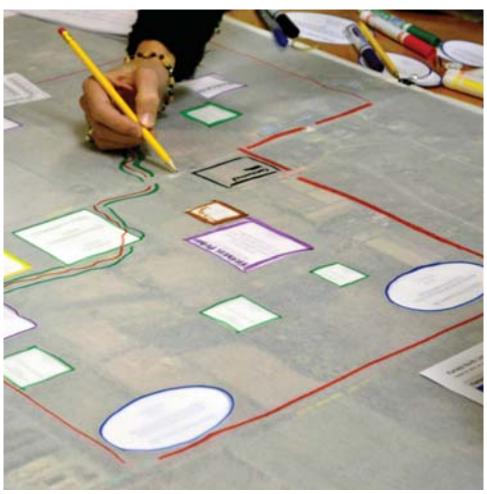
KANATA NORTH

COMMUNITY DESIGN PLAN

MASTER SERVICING STUDY **APPENDICES**



FINAL DRAFT
JUNE 28, 2016

Ottawa

NOVATECH
Engineers, Planners & Landscape Architects

KANATA NORTH COMMUNITY DESIGN PLAN

MASTER SERVICING STUDY

PREPARED BY:

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WITH THE ASSISTANCE OF:

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PATERSON GROUP INC

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MUNCASTER ENVIRONMENTAL PLANNING INC.
DST
BOWFIN ENVIRONMENTAL
MCKINLEY ENVIRONMENTAL SOLUTIONS

FLUVIAL GEOMORPHOLOGY
MATRIX SOLUTIONS AND PARISH GEOMORPHIC

ARCHAEOLOGY
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STANTEC CONSULTING LTD.

INTEGRATED ENVIRONMENTAL ASSESSMENT
MORRISON HERSHFIELD GROUP INC.

JUNE/28/2016

NOVATECH FILE NO. 112117
REPORT NO. R-2016-041

APPENDIX

List of Appendices

APPENDIX A

Supporting Documentation

- Kanata North Urban Expansion, Community Design Plan, Master Servicing Study – Terms of Reference, Novatech, September 9, 2013
- Kanata North Urban Expansion Study Area Community Design Plan Master Servicing Study – Existing Conditions Report, Municipal Infrastructure, Novatech Report #R-2013-127, November 2013

Kanata North Urban Expansion, Community Design Plan
Master Servicing Study – Terms of Reference

Introduction:

The Kanata North Urban Expansion (Area 1) is proposed to encompass approximately 181 hectares of land between the established communities of Morgan's Grant to the south, the railway corridor to the east, and the Hillsview Estates Subdivision to the north, all within the West Urban Area of the City of Ottawa.

Refer to Figure 1 (attached) for the study area boundary.

The project elements covered by this scope of work include evaluation of water and wastewater infrastructure, on-site stormwater drainage, and utility infrastructure for the development area. An overview of the potentially affected, existing civil infrastructure is attached as Figure 2.

The intent is to complete this work in coordination with development of the land use plan, through the integrated planning and EA process.

Under this process, the inventory of existing conditions, evaluation of alternatives and the selection of the preferred solutions will be completed in concert with the development and evolution of the land use plan, the Transportation Master Plan (TMP) and the Environmental Management Plan (EMP). All plans would be finalized at the same time, taking into account the two-way feedback between the various components.

The scope of work is summarized on the following pages and will include input from all pertinent Technical Advisory Committee (TAC) members, including the City of Ottawa, Mississippi Valley Conservation (MVC), Ministry of Natural Resources (MNR), and Ministry of the Environment (MOE). The scope of work is general in nature with the intent that work will be undertaken in a manner that will satisfy the requirements of the planning and EA process as well as City and agency requirements.

Objectives:

The process to be followed for each element of the study would be the EA planning process for Phase 1 & 2 including:

- Inventory of existing conditions, opportunities and constraints;
- Evaluation of alternatives;
- Selection of preferred alternative

The process will include the necessary coordination with the Land Use Plan, Transportation Plan, Environmental Management Plan, as well as the required public contact and documentation. In addition to satisfying the EA process requirements, the analysis will identify the impact of the proposed development on the environment, and both existing and planned infrastructure.

A comprehensive analysis of the alternatives will be completed and documented, in support of the preferred alternative. A cost-benefit analysis will be prepared as part of the evaluation.

Development of the preferred alternatives will include identification of specific projects or project modifications that will be required in support development, including the approval process, costs, phasing, and probably timelines. Any interim solutions will also be identified at this point.

The study will be completed in accordance with the following key principles for successful environmental assessment planning:

- Consultation
- Analysis of off-site impacts on existing infrastructure
- Develop a reasonable range of alternatives for on-site services
  - Evaluation of stormwater management alternatives included in the EMP study will be summarized in the master servicing document.
  - Watermains, storm sewers, and sanitary sewer distribution system options that are within proposed road corridors are deemed to have no measurable variables with respect to the environment or social impact, and therefore the most efficient network will generally be presented.
- Consider the impact on all aspects of the environment (social, fiscal, and natural)
- Systematic evaluation
- Clear documentation
- Traceable decision making

Existing Conditions:

An inventory of existing conditions for the study area will be prepared including:

1. Land Ownership Plan with boundary information
2. Air photo
3. Topographical mapping
4. A drawing with all existing water, wastewater, storm, and utility plant. The plan will include existing facilities, planned facilities, and modelling information on both the existing conditions and planned growth.
5. An inventory of existing natural environment conditions will be prepared as part of the EMP Scope of Works; these findings will be used, as appropriate, to develop servicing solutions.

The resulting information will be consolidated into an Existing Conditions Plan and report that will identify specific constraints and opportunities in the study area. In turn, this will be used to develop a Land Use Plan, and to guide preparation of the alternative servicing solutions.

Wastewater:

Following is the proposed wastewater evaluation process:

1. The latest sanitary sewer model for the area will be obtained from the City.
2. The model will be updated as required to account for the proposed development.
3. Analysis of downstream impacts from development will extend to the March Road PS.

4. The capacity and condition of existing infrastructure will be identified through analysis and evaluation of information provided by the City. Design alternatives will be investigated and analyzed, including:
    a. Extension of a new trunk sewer in March Road to the East March Trunk;
    b. Conveyance of wastewater from the low-lying lands along the east boundary (near the railway corridor) to the Briar Ridge Pump Station;
    c. Investigate the cost-benefit of constructing a new local pump station conveyed to a new sewer in March Road.
5. Operational issues with retaining or upgrading existing infrastructure will be part of the evaluation.
6. Investigate and make provision for any adjacent servicing needs. This means providing residual infrastructure capacity and integrating design elements to achieve reduced costs.
7. Sewer sizes, elevations, grades and catchment boundaries are to be shown on drawings. An Overall Servicing Plan will be prepared that shows the water, wastewater and stormwater infrastructure.
8. The expected timing of improvements, estimated cost, and the conditions that initiate a need shall be listed.
9. The analysis and solutions will identify any pump station requirements, locations and elevations, overflows, HGL analysis and redundancy requirements.
10. Servicing conflicts and water crossing requirements will be identified.
11. Operational issues will be considered (i.e. initial low flow, corrosion, etc.).

<u>Water:</u>

The currently proposed infrastructure for the area may be found in the City's Water Master Plan Update, and in recent design studies. The phasing and staging of infrastructure proposed in these studies will form the basis for the Kanata North Urban Expansion Master Servicing Study.

Anticipated development levels in the entire WUC, including and excluding the Kanata North Expansion Community, will be provided by the City. Development levels will be provided to 2031 and to Build-out levels.

It is proposed that low and high unit water demand rates will be utilized to determine the sensitivity of the staging/phasing plan to water demands. The low demand rates can be based on those included in the Zone 3W PS report while the high demand rates would be based on the City's current design guidelines. The City needs to confirm that this approach is acceptable.

The following are a series of issues that should be accounted for in the water analysis.

1. Water analysis should account for recent initiatives by the City for this area.

2. The City is to provide updated population projections and distributions.

3. The analysis / solutions will identify locations (if any) for storage or pumping facilities. Coordination with City Staff on system-level opportunities that may have implications on servicing such as interconnection of pressure zones.

4. Staging, looping strategies or temporary installation of any facilities to address operational issues such as initial low flows or temporary dead ends will be analysed and identified.

Hydraulic simulation of key failure scenarios will be required to support sizing and configuration of trunk level and other key infrastructure.

5. The City is to provide the latest water model of the WUC water system that is currently being used to assess pumping requirements for the new pump station. Although future growth has been included in the model, more detail is required for the Kanata North Urban Expansion. Servicing provisions for potential urban expansion beyond the subject lands will be considered but not the primary focus of the model update. The model will be adjusted as required.

6. An implementation plan concept will be developed to show how the water distribution system needs to be developed.

7. A pressure contour map showing basic-day and peak-day pressures under average and peak-hour conditions for the year 2031 will be developed.

8. The expected timing of improvements, estimated cost and the conditions that initiate the need will be documented.

Storm Drainage:

The proposed scope of work for stormwater servicing follows:

- Prepare pre and post development condition drainage plans.
- Prepare a Servicing Plan of the internal storm sewer network with a solution for both the major and minor drainage systems.
- Analyze the 100-year storm sewer hydraulic grade line.
- Ensure conformance to the Grade Control Plan and any grade-raise restrictions
- Identify the major system storage requirements (surface ponding).
- Integrate the design with findings from the Environmental Management Plan.
- Establish, in conjunction with wastewater and water services, a preferred minor system (storm sewer) sizing and configuration plan including profiles with HGL, original ground and proposed grade that is free of conflicts from other infrastructure components. Sizing will be performed using a combination of Rational Method spreadsheets and/or hydrologic/hydraulic modelling (SWMHYMO/XP-SWMM).
- Hydraulic grade line elevations are to be provided for the 5-year and 100-year storms along the recommended trunk sewer alignments.
- Peak flow and depth of flow along the major-system for the 100-year storm are to be provided for all road sections of the major system to ensure compliance with Sewer Design Guidelines criteria.
- A comparison of end-of-pipe SWM facilities should be undertaken to identify the preferred option.
- Establish a functional-level design for SWM facilities identifying the preferred sizing, configuration and operating levels, using the recommendations of the EMP, MOE, and City of Ottawa design guidelines. Sediment drying areas, access roads as well as inlet and outlet structures will be presented on an individual figure with a cross section of the facility.

- Characterize and delineate the overall catchment area and constraint boundaries (detailed topography, environmental protection zones, flood plain, embankment areas, geotechnical constraints, aquatic habitat conditions, existing land uses, etc.).

Additional specific issues that will be addressed include:

1. Any submerged outlets need to be evaluated from a maintenance and hydraulic perspective.
2. Discussions with city staff will be required in regards to the design events and criteria to be used in determining the major-minor drainage. Dynamic modelling will be used to simulate and evaluate alternatives. Detailed hydrologic and hydraulic assumptions will be presented, including a summary of all the key parameters. The results of the modelling will be summarized in tables.
3. The proposed surface elevations, HGL, pipe sizes, slopes and obvert/invert elevations will be presented on the Storm Drainage Area Plan.
4. Preferred SWM Facility locations will be identified, with consideration for using rural lands.
5. The Drainage and Wastewater Services Division will be circulated, with ongoing coordination to ensure their requirements are met and implemented,

Process:

As noted above, the Master Servicing Study will be developed through a step-by-step process, in conjunction with the Community Design Plan (CDP), Environmental Management Plan (EMP), and Transportation Master Plan (TMP) through the integrated planning and EA process. The process is iterative and incremental by its very nature as alternative solutions are developed, analyzed and discussed amongst the stakeholder groups.

This process, the interrelationship of the various components, and the schedule for completion of the studies are included as Figure 3 and Figure 4 of the Kanata North Urban Expansion CDP Terms of Reference (copy attached). Reporting alternatives and conclusions will be completed in stages. A consolidated report documenting the process, outlining the solutions, and classifying the various required projects will be the final product.

The impact on planned and existing infrastructure will be identified. Any upgrades, whether new or incremental, will be determined. Alternative and selected solutions will be developed. The analysis and solutions will be developed in accordance with City of Ottawa Sewer and Water Design Guidelines, criteria and practices. Geotechnical information related to sewer and water construction will be in accordance with the City of Ottawa Geotechnical Investigation and Reporting Guidelines.

The resulting documentation will identify timing, costs and staging of major infrastructure works, including any interim solutions. The approval requirements and process for implementation will also be outlined.

Deliverables:

The deliverables for the project include:

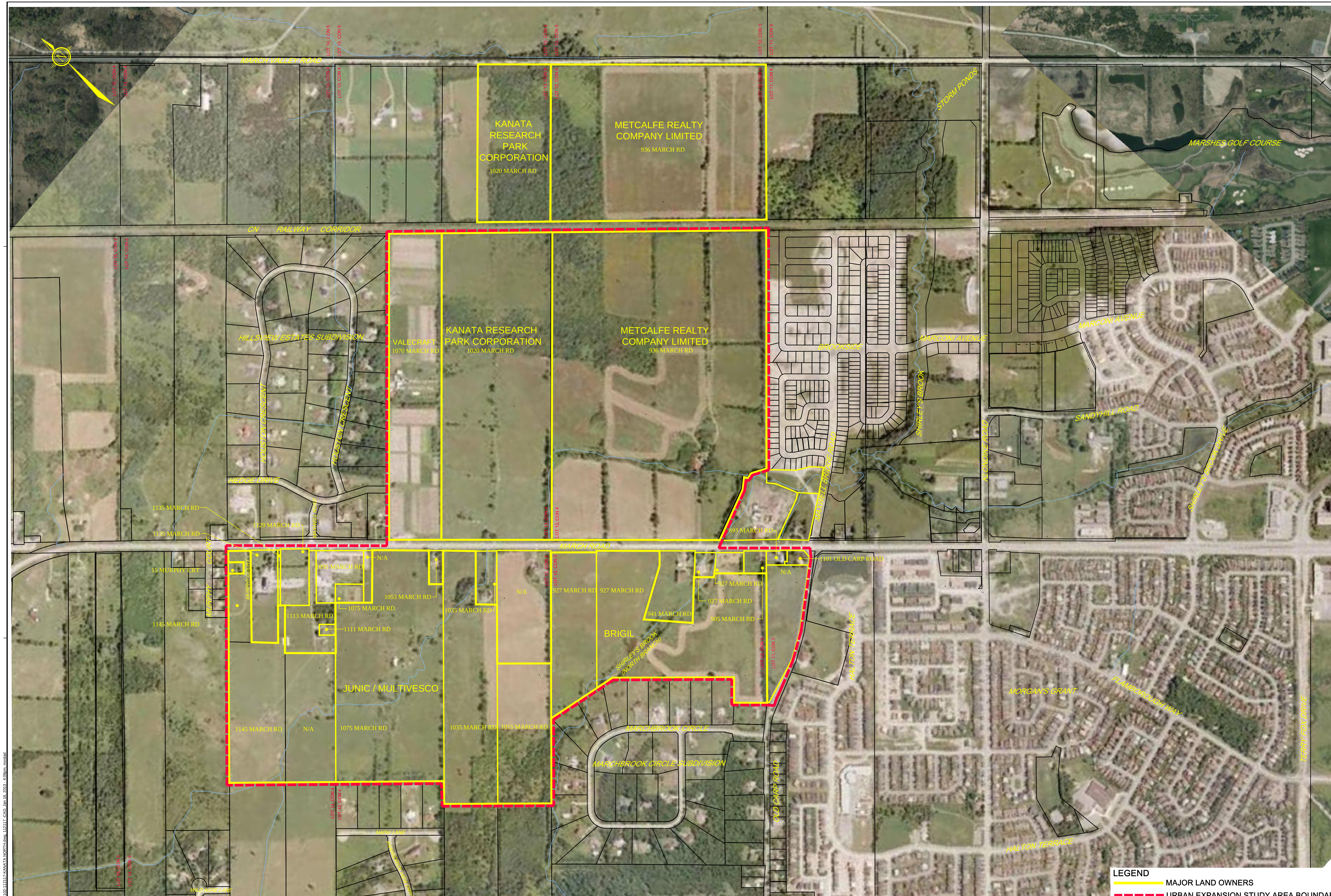
A detailed Master Servicing Study prepared following the requirements of the Class EA process that details storm drainage, wastewater, and water infrastructure needs in support of the proposed development. This report will include but not be limited to:

1. Master Grade Control Plan(s), identifying fill constraint areas;
2. Major System Flow Routing Plan;
3. Trunk Storm Sewer Distribution Plan;
4. Trunk Sanitary Distribution Plan;
5. Trunk Water Distribution Plan; including the delineation of pressure zone boundaries, storage facilities, pump stations or pump station expansions.
6. Master Stormwater Management Plan, including conceptual SWM facility designs, and
7. Digital copies of all models used for the analysis of the proposed infrastructure.

Prepared by:

NOVATECH ENGINEERING CONSULTANTS LTD.

January 16, 2013
September 9, 2013 (Comments addressed)



LEGEND

- MAJOR LAND OWNERS
- URBAN EXPANSION STUDY AREA BOUNDARY

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.

NOTE::
THIS PLAN HAS BEEN COMPILED USING LEGAL INFORMATION OBTAINED FROM VARIOUS SITE PLAN DEVELOPMENTS. REFER TO LEGAL DIRECTORIES IN NECL JOB £'s 103106, 105068, 98111 AND 102095. ALL LEGAL LIMITS DEPICTED HERE ARE APPROXIMATE. CONFIRM ALL LEGAL BOUNDARIES PRIOR TO UNDERTAKING DESIGN WORK IN ANY OF THESE AREAS.

No.	REVISION	DATE	BY
No.	UPDATED OWNER INFORMATION	2012/06/11	EB

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DESIGN	X
CHECKED	X
DRAWN	WLS
CHECKED	X
APPROVED	X

SCALE
1 : 4000
(B1 PLOT)

KANATA NORTH URBAN EXPANSION AREA CDP

STUDY AREA

PROJECT No. 112117-6
DATE NOVEMBER, 2012
DRAWING No. FIGURE 1

PLANB1.DWG - 1000mmX707mm

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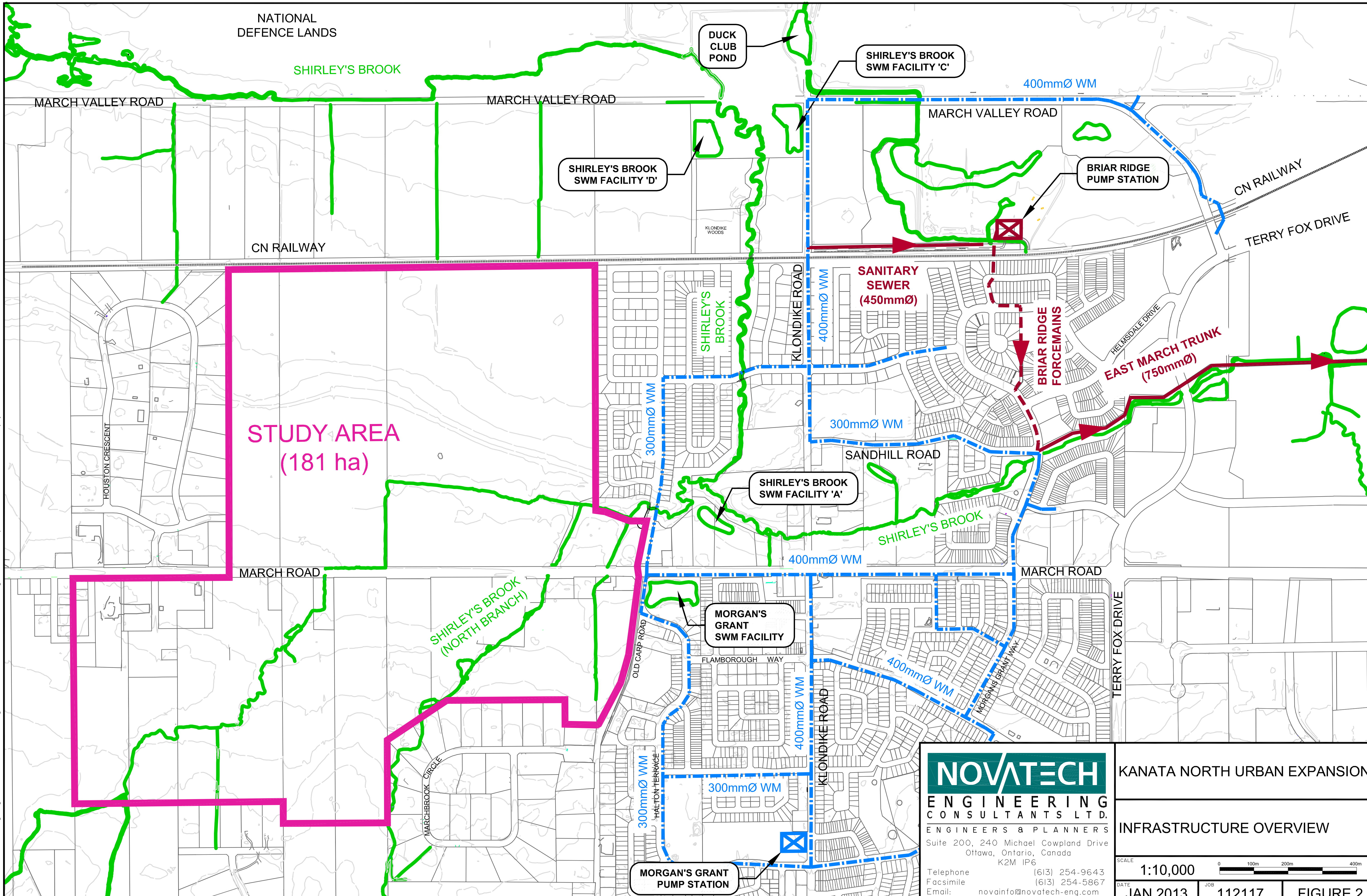

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KANATA NORTH URBAN EXPANSION STUDY AREA CDP
Class EA and Planning Act Processes

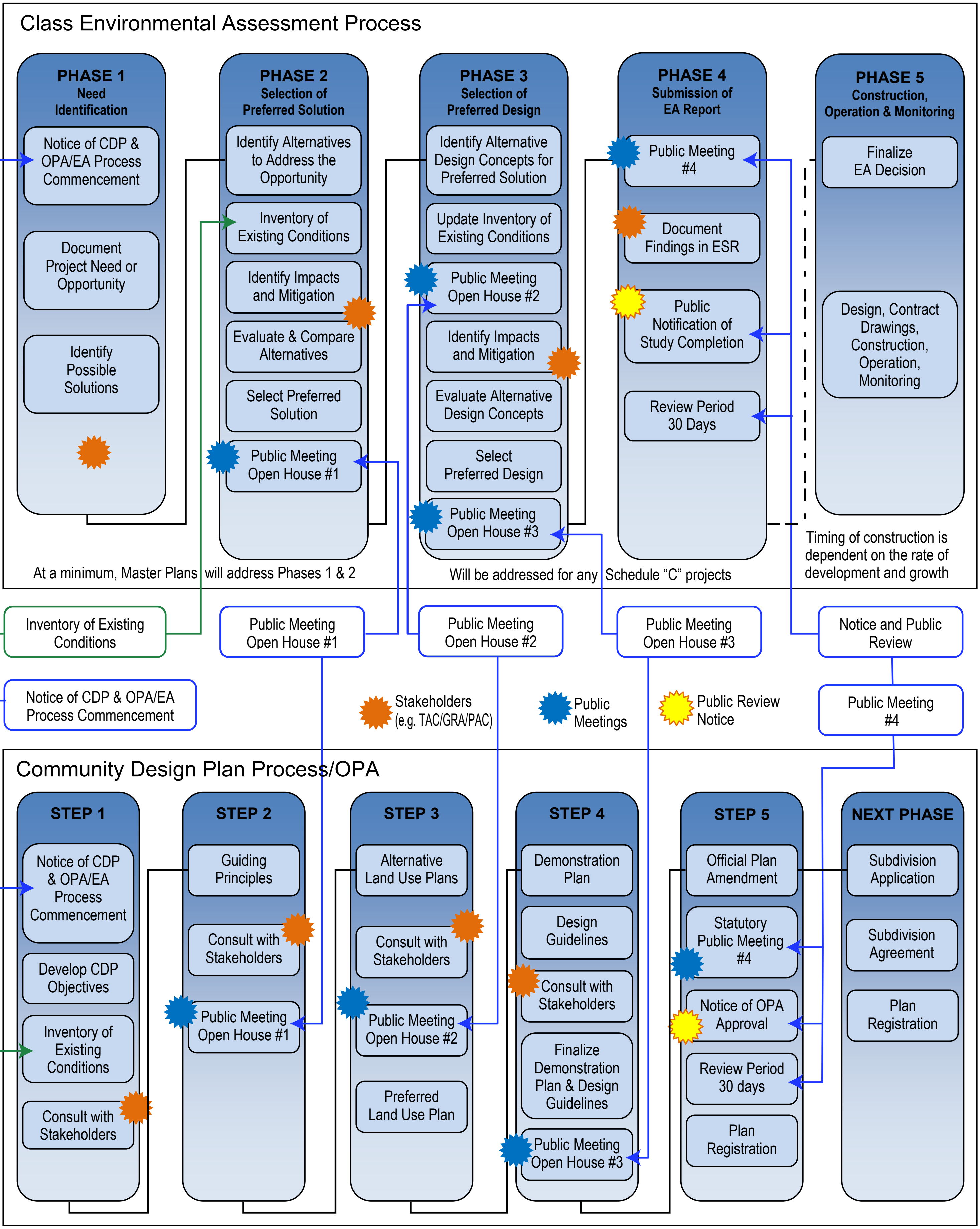

Figure 3

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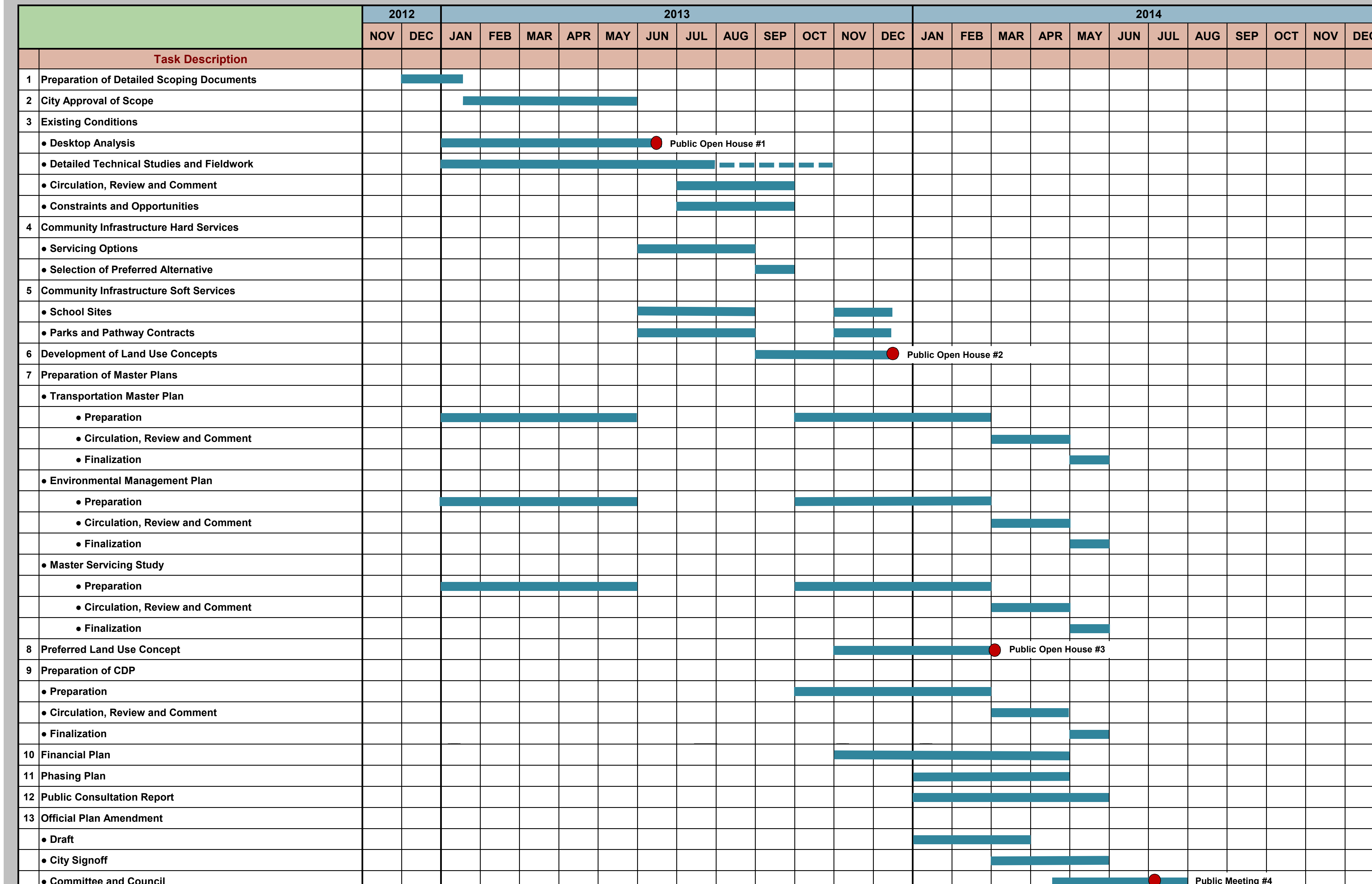
Kanata North Urban Expansion Study Area CDP

Project Work Plan and Schedule



● **Public Meeting**

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FIGURE 4

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Engineering

- Land/Site Development
- Municipal Infrastructure
- Environmental/ Water Resources
- Traffic/Transportation
- Structural
- Recreational

Planning

- Land/Site Development
- Municipal
- Planning Documents & Studies
- Urban Design
- Expert Witness (OMB)
- Wireless Industry

Kanata North Urban Expansion Study Area Community Design Plan Master Servicing Study

Existing Conditions Report

Municipal Infrastructure

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KANATA NORTH URBAN EXPANSION STUDY AREA COMMUNITY DESIGN PLAN MASTER SERVICING STUDY

EXISTING CONDITIONS REPORT

MUNICIPAL INFRASTRUCTURE

Prepared By:

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November 2013

Novatech File: 112117
R-2013-127

NOVATECH
ENGINEERING
CONSULTANTS LTD.

December 4, 2013

City of Ottawa
Planning and Growth Management Department
110 Laurier Avenue West
Ottawa, ON K1P 1J1

Attention: **Wendy Tse, MCIP, RPP, LEED Green Associate**

Dear Madame:

Reference: **Kanata North Urban Expansion Study Area**
Our File No.: 112117

Submitted herein is a Final Kanata North Urban Expansion Study Area Master Servicing Study Existing Conditions Report. This report has been revised per City comments dated November 7, 2013.

Should you have any questions or required additional information, please do not hesitate to contact the undersigned.

Yours truly,

NOVATECH ENGINEERING CONSULTANTS LTD.

Cara Ruddle, P.Eng.
Project Manager

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EXECUTIVE SUMMARY

This report has been prepared in accordance with the Scope of Work documents for the Kanata North CDP, the purpose of which is to document the existing municipal infrastructure for the Study Area. The Kanata North CDP lands are generally located north of Old Carp Road, west of the CN railway corridor, south of Murphy Court, and east of the Marchbrook Circle Subdivision.

The purpose of this report is to compile an overview of the existing high-level water, sanitary, and utility infrastructure that currently services land in the vicinity of the study area. The report establishes the baseline conditions upon which future design and analysis occur.

The study area is located at the northern boundary of the 2W pressure zone, with a 400mm watermain immediately adjacent the site in March Road. Line pressure is generally good, and is likely suitable to service the entire study area. The City has recently completed several projects in the West Urban Community that improve water supply and system robustness. The Morgan's Grant Pressure Zone is located south and west of the study area and serves a residential enclave above 90m ground elevation. Alternative design solutions will be prepared and evaluated in future reporting to address issues of supply, reliability, and pressure to the study area. Off-site impacts on the City supply network will be analyzed at that time.

The March Pump Station services North Kanata, supplied from a network of trunk sewers. Planned upgrades to this facility will significantly increase residual capacity, by routing the Marchwood Trunk directly into the North Kanata Trunk with a gravity connection. Moderate residual capacity is available in both the East March Trunk and the Marchwood Trunk. Future analysis will evaluate the preferred wastewater route. The Briar Ridge Pump Station is located at the north end of the East March Trunk sewershed. Wastewater flow generation will use parameters recently agreed upon by a City technical advisory committee. The values are deemed reasonably conservative, and provide consistency of analysis. Next steps involve preparation of alternative design solutions, their evaluation, and ranking thereof.

Pole-mounted Hydro Ottawa infrastructure is located on the east side of March Road, together with Bell and Rogers plant. Improvements to the pole line are likely required in conjunction with development of the study area and/or reconstruction of March Road. Hydro One does not have any infrastructure in the study area. A high pressure gas line is located on the west side of March Road. All utilities report they have adequate infrastructure to support development expansion.

1.0 INTRODUCTION

The purpose of this report is to document existing infrastructure within and adjacent to the study area, and to summarize relevant information from a review of various infrastructure studies and investigations that have been completed for the West Urban Community. The works have been prepared for and funded by the Kanata North Land Owners Group (KNLOG), which is comprised of four separate landowners within the study area; listed alphabetically the sponsoring landowners are Group Brigil, Junic/Multivesco, Metcalfe Realty, and Valecraft Homes.

This report has been prepared by Novatech Engineering Consultants Ltd., on behalf of the Kanata North Landowner's Group and in support of the Kanata North Community Design Plan. It is hereby acknowledged that Metcalfe Realty Company Limited, J.G Rivard Limited and 8409706 Canada Inc. (Valecraft Homes), 3223701 Canada Inc. and 7089121 Canada Inc. (Junic/Multivesco) can rely upon and utilize this report for the purpose of obtaining approval of the community design plan and for their own use to seek development approval.

It is further acknowledged that future confirmed participating landowners within the Kanata North Landowner's Group, can rely upon and utilize this report for the purpose of obtaining approval of the community design plan and for their own use to seek development approval.

Figure 1 is an aerial photo from 2011 showing part of North Kanata. The Study Area is outlined for identification, and is approximately 180 hectares with all ownerships combined.

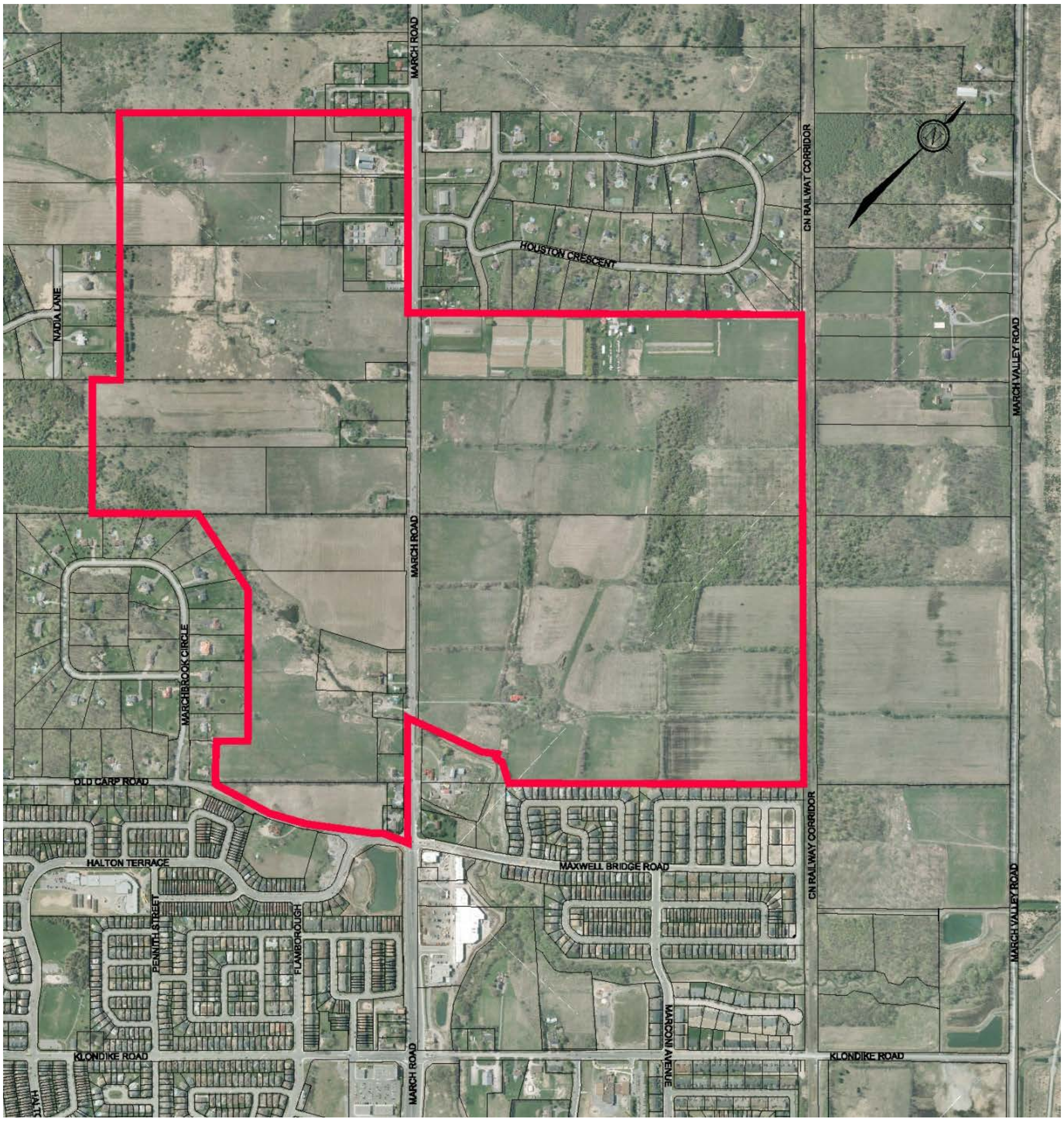


Figure 1: Study Area Aerial View

Information herein was prepared in accordance with the approved Scope of Work Documents for the Master Servicing Study component of the Community Design Plan (CDP) and was prepared to satisfy Phase 1 of the Class Environmental Assessment (EA) process.

This is a desk-top review of the existing infrastructure conditions that are deemed pertinent to the urbanization of the Kanata North Lands. The following sections discuss the water, sanitary and utility infrastructure components.

Figure 2 is a colour-coded image of the Study Area topography. Lower elevation to the east is shown in blue (~70m), while higher ground to the west is shown in red (~90m). A full-size Topographic Plan is attached in **Appendix C**.

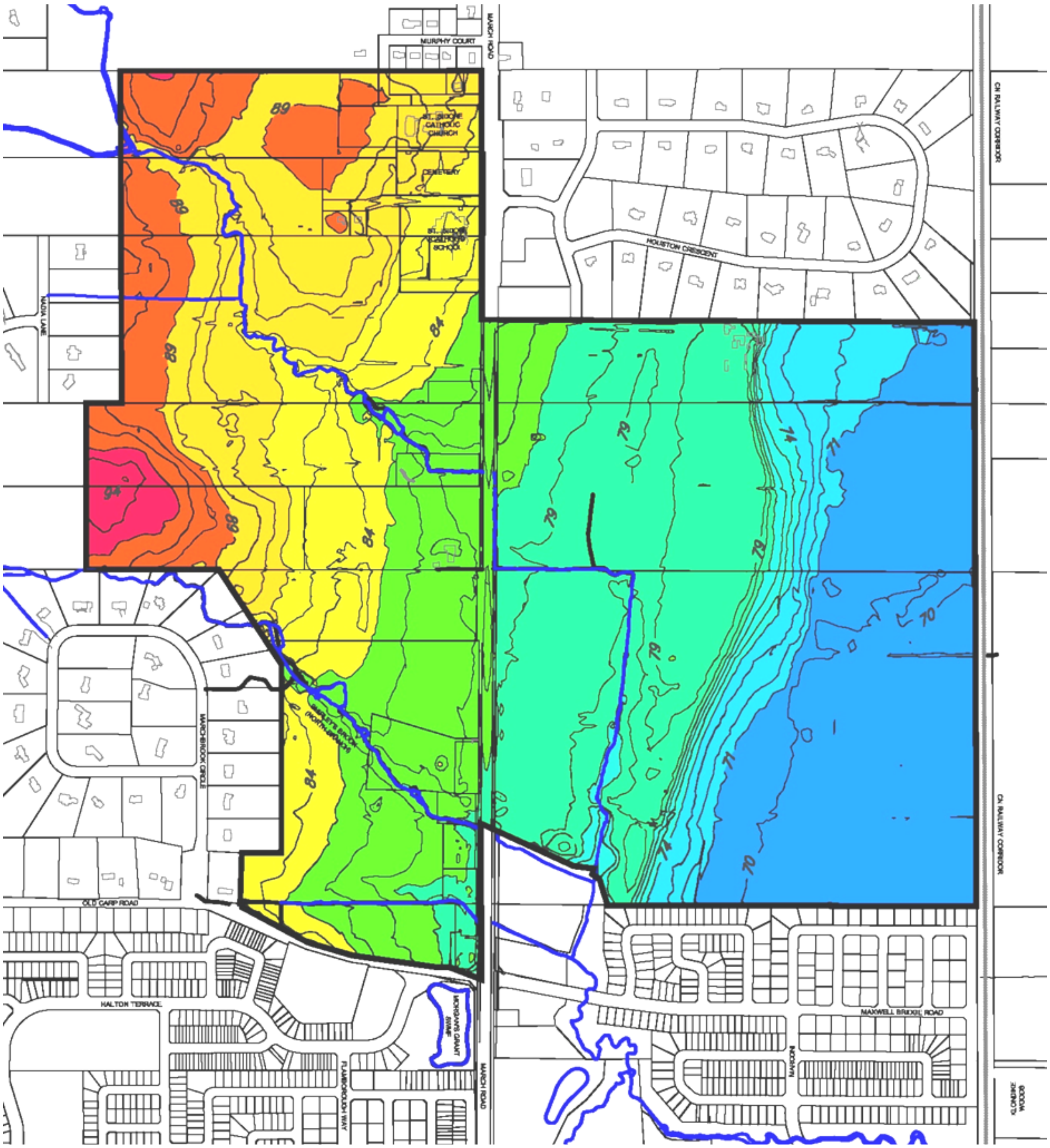


Figure 2: Study Area Topography

2.0 WATER INFRASTRUCTURE

2.1 Background

Water for the majority of City of Ottawa residents is taken from the Ottawa River, where it is treated at the Lemieux Island and Britannia Water Purification Plants and then distributed through pumping stations, storage facilities and over 2,500km of watermains. Water distribution systems operate under pressure, and different pressure zones are required to provide appropriate levels of service to all parts of the City. Pressures are maintained in the system by either pumping or by using elevated storage. Due to the complex operation of the City's many different pressure zones, planning and analyses are needed for each major pressure zone, and for the system as a whole.

Design of the City of Ottawa's water supply system has evolved over the years based on management practices, legislative requirements, engineering methods, and public health and safety considerations. The current design practices have allowed the City to establish a water supply system that provides an excellent level of service and value to the residents and businesses of the City of Ottawa. Planning of the public water system has been developed based on the following basic set of objectives:

- Quality (to provide drinking water that meets or exceeds all federal and provincial health guidelines, standards and regulations);
- Quantity (to provide sufficient water at adequate pressure to meet the needs of the existing population and future growth, taking into account patterns of peak demands and fire-fighting requirements);
- Reliability (to ensure a constant supply of water even under emergency conditions such as power failures, or failures of individual system components);
- Demand Management Planning (to pursue demand management opportunities as a cost effective means of ensuring the long-term sustainability of the water supply system);
- Affordability (to minimize life-cycle costs of the water supply system while maintaining appropriate levels of services)

2.2 Existing Water Infrastructure

The Study Area is located at the north end of Kanata in the West Urban Community (WUC), and is bounded by the 2W pressure zone immediately to the south. The Brittania Filtration Plant and Pumping Station service this community from a large diameter feedermain routed through Bells Corners. A second feedermain was recently constructed through Crystal Beach and the NCC Greenbelt to improve system reliability and capacity. Assisted by the Carlington Heights Pumping Station, these two pumping facilities supply water to the WUC.

A north-south feedermain generally follows the Teron Road / March Road corridor towards North Kanata. Between Shirley's Brook Drive and Klondike Road, the water main drops to a 400mm pipe and continues north to the Zone 2W boundary at Old Carp Road. The modelled hydraulic grade line (HGL) in the watermain at March Road and Old Carp Road is presented below in **Table 1** under various operating conditions:

Table 1: Existing Watermain HGL - March Road and Old Carp Road

Operating Conditions	Hydraulic Grade Line (m)
HGL - Maximum	132.0m
HGL - Average	129.3m
HGL - Peak Hour	124.4m
Max Day + Fire (13,000 L/min)	120.6m

The HGL values above were provided by staff, and are intended for guidance only. A system-level analysis will be required once population and demand values are determined.
The Morgan's Grant Pressure Zone is an isolated parcel located west of March Road and south of the Study Area. There is a small local pump station at the intersection of Klondike Road and Wimbledon Way that regulates water pressure (HGL) in this area. The station is needed due to local high topography with ground elevations between 91m and 109m. The Morgan's Grant Pump Station (MGPS) operates with discharge HGL values from 139m to 152m.

The Campeau Drive Pump Station was recently constructed including new suction and discharge headers. The facility is operable, and supports the existing distribution system on an as-needed basis.

Construction on the Hazeldean Road watermain is nearing completion. This large diameter feedermain will soon be operable between Carp Road and Castlefrank Road improving conveyance capacity within the 3W pressure zone.

An existing water distribution schematic taken from the 2013 Draft Infrastructure Master Plan is attached in **Appendix A**, and depicts a skeletonized system for the entire City of Ottawa. Most of the features discussed above can be identified on this high-level drawing. **Figure 3** zooms into the North Kanata area and depicts the Morgan's Grant Pressure Zone and part of the 2W Pressure Zone, in relation to the Study Area.

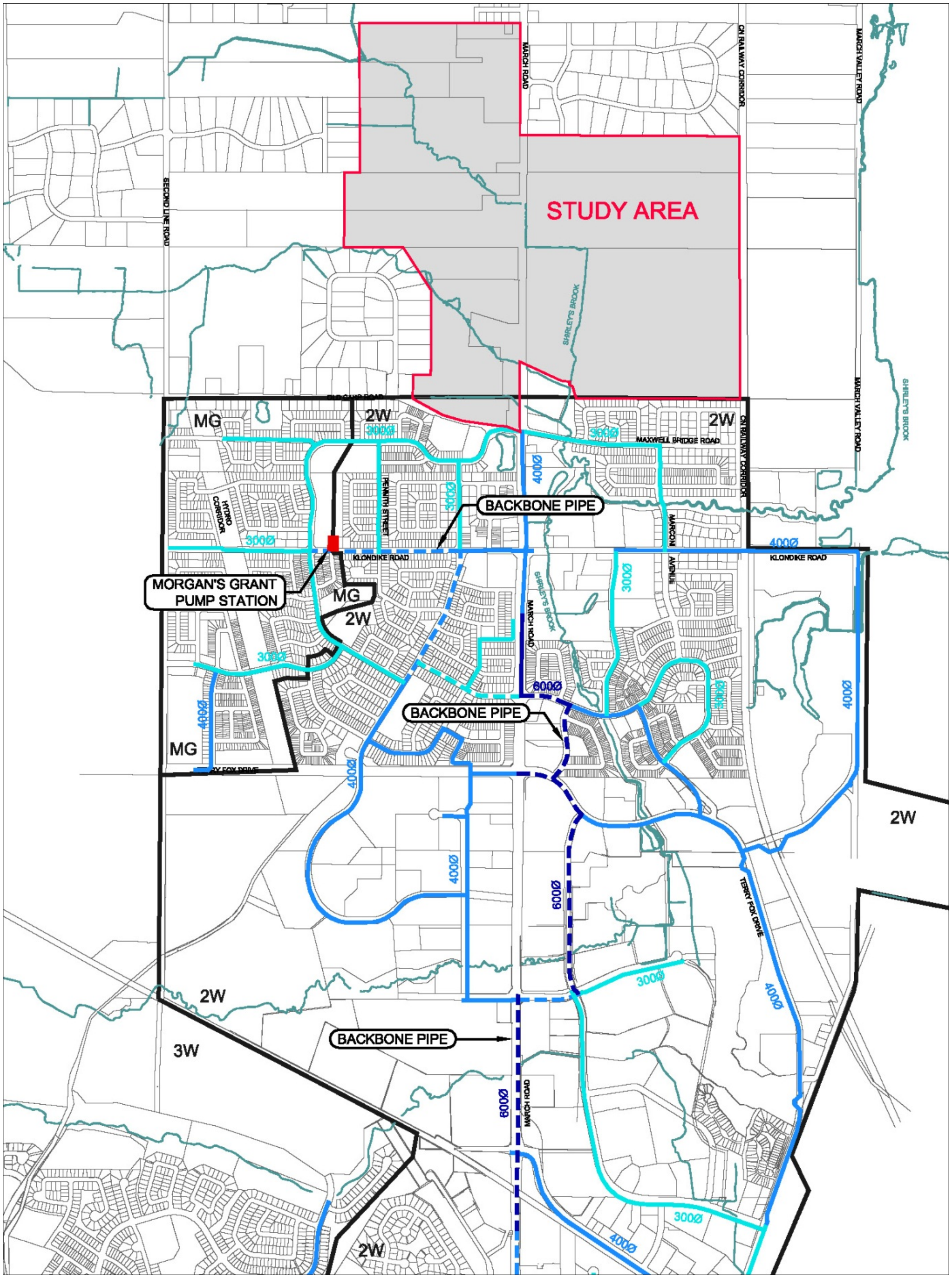


Figure 3: North Kanata Water Distribution Infrastructure

2.3 Planned Water Infrastructure

The City has identified several projects in the 2009 Infrastructure Master Plan to reinforce the current water distribution system. Specific to the WUC, some of these projects will directly affect the Study Area, and have been listed below:

March Road Pipe Upgrades: the March Road Watermain is predominantly a 600mm feedermain system with several short sections of 400mm pipe. These smaller pipe segments restrict capacity, and reduce system pressure in North Kanata. Replacement of the undersized pipes with 600mm conduit was proposed and construction was expected around 2015 in the 2009 IMP. The 2013 Draft IMP states the upgrade is no longer necessary.

Morgan's Grant Secondary Supply and PRV: the objective of this project is to provide a secondary link between the 3W pressure zone and the Morgan's Grant pressure zone. This infrastructure would improve system reliability in the event of mechanical failure at the MGPS. Staff advises this project has not been scheduled. This project is only relevant to the Study Area if it's determined a connection is needed to this pressure zone.

Glen Cairn Pump Station Upgrades & Reservoir Expansion: these are two distinct projects. Staff advises some pump improvements were done recently at the same time as the Campeau Drive facility works. Additional upgrades are expected in the future, the timing and need for which will be strongly linked to growth in the WUC.

No work is currently scheduled on the reservoir expansion. Staff has indicated work on the reservoir will be needed around 2019.

2.4 Next Steps

Many of the planned water infrastructure projects from the 2009 IMP have been constructed within the WUC. Reasonable pressures and reliability looping are available at the boundary of the Study Area, with no apparent design concerns.

Next steps in the watermain analysis will be to recognize zone boundary options, high pressure options and to design the preliminary feedermain sizes for the Kanata North CDP Lands and, in coordination with the City of Ottawa, to assess the impact this development has upon existing infrastructure and to evaluate the timing and need of specific water infrastructure upgrades.

Phase 2 Class EA reporting will identify opportunities and constraints related to developing the Study Area. Alternative designs will be presented, evaluated and ranked. The solutions will need to demonstrate proper reliability (looping), supply (pipe size), pressure (boundary zones), quality (chlorine residual), demand management planning (off-site impacts), and respect for environmental and social features.

3.0 SANITARY INFRASTRUCTURE

Existing sanitary infrastructure that may be affected by the Kanata North CDP process is documented in this section of the report through review of prior studies and recent analysis. The fundamental characteristics and condition of each sewer is reviewed, planned changes that affect the sewer are discussed, and the next steps for analysis are outlined.

3.1 Background

The City of Ottawa West Urban Community (former City of Kanata) sanitary collection network is a relatively modern system of separated gravity sewers and local pumping stations. These facilities discharge into a regional trunk system that carries sewage flow to the Robert O. Pickard Environmental Centre in eastern Ottawa for treatment of wastewater.

Several trunk sanitary infrastructure components within the West Urban Community would be directly affected as a result of development within the study area boundaries. These components potentially include the East March Trunk, Marchwood Trunk, Kanata Lakes Trunk, March Pump Station, Briar Ridge Pump Station, and North Kanata Trunk, all of which drains into the Watt's Creek Relief Sewer that provides service to the entire West Urban Community and empties into the Acres Road Pump Station. Staff has directed the inlet pipe to the March Pump Station is a reasonable boundary limit for wastewater analysis.

A schematic of the existing and planned wastewater collection system is attached in **Appendix B** (taken from the 2009 Infrastructure Master Plan).

3.2 Existing Wastewater Infrastructure

There are three primary trunk sewers that service the Kanata North region, and drain to the March Pump Station. These are the East March Trunk, Marchwood Trunk, and the Kanata Lakes Trunk. **Figure 4** depicts the skeletonized wastewater system north of Highway 417.

A brief description of each trunk sewer follows, along with capacity and probable flow rates. The flow generation and wastewater modelling was completed in 2012 on behalf of the City in the report *West Urban Community – Wastewater Collection System Master Servicing Plan Study* (RVA, July 2012). This document provides the most current sanitary analysis of the entire WUC and establishes a basis upon which both the 2013 Infrastructure Master Plan and the Kanata North CDP can be evaluated. Select values pertinent to the study are summarized in **Table 2**.

The **East March Trunk** (EMT) is a 750mm diameter pipe that extends north from the March Pump Station through the Kanata Research Park to Shirley's Brook Drive, with the upper reach generally following the creek corridor. The pipe has a free-flow capacity of 550 L/s and an obvert elevation of 72.1m at Shirley's Brook Drive. Flow generation and modelling for the City suggests peak flow rates in the EMT of 96 L/s in 2010, and 172 L/s in 2031. This suggests the EMT is currently flowing at approximately 17% of the free-flow capacity, and will reach 31% at built-out. These values do not account for the Study Area lands. The sewer alignment, existing catchment boundaries, and land uses are presented in **Figure 5**.

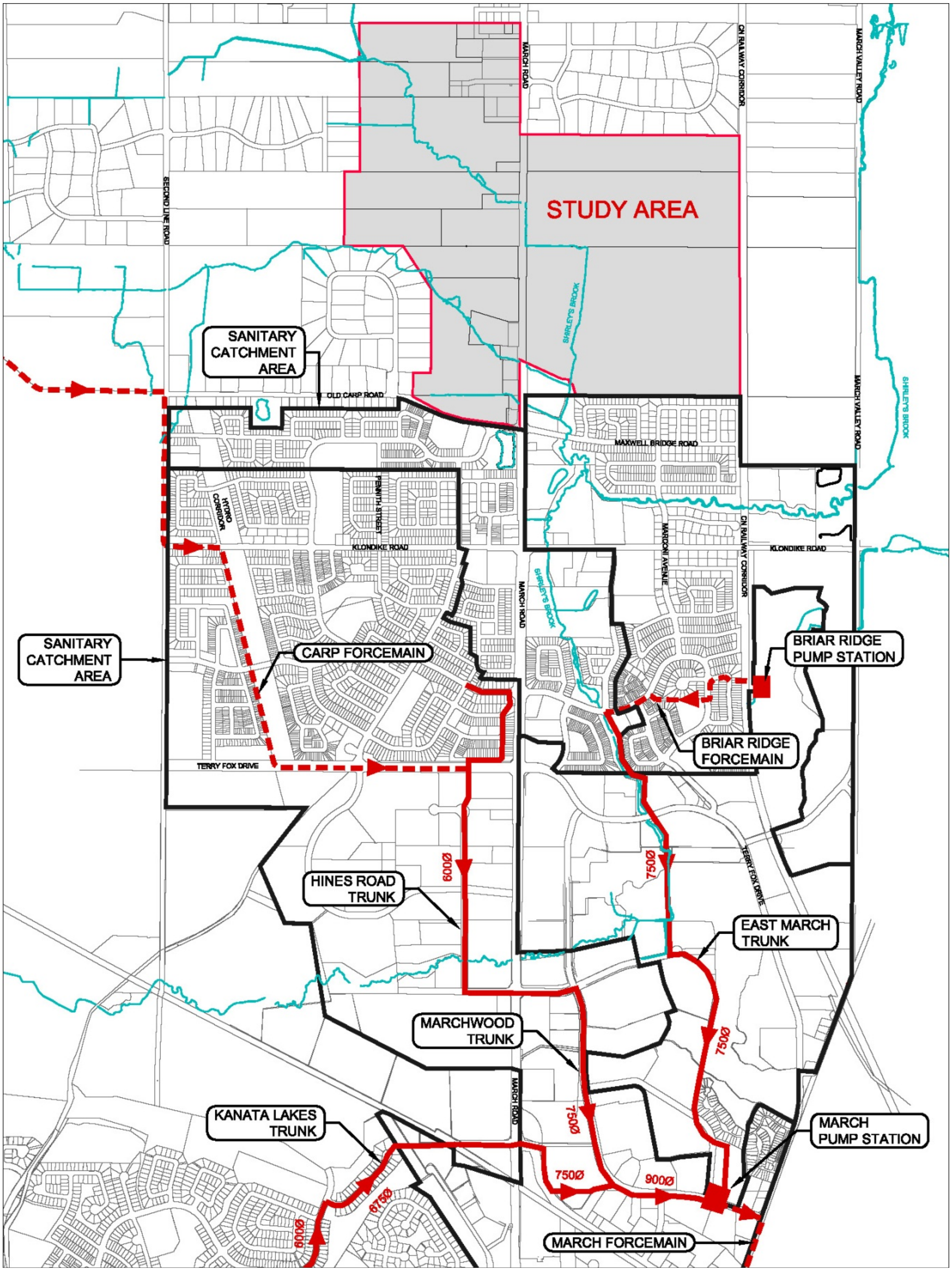
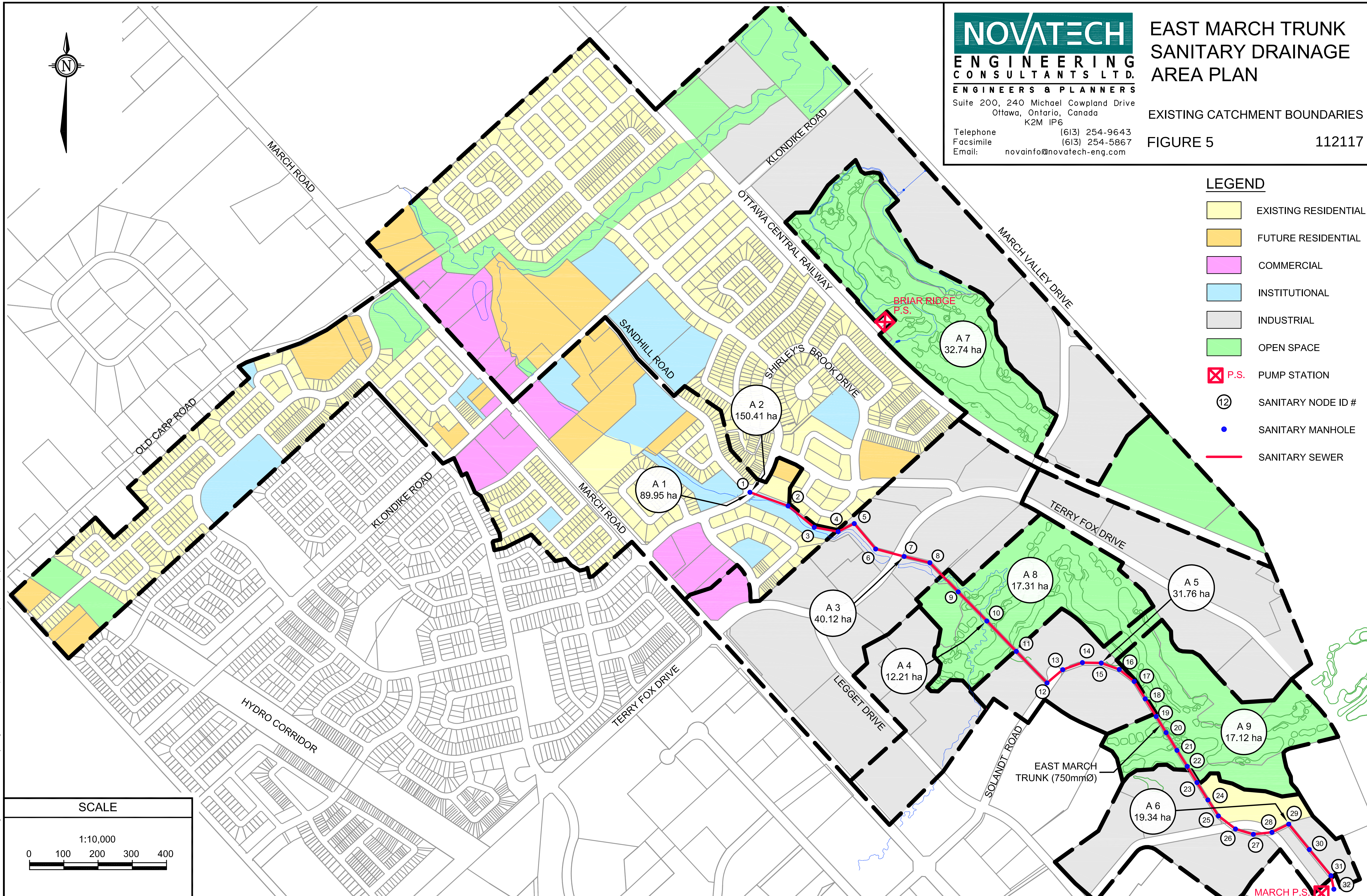


Figure 4: North Kanata Wastewater Collection Infrastructure



M:\2008\108001\CAD\design\East March Sanitary.dwg, 11x17 landscape, Mar 10, 2009 - 1:29pm, kmurphy

SHT11X17.DWG - 279mmX432mm

The **Marchwood Trunk** (MWT) is 900mm in diameter, and generally follows Leggett Drive. Flow from the Kanata Lakes Trunk is intercepted west of Schneider, all of which is conveyed to the March Pump Station. The MWT decreases in size to a 750mm pipe south of Farrar Road; the trunk continues north on Legget, turning west at Solandt Drive and generally services land on the west side of March Road. The upper reach of the MWT is located at the intersection of Solandt and Hines Road with an obvert elevation of 79.7m. The lower-reach of the MWT has a free-flow capacity of 1,100 L/s. Flow generation by the City has an estimated peak flow of 230 L/s in 2010, and 574 L/s in 2031. This puts the free-flow capacity at approximately 21% (2010) and 52% (2031), again excluding any contribution from the Study Area Lands.

The **Hines Road Trunk** (HRT) is essentially a northward continuation of the Marchwood Trunk. The HRT is a 600mm gravity pipe that services lands in North Kanata, and conveys flow from the Carp Forcemain to the Marchwood Trunk and March Pump Station.

The **Kanata Lakes Trunk** (KLT) is a 750mm diameter pipe that conveys flow from lands west and south of the March Pump Station. The pipe obvert is approximately 74.3 where it connects to the Marchwood Trunk on Legget Drive. Capacity calculations in the KLT were not readily available; however this pipe is likely too distant to be of further consideration in the future analysis of the Study Area lands.

The **March Pump Station** (MPS) is located at the downstream end of these trunk sewers with a firm capacity of 490 L/s. City modelling has peak flows of 326 L/s (2010) and 771 L/s (2031). This represents 67% and 157% of the firm capacity. Pumps currently discharge through the March Forcemain, routing flow south along Herzberg Road to the March Road Trunk. There are significant changes that will affect how this facility operates, and the reader is directed to the next section on planned infrastructure for details.

The **Briar Ridge Pump Station** (BRPS) is located south of Klondike Road and east of the railway corridor. This facility discharges into the East March Trunk and has a firm capacity of 183 L/s with three pumps installed. Due to low initial flows, only two of the three pumps are currently installed; as such the station has a temporary firm capacity of 53 L/s. Flow monitoring by City staff will determine when the third pump is required. The facility was constructed with this in mind, and the third pump can be installed on short notice. The sanitary catchment area of the station is shown on **Figure 5**.

Table 2: Existing Capacity and Probable Wastewater Flow

Infrastructure	Ex. Capacity (L/s)	Flow - 2010 (L/s)	Q/Q Capacity (%)
March Pump Station	490	326	67%
Briar Ridge Pump Station	53	32	60%
East March Trunk	550	96	18%
March Wood Trunk	1,100	230	21%

3.3 Planned Wastewater Infrastructure

Phase 2 of the **North Kanata Trunk** (NKT) will extend a 1200mm pipe with a design capacity of 1,290 L/s from the March PS to the temporary cap where Phase 1 construction ended. A gravity connection will be made from the Marchwood Trunk to the NKT, allowing wastewater to bypass the March PS. This measure will significantly reduce flow to the station, thereby increasing residual capacity at the March PS. Construction of the NKT is expected to be complete by 2018 as per the 2013 draft IMP.

The **March Pump Station** (MPS) will be converted to a low-lift facility that connects to the North Kanata Trunk. The March Forcemain will be decommissioned as part of these works. The 2009 IMP suggests construction would occur sometime after 2016. With diversion of the Marchwood Trunk, there will be no urgency to complete this project. The projected 2031 flow in this configuration is 197 L/s, or 40% of the station firm capacity.

3.4 Wastewater Modelling

A hydraulic model of the sanitary sewer system was commissioned by the City in 2010 for the WUC. This resulted in the preparation and issuance of *Wastewater Collection System Dynamic Model – WEST* (Stantec, August 2010). In collaboration with the Technical Advisory Committee (TAC) for that project, several flow generation scenarios were considered. The TAC concluded that Design Flow Scenario 1 was the most appropriate loading condition to evaluate the combination of existing and growth alternatives.

City staff has agreed that wastewater modelling for the Kanata North CDP should use the same flow generation parameters recommended by the TAC. The flow generation parameters are listed below:

Residential Flow, Existing	= 200 L/cap/day
Residential Flow, Future	= 350 L/cap/day
ICI Flow, Existing	= 20,000 L/ha/day
ICI Flow, Future	= 50,000 L/ha/day
I/I Flow, Existing	= 0.35 L/s/ha (Jan 2008 monitored event)
I/I Flow, Future	= 0.28 L/s/ha

Using these flow generation parameters recently established by the City, Novatech analyzed the steady-state hydraulic conditions in the East March Trunk. Early modelling results closely match the City-generated flow rates. Coordination with City staff will confirm if we proceed with proprietary (Novatech) modelling, or build upon the City wastewater model.

3.5 Next Steps

With City concurrence of the existing conditions, multiple wastewater solutions need to be developed and compared. Preparation of an Opportunities and Constraints Plan will help designers identify any areas of special concern.

In ranking alternate solutions, the evaluation categories and criteria must be developed and assigned appropriate weightings. Typically, the broad categories include a ranking for effect on the natural environment, social impact, technical function, and economy. Construction and phasing estimates would be developed for viable solutions.

4.0 UTILITY INFRASTRUCTURE

Select utility companies were circulated a copy of the study area, along with a general description of the intended land use. The purpose of the circulation was to:

- Establish the limits of existing utility infrastructure near the study area;
- Alert the utilities that a CDP is underway, and plan for future development;
- Identify if there are any known constraints to extend utility service.

4.1 Hydro One

Hydro One protects an easement for an aerial transmission line that traverses the western edge of the Morgan's Grant community. The line crosses near the roadway intersection of Old Carp and Second Line, continuing generally in an east-west direction. This infrastructure is approximately 1km west of the study area, and will not be affected by development of the Area 1 lands. Hydro One does not service this territory.

4.2 Hydro Ottawa

Hydro Ottawa confirms they service this territory, and were aware of a pending CDP.

Pole mounted Hydro Ottawa infrastructure was recently upgraded between Klondike Road and Old Carp Road in conjunction with the City-initiated March Road widening. This is a 27kV aerial line located on the east side of March Road, that continues northward past the Area 1 lands. New poles and conductors will likely be required on March Road to modernize the plant, and conform to current Electrical Safety Authority standards; otherwise, there are no initial constraints to line expansion and servicing Area 1.

4.3 Enbridge Gas

Enbridge reports a 6" high-pressure gas main is located on the west side of March Road in the vicinity of Area 1. This is the service main for Constance Bay, and is well suited to service the study area lands. There are no known constraints for gas service.

4.4 Communications

Bell Canada reports they have fibre-optic cable at the intersection of March Road and Old Carp Road. Bell is ready to extend their infrastructure north along March Road, and would likely do so in conjunction with Hydro Ottawa pole upgrades.

Rogers Ottawa advises they have the necessary infrastructure to service this community; they have no design constraints to service the study area lands.

4.5 Closing

The existing utility infrastructure is presented on **Figure 6**. This information was developed in consultation with the respective utility companies, all of whom have indicated that there is adequate proximity and supply to service future development within the study area. The utility firms have requested they are kept apprised throughout the CDP process; but no further investigation or analysis is deemed necessary until detail design.

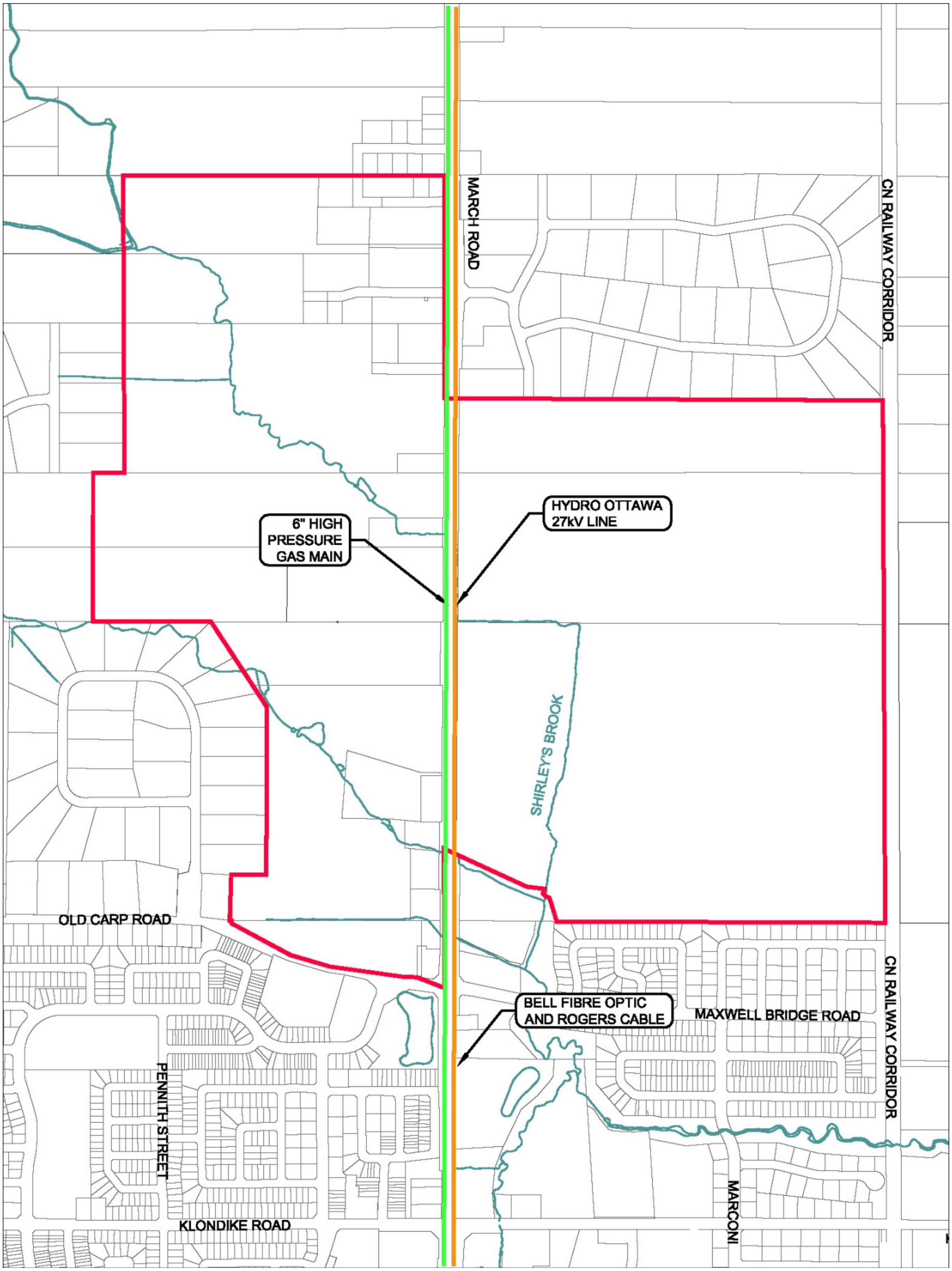


Figure 6: Existing Utility Infrastructure

5.0 SUMMARY AND CONCLUSIONS

The core findings of the existing condition infrastructure review are summarized below:

1. Many of the water infrastructure needs as outlined in the 2009 *Infrastructure Master Plan* have been constructed in the West Urban Community. The system is well serviced and robust. The 2013 *draft Infrastructure Master Plan* provides updated guidance on system priorities.

2. Water infrastructure projects to 2031 that would affect the study area include:
   a. March Road Pipe Upgrades
   b. Glen Cairn Reservoir Expansion

3. Next steps in the watermain analysis will be to analyze options and complete preliminary sizing of feedermains for the Kanata North CDP Lands and, in coordination with the City of Ottawa, to assess the impact this development has upon existing infrastructure and to evaluate the timing and need of specific water infrastructure upgrades.

4. Wastewater infrastructure projects outlined in the 2013 *draft Infrastructure Master Plan* that affect the Study Area are listed below:
   a. Extend North Kanata Trunk to the March PS
   b. Connect the Marchwood Trunk to the North Kanata Trunk
   c. Convert the March PS to a low-lift facility, and decommission the feedermain

5. Wastewater flow generation parameters developed by the City technical advisory committee for the WUC model will be used in modelling Kanata North CDP works.

6. Sanitary modelling will be used in the next steps of this project to:
   a. Design options for servicing the Kanata North CDP with sanitary infrastructure
   b. Assess the off-site impacts to existing infrastructure
   c. Evaluate the timing of infrastructure upgrades

7. Utility infrastructure summary:
   a. Hydro Ottawa pole-mounted lines are located on March Road; upgrades to the hydro infrastructure are likely required to improve system reliability.
   b. Hydro One does not have any infrastructure in the study area.
   c. Enbridge has a high-pressure line on March Road that to service the study area.
   d. Bell Canada and Rogers Ottawa infrastructure are located on March Road, and can be readily expanded to service the study area development.

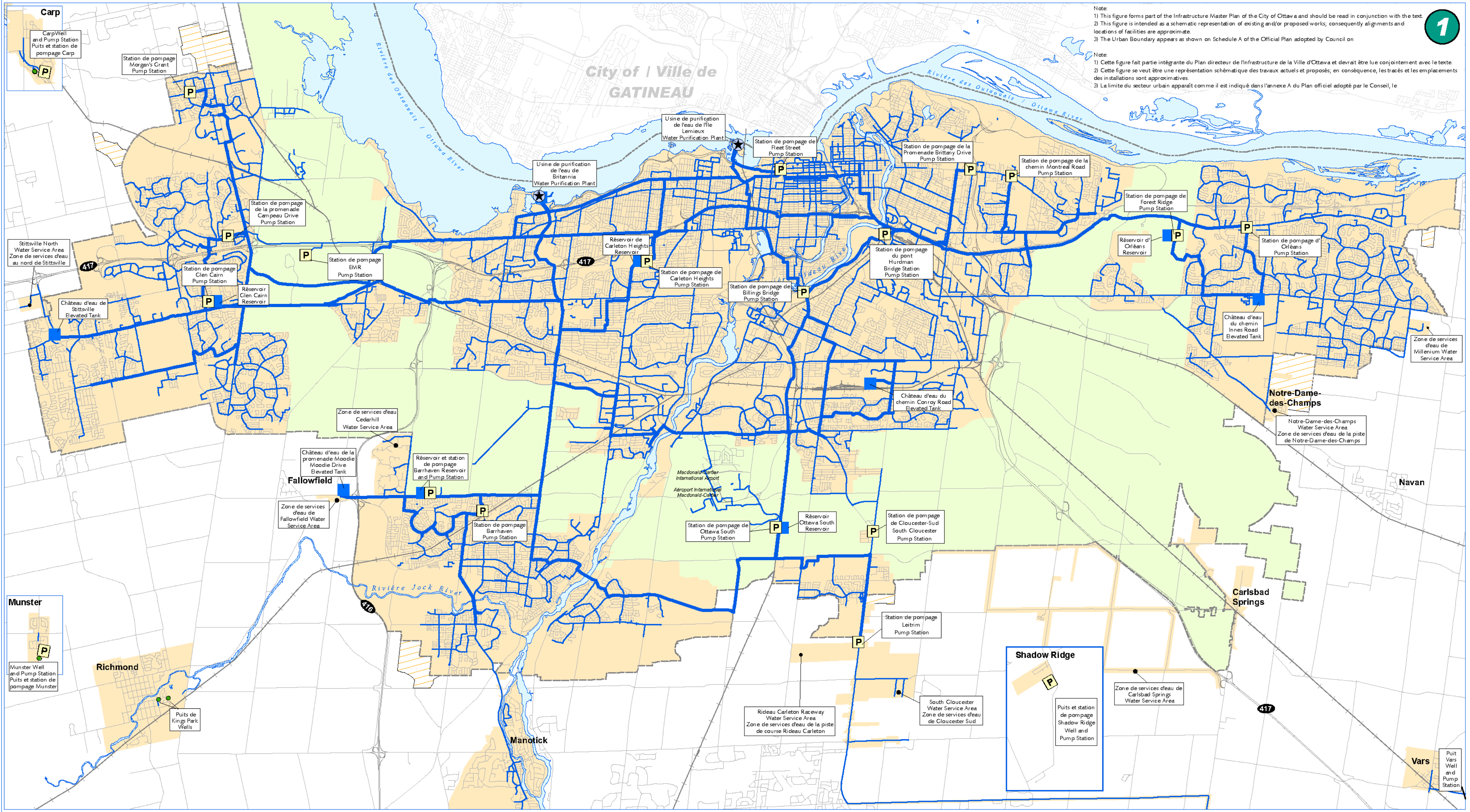
References

1. Infrastructure Master Plan, City of Ottawa (June 2009)
2. Study Report, West Urban Community – Wastewater Collection System Master Servicing Plan – Study, R.V. Anderson Associates Ltd. (July 2012)
3. Infrastructure Master Plan Update – Wastewater Collection System Assessment, Stantec (April 2008)
4. North Kanata Sanitary Sewage Infrastructure Upgrade Study, Functional Design Report, R.V. Anderson Associates Ltd. (August 2001)
5. Briarridge Sanitary Pumping Station, Pre-Design Report, Cumming Cockburn Ltd. (November 2000)
6. Wastewater Master Plan, RMOC (1997)
7. 2W/2C Feedermain Link Class EA Study and Functional Design, Stantec (December 2007)
8. Zone 3W Pump Station Study and Functional Design, Stantec (April 2004)
9. Water Master Plan, RMOC (1997)

Appendix A – Water Distribution System Schematics

1) **2013 Draft Infrastructure Master Plan - Figure 1**
   Existing Water Distribution System: Schematic

2) **2013 Draft Infrastructure Master Plan - Figure 4**
   Growth Projects 2013-2031 - Water Distribution System: Schematic



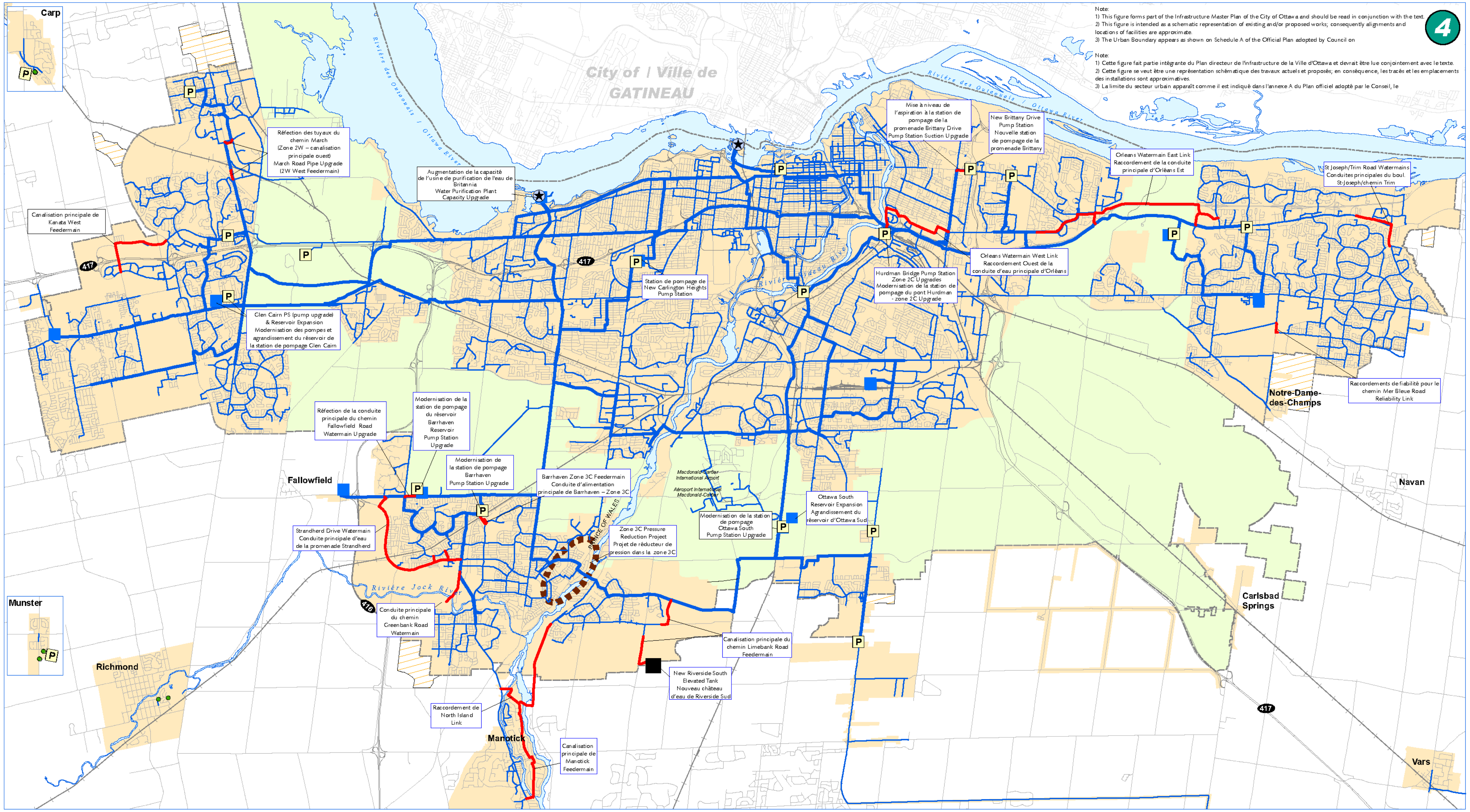
INFRASTRUCTURE MASTER PLAN - Figure 1
Existing Water Distribution System: Schematic

PLAN DIRECTEUR DE L'INFRASTRUCURE Figure 1
Réseau de distribution d'eau existant : schéma

- Water Pump Station / Stations de pompage
- Treatment Plant / Usine de traitement
- Water Storage Facility / Réservoirs d'eau
- City Operated Well / Puits exploités par la Ville
- Backbone Watermain / Conduite principale de distribution d'eau
- Distribution Watermain / Conduite de distribution d'eau
- Urban Boundary (Official Plan)
- Greenbelt / Ceinture de verdure
- Public Service Area / Zone de desserte
- Urban Expansion Areas / Zone d'expansion urbaine

1 0.5 0 1 2 3 4 5 Km

Prepared by: Planning and Growth Management Department, Mapping & Graphics Unit, 2013
Préparé par: Service de l'urbanisme et de la gestion de la croissance, Unité de la cartographie et des graphiques, 2013



INFRASTRUCTURE MASTER PLAN - Figure 4

Growth Projects 2013-2031 - Water Distribution System: Schematic

PLAN DIRECTEUR DE L'INFRASTRUCURE Figure 4

Projets de croissance 2009-2019 - Réseau de distribution d'eau : schéma

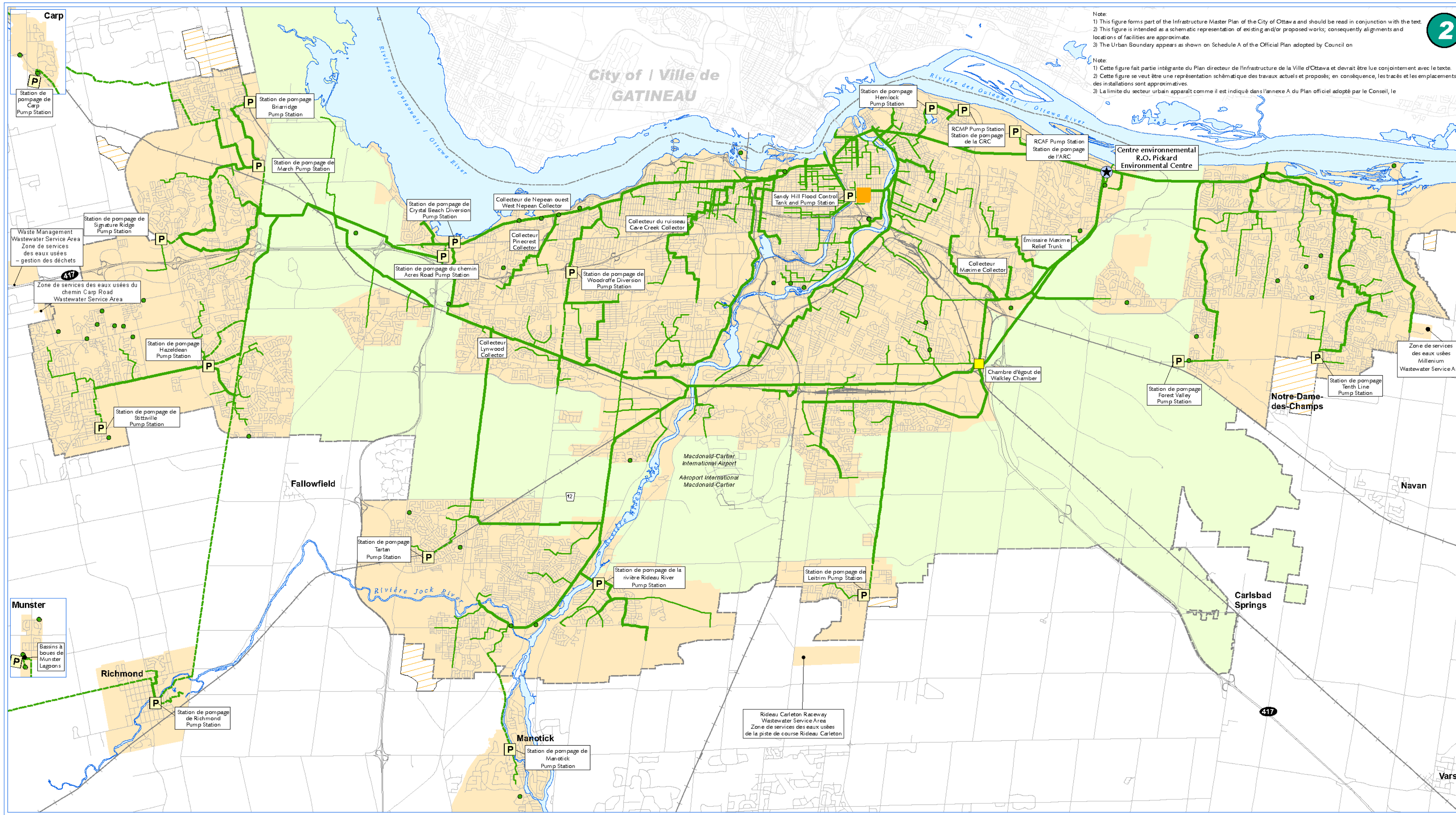
- Water Pump Station / Stations de pompage
- Treatment Plant / Usine de traitement
- City Operated Well / Puits exploités par la Ville
- Water Storage Facility / Réservoirs d'eau
- New Elevated Tank / Nouveau château d'eau
- Future Watermains / Conduites principales futures
- Backbone Watermain / Conduite principale de distribution d'eau
- Distribution Watermain / Conduite de distribution d'eau
- Pressure Reduction Project / Projet de réducteur de pression
- Urban Boundary (Official Plan)
- Greenbelt / Ceinture de verdure
- Public Service Area / Zone de desserte
- Urban Expansion Areas / Zones d'expansion urbaine

Prepared by: Planning and Growth Management Department, Mapping & Graphics Unit, 2013
Préparé par : Service de l'urbanisme et de la gestion de la croissance, Unité de la cartographie et des graphiques, 2013

Appendix B – Wastewater Collection System Schematics

1) **2013 Draft Infrastructure Master Plan - Figure 2**
   Existing Wastewater Collection System: Schematic

2) **2013 Draft Infrastructure Master Plan - Figure 5**
   Growth Projects 2013-2031 - Wastewater Collection System: Schematic



INFRASTRUCTURE MASTER PLAN - Figure 2

Existing Wastewater Collection System: Schematic

PLAN DIRECTEUR DE L'INFRASTRUCURE Figure 2

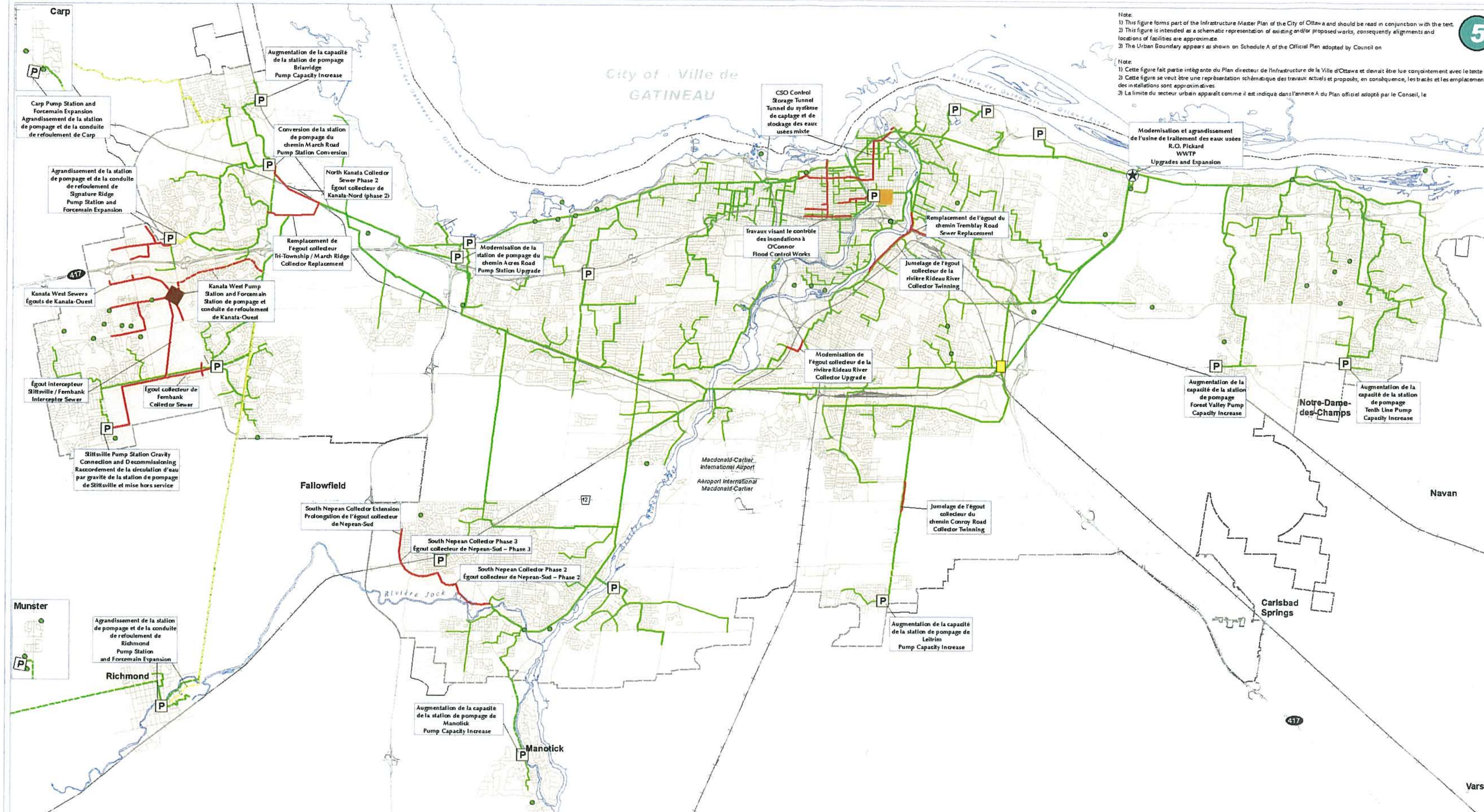
Réseau de collecte des eaux usées existant : schéma

- Local Pump Station / Stations de pompage locale
- Treatment Plant / Usine de traitement
- Main Pump Station / Stations de pompage principal
- Chambers / Chambres
- Storage Tank / Réservoir d'entreposage
- Collector Sewer / Égout collecteur
- Main Sewer / Égout principal
- Forcemains / Conduites de refoulement
- Urban Boundary / Limite urbaine
- Greenbelt / Ceinture de verdure
- Public Service Area / Zone de desserte
- Urban Expansion Areas / Zones d'expansion urbaine

Ottawa

Prepared by: Planning and Growth Management Department, Mapping & Graphics Unit, 2013

Préparé par: Service de l'urbanisme et de la gestion de la croissance, Unité de la cartographie et des graphiques, 2013



INFRASTRUCTURE MASTER PLAN - Figure 5

Growth Projects 2013-2031 - Wastewater Collection System: Schematic

PLAN DIRECTEUR DE L'INFRASTRUCRURE Figure 5

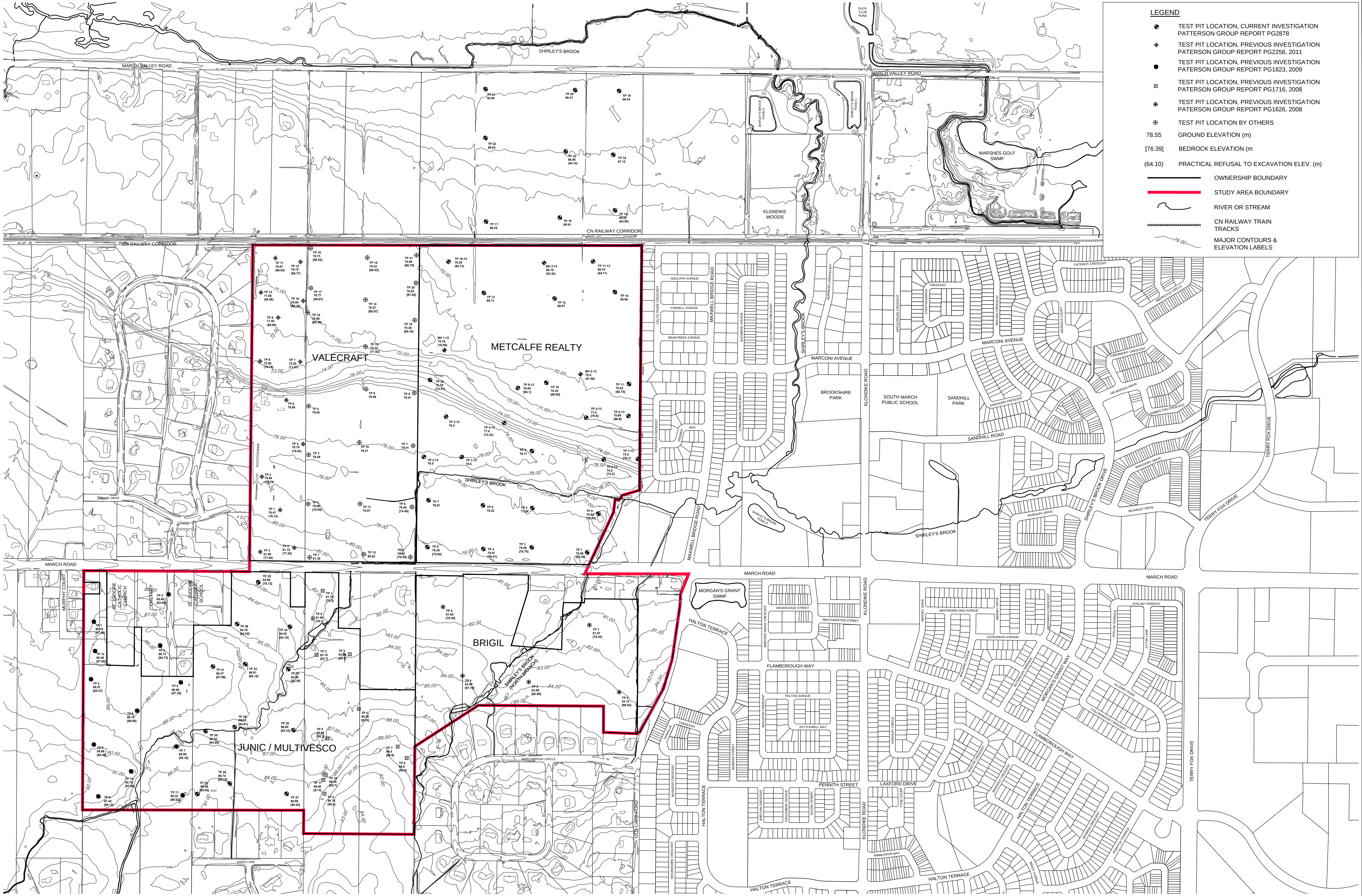
Projets de croissance 2013-2031 - Réseau de collecte des eaux usées : schéma

- Treatment Plant / Usine de traitement
- Main Pump Station / Stations de pompage principal
- Local Pump Station / Stations de pompage locale
- Storage Tank / Réservoir d'entreposage
- New Pump Station / Nouvelle station de pompage
- New Forcemain / Nouvelle conduite de refoulement
- New Sewer / Nouvel égout
- Twin Forcemain
- Collector Sewer / Égout collecteur
- Main Sewer / Égout principal
- Forcemain / Conduite de refoulement
- Urban Boundary / Limite urbaine
- Greenbelt / Ceinture de verdure
- Public Service Areas / Zone de desserte
- Urban Expansion Areas / Zones d'expansion urbaine

Ottawa

Prepared by: Planning and Growth Management Department, Mapping & Graphics Unit, 2013
Préparé par: Service de l'urbanisme et de la gestion de la croissance, Unité de la cartographie et des graphiques, 2013

Appendix C – Topographic Mapping: Kanata North CDP 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.

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No.	REVISION	DATE	BY
1.	PREPARED FOR EXISTING CONDITIONS REPORT	APR 10/13	MAB

SCALE 1:4000

1:4000
0 40 80 120 160

DESIGN	KJM
CHECKED	MAB
DRAWN	DTD
CHECKED	MAB
APPROVED	JGR

FOR REVIEW ONLY

LICENSED PROFESSIONAL ENGINEER K. J. MURPHY 100123021 PROVINCE OF ONTARIO

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CITY OF OTTAWA
KANATA NORTH EXPANSION AREA CDP

EXISTING TOPOGRAPHY

PROJECT No. 112117
REV # 1
DRAWING No. 112117-TP

PLANB1.DWG - 1000mmx707mm

APPENDIX B

Storm Drainage

- Preliminary Stormwater Facility Cost Estimates (Pond 1, Pond 2, Pond 2A, Pond 3)

- Trunk Storm Sewer Design Sheets (Rational Method)
    - Table B-1a: Conceptual Design for Northwest SWMF (Pond 1)
    - Table B-1b: Conceptual Design for Southwest SWMF (Pond 2)
    - Table B-1c: Conceptual Design for East SWMF (Pond 3)

- Hydraulic Grade Line - Autodesk Storm and Sanitary Analysis Output (SSA Modelling)

- Table B-2: Major Overland Flow Summary

- Abandoned Rail Corridor existing ditch analysis
    - Figure B-3: Abandoned Rail Corridor Ditch
    - Table B3-a: Section AA' Capacity Analysis
    - Table B3-b: Section BB' Capacity Analysis
    - Table B3-c: Section CC' Capacity Analysis
    - Table B3-d: Section DD' Capacity Analysis
    - Table B-4: Existing Culvert Capacity Analysis

- City Review of April 4, 2016 Draft
    - City Comment Letter (May 2, 2016)
        - Supplementary memo (Key SWM Issues, May 2, 2016)
        - Novatech Response Letter (May 10, 2016)
        - Novatech Response Letter to Key SWM Issues (May 10, 2016)
    - City Comment Letter (May 10, 2016)
        - City Comment Letter (May 10, 2016)
        - Novatech Response Letter (May 18, 2016)

<u>Drawing List</u>

- 112117-STM1 Storm Drainage Area Plan – Minor System Drainage
- 112117-STM2 Storm Drainage Area Plan – Major System Drainage

Kanata North Urban Expansion Area
Community Design Plan

Preliminary Stormwater Facility Cost
POND 1 - Junic/ Multivesco SWMF

ITEM NO.	ITEM	EST. QTY	UNIT	UNIT PRICE	TOTAL AMOUNT
SECTION A - STORMWATER FACILITY (32,000m³)					
1	Earthworks				
	i) Earth Excavation (incl Topsoil Stripping)	45,000	m³	$10.00	$450,000.00
	ii) Rock Excavation	34,000	m³	$40.00	$1,360,000.00
	iii) Clay Liner (0.6m Thick)	12,000	m²	$9.00	$108,000.00
2	Inlet				
	i) Flow Splitter	1	ea.	$30,000.00	$30,000.00
	ii) 1950mm dia. Storm Sewer	12.0	m	$2,200.00	$26,000.00
	iii) 2100mm dia. Storm Sewer	33.0	m	$2,400.00	$79,000.00
	iv) Manholes	1	ea.	$30,000.00	$30,000.00
	v) Concrete Headwall	2	ea.	$20,000.00	$40,000.00
3	Outlet				
	i) Structure (incl control & minor piping)	1	ea.	$5,000.00	$5,000.00
	ii) 600mm dia. Storm Sewer	59	m	$350.00	$21,000.00
	iii) Manholes	2	ea.	$30,000.00	$60,000.00
	iv) Concrete Headwall	1	ea.	$20,000.00	$20,000.00
	v) Overflow spillway	1	ea.	$3,000.00	$3,000.00
4	Rock Check Dam	2	ea.	$3,000.00	$6,000.00
5	Hydro Seeding	11,000	m²	$4.00	$44,000.00
6	Landscaping Allowance	1	LS	$95,000.00	$95,000.00
7	Access Road/ Pathway Connection	650	m	$205.00	$133,000.00
TOTAL SECTION A - STORMWATER FACILITY					**$2,510,000.00**

Construction Total		**$2,510,000.00**
60% Soft Costs and Contingency		**$1,506,000.00**
Urban Land (ac)	**6.2**	
Total		**$4,016,000.00**

Kanata North Urban Expansion Area

Community Design Plan

Preliminary Stormwater Facility Cost
POND 2 - Brigil SWMF

ITEM NO.	ITEM	EST. QTY	UNIT	UNIT PRICE	TOTAL AMOUNT
SECTION A - STORMWATER FACILITY (10,000m³)					
1	Earthworks				
	i) Earth Excavation (incl Topsoil Stripping)	10,500	m³	$10.00	$105,000.00
	ii) Rock Excavation	2,000	m³	$40.00	$80,000.00
	iii) Clay Liner (0.6m Thick)	2,700	m²	$9.00	$24,000.00
2	Inlet				
	i) 1800mm dia. Storm Sewer	82.0	m	$2,000.00	$164,000.00
	ii) Manholes	2	ea.	$30,000.00	$60,000.00
	iii) Concrete Headwall	1	ea.	$20,000.00	$20,000.00
3	Outlet				
	i) Structure (incl control & minor piping)	1	ea.	$40,000.00	$40,000.00
	ii) 375mm dia. Storm Sewer	95	m	$200.00	$19,000.00
	iii) Manholes	1	ea.	$20,000.00	$20,000.00
	iv) Concrete Headwall	1	ea.	$15,000.00	$15,000.00
	v) Overflow spillway	1	ea.	$3,000.00	$3,000.00
4	Rock Check Dam	2.0	ea.	$3,000.00	$6,000.00
5	Hydro Seeding	9,000	m²	$4.00	$36,000.00
6	Landscaping Allowance	1.0	LS	$63,000.00	$63,000.00
7	Access Road/ Pathway Connection	500	m	$205.00	$103,000.00
TOTAL SECTION A - STORMWATER FACILITY					**$758,000.00**

Construction Total		**$758,000.00**
60% Soft Costs and Contingency		**$454,800.00**
Urban Land (ac)	**4.2**	
Total		**$1,212,800.00**

Kanata North Urban Expansion Area

Community Design Plan

Preliminary Stormwater Facility Cost

POND 2A - Brigil SWMF (Alternative Location)

ITEM NO.	ITEM	EST. QTY	UNIT	UNIT PRICE	TOTAL AMOUNT
SECTION A - STORMWATER FACILITY (10,000m³)					
1	Earthworks				
	i) Earth Excavation (incl Topsoil Stripping)	14,000	m³	$10.00	$140,000.00
	ii) Rock Excavation	2,000	m³	$40.00	$80,000.00
	iii) Clay Liner (0.6m Thick)	3,000	m²	$9.00	$27,000.00
2	Inlet				
	i) 1800mm dia. Storm Sewer	42.0	m	$2,000.00	$84,000.00
	ii) Manholes	1	ea.	$30,000.00	$30,000.00
	iii) Concrete Headwall	1	ea.	$20,000.00	$20,000.00
3	Outlet				
	i) Structure (incl control & minor piping)	1	ea.	$40,000.00	$40,000.00
	ii) 375mm dia. Storm Sewer	213	m	$200.00	$43,000.00
	iii) Manholes	2	ea.	$20,000.00	$40,000.00
	iv) Concrete Headwall	1	ea.	$15,000.00	$15,000.00
	v) Overflow spillway	1	ea.	$3,000.00	$3,000.00
4	Rock Check Dam	2.0	ea.	$3,000.00	$6,000.00
5	Hydro Seeding	9,000	m²	$4.00	$36,000.00
6	Landscaping Allowance	1.0	LS	$63,000.00	$63,000.00
7	Access Road/ Pathway Connection	500	m	$205.00	$103,000.00
TOTAL SECTION A - STORMWATER FACILITY					**$730,000.00**

Construction Total		**$730,000.00**
60% Soft Costs and Contingency		**$438,000.00**
Urban Land (ac)	**3.5**	
Total		**$1,168,000.00**

Kanata North Urban Expansion Area

Community Design Plan

Preliminary Stormwater Facility Cost
POND 3 - Metcalfe & Valecraft SWMF

ITEM NO.	ITEM	EST. QTY	UNIT	UNIT PRICE	TOTAL AMOUNT
SECTION C - STORMWATER FACILITY SHARED COSTS (62,000m³)					
1	Earthworks				
	i) Earth Excavation (incl Topsoil Stripping)	75,800	m³	$10.00	$758,000.00
	ii) Rock Excavation	500	m³	$40.00	$20,000.00
	iii) Clay Liner (0.6m Thick)	1000	m²	$9.00	$9,000.00
2	Clearing and Grubbing	6	ha	$10,000.00	$60,000.00
3	Inlet				
	i) Manholes	1	ea.	$30,000.00	$30,000.00
	ii) Rail Line Crossing - 1950mm Conc Pipe	75	m	$2,200.00	$165,000.00
	iii) Rail Line Crossing - 2250mm Conc Pipe	63	m	$2,600.00	$164,000.00
	iv) Concrete Headwall	2	ea.	$20,000.00	$40,000.00
	v) Ditching (incl Earth Excavation)	500	m	$700.00	$350,000.00
	vi) 1800mm Conc Pipe	177.0	m	$2,000.00	$354,000.00
	vii) 2440mm Conc Pipe	30.0	m	$3,000.00	$90,000.00
	ix) Flow Splitter manhole	2	ea.	$30,000.00	$60,000.00
5	Outlet				
	i) Structure	1	ea.	$50,000.00	$50,000.00
	ii) 975mm Conc Pipe	76.0	m	$900.00	$68,000.00
	iii) Concrete Headwall	2	ea.	$20,000.00	$40,000.00
	iv) Ditching (incl Earth Excavation)	15	m	$100.00	$2,000.00
	v) Overflow Spillway	1	ea.	$3,000.00	$3,000.00
	vi) Road Reinstatement (March Valley Road)	40	m²	$100.00	$4,000.00
6	Rock Check Dam	2	ea.	$3,000.00	$6,000.00
7	Hydro Seeding	53,000	m²	$4.00	$212,000.00
8	Landscaping Allowance	1	LS	$225,000.00	$225,000.00
9	Access Road/ Pathway Connection	1,600	m	$205.00	$328,000.00
TOTAL SECTION C - STORMWATER FACILITY					**$3,038,000.00**

Construction Total		**$3,038,000.00**
60% Capital Cost Allowance		**$1,822,800.00**
Valecraft Rural Land (ac)	**14.5**	
Metcalfe Rural Land (ac)	**14.7**	
Total		**$4,860,800.00**

KANATA NORTH URBAN EXPANSION AREA
COMMUNITY DESIGN PLAN

STORM SEWER DESIGN SHEET

TABLE B-1a:
CONCEPUTAL DESIGN FOR NORTHWEST SWMF
FLOW RATES BASED ON RATIONAL METHOD

NOVATECH
Engineers, Planners & Landscape Architects

LOCATION			AREA (ha)			FLOW					SEWER DATA								
Catchment ID	From Node	To Node	Area (ha)	C	AC (ha)	Indiv 2.78 AC	Accum 2.78 AC	Time of Conc.	Intensity (mm/hr)	Peak Flow (L/s)	Dia. (m) Actual	Dia. (mm)	Type	Slope (%)	Length (m)	Capacity (L/s)	Velocity (m/s)	Flow Time (min)	Ratio Q/Q full
NW-1	NW-1	NW-3	7.04	0.65	4.58	12.721	12.721	15.00	83.56	1,063	0.914	900	Conc	0.60	204.0	1,462.2	2.23	1.53	73%
NW-2	NW-2	NW-3	8.96	0.65	5.82	16.191	16.191	15.00	83.56	1,353	1.219	1200	Conc	0.20	222.0	1,818.2	1.56	2.38	74%
NW-3	NW-3	NW-5	4.35	0.67	2.91	8.102	37.014	17.38	76.59	2,835	1.651	1650	Conc	0.20	327.0	4,081.5	1.91	2.86	69%
NW-4	NW-4	NW-5	1.58	0.85	1.34	3.734	3.734	15.00	83.56	312	0.914	900	Conc	0.10	97.0	596.9	0.91	1.78	52%
NW-5	NW-5	INLET	4.11	0.78	3.21	8.912	49.660	16.78	78.22	3,884	1.956	1950	Conc	0.10	19.0	4,534.6	1.51	0.21	86%
NW-6	NW-6	NW-7	5.21	0.60	3.15	8.747	8.747	20.00	70.25	615	0.914	900	Conc	0.50	223.0	1,334.8	2.03	1.83	46%
NW-7	NW-7	NW-8	6.67	0.56	3.73	10.376	19.124	21.83	66.48	1,271	1.067	1050	Conc	0.50	360.0	2,013.5	2.25	2.66	63%
NW-8	NW-8	NW-10	8.34	0.63	5.23	14.537	33.660	24.49	61.72	2,077	1.372	1350	Conc	0.30	84.0	3,048.7	2.06	0.68	68%
NW-9	NW-9	NW-10	4.82	0.65	3.13	8.710	8.710	15.00	83.56	728	0.914	900	Conc	0.20	140.0	844.2	1.29	1.82	86%
NW-10	NW-10	INLET	2.60	0.69	1.80	5.008	47.378	25.17	60.63	2,872	1.956	1950	Conc	0.10	288.0	4,534.6	1.51	3.18	63%
	INLET	NW-SWMF			0.00	0.000	97.038	28.35	56.02	5,436	2.464	2440	Conc	0.10	37.0	8,394.3	1.76	0.35	65%
NADIA LANE	NADIA	TRIB 2	25.65	0.35	8.98	24.957	24.957	132.00	30.53 *	762	0.838	825	Conc	0.50	199.0	1,058.3	1.92	1.73	72%

Q = 2.78 AIC, where
Q = Peak Flow in Litres per Second (L/s)
A = Area in hectares (ha)
I = Rainfall Intensity (mm/hr), 5 year storm

Note:
* Indicates 100 Year intensity for Nadia Lane bypass storm sewers

Consultant:	**Novatech Engineering Consultants Ltd.**	
Date:	May, 2016	
Design By:	Alex McAuley	
Client:	**Dwg. Reference:**	**Checked By:**

KANATA NORTH URBAN EXPANSION AREA
COMMUNITY DESIGN PLAN

STORM SEWER DESIGN SHEET

TABLE B-1a:
CONCEPUTAL DESIGN FOR NORTHWEST SWMF
FLOW RATES BASED ON RATIONAL METHOD

Engineers, Planners & Landscape Architects

LOCATION			AREA (ha)			FLOW					SEWER DATA									
Catchment ID	From Node	To Node	Area (ha)	C	AC (ha)	Indiv 2.78 AC	Accum 2.78 AC	Time of Conc.	Intensity (mm/hr)	Peak Flow (L/s)	Dia. (m) Actual	Dia. (mm)	Type	Slope (%)	Length (m)	Capacity (L/s)	Velocity (m/s)	Flow Time (min)	Ratio Q/Q full

C = Runoff Coefficient	Kanata North Land Owners	112117-STM1, 112117-STM2	CJR

KANATA NORTH URBAN EXPANSION AREA
COMMUNITY DESIGN PLAN

STORM SEWER DESIGN SHEET

TABLE B-1b:
CONCEPUTAL DESIGN FOR SOUTHWEST SWMF
FLOW RATES BASED ON RATIONAL METHOD

NOVATECH
Engineers, Planners & Landscape Architects

LOCATION			AREA (ha)			FLOW					SEWER DATA									
Catchment ID	From Node	To Node	Area (ha)	C	AC (ha)	Indiv 2.78 AC	Accum 2.78 AC	Time of Conc.	Intensity (mm/hr)	Peak Flow (L/s)	Dia. (m) Actual	Dia. (mm)	Type	Slope (%)	Length (m)	Capacity (L/s)	Velocity (m/s)	Flow Time (min)	Ratio Q/Q full
SW-1	SW-1	SW-3	1.48	0.70	1.04	2.880	2.880	15.00	83.56	241	0.533	525	Conc	1.00	179.0	448.4	2.01	1.49	54%
SW-2	SW-2	SW-3	7.69	0.65	5.00	13.896	13.896	15.00	83.56	1,161	1.219	1200	Conc	0.10	230.0	1,285.7	1.10	3.48	90%
SW-3	SW-3	INLET	0.56	0.70	0.39	1.090	17.866	18.48	73.77	1,318	1.524	1500	Conc	0.10	33.0	2,331.3	1.28	0.43	57%
SW-4	SW-4	INLET	8.90	0.57	5.04	14.006	14.006	15.00	83.56	1,170	1.372	1350	Conc	0.20	464.0	2,489.3	1.68	4.59	47%
	INLET	SW-SWMF			0.00	0.000	31.872	19.59	71.16	2,268	1.803	1800	Conc	0.10	176.0	3,652.3	1.43	2.05	62%
401 (OFFSITE)	401	OFF-1	15.10	0.35	5.29	14.692	14.692	95.00 [1]	23.31	342	0.762	750	Conc	0.20	298.0	519.1	1.14	4.36	66%
OFF-1	OFF-1	March Road	6.49	0.70	4.54	12.630	27.322	99.36	22.52	615	0.914	900	Conc	0.50	363.0	1,334.8	2.03	2.98	46%

Q = 2.78 AIC, where
Q= Peak Flow in Litres per Second (L/s)
A= Area in hectares (ha)
I= Rainfall Intensity (mm/hr), 5 year storm
C= Runoff Coefficient

Consultant:	**Novatech Engineering Consultants Ltd.**	
Date:	May, 2016	
Design By:	Alex McAuley	
Client:	**Dwg. Reference:**	**Checked By:**
Kanata North Land Owners	112117-STM1, 112117-STM2	CJR

Note: 1. TC based on flow provided by SWMHYMO model

KANATA NORTH URBAN EXPANSION AREA
COMMUNITY DESIGN PLAN

STORM SEWER DESIGN SHEET

TABLE B-1c:
CONCEPUTAL DESIGN FOR EAST SWMF
FLOW RATES BASED ON RATIONAL METHOD

NOVATECH
Engineers, Planners & Landscape Architects

LOCATION			AREA (ha)			FLOW					SEWER DATA								
Catchment ID	From Node	To Node	Area (ha)	C	AC (ha)	Indiv 2.78 AC	Accum 2.78 AC	Time of Conc.	Intensity (mm/hr)	Peak Flow (L/s)	Dia. (m) Actual	Dia. (mm)	Type	Slope (%)	Length (m)	Capacity (L/s)	Velocity (m/s)	Flow Time (min)	Ratio Q/Q full
NE-1	NE-1	NE-3	0.44	0.70	0.31	0.856	0.856	15.00	97.85*	84	0.610	600	Conc	0.20	74.0	286.3	0.98	1.26	29%
NE-2	NE-2	NE-3	0.80	0.70	0.56	1.557	1.557	15.00	97.85*	152	0.610	600	Conc	0.20	147.0	286.3	0.98	2.50	53%
NE-3	NE-3	NE-4	8.87	0.73	6.48	18.001	20.414	17.50	76.27	1,557	0.914	900	Conc	1.00	326.0	1,887.7	2.87	1.89	82%
NE-4	NE-4	NE-5	9.21	0.65	5.99	16.642	37.056	19.39	71.62	2,654	1.372	1350	Conc	0.45	199.0	3,733.9	2.53	1.31	71%
NE-5	NE-5	RAIL	6.76	0.65	4.39	12.215	49.272	20.70	68.75	3,387	1.524	1500	Conc	0.45	253.0	4,945.4	2.71	1.56	68%
NE-6	NE-6	NE-7	4.60	0.65	2.99	8.312	8.312	15.00	83.56	695	0.762	750	Conc	0.70	218.0	971.2	2.13	1.71	72%
NE-7	NE-7	NE-8	4.35	0.55	2.39	6.651	14.963	16.71	78.42	1,173	1.067	1050	Conc	0.30	79.0	1,559.7	1.74	0.75	75%
NE-8	NE-8	RAIL	3.48	0.65	2.26	6.288	21.252	17.46	76.37	1,623	1.372	1350	Conc	0.20	308.0	2,489.3	1.68	3.05	65%
	RAIL	E-SWMF			0.00	0.000	70.523	22.26	65.66	4,631	1.956	1950	Conc	0.20	75.0	6,412.8	2.13	0.59	72%
SE-1	SE-1	SE-3	2.71	0.70	1.90	5.274	5.274	15.00	97.85*	516	0.838	825	Conc	0.25	300.0	748.4	1.36	3.69	69%
SE-2	SE-2	SE-3	1.37	0.70	0.96	2.666	2.666	15.00	97.85*	261	0.610	600	Conc	0.25	230.0	320.1	1.10	3.50	82%
SE-3	SE-3	SE-4	9.23	0.85	7.85	21.810	29.750	18.69	73.27	2,180	1.219	1200	Conc	0.90	423.0	3,857.1	3.30	2.13	57%
SE-4	SE-4	SE-5	10.76	0.63	6.78	18.845	48.595	20.82	68.50	3,329	1.372	1350	Conc	1.20	194.0	6,097.5	4.13	0.78	55%

KANATA NORTH URBAN EXPANSION AREA
COMMUNITY DESIGN PLAN

STORM SEWER DESIGN SHEET

TABLE B-1c:
CONCEPUTAL DESIGN FOR EAST SWMF
FLOW RATES BASED ON RATIONAL METHOD

NOVATECH
Engineers, Planners & Landscape Architects

LOCATION			AREA (ha)			FLOW					SEWER DATA									
Catchment ID	From Node	To Node	Area (ha)	C	AC (ha)	Indiv 2.78 AC	Accum 2.78 AC	Time of Conc.	Intensity (mm/hr)	Peak Flow (L/s)	Dia. (m) Actual	Dia. (mm)	Type	Slope (%)	Length (m)	Capacity (L/s)	Velocity (m/s)	Flow Time (min)	Ratio Q/Q full
SE-6	SE-6	SE-7	9.41	0.63	5.93	16.481	16.481	15.00	83.56	1,377	1.067	1050	Conc	0.40	296.0	1,800.9	2.01	2.45	76%
SE-7	SE-7	SE-5	6.92	0.65	4.50	12.504	28.985	17.45	76.40	2,214	1.524	1500	Conc	0.20	360.0	3,296.9	1.81	3.32	67%
SE-5	SE-5	SE-8	4.53	0.65	2.94	8.186	85.766	21.60	66.92	5,739	2.108	2100	Conc **	0.20	236.0	7,833.6	2.24	1.75	73%
													** 2100mm or 1705mmx2690mm Elliptical						
SE-8	SE-8	E-SWMF	5.14	0.65	3.34	9.288	95.054	23.36	63.65	6,050	2.261	2250	Conc	0.20	63.0	9,436.3	2.35	0.45	64%

Q = 2.78 AIC, where
Q = Peak Flow in Litres per Second (L/s)
A = Area in hectares (ha)
I = Rainfall Intensity (mm/hr), 5 year storm
C = Runoff Coefficient

Note:
* Indicates 10 Year intensity for March Road storm sewers

Consultant:	**Novatech Engineering Consultants Ltd.**	
Date:	May, 2016	
Design By:	Alex McAuley	
Client:	**Dwg. Reference:**	**Checked By:**
Kanata North Land Owners	112117-STM1, 112117-STM2	CJR

Autodesk® Storm and Sanitary Analysis 2016 - Version 10.1.53 (Build 1)

Project Description

File Name .... 20160516 - Prelim HGL.SPF
Description .... M:\2012\112117\CAD\Design_MSS\112117-GP.dwg

Analysis Options

Flow Units .... LPS
Link Routing Method .... Hydrodynamic
Storage Node Exfiltration.. None
Starting Date MAY-16-2016 00:00:00
Ending Date MAY-16-2016 03:00:00
Antecedent Dry Days 0.0
Report Time Step 00:05:00
Routing Time Step .... 5.00 sec

Element Count

Number of rain gages 0
Number of subbasins 0
Number of nodes 89
Number of links 85
Number of pollutants 0
Number of land uses 0

Node Summary

Node ID	Element Type	Invert Elevation m	Maximum Elev. m	Ponded Area m²	External Inflow
1007 (STM)	JUNCTION	85.47	89.80	0.00	Yes
1009 (STM)	JUNCTION	80.91	89.08	0.00	
1011 (STM)	JUNCTION	80.64	87.91	0.00	
1013 (STM)	JUNCTION	80.53	87.14	0.00	Yes
1015 (STM)	JUNCTION	80.13	83.90	0.00	Yes
1017 (STM)	JUNCTION	80.33	83.56	0.00	Yes
1025 (STM)	JUNCTION	77.07	81.67	0.00	
1027 (STM)	JUNCTION	75.19	79.86	0.00	
1029 (STM)	JUNCTION	73.44	79.53	0.00	Yes
1031 (STM)	JUNCTION	72.24	77.88	0.00	
1033 (STM)	JUNCTION	69.80	74.82	0.00	
1035 (STM)	JUNCTION	68.19	73.26	0.00	Yes
1037 (STM)	JUNCTION	67.51	72.18	0.00	
1039 (STM)	JUNCTION	66.97	72.25	0.00	
1501 (STM)	JUNCTION	81.41	87.36	0.00	Yes
2001 (STM)	JUNCTION	74.72	79.53	0.00	
2003 (STM)	JUNCTION	73.49	79.03	0.00	Yes
2005 (STM)	JUNCTION	71.88	78.45	0.00	
2007 (STM)	JUNCTION	69.86	74.81	0.00	
2009 (STM)	JUNCTION	67.90	72.30	0.00	
2013 (STM)	JUNCTION	66.07	70.99	0.00	
2015 (STM)	JUNCTION	65.73	70.92	0.00	Yes
2021 (STM)	JUNCTION	68.22	72.26	0.00	Yes
2023 (STM)	JUNCTION	67.42	71.28	0.00	
2025 (STM)	JUNCTION	67.19	71.17	0.00	
2027 (STM)	JUNCTION	66.39	71.06	0.00	
3019 (STM)	JUNCTION	79.26	83.85	0.00	
3021 (STM)	JUNCTION	81.06	84.10	0.00	Yes

3031 (STM)	JUNCTION	79.44	86.60	0.00	
3033 (STM)	JUNCTION	79.37	86.31	0.00	
3035 (STM)	JUNCTION	79.28	85.98	0.00	
3037 (STM)	JUNCTION	79.20	85.75	0.00	Yes
3-99 (STM)	JUNCTION	65.56	70.79	0.00	Yes
4003 (STM)	JUNCTION	66.45	71.32	0.00	Yes
4005 (STM)	JUNCTION	67.56	72.51	0.00	
4007 (STM)	JUNCTION	67.09	72.40	0.00	Yes
5001 (STM)	JUNCTION	80.87	88.14	0.00	Yes
5501 (STM)	JUNCTION	83.11	88.01	0.00	Yes
5503 (STM)	JUNCTION	84.06	88.54	0.00	
5505 (STM)	JUNCTION	84.52	88.73	0.00	
5507 (STM)	JUNCTION	84.83	88.93	0.00	Yes
7001 (STM)	JUNCTION	65.92	72.44	0.00	
803 (STM)	JUNCTION	76.31	80.33	0.00	Yes
805 (STM)	JUNCTION	75.87	80.88	0.00	
807 (STM)	JUNCTION	76.71	81.00	0.00	Yes
815 (STM)	JUNCTION	78.10	81.14	0.00	Yes
817 (STM)	JUNCTION	77.50	82.12	0.00	
819 (STM)	JUNCTION	78.33	82.72	0.00	Yes
STM (1)-68 (STM)	JUNCTION	66.65	72.33	0.00	Yes
STM- BRIGIL - OPT3-30 (STM)	JUNCTION	78.99	83.56	0.00	
STM- BRIGIL - OPT3-32 (STM)	JUNCTION	79.09	83.94	0.00	Yes
STM- BRIGIL - OPT3-34 (STM)	JUNCTION	79.33	84.18	0.00	
STM- BRIGIL - OPT3-36 (STM)	JUNCTION	79.52	84.52	0.00	Yes
STM-1 (STM)	JUNCTION	65.80	70.69	0.00	
STM-1066 (STM)	JUNCTION	79.70	84.70	0.00	Yes
STM-1069 (STM)	JUNCTION	79.48	83.46	0.00	Yes
STM-1073 (STM)	JUNCTION	66.70	72.20	0.00	Yes
STM-1074 (STM)	JUNCTION	66.81	72.21	0.00	
STM-1075 (STM)	JUNCTION	66.97	72.34	0.00	
STM-1077 (STM)	JUNCTION	69.02	74.97	0.00	
STM-1078 (STM)	JUNCTION	72.60	77.75	0.00	
STM-1079 (STM)	JUNCTION	74.62	79.81	0.00	Yes
STM-1083 (STM)	JUNCTION	79.09	84.21	0.00	
STM-1084 (STM)	JUNCTION	79.05	160.34	0.00	
STM-1090 (STM)	JUNCTION	76.19	80.66	0.00	
STM-1092 (STM)	JUNCTION	82.20	85.54	0.00	
STM-1093 (STM)	JUNCTION	82.44	86.48	0.00	Yes
STM-1094 (STM)	JUNCTION	66.57	72.18	0.00	
STM-1096 (STM)	JUNCTION	82.05	85.09	0.00	
STM-1097 (STM)	JUNCTION	81.95	85.02	0.00	
STM-1098 (STM)	JUNCTION	79.86	85.01	0.00	
STM-1099 (STM)	JUNCTION	79.11	82.71	0.00	
STM-1100 (STM)	JUNCTION	78.04	81.04	0.00	
STM-1101 (STM)	JUNCTION	77.62	78.69	0.00	
STM-1103 (STM)	JUNCTION	87.05	89.31	0.00	Yes
STM-1104 (STM)	JUNCTION	87.11	89.87	0.00	
STM-1105 (STM)	JUNCTION	86.55	88.19	0.00	
STM-1106 (STM)	JUNCTION	86.44	88.67	0.00	
STM-1108 (STM)	JUNCTION	83.64	88.25	0.00	
STM-1109 (STM)	JUNCTION	73.09	79.00	0.00	
STM-1114 (STM)	JUNCTION	79.90	83.67	0.00	
STM-POND3-100 (STM)	JUNCTION	65.98	70.92	0.00	Yes
{STM}.STM-413 (STM)	OUTFALL	79.35	81.30	0.00	
StartNullStruct1	OUTFALL	65.74	67.99	0.00	
STM- BRIGIL - OPT3-29 (STM)	OUTFALL	79.21	81.01	0.00	
STM-1086 (STM)	OUTFALL	79.50	81.60	0.00	
STM-1102 (STM)	OUTFALL	75.37	78.27	0.00	
STM-1107 (STM)	OUTFALL	86.60	87.42	0.00	
STM-3 (STM)	OUTFALL	65.72	67.97	0.00	

****
Link Summary
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Link ID	From Node	To Node	Element Type	Length m	Slope %	Manning's Roughness

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{STM}.100 (STM)	2005 (STM)	2007 (STM)	CONDUIT	102.3	0.8795	0.0130
{STM}.102 (1) (STM)	2003 (STM)	STM-1109 (STM)	CONDUIT	54.6	0.7397	0.0130
{STM}.102 (STM)	STM-1109 (STM)	2005 (STM)	CONDUIT	53.6	1.0029	0.0130
{STM}.106 (STM)	2001 (STM)	2003 (STM)	CONDUIT	116.6	0.8172	0.0130
{STM}.108 (STM)	805 (STM)	2001 (STM)	CONDUIT	107.2	0.9014	0.0130
{STM}.118 (1) (STM)	1025 (STM)	STM-1090 (STM)	CONDUIT	86.5	0.9909	0.0130
{STM}.118 (STM)	STM-1090 (STM)	1027 (STM)	CONDUIT	98.1	1.0008	0.0130
{STM}.120 (STM)	817 (STM)	1025 (STM)	CONDUIT	42.3	0.9998	0.0130
{STM}.122 (1) (STM)	STM-1083 (STM)	STM-1084 (STM)	CONDUIT	36.6	0.1093	0.0130
{STM}.122 (STM)	STM-1084 (STM)	{STM}.STM-413 (STM)	CONDUIT	11.6	683.4832	0.0130
{STM}.128 (1) (STM)	1015 (STM)	STM-1114 (STM)	CONDUIT	37.0	0.2919	0.0130
{STM}.128 (STM)	1017 (STM)	STM-1114 (STM)	CONDUIT	21.9	0.0915	0.0130
{STM}.130 (STM)	1013 (STM)	1015 (STM)	CONDUIT	107.5	0.2501	0.0130
{STM}.132 (STM)	1011 (STM)	1013 (STM)	CONDUIT	48.6	0.1994	0.0130
{STM}.134 (STM)	1009 (STM)	1011 (STM)	CONDUIT	134.1	0.1984	0.0130
{STM}.136 (STM)	1007 (STM)	1009 (STM)	CONDUIT	99.5	0.5998	0.0130
{STM}.144 (STM)	3021 (STM)	3019 (STM)	CONDUIT	24.6	1.4706	0.0130
{STM}.156 (STM)	3031 (STM)	3033 (STM)	CONDUIT	46.9	0.1281	0.0130
{STM}.158 (STM)	3033 (STM)	3035 (STM)	CONDUIT	68.8	0.1017	0.0130
{STM}.160 (STM)	3035 (STM)	3037 (STM)	CONDUIT	67.6	0.0962	0.0130
{STM}.162 (STM)	3037 (STM)	STM-1083 (STM)	CONDUIT	105.1	0.0999	0.0130
{STM}.182 (1) (STM)	815 (STM)	817 (STM)	CONDUIT	147.3	0.2003	0.0130
{STM}.182 (10) (STM)	5001 (STM)	3031 (STM)	CONDUIT	83.8	0.2934	0.0130
{STM}.182 (16) (STM)	5501 (STM)	5001 (STM)	CONDUIT	58.1	0.5332	0.0130
{STM}.182 (17) (1) (STM)	5503 (STM)	STM-1108 (STM)	CONDUIT	63.6	0.6192	0.0130
{STM}.182 (17) (STM)	STM-1108 (STM)	5501 (STM)	CONDUIT	96.2	0.5002	0.0130
{STM}.182 (18) (STM)	5505 (STM)	5503 (STM)	CONDUIT	88.4	0.4979	0.0130
{STM}.182 (19) (STM)	5507 (STM)	5505 (STM)	CONDUIT	53.7	0.5005	0.0130
{STM}.182 (33) (STM)	1501 (STM)	1009 (STM)	CONDUIT	81.5	0.2000	0.0130
{STM}.182 (39) (STM)	2007 (STM)	2009 (STM)	CONDUIT	100.5	1.1935	0.0130
{STM}.182 (4) (STM)	807 (STM)	805 (STM)	CONDUIT	52.4	0.4864	0.0130
{STM}.182 (40) (STM)	STM-1066 (STM)	3031 (STM)	CONDUIT	137.8	0.0668	0.0130
{STM}.182 (43) (STM)	3019 (STM)	STM- BRIGIL - OPT3-32 (STM)	CONDUIT	32.6	0.1013	0.0130
{STM}.182 (44) (STM)	STM-1069 (STM)	3019 (STM)	CONDUIT	64.9	0.0955	0.0130

{STM}.182 (48)	(STM)STM-1074 (STM)	STM-1073 (STM)	CONDUIT	56.5	0.2001	0.0130
{STM}.182 (49)	(STM)STM-1075 (STM)	STM-1074 (STM)	CONDUIT	78.7	0.1996	0.0130
{STM}.182 (50)	(STM)4007 (STM)	STM-1075 (STM)	CONDUIT	80.3	0.1507	0.0130
{STM}.182 (52)	(STM)STM-1077 (STM)	4005 (STM)	CONDUIT	84.3	1.5007	0.0130
{STM}.182 (53)	(STM)STM-1078 (STM)	STM-1077 (STM)	CONDUIT	95.5	1.5010	0.0130
{STM}.182 (54)	(STM)STM-1079 (STM)	STM-1078 (STM)	CONDUIT	98.3	1.4989	0.0130
{STM}.182 (58)	(STM)STM-1084 (STM)	STM-1086 (STM)	CONDUIT	32.9	0.1214	0.0130
{STM}.182 (6)	(STM)819 (STM)	817 (STM)	CONDUIT	74.0	0.1999	0.0130
{STM}.182 (62)	(STM)STM-1092 (STM)	STM-1096 (STM)	CONDUIT	56.0	0.2001	0.0130
{STM}.182 (63)	(STM)STM-1093 (STM)	STM-1092 (STM)	CONDUIT	102.4	0.2002	0.0130
{STM}.182 (64)	(STM)STM-1073 (STM)	STM-1094 (STM)	CONDUIT	67.4	0.2018	0.0130
{STM}.182 (65)	(STM)STM-1094 (STM)	7001 (STM)	CONDUIT	25.2	0.1983	0.0130
{STM}.182 (67)	(STM)STM-1096 (STM)	STM-1097 (STM)	CONDUIT	42.0	0.1999	0.0130
{STM}.182 (68)	(STM)STM-1097 (STM)	STM-1098 (STM)	CONDUIT	76.4	0.2527	0.0130
{STM}.182 (69)	(STM)STM-1098 (STM)	STM-1099 (STM)	CONDUIT	104.8	0.5097	0.0130
{STM}.182 (7)	(STM)803 (STM)	805 (STM)	CONDUIT	128.2	0.2496	0.0130
{STM}.182 (70)	(STM)STM-1099 (STM)	STM-1100 (STM)	CONDUIT	110.0	0.5065	0.0130
{STM}.182 (71)	(STM)STM-1100 (STM)	STM-1101 (STM)	CONDUIT	83.8	0.5013	0.0130
{STM}.182 (72)	(STM)STM-1101 (STM)	STM-1102 (STM)	CONDUIT	65.4	0.3714	0.0130
{STM}.182 (73)	(STM)STM-1090 (STM)	1027 (STM)	CONDUIT	98.1	1.0192	0.0130
{STM}.182 (74)	(STM)1029 (STM)	1031 (STM)	CONDUIT	80.0	1.4999	0.0130
{STM}.182 (75)	(STM)STM-1103 (STM)	STM-1104 (STM)	CONDUIT	20.8	0.8541	0.0130
{STM}.182 (76)	(STM)STM-1104 (STM)	STM-1105 (STM)	CONDUIT	87.7	0.5704	0.0130
{STM}.182 (77)	(STM)STM-1105 (STM)	STM-1106 (STM)	CONDUIT	20.1	0.2440	0.0130
{STM}.182 (78)	(STM)STM-1106 (STM)	STM-1107 (STM)	CONDUIT	47.2	0.2990	0.0130
{STM}.182 (80)	(STM)STM-1114 (STM)	STM-1084 (STM)	CONDUIT	18.9	0.1004	0.0130
{STM}.STM (1)-69	(STM)STM (1)-68 (STM)	7001 (STM)	CONDUIT	62.1	0.4491	0.0130
{STM}.STM (1)-71	(STM)1039 (STM)	STM (1)-68 (STM)	CONDUIT	69.6	0.4509	0.0130
{STM}.STM (1)-73	(STM)1037 (STM)	1039 (STM)	CONDUIT	121.2	0.4495	0.0130
{STM}.STM (1)-75	(STM)1035 (STM)	1037 (STM)	CONDUIT	118.4	0.4503	0.0130
{STM}.STM (1)-77	(STM)1033 (STM)	1035 (STM)	CONDUIT	80.9	1.5003	0.0130
{STM}.STM (1)-79	(STM)1031 (STM)	1033 (STM)	CONDUIT	120.0	1.4998	0.0130
{STM}.STM (1)-81	(STM)1029 (STM)	1031 (STM)	CONDUIT	80.0	1.4999	0.0130
{STM}.STM (1)-83	(STM)1027 (STM)	1029 (STM)	CONDUIT	100.0	0.9919	0.0130
{STM}.STM (1)-99	(STM)4005 (STM)	4007 (STM)	CONDUIT	79.1	0.2985	0.0130

{STM}.STM- BRIGIL - OPT3-31 (STM)STM- BRIGIL - OPT3-30 (STM)STM- BRIGIL - OPT3-29 (STM)CONDUIT 77.7 0.1055 0.0130

{STM}.STM- BRIGIL - OPT3-33 (STM)STM- BRIGIL - OPT3-32 (STM)STM- BRIGIL - OPT3-30 (STM)CONDUIT 94.3 0.1007 0.0130

{STM}.STM- BRIGIL - OPT3-35 (STM)STM- BRIGIL - OPT3-34 (STM)STM- BRIGIL - OPT3-32 (STM)CONDUIT 45.1 0.1995 0.0130

{STM}.STM- BRIGIL - OPT3-37 (STM)STM- BRIGIL - OPT3-36 (STM)STM- BRIGIL - OPT3-34 (STM)CONDUIT 83.4 0.1955 0.0130
{STM}.STM-2 (STM)STM-1 (STM) STM-3 (STM) CONDUIT 38.4 0.2084 0.0130
{STM}.STM-6 (STM)7001 (STM) STM-1 (STM) CONDUIT 37.0 0.2002 0.0130
{STM}.STM-POND3-1 (STM)2025 (STM) 2027 (STM) CONDUIT 79.3 0.2005 0.0130
{STM}.STM-POND3-101 (STM)STM-POND3-100 (STM)2015 (STM) CONDUIT 94.8 0.2119 0.0130
{STM}.STM-POND3-13 (STM)2023 (STM) 2025 (STM) CONDUIT 77.0 0.2922 0.0130
{STM}.STM-POND3-15 (STM)2021 (STM) 2023 (STM) CONDUIT 100.4 0.3985 0.0130
{STM}.STM-POND3-19 (STM)2015 (STM) 3-99 (STM) CONDUIT 77.6 0.2011 0.0130
{STM}.STM-POND3-21 (STM)2013 (STM) 2015 (STM) CONDUIT 76.7 0.2046 0.0130
{STM}.STM-POND3-23 (STM)4003 (STM) 2013 (STM) CONDUIT 82.0 0.1939 0.0130
{STM}.STM-POND3-25 (STM)2009 (STM) 4003 (STM) CONDUIT 90.8 1.2373 0.0130
{STM}.STM-POND3-30 (STM)3-99 (STM) StartNullStruct1CONDUIT 63.9 0.1972 0.0130
{STM}.STM-POND3-72 (STM)2027 (STM) STM-POND3-100 (STM)CONDUIT 104.3 0.1936 0.0130

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Cross Section Summary
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Link ID	Shape	Depth/ Diameter m	Width m	No. of Barrels	Cross Sectional Area m²	Full Flow Hydraulic Radius m	Design Flow Capacity LPS
{STM}.100 (STM)	CIRCULAR	1.20	1.20	1	1.13	0.30	3656.58
{STM}.102 (1) (STM)	CIRCULAR	1.20	1.20	1	1.13	0.30	3353.33
{STM}.102 (STM)	CIRCULAR	1.20	1.20	1	1.13	0.30	3904.52
{STM}.106 (STM)	CIRCULAR	1.20	1.20	1	1.13	0.30	3524.60
{STM}.108 (STM)	CIRCULAR	1.20	1.20	1	1.13	0.30	3701.84
{STM}.118 (1) (STM)	CIRCULAR	0.90	0.90	1	0.64	0.23	1802.14
{STM}.118 (STM)	CIRCULAR	0.90	0.90	1	0.64	0.23	1811.18
{STM}.120 (STM)	CIRCULAR	0.90	0.90	1	0.64	0.23	1810.25
{STM}.122 (1) (STM)	CIRCULAR	2.10	2.10	1	3.46	0.53	5732.14

{STM}.122 (STM)	CIRCULAR	1.95	1.95	1	2.99	0.49	372039.38
{STM}.128 (1) (STM)	CIRCULAR	1.65	1.65	1	2.14	0.41	4924.96
{STM}.128 (STM)	CIRCULAR	0.90	0.90	1	0.64	0.23	547.51
{STM}.130 (STM)	CIRCULAR	1.65	1.65	1	2.14	0.41	4558.64
{STM}.132 (STM)	CIRCULAR	1.65	1.65	1	2.14	0.41	4070.52
{STM}.134 (STM)	CIRCULAR	1.65	1.65	1	2.14	0.41	4059.95
{STM}.136 (STM)	CIRCULAR	0.90	0.90	1	0.64	0.23	1402.16
{STM}.144 (STM)	CIRCULAR	0.53	0.53	1	0.22	0.13	521.57
{STM}.156 (STM)	CIRCULAR	1.95	1.95	1	2.99	0.49	5092.46
{STM}.158 (STM)	CIRCULAR	1.95	1.95	1	2.99	0.49	4538.64
{STM}.160 (STM)	CIRCULAR	1.95	1.95	1	2.99	0.49	4413.36
{STM}.162 (STM)	CIRCULAR	1.95	1.95	1	2.99	0.49	4497.82
{STM}.182 (1) (STM)	CIRCULAR	0.60	0.60	1	0.28	0.15	274.79
{STM}.182 (10) (STM)	CIRCULAR	1.35	1.35	1	1.43	0.34	2891.33
{STM}.182 (16) (STM)	CIRCULAR	1.05	1.05	1	0.87	0.26	1994.09
{STM}.182 (17) (1) (STM)	CIRCULAR	1.05	1.05	1	0.87	0.26	2148.87
{STM}.182 (17) (STM)	CIRCULAR	1.05	1.05	1	0.87	0.26	1931.36
{STM}.182 (18) (STM)	CIRCULAR	1.05	1.05	1	0.87	0.26	1927.05
{STM}.182 (19) (STM)	CIRCULAR	1.05	1.05	1	0.87	0.26	1931.98
{STM}.182 (33) (STM)	CIRCULAR	1.20	1.20	1	1.13	0.30	1743.70
{STM}.182 (39) (STM)	CIRCULAR	1.35	1.35	1	1.43	0.34	5831.31
{STM}.182 (4) (STM)	CIRCULAR	0.82	0.82	1	0.53	0.21	1001.19
{STM}.182 (40) (STM)	CIRCULAR	0.97	0.97	1	0.75	0.24	579.04
{STM}.182 (43) (STM)	CIRCULAR	1.50	1.50	1	1.77	0.38	2250.22
{STM}.182 (44) (STM)	CIRCULAR	1.20	1.20	1	1.13	0.30	1204.92
{STM}.182 (48) (STM)	CIRCULAR	1.35	1.35	1	1.43	0.34	2387.50
{STM}.182 (49) (STM)	CIRCULAR	1.35	1.35	1	1.43	0.34	2384.75
{STM}.182 (50) (STM)	CIRCULAR	1.35	1.35	1	1.43	0.34	2071.79
{STM}.182 (52) (STM)	CIRCULAR	0.82	0.82	1	0.53	0.21	1758.58
{STM}.182 (53) (STM)	CIRCULAR	0.82	0.82	1	0.53	0.21	1758.75
{STM}.182 (54) (STM)	CIRCULAR	0.82	0.82	1	0.53	0.21	1757.52
{STM}.182 (58) (STM)	CIRCULAR	2.10	2.10	1	3.46	0.53	6041.80
{STM}.182 (6) (STM)	CIRCULAR	0.60	0.60	1	0.28	0.15	274.54
{STM}.182 (62) (STM)	CIRCULAR	0.75	0.75	1	0.44	0.19	498.00
{STM}.182 (63) (STM)	CIRCULAR	0.75	0.75	1	0.44	0.19	498.09

{STM}.182 (64) (STM) CIRCULAR	1.35	1.35	1	1.43	0.34	2397.81
{STM}.182 (65) (STM) CIRCULAR	1.35	1.35	1	1.43	0.34	2377.19
{STM}.182 (67) (STM) CIRCULAR	0.75	0.75	1	0.44	0.19	497.74
{STM}.182 (68) (STM) CIRCULAR	0.75	0.75	1	0.44	0.19	559.62
{STM}.182 (69) (STM) CIRCULAR	0.90	0.90	1	0.64	0.23	1292.47
{STM}.182 (7) (STM) CIRCULAR	0.60	0.60	1	0.28	0.15	306.77
{STM}.182 (70) (STM) CIRCULAR	0.90	0.90	1	0.64	0.23	1288.52
{STM}.182 (71) (STM) CIRCULAR	0.90	0.90	1	0.64	0.23	1281.85
{STM}.182 (72) (STM) CIRCULAR	0.90	0.90	1	0.64	0.23	1103.33
{STM}.182 (73) (STM) CIRCULAR	0.90	0.90	1	0.64	0.23	1827.70
{STM}.182 (74) (STM) CIRCULAR	0.90	0.90	1	0.64	0.23	2217.23
{STM}.182 (75) (STM) CIRCULAR	0.82	0.82	1	0.53	0.21	1326.66
{STM}.182 (76) (STM) CIRCULAR	0.82	0.82	1	0.53	0.21	1084.14
{STM}.182 (77) (STM) CIRCULAR	0.82	0.82	1	0.53	0.21	709.11
{STM}.182 (78) (STM) CIRCULAR	0.82	0.82	1	0.53	0.21	784.97
{STM}.182 (80) (STM) CIRCULAR	1.95	1.95	1	2.99	0.49	4509.51
{STM}.STM (1)-69 (STM) CIRCULAR	1.50	1.50	1	1.77	0.38	4737.61
{STM}.STM (1)-71 (STM) CIRCULAR	1.50	1.50	1	1.77	0.38	4746.85
{STM}.STM (1)-73 (STM) CIRCULAR	1.50	1.50	1	1.77	0.38	4739.67
{STM}.STM (1)-75 (STM) CIRCULAR	1.35	1.35	1	1.43	0.34	3582.04
{STM}.STM (1)-77 (STM) CIRCULAR	1.35	1.35	1	1.43	0.34	6538.05
{STM}.STM (1)-79 (STM) CIRCULAR	0.90	0.90	1	0.64	0.23	2217.14
{STM}.STM (1)-81 (STM) CIRCULAR	0.90	0.90	1	0.64	0.23	2217.23
{STM}.STM (1)-83 (STM) CIRCULAR	0.90	0.90	1	0.64	0.23	1803.11
{STM}.STM (1)-99 (STM) CIRCULAR	1.05	1.05	1	0.87	0.26	1492.12
{STM}.STM- BRIGIL - OPT3-31 (STM) CIRCULAR	1.80	1.80	1	2.54	0.45	3733.81
{STM}.STM- BRIGIL - OPT3-33 (STM) CIRCULAR	1.80	1.80	1	2.54	0.45	3648.30
{STM}.STM- BRIGIL - OPT3-35 (STM) CIRCULAR	0.90	0.90	1	0.64	0.23	808.71
{STM}.STM- BRIGIL - OPT3-37 (STM) CIRCULAR	1.35	1.35	1	1.43	0.34	2360.02
{STM}.STM-2 (STM) CIRCULAR	1.95	1.95	1	2.99	0.49	6496.39
{STM}.STM-6 (STM) CIRCULAR	1.95	1.95	1	2.99	0.49	6367.16
{STM}.STM-POND3-1 (STM) CIRCULAR	1.50	1.50	1	1.77	0.38	3165.33
{STM}.STM-POND3-101 (STM) CIRCULAR	1.50	1.50	1	1.77	0.38	3254.46
{STM}.STM-POND3-13 (STM) CIRCULAR	1.50	1.50	1	1.77	0.38	3821.12
{STM}.STM-POND3-15 (STM) CIRCULAR	1.05	1.05	1	0.87	0.26	1724.00

{STM}.STM-POND3-19 (STM)	HORIZ_ELLIPSE	1.70	2.70	1	3.67
0.52	8186.55				
{STM}.STM-POND3-21 (STM)	CIRCULAR	1.95	1.95	1	2.99
0.49	6437.38				
{STM}.STM-POND3-23 (STM)	CIRCULAR	1.95	1.95	1	2.99
0.49	6266.03				
{STM}.STM-POND3-25 (STM)	CIRCULAR	1.35	1.35	1	1.43
0.34	5937.33				
{STM}.STM-POND3-30 (STM)	CIRCULAR	2.25	2.25	1	3.98
0.56	9255.89				
{STM}.STM-POND3-72 (STM)	CIRCULAR	1.50	1.50	1	1.77
0.38	3110.74				

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Flow Routing Continuity	Volume hectare-m	Volume Mliters
Dry Weather Inflow	0.000	0.000
Wet Weather Inflow	0.000	0.000
Groundwater Inflow	0.000	0.000
RDII Inflow	0.000	0.000
External Inflow	27.975	279.753
External Outflow	27.993	279.937
Surface Flooding	0.000	0.000
Evaporation Loss	0.000	0.000
Initial Stored Volume	0.717	7.165
Final Stored Volume	0.702	7.019
Continuity Error (%)	-0.013	

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Node Depth Summary
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Node ID	Average Depth Attained m	Maximum Depth Attained m	Maximum HGL Attained m	Time of Max Occurrence days	Time of Max Occurrence hh:mm	Total Flooded Volume ha-mm	Total Time Flooded minutes	Retention Time hh:mm:ss
1007 (STM)	0.98	0.98	86.45	0	00:00	0	0	0:00:00
1009 (STM)	1.79	1.79	82.70	0	00:07	0	0	0:00:00
1011 (STM)	1.91	1.91	82.55	0	00:07	0	0	0:00:00
1013 (STM)	1.92	1.92	82.45	0	00:06	0	0	0:00:00
1015 (STM)	2.09	2.10	82.23	0	00:00	0	0	0:00:00
1017 (STM)	1.64	1.65	81.97	0	00:00	0	0	0:00:00
1025 (STM)	0.54	0.54	77.60	0	00:31	0	0	0:00:00
1027 (STM)	0.53	0.53	75.72	0	00:36	0	0	0:00:00
1029 (STM)	1.03	1.03	74.47	0	00:00	0	0	0:00:00
1031 (STM)	1.00	1.00	73.24	0	01:12	0	0	0:00:00
1033 (STM)	0.78	0.78	70.57	0	00:00	0	0	0:00:00
1035 (STM)	1.86	1.86	70.05	0	00:00	0	0	0:00:00
1037 (STM)	1.89	1.90	69.41	0	00:00	0	0	0:00:00
1039 (STM)	2.01	2.02	68.98	0	00:00	0	0	0:00:00
1501 (STM)	1.46	1.46	82.88	0	00:08	0	0	0:00:00
2001 (STM)	0.68	0.68	75.40	0	00:00	0	0	0:00:00
2003 (STM)	1.41	1.41	74.91	0	00:00	0	0	0:00:00
2005 (STM)	1.20	1.20	73.08	0	00:01	0	0	0:00:00
2007 (STM)	1.05	1.05	70.91	0	00:01	0	0	0:00:00
2009 (STM)	1.03	1.73	69.63	0	00:00	0	0	0:00:00
2013 (STM)	2.26	2.57	68.64	0	00:00	0	0	0:00:00
2015 (STM)	2.44	2.66	68.39	0	00:00	0	0	0:00:00
2021 (STM)	1.14	1.46	69.68	0	00:00	0	0	0:00:00
2023 (STM)	1.23	1.86	69.28	0	00:00	0	0	0:00:00
2025 (STM)	1.37	1.94	69.13	0	00:00	0	0	0:00:00
2027 (STM)	2.07	2.59	68.98	0	00:00	0	0	0:00:00
3019 (STM)	1.63	1.63	80.89	0	00:00	0	0	0:00:00
3021 (STM)	0.61	0.61	81.68	0	00:00	0	0	0:00:00
3031 (STM)	2.94	2.95	82.39	0	00:00	0	0	0:00:00
3033 (STM)	2.90	2.90	82.28	0	00:00	0	0	0:00:00

3035 (STM)	2.86	2.88	82.16	0	00:00	0	0	0:00:00
3037 (STM)	2.84	2.85	82.05	0	00:00	0	0	0:00:00
3-99 (STM)	2.28	2.43	68.00	0	00:00	0	0	0:00:00
4003 (STM)	2.05	2.48	68.93	0	00:00	0	0	0:00:00
4005 (STM)	1.15	1.16	68.72	0	00:01	0	0	0:00:00
4007 (STM)	1.54	1.55	68.64	0	00:00	0	0	0:00:00
5001 (STM)	2.00	2.00	82.87	0	00:01	0	0	0:00:00
5501 (STM)	1.24	1.24	84.36	0	00:01	0	0	0:00:00
5503 (STM)	0.79	0.79	84.85	0	00:00	0	0	0:00:00
5505 (STM)	0.82	0.82	85.33	0	00:00	0	0	0:00:00
5507 (STM)	0.85	0.85	85.67	0	00:00	0	0	0:00:00
7001 (STM)	2.18	2.19	68.11	0	00:00	0	0	0:00:00
803 (STM)	0.78	0.78	77.09	0	00:24	0	0	0:00:00
805 (STM)	0.71	0.71	76.57	0	00:28	0	0	0:00:00
807 (STM)	0.80	0.80	77.51	0	00:01	0	0	0:00:00
815 (STM)	0.66	0.66	78.76	0	00:29	0	0	0:00:00
817 (STM)	0.55	0.55	78.04	0	00:00	0	0	0:00:00
819 (STM)	0.55	0.55	78.88	0	00:00	0	0	0:00:00
STM (1)-68 (STM)	2.02	2.03	68.69	0	00:00	0	0	0:00:00
STM- BRIGIL - OPT3-30 (STM)	1.70	1.70	80.69	0	00:02	0	0	0:00:00
STM- BRIGIL - OPT3-32 (STM)	1.74	1.74	80.83	0	00:01	0	0	0:00:00
STM- BRIGIL - OPT3-34 (STM)	1.91	1.91	81.25	0	02:52	0	0	0:00:00
STM- BRIGIL - OPT3-36 (STM)	1.80	1.81	81.33	0	00:12	0	0	0:00:00
STM-1 (STM)	1.93	1.94	67.74	0	00:00	0	0	0:00:00
STM-1066 (STM)	2.90	2.91	82.61	0	00:00	0	0	0:00:00
STM-1069 (STM)	1.52	1.53	81.02	0	00:00	0	0	0:00:00
STM-1073 (STM)	1.70	1.79	68.49	0	00:00	0	0	0:00:00
STM-1074 (STM)	1.66	1.77	68.59	0	00:00	0	0	0:00:00
STM-1075 (STM)	1.58	1.60	68.57	0	00:00	0	0	0:00:00
STM-1077 (STM)	0.68	0.68	69.71	0	00:02	0	0	0:00:00
STM-1078 (STM)	0.70	0.70	73.30	0	00:00	0	0	0:00:00
STM-1079 (STM)	0.70	0.70	75.32	0	00:00	0	0	0:00:00
STM-1083 (STM)	2.75	2.76	81.85	0	00:00	0	0	0:00:00
STM-1084 (STM)	2.68	2.68	81.73	0	00:00	0	0	0:00:00
STM-1090 (STM)	0.46	0.46	76.65	0	00:00	0	0	0:00:00
STM-1092 (STM)	0.59	0.59	82.79	0	02:33	0	0	0:00:00
STM-1093 (STM)	0.57	0.57	83.01	0	00:00	0	0	0:00:00
STM-1094 (STM)	1.66	1.68	68.25	0	00:00	0	0	0:00:00
STM-1096 (STM)	0.57	0.57	82.62	0	02:50	0	0	0:00:00
STM-1097 (STM)	0.52	0.52	82.47	0	02:35	0	0	0:00:00
STM-1098 (STM)	0.36	0.36	80.22	0	00:00	0	0	0:00:00
STM-1099 (STM)	0.36	0.36	79.47	0	00:00	0	0	0:00:00
STM-1100 (STM)	0.37	0.37	78.41	0	00:01	0	0	0:00:00
STM-1101 (STM)	0.44	0.44	78.06	0	00:02	0	0	0:00:00
STM-1103 (STM)	1.29	2.26	89.31	0	00:00	0.00	0	0:00:00
STM-1104 (STM)	0.97	1.99	89.10	0	00:00	0	0	0:00:00
STM-1105 (STM)	1.20	1.41	87.96	0	00:00	0	0	0:00:00
STM-1106 (STM)	1.13	1.21	87.65	0	00:00	0	0	0:00:00
STM-1108 (STM)	0.83	0.83	84.46	0	00:00	0	0	0:00:00
STM-1109 (STM)	1.23	1.23	74.32	0	00:00	0	0	0:00:00
STM-1114 (STM)	2.04	2.04	81.95	0	00:00	0	0	0:00:00
STM-POND3-100 (STM)	2.41	2.80	68.78	0	00:00	0	0	0:00:00
{STM}.STM-413 (STM)	1.15	1.15	80.50	0	00:00	0	0	0:00:00
StartNullStruct1	1.62	1.76	67.50	0	00:00	0	0	0:00:00
STM- BRIGIL - OPT3-29 (STM)	1.29	1.29	80.50	0	00:00	0	0	0:00:00
STM-1086 (STM)	1.36	1.36	80.86	0	00:00	0	0	0:00:00
STM-1102 (STM)	0.00	0.00	75.37	0	00:00	0	0	0:00:00
STM-1107 (STM)	0.53	0.55	87.15	0	00:00	0	0	0:00:00
STM-3 (STM)	0.00	0.00	65.72	0	00:00	0	0	0:00:00

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Node Flow Summary

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Node ID	Element Type	Maximum Lateral Inflow LPS	Peak Inflow LPS	Time of Peak Inflow Occurrence days	Time of Peak Inflow Occurrence hh:mm	Maximum Flooding Overflow LPS	Time of Peak Flooding Occurrence days	Time of Peak Flooding Occurrence hh:mm
1007 (STM)	JUNCTION	1063.00	1063.00	0	00:00	0.00		
1009 (STM)	JUNCTION	0.00	2416.06	0	00:01	0.00		
1011 (STM)	JUNCTION	0.00	2416.23	0	00:00	0.00		
1013 (STM)	JUNCTION	677.00	3093.51	0	00:00	0.00		
1015 (STM)	JUNCTION	745.00	3840.21	0	00:00	0.00		
1017 (STM)	JUNCTION	312.00	312.00	0	00:00	0.00		
1025 (STM)	JUNCTION	0.00	236.00	0	00:00	0.00		
1027 (STM)	JUNCTION	0.00	236.00	0	00:00	0.00		
1029 (STM)	JUNCTION	1504.00	1740.00	0	02:29	0.00		
1031 (STM)	JUNCTION	0.00	1740.00	0	00:00	0.00		
1033 (STM)	JUNCTION	0.00	1740.00	0	01:27	0.00		
1035 (STM)	JUNCTION	1391.00	3131.00	0	00:00	0.00		
1037 (STM)	JUNCTION	0.00	3132.66	0	00:00	0.00		
1039 (STM)	JUNCTION	0.00	3132.44	0	00:00	0.00		
1501 (STM)	JUNCTION	1353.00	1353.00	0	00:00	0.00		
2001 (STM)	JUNCTION	0.00	758.00	0	00:32	0.00		
2003 (STM)	JUNCTION	1822.00	2580.00	0	00:00	0.00		
2005 (STM)	JUNCTION	0.00	2580.00	0	00:00	0.00		
2007 (STM)	JUNCTION	0.00	2580.00	0	00:01	0.00		
2009 (STM)	JUNCTION	0.00	2580.31	0	00:01	0.00		
2013 (STM)	JUNCTION	0.00	4701.91	0	00:00	0.00		
2015 (STM)	JUNCTION	684.00	8190.04	0	00:00	0.00		
2021 (STM)	JUNCTION	1377.00	1377.00	0	00:00	0.00		
2023 (STM)	JUNCTION	0.00	1465.02	0	00:00	0.00		
2025 (STM)	JUNCTION	0.00	1741.21	0	00:00	0.00		
2027 (STM)	JUNCTION	0.00	1830.02	0	00:00	0.00		
3019 (STM)	JUNCTION	0.00	1409.19	0	00:00	0.00		
3021 (STM)	JUNCTION	241.00	241.00	0	00:00	0.00		
3031 (STM)	JUNCTION	0.00	3557.50	0	01:11	0.00		
3033 (STM)	JUNCTION	0.00	3557.11	0	00:06	0.00		
3035 (STM)	JUNCTION	0.00	3557.14	0	00:00	0.00		
3037 (STM)	JUNCTION	418.00	3975.41	0	00:06	0.00		
3-99 (STM)	JUNCTION	776.00	8965.79	0	00:00	0.00		
4003 (STM)	JUNCTION	1575.00	4702.44	0	00:00	0.00		
4005 (STM)	JUNCTION	0.00	696.52	0	00:01	0.00		
4007 (STM)	JUNCTION	556.00	1263.45	0	00:01	0.00		
5001 (STM)	JUNCTION	1215.00	2813.00	0	00:00	0.00		
5501 (STM)	JUNCTION	867.00	1598.00	0	00:00	0.00		
5503 (STM)	JUNCTION	0.00	731.00	0	00:00	0.00		
5505 (STM)	JUNCTION	0.00	731.00	0	00:00	0.00		
5507 (STM)	JUNCTION	731.00	731.00	0	00:00	0.00		
7001 (STM)	JUNCTION	0.00	6053.37	0	00:00	0.00		
803 (STM)	JUNCTION	261.00	261.00	0	00:00	0.00		
805 (STM)	JUNCTION	0.00	758.00	0	00:27	0.00		
807 (STM)	JUNCTION	497.00	497.00	0	00:00	0.00		
815 (STM)	JUNCTION	152.00	152.00	0	00:00	0.00		
817 (STM)	JUNCTION	0.00	236.00	0	00:36	0.00		
819 (STM)	JUNCTION	84.00	84.00	0	00:00	0.00		
STM (1)-68 (STM)	JUNCTION	1021.00	4153.38	0	00:00	0.00		
STM- BRIGIL - OPT3-30 (STM)	JUNCTION	0.00	2663.33	0	00:02	0.00		
STM- BRIGIL - OPT3-32 (STM)	JUNCTION	91.00	2664.53	0	00:01	0.00		
STM- BRIGIL - OPT3-34 (STM)	JUNCTION	0.00	1170.37	0	02:52	0.00		
STM- BRIGIL - OPT3-36 (STM)	JUNCTION	1170.00	1170.00	0	00:00	0.00		
STM-1 (STM)	JUNCTION	0.00	5971.48	0	00:00	0.00		
STM-1066 (STM)	JUNCTION	743.00	743.00	0	00:00	0.00		
STM-1069 (STM)	JUNCTION	1161.00	1161.00	0	00:00	0.00		
STM-1073 (STM)	JUNCTION	525.00	1832.89	0	00:00	0.00		
STM-1074 (STM)	JUNCTION	0.00	1312.65	0	00:00	0.00		
STM-1075 (STM)	JUNCTION	0.00	1276.71	0	00:00	0.00		
STM-1077 (STM)	JUNCTION	0.00	695.00	0	00:01	0.00		
STM-1078 (STM)	JUNCTION	0.00	695.00	0	00:00	0.00		
STM-1079 (STM)	JUNCTION	695.00	695.00	0	00:00	0.00		

STM-1083 (STM)	JUNCTION	0.00	3976.08	0	00:06	0.00		
STM-1084 (STM)	JUNCTION	0.00	8126.62	0	00:06	0.00		
STM-1090 (STM)	JUNCTION	0.00	236.00	0	01:48	0.00		
STM-1092 (STM)	JUNCTION	0.00	386.00	0	00:01	0.00		
STM-1093 (STM)	JUNCTION	386.00	386.00	0	00:00	0.00		
STM-1094 (STM)	JUNCTION	0.00	1849.77	0	00:00	0.00		
STM-1096 (STM)	JUNCTION	0.00	386.00	0	00:02	0.00		
STM-1097 (STM)	JUNCTION	0.00	386.00	0	01:52	0.00		
STM-1098 (STM)	JUNCTION	0.00	386.00	0	00:00	0.00		
STM-1099 (STM)	JUNCTION	0.00	386.00	0	00:00	0.00		
STM-1100 (STM)	JUNCTION	0.00	386.00	0	00:00	0.00		
STM-1101 (STM)	JUNCTION	0.00	386.00	0	00:01	0.00		
STM-1103 (STM)	JUNCTION	762.00	762.00	0	00:00	68.05	0	00:00
STM-1104 (STM)	JUNCTION	0.00	796.26	0	00:00	0.00		
STM-1105 (STM)	JUNCTION	0.00	834.92	0	00:00	0.00		
STM-1106 (STM)	JUNCTION	0.00	837.89	0	00:00	0.00		
STM-1108 (STM)	JUNCTION	0.00	731.00	0	00:00	0.00		
STM-1109 (STM)	JUNCTION	0.00	2580.00	0	00:00	0.00		
STM-1114 (STM)	JUNCTION	0.00	4154.73	0	00:00	0.00		
STM-POND3-100 (STM)	JUNCTION	1045.00	2896.49	0	00:01	0.00		
{STM}.STM-413 (STM)	OUTFALL	0.00	0.00	0	00:00	0.00		
StartNullStruct1	OUTFALL	0.00	8833.28	0	00:00	0.00		
STM- BRIGIL - OPT3-29 (STM)	OUTFALL	0.00	2663.10	0	00:02	0.00		
STM-1086 (STM)	OUTFALL	0.00	8124.28	0	00:00	0.00		
STM-1102 (STM)	OUTFALL	0.00	386.00	0	00:02	0.00		
STM-1107 (STM)	OUTFALL	0.00	839.81	0	00:00	0.00		
STM-3 (STM)	OUTFALL	0.00	5948.72	0	00:00	0.00		

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Outfall Loading Summary
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Outfall Node ID	Flow Frequency (%)	Average Flow LPS	Peak Inflow LPS
{STM}.STM-413 (STM)	0.00	0.00	0.00
StartNullStruct1	100.00	8053.12	8833.28
STM- BRIGIL - OPT3-29 (STM)	100.00	2663.00	2663.10
STM-1086 (STM)	100.00	8124.00	8124.28
STM-1102 (STM)	100.00	386.00	386.00
STM-1107 (STM)	100.00	762.83	839.81
STM-3 (STM)	100.00	5928.04	5948.72
System	85.71	25917.00	26733.44

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Link Flow Summary
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Link ID	Element Type	Time of Peak Flow Occurrence days	hh:mm	Maximum Velocity Attained m/sec	Length Factor	Peak Flow during Analysis LPS	Design Flow Capacity LPS	Ratio of Maximum /Design Flow	Ratio of Maximum Flow Depth	Total Time Surcharged minutes	Reported Condition
{STM}.100 (STM)	CONDUIT	0	00:01	3.13	1.00	2580.00	3656.58	0.71	0.68	0	Calculated
{STM}.102 (1) (STM)	CONDUIT	0	00:00	2.52	1.00	2580.00	3353.33				

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0.77      0.85           0  Calculated
  {STM}.102 (STM)      CONDUIT      0  00:00      3.13    1.00     2580.00     3904.52
0.66      0.68           0  Calculated
  {STM}.106 (STM)      CONDUIT      0  00:00      1.32    1.00      758.00     3524.60
0.22      0.51           0  Calculated
  {STM}.108 (STM)      CONDUIT      0  00:32      2.40    1.00      758.00     3701.84
0.20      0.32           0  Calculated
  {STM}.118 (1) (STM)  CONDUIT      0  01:48      1.87    1.00      236.00     1802.14
0.13      0.25           0  Calculated
  {STM}.118 (STM)      CONDUIT      0  00:00      1.25    1.00      117.46     1811.18
0.06      0.21           0  Calculated
  {STM}.120 (STM)      CONDUIT      0  00:00      1.78    1.00      236.00     1810.25
0.13      0.26           0  Calculated
  {STM}.122 (1) (STM)  CONDUIT      0  00:06      1.15    1.00     3976.88     5732.14
0.69      1.00         180  SURCHARGED
  {STM}.122 (STM)      CONDUIT      0  00:00      0.00    1.00        0.00   372039.38
0.00      0.29           0  Calculated
  {STM}.128 (1) (STM)  CONDUIT      0  00:00      1.80    1.00     3842.71     4924.96
0.78      0.99           0  Calculated
  {STM}.128 (STM)      CONDUIT      0  00:00      0.49    1.00      313.31      547.51
0.57      1.00         180  SURCHARGED
  {STM}.130 (STM)      CONDUIT      0  00:00      1.45    1.00     3095.21     4558.64
0.68      0.99           0  Calculated
  {STM}.132 (STM)      CONDUIT      0  00:00      1.14    1.00     2416.51     4070.52
0.59      0.97           0  Calculated
  {STM}.134 (STM)      CONDUIT      0  00:00      1.16    1.00     2416.23     4059.95
0.60      0.94           0  Calculated
  {STM}.136 (STM)      CONDUIT      0  00:00      2.22    1.00     1063.00     1402.16
0.76      0.70           0  Calculated
  {STM}.144 (STM)      CONDUIT      0  00:00      2.04    1.00      241.00      521.57
0.46      0.54           0  Calculated
  {STM}.156 (STM)      CONDUIT      0  00:06      1.19    1.00     3557.11     5092.46
0.70      1.00         180  SURCHARGED
  {STM}.158 (STM)      CONDUIT      0  00:00      1.19    1.00     3557.14     4538.64
0.78      1.00         180  SURCHARGED
  {STM}.160 (STM)      CONDUIT      0  00:06      1.19    1.00     3557.41     4413.36
0.81      1.00         180  SURCHARGED
  {STM}.162 (STM)      CONDUIT      0  00:06      1.33    1.00     3976.08     4497.82
0.88      1.00         180  SURCHARGED
  {STM}.182 (1) (STM)  CONDUIT      0  00:36      1.06    1.00      152.00      274.79
0.55      0.51           0  Calculated
  {STM}.182 (10) (STM) CONDUIT      0  01:11      1.97    1.00     2814.00     2891.33
0.97      1.00         180  SURCHARGED
  {STM}.182 (16) (STM) CONDUIT      0  00:00      2.18    1.00     1598.00     1994.09
0.80      0.79           0  Calculated
  {STM}.182 (17) (1) (STM) CONDUIT      0  00:00      1.81    1.00      731.00     2148.87
   0.34      0.47           0  Calculated
  {STM}.182 (17) (STM) CONDUIT      0  00:00      1.16    1.00      731.00     1931.36
0.38      0.68           0  Calculated
  {STM}.182 (18) (STM) CONDUIT      0  00:00      1.82    1.00      731.00     1927.05
0.38      0.47           0  Calculated
  {STM}.182 (19) (STM) CONDUIT      0  00:00      1.75    1.00      731.00     1931.98
0.38      0.49           0  Calculated
  {STM}.182 (33) (STM) CONDUIT      0  00:01      1.21    1.00     1353.06     1743.70
0.78      0.97           0  Calculated
  {STM}.182 (39) (STM) CONDUIT      0  00:01      3.52    1.00     2580.31     5831.31
0.44      0.52           0  Calculated
  {STM}.182 (4) (STM)  CONDUIT      0  00:02      1.65    1.00      497.00     1001.19
0.50      0.55           0  Calculated
  {STM}.182 (40) (STM) CONDUIT      0  01:11      1.00    1.00      743.50      579.04
1.28      1.00         180  SURCHARGED
  {STM}.182 (43) (STM) CONDUIT      0  00:01      0.85    1.00     1403.53     2250.22
0.62      0.88           0  Calculated
  {STM}.182 (44) (STM) CONDUIT      0  00:00      1.04    1.00     1168.19     1204.92
0.97      0.99           0  Calculated
  {STM}.182 (48) (STM) CONDUIT      0  00:00      0.91    1.00     1307.89     2387.50
0.55      1.00         179  SURCHARGED
  {STM}.182 (49) (STM) CONDUIT      0  00:00      0.92    1.00     1312.65     2384.75
0.55      0.98           0  Calculated
  {STM}.182 (50) (STM) CONDUIT      0  00:00      0.92    1.00     1276.71     2071.79
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0.62      0.94            0  Calculated
  {STM}.182 (52) (STM) CONDUIT      0  00:01      1.97    1.00      696.52     1758.58
0.40      0.63            0  Calculated
  {STM}.182 (53) (STM) CONDUIT      0  00:01      2.89    1.00      695.00     1758.75
0.40      0.46            0  Calculated
  {STM}.182 (54) (STM) CONDUIT      0  00:00      2.90    1.00      695.00     1757.52
0.40      0.46            0  Calculated
  {STM}.182 (58) (STM) CONDUIT      0  00:00      2.66    1.00     8124.28     6041.80
1.34      0.82            0  > CAPACITY
  {STM}.182 (6) (STM)  CONDUIT      0  00:01      0.91    1.00       84.00      274.54
0.31      0.36            0  Calculated
  {STM}.182 (62) (STM) CONDUIT      0  00:02      1.09    1.00      386.00      498.00
0.78      0.74            0  Calculated
  {STM}.182 (63) (STM) CONDUIT      0  00:01      1.08    1.00      386.00      498.09
0.77      0.75            0  Calculated
  {STM}.182 (64) (STM) CONDUIT      0  00:00      1.29    1.00     1849.77     2397.81
0.77      1.00          180  SURCHARGED
  {STM}.182 (65) (STM) CONDUIT      0  00:00      1.34    1.00     1900.45     2377.19
0.80      0.98            0  Calculated
  {STM}.182 (67) (STM) CONDUIT      0  01:52      1.14    1.00      386.00      497.74
0.78      0.72            0  Calculated
  {STM}.182 (68) (STM) CONDUIT      0  00:00      1.39    1.00      386.00      559.62
0.69      0.60            0  Calculated
  {STM}.182 (69) (STM) CONDUIT      0  00:00      1.68    1.00      386.00     1292.47
0.30      0.39            0  Calculated
  {STM}.182 (7) (STM)  CONDUIT      0  00:00      1.28    1.00      261.00      306.77
0.85      0.68            0  Calculated
  {STM}.182 (70) (STM) CONDUIT      0  00:00      1.68    1.00      386.00     1288.52
0.30      0.39            0  Calculated
  {STM}.182 (71) (STM) CONDUIT      0  00:01      1.40    1.00      386.00     1281.85
0.30      0.45            0  Calculated
  {STM}.182 (72) (STM) CONDUIT      0  00:02      1.41    1.00      386.00     1103.33
0.35      0.44            0  Calculated
  {STM}.182 (73) (STM) CONDUIT      0  00:00      1.18    1.00      118.54     1827.70
0.06      0.22            0  Calculated
  {STM}.182 (74) (STM) CONDUIT      0  00:00      3.13    1.00     1703.11     2217.23
0.77      0.80            0  Calculated
  {STM}.182 (75) (STM) CONDUIT      0  00:00      1.70    1.00      796.26     1326.66
0.60      1.00            0  SURCHARGED
  {STM}.182 (76) (STM) CONDUIT      0  00:00      1.56    1.00      834.92     1084.14
0.77      1.00            0  SURCHARGED
  {STM}.182 (77) (STM) CONDUIT      0  00:00      1.57    1.00      837.89      709.11
1.18      1.00            0  SURCHARGED
  {STM}.182 (78) (STM) CONDUIT      0  00:00      1.76    1.00      839.81      784.97
1.07      0.84            0  > CAPACITY
  {STM}.182 (80) (STM) CONDUIT      0  00:00      1.55    1.00     4152.45     4509.51
0.92      0.84            0  Calculated
  {STM}.STM (1)-69 (STM) CONDUIT      0  00:00      2.37    1.00     4153.56     4737.61
 0.88      0.98            0  Calculated
  {STM}.STM (1)-71 (STM) CONDUIT      0  00:00      1.77    1.00     3132.38     4746.85
 0.66      1.00          180  SURCHARGED
  {STM}.STM (1)-73 (STM) CONDUIT      0  00:00      1.77    1.00     3132.44     4739.67
 0.66      1.00          180  SURCHARGED
  {STM}.STM (1)-75 (STM) CONDUIT      0  00:00      2.19    1.00     3132.66     3582.04
 0.87      1.00          180  SURCHARGED
  {STM}.STM (1)-77 (STM) CONDUIT      0  00:00      1.91    1.00     1740.00     6538.05
 0.27      0.61            0  Calculated
  {STM}.STM (1)-79 (STM) CONDUIT      0  01:27      3.52    1.00     1740.00     2217.14
 0.78      0.72            0  Calculated
  {STM}.STM (1)-81 (STM) CONDUIT      0  01:33      1.28    1.00       36.89     2217.23
 0.02      0.09            0  Calculated
  {STM}.STM (1)-83 (STM) CONDUIT      0  02:29      1.88    1.00      236.00     1803.11
 0.13      0.25            0  Calculated
  {STM}.STM (1)-99 (STM) CONDUIT      0  00:01      0.87    1.00      707.45     1492.12
 0.47      0.89            0  Calculated
  {STM}.STM- BRIGIL - OPT3-31 (STM) CONDUIT      0  00:02      1.30    1.00     2663.10
3733.81      0.71      0.75            0  Calculated
  {STM}.STM- BRIGIL - OPT3-33 (STM) CONDUIT      0  00:02      1.24    1.00     2663.33
3648.30      0.73      0.79            0  Calculated
  {STM}.STM- BRIGIL - OPT3-35 (STM) CONDUIT      0  02:57      1.84    1.00     1170.22
```

808.71 1.45 1.00 180 SURCHARGED
{STM}.STM- BRIGIL - OPT3-37 (STM) CONDUIT 0 02:52 0.82 1.00 1170.37
2360.02 0.50 1.00 180 SURCHARGED
{STM}.STM-2 (STM) CONDUIT 0 00:00 2.57 1.00 5948.72 6496.39
0.92 0.72 0 Calculated
{STM}.STM-6 (STM) CONDUIT 0 00:00 2.13 1.00 5971.48 6367.16
0.94 0.89 0 Calculated
{STM}.STM-POND3-1 (STM) CONDUIT 0 00:00 1.04 1.00 1830.02 3165.33
0.58 1.00 0 SURCHARGED
{STM}.STM-POND3-101 (STM) CONDUIT 0 00:01 1.64 1.00 2897.00 3254.46
0.89 1.00 180 SURCHARGED
{STM}.STM-POND3-13 (STM) CONDUIT 0 00:00 1.11 1.00 1741.21 3821.12
0.46 1.00 0 SURCHARGED
{STM}.STM-POND3-15 (STM) CONDUIT 0 00:00 2.09 1.00 1465.02 1724.00
0.85 1.00 0 SURCHARGED
{STM}.STM-POND3-19 (STM) CONDUIT 0 00:00 2.23 1.00 8189.79 8186.55
1.00 1.00 180 SURCHARGED
{STM}.STM-POND3-21 (STM) CONDUIT 0 00:00 1.58 1.00 4713.19 6437.38
0.73 1.00 12 SURCHARGED
{STM}.STM-POND3-23 (STM) CONDUIT 0 00:00 1.57 1.00 4701.91 6266.03
0.75 1.00 1 SURCHARGED
{STM}.STM-POND3-25 (STM) CONDUIT 0 00:00 2.29 1.00 3127.44 5937.33
0.53 1.00 0 SURCHARGED
{STM}.STM-POND3-30 (STM) CONDUIT 0 00:00 2.42 1.00 8833.28 9255.89
0.95 0.86 0 Calculated
{STM}.STM-POND3-72 (STM) CONDUIT 0 00:01 1.05 1.00 1851.49 3110.74
0.60 1.00 180 SURCHARGED

****
Flow Classification Summary
****

Link	Dry	Up Dry	Down Dry	Sub Crit	Sup Crit	Up Crit	Down Crit	Avg. Froude Number	Avg. Flow Change
	--- Fraction of Time in Flow Class ----								
{STM}.100 (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.16	0.0000
{STM}.102 (1) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.73	0.0000
{STM}.102 (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.16	0.0000
{STM}.106 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.61	0.0000
{STM}.108 (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.44	0.0000
{STM}.118 (1) (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.48	0.0000
{STM}.118 (STM)	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.11	0.0000
{STM}.120 (STM)	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.38	0.0000
{STM}.122 (1) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0000
{STM}.122 (STM)	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0000
{STM}.128 (1) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.18	0.0000
{STM}.128 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0000
{STM}.130 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.15	0.0000
{STM}.132 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.18	0.0000
{STM}.134 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.23	0.0000
{STM}.136 (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.93	0.0000
{STM}.144 (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.37	0.0000
{STM}.156 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0001
{STM}.158 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0001
{STM}.160 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0000
{STM}.162 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0000
{STM}.182 (1) (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.69	0.0000
{STM}.182 (10) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0000
{STM}.182 (16) (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.75	0.0000
{STM}.182 (17) (1) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.93	0.0000
{STM}.182 (17) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.46	0.0000
{STM}.182 (18) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.93	0.0000
{STM}.182 (19) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.88	0.0000
{STM}.182 (33) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.24	0.0000
{STM}.182 (39) (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.52	0.0000
{STM}.182 (4) (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.87	0.0000
{STM}.182 (40) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0001

{STM}.182 (43) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.21	0.0000
{STM}.182 (44) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.15	0.0000
{STM}.182 (48) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0000
{STM}.182 (49) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.15	0.0000
{STM}.182 (50) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.20	0.0000
{STM}.182 (52) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.94	0.0000
{STM}.182 (53) (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.71	0.0000
{STM}.182 (54) (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.71	0.0000
{STM}.182 (58) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.61	0.0000
{STM}.182 (6) (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.72	0.0000
{STM}.182 (62) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.48	0.0000
{STM}.182 (63) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.47	0.0000
{STM}.182 (64) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0000
{STM}.182 (65) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.22	0.0000
{STM}.182 (67) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.51	0.0000
{STM}.182 (68) (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.72	0.0000
{STM}.182 (69) (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.05	0.0000
{STM}.182 (7) (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.67	0.0000
{STM}.182 (70) (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.05	0.0000
{STM}.182 (71) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.80	0.0000
{STM}.182 (72) (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.82	0.0000
{STM}.182 (73) (STM)	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.02	0.0000
{STM}.182 (74) (STM)	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.15	0.0000
{STM}.182 (75) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.66	0.0000
{STM}.182 (76) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.47	0.0000
{STM}.182 (77) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.34	0.0001
{STM}.182 (78) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.60	0.0001
{STM}.182 (80) (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.36	0.0000
{STM}.STM (1)-69 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.38	0.0000
{STM}.STM (1)-71 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0000
{STM}.STM (1)-73 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0000
{STM}.STM (1)-75 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0000
{STM}.STM (1)-77 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.73	0.0000
{STM}.STM (1)-79 (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.44	0.0000
{STM}.STM (1)-81 (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.72	0.0000
{STM}.STM (1)-83 (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	1.50	0.0000
{STM}.STM (1)-99 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.25	0.0000
{STM}.STM- BRIGIL - OPT3-31 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.36	0.0000
{STM}.STM- BRIGIL - OPT3-33 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.33	0.0000
{STM}.STM- BRIGIL - OPT3-35 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0001
{STM}.STM- BRIGIL - OPT3-37 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0001
{STM}.STM-2 (STM)	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.71	0.0000
{STM}.STM-6 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.45	0.0000
{STM}.STM-POND3-1 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.31	0.0001
{STM}.STM-POND3-101 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0001
{STM}.STM-POND3-13 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.38	0.0000
{STM}.STM-POND3-15 (STM)	0.00	0.00	0.00	0.02	0.00	0.00	0.98	0.79	0.0000
{STM}.STM-POND3-19 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0000
{STM}.STM-POND3-21 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.05	0.0000
{STM}.STM-POND3-23 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.31	0.0000
{STM}.STM-POND3-25 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.68	0.0000
{STM}.STM-POND3-30 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.55	0.0000
{STM}.STM-POND3-72 (STM)	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.0001

****
Time-Step Critical Elements
****
Link {STM}.STM-POND3-21 (STM) (94.15%)
Link {STM}.128 (1) (STM) (4.73%)

****
Highest Flow Instability Indexes
****
Link {STM}.STM- BRIGIL - OPT3-37 (STM) (135)

```
  Link {STM}.156 (STM) (123)
  Link {STM}.158 (STM) (116)
  Link {STM}.182 (10) (STM) (115)
  Link {STM}.182 (40) (STM) (115)


  *************************
  Routing Time Step Summary
  *************************
  Minimum Time Step           :     0.50 sec
  Average Time Step           :     1.94 sec
  Maximum Time Step           :     2.38 sec
  Percent in Steady State     :     0.00
  Average Iterations per Step :     2.55

  WARNING 008 : Elevation drop exceeds length for Conduit {STM}.122 (STM).
  WARNING 002 : Max/rim elevation (depth) increased to account for connecting conduit height
dimensions for Node STM-1084 (STM).

  Analysis began on:  Tue May 17 09:45:19 2016
  Analysis ended on:  Tue May 17 09:45:20 2016
  Total elapsed time: 00:00:01
```

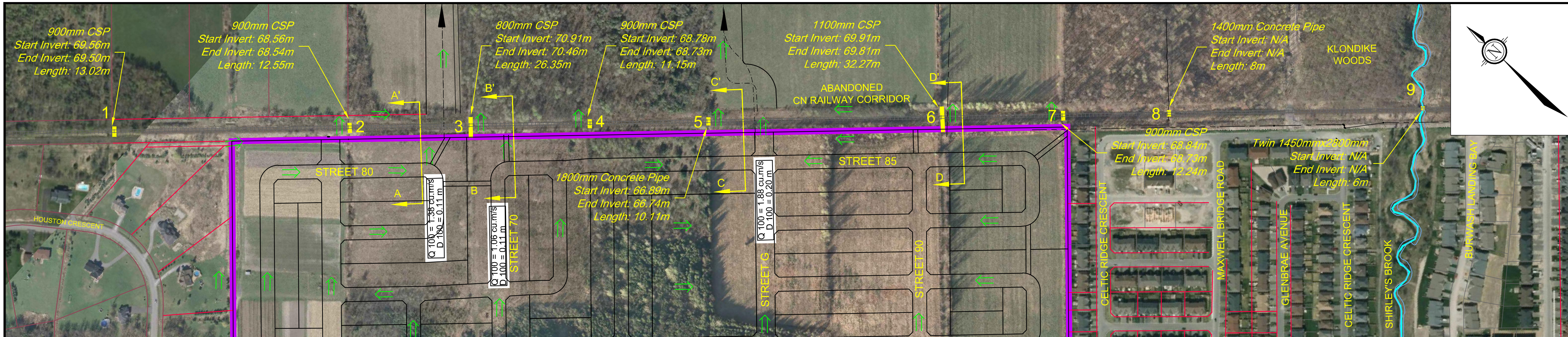
KANATA NORTH URBAN EXPANSION AREA
COMMUNITY DESIGN PLAN

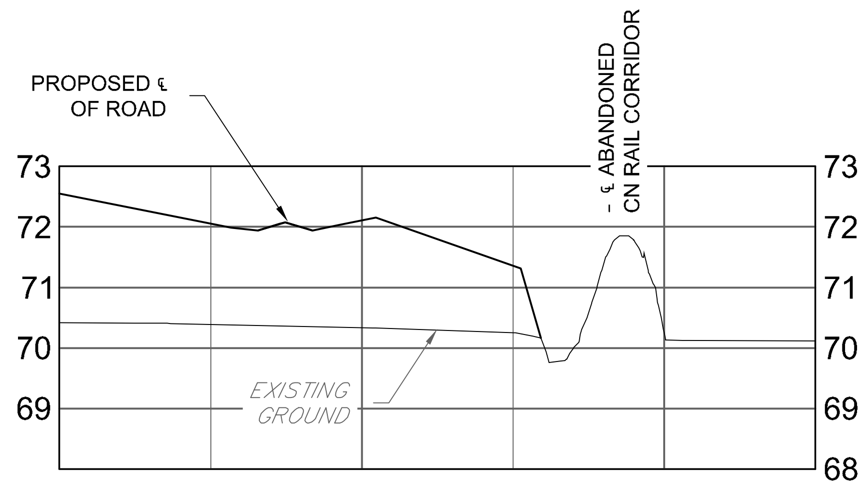
PROJECT : 112117
DESIGNED BY: ARM
CHECKED BY: CJR
DATE: May-16

NOVATECH
Engineers, Planners & Landscape Architects

Table B-2 - Major Overland Flow Summary

Area ID	Indiv. Area (ha)	Indiv C	Tot. Area (ha)	Tot C	Contribution (L/s/ha)	Flow (m^3/s)	Cross-section	Manning's n	Slope	Depth (m)	Velocity (m/s)	Notes	V*D check
Pond 1													
M1.1	7.04	0.65	7.04	0.65	110	0.77	18m ROW	0.015	0.72%	0.11	2.01		0.2
M1.3	4.35	0.67	11.39	0.66	90	1.03	18m ROW	0.015	0.95%	0.11	2.39		0.3
M1.4	4.24	0.78	15.63	0.69	75	1.17	18m ROW	0.015	3.00%	0.10	3.81		0.4
M1.6	5.21	0.60	5.21	0.60	120	0.63	18m ROW	0.015	0.58%	0.10	1.76	Significant high density	0.2
M1.7	6.67	0.58	11.88	0.59	80	0.95	18m ROW	0.015	0.43%	0.13	1.74		0.2
M1.8	8.76	0.62	8.76	0.62	125	1.10	18m ROW	0.015	1.20%	0.11	2.65		0.3
M1.9	5.95	0.65	5.95	0.65	130	0.77	18m ROW	0.015	0.81%	0.11	2.10		0.2
M1.10	1.39	0.72	1.39	0.72	130	0.18	18m ROW	0.015	0.81%	0.06	1.46		0.1
M1.11	1.21	0.69	21.85	0.61	60	1.31	18m ROW	0.015	0.16%	0.17	1.30		0.2
M1.2	10.00	0.65	10.00	0.65	90	0.90	24m ROW	0.015	0.68%	0.11	2.04		0.2
M1.5	2.13	0.81	12.13	0.68	85	1.03	24m ROW	0.015	0.24%	0.15	1.43		0.2
Pond 2													
M2.1	1.96	0.70	8.77	0.56	110	0.96	18m ROW	0.015	1.53%	0.10	2.82	Significant high density	0.3
M2.4	1.59	0.70	1.59	0.70	130	0.21	18m ROW	0.015	1.15%	0.06	1.72	Significant high density	0.1
M2.5	3.36	0.65	6.81	0.52	100	0.68	18m ROW	0.015	0.20%	0.13	1.20	Significant high density	0.2
M2.6	3.45	0.40	3.45	0.40	76	0.26	18m ROW	0.015	0.31%	0.08	1.12	Significant high density	0.1
M2.2	4.55	0.40	4.55	0.40	76	0.35	24m ROW	0.015	0.75%	0.08	1.67	Significant high density	0.1
M2.3	1.67	0.65	6.22	0.47	76	0.47	24m ROW	0.015	0.75%	0.09	1.80	Significant high density	0.2
Pond 3 (North)													
M1.12	0.76	0.65	0.76	0.65	130	0.10	18m ROW	0.015	1.82%	0.04	1.70		0.1
M3.1	9.11	0.73	9.11	0.73	90	0.82	18m ROW	0.015	1.14%	0.10	2.42	Significant high density	0.2
M3.2	9.21	0.65	18.32	0.69	65	1.19	18m ROW	0.015	0.33%	0.15	1.67		0.2
M3.3	6.76	0.65	25.08	0.68	55	1.38	18m ROW	0.015	2.55%	0.11	3.73		0.4
M3.4	4.60	0.65	4.60	0.65	130	0.60	18m ROW	0.015	0.33%	0.11	1.41		0.2
M3.5	4.34	0.55	8.94	0.60	110	0.98	18m ROW	0.015	2.23%	0.10	3.26	Park Area	0.3
M3.6	3.48	0.65	12.42	0.62	85	1.06	18m ROW	0.015	1.50%	0.11	2.86		0.3
Pond 3 (South)													
M4.1	0.92	0.65	0.92	0.65	130	0.12	18m ROW	0.015	3.86%	0.04	2.37		0.1
M4.5	11.30	0.63	12.22	0.63	85	1.04	18m ROW	0.015	3.86%	0.09	4.06		0.4
M4.6	8.94	0.63	8.94	0.63	90	0.80	18m ROW	0.015	0.16%	0.14	1.15		0.2
M4.7	6.55	0.65	15.49	0.64	80	1.24	18m ROW	0.015	0.16%	0.17	1.29		0.2
M4.8	9.96	0.65	37.67	0.64	50	1.88	18m ROW	0.015	0.16%	0.20	1.43		0.3





SECTION B-B'
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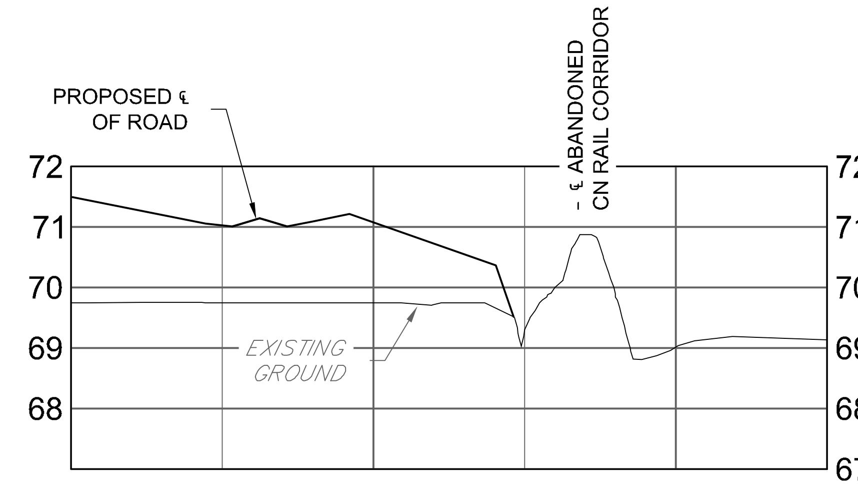

SECTION D-D'
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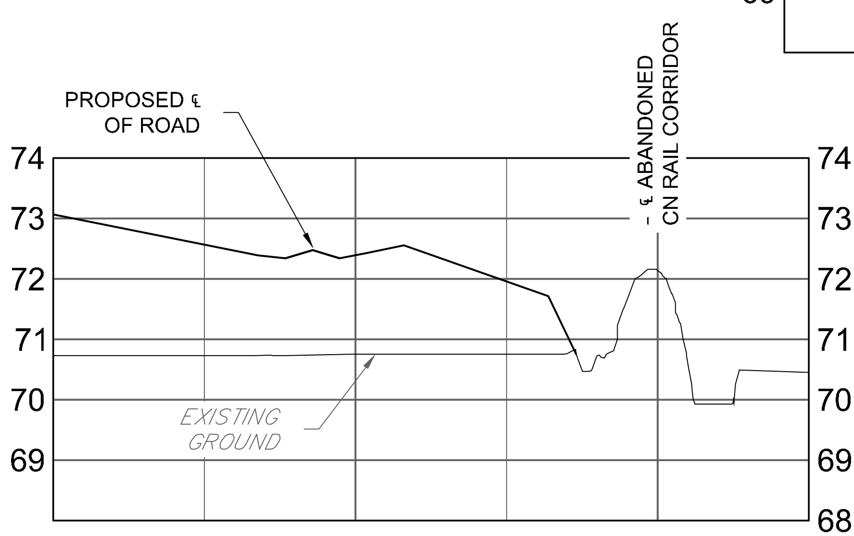

SECTION A-A'
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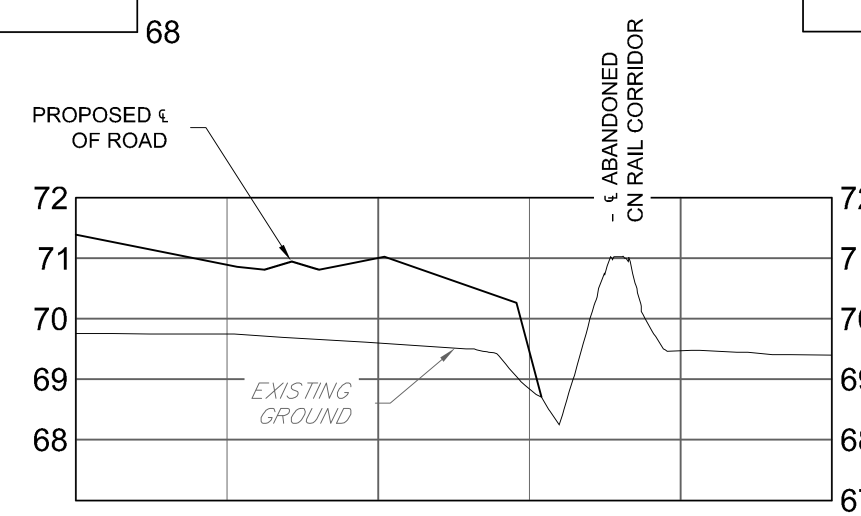

SECTION C-C'
SCALE: 1:1250

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CITY OF OTTAWA
KANATA NORTH URBAN EXPANSION AREA STUDY

ABANDONED CN RAIL CORRIDOR DITCH SECTIONS

SCALE	1:5000
DATE	MAY 2016
JOB	112117
FIGURE	RAIL-XS

M:\2012\112117\CAD\Design_EMP\Figure 7.1 CN Rail Culvert Crossings.dwg, Rail Culverts SECTIONS, May 20, 2016 - 12:53pm, mhrehoriak

SHT11X17.DWG - 279mmX432mm

KANATA NORTH URBAN EXPANSION AREA
COMMUNITY DESIGN PLAN

TABLE B-3a: Mannings Ditch Capacity Analysis

NOVATECH
Engineers, Planners & Landscape Architects

Location : **Abandonded CN Rail Corridor Ditch - Section AA'**

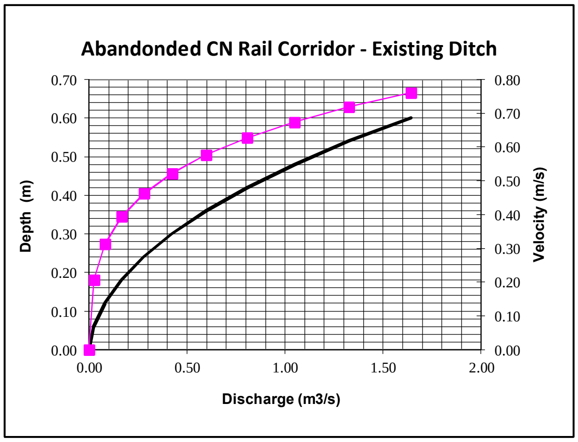
Description: Existing Grassed Ditch
Major Overland Flows contained within existing corridor

Major Flow: 1.54 (m3/s) (Refer to Figure 112117-RAIL-XS)

Dimensions:
Bottom width = 1.80 m
Right Side slopes = 3.0 :1
Left Side slopes = 3.0 :1

Slope = 0.15%
Mannings n = 0.027
Maximum depth = 0.60 m
(to be contained within existing ditch)

Depth (m)	Area (m2)	Hydraulic Radius (m)	Velocity (m/s)	Flow (m3/s)
0.00	0.00	0.00	0.00	0.00
0.06	0.12	0.05	0.21	0.02
0.12	0.26	0.10	0.31	0.08
0.18	0.42	0.14	0.39	0.17
0.24	0.60	0.18	0.46	0.28
0.30	0.81	0.22	0.52	0.42
0.36	1.04	0.25	0.58	0.60
0.42	1.29	0.29	0.63	0.81
0.48	1.56	0.32	0.67	1.05
0.54	**1.85**	**0.35**	**0.72**	**1.33**
0.60	2.16	0.39	0.76	1.64



KANATA NORTH URBAN EXPANSION AREA
COMMUNITY DESIGN PLAN

TABLE B-3b: Mannings Ditch Capacity Analysis

Location : **Abandonded CN Rail Corridor Ditch - Section BB'**

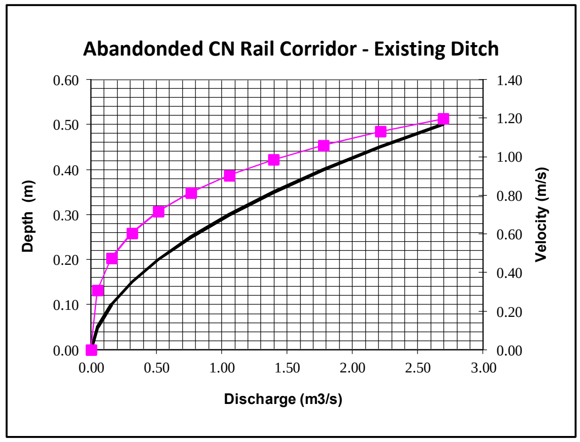
Description: Existing Grassed Ditch
Major Overland Flows contained within existing corridor

Major Flow: 1.06 (m3/s) (Refer to Figure 112117-RAIL-XS)

Dimensions:
Bottom width = 3.00 m
Right Side slopes = 3.0 :1
Left Side slopes = 3.0 :1

Slope = 0.40%
Mannings n = 0.027
Maximum depth = 0.50 m
(to be contained within existing ditch)

Depth (m)	Area (m2)	Hydraulic Radius (m)	Velocity (m/s)	Flow (m3/s)
0.00	0.00	0.00	0.00	0.00
0.05	0.16	0.05	0.31	0.05
0.10	0.33	0.09	0.47	0.16
0.15	0.52	0.13	0.61	0.31
0.20	0.72	0.17	0.72	0.52
0.25	0.94	0.20	0.81	0.76
0.30	**1.17**	**0.24**	**0.90**	**1.06**
0.35	1.42	0.27	0.98	1.39
0.40	1.68	0.30	1.06	1.78
0.45	1.96	0.33	1.13	2.21
0.50	2.25	0.37	1.20	2.69



KANATA NORTH URBAN EXPANSION AREA
COMMUNITY DESIGN PLAN

TABLE B-3c: Mannings Ditch Capacity Analysis

Location : **Abandonded CN Rail Corridor Ditch - Section CC'**

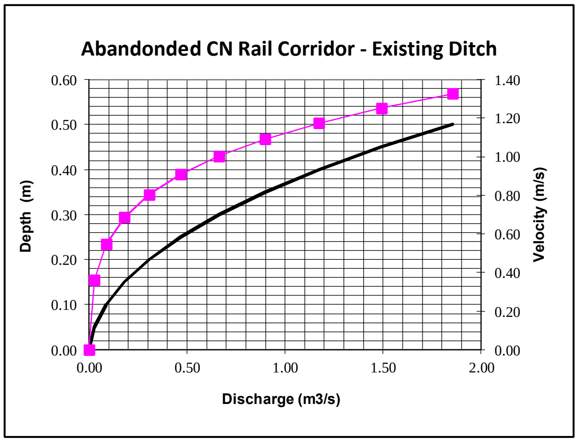
Description: Existing Grassed Ditch
Major Overland Flows contained within existing corridor

Major Flow: 1.84 (m3/s) (Refer to Figure 112117-RAIL-XS)

Dimensions:
Bottom width = 1.30 m
Right Side slopes = 3.0 :1
Left Side slopes = 3.0 :1

Slope = 0.60%
Mannings n = 0.027
Maximum depth = 0.50 m
(to be contained within existing ditch)

Depth (m)	Area (m2)	Hydraulic Radius (m)	Velocity (m/s)	Flow (m3/s)
0.00	0.00	0.00	0.00	0.00
0.05	0.07	0.04	0.36	0.03
0.10	0.16	0.08	0.55	0.09
0.15	0.26	0.12	0.69	0.18
0.20	0.38	0.15	0.80	0.31
0.25	0.51	0.18	0.91	0.47
0.30	0.66	0.21	1.00	0.66
0.35	0.82	0.23	1.09	0.90
0.40	1.00	0.26	1.17	1.17
0.45	1.19	0.29	1.25	1.49
0.50	**1.40**	**0.31**	**1.33**	**1.86**



KANATA NORTH URBAN EXPANSION AREA
COMMUNITY DESIGN PLAN

TABLE B-3d: Mannings Ditch Capacity Analysis

Location : **Abandonded CN Rail Corridor Ditch - Section DD'**

Description: Existing Grassed Ditch
Major Overland Flows contained within existing corridor

Major Flow: 0 (m3/s) (Refer to Figure 112117-RAIL-XS)

Dimensions:
Bottom width = 0.70 m
Right Side slopes = 3.0 :1
Left Side slopes = 3.0 :1

Slope = 0.20%
Mannings n = 0.027
Maximum depth = 0.60 m
(to be contained within existing ditch)

Depth (m)	Area (m2)	Hydraulic Radius (m)	Velocity (m/s)	Flow (m3/s)
0.00	0.00	0.00	0.00	0.00
0.06	**0.05**	**0.05**	**0.22**	**0.01**
0.12	0.13	0.09	0.33	0.04
0.18	0.22	0.12	0.41	0.09
0.24	0.34	0.15	0.48	0.16
0.30	0.48	0.18	0.54	0.26
0.36	0.64	0.22	0.60	0.38
0.42	0.82	0.25	0.65	0.53
0.48	1.03	0.27	0.70	0.72
0.54	1.25	0.30	0.75	0.94
0.60	1.50	0.33	0.80	1.20

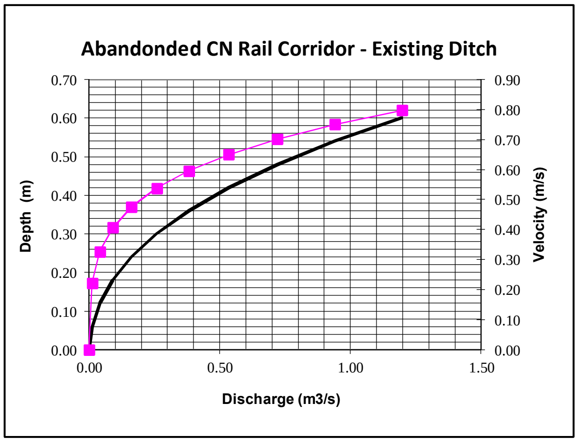


Table B-4: Existing Culvert Capacity Analysis

HY-8 Analysis Results

Crossing Summary Table

Culvert Crossing: CNR

Headwater Elevation (m)	Total Discharge (cms)	R1 Discharge (cms)	R2 Discharge (cms)	R3 Discharge (cms)	R4 Discharge (cms)	R5 Discharge (cms)	R6 Discharge (cms)	Roadway Discharge (cms)	Iterations
66.89	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0
67.69	1.50	0.00	0.00	0.00	0.00	1.50	0.00	0.00	5
68.09	3.00	0.00	0.00	0.00	0.00	3.00	0.00	0.00	5
68.40	4.50	0.00	0.00	0.00	0.00	4.50	0.00	0.00	3
68.69	6.00	0.00	0.02	0.00	0.00	5.98	0.00	0.00	2
68.97	7.50	0.00	0.18	0.00	0.04	7.27	0.00	0.00	3
69.23	9.00	0.00	0.46	0.00	0.23	8.31	0.00	0.00	3
69.39	10.00	0.00	0.67	0.00	0.41	8.92	0.00	0.00	3
69.73	12.00	0.03	1.09	0.00	0.85	10.03	0.00	0.00	3
69.96	13.50	0.19	1.39	0.00	1.15	10.73	0.04	0.00	3
70.19	15.00	0.43	1.58	0.00	1.38	11.38	0.24	0.00	3
70.50	17.10	0.83	1.79	0.00	1.63	12.17	0.68	0.00	Overtopping

Under fully developed conditions, some localized rear yard minor system flows may be directed to the existing rail corridor ditch and existing culverts. Otherwise, only major overland flows will continue to drain to the rail corridor. The total post development major overland flow is 2.9 cms. This flow can be conveyed, mostly through Culvert R5, at an elevation of 68.09m.

Additional culverts may be required at the time of detailed design to convey flows across the rail corridor at more preferable locations.

M E M O / N O T E D E S E R V I C E

To / Destinataire	Wendy Tse	File/N° de fichier:	
From / Expéditeur	Ted Cooper, P. Eng. Darlene Conway, P. Eng.		
Subject / Objet	Kanata North Community Design Plan EMP and MSS Final Drafts (Novatech, April 4, 2016)	Date: May 2, 2016	

These comments are provided in conjunction with "Key SWM Issues for Discussion," a summary of alternative drainage options to be reviewed with Novatech during the week of May 2nd, 2016.

A. **Environmental Management Plan (Novatech, April 4, 2016):**

3.10 Storm Drainage and Hydrology (pre-development):

1. Table 3.6 – Please identify location of peak flow, i.e., immediately upstream of confluence? Is this the same location at which the post-development peak flow is compared (Table 7.1)? Please also reference the pre-development peak flows just upstream of the confluence with the main branch of Shirley's Brook and include the post-value at this location in Table 7.1.

2. Table 3.7 – Please document peak flows corresponding to water levels.

3. Please clarify the differences in drainage areas for Tributary 2 (465.80 ha) and Tributary 3 (253.67 ha) differ from the areas identified in the Shirley's Brook & Watt's Creek Phase 2 Stormwater Management Study of 444.63 ha and
285.53 ha, respectively.

4. Please identify and label the drainage channels in the Pre-Development Figure 3.15, similar to the Post- Development Drainage Area Plan Figure 7.1.

5. Please clarify Section 3.10.5 where it is noted that the 100 year SCS 12-hour storm distribution generates the highest peak flows. From the model it appears that the 100 year SCS 24-hour storm distribution governs?

6. The pre-development peak values for Tributary 2 differ significantly from the pre-development values from the Shirley's Brook Phase 2 Study (2.55 m^3/s vs 1.2 m^3/s, respectively). Please justify the difference or revise as required.

7. Table 4.4: Standard Initial Abstraction (Ia) values is missing from the report. Please also identify how the Ia values were assigned and why they differ from the Shirley's Brook Phase 2 Study values.

8. Please append the '20150911 – Shirley's Brook Modeling Parameters.xlxs' file referenced in the model and the pre- and post- modeling schematics.

3.11 Floodplain Mapping:

9. The limits of the floodplain should be shown on an appropriate base (the "approximate" limit shown on Figure 3.17 is not sufficient).

3.12 Fluvial Geomorphology:

10. Table 3.11:
- the critical discharges noted are greater than the respective 2yr peak flows and the bankfull discharges also significantly exceed the 2yr peak flows - please document these comparisons and comment
- erosion threshold parameters should be provided for a sufficient distance on the main branch so that it can be demonstrated additional erosion will not occur as a result of the urbanization of the north tributary watershed.

11. Table 3.11:
- the critical discharges noted are greater than the respective 2yr peak flows and the bankfull discharges also significantly exceed the 2yr peak flows - please document these comparisons and comment
- erosion threshold parameters should be provided for a sufficient distance on the main branch so that it can be demonstrated additional erosion will not occur as a result of the urbanization of the north tributary watershed.

12. Dwgs 112117-ENV and 112117-EMP: Why are meander belt widths not shown on one (or both) of these drawings?

5.0 SWM Criteria:
13. Watercourse Crossings (culverts): provide further direction, typical examples with respect to designing in accordance with geomorphic principles, "any additional requirements for aquatic habitat," etc.

14. p.53 – Low Impact Development:
"Thorough planning and investigation of subsurface conditions, coordination with proposed land use plans, and thorough consideration of long-term operation and maintenance requirements are all critical to the long-term success of LID designs. As such, it is premature to recommend LID as a primary means for stormwater management at the CDP / EMP scale. Instead, the EMP will provide general guidance for areas where LID techniques could be considered at the plan of subdivision / site plan stage."
Please revise the above paragraph as it indicates that it would be premature to recommend LID at the master planning stage of development, when in fact this is the preferred time to do so. However, as the previous paragraph notes, given the City's limited experience with LID, the locations where it is being implemented for the next few years will be limited in order to "learn by doing." That being the case, it is anticipated that LID approaches may become a requirement before this plan is built out so wording and direction to that effect should be provided.

15. p.53 - *"The surficial geology over a significant portion of the KNUEA is not conducive to infiltration (clay & silty clay soils, shallow depths to bedrock). As such, infiltration-based controls and LID should not be considered as an integral part of the overall SWM strategy."*
Please revise or delete this statement as it disregards the presence of locations with medium coarse sand/loamy sand as indicated on Figure 3.5. While in some locations the shallow overburden may preclude LIDs, the presence of non-sandy soils does not.

6.4 Recommended SWM Strategy
16. Section 6.4.4 and Table 6.5 – Further discussion in the main text is required regarding the selection of relocating Shirley's Brook away from March Valley Road (similar to what was previously provided in the memo to NCC of August 10, 2015). For example, although option 1 is indicated as the lowest cost option, it was not recommended

for various reasons (regardless of the lowest cost) – there is no indication of this in Table 6.5. Further, with respect to the relocation of Shirley's Brook, it is indicated as the highest cost option, however this option's estimate also includes March Valley roadside ditch improvements which should not be required if the outflow from the pond is conveyed directly to Shirley's Brook? If this item is not included, the relocation becomes lower or comparable in cost to option 2. Please clarify and provide further details (including cost estimates) in the main text supporting the selected option.

17. Figure no. 6.5 – Option 3: What is the intent of the note:" divert flow to relocated ditch?" Presumably once relocated, the new brook will be disconnected from the roadside ditch? Also, why is the outlet of the SWM pond shown to discharge to the existing ditch on the west side of March Valley given this was previously identified as being very flat and requiring work if the pond was to discharge to it (but also eliminated as an option)? Please identify what is required to convey the pond outflow directly to the relocated Shirley's Brook.

7.0 Post-Development Storm Drainage Conditions

18. Please identify what the parameter 'CLI' represents and document the assumptions for this value.

19. Please identify the location of channel route 310 in Figure 7.1.

20. Please provide a table and explanation justifying imperviousness for the developed locations as well as the established low density areas within the report.

21. Please show the imperviousness in Figure 7.1.

7.3 Continuous Modeling

22. Table 7.2 – Please provide commentary on the results, e.g., why, in the post-development condition, is the average flow so significantly reduced on Tributary 3 and the peak flow is larger?; likewise, the peak flow at the confluence is significantly reduced?

23. Table 7.3 – Please provide commentary – why are the hours of exceedance so significantly reduced in the post- condition at Location 3?

9.0 Conceptual SWM Design:

24. Figure 9.3: The conceptual layout drawing of alternative pond 2A appears to show an overflow spillway that would discharge to March Road while also indicating a major system outlet from March Road (same location) into the pond. Why is it necessary to discharge the pond spillway to March Road when it appears the spillway could be directed to Tributary 3?

25. Pond 3:

- Provide the reference for the 2 yr water elevation on Shirley's Brook (source, water level, HEC-RAS section no., etc.).
- p.77 – The report notes: *"The existing culverts crossing the CN Rail line would be used to convey major system flow.* Has it been confirmed that these culverts have sufficient capacity for this? Who currently owns the rail line? Are any agency approvals required for future crossings, etc.?
- The existing catchment area upstream of the pond includes drainage through a number of culverts under the railway embankment and is directed via a combination of several swales and overland flow. Please identify the full scope of work (at a functional design level) required to collect and safely convey the future drainage from upstream of the CNR to the pond including supporting calculations, preliminary sizing of swales, culverts, etc.

- p.77 – *"Pond 3 will outlet to the Main Branch of Shirley's Brook. Ideally, outflows from Pond 3 would be directed to the roadside ditch on the west side of March Valley Road and through the existing culverts crossing March Valley Road immediately north of Pond 3. This outlet configuration would eliminate the need for a new connection to Shirley's Brook, thereby avoiding any in-water works. The conceptual outlet design will need to be confirmed during detail design. If the existing culverts are deemed unsuitable, a new crossing can be provided."*

  This rationale is inconsistent with the characterization of the existing ditch on the west side of March Road provided in the memo of August 15, 2015, i.e., that it is very flat, would be subject to standing water, would require regrading/tree removal, possible filling outside the ROW, etc. Further, where the pre-development condition consists of several outlets to the ditch, the post- condition will concentrate the flow at one outlet and consist of a much higher volume that will compound existing poor drainage conditions. Accordingly, please provide a functional design that demonstrates the outflow from pond 3 can be conveyed to the relocated Shirley's Brook, in particular details of its compatibility with existing drainage along March Valley Road, a dedicated outlet channel/crossing of March Valley Road, etc.
- Figure 9.4 – Why is the southern ditch as it exits the CNR corridor located outside the pond block? Please clarify and/or revise the extent of the pond block.
- The pond outlet should be located to maximize flow length from both inlets – that does not appear to be the case on Figure 9.4. Please clarify or revise as required.
- The pond footprint should be provided with an air photo background with property boundaries and the limit of the woodlot to be dedicated to the City. Clear limits of grading for the pond and inlet ditches are to be shown to demonstrate no impacts to the woodlot (provide typical sections of ditching, capacity calculations, etc., to confirm this).
- Please address the following comments previously provided in September 2015:
  - Should the southerly pathway along outflow channel not be located adjacent to the woodlot?
  - Northerly pathway – why does this cut through the NW corner of the woodlot?
  - Figure 9.4 – correct the references to other figures (9.4.1, not 10.4.1, etc.).
  - Identify minimum setback for grading disturbance to avoid impacts to wooded area to remain and incorporate this in the pond block sizing, i.e., have ditches been located sufficient distance from the woodlot?
  - Complete cross-sections through the pond (one end to the other) must be provided; what is the extent of berming required on the east side of the pond/at March Valley Road?; provide sufficient grading detail to clearly demonstrate no encroachment into the floodplain.
  - Figures 9.4.1 and 9.4.2: provide cross-sections of ditch with elevations (as per longitudinal sections).

26. A relaxation of the quantity control criterion for pond 3 should be assessed given the location of the outlet (at the bottom of the Shirley's Brook watershed) and provided that a direct connection to the relocated Shirley's Brook via a crossing of March Valley can be established. Given the significant difference in times to peak, it may be sufficient to compare hydrographs from pond 3 (uncontrolled or less than 100yr control) with the hydrograph of Shirley's Brook where the pond will outlet. If no change in peak flows on Shirley's Brook can be demonstrated, this could reduce the footprint requirements of the pond and lessen the impact on existing features within the area currently slated for the pond block. It will also be necessary to confirm what level of control for more frequent events may still be required to avoid erosion impacts on the relocated brook.

9.7 External Drainage Areas
27. p.79 – Text indicates that Nadia Lane existing drainage will be collected by a rear yard ditch and conveyed to Tributary 3 while MSS drawing 112117-STM1 indicates capture into the storm sewer going south? (or at least no separate outlet to the trib is identified on STM1?). Please clarify. Has the required grading for the rear yard ditch (presumably to be located within the park block) been accounted for in the park block?

9.9 Shirley's Brook Realignment
28. Per comments on earlier sections, please confirm the feasibility of discharging directly to Shirley's Brook by conveying outflows under a new culvert at the pond 3 outlet rather than first discharging to the ditch on the west side of March Road.

29. Figure 9.6 – Provide additional proposed sections (only one (A-A) is provided) and indicate both existing and proposed grades on the sections. Approximate extent of anticipated tree removal should also be indicated. Per comment above, show extent of grading required for pond 3 on this figure also.

Section 10.0 Floodplain Evaluation

30. As per comments on the existing condition, the future condition floodplain should be identified on a plan that confirms containment within the proposed corridor widths on the basis of existing/proposed grades, etc.

11.10 Compensation by Quadrant
31. Northeast/Southeast Quadrants: Text notes that, *"Rear-yard flows from properties along eastern boundary should be directed to culverts crossing the abandoned CN rail corridor to maintain flows in channel 'B.'"* However, will not channel B be intercepted/eliminated by pond 3 (see Figure 9.4)? Please clarify.

12.1 Shirley's Brook Main Branch Realignment
32. p.96 – The text notes, *"Realignment of the watercourse will benefit multiple landowners, and could be completed by way of drainage area development charges, or through cost-sharing between landowners, the NCC, DND, and the City of Ottawa."*
Responsibility for implementing the realignment must be identified as this is an integral component of the drainage system for the northeast/southeast quadrants. The City has made no commitment to cost-sharing and foresees no such commitment. If NCC/DND has provided any such commitment, please document this. As commented above, while the alternatives evaluation identified the relocation of Shirley's Brook as the highest cost option, this option's estimate includes March Valley roadside ditch improvements which should not be required if the outflow from the pond is conveyed directly to Shirley's Brook. Without this item, the relocation becomes lower or comparable in cost to option 2. This provides a rationale for this work being the responsibility of the proponents to implement.

13.0 Project Listing
33. The text notes, *"Class EA documents will be advertised through a **Notice of Completion** and there will be an opportunity to appeal to the Ontario Municipal Board (OMB)."*
This statement should be corrected per the amendment to the integration provision – refer to the MEA website: http://www.municipalclassea.ca/Amendments/Approved.aspx . Per this amendment, regardless of the process followed, the public can appeal to the Minister, per the following excerpt:

> *If a project has been appealed to the OMB, the requirements of the integrated approach have not been met until the OMB renders a decision allowing the project to proceed. As outlined in section 2.8.1 of this Class EA, a Part II Order (PIIO) request may also be made to the Minister of the Environment or delegate. However, the purpose of the integration provisions is to coordinate requirements under the Planning Act with this Class EA. When reviewing a PIIO request, the Minister of the Environment or delegate will consider the purpose and intent of the integration provisions.*

B. **Master Servicing Study – Storm Servicing**

1. Major/minor system flows, velocities, depths and hydraulic gradelines have been simulated using the Autodesk Storm and Sanitary Analysis (SSA) model. On previous occasions, the City has brought to Novatech's attention the need for additional information requirements should this software be used:

- *Please note that Autodesk SSA is not available to City staff and only the output files from the submission can be used for the review. Therefore, please provide the following additional information:*
    - *Description of the model (e.g., runoff calculation method, dynamic wave routing method, and other fundamental principles.); please also describe any specific user inputs such as downstream restricting conditions;*
    - *A print-out of the cross sections used to model the major system flows;*
    - *Supporting documentation for the entrance and exit losses;*
    - *A summary of the rainfall volume and maximum intensities for each storm event used;*
    - *For future submissions, please note that prior to proceeding with any modeling approach, the choice of model should be confirmed with the City (see OSDG, Section 3.5.4).*
- In addition to the above, please provide documentation that summarizes peak flow, depth of flow, and storage being provided along the major system (all road sections) for the 100year event.

2. Further details should be provided that demonstrate the proposed rear yard grading at the east limit of the plan (immediately adjacent to the rail line) can adequately convey the major system flows directed to this area/does not impact minimum lot sizes, etc. Depending on the quantity of flow to be conveyed, a separate block or easement may be required to ensure the City has access to this should it be subject to filling by future homeowners, etc.

Ted Cooper, P. Eng.
Project Manager

Darlene Conway, P. Eng.
Senior Project Manager

cc.
Joe Zagorski, P. Eng.
Michel Kearney, P. Eng.
Chris Rogers, P. Eng.
Tim Newton, P. Eng.
Amy MacPherson

Review of April 2016 Kanata North MSS and EMP - Key Stormwater Issues

Synopsis of issues to be reviewed with Novatech prior to finalizing comments on Kanata North EMP and MSS:

1) Development and evaluation of storm drainage options that could avoid the need (or minimize the extent/depth) of trunk storm sewers and SWM ponds being constructed in bedrock (to minimize rock blasting requirements, impacts to groundwater and risks to existing wells in the area); see below: Description of Alternative Drainage Options for Consideration;

2) MSS should include tables summarizing the cost of constructing the alternative storm trunk servicing options (similar to the cost summary tables prepared for sanitary sewer options 1 – 5B included in Appendix C of the MSS, i.e., that document rock removal costs with each option);

3) A benefit vs. cost assessment of the alternative storm sewer servicing strategies should be completed to determine if there may be interim approaches to stormwater management that could prove advantageous and avoid the need for construction of trunk storm sewers in bedrock and crossings under Tributaries 2 and 3; [*p.103 of the EMP notes, "As demonstrated in the Master Servicing Plan, Transportation Master Plan and the Environmental Master Plan, development can generally proceed from any location within the Study Area. Development is expected to begin close to March Road and spread out to the east and west."* Given this flexibility, it appears that phasing requirements may not preclude consideration of the alternative options.]

4) There appear to be a number of locations within the March Road corridor where details of the major and minor storm drainage system requirements appear to be incomplete / insufficient to guide implementation of the MSS in subsequent planning approval stages;

5) Storm drainage servicing requirements for the entirety of lands located south of Tributary 3, west of March Road should be completed in sufficient detail to streamline future development approvals. This should include an evaluation of an alternate drainage strategy described below.

Changes in storm servicing to be investigated:

1. **Minor System:**

- Storm servicing of lands immediately west of March Road (and runoff from March Road): the MSS indicates runoff in this area is to be directed to SWM Ponds 1 and 2 – into sewers that are to drain against grade and require deep excavation into rock. Is it feasible to direct drainage from this area to SWM Pond 3 instead, to avoid or minimize rock removal requirements?
- Servicing of St. Isadore area (NW-2 Catchment) by SWM Pond 1 forces a deep storm sewer constructed in bedrock. Can an alternative major-minor system design be investigated in this area, i.e., directing runoff from this area to SWM Pond 3?

2. **SWM Ponds 1 and 2**

During the evaluation of the alternative CDP Concepts, the following considerations were to be factored into the selection of the preferred CDP concept plan:

The depth of excavation should be considered when selecting the location of any future SWM facilities:

- *Deep excavations can result in potential issues with groundwater inflow;*

- *Where possible, the bottom of the pond should be situated above the bedrock;*
- *Deep excavations require a larger pond footprint to tie back into the surrounding grade and can be more difficult to integrate as a feature into the community.*

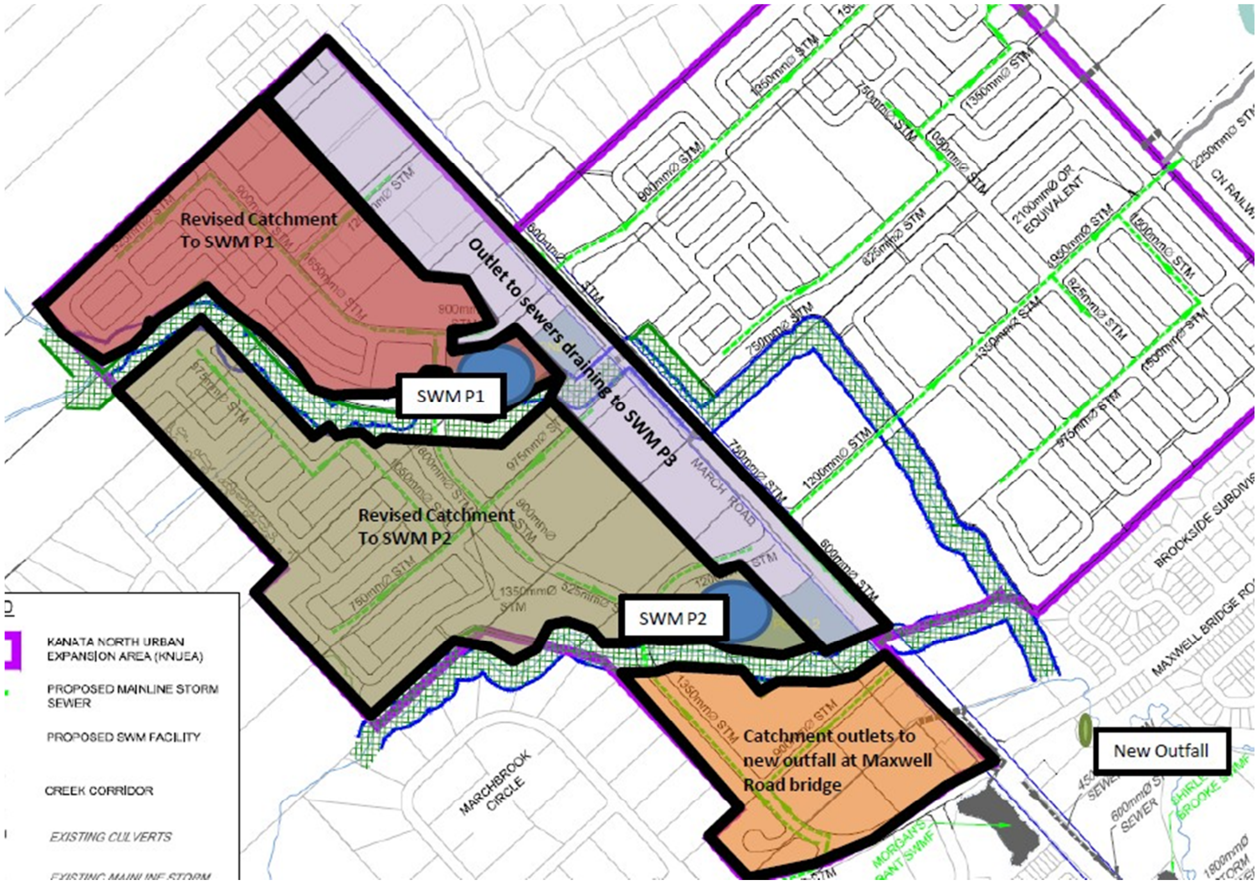
Based on information included in Appendix 2 of the MSS, the recommended storm servicing strategy will require 42,000 m^3 of rock removal to construct Pond 1, and 7,500 m^3 of rock removal to construct Pond 2. From a review of the MSS, it appears that much of the requirement for rock removal is created by the choice to construct 1800mm and 1350mm storm sewers ***under*** Tributaries 1 and 2, rather than to employ a conventional drainage strategy in which storm drainage is designed to follow the existing topography (rock removal volumes noted do not include the rock removal required to construct storm services below bedrock, just the ponds). Concerns were previously raised about these under-crossings in September 2015: " *Why not drain southern portion of Pond 1 catchment to Pond 2 (and avoid undercrossing)*?

Given the extent of rock removal, are there other alternatives available that can avoid the substantial rock removal requirements associated with the current MSS/EMP (i.e., by investigating the feasibility of expanding the capture area of SWM Pond 3 to include a portion of lands west of March Road, and if necessary, construction of temporary SWM controls until SWM Pond 3 is in operation?)

<u>Description of Alternative Drainage Options for Consideration:</u>

1 – Alternative option for drainage west of March Road

The City requests alternatives be developed that would implement the conceptual catchment areas of SWM Ponds 1 and 2 and revised outlet for the lands south of Tributary 3 and the lands to the west of March Road as illustrated in the figure that follows below (the boundary to the west of March Road is conceptual, and needs refinement based on a review of grading and servicing plans in the area).
To facilitate implementation of the alternative servicing strategy, the cost of employing interim stormwater drainage systems / controls (until the outlet to SWM Pond 3 becomes available) should be compared against the cost of constructing deep trunk sewers through bedrock on the west side of March Road that would be required if the April 2016 stormwater strategy was to be implemented.

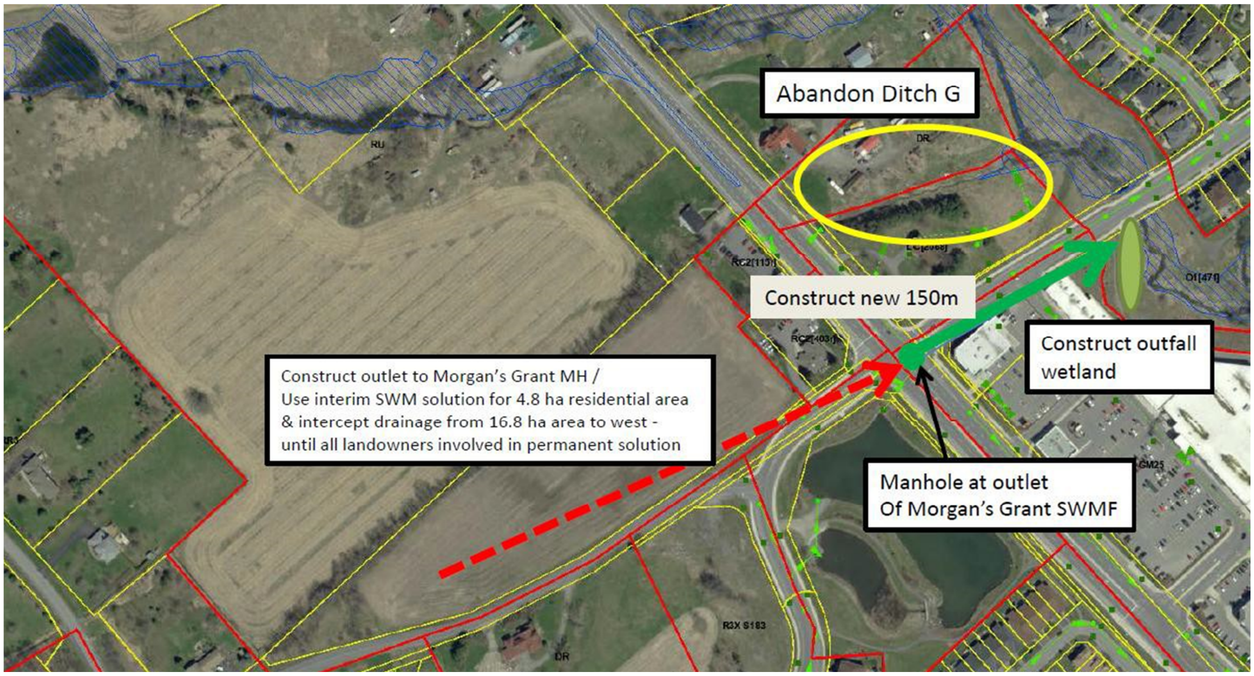


2 – Alternative option for drainage south of Tributary 3

The existing drainage patterns in the Southwest Quadrant – and at a broader scale - in the area west of Shirley's Brook north of Maxwell Bridge Road, have long been interrupted by the construction ofMarch Road. This has necessitated the construction of a number of ad hoc drainage solutions, including the outfall sewer from the Morgan's Grant SWMF which discharges into Ditch G, to which the City has no apparent maintenance access.

The preferred solution identified in the April 2016 EMP proposes construction of a lengthy interceptor sewer to collect drainage from the 16.8 ha area that includes the Marchbrook Circle subdivision, and construction of a storm sewer under tributary 3 to provide an outlet to SWM Pond 2 for the relatively small 4.8 ha residential area located south of tributary 3.

An alternative solution that warrants evaluation involves construction of a new outfall to the branch of Shirley's Brook on the southwest side of the Maxwell Bridge Road crossing. The alternative presented in the figure below would avoid the need to construct the lengthy interceptor sewer and sewer under tributary 3, and would provide an opportunity for improved maintenance access for the City to the Morgan's Grant outfall. Introducing the necessary infrastructure to intercept local drainage along March Road that outlets to Ditch G (while constructing the sanitary sewer and other infrastructure in this area) would allow for the eventual abandonment of Ditch G, with mitigation being provided at the storm outfall at the new Maxwell Bridge outfall.



A storm servicing / management system would need to be developed for the area south of Tributary 3 that would allow interim development to proceed, until all property owners become active in advancing development of their land, at which time a permanent solution would be required. If lands along March Road north of Tributary 3 can be successfully re-directed to the catchment area of SWM Pond 3 (hence removing some drainage from the branch of Shirley's Brook), there may be an opportunity to relax standard quantity control requirements that the lands south of Tributary 3 may otherwise need to provide. Quality control in this relatively small catchment area could likely achieved through the use of oil-grit separators and it would have to be confirmed that this approach did not exacerbate erosion.

May 10, 2016

Wendy Tse
City of Ottawa
110 Laurier Street West
4th Floor Infrastructure Approvals Division
Ottawa, Ontario K1P 1J1

Attention:

Dear Ms. Tse:

Reference: Kanata North CDP - EMP and MSS Final Drafts
Response to Comments
Our File No. 112117

This letter is provided in response to comments provided by the City on May 2, 2016, based on final drafts of the Kanata North CDP EMP and MSS reports.

Responses to comments are provided in red.

Environmental Management Plan (Novatech, April 4, 2016)

3.10 Storm Drainage and Hydrology (pre-development):

1. Table 3.6 – Please identify location of peak flow, i.e., immediately upstream of confluence? Is this the same location at which the post-development peak flow is compared (Table 7.1)? Please also reference the pre- development peak flows just upstream of the confluence with the main branch of Shirley's Brook and include the post-value at this location in Table 7.1.
   - Location of flow to be added to table 3.6
   - Yes the flows are 'measured' at the same locations both pre & post
   - Pre-development and post-development peak flows listed in Table 3.6 are measured approximately 140 m (Tributary 2) and 160 m (Tributary 3) upstream of the confluence. Flows at the confluence are listed in Table 3.6.
   - Flows in Table 7.1 are taken from the same location as those in Table 3.6. Location has also been added to the table.
2. Table 3.7 – Please document peak flows corresponding to water levels.
   - Peak flows have been added to Table 3.7
3. Please clarify the differences in drainage areas for Tributary 2 (465.80 ha) and Tributary 3 (253.67 ha) differ from the areas identified in the Shirley's Brook & Watt's Creek Phase 2 Stormwater Management Study of 444.63 ha and 285.53 ha, respectively.
   - Our record drawings from the SBWC Phase 2 Study (Draft - March 2013) indicate drainage areas of approximately 441 ha (Tributary 2) and 289 ha (Tributary 3) for a total area of 730 ha.

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As a part of the detailed hydrologic analysis for the KNUEA, the drainage areas from the SBWC Ph2 Study were re-assessed based on more detailed topographic mapping. The total pre-development drainage area for Tributaries 2 and 3 is still 730 ha, although the catchment boundaries between the tributaries have shifted slightly to reflect the topographic contours.

4. Please identify and label the drainage channels in the Pre-Development Figure 3.15, similar to the Post- Development Drainage Area Plan Figure 7.1.

- The drainage channels have been identified and labeled on the revised pre-development drainage area plan.

5. Please clarify Section 3.10.5 where it is noted that the 100 year SCS 12-hour storm distribution generates the highest peak flows. From the model it appears that the 100 year SCS 24-hour storm distribution governs?

- The 24-hour SCS storm distribution does govern and the report has been revised accordingly. This correction does not change any of the model results or the pond sizing calculations, as each of the ponds was sized such that flows in the receiving watercourses are controlled to pre-development levels for all return periods and storm distributions.

6. The pre-development peak values for Tributary 2 differ significantly from the pre-development values from the Shirley's Brook Phase 2 Study (2.55 m^3/s vs 1.2 m^3/s, respectively). Please justify the difference or revise as required.

- As a part of the SWMHYMO model development, the SBWC Phase 2 model was reviewed to verify its accuracy in simulating the existing conditions within the Shirley's Brook Northwest Branch subwatershed.
  - The AECOM SWMHYMO model (Draft – December 2013) discretized the Northwest Branch into 3 large subcatchment areas.
  - As part of the KNUEA hydrologic analysis, the Northwest Branch catchments were further discretized to reflect the different land uses, using appropriate SCS curve numbers for each. The headwater areas consist primarily of wetlands and heavily wooded areas, while the lower portions of the catchment (KNUEA lands) are primarily agricultural. This approach was necessary to separate the KNUEA lands from the upstream areas for the post-development model.
  - Where appropriate, the KNUEA model uses the hydrologic parameters from the AECOM model. Other parameters were revised to reflect the hydrologic characteristics of the more discretized catchments. This approach results in lower flows from the headwater areas, but higher peak flows from the agricultural areas within the KNUEA, and generates slightly higher overall peak flows when compared to the AECOM model.
- Model calibration efforts were undertaken as part of a flow monitoring program undertaken by Novatech in 2014:
  - Preliminary analysis indicated significantly larger times to peak (approximately 10 hours) than the AECOM SWMHYMO model (approximately 3 hours). The peak flows were lower, but the significant difference in timing between the upstream areas and the KNUEA lands meant that no significant modifications were required to the required storage volumes in the SWM ponds.
  - Rather than preparing a calibrated model that was significantly different than the

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AECOM, we opted to use the AECOM model as a starting point and adjust the model parameters where appropriate using industry standard methodologies for calculating Curve Numbers and Times to Peak.

- It should be noted that the higher peak flows in the KNUEA model are still relatively low when compared with the bankfull and critical (erosion threshold) flow values established as part of the geomorphic analysis (see Comment # 10). The lower flows from the AECOM study represent an even greater difference from the threshold flows established by the geomorphic study. As such, we feel the KNUEA model provides a more accurate representation of the Northwest Branch than the AECOM model.
- Lastly, the release rates used in the conceptual designs for the proposed SWMFs are very low, and the controlled-post development outflows from the KNUEA will have minimal impact on the overall peak flows in Tributaries 2 and 3 regardless of the peak flow from the upstream area.
  - Pond 1 100yr Release Rate: 276 L/s
  - Pond 2 100yr Release Rate: 58 L/s

7. Table 4.4: Standard Initial Abstraction (Ia) values is missing from the report. Please also identify how the Ia values were assigned and why they differ from the Shirley's Brook Phase 2 Study values.

- The Final Draft of the EMP (April 4, 2016) does not include a 'Table 4.4'. Standard Initial Abstraction values and supporting text is provided in the *KNUEA Existing Conditions Report – Storm Drainage and Hydrology* (Table 4.1), which can be found in EMP Volume 3, Appendix A. Initial Abstraction values are also listed in the Pre-Development Model Parameters table in EMP Volume 2, Appendix H. The EMP has been revised to include the appropriate references in section 3.10.4.

8. Please append the '20150911 – Shirley's Brook Modeling Parameters.xlxs' file referenced in the model and the pre- and post- modeling schematics.

- This file was provided in Appendix H – Hydrologic Calculations & Modeling Files. A reference to the location of the parameters has been added to the report in section 3.10.4.

3.11 Floodplain Mapping:

9. The limits of the floodplain should be shown on an appropriate base (the "approximate" limit shown on Figure 3.17 is not sufficient).

- Additional figures with the appropriate base mapping will be included in the final report.

3.12 Fluvial Geomorphology:

10. Table 3.11:

a) the critical discharges noted are greater than the respective 2yr peak flows and the bankfull discharges also significantly exceed the 2yr peak flows - please document these comparisons and comment

- A response will be provided under separate cover.

b) Erosion threshold parameters should be provided for a sufficient distance on the main

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branch so that it can be demonstrated additional erosion will not occur as a result of the urbanization of the north tributary watershed.

- A response will be provided under separate cover.

11. Dwgs 112117-ENV and 112117-EMP: Why are meander belt widths not shown on one (or both) of these drawings?

    - The meander belt widths are not shown on either of these drawings, as they will be fully confined within the proposed 40m corridors inside the KNUEA boundary.

5.0 SWM Criteria:

12. Watercourse Crossings (culverts): provide further direction, typical examples with respect to designing in accordance with geomorphic principles, "any additional requirements for aquatic habitat," etc.

    - This section provides an overview of the criteria used to develop the recommended SWM strategy for the KNUEA. Watercourse crossings are discussed in greater detail in Section 9.8 of the EMP, including preliminary sizing calculations (which will be refined at the detailed design stage for each crossing).

13. p.53 – Low Impact Development:

"Thorough planning and investigation of subsurface conditions, coordination with proposed land use plans, and thorough consideration of long-term operation and maintenance requirements are all critical to the long-term success of LID designs. As such, it is premature to recommend LID as a primary means for stormwater management at the CDP / EMP scale. Instead, the EMP will provide general guidance for areas where LID techniques could be considered at the plan of subdivision / site plan stage."

Please revise the above paragraph as it indicates that it would be premature to recommend LID at the master planning stage of development, when in fact this is the preferred time to do so. However, as the previous paragraph notes, given the City's limited experience with LID, the locations where it is being implemented for the next few years will be limited in order to "learn by doing." That being the case, it is anticipated that LID approaches may become a requirement before this plan is built out so wording and direction to that effect should be provided.

- The paragraph outlining the use of LIDs within the KUNEA will be revised as follows:

  Thorough planning and investigation of subsurface conditions, coordination with proposed land use plans, and thorough consideration of long-term operation and maintenance requirements are all critical to the long-term success of LID designs. Given the City of Ottawa's limited experience with LID to-date, implementation of green stormwater infrastructure over the next few years will be limited as the City gains practical knowledge through the monitoring and evaluation of pilot projects.

  Low impact development and other practices that better mimic the pre-development hydrologic cycle are expected to be incorporated into the MOECC Environmental Compliance Approval (ECA) process in the near future. The MOECC have stated that it is critical to consider options and opportunities for the incorporation of LID practices during the watershed and subwatershed planning process, and early in the development planning process, and not left to the preparation of the detailed stormwater management plan

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submission. As such, the EMP has been developed to provide general guidance for areas and opportunities where LID techniques could be considered at the plan of subdivision / site plan stage.

14. p.53 - *"The surficial geology over a significant portion of the KNUEA is not conducive to infiltration (clay & silty clay soils, shallow depths to bedrock). As such, infiltration-based controls and LID should not be considered as an integral part of the overall SWM strategy."*

Please revise or delete this statement as it disregards the presence of locations with medium coarse sand/loamy sand as indicated on Figure 3.5. While in some locations the shallow overburden may preclude LIDs, the presence of non-sandy soils does not.

- This statement will be deleted as part of the revised response to Comment #13.

6.4 Recommended SWM Strategy

15. Section 6.4.4 and Table 6.5 – Further discussion in the main text is required regarding the selection of relocating Shirley's Brook away from March Valley Road (similar to what was previously provided in the memo to NCC of August 10, 2015). For example, although option 1 is indicated as the lowest cost option, it was not recommended for various reasons (regardless of the lowest cost) – there is no indication of this in Table 6.5. Further, with respect to the relocation of Shirley's Brook, it is indicated as the highest cost option, however this option's estimate also includes March Valley roadside ditch improvements which should not be required if the outflow from the pond is conveyed directly to Shirley's Brook? If this item is not included, the relocation becomes lower or comparable in cost to option 2. Please clarify and provide further details (including cost estimates) in the main text supporting the selected option.

- March Valley roadside ditch improvements were added to this cost estimate, as some improvements will be required as a portion of the ditch will remain as an outlet for Pond 3 (See Section 9.9 and Figure 9.6 for reference.)
- Additional details on the selected option will be included in the final EMP (report text and Table 6.5).

16. Figure no. 6.5 – Option 3: What is the intent of the note: "divert flow to relocated ditch?" Presumably once relocated, the new brook will be disconnected from the roadside ditch? Also, why is the outlet of the SWM pond shown to discharge to the existing ditch on the west side of March Valley given this was previously identified as being very flat and requiring work if the pond was to discharge to it (but also eliminated as an option)? Please identify what is required to convey the pond outflow directly to the relocated Shirley's Brook.

- Flows in Shirley's Brook would be diverted into the proposed realigned channel, and the existing reach adjacent to March Valley Road will only convey runoff from the right-of-way and adjacent areas. The existing channel can also serve as the outlet for the proposed SWM pond via the existing culverts. This would eliminate the need to construct a new crossing on March Valley Road.
- The existing ditch on the west side is flat, but it does drain to the existing culverts. It is not feasible to re-grade this ditch to convey flows further north to a new crossing that would tie back into Shirley's Brook where it moves away from March Valley Road.

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7.0 Post-Development Storm Drainage Conditions

17. Please identify what the parameter 'CLI' represents and document the assumptions for this value.

- "CLI" is a parameter within SWMHYMO used to approximate the impervious length of a given area. The "DESIGN STANDHYD" subroutine uses CLI in the equation L=(Area/CLI)^.5 to approximate the average length of the impervious flow path. It is roughly analogous to the 'equivalent width' parameter in other SWMM models (PCSWMM, etc.).

18. Please identify the location of channel route 310 in Figure 7.1.

- Figure 7.1 has been updated.

19. Please provide a table and explanation justifying imperviousness for the developed locations as well as the established low density areas within the report.

- This has been added to the report.

20. Please show the imperviousness in Figure 7.1.

- Figure 7.1 has been updated.

7.3 Continuous Modeling

21. Table 7.2 – Please provide commentary on the results, e.g., why, in the post-development condition, is the average flow so significantly reduced on Tributary 3 and the peak flow is larger?; likewise, the peak flow at the confluence is significantly reduced?

- An error was discovered in the post-development continuous model, in which the incorrect hydrographs were being added (the event-based SWMHYMO model did not contain this error). The error in the continuous model has been corrected and the peak flows and average flows have been updated as follows. Additional discussion of the continuous modeling results will be provided in the final EMP report.

Location	Model Run	Peak Flow (m^3/s)	Average Flow (m^3/s)
Shirley's Brook Northwest Branch			
Tributary 2	*Pre*	1.461	0.021
	Post	1.242	0.018
Tributary 3	*Pre*	0.699	0.014
	Post	0.779	0.016
Confluence of Tributaries 2&3	*Pre*	2.461	0.037
	Post	2.014	0.034
KNUEA Lands to Main Branch of Shirley's Brook at March Valley Road			
Flows from East Pond (to Shirley's Brook Main Branch)	*Pre*	0.857	0.009
	Post	0.120	0.008

22. Table 7.3 – Please provide commentary – why are the hours of exceedance so significantly

reduced in the post- condition at Location 3?

- The post-development continuous model has been updated to correct an error in the model (refer to Comment # 21). Peak flows and average flows have been updated as follows. Additional discussion of the erosion analysis will be provided in the final EMP.

Location	Reach ID	Critical Discharge (m^3/s)	Bankfull Discharge (m^3/s)	Hours of Exceedance (hrs)		Peak Flow (m^3/s)		Average Flow (m^3/s)	
				Pre	Post	Pre	Post	Pre	Post
1	SBT-4	0.730	2.11	11.0	8.5	1.461	1.242	0.021	0.018
2	SBT-5	0.570	4.54	5.5	10.0	0.699	0.799	0.014	0.016
3	SBT-7B	0.570	4.33	72.5	50.5	2.575	2.014	0.037	0.034

9.0 Conceptual SWM Design:

23. Figure 9.3: The conceptual layout drawing of alternative pond 2A appears to show an overflow spillway that would discharge to March Road while also indicating a major system outlet from March Road (same location) into the pond. Why is it necessary to discharge the pond spillway to March Road when it appears the spillway could be directed to Tributary 3?

- The location of the overflow spillway for alternative pond 2A has been revised to the southeast corner of the pond, closer to Tributary 3. Overflows cannot be conveyed directly to Tributary 3 due to the topographic constraints. The overflow spillway for Pond 2A will be directed to the March Road right-of-way and not onto the 941 March Road property.

24. Pond 3:

a) Provide the reference for the 2 yr water elevation on Shirley's Brook (source, water level, HEC-RAS section no., etc.)

- The water elevations in the main branch of Shirley's Brook are taken from the AECOM report. A reference has been added to Section 9.5 of the EMP.

b) p.77 – The report notes: "The existing culverts crossing the CN Rail line would be used to convey major system flow. Has it been confirmed that these culverts have sufficient capacity for this? Who currently owns the rail line? Are any agency approvals required for future crossings, etc.?

- The culvert capacity calculations are included in Appendix B of the Master Servicing Study.
- While the rail corridor has been formally abandoned, CN Rail is still the current owner of the corridor, and will have to provide approval for future crossings.

c) The existing catchment area upstream of the pond includes drainage through a number of culverts under the railway embankment and is directed via a combination of several swales and overland flow. Please identify the full scope of work (at a functional design level) required to collect and safely convey the future drainage from upstream of the CNR to the pond including supporting calculations, preliminary sizing of swales, culverts, etc.

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- The design of the minor & major system network to convey flows from the development upstream of the CN Rail line to the Pond 3 inlet swales has been completed as a part of the MSS. Please refer to the MSS for detailed information.
- The dimensions of the proposed Pond 3 inlet swales are shown on Figure 9.4.1 and 9.4.2 in the EMP. Supporting design calculations for these swales have been added to Appendix F – Pond Design Spreadsheets.

d) p.77 – "Pond 3 will outlet to the Main Branch of Shirley's Brook. Ideally, outflows from Pond 3 would be directed to the roadside ditch on the west side of March Valley Road and through the existing culverts crossing March Valley Road immediately north of Pond 3. This outlet configuration would eliminate the need for a new connection to Shirley's Brook, thereby avoiding any in-water works. The conceptual outlet design will need to be confirmed during detail design. If the existing culverts are deemed unsuitable, a new crossing can be provided." This rationale is inconsistent with the characterization of the existing ditch on the west side of March Road provided in the memo of August 15, 2015, i.e., that it is very flat, would be subject to standing water, would require regrading/tree removal, possible filling outside the ROW, etc. Further, where the pre-development condition consists of several outlets to the ditch, the post- condition will concentrate the flow at one outlet and consist of a much higher volume that will compound existing poor drainage conditions. Accordingly, please provide a functional design that demonstrates the outflow from pond 3 can be conveyed to the relocated Shirley's Brook, in particular details of its compatibility with existing drainage along March Valley Road, a dedicated outlet channel/crossing of March Valley Road, etc.

- The ditch on the west side of March Valley Road was characterized as being too flat to convey outflows from Pond 3 to the location where Shirley's Brook veers away from March Valley Road. Re-grading of the existing ditch would require works on private property not owned by participating landowners, as well as extensive tree removal.
- The preferred outlet configuration was selected after reviewing several outlet options. The existing culverts crossing March Valley Road have sufficient capacity to convey outflows from Pond 3 to the existing channel on the east side, which will no longer be the main branch of Shirley's Brook, eliminating the need to construct a new crossing – refer to response to Comment # 16.

e) Figure 9.4 – Why is the southern ditch as it exits the CNR corridor located outside the pond block? Please clarify and/or revise the extent of the pond block.

- This has been revised. Figure 9.4 has been updated.

f) The pond outlet should be located to maximize flow length from both inlets – that does not appear to be the case on Figure 9.4. Please clarify or revise as required.

- The pond outlet location has been revised. Figure 9.4 has been updated.

g) The pond footprint should be provided with an air photo background with property boundaries and the limit of the woodlot to be dedicated to the City. Clear limits of grading for the pond and inlet ditches are to be shown to demonstrate no impacts to the woodlot (provide typical sections of ditching, capacity calculations, etc., to confirm this).

- The Pond Concept Plan provides a general outline of the land required for the pond and appurtenances. The detailed design of Pond 3 will establish the limits of the pond block.

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h) Please address the following comments previously provided in September 2015:

i) Should the southerly pathway along outflow channel not be located adjacent to the woodlot?

- The current design has the pathway connection south of the outflow channel, as this provides a better alignment with the proposed ROW block shown on the demonstration plan. This pathway can be located on either side of the outflow channel, and can be confirmed at the detailed design stage.

ii) Northerly pathway – why does this cut through the NW corner of the woodlot?

- The northern pond pathway cuts through the woodlot to provide a perpendicular connection to the proposed pathway block across the CN rail corridor as shown on the demonstration plan.

iii) Figure 9.4 – correct the references to other figures (9.4.1, not 10.4.1, etc.).

- The references on Figure 9.4 will be corrected in the final EMP.

iv) Identify minimum setback for grading disturbance to avoid impacts to wooded area to remain and incorporate this in the pond block sizing, i.e., have ditches been located sufficient distance from the woodlot?

- At this stage, exact setbacks have not been determined. From site surveys, it has been shown that there are butternut trees along the boundary of the wooded area. At the detailed design stage, detailed tree surveys will be required and an exact setback distance or compensation can be determined. Furthermore the detailed design will confirm the exact size and layout of the pond, the remaining land within the block will form the woodlot block.

v) Complete cross-sections through the pond (one end to the other) must be provided; what is the extent of berming required on the east side of the pond/at March Valley Road? Provide sufficient grading detail to clearly demonstrate no encroachment into the floodplain.

- This has been completed for all pond options, and figures will be included in the final EMP.

vi) Figures 9.4.1 and 9.4.2: provide cross-sections of ditch with elevations (as per longitudinal sections).

- Ditch cross-sections have been added to Figures 9.4.1 and 9.4.2.

25. A relaxation of the quantity control criterion for pond 3 should be assessed given the location of the outlet (at the bottom of the Shirley's Brook watershed) and provided that a direct connection to the relocated Shirley's Brook via a crossing of March Valley can be established. Given the significant difference in times to peak, it may be sufficient to compare hydrographs from pond 3 (uncontrolled or less than 100yr control) with the hydrograph of Shirley's Brook where the pond will outlet. If no change in peak flows on Shirley's Brook can be demonstrated, this could reduce the footprint requirements of the pond and lessen the impact on existing features within the area currently slated for the pond block. It will also be necessary to confirm what level of control for more frequent events may still be required to avoid erosion impacts on the relocated brook.

    - The final EMP will be revised to include discussion of this approach, which could be considered at the detailed design stage. Relaxation of the quantity control criterion would require acceptance by NCC as well.

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- For the purposes of the EMP, this level of analysis was not deemed necessary – even if the required pond footprint can be reduced, both the pond block and the balance of the remaining woodlot area will be conveyed to the City.

9.7 External Drainage Areas

26. p.79 – Text indicates that Nadia Lane existing drainage will be collected by a rear yard ditch and conveyed to Tributary 3 while MSS drawing 112117-STM1 indicates capture into the storm sewer going south? (or at least no separate outlet to the tributary is identified on STM1?). Please clarify. Has the required grading for the rear yard ditch (presumably to be located within the park block) been accounted for in the park block?

    - Text has been revised as follows: "Under post-development conditions, runoff from Nadia Lane will be collected by a DICB at the KNUEA property boundary and piped directly to Tributary 2." This is stated in other points through the report.
    - This is shown on 112117-EMP, as well as on Figure 5.7.1 in the MSS.

9.9 Shirley's Brook Realignment

27. Per comments on earlier sections, please confirm the feasibility of discharging directly to Shirley's Brook by conveying outflows under a new culvert at the pond 3 outlet rather than first discharging to the ditch on the west side of March Road.

    - Refer to responses to Comments #16 and 24 above.

28. Figure 9.6 – Provide additional proposed sections (only one (A-A) is provided) and indicate both existing and proposed grades on the sections. Approximate extent of anticipated tree removal should also be indicated. Per comment above, show extent of grading required for pond 3 on this figure also.

    - An additional cross section will be added. Extent of anticipated tree removal will be dealt with at the time of detailed design.

Section 10.0 Floodplain Evaluation

29. As per comments on the existing condition, the future condition floodplain should be identified on a plan that confirms containment within the proposed corridor widths on the basis of existing/proposed grades, etc.

    - Additional figures for the proposed floodplain will be provided in the final EMP.

11.10 Compensation by Quadrant

30. Northeast/Southeast Quadrants: Text notes that, *"Rear-yard flows from properties along eastern boundary should be directed to culverts crossing the abandoned CN rail corridor to maintain flows in channel 'B.'"* However, will not channel B be intercepted/eliminated by pond 3 (see Figure 9.4)? Please clarify.

    - Channel B will be intercepted by Pond 3 (Figure 9.4 has been updated to reflect this), but will still provide some ecological headwater functions to Woodlot S23.

12.1 Shirley's Brook Main Branch Realignment

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31. p.96 – The text notes, *“Realignment of the watercourse will benefit multiple landowners, and could be completed by way of drainage area development charges, or through cost-sharing between landowners, the NCC, DND, and the City of Ottawa.”*

Responsibility for implementing the realignment must be identified, as this is an integral component of the drainage system for the northeast/southeast quadrants. The City has made no commitment to cost-sharing and foresees no such commitment. If NCC/DND has provided any such commitment, please document this. As commented above, while the alternatives evaluation identified the relocation of Shirley’s Brook as the highest cost option, this option’s estimate includes March Valley roadside ditch improvements which should not be required if the outflow from the pond is conveyed directly to Shirley’s Brook. Without this item, the relocation becomes lower or comparable in cost to option 2. This provides a rationale for this work being the responsibility of the proponents to implement.

- This work is the developer’s responsibility. The developers may pursue cost sharing opportunities at the detailed design stage.
- March Valley roadside ditch improvements were added to this cost estimate, as some improvements will be required as a portion of the ditch will remain as an outlet for Pond 3 (See Section 9.9 and Figure 9.6 for reference.)

13.0 Project Listing

32. The text notes, *“Class EA documents will be advertised through a **Notice of Completion** and there will be an opportunity to appeal to the Ontario Municipal Board (OMB).”*

This statement should be corrected per the amendment to the integration provision – refer to the MEA website: http://www.municipalclassea.ca/Amendments/Approved.html. Per this amendment, regardless of the process followed, the public can appeal to the Minister, per the following excerpt:

“If a project has been appealed to the OMB, the requirements of the integrated approach have not been met until the OMB renders a decision allowing the project to proceed. As outlined in section 2.8.1 of this Class EA, a Part II Order (PIIO) request may also be made to the Minister of the Environment or delegate.

However, the purpose of the integration provisions is to coordinate requirements under the Planning Act with this Class EA. When reviewing a PIIO request, the Minister of the Environment or delegate will consider the purpose and intent of the integration provisions.”

- The KNUEA reports will be revised to include the appropriate information.

<u>Master Servicing Study – Storm Servicing</u>

1. Major/minor system flows, velocities, depths and hydraulic gradelines have been simulated using the Autodesk Storm and Sanitary Analysis (SSA) model. On previous occasions, the City has brought to Novatech’s attention the need for additional information requirements should this software be used:
   - *Please note that Autodesk SSA is not available to City staff and only the output files from the submission can be used for the review. Therefore, please provide the following additional information:*
     - *Description of the model (e.g., runoff calculation method, dynamic wave routing method, and other fundamental principles.); please also describe any specific user inputs such as downstream restricting conditions;*

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- *A print-out of the cross sections used to model the major system flows;*
- *Supporting documentation for the entrance and exit losses;*
- *A summary of the rainfall volume and maximum intensities for each storm event used;*
- *For future submissions, please note that prior to proceeding with any modeling approach, the choice of model should be confirmed with the City (see OSDG, Section 3.5.4).*

Autodesk SSA was used to model the pipe network for preliminary sizing of the trunk storm sewer network. The model was developed in conformance with the City of Ottawa standards for the above noted items. The Autodesk SSA model has been converted to PCSWMM and the results are essentially identical.

Future model submissions to the City will be provided in PCSWMM format to allow the City to open and review the model.

- In addition to the above, please provide documentation that summarizes peak flow, depth of flow, and storage being provided along the major system (all road sections) for the 100year event.

The major system flows were determined using an empirical approach as detailed in Section 5.4.3. The calculated flows are recorded on drawing 112117-STM2, and in a table (now indicated as Table B-2) in the MSS Appendix B along with the depths which were calculated using Manning's. As the method is empirical, no specific storage values are used which can be reported.

2. Further details should be provided that demonstrate the proposed rear yard grading at the east limit of the plan (immediately adjacent to the rail line) can adequately convey the major system flows directed to this area/does not impact minimum lot sizes, etc. Depending on the quantity of flow to be conveyed, a separate block or easement may be required to ensure the City has access to this should it be subject to filling by future homeowners, etc.

The intent, as indicated Section 5.4.1 of the MSS and Section 11.7.3 of the EMP, is to allow primarily vegetated areas, including rear yards, to surface drain to existing drainage channels where possible. The rear yard drainage along the abandoned CN Rail Corridor is intended to drain directly to the existing ditch along the rail corridor; therefore no additional rear yard swales would be required. Major overland flows to this area were evaluated during the functional design process and have been added to Appendix B in Tables B-3a to B-3d, with a supporting Figure 112117-Rail-XS. The major overland flows in this area will be contained within the existing ditches and conveyed across the rail corridor via the existing culverts, and any new culverts as determined during the detailed design process.

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Based on the response to the City's questions presented above, we are confident we have demonstrated the feasibility of the proposed stormwater system.

Yours truly,

Michael Petepiece, P.Eng.
Project Manager

cc.
Ted Cooper, P. Eng. Project Manager
Darlene Conway, P. Eng. Senior Project Manager
Joe Zagorski, P. Eng.
Michel Kearney, P. Eng.
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May 10, 2016

Wendy Tse
City of Ottawa
110 Laurier Street West
4th Floor Infrastructure Approvals Division
Ottawa, Ontario K1P 1J1

Attention:

Dear Ms. Tse:

Reference: Kanata North CDP Environmental Management Plan
April 2016 Kanata North MSS and EMP - Key Stormwater Issues
Response to Comments
Our File No. 112117

This letter is provided in response to the "Key Stormwater Issues" provided by the City on May 2, 2016, based on their review of the final drafts of the Kanata North CDP EMP and MSS reports.

Responses to comments are provided in red.

Synopsis of issues to be reviewed with Novatech prior to finalizing comments on Kanata North EMP and MSS:

1) Development and evaluation of storm drainage options that could avoid the need (or minimize the extent/depth) of trunk storm sewers and SWM ponds being constructed in bedrock (to minimize rock blasting requirements, impacts to groundwater and risks to existing wells in the area); see below: Description of Alternative Drainage Options for Consideration;

2) MSS should include tables summarizing the cost of constructing the alternative storm trunk servicing options (similar to the cost summary tables prepared for sanitary sewer options 1 – 5B included in Appendix C of the MSS, i.e., that document rock removal costs with each option);

3) A benefit vs. cost assessment of the alternative storm sewer servicing strategies should be completed to determine if there may be interim approaches to stormwater management that could prove advantageous and avoid the need for construction of trunk storm sewers in bedrock and crossings under Tributaries 2 and 3; [*p.103 of the EMP notes, "As demonstrated in the Master Servicing Plan, Transportation Master Plan and the Environmental Master Plan, development can generally proceed from any location within the Study Area. Development is expected to begin close to March Road and spread out to the east and west."* Given this flexibility, it appears that phasing requirements may not preclude consideration of the alternative options.]

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