.651 | 17.178 | 17.009 | 19.194 | 21.641 |
| | *Post-Dev - Pre-Dev* | *0.798* | *0.775* | *0.772* | *0.760* | *0.774* |
| 100-Yr | Pre-Development | 17.201 | 16.712 | 16.543 | 19.105 | 21.974 |
| | Post-Development | 18.154 | 17.649 | 17.467 | 20.018 | 22.925 |
| | *Post-Dev - Pre-Dev* | *0.953* | *0.937* | *0.924* | *0.913* | *0.951* |

(1) Preliminary pond storage-discharge relationships in the post-development model as designed by Novatech (refer to Table 1 for Pond 3 design).

As may be seen in Table 2, the proposed quantity control provided in Ponds 1, 2 and 3 is not sufficient to match post- to pre-development peak flows along the main branch of Shirley's Brook. To confirm that this increase in peak flows along the main branch is related to the quantity control requirements for Ponds 1 and 2 (discharging to the tributaries) as well as Pond 3 (discharging to the main branch), the combined post-development model was modified to remove Pond 3 and return its associated drainage area to pre-development conditions. The pre-development conditions drainage area associated with Pond 3 was modelled as per the combined pre-development model provided by Novatech in August 2018. The pre- and post-development flows on Shirley's Brook under these conditions are summarized in Table 3.

**Table 3: Peak flows at Key Nodes on the Main Branch of Shirley's Brook (Ponds 1-2 Only In Place) (1)**

| Event | Condition | Flow ($m^3/s$) | | | | |
|---|---|---|---|---|---|---|
| | | SFP12 | SB-5A (1) | SB-5A (2) | SFP13 | SB-OR |
| 2-Yr | Pre-Development | 5.519 | 5.367 | 5.352 | 6.173 | 6.858 |
| | Post-Development | 5.544 | 5.396 | 5.380 | 6.201 | 6.901 |
| | *Post-Dev - Pre-Dev* | *0.025* | *0.029* | *0.028* | *0.028* | *0.043* |
| 5-Yr | Pre-Development | 8.468 | 8.192 | 8.162 | 9.359 | 10.726 |
| | Post-Development | 8.594 | 8.300 | 8.277 | 9.469 | 10.851 |
| | *Post-Dev - Pre-Dev* | *0.126* | *0.108* | *0.115* | *0.110* | *0.125* |
| 10-Yr | Pre-Development | 10.801 | 10.581 | 10.521 | 12.000 | 13.738 |
| | Post-Development | 10.992 | 10.772 | 10.709 | 12.189 | 13.926 |
| | *Post-Dev - Pre-Dev* | *0.191* | *0.191* | *0.188* | *0.189* | *0.188* |
| 25-Yr | Pre-Development | 14.042 | 13.716 | 13.603 | 15.469 | 17.571 |
| | Post-Development | 14.303 | 13.968 | 13.854 | 15.720 | 17.823 |
| | *Post-Dev - Pre-Dev* | *0.261* | *0.252* | *0.251* | *0.251* | *0.252* |
| 50-Yr | Pre-Development | 16.853 | 16.403 | 16.237 | 18.434 | 20.867 |
| | Post-Development | 17.189 | 16.740 | 16.579 | 18.764 | 21.206 |
| | *Post-Dev - Pre-Dev* | *0.336* | *0.337* | *0.342* | *0.330* | *0.339* |
| 100-Yr | Pre-Development | 17.201 | 16.712 | 16.543 | 19.105 | 21.974 |
| | Post-Development | 17.625 | 17.121 | 16.935 | 19.497 | 22.387 |
| | *Post-Dev - Pre-Dev* | *0.424* | *0.409* | *0.392* | *0.392* | *0.413* |

(1) Preliminary pond storage-discharge relationships in the post-development model as designed by Novatech.

As may be seen in Table 3, an increase in post-development flows along the main branch of the watercourse is simulated even without the drainage area to Pond 3 developed. However, as the increases in peak flows under these conditions are less than those simulated under full build-out (per Table 2), increased quantity control may be required for Pond 3.

To separate out the quantity control required in Pond 3 from the quantity control requirements of Ponds 1 and 2, the pre-development model was modified to insert proposed Pond 3 and its post-development drainage area, with the drainage areas to Ponds 1 and 2 remaining undeveloped. The drainage area of 106.8 ha at 71% imperviousness to Pond 3 was modelled as per the combined post-development model provided by Novatech in August 2018. The 2-, 5- and 100-year quantity control targets for Pond 3 were iterated to arrive at a solution where the 2- to 100-year post-development peak flows at all key nodes along the main branch of Shirley's Brook were equal to or less than pre-development levels. The proposed pond requirements are presented in Table 4, and the pre- and post-development flows on Shirley's Brook under these conditions are summarized in Table 5.

**Table 4: SWM Pond 3 Requirements - JFSA (Pond 3 Only In Place)**

| Pond Component | Unit Outflow (2) ($m^3/s/ha$) | Pond Outflow (3) ($m^3/s$) | Required Storage ($m^3$) |
|---|---|---|---|
| Permanent Pool (1) | N/A | N/A | 19927 |
| Quality Control (1) | N/A | 0.099 | 4270 |
| 2yr/24hr SCS | 0.0012 | 0.125 | 25750 |
| 5yr/24hr SCS | 0.0019 | 0.200 | 36600 |
| 100yr/24hr SCS | 0.0047 | 0.500 | 64550 |

(1) Permanent Pool as per MOE requirements for enhanced protection; Quality Control = 40 $m^3$/ha released over 24 hours.
(2) Unit outflows calculated based on target outflows and post-development drainage area of 106.8 ha.
(3) Target release rates calculated based on matching pre-development flows in downstream Shirley's Brook.

**Table 5: Peak flows at Key Nodes on the Main Branch of Shirley's Brook (Pond 3 Only In Place)** [(1)]

| Event | Condition | Flow ($m^3/s$) | | | | |
|---|---|---|---|---|---|---|
| | | SFP12 | SB-5A (1) | SB-5A (2) | SFP13 | SB-OR |
| 2-Yr | Pre-Development | 5.519 | 5.367 | 5.352 | 6.173 | 6.858 |
| | Post-Development | 5.506 | 5.352 | 5.337 | 6.158 | 6.851 |
| | *Post-Dev - Pre-Dev* | *-0.013* | *-0.015* | *-0.015* | *-0.015* | *-0.007* |
| 5-Yr | Pre-Development | 8.468 | 8.192 | 8.162 | 9.359 | 10.726 |
| | Post-Development | 8.398 | 8.181 | 8.158 | 9.353 | 10.717 |
| | *Post-Dev - Pre-Dev* | *-0.070* | *-0.011* | *-0.004* | *-0.006* | *-0.009* |
| 10-Yr | Pre-Development | 10.801 | 10.581 | 10.521 | 12.000 | 13.738 |
| | Post-Development | 10.784 | 10.563 | 10.503 | 11.981 | 13.722 |
| | *Post-Dev - Pre-Dev* | *-0.017* | *-0.018* | *-0.018* | *-0.019* | *-0.016* |
| 25-Yr | Pre-Development | 14.042 | 13.716 | 13.603 | 15.469 | 17.571 |
| | Post-Development | 14.029 | 13.703 | 13.588 | 15.455 | 17.558 |
| | *Post-Dev - Pre-Dev* | *-0.013* | *-0.013* | *-0.015* | *-0.014* | *-0.013* |
| 50-Yr | Pre-Development | 16.853 | 16.403 | 16.237 | 18.434 | 20.867 |
| | Post-Development | 16.836 | 16.386 | 16.219 | 18.413 | 20.853 |
| | *Post-Dev - Pre-Dev* | *-0.017* | *-0.017* | *-0.018* | *-0.021* | *-0.014* |
| 100-Yr | Pre-Development | 17.201 | 16.712 | 16.543 | 19.105 | 21.974 |
| | Post-Development | 17.185 | 16.696 | 16.525 | 19.087 | 21.967 |
| | *Post-Dev - Pre-Dev* | *-0.016* | *-0.016* | *-0.018* | *-0.018* | *-0.007* |

[(1)] Preliminary pond storage-discharge relationship for Pond 3 as per JFSA (refer to Table 4)

As may be seen in the tables above, the proposed revised quantity control requirements for Pond 3 are sufficient to match post- to pre-development flows at key nodes along the downstream Shirley's Brook watercourse. Note that in accordance with the July 2016 *EMP*, no erosion control above that provided by the 40 $m^3$/ha active quality control volume has been proposed in the revised Pond 3 requirements. A continuous erosion analysis of the main branch of Shirley's Brook may be required to confirm this assumption based on the revised Pond 3 design, and potentially for Ponds 1 and 2, which to our knowledge have only been evaluated based on erosion in tributaries to Shirley's Brook and not the main branch.

## PRELIMINARY STAGE-STORAGE-DISCHARGE RELATIONSHIP

Subsequent to the analysis above, a refined drainage area to Pond 3 of 98.1 ha at 67% imperviousness was provided by DSEL. As this is less than the assumed 106.8 ha at 71% imperviousness from the July 2016 *EMP*, it may be expected that the proposed 2-, 5- and 100-year unit outflows identified in the quantity control analysis are also applicable or conservative for the refined drainage area.

The preliminary pond stage-storage-discharge curve, extended detention drawdown time calculations, and outlet controls are presented in Attachment B. The pond operation was evaluated under both free outfall and restrictive downstream conditions, where restrictive downstream conditions at the pond outfall were modelled based on the 100-year flood level of 65.28 m at cross-section 2199.535 on Shirley's Brook, per the April 2015 *Shirley's Brook and Watt's Creek Phase 2 Stormwater Management Study*. The pond operating characteristics based on the preliminary design, as modelled in SWMHYMO, are presented in Table 8.

**Table 8: Preliminary SWM Pond 3 Operating Characteristics**

| Pond Component | Unit Release Rate [1] ($m^3$/s/ha) | Target Outflow [2] ($m^3$/s) | Free Outfall Conditions | | Restrictive D/S Conditions [3] | |
|---|---|---|---|---|---|---|
| | | | Provided | Storage | Provided | Storage |
| Permanent Pool [4] | N/A | N/A | N/A | 31251 | N/A | 31251 |
| Quality Control [4] | N/A | N/A | 0.025 | 3924 | 0.025 | 3924 |
| Extended Detention | N/A | N/A | 0.027 | 4260 | 0.027 | 4260 |
| 2yr/24hr SCS | 0.0012 | 0.118 | 0.105 | 24160 | 0.076 | 25820 |
| 5yr/24hr SCS | 0.0019 | 0.186 | 0.167 | 34100 | 0.151 | 35260 |
| 10yr/24hr SCS | N/A | N/A | 0.222 | 40400 | 0.208 | 41550 |
| 25yr/24hr SCS | N/A | N/A | 0.332 | 47320 | 0.318 | 48400 |
| 50yr/24hr SCS | N/A | N/A | 0.376 | 53130 | 0.363 | 54300 |
| 100yr/24hr SCS | 0.0047 | 0.461 | 0.418 | 59710 | 0.406 | 60960 |

(1) Unit release rates based on matching pre-development flows on Shirley's Brook with Pond 3 only in place, and Ponds 1 and 2 undeveloped.
(2) Target release rates based on post-development drainage area to SWM Pond 3 of 118.1 ha.
(3) Restrictive downstream water level set at 65.28 m as per the 100-year flood level at cross-section 2199.535 on Shirley's Brook (*Shirley's Brook & Watt's Creek Phase 2 Stormwater Management Study*, AECOM, April 2015)
(4) Permanent Pool as per MOE requirements for enhanced protection; Quality Control = 40 $m^3$/ha released over 24 hours.

## PRELIMINARY HYDRAULIC GRADELINE CALCULATIONS

Preliminary hydraulic gradeline calculations for the proposed storm sewer to Pond 3 were performed using spreadsheet calculations and are presented in Attachment C. Pipe data, storm sewer layout and Rational Method flows in the storm sewer are as provided by DSEL. The Rational Method flows were calculated based on the 2- or 5-year level of service requirements, and the 100-year flows in the hydraulic gradeline calculations were estimated as 14% greater than the Rational Method flows, to account for the additional flows captured by catchbasin grates, lead pipes and / or inlet control devices under the higher surface water depths of the 100-year storm. As may be seen in Attachment C, a freeboard of 0.3 m between the hydraulic gradeline and the estimated underside of footing elevations (estimated as 1.8 m below ground level) has been provided throughout the proposed development.

Yours truly,
**J.F. Sabourin and Associates Inc.**

Laura Pipkins, P.Eng.

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

Attachment A: Kanata North Pre- and Post-Development Drainage Areas (Novatech, August 2019)
Shirley's Brook Existing Conditions Drainage Areas (AECOM, April 2015)
Attachment B: Preliminary Pond 3 Design
Attachment C: Pipe Data and Hydraulic Simulation Results

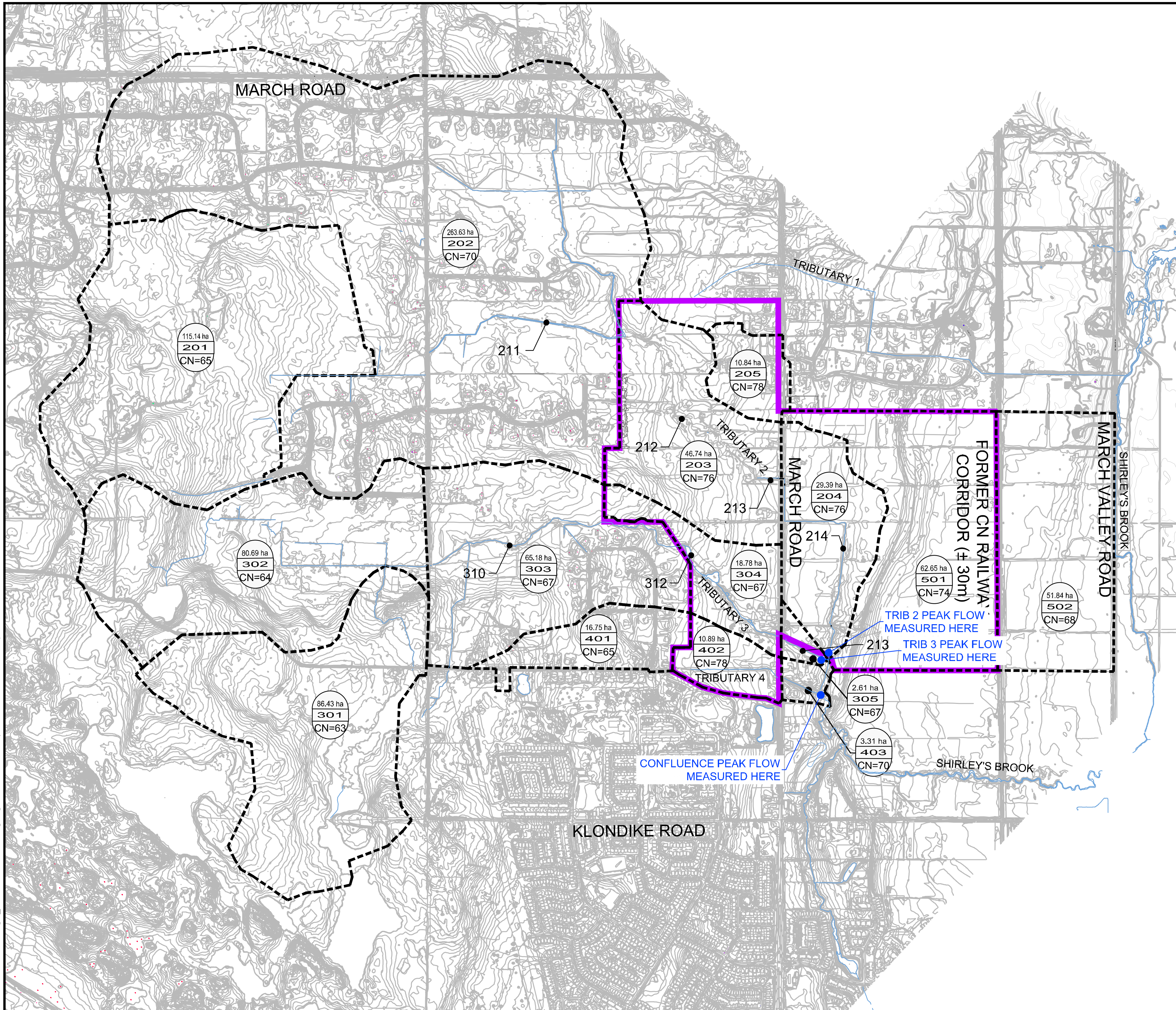
# ATTACHMENT

# A

Kanata North Pre- and Post- Development Drainage Areas
(Novatech, August 2019)

Shirley's Brook Existing Conditions Drainage Areas
(AECOM, April 2015)

JFSA Water Resources and Environmental Consultants




## LEGEND

- KNUEA
- DRAINAGE CHANNEL
- SUBCATCHMENT DRAINAGE BOUNDARIES
- 29.39 ha — SUBCATCHMENT AREA (HA)
- 204 — DRAINAGE AREA ID
- CN=76 — SCS CURVE NUMBER

**KANATA NORTH**
COMMUNITY DESIGN PLAN

**FIGURE NO. 3.15**
PRE-DEVELOPMENT DRAINAGE AREAS

DATE: JUN 2016
JOB: 112117
SCALE: NTS

NOVATECH
Engineers, Planners & Landscape Architects

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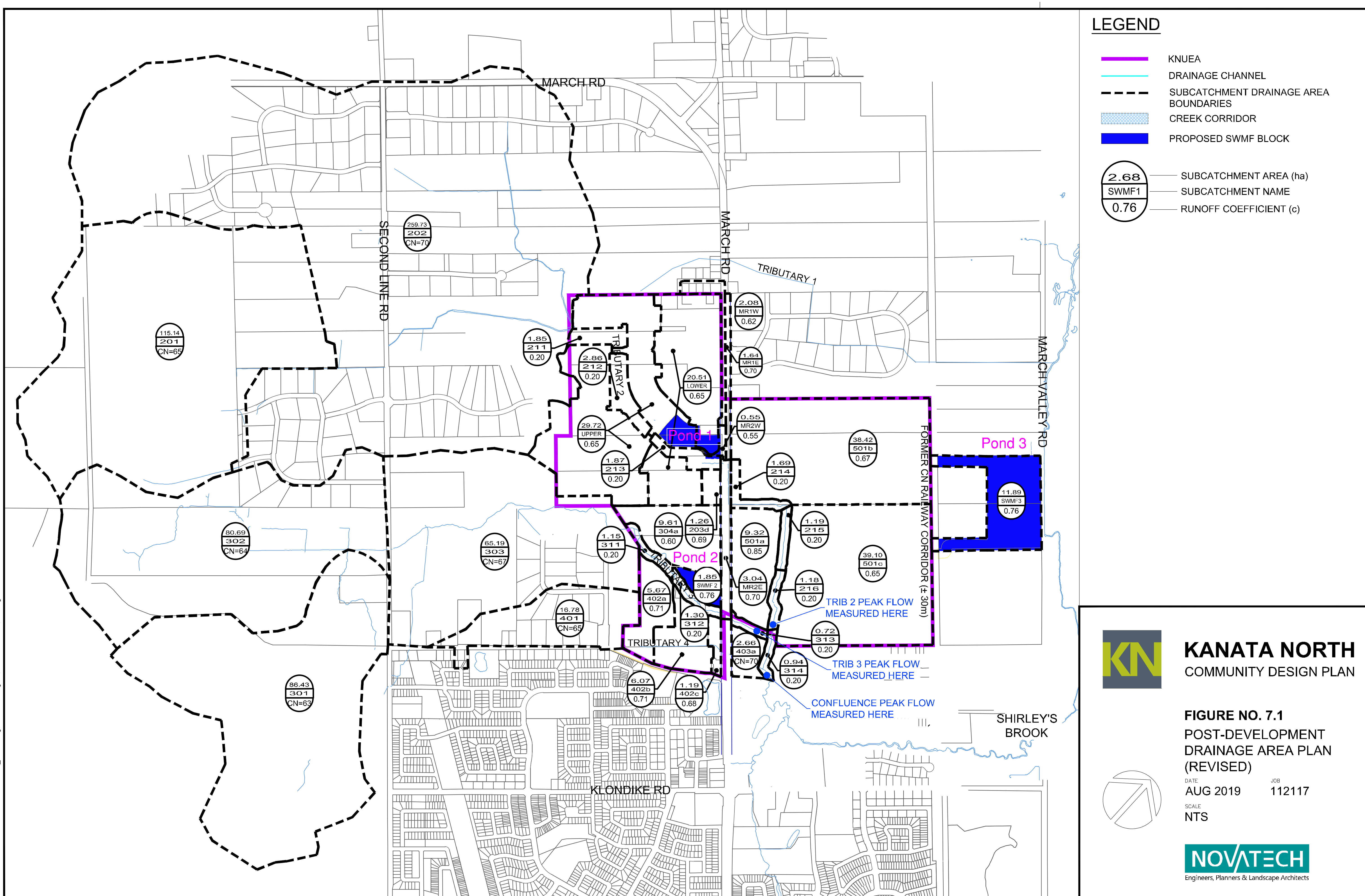
LEGEND
KNUEA
DRAINAGE CHANNEL
SUBCATCHMENT DRAINAGE AREA BOUNDARIES
CREEK CORRIDOR
PROPOSED SWMF BLOCK
2.68 SWMF1 0.76
SUBCATCHMENT AREA (ha)
SUBCATCHMENT NAME
RUNOFF COEFFICIENT (c)
MARCH RD
SECOND LINE RD
MARCH VALLEY RD
KLONDIKE RD
FORMER CN RAILWAY CORRIDOR (± 30m)
TRIBUTARY 1
TRIBUTARY 2
TRIBUTARY 3
TRIBUTARY 4
SHIRLEY'S BROOK
Pond 1
Pond 2
Pond 3
TRIB 2 PEAK FLOW MEASURED HERE
TRIB 3 PEAK FLOW MEASURED HERE
CONFLUENCE PEAK FLOW MEASURED HERE
259.73 202 CN=70
115.14 201 CN=65
80.69 302 CN=64
86.43 301 CN=63
65.19 303 CN=67
16.78 401 CN=65
1.85 211 0.20
2.86 212 0.20
20.51 LOWER 0.65
29.72 UPPER 0.65
1.87 213 0.20
2.08 MR1W 0.62
1.64 MR1E 0.70
0.55 MR2W 0.55
38.42 501b 0.67
1.69 214 0.20
11.89 SWMF3 0.76
9.61 304a 0.60
1.26 203d 0.69
9.32 501a 0.85
1.19 215 0.20
39.10 501c 0.65
1.15 311 0.20
1.85 SWMF 2 0.76
3.04 MR2E 0.70
1.18 216 0.20
5.67 402a 0.71
1.30 312 0.20
0.72 313 0.20
2.66 403a CN=70
0.94 314 0.20
6.07 402b 0.71
1.19 402c 0.68
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KN
KANATA NORTH
COMMUNITY DESIGN PLAN
FIGURE NO. 7.1
POST-DEVELOPMENT DRAINAGE AREA PLAN (REVISED)
DATE AUG 2019
JOB 112117
SCALE NTS
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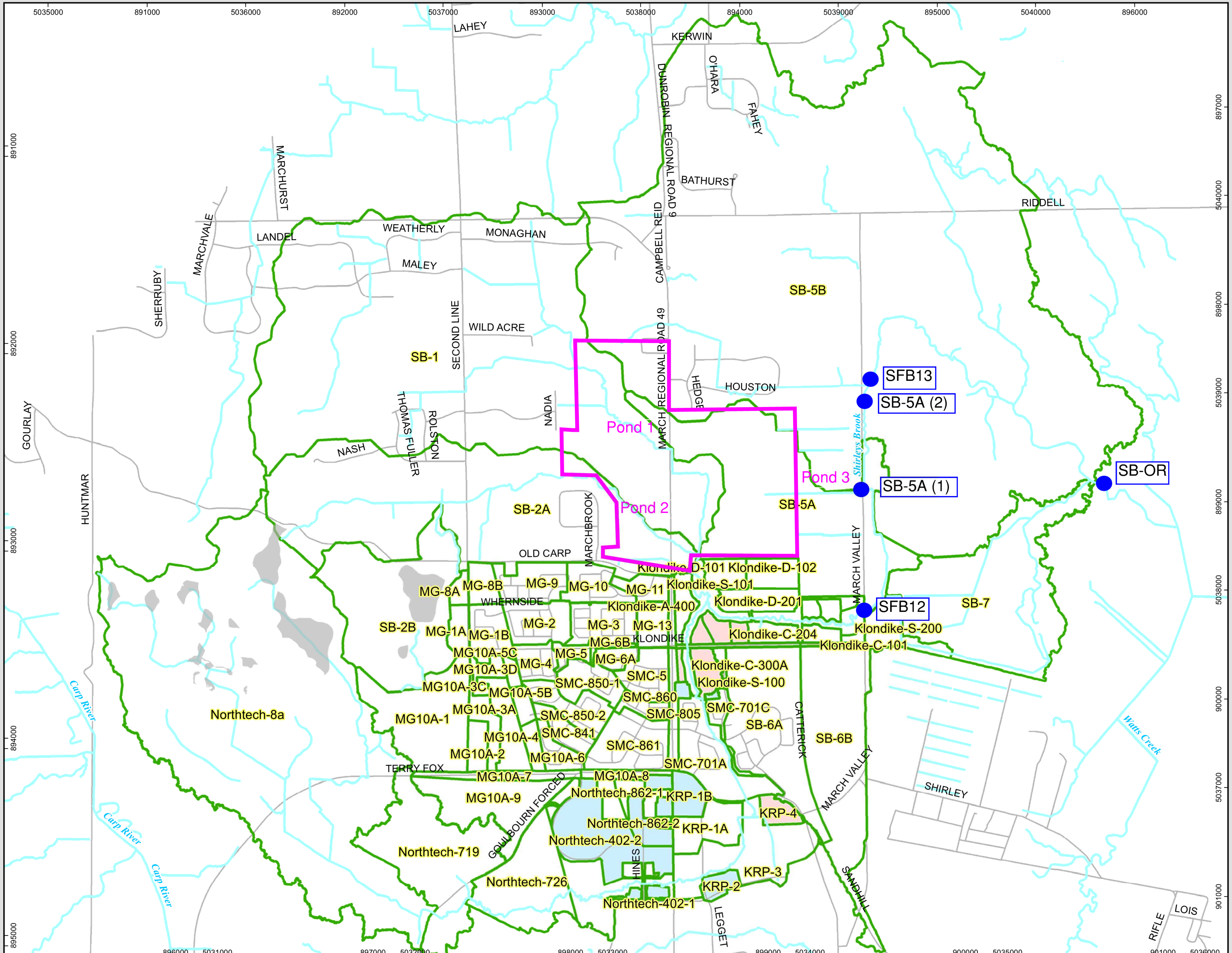
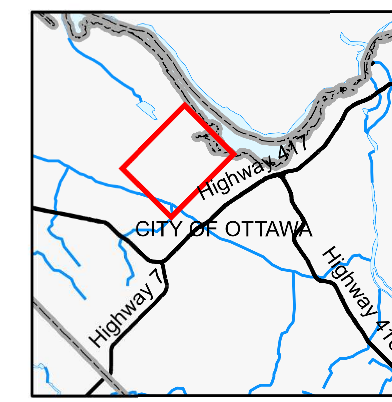
Engineers, Planners & Landscape Architects
SHT11x17.DWG - 279mmx432mm




**Legend**

- Stream and River
- Urban Area with Site Level SWM
- Urban Area with No Identified SWM / No Available SWM Information
- Subcatchments
- Catchments with Depressional Topography (Increased Ia)

Ottawa




Basemapping and orthophotography provided by the City of Ottawa.

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NAD 83, MTM 9



Shirley s Brook & Watt s Creek Phase 2 SWM Study

**Existing Conditions SWMHYMO Model - Shirley's Brook**

February 2015
60264539

AECOM

Figure C-1-5

Path: P:\60264539\000-CADD\050 GIS WIP\MXDs\WorkingMXDs\20150204 - Revised Rep Figs\60264539_Existing_Conditions_SWMHYMO_Model-Shirleys C-5.mxd
Time: 4:31:47 PMDate: 2/5/2015

# ATTACHMENT B

Preliminary Pond 3 Design

JFSA Water Resources and Environmental Consultants

**Table B-1 : Summary of Drainage Area**

| Land Use | Area (ha) | Imp. (%) | Area x Imp. | Required Storage (1) ($m^3$) | |
|---|---|---|---|---|---|
| | | | | Permanent Pool | Quality Control |
| SWM Pond 3 | 98.10 | 67 | 6572.70 | 17462 | 3924 |

(1) Permanent pool and quality control provided for MOE enhanced protection (Wet Pond).

**Table B-2 : Actual Volumes to Meet Allowable Release Rates**

| Pond Component | Unit Release Rate (1) ($m^3$/s/ha) | Target Outflow (2) ($m^3$/s) | Free Outfall Conditions | | Restrictive Downstream Conditions (3) | |
|---|---|---|---|---|---|---|
| | | | Provided Outflow ($m^3$/s) | Storage Used ($m^3$) | Provided Outflow ($m^3$/s) | Storage Used ($m^3$) |
| Permanent Pool (4) | N/A | N/A | N/A | 31251 | N/A | 31251 |
| Quality Control (4) | N/A | N/A | 0.025 | 3924 | 0.025 | 3924 |
| Extended Detention | N/A | N/A | 0.027 | 4260 | 0.027 | 4260 |
| 2yr/24hr SCS | 0.0012 | 0.118 | 0.105 | 24160 | 0.076 | 25820 |
| 5yr/24hr SCS | 0.0019 | 0.186 | 0.167 | 34100 | 0.151 | 35260 |
| 10yr/24hr SCS | N/A | N/A | 0.222 | 40400 | 0.208 | 41550 |
| 25yr/24hr SCS | N/A | N/A | 0.332 | 47320 | 0.318 | 48400 |
| 50yr/24hr SCS | N/A | N/A | 0.376 | 53130 | 0.363 | 54300 |
| 100yr/24hr SCS | 0.0047 | 0.461 | 0.418 | 59710 | 0.406 | 60960 |

(1) Unit release rates based on matching pre-development flows on Shirley's Brook with Pond 3 only in place, and Ponds 1 and 2 undeveloped.

(2) Target release rates based on post-development drainage area to SWM Pond.

(3) Restrictive downstream water level set at 65.28 m as per the 100-year flood level at cross-section 2199.535 on Shirley's Brook (Shirley's Brook & Watt's Creek Phase 2 Stormwater Management Study (AECOM, April 2015)

(4) Permanent Pool as per MOE requirements for enhanced protection; Quality Control = 40 $m^3$/ha released over 24-48 hours. No erosion control specified.

**Table B-3: Extended Detention Parameters for SWM Facility**

| Permanent Pool Parameters | | | Quality Orifice Parameters | | |
|---|---|---|---|---|---|
| Area (C3) | 27750.60 | $m^2$ | Diameter | 0.240 | m |
| Volume | 31251.15 | $m^3$ | | | |
| PP Elev | 64.800 | m | Area | 0.045 | $m^2$ |
| QC Elev | 64.938 | m | Invert | 64.800 | m |
| h (m) | 0.138 | m | $C_o$ | 0.62 | |

Notes:
- C3 is the intercept from the area-depth linear regression.
- PP Elev indicates the elevation of the permanent pool.
- QC Elev indicates the elevation of the storage volume required by MOE for quality control.
- h is the maximum water elevation above the orifice (m).

**Table B-4: Extended Detention Drawdown Time for SWM Facility**

| Elev. (m) | Active Storage V ($m^3$) | Active Storage A ($m^2$) | Active Storage depth (m) | C2 ($m^2/m$) | Drawdown Time (h) | Drawdown Time (days) | Flow ($m^3/s$) | Demarkation Point |
|---|---|---|---|---|---|---|---|---|
| **64.80** | **0.00** | **27750.60** | **0.00** | | | | **0.000** | **PP Elev** |
| 64.85 | 1397.25 | 27961.20 | 0.05 | 4212 | 27.78 | 1.16 | 0.009 | |
| 64.90 | 2820.78 | 28473.75 | 0.10 | 7231 | 39.53 | 1.65 | 0.018 | |
| **64.938** | **3924.00** | **28785.07** | **0.14** | **7479** | **46.66** | **1.94** | **0.025** | **QC Elev** |
| **64.95** | **4260.42** | **28880.01** | **0.15** | **7529** | **48.64** | **2.03** | **0.027** | **Ext. Det.** |
| 65.00 | 5721.57 | 29286.45 | 0.20 | 7679 | 56.43 | 2.35 | 0.036 | |
| 65.05 | 7173.72 | 29749.77 | 0.25 | 7997 | 63.43 | 2.64 | 0.045 | |
| 65.10 | 8653.41 | 29758.32 | 0.30 | 6692 | 69.50 | 2.90 | 0.053 | |
| 65.15 | 10160.64 | 30309.30 | 0.35 | 7311 | 75.55 | 3.15 | 0.060 | |
| 65.20 | 11705.22 | 30945.87 | 0.40 | 7988 | 81.35 | 3.39 | 0.066 | |
| 65.25 | 13269.60 | 31492.08 | 0.45 | 8314 | 86.83 | 3.62 | 0.071 | |
| 65.30 | 14869.26 | 32117.04 | 0.50 | 8733 | 92.18 | 3.84 | 0.077 | |
| 65.35 | 16495.38 | 32659.65 | 0.55 | 8926 | 97.27 | 4.05 | 0.081 | |
| 65.40 | 18130.77 | 32975.01 | 0.60 | 8707 | 101.95 | 4.25 | 0.086 | |
| 65.45 | 19792.98 | 33507.45 | 0.65 | 8857 | 106.75 | 4.45 | 0.090 | |
| 65.50 | 21481.47 | 33825.24 | 0.70 | 8678 | 111.17 | 4.63 | 0.095 | |
| 65.55 | 23195.34 | 34348.59 | 0.75 | 8797 | 115.74 | 4.82 | 0.099 | |
| 65.60 | 24888.96 | 34697.70 | 0.80 | 8684 | 120.00 | 5.00 | 0.102 | |
| 65.65 | 26671.23 | 35199.00 | 0.85 | 8763 | 124.37 | 5.18 | 0.106 | |
| 65.70 | 28461.96 | 35481.06 | 0.90 | 8589 | 128.37 | 5.35 | 0.110 | |
| 65.75 | 30236.31 | 36762.12 | 0.95 | 9486 | 133.73 | 5.57 | 0.113 | |
| 65.80 | 32056.47 | 37405.53 | 1.00 | 9655 | 138.15 | 5.76 | 0.117 | |

Notes:
- C2 is the slope coefficient from the area-depth linear regression.
- PP Elev indicates the elevation of the permanent pool.
- QC Elev indicates the elevation of the storage volume required by MOE for quality control.
- Ext Det indicates the elevation of extended detention provided based on 40 $m^3$/imp·ha and an approximately 24-48 hour drawdown time.

**Table B-5A: Stage-Storage-Outflow Curve for SWM Facility (Free Outfall Conditions)**

| | | | Quality Control 1 | | Quantity Control 1 | | Quantity Control 2 | | Emergency Overflow | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vertical Orifice | | Vertical Orifice | | Vertical Rect. Orifice | | Broad Crested Weir | | | |
| | | | Dia (m) | 0.240 | Dia (m) | 0.050 | Width (m) | 0.300 | L (m) | 12.000 | | |
| | | | | | | | Height (m) | 0.400 | | | | |
| | | | Area ($m^2$) | 0.045 | Area ($m^2$) | 0.002 | Area ($m^2$) | 0.120 | | | | |
| | | | Invert (m) | 64.80 | Invert (m) | 64.95 | Invert (m) | 65.65 | $C_w$ | 1.580 | | |
| | | | $C_o$ | 0.62 | $C_o$ | 0.62 | $C_o$ | 0.62 | Invert (m) | 66.60 | | |
| | | | Q @ D | 0.043 | Q @ D | 0.001 | $C_w$ | 1.800 | n contr. | 0 | | |
| Elevation | Active Sto. | Demarkation Points | Head | Outflow | Head | Outflow | Head | Outflow | Head | Outflow | Outflow | Storage |
| (m) | ($m^3$) | | (m) | ($m^3$/s) | (m) | ($m^3$/s) | (m) | ($m^3$/s) | (m) | ($m^3$/s) | ($m^3$/s) | (ha·m) |
| **64.80** | **0** | **PP Elev** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| 64.85 | 1397 | | 0.050 | 0.009 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.009 | 0.140 |
| 64.90 | 2821 | | 0.100 | 0.018 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.018 | 0.282 |
| **64.938** | **3924** | **QC Elev** | **0.138** | **0.025** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.025** | **0.392** |
| **64.95** | **4260** | **Ext. Det.** | **0.150** | **0.027** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.027** | **0.426** |
| 65.00 | 5722 | | 0.200 | 0.036 | 0.050 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.037 | 0.572 |
| 65.05 | 7174 | | 0.250 | 0.045 | 0.100 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.046 | 0.717 |
| 65.10 | 8653 | | 0.300 | 0.053 | 0.150 | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.055 | 0.865 |
| 65.15 | 10161 | | 0.350 | 0.060 | 0.200 | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.062 | 1.016 |
| 65.20 | 11705 | | 0.400 | 0.066 | 0.250 | 0.003 | 0.000 | 0.000 | 0.000 | 0.000 | 0.068 | 1.171 |
| 65.25 | 13270 | | 0.450 | 0.071 | 0.300 | 0.003 | 0.000 | 0.000 | 0.000 | 0.000 | 0.074 | 1.327 |
| 65.30 | 14869 | | 0.500 | 0.077 | 0.350 | 0.003 | 0.000 | 0.000 | 0.000 | 0.000 | 0.080 | 1.487 |
| 65.35 | 16495 | | 0.550 | 0.081 | 0.400 | 0.003 | 0.000 | 0.000 | 0.000 | 0.000 | 0.085 | 1.650 |
| 65.40 | 18131 | | 0.600 | 0.086 | 0.450 | 0.004 | 0.000 | 0.000 | 0.000 | 0.000 | 0.090 | 1.813 |
| 65.45 | 19793 | | 0.650 | 0.090 | 0.500 | 0.004 | 0.000 | 0.000 | 0.000 | 0.000 | 0.094 | 1.979 |
| 65.50 | 21481 | | 0.700 | 0.095 | 0.550 | 0.004 | 0.000 | 0.000 | 0.000 | 0.000 | 0.099 | 2.148 |
| 65.55 | 23195 | | 0.750 | 0.099 | 0.600 | 0.004 | 0.000 | 0.000 | 0.000 | 0.000 | 0.103 | 2.320 |
| 65.60 | 24889 | | 0.800 | 0.102 | 0.650 | 0.004 | 0.000 | 0.000 | 0.000 | 0.000 | 0.107 | 2.489 |
| **65.65** | **26671** | | **0.850** | **0.106** | **0.700** | **0.004** | **0.000** | **0.000** | **0.000** | **0.000** | **0.111** | **2.667** |
| 65.70 | 28462 | | 0.900 | 0.110 | 0.750 | 0.005 | 0.050 | 0.006 | 0.000 | 0.000 | 0.120 | 2.846 |
| 65.75 | 30236 | | 0.950 | 0.113 | 0.800 | 0.005 | 0.100 | 0.016 | 0.000 | 0.000 | 0.134 | 3.024 |
| 65.80 | 32056 | | 1.000 | 0.117 | 0.850 | 0.005 | 0.150 | 0.028 | 0.000 | 0.000 | 0.150 | 3.206 |
| 65.85 | 34074 | | 1.050 | 0.120 | 0.900 | 0.005 | 0.200 | 0.042 | 0.000 | 0.000 | 0.167 | 3.407 |
| 65.90 | 36095 | | 1.100 | 0.123 | 0.950 | 0.005 | 0.250 | 0.056 | 0.000 | 0.000 | 0.184 | 3.609 |
| 65.95 | 38121 | | 1.150 | 0.126 | 1.000 | 0.005 | 0.300 | 0.071 | 0.000 | 0.000 | 0.202 | 3.812 |
| 66.00 | 40160 | | 1.200 | 0.129 | 1.050 | 0.005 | 0.350 | 0.086 | 0.000 | 0.000 | 0.220 | 4.016 |
| 66.05 | 42230 | | 1.250 | 0.132 | 1.100 | 0.006 | 0.400 | 0.100 | 0.000 | 0.000 | 0.238 | 4.223 |
| 66.10 | 44298 | | 1.300 | 0.135 | 1.150 | 0.006 | 0.450 | 0.165 | 0.000 | 0.000 | 0.305 | 4.430 |
| 66.15 | 46384 | | 1.350 | 0.138 | 1.200 | 0.006 | 0.500 | 0.181 | 0.000 | 0.000 | 0.324 | 4.638 |
| 66.20 | 48481 | | 1.400 | 0.141 | 1.250 | 0.006 | 0.550 | 0.195 | 0.000 | 0.000 | 0.341 | 4.848 |
| 66.25 | 50592 | | 1.450 | 0.143 | 1.300 | 0.006 | 0.600 | 0.208 | 0.000 | 0.000 | 0.358 | 5.059 |
| 66.30 | 52713 | | 1.500 | 0.146 | 1.350 | 0.006 | 0.650 | 0.221 | 0.000 | 0.000 | 0.373 | 5.271 |
| 66.35 | 54837 | | 1.550 | 0.149 | 1.400 | 0.006 | 0.700 | 0.233 | 0.000 | 0.000 | 0.388 | 5.484 |

## Table B-5A: Stage-Storage-Outflow Curve for SWM Facility (Free Outfall Conditions)

| | | | Quality Control 1 | | Quantity Control 1 | | Quantity Control 2 | | Emergency Overflow | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vertical Orifice | | Vertical Orifice | | Vertical Rect. Orifice | | Broad Crested Weir | | | |
| | | | Dia (m) | 0.240 | Dia (m) | 0.050 | Width (m) | 0.300 | L (m) | 12.000 | | |
| | | | | | | | Height (m) | 0.400 | | | | |
| | | | Area ($m^2$) | 0.045 | Area ($m^2$) | 0.002 | Area ($m^2$) | 0.120 | | | | |
| | | | Invert (m) | 64.80 | Invert (m) | 64.95 | Invert (m) | 65.65 | $C_w$ | 1.580 | | |
| | | | $C_o$ | 0.62 | $C_o$ | 0.62 | $C_o$ | 0.62 | Invert (m) | 66.60 | | |
| | | | Q @ D | 0.043 | Q @ D | 0.001 | $C_w$ | 1.800 | n contr. | 0 | | |
| Elevation | Active Sto. | Demarkation Points | Head | Outflow | Head | Outflow | Head | Outflow | Head | Outflow | Outflow | Storage |
| (m) | ($m^3$) | | (m) | ($m^3$/s) | (m) | ($m^3$/s) | (m) | ($m^3$/s) | (m) | ($m^3$/s) | ($m^3$/s) | (ha·m) |
| 66.40 | 56989 | | 1.600 | 0.151 | 1.450 | 0.006 | 0.750 | 0.244 | 0.000 | 0.000 | 0.402 | 5.699 |
| 66.45 | 59145 | | 1.650 | 0.154 | 1.500 | 0.007 | 0.800 | 0.255 | 0.000 | 0.000 | 0.415 | 5.914 |
| 66.50 | 61300 | | 1.700 | 0.156 | 1.550 | 0.007 | 0.850 | 0.266 | 0.000 | 0.000 | 0.429 | 6.130 |
| 66.55 | 63488 | | 1.750 | 0.159 | 1.600 | 0.007 | 0.900 | 0.276 | 0.000 | 0.000 | 0.441 | 6.349 |
| **66.60** | **65674** | **Ovf Elev** | **1.800** | **0.161** | **1.650** | **0.007** | **0.950** | **0.285** | **0.000** | **0.000** | **0.453** | **6.567** |
| 66.65 | 67934 | | 1.850 | 0.163 | 1.700 | 0.007 | 1.000 | 0.295 | 0.050 | 0.212 | 0.677 | 6.793 |
| 66.70 | 70627 | | 1.900 | 0.166 | 1.750 | 0.007 | 1.050 | 0.304 | 0.100 | 0.600 | 1.076 | 7.063 |
| 66.75 | 72341 | | 1.950 | 0.168 | 1.800 | 0.007 | 1.100 | 0.313 | 0.150 | 1.101 | 1.589 | 7.234 |
| 66.80 | 74569 | | 2.000 | 0.170 | 1.850 | 0.007 | 1.150 | 0.321 | 0.200 | 1.696 | 2.195 | 7.457 |
| 66.85 | 76838 | | 2.050 | 0.173 | 1.900 | 0.007 | 1.200 | 0.330 | 0.250 | 2.370 | 2.880 | 7.684 |
| 66.90 | 79209 | | 2.100 | 0.175 | 1.950 | 0.007 | 1.250 | 0.338 | 0.300 | 3.115 | 3.635 | 7.921 |
| 66.95 | 81627 | | 2.150 | 0.177 | 2.000 | 0.008 | 1.300 | 0.346 | 0.350 | 3.926 | 4.456 | 8.163 |
| 67.00 | 84116 | | 2.200 | 0.179 | 2.050 | 0.008 | 1.350 | 0.353 | 0.400 | 4.797 | 5.337 | 8.412 |
| 67.05 | 86673 | | 2.250 | 0.181 | 2.100 | 0.008 | 1.400 | 0.361 | 0.450 | 5.723 | 6.274 | 8.667 |
| 67.10 | 89286 | | 2.300 | 0.183 | 2.150 | 0.008 | 1.450 | 0.368 | 0.500 | 6.703 | 7.263 | 8.929 |
| 67.15 | 91993 | | 2.350 | 0.186 | 2.200 | 0.008 | 1.500 | 0.376 | 0.550 | 7.734 | 8.303 | 9.199 |
| 67.20 | 94858 | | 2.400 | 0.188 | 2.250 | 0.008 | 1.550 | 0.383 | 0.600 | 8.812 | 9.390 | 9.486 |
| 67.25 | 97449 | | 2.450 | 0.190 | 2.300 | 0.008 | 1.600 | 0.390 | 0.650 | 9.936 | 10.524 | 9.745 |
| **67.30** | **100310** | **Top of Berm** | **2.500** | **0.192** | **2.350** | **0.008** | **1.650** | **0.397** | **0.700** | **11.104** | **11.701** | **10.031** |

Notes :
- PP Elev indicates the elevation of the permanent pool.
- QC Elev indicates the elevation of the storage volume required by MOE for quality control.
- Ext Det indicates the elevation of extended detention provided.
- Ovf Elev indicates the elevation of the overflow provided above the 100-year water level.
- Top of Berm indicates the elevation at the top of the berm.

**Table B-5B: Stage-Storage-Outflow Curve for SWM Facility (Restrictive Downstream Conditions)**

| | | | Quality Control 1 | | Quantity Control 1 | | Quantity Control 2 | | Emergency Overflow | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vertical Orifice | | Vertical Orifice | | Vertical Rect. Orifice | | Broad Crested Weir | | | |
| | | | Dia (m) | 0.240 | Dia (m) | 0.050 | Width (m) | 0.300 | L (m) | 12.000 | | |
| | | | | | | | Height (m) | 0.400 | | | | |
| | | | Area ($m^2$) | 0.045 | Area ($m^2$) | 0.002 | Area ($m^2$) | 0.120 | | | | |
| | | | Invert (m) | 65.28 | Invert (m) | 65.28 | Invert (m) | 65.65 | $C_w$ | 1.580 | | |
| | | | $C_o$ | 0.62 | $C_o$ | 0.62 | $C_o$ | 0.62 | Invert (m) | 66.60 | | |
| | | | Q @ D | 0.043 | Q @ D | 0.001 | $C_w$ | 1.800 | n contr. | 0 | | |
| Elevation | Active Sto. | Demarkation Points | Head | Outflow | Head | Outflow | Head | Outflow | Head | Outflow | Outflow | Storage |
| (m) | ($m^3$) | | (m) | ($m^3$/s) | (m) | ($m^3$/s) | (m) | ($m^3$/s) | (m) | ($m^3$/s) | ($m^3$/s) | (ha·m) |
| **64.80** | **0** | **PP Elev** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** |
| 64.85 | 1397 | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.140 |
| 64.90 | 2821 | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.282 |
| **64.938** | **3924** | **QC Elev** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.392** |
| **64.95** | **4260** | **Ext. Det.** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.000** | **0.426** |
| 65.00 | 5722 | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.572 |
| 65.05 | 7174 | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.717 |
| 65.10 | 8653 | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.865 |
| 65.15 | 10161 | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.016 |
| 65.20 | 11705 | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.171 |
| 65.25 | 13270 | | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 1.327 |
| 65.30 | 14869 | | 0.020 | 0.018 | 0.020 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.018 | 1.487 |
| 65.35 | 16495 | | 0.070 | 0.033 | 0.070 | 0.001 | 0.000 | 0.000 | 0.000 | 0.000 | 0.034 | 1.650 |
| 65.40 | 18131 | | 0.120 | 0.043 | 0.120 | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.045 | 1.813 |
| 65.45 | 19793 | | 0.170 | 0.051 | 0.170 | 0.002 | 0.000 | 0.000 | 0.000 | 0.000 | 0.053 | 1.979 |
| 65.50 | 21481 | | 0.220 | 0.058 | 0.220 | 0.003 | 0.000 | 0.000 | 0.000 | 0.000 | 0.061 | 2.148 |
| 65.55 | 23195 | | 0.270 | 0.065 | 0.270 | 0.003 | 0.000 | 0.000 | 0.000 | 0.000 | 0.067 | 2.320 |
| 65.60 | 24889 | | 0.320 | 0.070 | 0.320 | 0.003 | 0.000 | 0.000 | 0.000 | 0.000 | 0.073 | 2.489 |
| **65.65** | **26671** | | **0.370** | **0.076** | **0.370** | **0.003** | **0.000** | **0.000** | **0.000** | **0.000** | **0.079** | **2.667** |
| 65.70 | 28462 | | 0.420 | 0.081 | 0.420 | 0.003 | 0.050 | 0.006 | 0.000 | 0.000 | 0.090 | 2.846 |
| 65.75 | 30236 | | 0.470 | 0.085 | 0.470 | 0.004 | 0.100 | 0.016 | 0.000 | 0.000 | 0.105 | 3.024 |
| 65.80 | 32056 | | 0.520 | 0.090 | 0.520 | 0.004 | 0.150 | 0.028 | 0.000 | 0.000 | 0.122 | 3.206 |
| 65.85 | 34074 | | 0.570 | 0.094 | 0.570 | 0.004 | 0.200 | 0.042 | 0.000 | 0.000 | 0.140 | 3.407 |
| 65.90 | 36095 | | 0.620 | 0.098 | 0.620 | 0.004 | 0.250 | 0.056 | 0.000 | 0.000 | 0.158 | 3.609 |
| 65.95 | 38121 | | 0.670 | 0.102 | 0.670 | 0.004 | 0.300 | 0.071 | 0.000 | 0.000 | 0.177 | 3.812 |
| 66.00 | 40160 | | 0.720 | 0.105 | 0.720 | 0.005 | 0.350 | 0.086 | 0.000 | 0.000 | 0.196 | 4.016 |
| 66.05 | 42230 | | 0.770 | 0.109 | 0.770 | 0.005 | 0.400 | 0.100 | 0.000 | 0.000 | 0.214 | 4.223 |
| 66.10 | 44298 | | 0.820 | 0.113 | 0.820 | 0.005 | 0.450 | 0.165 | 0.000 | 0.000 | 0.282 | 4.430 |
| 66.15 | 46384 | | 0.870 | 0.116 | 0.870 | 0.005 | 0.500 | 0.181 | 0.000 | 0.000 | 0.301 | 4.638 |
| 66.20 | 48481 | | 0.920 | 0.119 | 0.920 | 0.005 | 0.550 | 0.195 | 0.000 | 0.000 | 0.319 | 4.848 |
| 66.25 | 50592 | | 0.970 | 0.122 | 0.970 | 0.005 | 0.600 | 0.208 | 0.000 | 0.000 | 0.336 | 5.059 |
| 66.30 | 52713 | | 1.020 | 0.125 | 1.020 | 0.005 | 0.650 | 0.221 | 0.000 | 0.000 | 0.352 | 5.271 |
| 66.35 | 54837 | | 1.070 | 0.129 | 1.070 | 0.006 | 0.700 | 0.233 | 0.000 | 0.000 | 0.367 | 5.484 |

**Table B-5B: Stage-Storage-Outflow Curve for SWM Facility (Restrictive Downstream Conditions)**

| | | | Quality Control 1 | | Quantity Control 1 | | Quantity Control 2 | | Emergency Overflow | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Vertical Orifice | | Vertical Orifice | | Vertical Rect. Orifice | | Broad Crested Weir | | | |
| | | | Dia (m) | 0.240 | Dia (m) | 0.050 | Width (m) | 0.300 | L (m) | 12.000 | | |
| | | | | | | | Height (m) | 0.400 | | | | |
| | | | Area ($m^2$) | 0.045 | Area ($m^2$) | 0.002 | Area ($m^2$) | 0.120 | | | | |
| | | | Invert (m) | 65.28 | Invert (m) | 65.28 | Invert (m) | 65.65 | $C_w$ | 1.580 | | |
| | | | $C_o$ | 0.62 | $C_o$ | 0.62 | $C_o$ | 0.62 | Invert (m) | 66.60 | | |
| | | | Q @ D | 0.043 | Q @ D | 0.001 | $C_w$ | 1.800 | n contr. | 0 | | |
| Elevation | Active Sto. | Demarkation Points | Head | Outflow | Head | Outflow | Head | Outflow | Head | Outflow | Outflow | Storage |
| (m) | ($m^3$) | | (m) | ($m^3$/s) | (m) | ($m^3$/s) | (m) | ($m^3$/s) | (m) | ($m^3$/s) | ($m^3$/s) | (ha·m) |
| 66.40 | 56989 | | 1.120 | 0.131 | 1.120 | 0.006 | 0.750 | 0.244 | 0.000 | 0.000 | 0.382 | 5.699 |
| 66.45 | 59145 | | 1.170 | 0.134 | 1.170 | 0.006 | 0.800 | 0.255 | 0.000 | 0.000 | 0.395 | 5.914 |
| 66.50 | 61300 | | 1.220 | 0.137 | 1.220 | 0.006 | 0.850 | 0.266 | 0.000 | 0.000 | 0.409 | 6.130 |
| 66.55 | 63488 | | 1.270 | 0.140 | 1.270 | 0.006 | 0.900 | 0.276 | 0.000 | 0.000 | 0.422 | 6.349 |
| **66.60** | **65674** | **Ovf Elev** | **1.320** | **0.143** | **1.320** | **0.006** | **0.950** | **0.285** | **0.000** | **0.000** | **0.434** | **6.567** |
| 66.65 | 67934 | | 1.370 | 0.145 | 1.370 | 0.006 | 1.000 | 0.295 | 0.050 | 0.212 | 0.658 | 6.793 |
| 66.70 | 70627 | | 1.420 | 0.148 | 1.420 | 0.006 | 1.050 | 0.304 | 0.100 | 0.600 | 1.058 | 7.063 |
| 66.75 | 72341 | | 1.470 | 0.151 | 1.470 | 0.007 | 1.100 | 0.313 | 0.150 | 1.101 | 1.571 | 7.234 |
| 66.80 | 74569 | | 1.520 | 0.153 | 1.520 | 0.007 | 1.150 | 0.321 | 0.200 | 1.696 | 2.177 | 7.457 |
| 66.85 | 76838 | | 1.570 | 0.156 | 1.570 | 0.007 | 1.200 | 0.330 | 0.250 | 2.370 | 2.862 | 7.684 |
| 66.90 | 79209 | | 1.620 | 0.158 | 1.620 | 0.007 | 1.250 | 0.338 | 0.300 | 3.115 | 3.618 | 7.921 |
| 66.95 | 81627 | | 1.670 | 0.161 | 1.670 | 0.007 | 1.300 | 0.346 | 0.350 | 3.926 | 4.439 | 8.163 |
| 67.00 | 84116 | | 1.720 | 0.163 | 1.720 | 0.007 | 1.350 | 0.353 | 0.400 | 4.797 | 5.320 | 8.412 |
| 67.05 | 86673 | | 1.770 | 0.165 | 1.770 | 0.007 | 1.400 | 0.361 | 0.450 | 5.723 | 6.257 | 8.667 |
| 67.10 | 89286 | | 1.820 | 0.168 | 1.820 | 0.007 | 1.450 | 0.368 | 0.500 | 6.703 | 7.247 | 8.929 |
| 67.15 | 91993 | | 1.870 | 0.170 | 1.870 | 0.007 | 1.500 | 0.376 | 0.550 | 7.734 | 8.287 | 9.199 |
| 67.20 | 94858 | | 1.920 | 0.172 | 1.920 | 0.007 | 1.550 | 0.383 | 0.600 | 8.812 | 9.374 | 9.486 |
| 67.25 | 97449 | | 1.970 | 0.174 | 1.970 | 0.008 | 1.600 | 0.390 | 0.650 | 9.936 | 10.508 | 9.745 |
| **67.30** | **100310** | **Top of Berm** | **2.020** | **0.177** | **2.020** | **0.008** | **1.650** | **0.397** | **0.700** | **11.104** | **11.685** | **10.031** |

Notes :
- PP Elev indicates the elevation of the permanent pool.
- QC Elev indicates the elevation of the storage volume required by MOE for quality control.
- Ext Det indicates the elevation of extended detention provided.
- Ovf Elev indicates the elevation of the overflow provided above the 100-year water level.
- Top of Berm indicates the elevation at the top of the berm.

# ATTACHMENT

# C

Pipe Data and Hydraulic Simulation Results

JFSA Water Resources and Environmental Consultants

**Table C-1: Storm Sewer Hydraulic Gradeline Calculations**

| Pipe Parameters | | | | | | | | | | Flow Characteristics | | | Friction and Minor Losses | | | | | | HGL Computations | | | USF Check | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Manhole Number | | Invert Elevation | | Diameter | Length | MH Cover Elev. | MH Cover Elev. | Slope | n | Qcap | Flow [1] | V actual Q/a | per Darcy-Weisbach | | Friction Losses | Minor Loss Coefficient | Minor Losses | Losses | Surch. (u/s) | HGL (u/s) | HGL (d/s) | USF [2] | Freeboard To USF |
| (u/s) | (d/s) | (u/s) (m) | (d/s) (m) | (mm) | (m) | (m) | (m) | (%) | | (L/s) | (L/s) | (m/s) | f | $H_L$ (m) | (m) | | (m) | (m) | (m) | (m) | (m) | | (m) |
| 1 | 2 | 78.30 | 77.95 | 300 | 99.5 | 81.00 | 81.00 | 0.35 | 0.013 | 57 | 0 | 0.000 | 0.031 | 0.000 | 0.000 | 0.02 | 0.000 | 0.000 | -0.300 | 78.300 | 77.802 | 79.20 | 0.900 |
| 2 | 3 | 77.80 | 77.60 | 450 | 99.5 | 81.00 | 81.00 | 0.20 | 0.013 | 128 | 0 | 0.000 | 0.027 | 0.000 | 0.000 | 0.02 | 0.000 | 0.000 | -0.450 | 77.802 | 77.583 | 79.20 | 1.398 |
| 3 | 7 | 77.58 | 77.38 | 450 | 99.5 | 81.00 | 81.00 | 0.20 | 0.013 | 128 | 0 | 0.000 | 0.027 | 0.000 | 0.000 | 1.33 | 0.000 | 0.000 | -0.450 | 77.583 | 77.571 | 79.20 | 1.617 |
| 4 | 5 | 78.30 | 77.96 | 300 | 96.0 | 81.00 | 81.00 | 0.35 | 0.013 | 57 | 0 | 0.000 | 0.031 | 0.000 | 0.000 | 0.02 | 0.000 | 0.000 | -0.300 | 78.300 | 77.814 | 79.20 | 0.900 |
| 5 | 6 | 77.81 | 77.61 | 450 | 100.0 | 81.00 | 81.00 | 0.20 | 0.013 | 128 | 0 | 0.000 | 0.027 | 0.000 | 0.000 | 0.02 | 0.000 | 0.000 | -0.450 | 77.814 | 77.594 | 79.20 | 1.386 |
| 6 | 7 | 77.59 | 77.39 | 450 | 100.0 | 81.00 | 81.00 | 0.20 | 0.013 | 128 | 0 | 0.000 | 0.027 | 0.000 | 0.000 | 1.33 | 0.000 | 0.000 | -0.450 | 77.594 | 77.571 | 79.20 | 1.606 |
| 7 | 8 | 76.93 | 76.73 | 900 | 80.5 | 80.55 | 80.29 | 0.25 | 0.013 | 905 | 769 | 1.598 | 0.022 | 0.145 | 0.145 | 0.08 | 0.010 | 0.156 | -0.263 | 77.571 | 77.239 | 78.75 | 1.179 |
| 8 | 9 | 76.70 | 76.49 | 900 | 54.5 | 80.29 | 79.79 | 0.40 | 0.013 | 1145 | 765 | 1.938 | 0.022 | 0.097 | 0.097 | 0.08 | 0.015 | 0.113 | -0.364 | 77.239 | 76.885 | 78.49 | 1.251 |
| 9 | 10 | 76.46 | 75.98 | 900 | 56.5 | 79.79 | 79.43 | 0.85 | 0.013 | 1669 | 775 | 2.581 | 0.022 | 0.104 | 0.104 | 0.11 | 0.037 | 0.141 | -0.470 | 76.885 | 74.032 | 77.99 | 1.105 |
| 10 | 11 | 73.08 | 72.77 | 1350 | 87.5 | 79.43 | 78.23 | 0.35 | 0.013 | 3158 | 2689 | 2.484 | 0.019 | 0.222 | 0.222 | 0.02 | 0.006 | 0.228 | -0.395 | 74.032 | 72.964 | 77.63 | 3.598 |
| 11 | 12 | 72.17 | 71.72 | 1350 | 76.0 | 78.23 | 75.66 | 0.60 | 0.013 | 4134 | 2696 | 3.088 | 0.019 | 0.194 | 0.194 | 0.043 | 0.021 | 0.215 | -0.558 | 72.964 | 71.250 | 76.43 | 3.466 |
| 12 | 20 | 70.46 | 70.14 | 1350 | 53.0 | 75.66 | 73.90 | 0.60 | 0.013 | 4134 | 2694 | 3.085 | 0.019 | 0.135 | 0.135 | 0.035 | 0.017 | 0.152 | -0.558 | 71.250 | 70.261 | 73.86 | 2.610 |
| 13 | 14 | 75.83 | 75.78 | 300 | 13.5 | 78.52 | 78.55 | 0.35 | 0.013 | 57 | 22 | 0.761 | 0.031 | 0.007 | 0.007 | 0.54 | 0.016 | 0.023 | -0.102 | 76.029 | 75.921 | 76.72 | 0.691 |
| 13 | 83 | 75.82 | 75.51 | 300 | 77.0 | 78.52 | 78.26 | 0.40 | 0.013 | 61 | 52 | 0.977 | 0.031 | 0.224 | 0.224 | 0.02 | 0.001 | 0.225 | -0.088 | 76.029 | 75.632 | 76.72 | 0.691 |
| 14 | 15 | 75.63 | 75.24 | 450 | 112.5 | 78.55 | 78.12 | 0.35 | 0.013 | 169 | 125 | 1.166 | 0.027 | 0.216 | 0.216 | 0.02 | 0.001 | 0.217 | -0.163 | 75.921 | 75.470 | 76.75 | 0.829 |
| 15 | 16 | 75.21 | 75.14 | 450 | 12.0 | 78.12 | 78.00 | 0.55 | 0.013 | 211 | 135 | 1.417 | 0.027 | 0.027 | 0.027 | 0.47 | 0.048 | 0.075 | -0.190 | 75.470 | 75.305 | 76.32 | 0.850 |
| 16 | 19 | 75.10 | 73.71 | 450 | 65.0 | 78.00 | 76.56 | 2.15 | 0.013 | 418 | 173 | 2.505 | 0.027 | 0.239 | 0.239 | 1.07 | 0.342 | 0.581 | -0.249 | 75.305 | 73.158 | 76.20 | 0.895 |
| 17 | 18 | 75.45 | 74.61 | 300 | 64.5 | 78.16 | 77.32 | 1.30 | 0.013 | 110 | 76 | 1.687 | 0.031 | 0.398 | 0.398 | 0.02 | 0.003 | 0.401 | -0.118 | 75.633 | 74.753 | 76.36 | 0.727 |
| 18 | 19 | 74.53 | 73.63 | 375 | 64.5 | 77.32 | 76.41 | 1.40 | 0.013 | 207 | 136 | 2.021 | 0.029 | 0.389 | 0.389 | 0.02 | 0.004 | 0.393 | -0.155 | 74.753 | 73.158 | 75.52 | 0.767 |
| 19 | 20 | 72.88 | 70.87 | 450 | 72.0 | 76.41 | 73.81 | 2.80 | 0.013 | 477 | 332 | 3.254 | 0.027 | 0.978 | 0.978 | 1.33 | 0.718 | 1.696 | -0.174 | 73.158 | 70.261 | 74.61 | 1.452 |
| 20 | 23 | 69.42 | 69.00 | 1350 | 70.0 | 73.90 | 72.75 | 0.60 | 0.013 | 4134 | 2960 | 3.144 | 0.019 | 0.215 | 0.215 | 0.02 | 0.010 | 0.225 | -0.506 | 70.261 | 68.505 | 72.10 | 1.839 |
| 21 | 22 | 75.11 | 72.77 | 300 | 90.0 | 77.81 | 75.49 | 2.60 | 0.013 | 156 | 107 | 2.385 | 0.031 | 1.109 | 1.109 | 0.02 | 0.006 | 1.115 | -0.118 | 75.293 | 72.923 | 76.01 | 0.717 |
| 22 | 23 | 72.68 | 69.85 | 375 | 111.0 | 75.49 | 72.70 | 2.55 | 0.013 | 280 | 214 | 2.797 | 0.029 | 1.657 | 1.657 | 1.33 | 0.530 | 2.188 | -0.130 | 72.923 | 68.505 | 73.69 | 0.767 |
| 23 | 26 | 66.39 | 66.08 | 1350 | 68.5 | 72.75 | 71.68 | 0.45 | 0.013 | 3580 | 3123 | 2.834 | 0.019 | 0.235 | 0.235 | 0.02 | 0.008 | 0.243 | 0.766 | 68.505 | 68.262 | 70.95 | 2.445 |
| 24 | 25 | 72.43 | 70.62 | 375 | 100.5 | 75.22 | 73.40 | 1.80 | 0.013 | 235 | 119 | 2.160 | 0.029 | 0.465 | 0.465 | 0.02 | 0.005 | 0.470 | -0.188 | 72.621 | 70.773 | 73.42 | 0.799 |
| 25 | 26 | 70.53 | 68.73 | 450 | 100.5 | 73.40 | 71.63 | 1.80 | 0.013 | 383 | 213 | 2.487 | 0.027 | 0.562 | 0.562 | 1.33 | 0.419 | 0.981 | -0.211 | 70.773 | 68.262 | 71.60 | 0.827 |
| 26 | 30 | 65.93 | 65.70 | 1500 | 78.5 | 71.68 | 70.49 | 0.30 | 0.013 | 3872 | 3278 | 2.468 | 0.018 | 0.169 | 0.169 | 0.02 | 0.006 | 0.175 | 0.831 | 68.262 | 68.087 | 69.88 | 1.618 |
| 27 | 28 | 68.00 | 67.37 | 375 | 97.5 | 72.56 | 70.91 | 0.65 | 0.013 | 141 | 116 | 1.428 | 0.029 | 0.424 | 0.424 | 0.02 | 0.002 | 0.426 | 0.483 | 68.859 | 68.433 | 70.76 | 1.901 |
| 28 | 30 | 66.96 | 66.65 | 525 | 103.5 | 70.91 | 70.51 | 0.30 | 0.013 | 236 | 209 | 1.230 | 0.026 | 0.243 | 0.243 | 1.33 | 0.103 | 0.346 | 0.947 | 68.433 | 68.087 | 69.11 | 0.677 |
| 30 | 31 | 65.68 | 65.38 | 1500 | 83.0 | 70.49 | 70.24 | 0.35 | 0.013 | 4182 | 3431 | 2.649 | 0.018 | 0.196 | 0.196 | 0.02 | 0.007 | 0.203 | 0.912 | 68.087 | 67.884 | 68.69 | 0.603 |
| 31 | 32 | 65.32 | 65.03 | 1500 | 83.0 | 70.24 | 69.99 | 0.35 | 0.013 | 4182 | 3779 | 2.686 | 0.018 | 0.237 | 0.237 | 0.02 | 0.007 | 0.245 | 1.060 | 67.884 | 67.640 | 68.44 | 0.556 |
| 32 | 97 | 65.01 | 64.52 | 1500 | 83.0 | 69.99 | 69.76 | 0.60 | 0.013 | 5476 | 3791 | 3.369 | 0.018 | 0.239 | 0.239 | 0.02 | 0.012 | 0.250 | 1.127 | 67.640 | 67.389 | 68.19 | 0.550 |
| 33 | 34 | 74.73 | 73.78 | 300 | 45.0 | 77.44 | 76.48 | 2.10 | 0.013 | 140 | 41 | 1.726 | 0.031 | 0.081 | 0.081 | 0.16 | 0.024 | 0.106 | -0.189 | 74.837 | 73.888 | 75.64 | 0.803 |
| 34 | 35 | 73.74 | 72.75 | 300 | 42.0 | 76.48 | 75.45 | 2.35 | 0.013 | 148 | 73 | 2.112 | 0.031 | 0.239 | 0.239 | 0.505 | 0.115 | 0.354 | -0.153 | 73.888 | 72.862 | 74.68 | 0.792 |
| 35 | 36 | 72.69 | 72.37 | 300 | 15.5 | 75.45 | 75.07 | 2.10 | 0.013 | 140 | 86 | 2.097 | 0.031 | 0.121 | 0.121 | 0.505 | 0.113 | 0.234 | -0.132 | 72.862 | 72.277 | 73.65 | 0.788 |
| 36 | 370 | 72.03 | 71.45 | 450 | 68.0 | 75.07 | 74.30 | 0.85 | 0.013 | 263 | 152 | 1.719 | 0.027 | 0.193 | 0.193 | 0.02 | 0.003 | 0.196 | -0.205 | 72.277 | 71.708 | 73.27 | 0.993 |
| 37 | 38 | 70.35 | 69.47 | 525 | 117.5 | 73.72 | 72.62 | 0.75 | 0.013 | 372 | 312 | 1.930 | 0.026 | 0.618 | 0.618 | 0.02 | 0.004 | 0.622 | -0.158 | 70.714 | 69.808 | 71.92 | 1.206 |
| 38 | 39 | 69.39 | 69.34 | 600 | 13.5 | 72.62 | 72.54 | 0.40 | 0.013 | 388 | 324 | 1.546 | 0.025 | 0.038 | 0.038 | 0.39 | 0.048 | 0.085 | -0.183 | 69.808 | 69.717 | 70.82 | 1.012 |
| 39 | 40 | 69.29 | 68.75 | 600 | 90.5 | 72.54 | 71.83 | 0.60 | 0.013 | 476 | 407 | 1.890 | 0.025 | 0.397 | 0.397 | 0.39 | 0.071 | 0.468 | -0.173 | 69.717 | 69.168 | 70.74 | 1.023 |
| 40 | 54 | 66.94 | 66.63 | 750 | 90.5 | 71.83 | 71.15 | 0.35 | 0.013 | 659 | 465 | 1.628 | 0.023 | 0.158 | 0.158 | 1.33 | 0.180 | 0.338 | 1.476 | 69.168 | 68.830 | 70.03 | 0.862 |
| 41 | 42 | 74.00 | 71.72 | 300 | 65.0 | 76.82 | 74.95 | 3.50 | 0.013 | 181 | 70 | 2.424 | 0.031 | 0.337 | 0.337 | 0.02 | 0.006 | 0.343 | -0.172 | 74.124 | 70.509 | 75.02 | 0.896 |
| 42 | 43 | 69.42 | 68.95 | 450 | 72.5 | 74.95 | 72.89 | 0.65 | 0.013 | 230 | 139 | 1.519 | 0.027 | 0.173 | 0.173 | 1.33 | 0.156 | 0.330 | 0.641 | 70.509 | 70.180 | 73.15 | 2.641 |
| 43 | 44 | 68.76 | 68.46 | 525 | 68.5 | 72.78 | 72.34 | 0.45 | 0.013 | 288 | 216 | 1.470 | 0.026 | 0.173 | 0.173 | 0.02 | 0.002 | 0.175 | 0.892 | 70.180 | 70.005 | 70.98 | 0.800 |
| 44 | 53 | 68.09 | 67.02 | 525 | 47.5 | 72.34 | 71.56 | 2.25 | 0.013 | 645 | 378 | 3.112 | 0.026 | 0.367 | 0.367 | 1.33 | 0.657 | 1.024 | 1.392 | 70.005 | 68.981 | 70.54 | 0.535 |
| 45 | 46 | 74.21 | 74.07 | 375 | 35.0 | 77.57 | 77.95 | 0.40 | 0.013 | 111 | 90 | 1.122 | 0.029 | 0.093 | 0.093 | 0.39 | 0.025 | 0.118 | -0.119 | 74.466 | 74.298 | 75.77 | 1.304 |
| 46 | 47 | 74.04 | 73.99 | 375 | 13.5 | 77.95 | 77.79 | 0.40 | 0.013 | 111 | 91 | 1.121 | 0.029 | 0.036 | 0.036 | 0.39 | 0.025 | 0.061 | -0.117 | 74.298 | 74.049 | 76.15 | 1.852 |
| 47 | 48 | 73.88 | 72.10 | 375 | 62.5 | 77.79 | 75.38 | 2.85 | 0.013 | 296 | 129 | 2.601 | 0.029 | 0.340 | 0.340 | 0.02 | 0.007 | 0.347 | -0.202 | 74.049 | 71.878 | 75.99 | 1.941 |
| 48 | 44 | 71.70 | 69.13 | 375 | 72.5 | 75.38 | 72.52 | 3.55 | 0.013 | 330 | 154 | 2.945 | 0.029 | 0.557 | 0.557 | 1.33 | 0.588 | 1.145 | -0.196 | 71.878 | 70.005 | 73.58 | 1.702 |

**Table C-1: Storm Sewer Hydraulic Gradeline Calculations**

| Pipe Parameters | | | | | | | | | | Flow Characteristics | | | Friction and Minor Losses | | | | | | HGL Computations | | | USF Check | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Manhole Number | | Invert Elevation | | Diameter | Length | MH Cover Elev. | MH Cover Elev. | Slope | n | Qcap | Flow [1] | V actual Q/a | per Darcy-Weisbach | | Friction Losses | Minor Loss Coefficient | Minor Losses | Losses | Surch. (u/s) | HGL (u/s) | HGL (d/s) | USF [2] | Freeboard To USF |
| (u/s) | (d/s) | (u/s) (m) | (d/s) (m) | (mm) | (m) | (m) | (m) | (%) | | (L/s) | (L/s) | (m/s) | f | $H_L$ (m) | (m) | | (m) | (m) | (m) | (m) | (m) | | (m) |
| 50 | 51 | 71.14 | 71.00 | 300 | 41.5 | 73.84 | 73.97 | 0.35 | 0.013 | 57 | 27 | 0.806 | 0.031 | 0.032 | 0.032 | 0.18 | 0.006 | 0.038 | -0.157 | 71.286 | 68.449 | 72.04 | 0.754 |
| 51 | 52 | 70.97 | 70.04 | 300 | 68.5 | 73.97 | 72.78 | 1.35 | 0.013 | 112 | 64 | 1.640 | 0.031 | 0.298 | 0.298 | 0.21 | 0.029 | 0.326 | -0.138 | 71.130 | 70.137 | 72.17 | 1.040 |
| 52 | 53 | 69.39 | 68.71 | 450 | 24.5 | 72.78 | 71.56 | 2.80 | 0.013 | 477 | 418 | 3.395 | 0.027 | 0.527 | 0.527 | 1.07 | 0.629 | 1.155 | 0.293 | 70.137 | 68.981 | 70.98 | 0.843 |
| 53 | 54 | 66.64 | 66.42 | 900 | 74.5 | 71.40 | 71.14 | 0.30 | 0.013 | 992 | 808 | 1.744 | 0.022 | 0.148 | 0.148 | 0.02 | 0.003 | 0.151 | 1.437 | 68.981 | 68.830 | 69.60 | 0.619 |
| 54 | 58 | 66.35 | 65.99 | 975 | 71.5 | 71.14 | 70.94 | 0.50 | 0.013 | 1585 | 1192 | 2.336 | 0.021 | 0.202 | 0.202 | 0.02 | 0.006 | 0.208 | 1.510 | 68.830 | 68.622 | 69.34 | 0.510 |
| 55 | 56 | 68.17 | 67.58 | 375 | 84.5 | 71.60 | 71.22 | 0.70 | 0.013 | 147 | 109 | 1.455 | 0.029 | 0.327 | 0.327 | 0.02 | 0.002 | 0.329 | 0.782 | 69.327 | 68.998 | 69.80 | 0.473 |
| 55 | 68 | 68.70 | 68.49 | 375 | 68.5 | 71.60 | 71.39 | 0.30 | 0.013 | 96 | 73 | 0.963 | 0.029 | 0.120 | 0.120 | 0.02 | 0.001 | 0.121 | 0.255 | 69.327 | 68.741 | 69.80 | 0.473 |
| 56 | 58 | 66.97 | 66.37 | 525 | 100.5 | 71.22 | 70.92 | 0.60 | 0.013 | 333 | 193 | 1.602 | 0.026 | 0.202 | 0.202 | 1.33 | 0.174 | 0.376 | 1.501 | 68.998 | 68.622 | 69.42 | 0.422 |
| 57 | 58 | 67.36 | 67.01 | 375 | 54.5 | 70.84 | 70.92 | 0.65 | 0.013 | 141 | 38 | 1.086 | 0.029 | 0.026 | 0.026 | 1.33 | 0.080 | 0.106 | 0.989 | 68.728 | 68.622 | 69.04 | 0.312 |
| 58 | 61 | 65.84 | 65.62 | 1050 | 65.5 | 70.94 | 70.86 | 0.35 | 0.013 | 1616 | 1385 | 2.103 | 0.021 | 0.169 | 0.169 | 0.02 | 0.005 | 0.173 | 1.728 | 68.622 | 68.449 | 69.14 | 0.518 |
| 59 | 60 | 68.00 | 67.42 | 375 | 88.5 | 71.37 | 71.12 | 0.65 | 0.013 | 141 | 109 | 1.413 | 0.029 | 0.342 | 0.342 | 0.02 | 0.002 | 0.344 | 0.658 | 69.029 | 68.684 | 69.57 | 0.541 |
| 60 | 61 | 66.44 | 66.14 | 525 | 86.0 | 71.12 | 70.87 | 0.35 | 0.013 | 254 | 166 | 1.257 | 0.026 | 0.128 | 0.128 | 1.33 | 0.107 | 0.235 | 1.718 | 68.684 | 68.449 | 69.32 | 0.636 |
| 61 | 64 | 65.47 | 65.33 | 1200 | 68.5 | 70.86 | 70.65 | 0.20 | 0.013 | 1744 | 1575 | 1.749 | 0.020 | 0.112 | 0.112 | 0.02 | 0.003 | 0.115 | 1.784 | 68.449 | 68.334 | 69.06 | 0.611 |
| 62 | 63 | 67.80 | 67.21 | 375 | 90.0 | 71.17 | 70.91 | 0.65 | 0.013 | 141 | 109 | 1.413 | 0.029 | 0.348 | 0.348 | 0.02 | 0.002 | 0.350 | 0.768 | 68.940 | 68.590 | 69.37 | 0.430 |
| 63 | 64 | 66.28 | 65.98 | 525 | 86.0 | 70.91 | 70.66 | 0.35 | 0.013 | 254 | 177 | 1.274 | 0.026 | 0.146 | 0.146 | 1.33 | 0.110 | 0.256 | 1.781 | 68.590 | 68.334 | 69.11 | 0.520 |
| 64 | 67 | 65.31 | 65.14 | 1200 | 68.5 | 70.65 | 70.45 | 0.25 | 0.013 | 1949 | 1706 | 1.949 | 0.020 | 0.131 | 0.131 | 0.02 | 0.004 | 0.135 | 1.826 | 68.334 | 68.199 | 68.85 | 0.516 |
| 65 | 66 | 67.59 | 67.01 | 375 | 90.0 | 70.98 | 70.71 | 0.65 | 0.013 | 141 | 109 | 1.413 | 0.029 | 0.348 | 0.348 | 0.02 | 0.002 | 0.350 | 0.862 | 68.827 | 68.477 | 69.18 | 0.353 |
| 66 | 67 | 66.09 | 65.79 | 525 | 86.0 | 70.71 | 70.46 | 0.35 | 0.013 | 254 | 188 | 1.293 | 0.026 | 0.165 | 0.165 | 1.33 | 0.113 | 0.278 | 1.859 | 68.477 | 68.199 | 68.91 | 0.433 |
| 67 | 75 | 65.12 | 64.91 | 1200 | 68.5 | 70.45 | 70.25 | 0.30 | 0.013 | 2135 | 1842 | 2.128 | 0.020 | 0.153 | 0.153 | 1.33 | 0.307 | 0.460 | 1.882 | 68.199 | 67.739 | 68.65 | 0.451 |
| 68 | 69 | 68.42 | 68.24 | 450 | 69.0 | 71.39 | 71.19 | 0.25 | 0.013 | 143 | 125 | 1.013 | 0.027 | 0.132 | 0.132 | 0.02 | 0.001 | 0.133 | -0.125 | 68.741 | 68.546 | 69.59 | 0.849 |
| 69 | 70 | 68.17 | 68.03 | 525 | 68.0 | 71.19 | 70.98 | 0.20 | 0.013 | 192 | 167 | 1.002 | 0.026 | 0.102 | 0.102 | 0.02 | 0.001 | 0.103 | -0.147 | 68.546 | 68.367 | 69.39 | 0.844 |
| 70 | 71 | 68.00 | 67.84 | 525 | 55.5 | 70.98 | 70.82 | 0.30 | 0.013 | 236 | 196 | 1.217 | 0.026 | 0.115 | 0.115 | 0.21 | 0.016 | 0.131 | -0.160 | 68.367 | 68.172 | 69.18 | 0.813 |
| 71 | 72 | 67.81 | 67.75 | 525 | 15.5 | 70.82 | 70.78 | 0.35 | 0.013 | 254 | 213 | 1.320 | 0.026 | 0.038 | 0.038 | 0.635 | 0.056 | 0.095 | -0.158 | 68.172 | 68.034 | 69.02 | 0.848 |
| 72 | 73 | 67.60 | 67.42 | 675 | 89.0 | 70.78 | 70.51 | 0.20 | 0.013 | 376 | 282 | 1.161 | 0.024 | 0.100 | 0.100 | 0.02 | 0.001 | 0.101 | -0.242 | 68.034 | 67.816 | 68.98 | 0.946 |
| 73 | 75 | 65.25 | 65.11 | 750 | 88.5 | 70.51 | 70.24 | 0.15 | 0.013 | 431 | 326 | 1.080 | 0.023 | 0.076 | 0.076 | 0.02 | 0.001 | 0.077 | 1.819 | 67.816 | 67.739 | 68.71 | 0.894 |
| 74 | 75 | 67.55 | 67.46 | 300 | 24.5 | 70.25 | 70.25 | 0.35 | 0.013 | 57 | 8 | 0.572 | 0.031 | 0.002 | 0.002 | 1.33 | 0.022 | 0.024 | -0.087 | 67.763 | 67.739 | 68.45 | 0.687 |
| 75 | 82 | 64.74 | 64.65 | 1500 | 62.5 | 70.24 | 69.98 | 0.15 | 0.013 | 2738 | 2135 | 1.717 | 0.018 | 0.057 | 0.057 | 0.02 | 0.003 | 0.060 | 1.500 | 67.739 | 67.679 | 68.44 | 0.701 |
| 77 | 78 | 68.57 | 67.54 | 300 | 55.5 | 73.33 | 72.32 | 1.85 | 0.013 | 132 | 71 | 1.909 | 0.031 | 0.301 | 0.301 | 0.02 | 0.004 | 0.305 | 0.266 | 69.137 | 68.832 | 71.53 | 2.393 |
| 78 | 79 | 67.47 | 66.60 | 375 | 91.0 | 72.32 | 70.72 | 0.95 | 0.013 | 171 | 144 | 1.740 | 0.029 | 0.610 | 0.610 | 0.02 | 0.003 | 0.613 | 0.988 | 68.832 | 68.219 | 70.52 | 1.688 |
| 79 | 80 | 66.45 | 66.27 | 525 | 63.0 | 70.72 | 70.53 | 0.30 | 0.013 | 236 | 172 | 1.193 | 0.026 | 0.101 | 0.101 | 0.02 | 0.001 | 0.103 | 1.240 | 68.219 | 68.116 | 68.92 | 0.701 |
| 80 | 81 | 66.19 | 65.92 | 600 | 78.5 | 70.53 | 70.30 | 0.35 | 0.013 | 363 | 239 | 1.372 | 0.025 | 0.119 | 0.119 | 0.02 | 0.002 | 0.120 | 1.326 | 68.116 | 67.995 | 68.73 | 0.614 |
| 81 | 82 | 65.84 | 65.45 | 675 | 111.5 | 70.30 | 69.97 | 0.35 | 0.013 | 497 | 325 | 1.487 | 0.024 | 0.166 | 0.166 | 1.33 | 0.150 | 0.316 | 1.480 | 67.995 | 67.679 | 68.50 | 0.505 |
| 82 | 97 | 64.63 | 64.52 | 1500 | 73.5 | 69.98 | 69.76 | 0.15 | 0.013 | 2738 | 2376 | 1.746 | 0.018 | 0.083 | 0.083 | 1.33 | 0.207 | 0.290 | 1.554 | 67.679 | 67.389 | 68.18 | 0.501 |
| 83 | 84 | 75.43 | 74.84 | 375 | 70.0 | 78.26 | 77.61 | 0.85 | 0.013 | 162 | 93 | 1.529 | 0.029 | 0.196 | 0.196 | 0.02 | 0.002 | 0.199 | -0.173 | 75.632 | 74.962 | 76.46 | 0.828 |
| 84 | 85 | 74.81 | 72.56 | 375 | 58.5 | 77.61 | 75.33 | 3.85 | 0.013 | 344 | 125 | 2.905 | 0.029 | 0.298 | 0.298 | 0.02 | 0.009 | 0.307 | -0.220 | 74.962 | 72.706 | 75.81 | 0.848 |
| 85 | 86 | 72.53 | 69.74 | 375 | 72.5 | 75.33 | 72.57 | 3.85 | 0.013 | 344 | 161 | 3.093 | 0.029 | 0.614 | 0.614 | 0.02 | 0.010 | 0.624 | -0.196 | 72.706 | 69.972 | 73.53 | 0.824 |
| 86 | 87 | 69.66 | 68.67 | 450 | 90.5 | 72.57 | 71.53 | 1.10 | 0.013 | 299 | 247 | 2.106 | 0.027 | 0.679 | 0.679 | 0.02 | 0.005 | 0.684 | -0.139 | 69.972 | 68.001 | 70.77 | 0.798 |
| 87 | 88 | 66.34 | 66.18 | 675 | 80.0 | 71.53 | 70.61 | 0.20 | 0.013 | 376 | 311 | 1.178 | 0.024 | 0.110 | 0.110 | 0.02 | 0.001 | 0.111 | 0.990 | 68.001 | 67.890 | 69.73 | 1.729 |
| 88 | 89 | 66.10 | 66.00 | 750 | 68.0 | 70.61 | 70.39 | 0.15 | 0.013 | 431 | 333 | 1.078 | 0.023 | 0.061 | 0.061 | 0.26 | 0.015 | 0.076 | 1.039 | 67.890 | 67.813 | 68.81 | 0.920 |
| 89 | 90 | 65.97 | 65.95 | 750 | 13.5 | 70.39 | 70.36 | 0.15 | 0.013 | 431 | 336 | 1.080 | 0.023 | 0.012 | 0.012 | 0.54 | 0.032 | 0.044 | 1.094 | 67.813 | 67.769 | 68.59 | 0.777 |
| 90 | 91 | 65.89 | 65.79 | 750 | 68.0 | 70.36 | 70.16 | 0.15 | 0.013 | 431 | 379 | 1.107 | 0.023 | 0.079 | 0.079 | 0.02 | 0.001 | 0.080 | 1.130 | 67.769 | 67.689 | 68.56 | 0.791 |
| 91 | 96 | 65.77 | 65.64 | 750 | 66.0 | 70.16 | 69.96 | 0.20 | 0.013 | 498 | 404 | 1.257 | 0.023 | 0.087 | 0.087 | 0.02 | 0.002 | 0.089 | 1.172 | 67.689 | 67.600 | 68.36 | 0.671 |
| 92 | 93 | 67.16 | 66.77 | 300 | 60.5 | 70.55 | 70.37 | 0.65 | 0.013 | 78 | 43 | 1.133 | 0.031 | 0.118 | 0.118 | 0.02 | 0.001 | 0.119 | 0.684 | 68.148 | 68.028 | 68.75 | 0.602 |
| 93 | 94 | 66.70 | 66.30 | 375 | 60.5 | 70.37 | 70.20 | 0.65 | 0.013 | 141 | 80 | 1.321 | 0.029 | 0.127 | 0.127 | 0.39 | 0.035 | 0.161 | 0.957 | 68.028 | 67.867 | 68.57 | 0.542 |
| 94 | 95 | 66.27 | 66.22 | 375 | 13.5 | 70.20 | 70.17 | 0.40 | 0.013 | 111 | 86 | 1.116 | 0.029 | 0.033 | 0.033 | 0.39 | 0.025 | 0.057 | 1.219 | 67.867 | 67.810 | 68.40 | 0.533 |
| 95 | 96 | 66.14 | 65.94 | 450 | 69.5 | 70.17 | 69.97 | 0.30 | 0.013 | 156 | 123 | 1.090 | 0.027 | 0.129 | 0.129 | 1.33 | 0.080 | 0.209 | 1.216 | 67.810 | 67.600 | 68.37 | 0.560 |
| 96 | 97 | 65.56 | 65.42 | 825 | 72.5 | 69.96 | 69.76 | 0.20 | 0.013 | 642 | 508 | 1.332 | 0.022 | 0.091 | 0.091 | 1.33 | 0.120 | 0.211 | 1.215 | 67.600 | 67.389 | 68.16 | 0.560 |
| 97 | 98 | 63.77 | 63.67 | 3000 | 92.5 | 69.76 | 69.46 | 0.10 | 0.013 | 14194 | 6347 | 1.971 | 0.015 | 0.018 | 0.018 | 0.39 | 0.077 | 0.096 | 0.624 | 67.389 | 67.294 | 67.96 | 0.571 |

**Table C-1: Storm Sewer Hydraulic Gradeline Calculations**

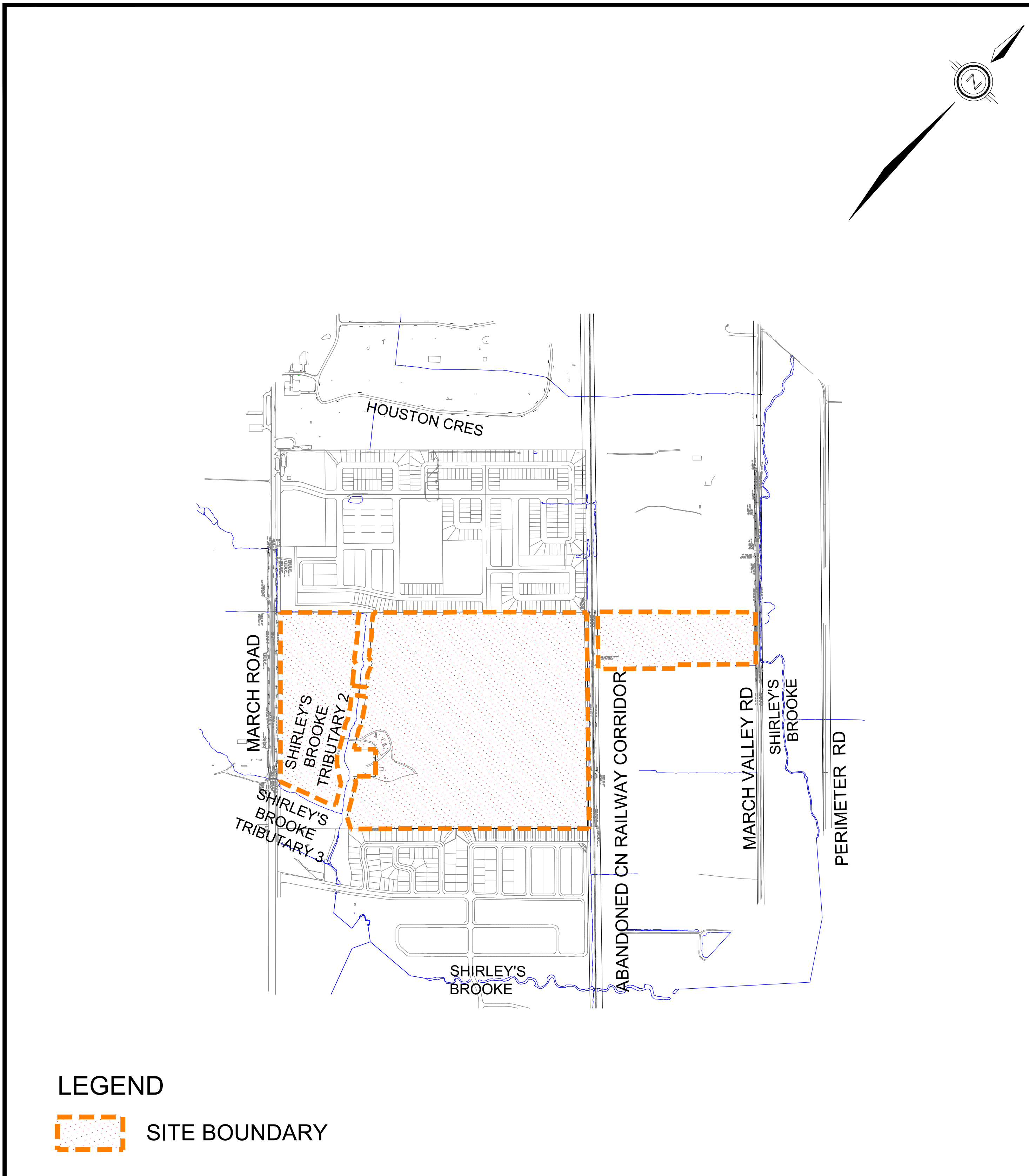
| Pipe Parameters | | | | | | | | | | Flow Characteristics | | | Friction and Minor Losses | | | | | | HGL Computations | | | USF Check | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Manhole Number | | Invert Elevation | | Diameter | Length | MH Cover Elev. | MH Cover Elev. | Slope | n | Qcap | Flow [1] | V actual Q/a | per Darcy-Weisbach | | Friction Losses | Minor Loss Coefficient | Minor Losses | Losses | Surch. (u/s) | HGL (u/s) | HGL (d/s) | USF [2] | Freeboard To USF |
| (u/s) | (d/s) | (u/s) (m) | (d/s) (m) | (mm) | (m) | (m) | (m) | (%) | | (L/s) | (L/s) | (m/s) | f | $H_L$ (m) | (m) | | (m) | (m) | (m) | (m) | (m) | | (m) |
| 98 | 990 | 63.67 | 63.66 | 3000 | 13.0 | 69.46 | 69.40 | 0.10 | 0.013 | 14194 | 6212 | 1.953 | 0.015 | 0.002 | 0.002 | 0.39 | 0.076 | 0.078 | 0.622 | 67.294 | 67.215 | 67.66 | 0.366 |
| 990 | 99 | 63.66 | 63.63 | 3000 | 25.0 | 69.40 | 69.37 | 0.10 | 0.013 | 14194 | 6194 | 1.947 | 0.015 | 0.005 | 0.005 | 0.39 | 0.075 | 0.080 | 0.556 | 67.215 | 67.135 | 67.60 | 0.385 |
| 99 | 100 | 63.63 | 63.61 | 3000 | 23.0 | 69.37 | 69.36 | 0.10 | 0.013 | 14194 | 6159 | 1.960 | 0.015 | 0.004 | 0.004 | 0.39 | 0.076 | 0.081 | 0.501 | 67.135 | 67.055 | 67.57 | 0.435 |
| 100 | 101 | 63.61 | 63.51 | 3000 | 98.5 | 69.51 | 69.22 | 0.10 | 0.013 | 14194 | 6127 | 1.950 | 0.015 | 0.018 | 0.018 | 0.39 | 0.076 | 0.094 | 0.444 | 67.055 | 66.961 | 67.71 | 0.655 |
| 101 | 1001 | 63.51 | 63.50 | 3000 | 10.0 | 69.20 | 69.20 | 0.10 | 0.013 | 14194 | 5994 | 1.931 | 0.015 | 0.002 | 0.002 | 0.39 | 0.074 | 0.076 | 0.449 | 66.961 | 66.885 | 67.40 | 0.439 |
| 1001 | 103 | 63.50 | 63.47 | 3000 | 28.0 | 69.20 | 69.20 | 0.10 | 0.013 | 14194 | 5980 | 1.927 | 0.015 | 0.005 | 0.005 | 0.39 | 0.074 | 0.079 | 0.383 | 66.885 | 66.806 | 67.40 | 0.515 |
| 103 | Pond 3 | 63.44 | 63.43 | 3000 | 13.0 | 68.52 | 68.52 | 0.10 | 0.013 | 14194 | 5944 | 1.939 | 0.015 | 0.002 | 0.002 | 0.02 | 0.004 | 0.006 | 0.362 | 66.806 | 66.800 | N/A | N/A |
| 370 | 37 | 71.43 | 70.77 | 450 | 58.0 | 74.30 | 73.71 | 1.15 | 0.013 | 306 | 213 | 2.089 | 0.027 | 0.325 | 0.325 | 0.02 | 0.004 | 0.329 | -0.174 | 71.708 | 70.714 | 72.50 | 0.792 |
| 430 | 43 | 69.41 | 68.99 | 300 | 59.5 | 73.05 | 72.78 | 0.70 | 0.013 | 81 | 43 | 1.170 | 0.031 | 0.116 | 0.116 | 0.02 | 0.001 | 0.118 | 0.592 | 70.297 | 70.180 | 71.25 | 0.953 |

Note: 100-year HGL boundary condition at Pond 3 set to 66.80 m (2 m above the permanent pool elevation).

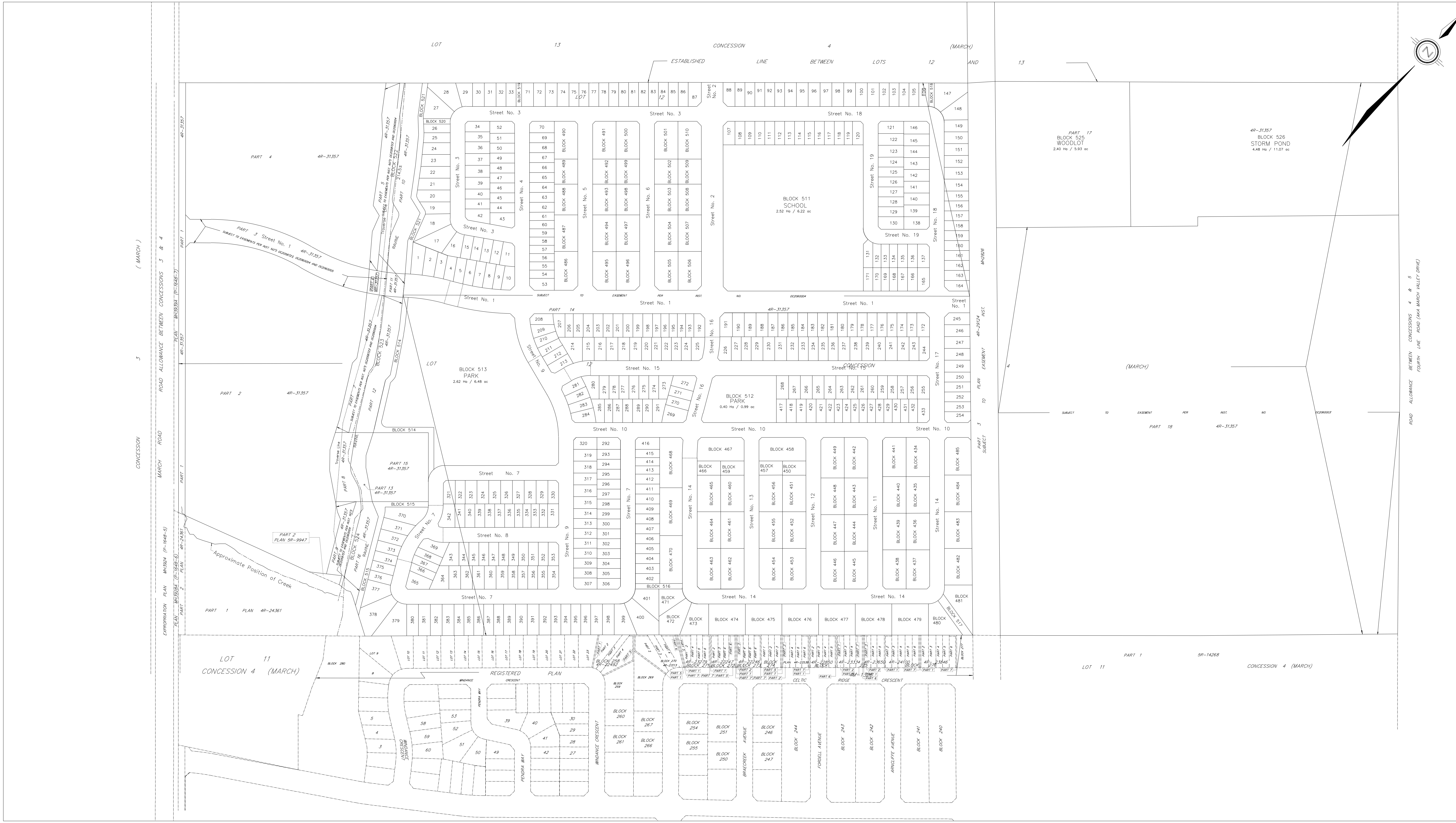
[1] Flow set equal to Rational Method flows (per DSEL) + 14% to account for additional flows captured during the 100-year storm.

[2] USF estimated as 1.8 m below the upstream manhole cover elevation.

# DRAWINGS & FIGURES




| | | |
|---|---|---|
| MINTO KANATA NORTH | SITE LOCATION | DATE: September 2019 |
| | | SCALE: 1:15,000 |
| DSEL david schaeffer engineering ltd | 120 Iber Road, Unit 203<br>Stittsville, ON K2S 1E9<br>TEL: (613) 836-0856<br>FAX: (613) 836-7183<br>www.DSEL.ca | PROJECT No.: 17-982 |
| | | FIGURE: 1 |





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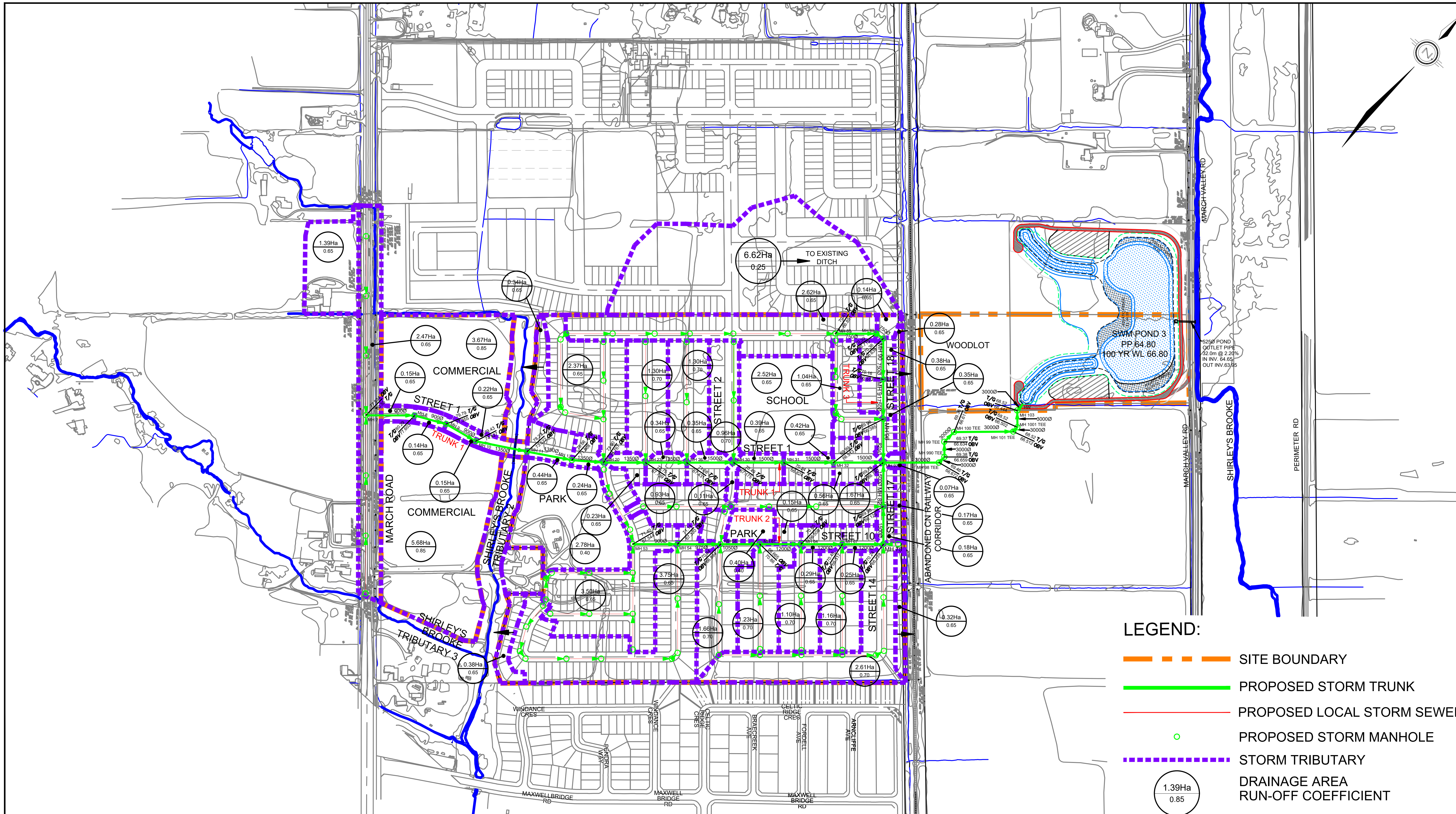
# CONCEPT PLAN
## MINTO KANATA NORTH

| | |
|---|---|
| PROJECT No.: | 17-982 |
| SCALE: | 1:4000 |
| DATE: | September 2019 |
| FIGURE: | 2 |

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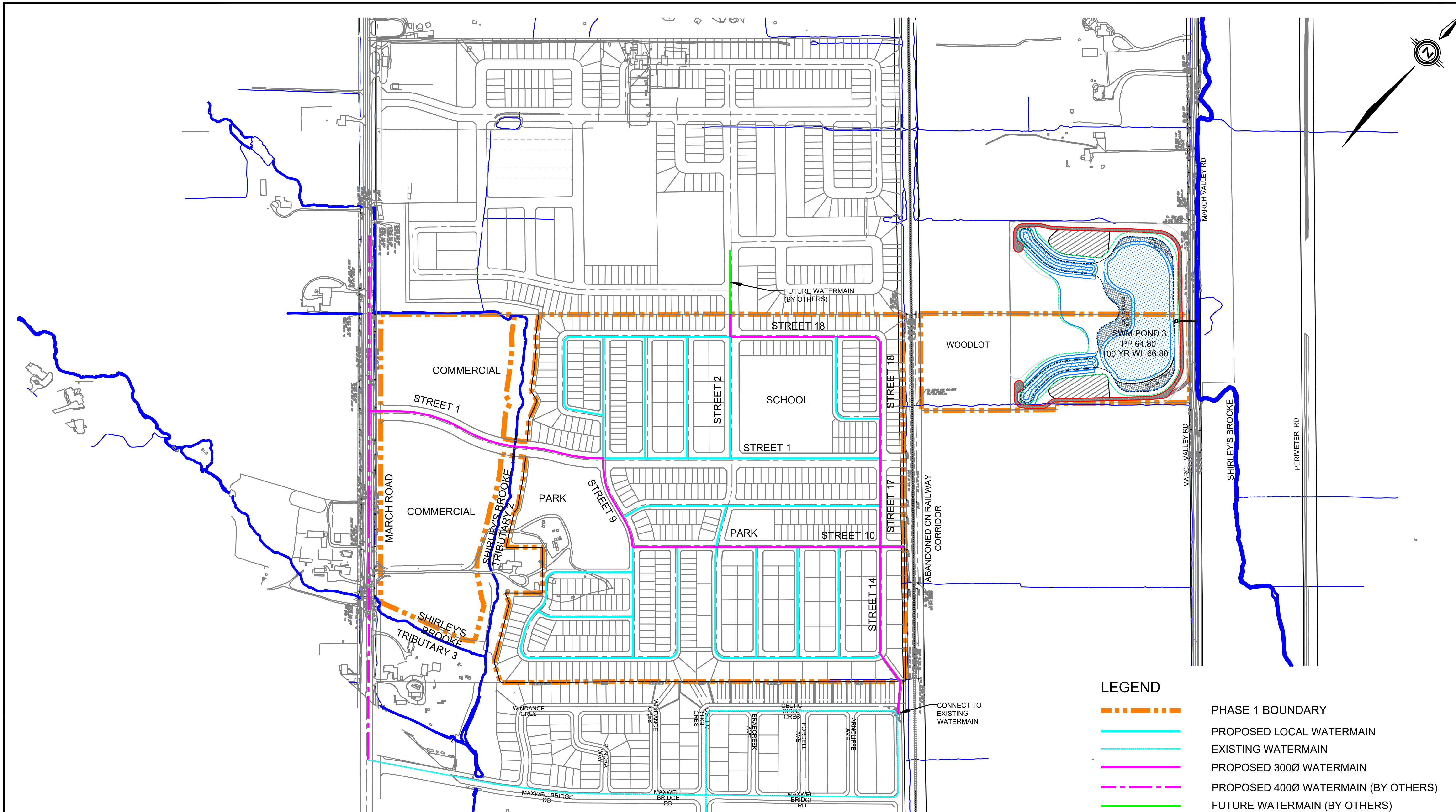
# STORM SERVICING PLAN
# MINTO KANATA NORTH

| | |
|---|---|
| PROJECT No.: | 17-982 |
| SCALE: | 1:6000 |
| DATE: | September 2019 |
| FIGURE: | 3 |





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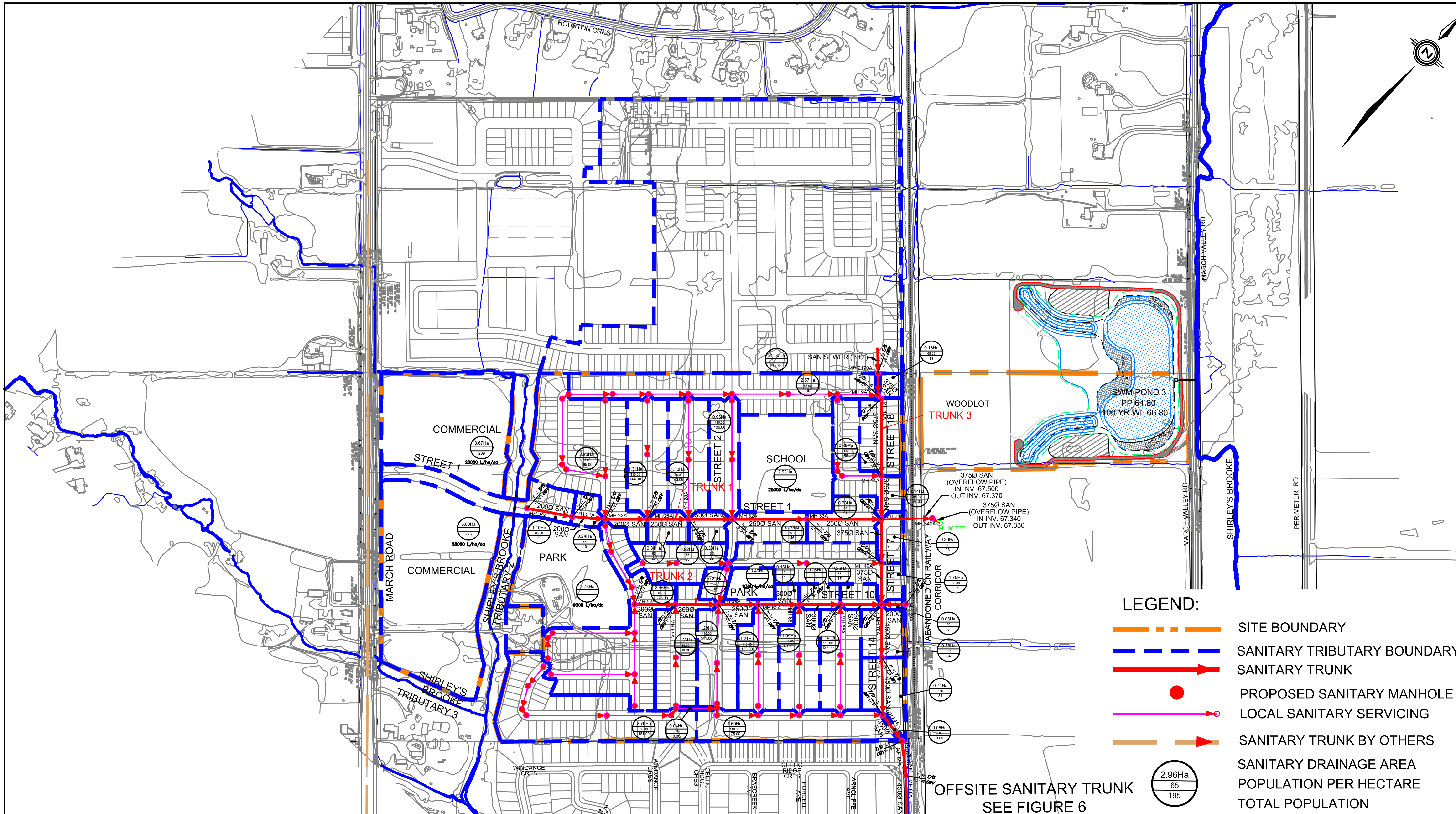
WATERMAIN SERVICING PLAN

MINTO KANATA NORTH

| | |
|---|---|
| PROJECT No.: | 17-982 |
| SCALE: | 1:6000 |
| DATE: | September 2019 |
| FIGURE: | 4 |

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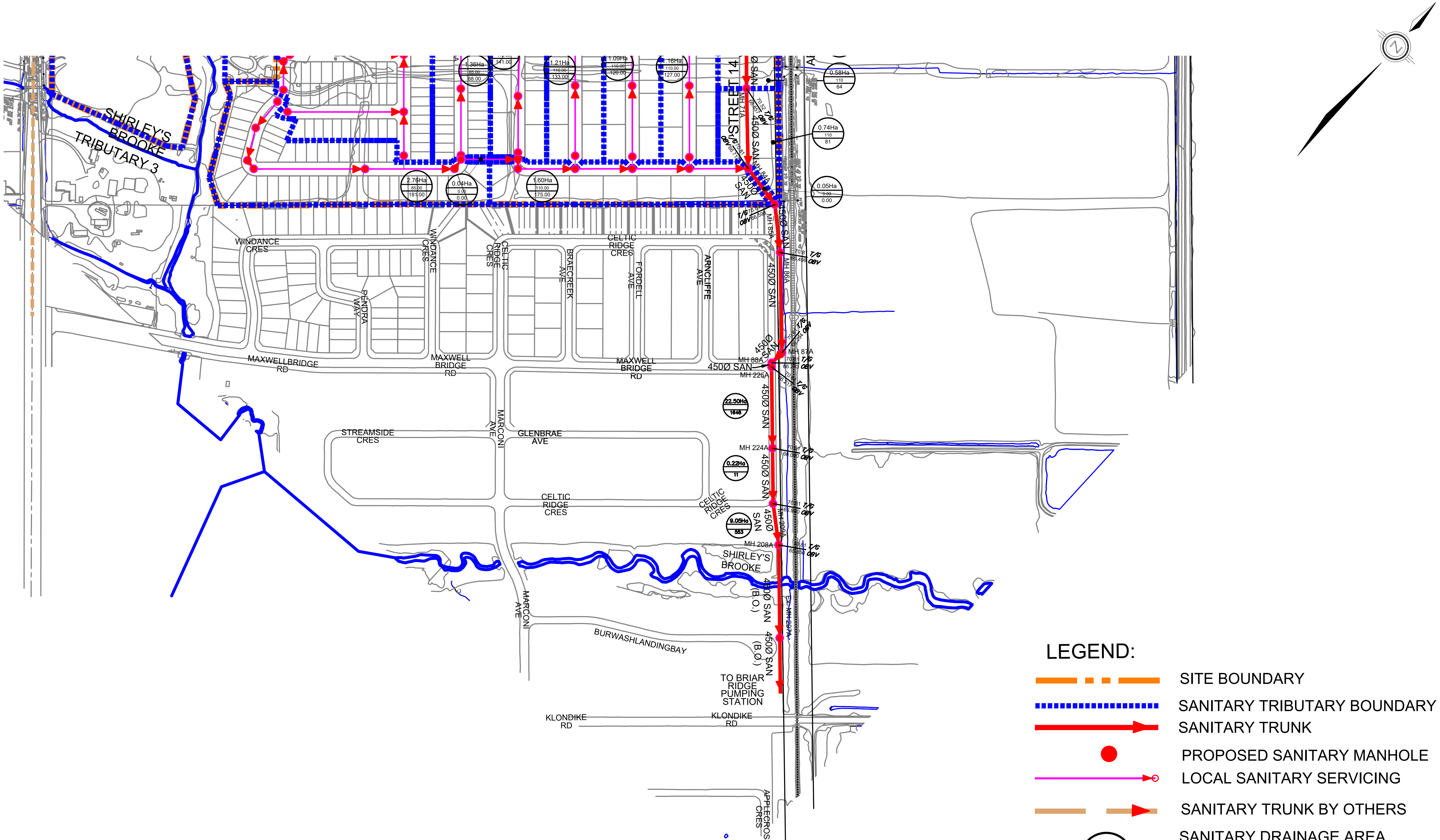
SANITARY SERVICING PLAN
MINTO KANATA NORTH

| | |
|---|---|
| PROJECT No.: | 17-982 |
| SCALE: | 1:6000 |
| DATE: | September 2019 |
| FIGURE: | 5 |




LEGEND:

- SITE BOUNDARY
- SANITARY TRIBUTARY BOUNDARY
- SANITARY TRUNK
- PROPOSED SANITARY MANHOLE
- LOCAL SANITARY SERVICING
- SANITARY TRUNK BY OTHERS
- 2.96Ha / 65 / 195 — SANITARY DRAINAGE AREA / POPULATION PER HECTARE / TOTAL POPULATION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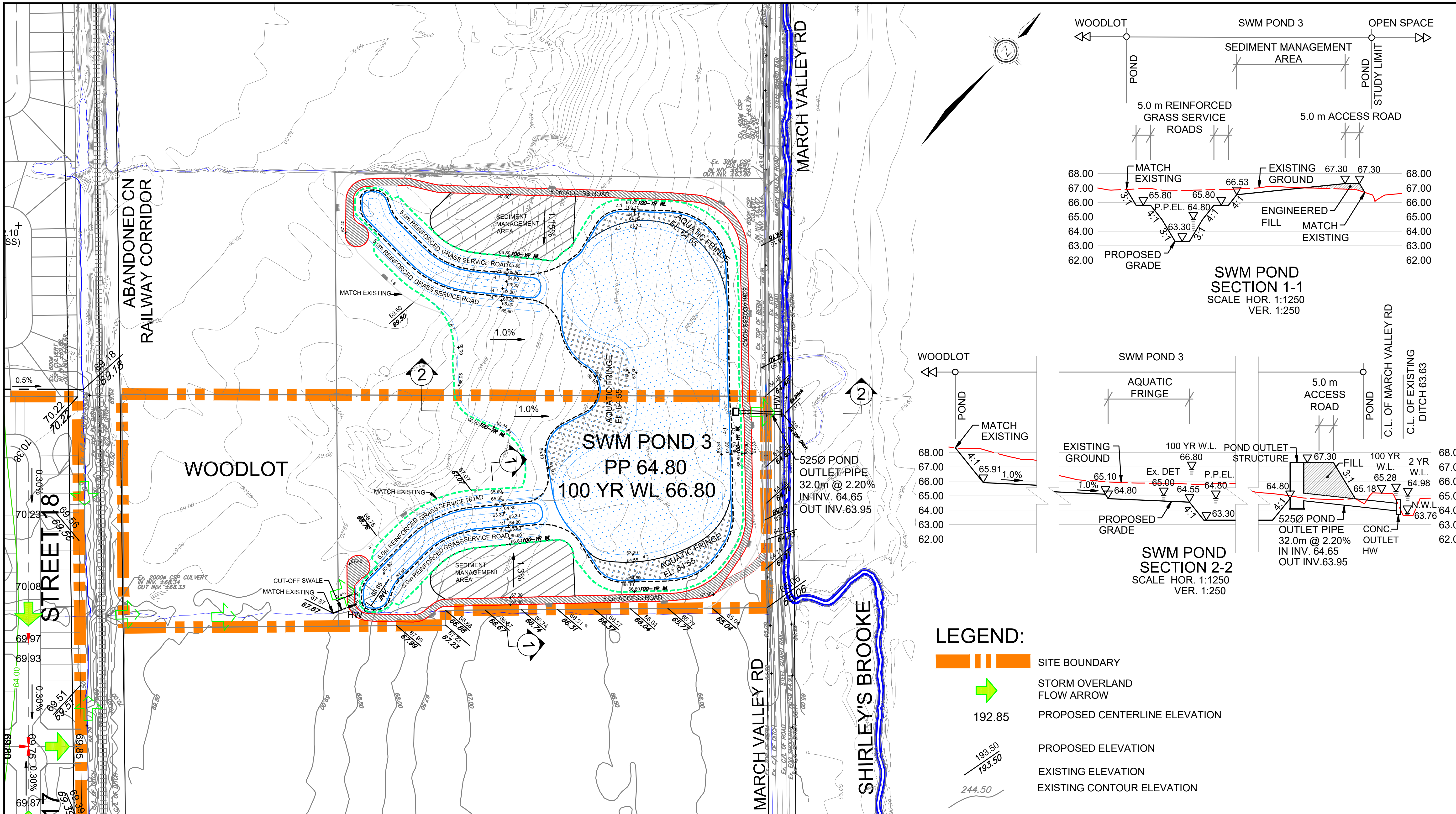
OFFSITE SANITARY SERVICING
MINTO KANATA NORTH

| | |
|---|---|
| PROJECT No.: | 17-982 |
| SCALE: | 1:5000 |
| DATE: | September 2019 |
| FIGURE: | 6 |




| | |
|---|---|
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SWM POND
MINTO KANATA NORTH

| | |
|---|---|
| PROJECT No.: | 17-982 |
| SCALE: | 1:2500 |
| DATE: | September 2019 |
| FIGURE: | 7 |


## LEGEND:

SITE BOUNDARY

STORM OVERLAND FLOW ARROW

192.85 PROPOSED CENTERLINE ELEVATION

193.50 PROPOSED ELEVATION

193.50 EXISTING ELEVATION

244.50 EXISTING CONTOUR ELEVATION

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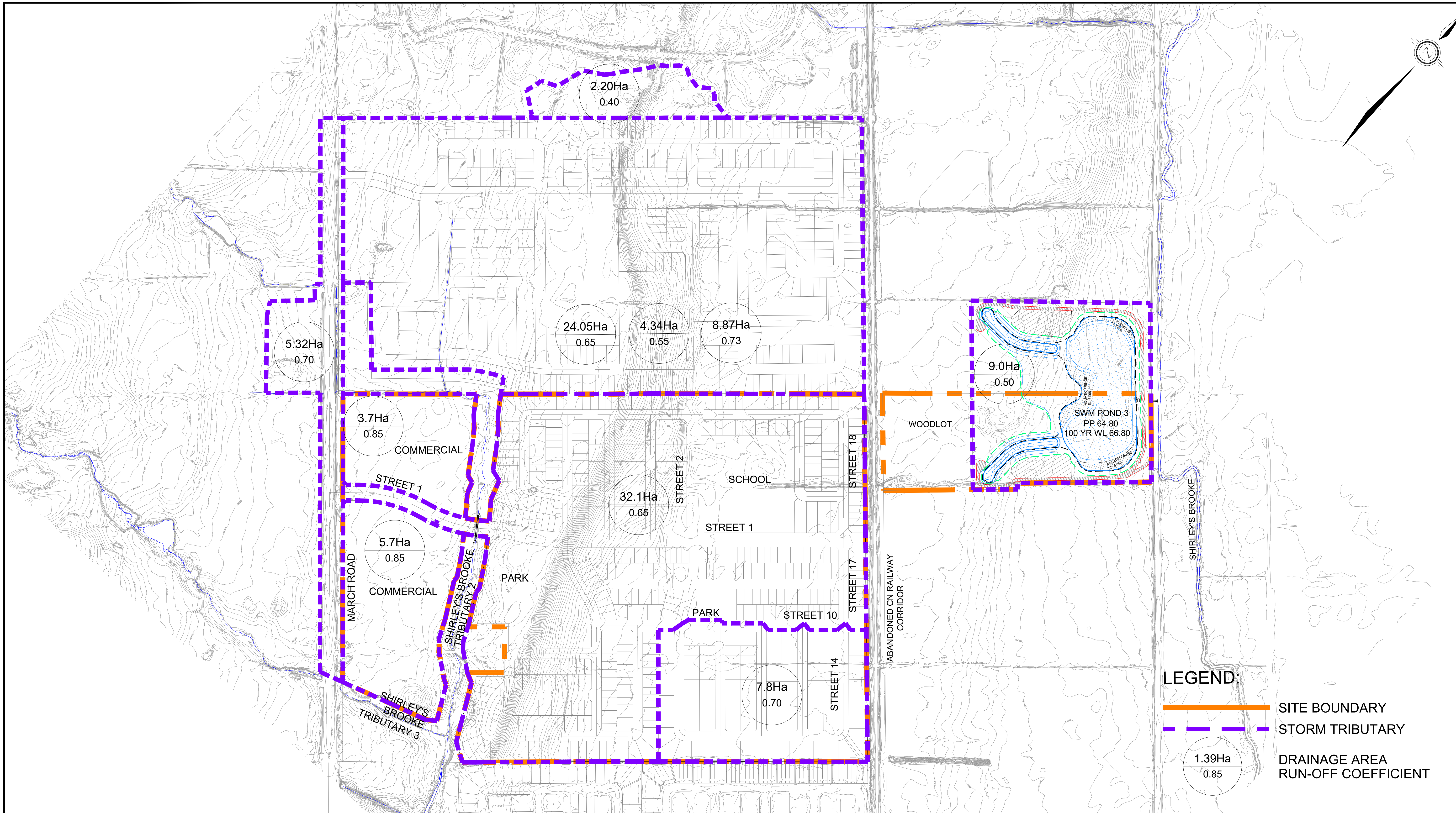
SWM POND - AERIAL MAP
MINTO KANATA NORTH

| | |
|---|---|
| PROJECT No.: | 17-982 |
| SCALE: | 1:2500 |
| DATE: | September 2019 |
| FIGURE: | 8 |

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SWM POND DRAINAGE AREA
MINTO KANATA NORTH

| | |
|---|---|
| PROJECT No.: | 17-982 |
| SCALE: | 1:6000 |
| DATE: | September 2019 |
| FIGURE: | 9 |


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# CONCEPTUAL GRADING PLAN
# MINTO KANATA NORTH

| | |
|---|---|
| PROJECT No. : | 17-982 |
| SCALE: | 1:2 |
| DATE: | September 2019 |
| DRAWING No. | 1 |