Section 5.0 Stormwater Management Criteria

A key objective of the Environmental Management Plan is to establish stormwater management criteria for the KNUEA that can be implemented through stormwater site management plans. In establishing stormwater management targets for the study area, it is important to consider the overall ultimate land uses within the subject watershed. As the study area is located in the Shirley's Brook watershed and upstream from Shirley's Bay, the stormwater management targets for the KNUEA must take into account the effects of development on the downstream areas.

The SWM criteria have been established on the basis of aquatic habitat protection and the sensitivity of the downstream erosion regime. Quality control objectives have been developed based on the recommendations of the Shirley's Brook and Watt's Creek Subwatershed Study. Quantity control objectives have been developed to ensure there is no adverse impact on the downstream watercourses resulting from the proposed development.

5.1 Regulatory Agencies

Stormwater Management Criteria were established with input from various agencies that have regulatory approval for works within a waterbody including:

- MVCA, Section 28 of the Conservation Authorities Act – Development, Interference with Wetlands, and Alterations to Shorelines and Watercourses;
- DFO, Section 35 of the Federal Fisheries Act – Fish Habitat;
- MOECC, Ontario Water Resources Act
- MNRF, Endangered Species Act 2007

The NCC have also provided some input into the development of the overall stormwater management strategy related to the increase in storm runoff to Shirley's Brook following development of the KNUEA.

5.2 Design Criteria

<u>Quantity Control</u>

- West of March Road, quantity control storage is to be designed to ensure no increase in peak flow in the receiving watercourses (Tributaries 2 & 3) downstream of the KNUEA;
- East of March Road, post-development peak flows from the development area are to be controlled to pre-development rates for all storms up to and including the 100-year event.
- Ensure no adverse impacts on erosion in the watercourses resulting from future development within the KNUEA.

<u>Quality Control</u>

- An *Enhanced* level of water quality treatment (80% long-term TSS removal) is required for all development within the Shirley's Brook subwatershed.

Storm Drainage

- Storm drainage within the urban area will be provided using storm sewers sized to convey the uncontrolled 5-year post-development peak flow (10-year for March Road).
- Major system flows are to be conveyed within the right-of-ways and/or along defined overland flow routes with no encroachment onto private property.
- Major system flows must not flow overland across arterial roads (March Road).

Watercourse Crossings (Culverts)

- Watercourse crossings are to be sized to convey the 100-year peak flow without overtopping the roadways.
- Watercourse crossings should be designed in accordance with geomorphology principles.
- Watercourse crossings should be designed to ensure they meet any additional requirements for terrestrial and aquatic habitat.

SWM Facilities

- All proposed SWM facilities are to be designed in accordance with the following guidelines and manuals:
    - City of Ottawa Stormwater Management Facility Design Guidelines & Standards (DRAFT, October 2012).
    - MOE SWM Planning and Design Manual (March 2003).
- The normal water level (permanent pool) in wet ponds should be above the 2-year water level in the receiving watercourse.
- Where possible, sanitary overflows are to be directed to SWM facilities. City design standards for overflows are currently in development. The following sanitary overflow criteria have been applied to the KNUEA:
    - Sanitary overflows are to operate by gravity and be directed to a SWM facility.
    - The sanitary overflow must be above the 100-year elevation in the SWM facility.
- SWM facilities should be integrated into the community through the use of pathways or other linkages.
- 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.

5.3 Climate Change

Warm summers, relatively cold winters, a moderate growing season, and usually reliable rainfall characterize the local climate. Annual precipitation (rain + snow) in the City of Ottawa is approximately 944 mm/yr.

The City of Ottawa has implemented an adaptive management policy to address climate change.

Section 6.0 Evaluation of SWM Alternatives

As part of the integrated EA process, several storm drainage and stormwater management options were considered for the KNUEA. The development of a preferred stormwater management strategy for the KNUEA included the assessment of several storm drainage and stormwater management alternatives.

Alternatives for stormwater management were developed using a two stage process. The first stage was the development of preliminary alternatives and a coarse screening process. The second stage was the selection of a preferred alternative, and refinement of that alternative to generate more detailed solutions.

6.1 Preliminary Alternatives

"Alternative Solutions" are defined as feasible alternative ways of solving an identified problem or addressing an opportunity. In this case, the "problem and/or opportunity" is to develop a stormwater management strategy for the KNUEA that meets all applicable design criteria and meets all targets required for approval by regulatory agencies.

The preliminary alternatives considered for the KNUEA included the following:

- Do Nothing / Limit Growth
- No Stormwater Management
- Lot-level & Conveyance Controls
- Low Impact Development / Green Stormwater Infrastructure
- End-of-Pipe SWM Facilities
- Combination of SWM Facilities / Lot Level Controls

<u>Do Nothing / Limit Growth</u>

The Do Nothing / Limit Growth alternative is not considered a viable option as it does not meet the development targets established for the study area, nor does it provide any opportunity for enhancement of existing features.

<u>No Stormwater Management</u>

Development of the study area with no stormwater management is not a viable option, as it would result in an unacceptable increase in storm runoff, increased flood risk, increased erosion potential and a degradation of water quality.

<u>Lot Level and Conveyance Controls</u>

Lot level and conveyance controls are considered an important part of an integrated treatment train approach to stormwater management, and will form an important component in the overall stormwater management strategy to ensure the development does not exceed design thresholds in the rate, frequency and/or duration of flow which would result in adverse impacts on the receiving watercourses.

While lot level and conveyance controls are necessary throughout the development and may suffice for some specific areas within the development, they are not sufficient to address the stormwater needs for the entire development. In addition to lot level and conveyance controls, other stormwater management controls will be required.

Low Impact Development / Green Stormwater Infrastructure

Low impact development (LID) represents a design philosophy which attempts to minimize the impacts on the hydrologic cycle resulting from development. Green stormwater infrastructure represents the stormwater management technologies used to achieve this objective.

In February 2015, the MOECC released a bulletin outlining planned revisions to the current *Stormwater Management Planning and Design Manual* (2003) that will emphasize and encourage the implementation of LID techniques for new development. The new guidelines are anticipated to be available in late 2016.

The City of Ottawa has recently implemented several pilot projects to evaluate the performance and maintenance requirements of LID designs. The findings of these pilot projects will be used to inform and provide guidance to the City and the development community regarding the implementation of LID stormwater management and the use of Green Stormwater Infrastructure such as bioretention and biofiltration.

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 submission. As such, the EMP provides general guidance for areas and opportunities where LID techniques could be considered at the plan of subdivision / site plan stage – refer to **Section 11.7.4**.

End-of-Pipe SWM Facilities

SWM Facilities represent an effective means of providing stormwater management for urban development. SWM facilities should be located near the lowest point in a watershed and in close proximity to an outlet watercourse. SWM facilities are well suited for treating runoff from large drainage areas and can be designed to achieve multiple objectives including: water quality treatment, peak flow control, erosion control, and baseflow enhancement. Potential drawbacks to SWM facilities include increased temperature of storm runoff, and minimal ability to reduce runoff volumes.

6.1.1 Identification of Preferred Preliminary Alternative

Based on the coarse screening process of the preliminary alternatives, end-of-pipe SWM facilities are recommended as the primary component of the stormwater management strategy for the Kanata North CDP lands.

To minimize the number of SWM facilities, on-site stormwater management controls can be implemented in areas where certain criteria are met:

- Proposed land use is compatible with on-site SWM control (commercial, med/high density residential, school);
- Total drainage area requiring on-site control is less than 10 ha;

6.2 Development of SWM Options

6.2.1 SWM Facilities

Following the coarse screening process and the identification of the overall preferred servicing strategy, SWM options were developed for each quadrant of the KNUEA. The options focus primarily on the number and location of proposed SWM facilities, and any areas where on-site controls are recommended. The SWM options are shown on the following figures:

- **Figure 6.1** Northwest Quadrant (Options 1 – 3)
- **Figure 6.2** Southwest Quadrant (Options 1 – 3)
- **Figure 6.3** Southwest Quadrant (Options 4 – 6)
- **Figure 6.4** Northeast / Southeast Quadrants (Options 1 – 4)

6.2.2 Shirley's Brook at March Valley Road

The reach of Shirley's Brook east of the KNUEA is within the right-of-way of March Valley Road. The road along this reach has no shoulder and the embankment is steep and prone to washout during periods of high flow. The channel through this reach has been reinforced with gabion baskets and riprap.

The development of the KNUEA will increase runoff volumes to Shirley's Brook, which may have further impacts on the ongoing erosion and bank stability issues along this reach. Three alternative solutions to address the increase in runoff volume have been considered as shown on the following figure:

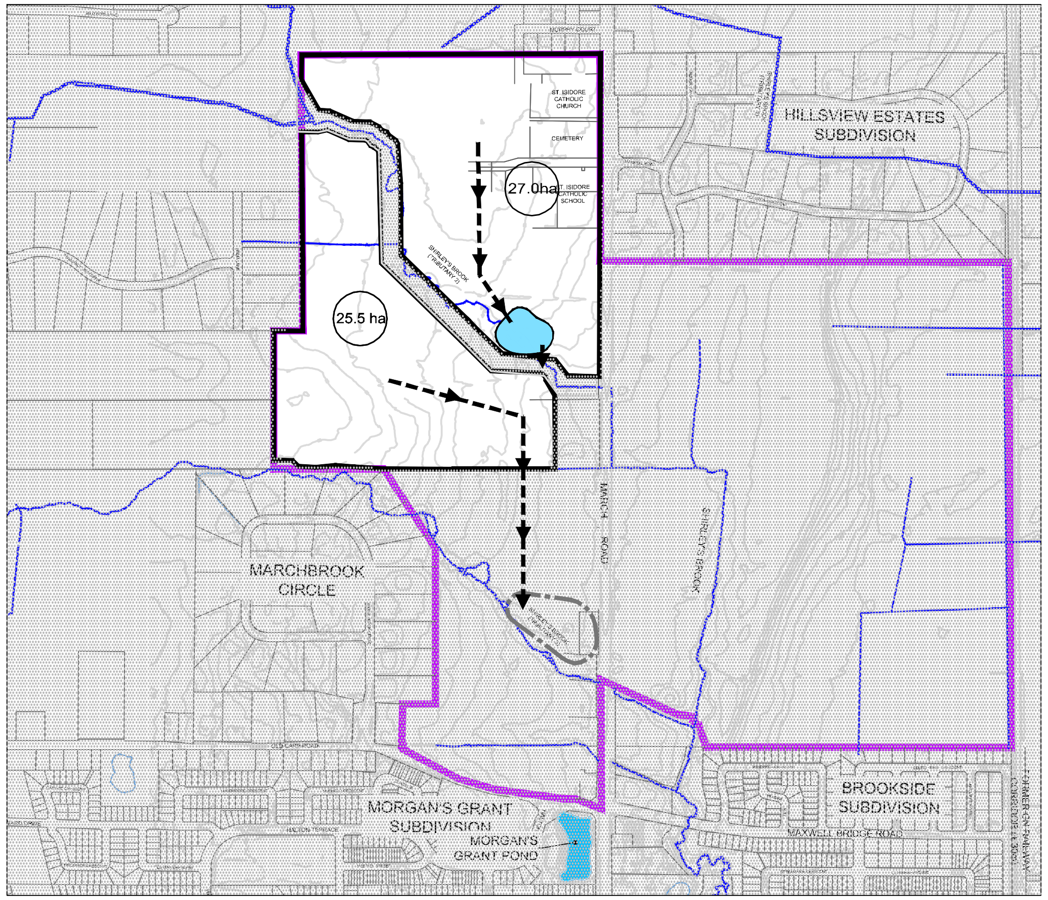
- **Figure 6.5** Shirley's Brook at March Valley Road (Options 1 – 3)

6.3 SWM Options Evaluation (as per Municipal Class EA)

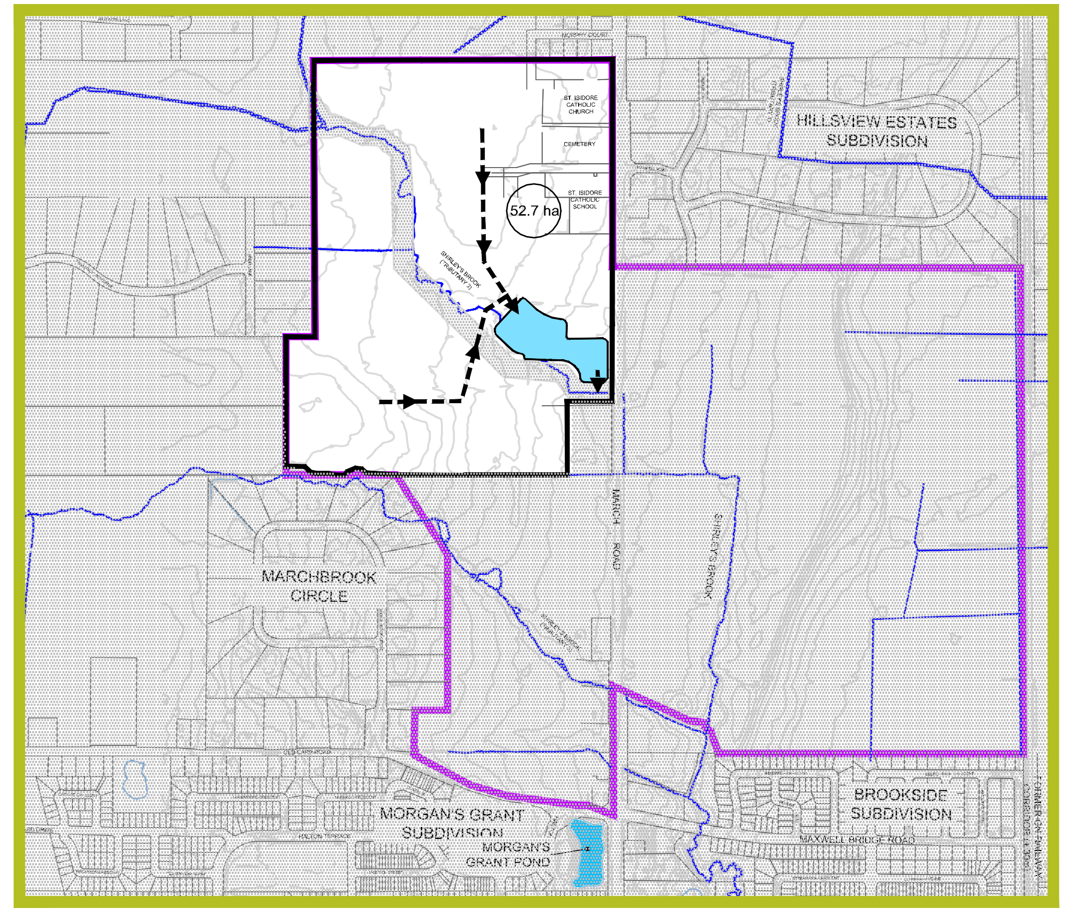
The options shown in **Figures 6.1 – 6.5** have been evaluated using the general criteria outlined in the Municipal Class Environmental Assessment Manual (MEA, 2015) for Municipal Water and Wastewater Projects to determine which alternative best meets the overall SWM objectives for each area.

6.3.1 Land Use Planning Objectives

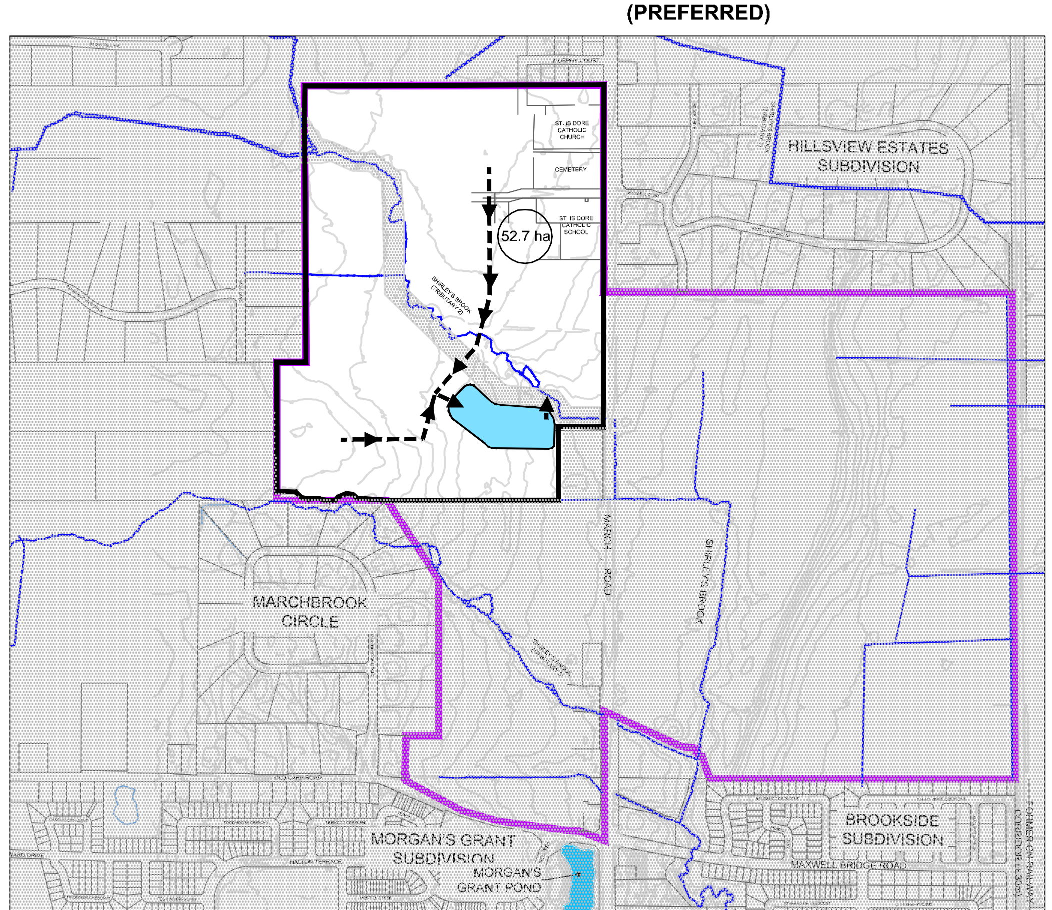
All SWM options are equivalent in terms of the applicable provincial, regional, and municipal planning policies.



OPTION 1 - ONE SWM FACILITY NORTH OF TRIBUTARY 2, NO TRIBUTARY CROSSING



OPTION 2 - ONE SWM FACILITY NORTH OF TRIBUTARY 2, CROSSING OF TRIBUTARY 2 (PREFERRED)



OPTION 3 - ONE SWM FACILITY SOUTH OF TRIBUTARY 2, CROSSING OF TRIBUTARY 2

LEGEND

- KNUEA
- DRAINAGE CHANNEL
- LANDS SERVICED BY SWM OPTION
- LANDS NOT SERVICED BY SWM OPTION
- 23.9 ha AREA (HECTARES)
- STORM SEWER

KANATA NORTH
COMMUNITY DESIGN PLAN

FIGURE NO. 6.1
SWMF ALTERNATIVES
NORTHWEST QUADRANT

DATE	JOB
JUN 2016	112117
SCALE	
NTS	

NOVATECH
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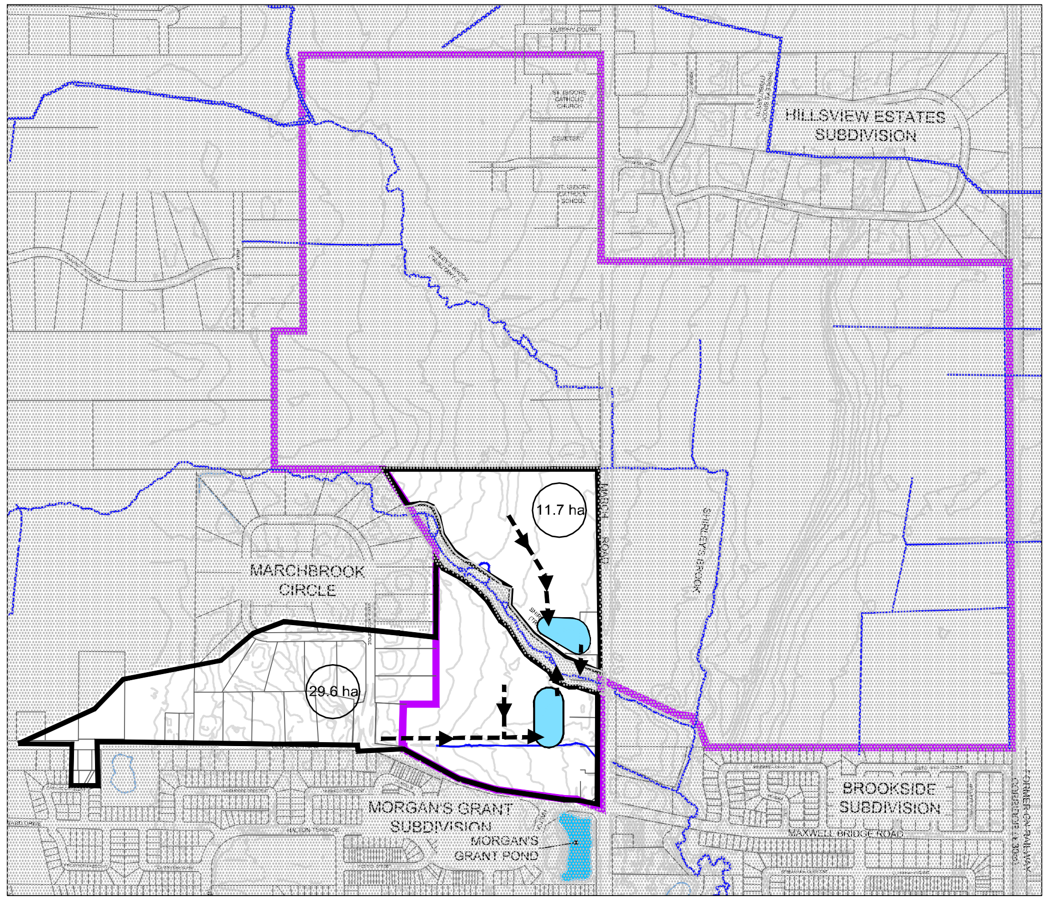
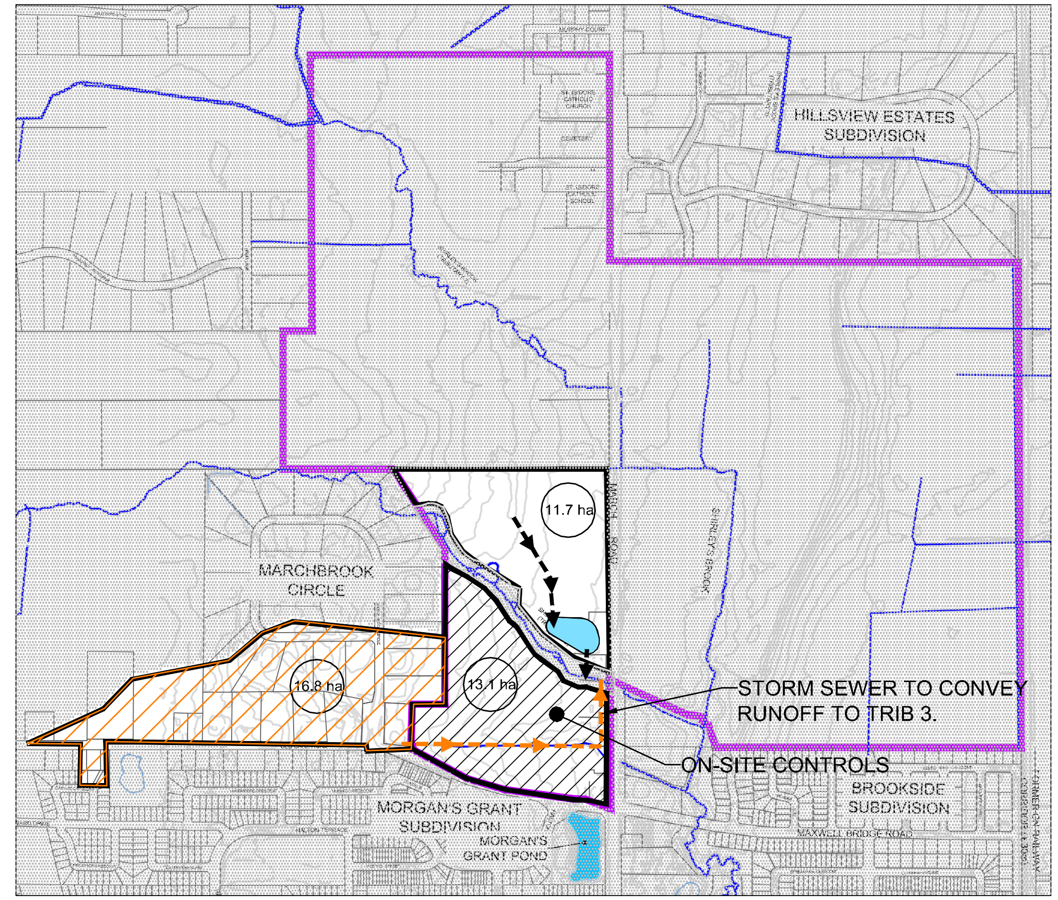
M:\2012\112117\CAD\Design_EMP\MEMO (KJA)\Figure 6.1-6.4 SWMF Alternatives.dwg, 6.1 Northwest Quad, Jun 23, 2016 - 3:20pm, kbanks



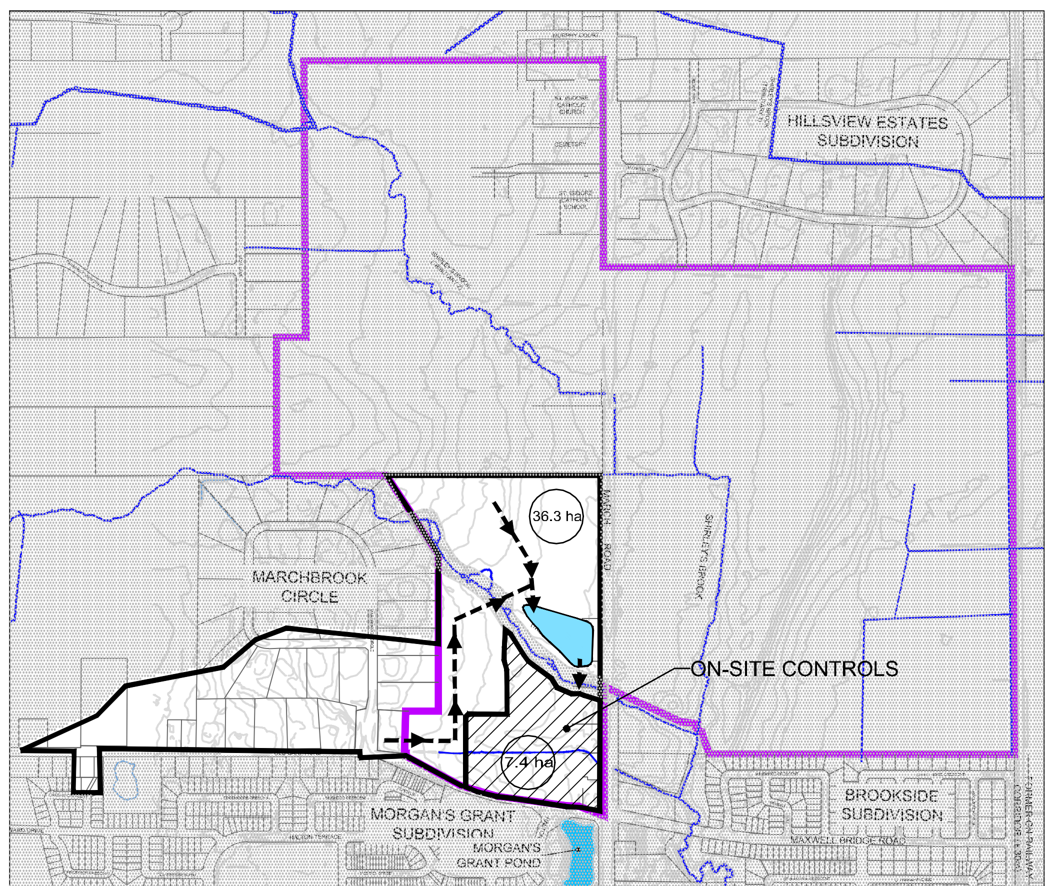
OPTION 1 - TWO SWM FACILITIES NORTH & SOUTH OF TRIBUTARY 3, MARCHBROOK AREA DIRECTED TO SOUTH POND



OPTION 2 - ONE SWM FACILITY NORTH OF TRIBUTARY 3, MARCHBROOK RUNOFF TO TRIBUTARY 3, ON-SITE CONTROLS

LEGEND

- KNUEA
- DRAINAGE CHANNEL
- LANDS SERVICED BY SWM OPTION
- LANDS NOT SERVICED BY SWM OPTION
- ON-SITE STORAGE REQUIRED
- 23.9 ha — AREA (HECTARES)
- STORM SEWER
- STORM SEWER TO TRIBUTARY 3
- RUNOFF FROM AREA DIRECTED TO TRIBUTARY 3



OPTION 3 - ONE SWM FACILITY NORTH OF TRIBUTARY 3, FLOW CROSSING TRIBUTARY 3, ON-SITE CONTROLS

KANATA NORTH
COMMUNITY DESIGN PLAN

FIGURE NO. 6.2
SWMF ALTERNATIVES
SOUTHWEST QUADRANT
(OPTIONS 1-3)

DATE: JUN 2016
JOB: 112117
SCALE: NTS

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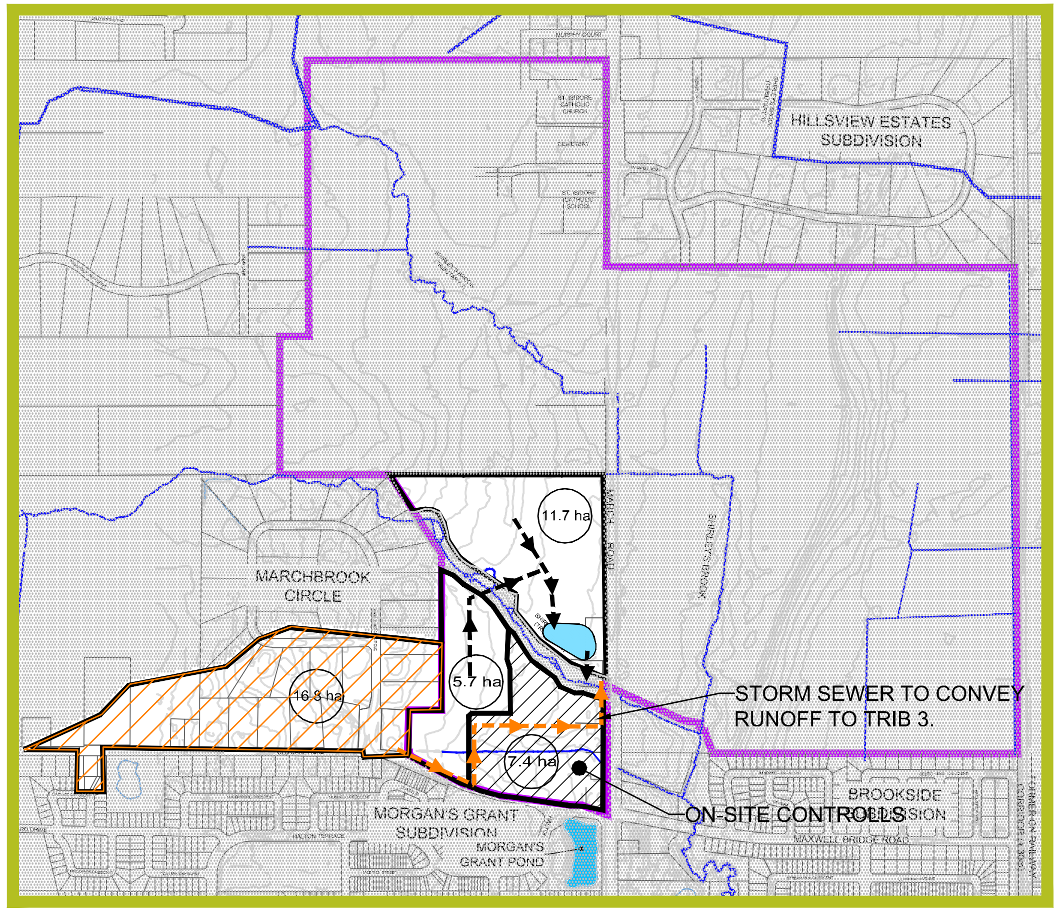
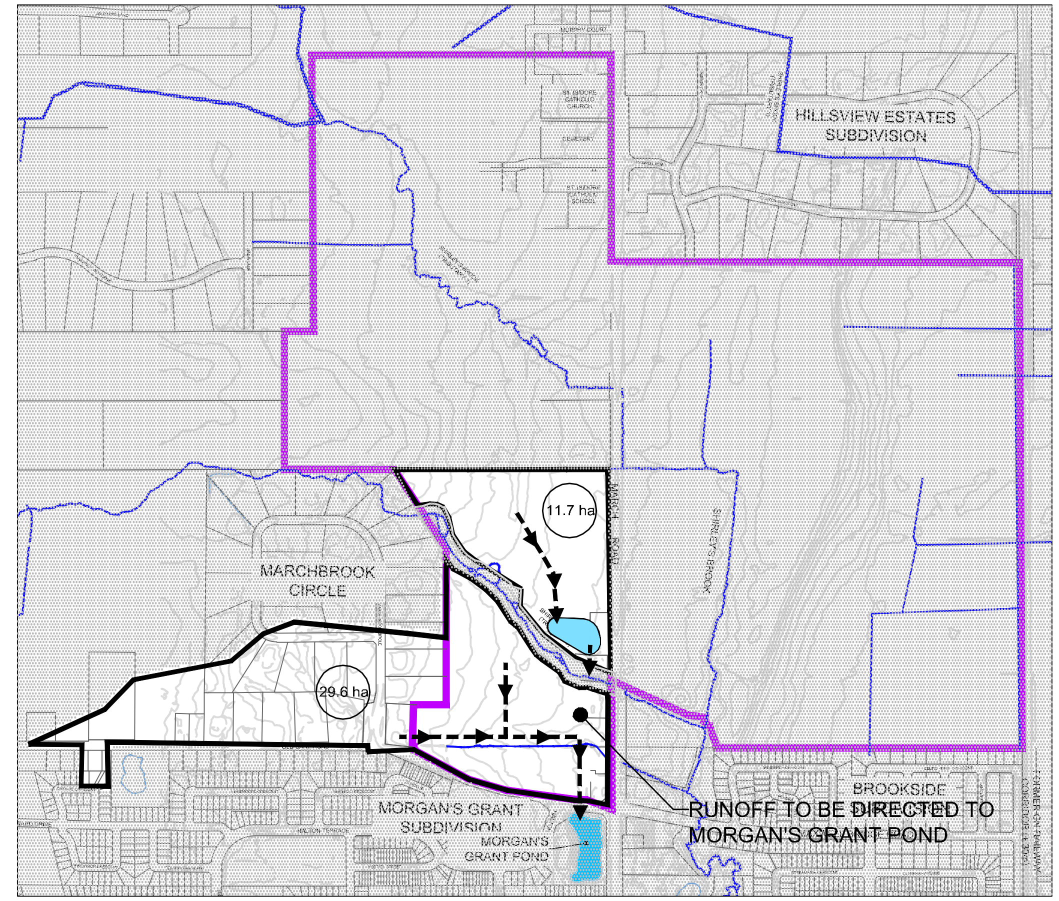
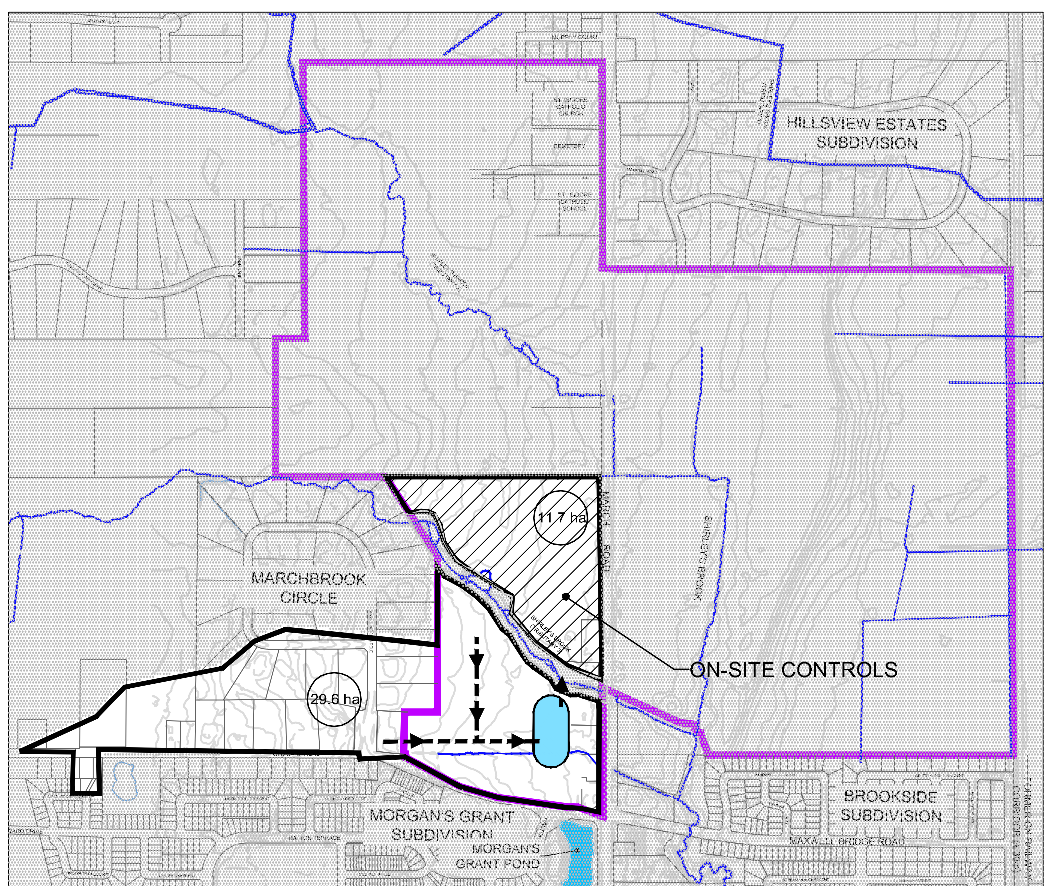


OPTION 4 - ONE SWM FACILITY NORTH OF TRIBUTARY 3, TRIBUTARY CROSSING, ON-SITE CONTROLS, MARCHBROOK RUNOFF TO TRIBUTARY 3 (PREFERRED)



OPTION 5 - ONE SWM FACILITY NORTH OF TRIBUTARY 3, AREA SOUTH OF TRIBUTARY 3 DIRECTED TO MORGAN'S GRANT SWMF



OPTION 6 - ONE SWM FACILITY SOUTH OF TRIBUTARY 3, ON-SITE CONTROLS

LEGEND

- KNUEA
- DRAINAGE CHANNEL
- LANDS SERVICED BY SWM OPTION
- LANDS NOT SERVICED BY SWM OPTION
- ON-SITE STORAGE REQUIRED
- 23.9 ha — AREA (HECTARES)
- STORM SEWER
- STORM SEWER TO TRIBUTARY 3
- RUNOFF FROM AREA DIRECTED TO TRIBUTARY 3

KANATA NORTH
COMMUNITY DESIGN PLAN

FIGURE NO. 6.3
SWMF ALTERNATIVES
SOUTHWEST QUADRANT
(OPTIONS 4-6)

DATE
JUN 2016

JOB
112117

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NOVATECH
Engineers, Planners & Landscape Architects

M:\2012\112117\CAD\Design_EMP\MEMO (KJA)\Figure 6.1-6.4 SWMF Alternatives.dwg, 6.3 Southwest Quad 2, Jun 23, 2016 - 3:20pm, kbanks

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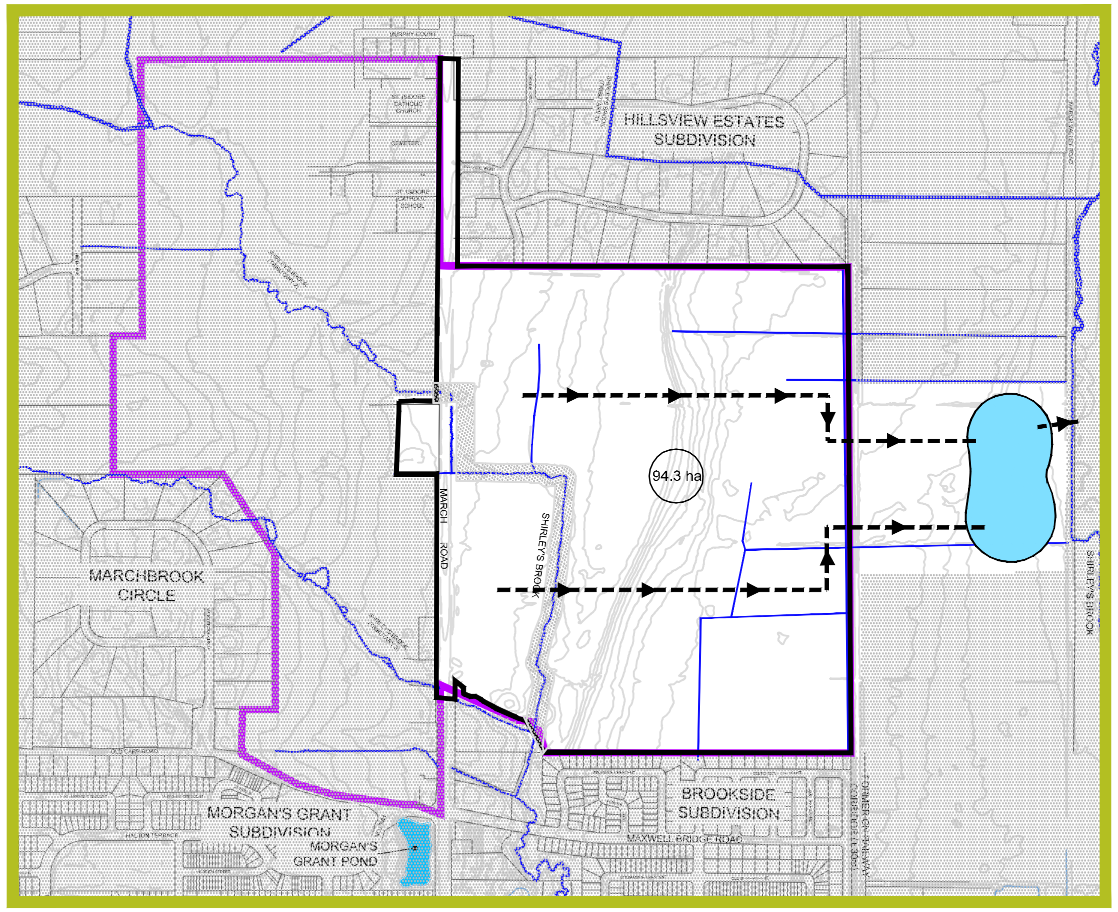
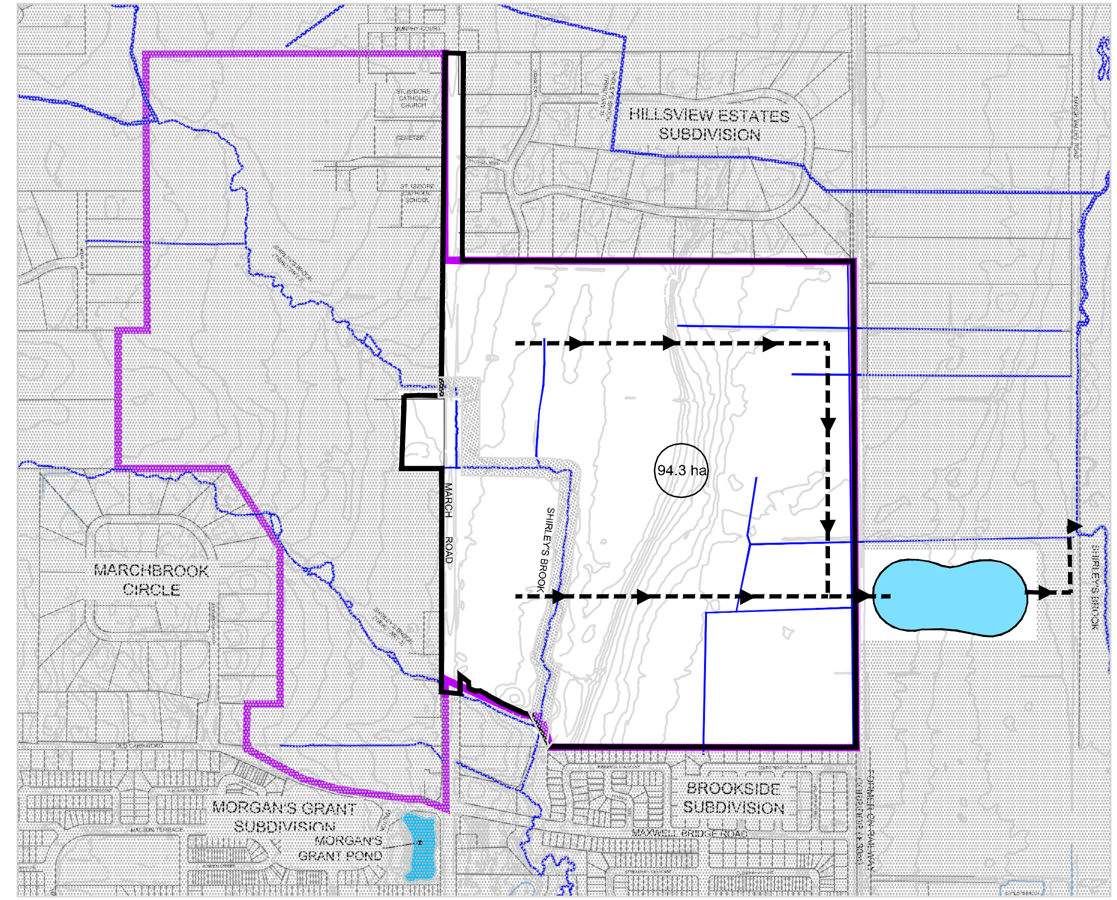
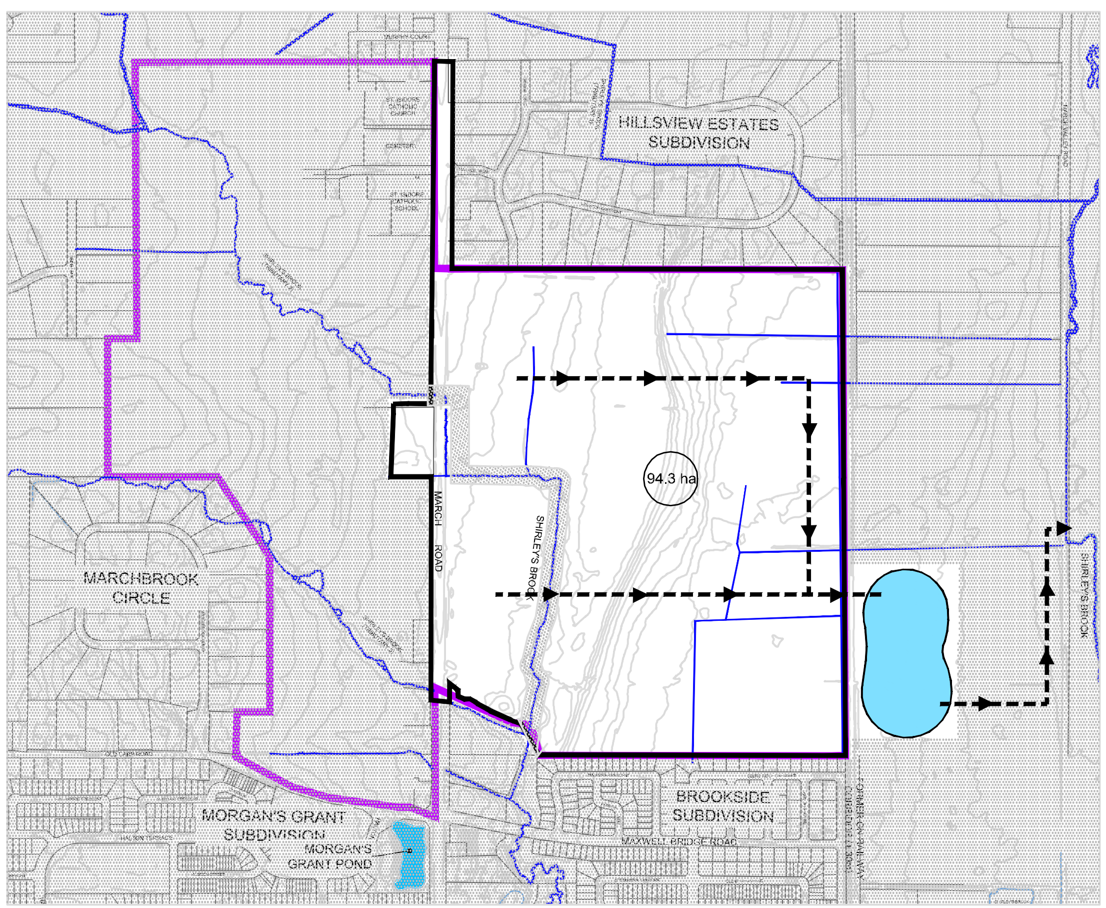


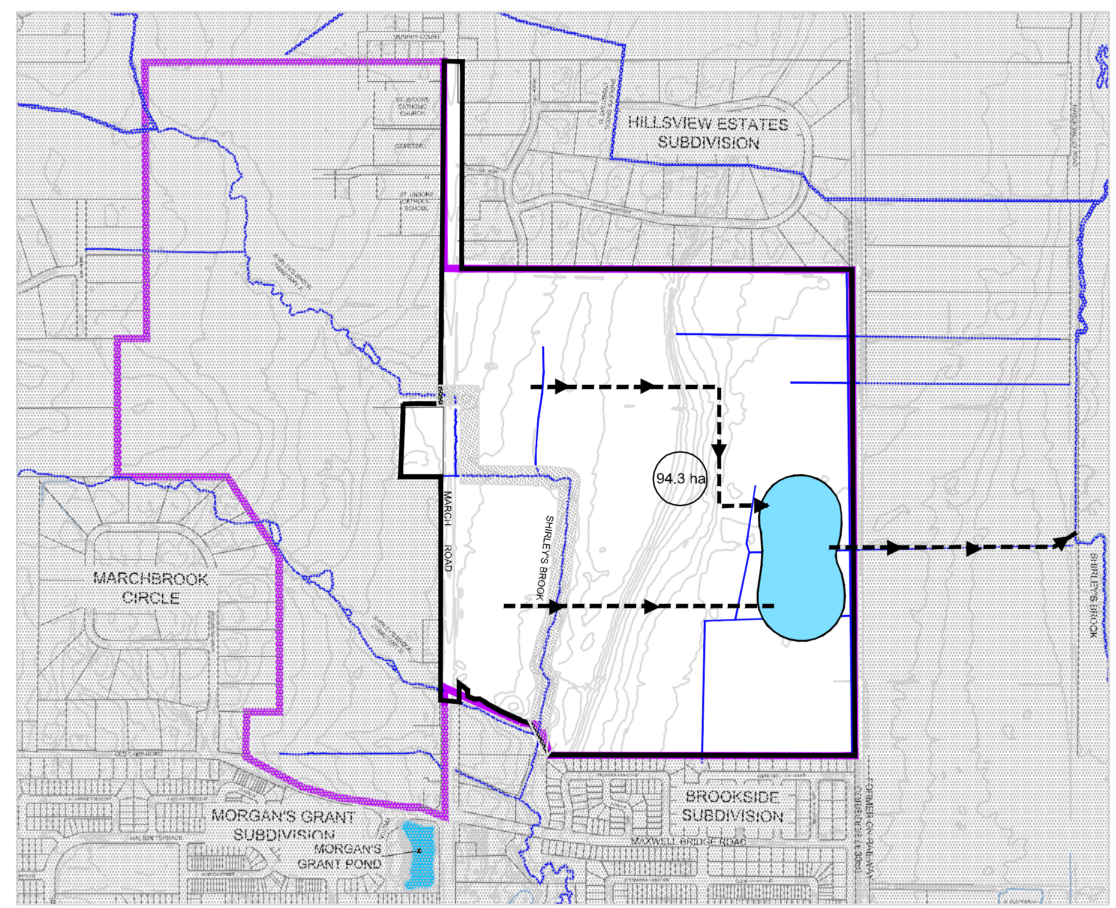
OPTION 1 - SWM FACILITY OUTSIDE URBAN BOUNDARY, INTEGRATED WITHIN WOODED AREA (PREFERRED)



OPTION 2 - SWM FACILITY OUTSIDE URBAN BOUNDARY, PERPENDICULAR TO RAIL LINE & MARCH VALLEY RD.



OPTION 3 - SWM FACILITY OUTSIDE URBAN BOUNDARY, PARALLEL TO RAIL LINE & MARCH VALLEY RD.



OPTION 4 - SWM FACILITY INSIDE URBAN BOUNDARY, INTEGRATED WITHIN DEVELOPMENT

LEGEND

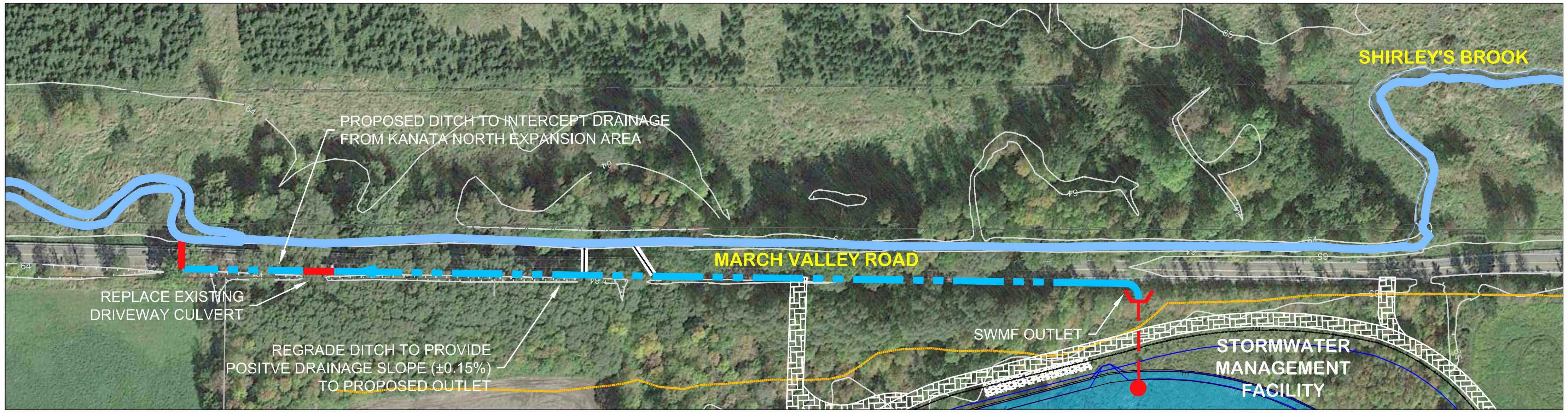
- KNUEA
- DRAINAGE CHANNEL
- LANDS SERVICED BY SWM OPTION
- LANDS NOT SERVICED BY SWM OPTION
- 23.9 ha AREA (HECTARES)
- STORM SEWER

KANATA NORTH
COMMUNITY DESIGN PLAN

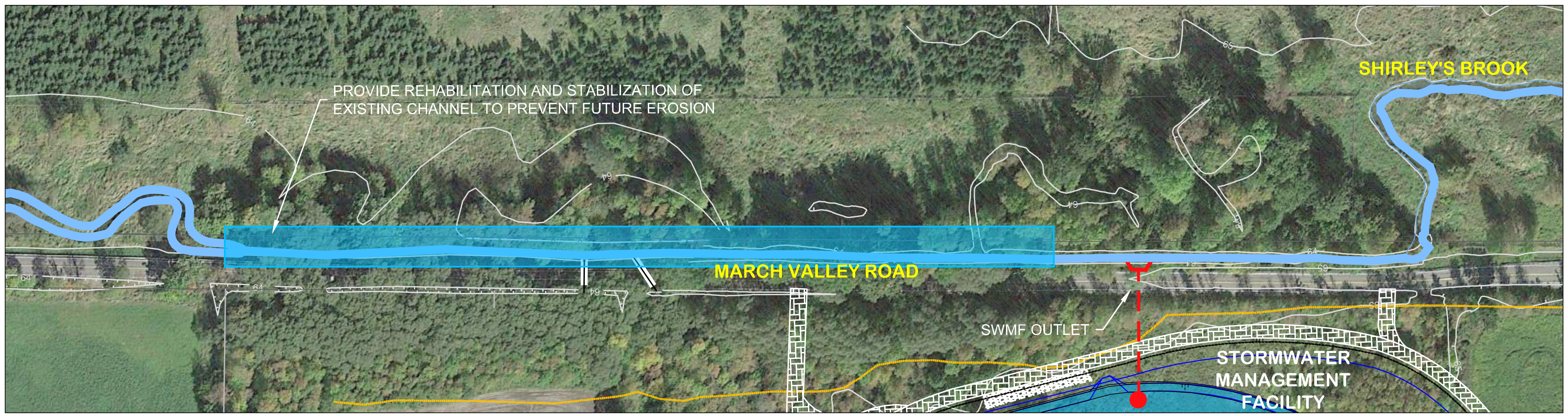
FIGURE NO. 6.4
SWMF ALTERNATIVES - EAST OF MARCH

DATE JUN 2016
JOB 112117
SCALE NTS

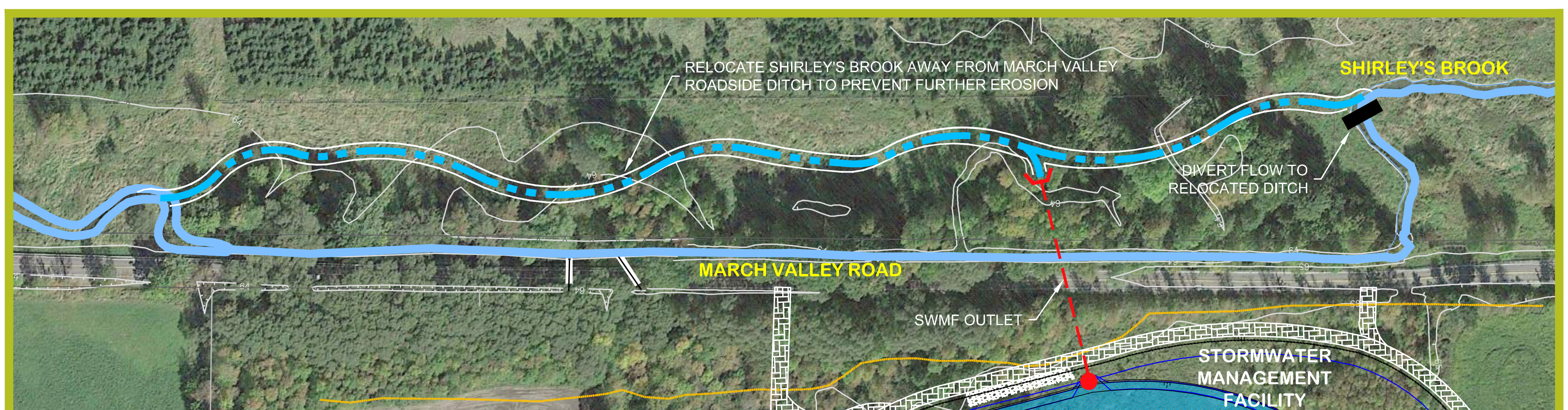
NOVATECH
Engineers, Planners & Landscape Architects



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



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



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

LEGEND

- KNUEA
- EXISTING DRAINAGE CHANNEL
- PROPOSED DRAINAGE CHANNEL

KANATA NORTH
COMMUNITY DESIGN PLAN

FIGURE NO. 6.5
SHIRLEY'S BROOK
REALIGNMENT
ALTERNATIVES

DATE	JOB
MAY 2016	112117

SCALE
1:2000
0 20m 40m 80m

NOVATECH
Engineers, Planners & Landscape Architects

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

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6.3.2 Natural Environment / Natural Heritage Features

The SWM facility locations for each option have been evaluated (**Tables 6.1 - 6.5**) to categorize their relative impact on the natural heritage system.

6.3.3 Social Environment

None of the SWM options will have any impact on existing communities, residential areas, or recreational facilities.

6.3.4 Cultural Environment Heritage

There are no built heritage resources or cultural heritage resources that will be affected by any of the SWM options, and all SWM option locations have roughly the same archaeological potential.

6.3.5 First Nations/Aboriginal Peoples

None of the SWM options are located in areas with treaty rights, land claims or known first nations archaeological sites.

6.3.6 Economic Environment

All of the SWM options have been developed in support of the proposed development of the KNUEA and are equivalent in terms of their impact on the economic environment relating to existing and future commercial, industrial, agricultural land use.

6.3.7 Cost Estimates

The relative costs of each option have been evaluated in terms of capital costs, property costs, and operation/maintenance costs (**Tables 6.1 – 6.5**).

6.3.8 Design / Technical

All of the options will meet the SWM objectives for the KNUEA. The selection of the recommended options is therefore dependent on other issues related to the technical design, impacts on the natural heritage system, compatibility with proposed land use, and compatibility with other planned municipal infrastructure.

6.4 Recommended SWM Strategy

Evaluation matrices have been developed to reflect the relative merits of each option and identify the recommended SWM servicing strategy for each quadrant of the KNUEA, as well as the recommended strategy to address erosion in Shirley's Brook at March Valley Road – refer to **Tables 6.1 – 6.5**. Note that each table number corresponds with the figure numbers listed on the previous page.

6.4.1 Northwest Quadrant

The recommended SWM strategy for the northwest quadrant of the KNUEA is a single SWM facility located on the north side of Tributary 2. A storm sewer crossing underneath Tributary 2 will allow the lands south of Tributary 2 to be serviced by this facility.

There is a small area adjacent to March Road that cannot be directed to the recommended pond. Depending on the proposed land use, storm runoff from this area could either be conveyed directly to Tributary 2, or collected by the future March Road storm sewers and conveyed to a SWM pond on the east side of March Road.

6.4.2 Southwest Quadrant

The recommended SWM strategy for the southwest quadrant of the KNUEA is a single SWM facility located on the north side of Tributary 3. A storm sewer crossing underneath Tributary 3 will allow the proposed street-oriented residential lands adjacent to Marchbrook Circle to be serviced by this facility.

The remaining areas in the southwest quadrant would require on-site stormwater controls for water quality and quantity treatment. The proposed land uses in this area (School, Multi-Unit Residential) are generally compatible with on-site SWM controls.

6.4.3 Northeast / Southeast Quadrants

The recommended SWM strategy for the KNUEA lands east of March Road is a single SWM facility located adjacent to March Valley Road at the eastern limit of Woodlot S23. Storm runoff from the KNUEA would be directed to the proposed facility through a pair of open channels on either side of the woodlot. The elevation of the proposed SWM facility will be low enough to accommodate the required sanitary overflow.

There is sufficient topographic relief across the eastern portion of the KNUEA for the lands between March Road and Tributary 2 to be serviced by this facility. Two storm sewer crossings under Tributary 2 would be constructed as part of the overall trunk sewer system.

6.4.4 Shirley's Brook at March Valley Road

The recommended SWM strategy to address erosion in the reach of Shirley's Brook Main Branch adjacent to March Valley Road is to realign this reach of the watercourse further east. This represents the most effective means of addressing the ongoing erosion and washout issues. This approach will provide the opportunity to improve the ecological health of the watercourse, create additional habitat, and provide the opportunity for future upgrades to March Valley Road.

6.5 Public Consultation

The evaluation of the SWM servicing alternatives and the selection of the preferred alternative for each subwatershed were presented at a public open house on March 30th, 2016. Meeting details, Public Notices, and Presentation Materials are contained in a separate report along with the comments and inputs received.

6.6 City Consultation

Following presentation of the preferred alternative at the public open house, further analysis of SWM alternatives was completed in response to comments provided by the City in May 2016. The outcome of this analysis has not changed the preferred alternative as presented to the public on March 30, 2016. Refer to correspondence in **Volume 2, Appendix B.**

Kanata North Urban Expansion Area

Table 6.1: Evaluation Matrix - SWM Options for Northwest Quadrant

Criteria	Indicators	Option #1 One SWM Pond to service lands north of Tributary 2.	Option #2 One SWM Pond on north side of Tributary 2 to service Northwest Quadrant	Option #3 One SWM Pond on south side of Tributary 2 to service Northwest Quadrant
Design and Constructability/Functionality				
Geotechnical issues and construction risks	Potential for encountering poor soils/rock and/or elevated groundwater conditions.	Shallow Bedrock. Rock excavation required for SWMF. Elevated groundwater conditions possible.	Shallow Bedrock. Rock excavation required for SWMF. Elevated groundwater conditions possible.	Shallow Bedrock. Rock excavation required for SWMF. Elevated groundwater conditions possible.
Pond Elevations / Operating Levels	Proximity to 100yr floodplain. Normal Water Level (NWL) preferably above 2yr level in receiver.	Operating levels in pond governed by Tributary 2 water levels, STM HGL.	Operating levels in pond governed by Tributary 2 water levels, STM HGL.	Operating levels in pond governed by Tributary 2 water levels, STM HGL.
Infrastructure Requirements	Size and number of SWM facilities. Pond Footprint. Size and length of STM sewers	Single pond north of Tributary 2 with outlet to Tributary 2 upstream (west) of March Road. Separate pond required for lands south of Tributary 2.	Single pond north of Tribuary 2 with outlet to Tributary 2 upstream (west) of March Road. Requires STM crossing under Tributary 2.	Single pond south of Tributary 2 with outlet to Tributary 2 upstream (west) of March Road. Requires STM crossing under Tributary 2.
Service Area	Contributing Area.	Services portion of Northwest Quadrant north of Tributary 2 (27 ha).	Services majority of Northwest Quadrant (53ha). Small area south of Tributary 2 adjacent to March Road would outlet directly to Tributary 2 or to KNUEA East pond.	Services majority of Northwest Quadrant (53ha). Small area north of Tributary 2 adjacent to March Road would outlet directly to Tributary 2 or to KNUEA East pond.
Compatability with Other Infrastructure	Watercourse crossings, pipe conflicts.	Compatible with SAN/Water infrastructure.	One (1) STM crossings under Tributary 2. Compatible with SAN/Water infrastructure.	One (1) STM crossings under Tributary 2. Compatible with SAN/Water infrastructure.
Servicing Flexibility	Ease of accomodating potential changes in servicing plans.	Pond only services areas north of Tributary 2. Development of lands to the south will require SWM coordination with Southwest Quadrant. Must be constructed in advance of development, or temporary SWM plan will be required.	Pond will service Northwest Quadrant. Must be constructed in advance of development, or temporary SWM plan will be required.	Pond will service Northwest Quadrant. Must be constructed in advance of development, or temporary SWM plan will be required. Pond outlet further upstream (vs. Option2) will impact servicing costs (grade raise, HGL).
Natural Environment				
Impact on Natural Features	Loss of natural area due to installation of works.	Pond location in active agricultural area. Small loss of wooded area on north side of Tributary 2.	Pond location in active agricultural area. Small loss of wooded area on north side of Tributary 2.	Pond location in active agricultural area. Small loss of wooded area on south side of Tributary 2.
Impact on Aquatic Systems	Potential impact on fish habitat due to installation of works.	Pond will provide water quality / quantity treatment. Increased temperature from urban runoff. No signficant impact on aquatic systems.	Pond will provide water quality / quantity treatment. Increased temperature from urban runoff. No signficant impact on aquatic systems.	Pond will provide water quality / quantity treatment. Increased temperature from urban runoff. No signficant impact on aquatic systems.
Impact on Groundwater	Potential impact on groundwater levels / groundwater quality.	Impermeable liner required to prevent migration of pollutants to aquifer.	Impermeable liner required to prevent migration of pollutants to aquifer.	Impermeable liner required to prevent migration of pollutants to aquifer.
Economy				
Capital Costs	Cost of SWM Facility	Lowest pond cost. Total cost equivalent to Option 2due to cost-sharing for SWM on south side.	Equivalent to Option 1	Higher cost than Options 1 & 2. Deeper excavation at western limit of pond.
Property Acquisition	Ease of property acquisition. (Depends on status of lands and adjacent lands ie. Vacant, leased or owner occupied).	No additional property acquisition required.	No additional property acquisition required.	No additional property acquisition required. Pond costs cound be reduced by shifting pond adjacent to March Road, but lands not owned by KNLOG.
Operation & Maintenance		Standard O&M cost for single SWMF.	Standard O&M cost for single SWMF.	Standard O&M cost for single SWMF.
Summary & Recommendation			**Recommended -** Lowest overall cost, provides SWM solution for all of Northwest Quadrant (exact drainage area to be refined at the detailed design stage).	

Kanata North Urban Expansion Area

Table 6.2: Evaluation Matrix - SWM Options for Southwest Quadrant (Options 1 - 3)

NOVATECH
Engineers, Planners & Landscape Architects

Criteria	Indicators	Option #1 Two SWM Ponds to Service Southwest Quadrant, one (1) each side of Tributary 3.	Option #2 One SWM Pond on north side of Tributary 3. On-site SWM controls for south side.	Option #3 One SWM Pond on north side of Tribuary 3. STM crossing of Tributary 3 sized for Marchbrook Circle and adjacent low density residential on south side. On-site SWM control for remaining areas.
Design and Constructability/Functionality				
Geotechnical issues and construction risks	Potential for encountering poor soils/rock and/or elevated groundwater conditions.	Shallow Bedrock. Rock excavation required for SWMFs. Elevated groundwater conditions possible.	Shallow Bedrock. Rock excavation required for SWMF. Elevated groundwater conditions possible.	Shallow Bedrock. Rock excavation required for SWMF and STM crossing of Tributary 3. Elevated groundwater conditions possible.
Pond Elevations / Operating Levels	Proximity to 100yr floodplain. Normal Water Level (NWL) preferably above 2yr level in receiver.	Operating levels in ponds governed by Tributary 3 water levels, STM HGL.	Operating levels in pond governed by Tributary 3 water levels, STM HGL.	Operating levels in pond governed by Tributary 3 water levels, STM HGL.
Infrastructure Requirements	Size and number of SWM facilities. Pond Footprint. Size and length of STM sewers	Two ponds on either side of Tributary 3 with outlets to Tributary 3 upstream (west) of March Road.	Single pond north of Tribuary 3 with outlet to Tributary 3 upstream (west) of March Road. On-site controls for KNUEA south of Tributary 3.	Single pond north of Tribuary 3 with outlet to Tributary 3 upstream (west) of March Road. On-site controls for portion of KNUEA south of Tributary 3. Requires STM crossing under Tributary 3.
Service Area	Contributing Area.	North Pond (11.7 ha) South Pond (13.1 ha + Marchbrook Circle)	North Pond (11.7 ha) On-site Controls (±13 ha).	North Pond (16.7 ha + Marchbrook Circle) On-site Controls (±8 ha).
Compatability with Other Infrastructure	Watercourse crossings, pipe conflicts.	Compatible with SAN/Water infrastructure.	One (1) STM crossings under Tributary 2. Compatible with SAN/Water infrastructure.	One (1) STM crossings under Tributary 2. Compatible with SAN/Water infrastructure.
Servicing Flexibility	Ease of accomodating potential changes in servicing plans.	Pond only services areas north of Tributary 2. Development of lands to the south will require SWM coordination with Southwest Quadrant. Must be constructed in advance of development, or temporary SWM plan will be required.	Pond will service Southwest Quadrant. Must be constructed in advance of development, or temporary SWM plan will be required.	Pond will service Southwest Quadrant. Must be constructed in advance of development, or temporary SWM plan will be required. Pond outlet further upstream (vs. Option2) will impact servicing costs (grade raise, HGL).
Natural Environment				
Impact on Natural Features	Loss of natural area due to installation of works.	North Pond located in active agricultural area, South Pond in pasture.	Pond located in active agricultural area.	Pond located in active agricultural area.
Impact on Aquatic Systems	Potential impact on fish habitat due to installation of works.	Ponds will provide water quality / quantity treatment. Increased temperature from urban runoff. No signficant impact on aquatic systems.	Pond will provide water quality / quantity treatment. Increased temperature from urban runoff. No signficant impact on aquatic systems.	Pond will provide water quality / quantity treatment. Increased temperature from urban runoff. No signficant impact on aquatic systems.
Impact on Groundwater	Potential impact on groundwater levels / groundwater quality.	Pond bottom on bedrock. Impermeable liner required to prevent migration of pollutants to aquifer.	Pond bottom on bedrock. Impermeable liner required to prevent migration of pollutants to aquifer.	Pond bottom on bedrock. Impermeable liner required to prevent migration of pollutants to aquifer.
Economy				
Capital Costs	Cost of SWM Facility	Highest capital cost for construction of two new SWMFs.	Smallest single pond option with lowest capital cost for SWMF. Largest area and highest cost for on-site controls.	Largest single pond option with highest capital cost for SWMF. Smallest area and lowest cost for on-site controls. Larger STM crossing of Tributary 3 to convey Marchbrook Circle to pond.
Property Acquisition	Ease of property acquisition. (Depends on status of lands and adjacent lands ie. Vacant, leased or owner occupied).	Property acquisition may be required depending on location of North Pond. South Pond could be shifted adjacent to March Road, but lands not owned by KNLOG.	Property acquisition may be required depending on location of North Pond.	Property acquisition may be required depending on location of North Pond.
Operation & Maintenance		Standard O&M cost for two SWMFs.	Standard O&M cost for single SWMF. Higher maintenace frequency but lower maintance cost for on-site SWM controls (vs. SWM pond).	Standard O&M cost for single SWMF. Higher maintenace frequency but lower maintance cost for on-site SWM controls (vs. SWM pond).
Summary & Recommendation				

Kanata North Urban Expansion Area
Table 6.3: Evaluation Matrix - SWM Options for Southwest Quadrant (Options 4-6)

NOVATECH
Engineers, Planners & Landscape Architects

Criteria	Indicators	Option #4 One SWM Pond on north side of Tribuary 3. STM crossing of Tributary 3 for Low Density Residential on south side. On-site SWM control for remaining areas. Drainage from Marchbrook Circle routed through KNUEA to Tributary 3.	Option #5 One SWM Pond on north side of Tribuary 3. Provide new outlet and expand existing Morgan's Grant Pond to accommodate KNUEA lands south of Tributary 3.	Option #6 One SWM Pond servicing lands on south side of Tributary 3 including drainage from Marchbrook Circle. On-site SWM controls for north side.
Design and Constructability/Functionality				
Geotechnical issues and construction risks	Potential for encountering poor soils/rock and/or elevated groundwater conditions.	Shallow Bedrock. Rock excavation required for SWMF and STM crossing of Tributary 3. Elevated groundwater conditions possible.	Shallow Bedrock. Rock excavation required for new SWMF. Elevated groundwater conditions possible. Potential geotech issues with expansion of Morgan's Grant SWMF.	Shallow Bedrock. Rock excavation required for SWMF. Elevated groundwater conditions possible.
Pond Elevations / Operating Levels	Proximity to 100yr floodplain. Normal Water Level (NWL) preferably above 2yr level in receiver.	Operating levels in pond governed by Tributary 3 water levels, STM HGL.	Operating levels in new pond governed by Tributary 3 water levels, STM HGL. Operating levels in Morgan's Grant pond controlled by ex. outlet structure.	Operating levels in pond governed by Tributary 3 water levels, STM HGL.
Infrastructure Requirements	Size and number of SWM facilities. Pond Footprint. Size and length of STM sewers	Single pond north of Triburary 3 with outlet to Tributary 3 upstream (west) of March Road. On-site controls for portion of KNUEA south of Tributary 3. Requires STM crossing under Tributary 3. Requires separate STM outlet for Marchbrook Circle Drainage.	Single pond north of Tributary 3 with outlet to Tributary 3 upstream (west) of March Road. New STM outlet & forebay added to existing Morgan's Grant SWMF.	Single pond south of Triburay 3 with outlet to Tributary 3 upstream (west) of March Road. On-site controls for KNUEA north of Tributary 3.
Service Area	Contributing Area.	North Pond (16.7 ha) On-site Controls (±8 ha).	North Pond (11.7 ha) Morgan's Grant SWMF (13.1 ha + Marchbrook Circle)	South Pond (13.1 ha + Marchbrook Circle) On-site Controls (±12 ha).
Compatability with Other Infrastructure	Watercourse crossings, pipe conflicts.	Compatible with SAN/Water infrastructure.	One (1) STM crossings under Tributary 2. Compatible with SAN/Water infrastructure.	One (1) STM crossings under Tributary 2. Compatible with SAN/Water infrastructure.
Servicing Flexibility	Ease of accomodating potential changes in servicing plans.	Pond will service the majority of the Southwest Quadrant, with some on-site storage required for lands south of Tributary 3 (±8 ha). Must be constructed in advance of development, or temporary SWM plan will be required.	Pond will service Southwest Quadrant, north of Tributary 3. Southwest Quadrant south of Tributary 3 as well as upstream drainage area from Marchbrook Circle will be serviced by the existing Morgan's Grant Pond. Must be constructed in advance of development, or temporary SWM plan will be required.	Pond will service Southwest Quadrant lands south of Tributary 3, as well as upstream drainage area from Marchbrook Circle. On-site controls for Southwest Quadrant lands north of Tributary 3 (±12 ha) will require on-site controls. Must be constructed in advance of development, or temporary SWM plan will be required. Pond outlet further upstream (vs. Option2) will impact servicing costs (grade raise, HGL).
Natural Environment				
Impact on Natural Features	Loss of natural area due to installation of works.	Pond located in active agricultural area.	New pond located in active agricultural area. Morgan's Grant pond already designated SWM area.	Pond located in pasture.
Impact on Aquatic Systems	Potential impact on fish habitat due to installation of works.	Pond will provide water quality / quantity treatment. Increased temperature from urban runoff. Slight temperature benefit from routing Marchbrook Circle drainage directly to Tributary 3. No signficant impact on aquatic systems.	Ponds will provide water quality / quantity treatment. Increased temperature from urban runoff. No signficant impact on aquatic systems.	Pond will provide water quality / quantity treatment. Increased temperature from urban runoff. No signficant impact on aquatic systems.
Impact on Groundwater	Potential impact on groundwater levels / groundwater quality.	Pond bottom on bedrock. Impermeable liner required to prevent migration of pollutants to aquifer.	Pond bottom on bedrock. Impermeable liner required to prevent migration of pollutants to aquifer.	Pond bottom on bedrock. Impermeable liner required to prevent migration of pollutants to aquifer.
Economy				
Capital Costs	Cost of SWM Facility	Smaller pond and lower SWMF cost vs. Option 3. Smallest area and lowest cost for on-site controls. Smaller STM crossing of Tributary 3, but larger STM to convey Marchbrook Circle to Tributary 3 at March Road.	Lowest cost for new SWMF (same as Option 2). Cost of expanding Morgan's Grant pond lower than cost of new pond.	Second largest single pond option. Second-largest area for on-site controls. Larger STM crossing of Tributary 3 to convey Marchbrook Circle to pond.
Property Acquisition	Ease of property acquisition. (Depends on status of lands and adjacent lands ie. Vacant, leased or owner occupied).	Property acquisition may be required depending on location of North Pond.	Property acquisition may be required depending on location of North Pond. Morgan's Grant Pond currently owned by City.	No property acquisition required. Pond could be moved adjacent to March Road, but lands not owned by KNLOG.
Operation & Maintenance		Standard O&M cost for single SWMF. Higher maintenace frequency but lower maintance cost for on-site SWM controls (vs. SWM pond).	Standard O&M cost for new SWMF. Slightly lower O&M cost for expansion of Morgan's Grant SWMF (new forebay will require similar maintenance to new pond).	Standard O&M cost for single SWMF. Higher maintenace frequency but lower maintance cost for on-site SWM controls (vs. SWM pond).
Summary & Recommendation		**Recommended -** SWM faciltiy will service majority of Southwest Quadrant. Proposed land use in remaining areas compatible with on-site controls. Upstream flows routed through KNUEA to Tributary 3 at March Road reduces size of proposed STM crossing (exact drainage area to be refined at the detailed design stage).		

Kanata North Urban Expansion Area

Table 6.4: Evaluation Matrix - SWM Options for Northeast / Southeast Quadrants

Criteria	Indicators	Option #1 SWM Pond adjacent to March Valley Road, east edge of Woodlot S23	Option #2 SWM Pond adjacent to eastern limit of KNUEA - East/West Orientation	Option #3 SWM Pond adjacent to eastern limit of KNUEA - North/South Orientation	Option #4 SWM Pond inside urban boundary at eastern limit of KNUEA
Design and Constructability/Functionality					
Geotechnical issues and construction risks	Potential for encountering poor soils/rock and/or elevated groundwater conditions.	Minimal rock excavation (pond bottom approx 1.5m below ex. grade). Goundwater levels should not significantly impact constructability.	Signficant rock excavation required in western portion of pond (pond bottom approx 3-5m below ex. grade adjacent to KNUEA). Groundwater levels may require special consideration during construction.	Signficant rock excavation required (pond bottom approx 3-5m below ex. grade). Groundwater levels may require special consideration during construction.	Significant rock excavation required (pond bottom approx 6m below ex. grade). Groundwater levels may require special consideration during construction.
Pond Elevations / Operating Levels	Proximity to 100yr floodplain. Normal Water Level (NWL) preferably above 2yr level in receiver.	Operating levels in pond governed by Shirley's Brook, STM HGL, requirement for SAN overflow.	Operating levels in pond governed by Shirley's Brook, STM HGL, requirement for SAN overflow.	Operating levels in pond governed by Shirley's Brook, STM HGL, requirement for SAN overflow.	Operating levels in pond governed by Shirley's Brook, STM HGL, requirement for SAN overflow.
Infrastructure Requirements	Size and number of SWM facilities. Pond Footprint. Size and length of STM sewers	Depth of facility will not require retaining walls. Requires construction of two new inlet channels from KNUEA (±300m x 2).	Depth of facility will require either large footprint or extensive use of retaining walls. Requires construction of new outlet channel to Shirley's Brook at March Valley Road (±150m).	Depth of pond will require either large footprint or extensive use of retaining walls. Requires construction of new outlet channel to Shirley's Brook at March Valley Road (±350m).	Depth of pond will require either large footprint or extensive use of retaining walls. Requires construction of new outlet channel to Shirley's Brook at March Valley Road (±460m).
Service Area	Contributing Area. Future Expansion.	Services all of KNUEA east of March Road (approx 95 ha). Future expansion possible to service lands east of KNUEA.	Services all of KNUEA east of March Road (approx 95 ha). Future expansion possible to service lands east of KNUEA.	Services all of KNUEA east of March Road (approx 95 ha). No possible future expansion.	Services all of KNUEA east of March Road (approx 95 ha). No possible future expansion.
Compatibility with Other Infrastructure	SAN Overflow. Watercourse crossings, pipe conflicts.	Two (2) STM crossings under Tributary 2. Compatible with SAN/Water infrastructure.	Two (2) STM crossings under Tributary 2. Compatible with SAN/Water infrastructure.	Two (2) STM crossings under Tributary 2. Compatible with SAN/Water infrastructure.	Two (2) STM crossings under Tributary 2. Compatible with SAN/Water infrastructure.
Servicing Flexibility	Ease of accommodating potential changes in servicing plans.	Pond will service all areas east of March Road. Must be constructed in advance of development, or temporary SWM plan will be required. Pond location outside urban area allows flexibility for changes to servicing/land use plans.	Pond will service all areas east of March Road. Must be constructed in advance of development, or temporary SWM plan will be required. Pond location outside urban area allows flexibility for changes to servicing/land use plans.	Pond will service all areas east of March Road. Must be constructed in advance of development, or temporary SWM plan will be required. Pond location outside urban area allows flexibility for changes to servicing/land use plans.	Pond will service all areas east of March Road. Must be constructed in advance of development, or temporary SWM plan will be required. Pond location may preclude changes to servicing/land use plans.
Natural Environment					
Impact on Natural Features	Loss of natural area due to installation of works.	Pond located in eastern portion of Woodlot S23. Some loss of reduced function wooded area. Remainder of woodlot would be conveyed to City. Butternut assessment required.	Pond location in active agricultural area. No loss of wooded area.	Pond location in active agricultural area. Minimal loss of wooded area (hedgerow).	Pond located inside KNUEA, no loss of natural area outside KNUEA.
Impact on Aquatic Systems	Potential impact on fish habitat due to installation of works.	Pond will provide water quality / quantity treatment. Increased temperature from urban runoff. No significant impact on aquatic systems.	Pond will provide water quality / quantity treatment. Increased temperature from urban runoff. No significant impact on aquatic systems.	Pond will provide water quality / quantity treatment. Increased temperature from urban runoff. No significant impact on aquatic systems.	Pond will provide water quality / quantity treatment. Increased temperature from urban runoff. No significant impact on aquatic systems.
Impact on Groundwater	Potential impact on groundwater levels / groundwater quality.	Pond bottom above rock, no requirement for pond liner to protect groundwater.	Impermeable liner required to prevent migration of pollutants to aquifer.	Impermeable liner required to prevent migration of pollutants to aquifer.	Impermeable liner required to prevent migration of pollutants to aquifer.
Economy					
Capital Costs	Cost of SWM Facility	Lowest overall cost.	Second Lowest Cost.	Second Highest Cost	Highest Cost.
Property Acquisition	Ease of property acquisition. (Depends on status of lands and adjacent lands ie. Vacant, leased or owner occupied).	No additional property acquisition required.	No additional property acquisition required.	No additional property acquisition required.	No additional property acquisition required.
Operation & Maintenance		Standard O&M cost for single SWMF.	Standard O&M cost for single SWMF.	Standard O&M cost for single SWMF.	Standard O&M cost for single SWMF.
Summary & Recommendation		**Recommended -** Lowest overall cost, no anticipated geotech issues (bedrock), provides SAN overflow outlet. remainder of Woodlot S23 conveyed to City.			

Kanata North Urban Expansion Area

Table 6.5: Evaluation Matrix - Shirley's Brook at March Valley Road

NOVATECH
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Criteria	Indicators	Option #1 Construct new SWM outlet ditch on west side of March Valley Road.	Option #2 Provide additional erosion protection for existing Shirley's Brook alignment.	Option #3 Relocate reach of Shirley's Brook adjacent to March Valley Road using natural channel design principles.
Design and Constructability/Functionality				
Geotechnical issues and construction risks	Potential for encountering poor soils/rock and/or elevated groundwater conditions.	No rock excavation required. Groundwater levels should not significantly impact constructability.	No rock excavation required. Groundwater levels should not significantly impact constructability.	No rock excavation required. Groundwater levels should not significantly impact constructability.
Infrastructure Requirements	Changes to March Valley Road ROW. Channel. Size and required culverts	Ditch regrading work will require works within ROW, and possibly some work on private property. Requires replacement of existing driveway culvert, and installation of new culvert crossing March Valley Road.	Ditch regrading & rehabilitation work will require works within ROW. Requires replacement of existing culvert crossing March Valley Road	Realignment of the tributary will required minimal works within the ROW. Requires replacement of one existing culvert, and removal of one culvert crossing March Valley Road
Compatibility with Other Infrastructure	Existing March Valley Road ROW	One culvert installation, one culvert replacement. Compatible with existing culverts & March Valley ROW	One culvert replacement. Compatible with existing culverts & March Valley ROW	One culvert replacement, one culvert removal. Compatible with existing culverts & March Valley ROW
Natural Environment				
Impact on Natural Features	Loss of natural area due to installation of works.	Will require substantial removal of trees from the west side of the March Valley ROW, may require some tree removal from the east side of the ROW	May require removal of some trees from both sided of the March Valley ROW	May require removal of some trees. Relocation of channel will be planned to avoid removal of trees if possible. Will provide additional habitat for amphibians, turtles, and other aquatic species.
Impact on Aquatic Systems	Potential impact on fish habitat due to installation of works.	Will reduce occurrence of erosion within the existing channel on the east side of March Valley	Will reduce occurrence of erosion within the existing channel on the east side of March Valley, will protect against ongoing road washout	Will reduce occurrence of erosion within the existing channel on the east side of March Valley. New channel will provide new habitat for various aquatic species.
Impact on Groundwater	Potential impact on groundwater levels / groundwater quality.	No rock excavation required, should not have any impact on groundwater	No rock excavation required, should not have any impact on groundwater	No rock excavation required, should not have any impact on groundwater
Economy				
Capital Costs	Cost of Construction	Lowest overall cost.	Highest cost	Second lowest cost
Property Acquisition	Ease of property acquisition. (Depends on status of lands and adjacent lands ie. Vacant, leased or owner occupied).	No additional property acquisition required.	No additional property acquisition required.	No additional property acquisition required. Approval in principal has been received from the NCC & DND
Operation & Maintenance		Standard O&M cost for roadside ditch	Standard O&M cost for roadside ditch	Little to no O&M required as relocated channel is to be naturalized.
Summary & Recommendation				**Recommended** - Provides more habitat for aquatic species within the area, improves overall functionality of existing channel, moves channel away from ROW and nearly eliminates potential for roadway erosion & washout. Approach approved in principle by NCC & DND.

Section 7.0 Post Development Storm Drainage Conditions

7.1 Hydrologic Modeling (SWMHYMO)

A conceptual post-development hydrologic analysis of the KNUEA has been completed using the SWMHYMO hydrologic model. The post-development analysis includes:

- Event-based hydrologic modeling using synthetic design storms for return periods ranging between 1:2yr to 1:100yr; and
- Continuous hydrologic modeling using historic rainfall data for the City of Ottawa.

The event-based modeling was used to determine the required storage volumes and release rates for the proposed stormwater management facilities. The continuous modeling was used to simulate erosion risk, and to quantify changes to the water balance following development of the KNUEA.

7.1.1 Model Parameters

The drainage areas and model parameters used in the post-development hydrologic analysis have been developed based on planned future land use, topography, and road patterns within the KNUEA - refer to the following figure:

- **Figure 7.1** Post-Development Storm Drainage Area Plan

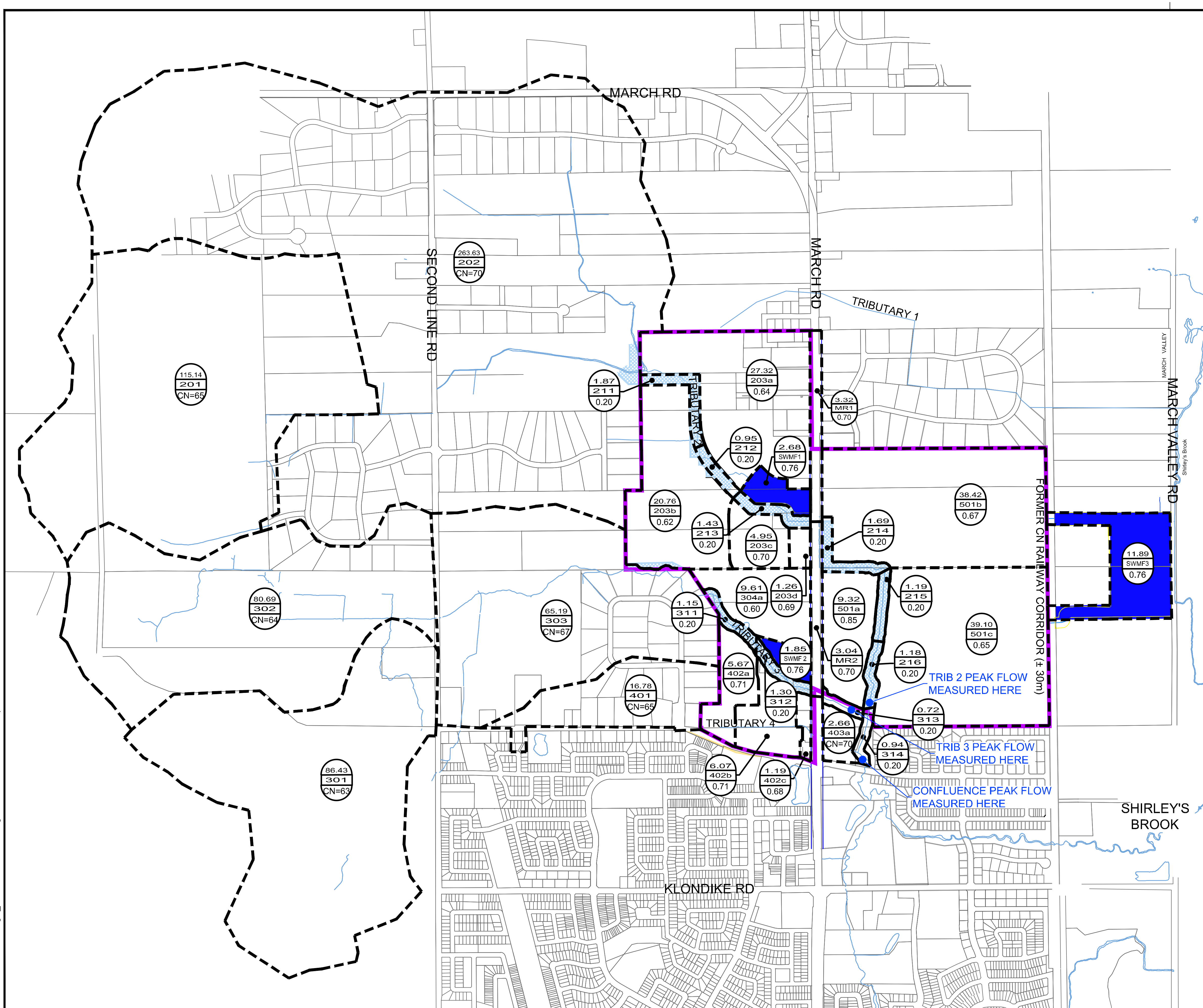
SWMHYMO model parameters and model schematics for the post-development model are located in **Volume 2**, **Appendix D**.

Runoff coefficients used in the post-development model have been based on the proposed land uses shown on the Demonstration Plan (see **Section 11**, **Figure 11.1** for reference). Coefficients used are based on standard Runoff Coefficients used for Rational Method calculations. **Table 7.1** outlines the runoff coefficients used, along with the calculated percent impervious. From these standard values, weighted runoff coefficients were calculated (as shown on **Figure 7.1**) based on the combined land use within a subcatchment area. A table of calculated weighted runoff coefficients for each subcatchment area can be found in **Appendix D**.

Table 7.1: Standard Runoff Coefficients

Land Use	Runoff Coefficient	% Impervious*
Low-density residential	0.65	64%
Medium-density residential	0.70	71%
High-density residential	0.75	79%
School/ Church	0.65	64%
Parks	0.40	29%
Open space	0.20	0%
Commercial	0.85	93%
Park & ride	0.85	93%
Roadways	0.90	100%

**Calculated using %i = [(c-0.2)/0.7]*



LEGEND

- KNUEA
- DRAINAGE CHANNEL
- SUBCATCHMENT DRAINAGE AREA BOUNDARIES
- CREEK CORRIDOR
- PROPOSED SWMF BLOCK

2.68 — SUBCATCHMENT AREA (ha)
SWMF1 — SUBCATCHMENT NAME
0.76 — RUNOFF COEFFICIENT (c)

KANATA NORTH
COMMUNITY DESIGN PLAN

FIGURE NO. 7.1
POST-DEVELOPMENT
DRAINAGE AREA PLAN

DATE
JUN 2016

JOB
112117

SCALE
NTS

NOVATECH
Engineers, Planners & Landscape Architects

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7.2 Event-Based Modeling

7.2.1 Critical Storm Distribution

Under pre-development conditions, the 24-hour SCS distribution generated the highest peak flows in the receiving watercourses and was consequently was used as the benchmark for the analysis of the proposed SWM strategy for the KNUEA.

7.2.2 Peak Flows

The peak flows generated by the 24-hour SCS storm distribution are listed in **Table 7.2**. SWMHYMO model results for other storm distributions are provided in **Volume 2**, **Appendix D**. Pre- vs. post-development hydrographs for the 100-year storm events are provided as **Figures 7.2** to **7.5**.

Table 7.2: Pre vs. Post-Development Model Results (Event-Based)

Storm Distribution ->		**SCS 24-Hour**			
Return Period ->		**25mm**	**2 year**	**5 year**	**100 year**
Shirley's Brook Northwest Branch					
Tributary 2 *(±230 m Upstream of Confluence)*	*Pre*	0.057	0.266	0.441	1.144
	Post	0.062	0.256	0.432	1.080
Tributary 3 *(±230 m Upstream of Confluence)*	*Pre*	0.044	0.245	0.426	1.180
	Post	0.114	0.299	0.505	1.451
Confluence of Tributaries 2&3 *(±50 m Upstream of Marchbrook Circle)*	*Pre*	0.110	0.549	0.929	2.481
	Post	0.125	0.509	0.895	2.457
KNUEA Lands to Main Branch of Shirley's Brook at March Valley Road					
Flows from East Pond (to Shirley's Brook Main Branch)	*Pre*	0.045	0.237	0.407	1.102
	Post	0.046	0.220	0.383	1.044

As outlined in the above table and following figures, the post development flows at the confluence of Shirley's Brook Tributaries 2 and 3 are less than the pre-development flows at this location. Although post-development peak flows in Tributary 3 are slightly higher downstream of the pond and on-site storage outlets, the overall flow at the confluence is less than pre-development. To ensure that there will be no increase in the erosive potential of the peak flows, continuous flow models were developed to show how the proposed SWM facilities will function through an average year of rainfall. This is discussed in the following **Section 7.3**.

The post-development SWMHYMO model was used to size the three proposed SWM facilities, based on the allowable release rates to Tributaries 2 & 3, and the Main Branch. The "Route Reservoir" command was used to determine the required amount of active storage in each of the facilities to ensure that the target peak flows are met. The volume of required on-site storage was also determined using the "Route Reservoir" command, based on the allowable release rate to Tributary 3. Peak flows in the above table and following graphs are taken downstream from the SWM facility outlets, and account for the storage and attenuation provided by these facilities.

Modeling results and conceptual designs for the proposed SWM facilities are provided in **Section 9.0**.

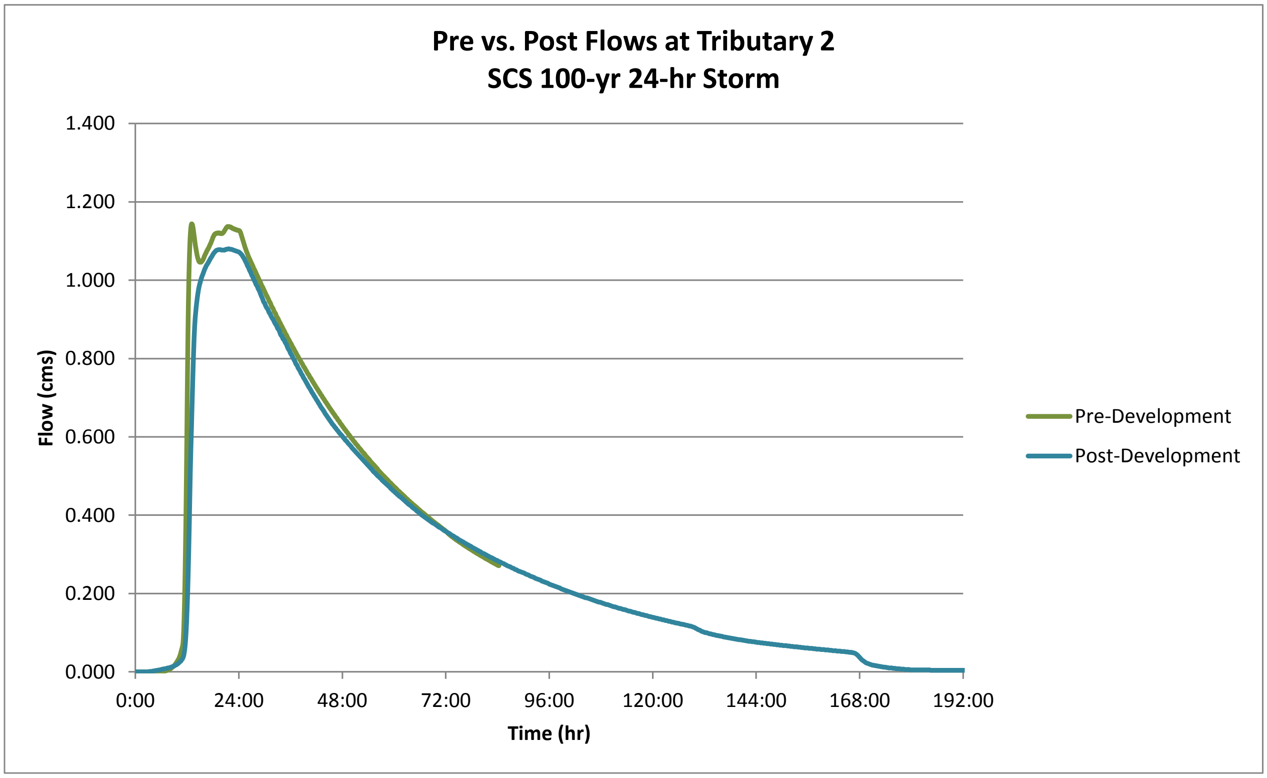


Figure 7.2: Pre vs. Post Development Peak Flows in Tributary 2, D/S of Pond 1

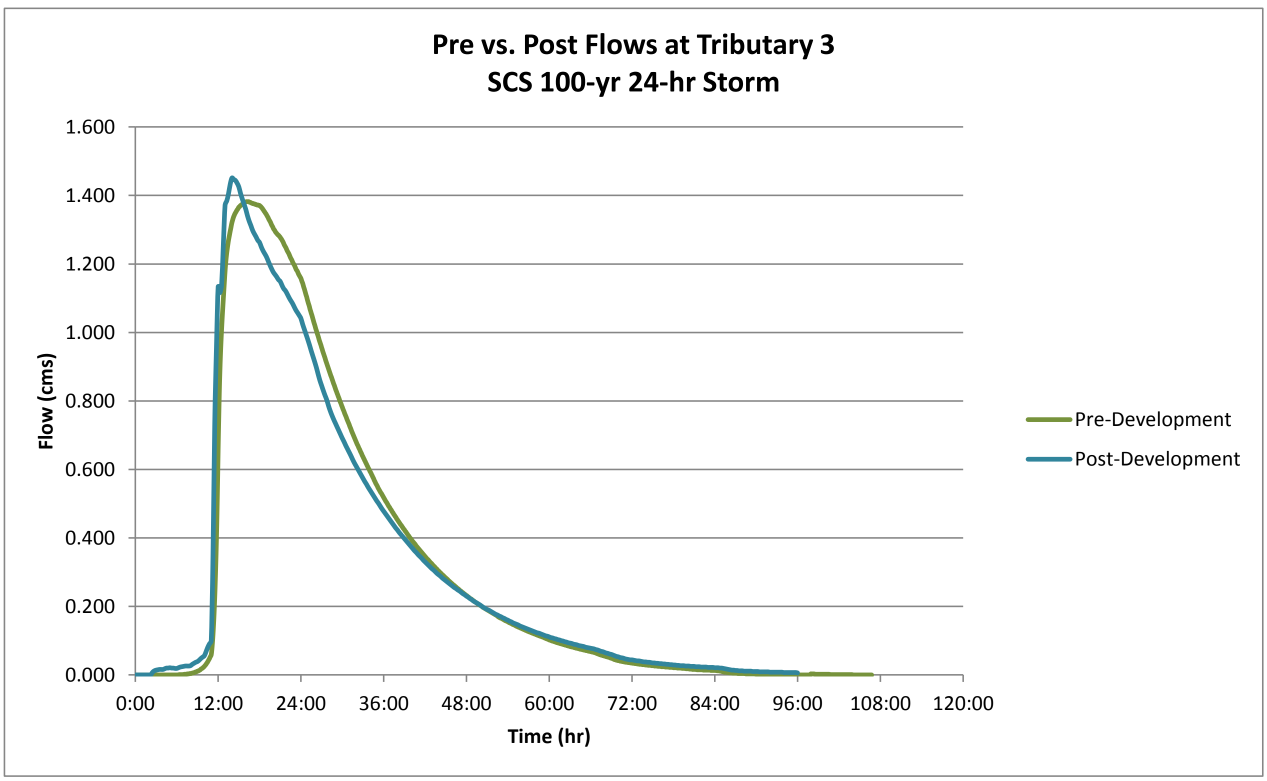


Figure 7.3: Pre vs. Post Development Peak Flows in Tributary 3, D/S of Pond 2

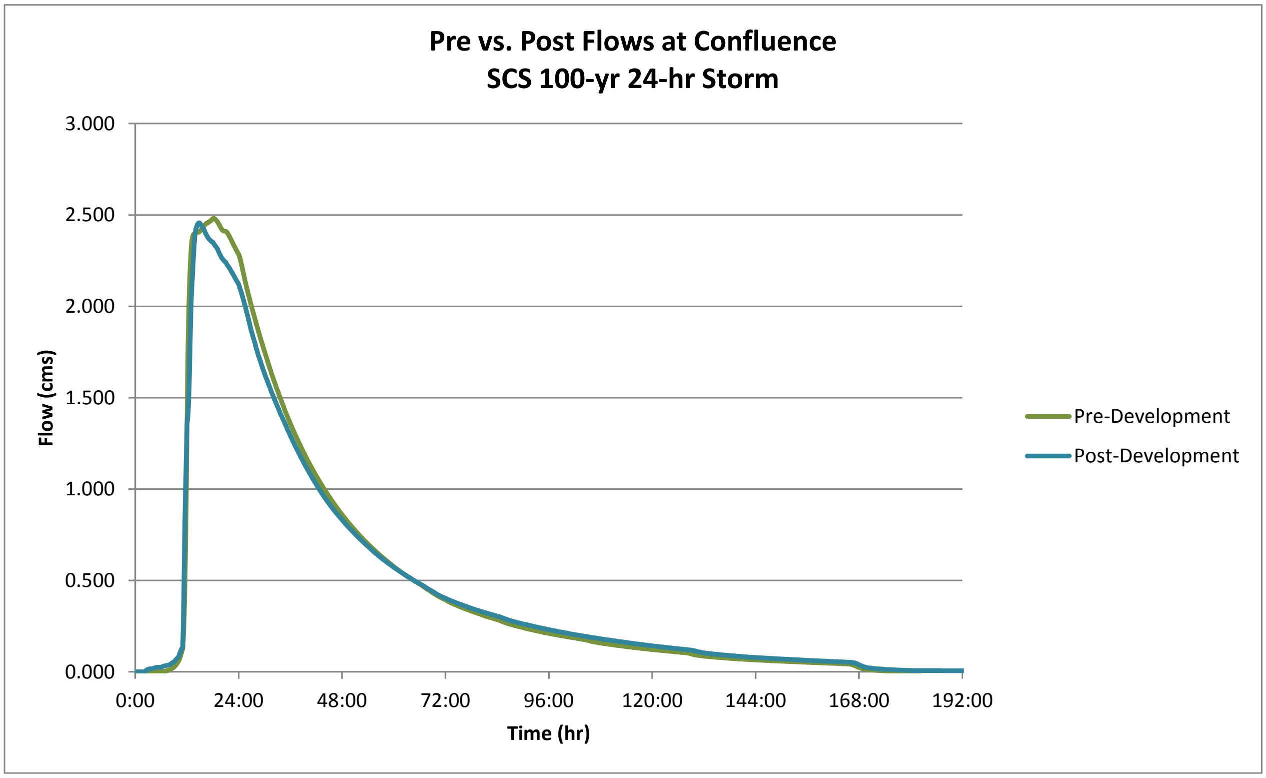


Figure 7.4: Pre vs. Post Development Peak Flows at Confluence of Tributaries 2 & 3

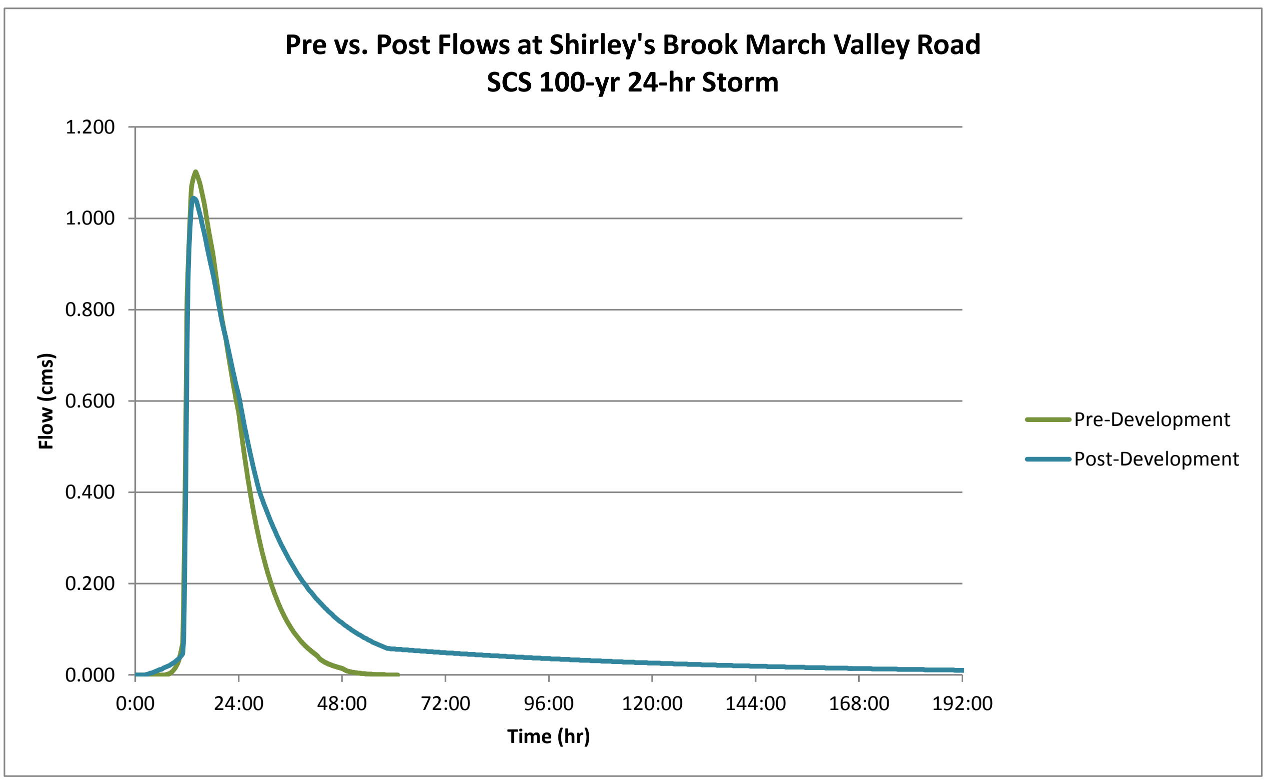


Figure 7.5: Pre vs. Post Development Peak Flows at Outlet to Shirley's Brook Main Branch, D/S of Pond 3 Outlet

7.3 Continuous Modeling

The protection of the fluvial geomorphic characteristics and functions of watercourses is an integral part of the Environmental Management Plan. Long-term hydrologic simulations have been performed using SWMHYMO to demonstrate that development of the KNUEA will not increase erosion in the receiving watercourses.

7.3.1 Rainfall Data

Continuous rainfall data was obtained from Environment Canada Atmospheric and Environmental Services for a period of 213 days, running April 17th through November 16th for the year 2014. The total overall rainfall (snowfall excluded) in Ottawa for 2014 was 800.3 mm, which is above the average (from the last 25 years) of 750 mm.

7.3.2 Model Results

The results of the continuous hydrologic analysis are summarized in **Table 7.3** and in **Figures 7.6 to 7.9**. Model input and output files for the pre- and post-development continuous SWMHYMO models can be found in **Volume 2**, **Appendix E**.

Table 7.3: Continuous Simulation Results (April – November 2014)

Location	Model Run	Peak Flow (m^3/s)	Average Flow (m^3/s)
Shirley's Brook Northwest Branch			
Tributary 2	*Pre*	0.640	0.200
	Post	0.497	0.016
Tributary 3	*Pre*	1.214	0.016
	Post	0.896	0.013
Confluence of Tributaries 2&3	*Pre*	1.802	0.037
	Post	1.368	0.033
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

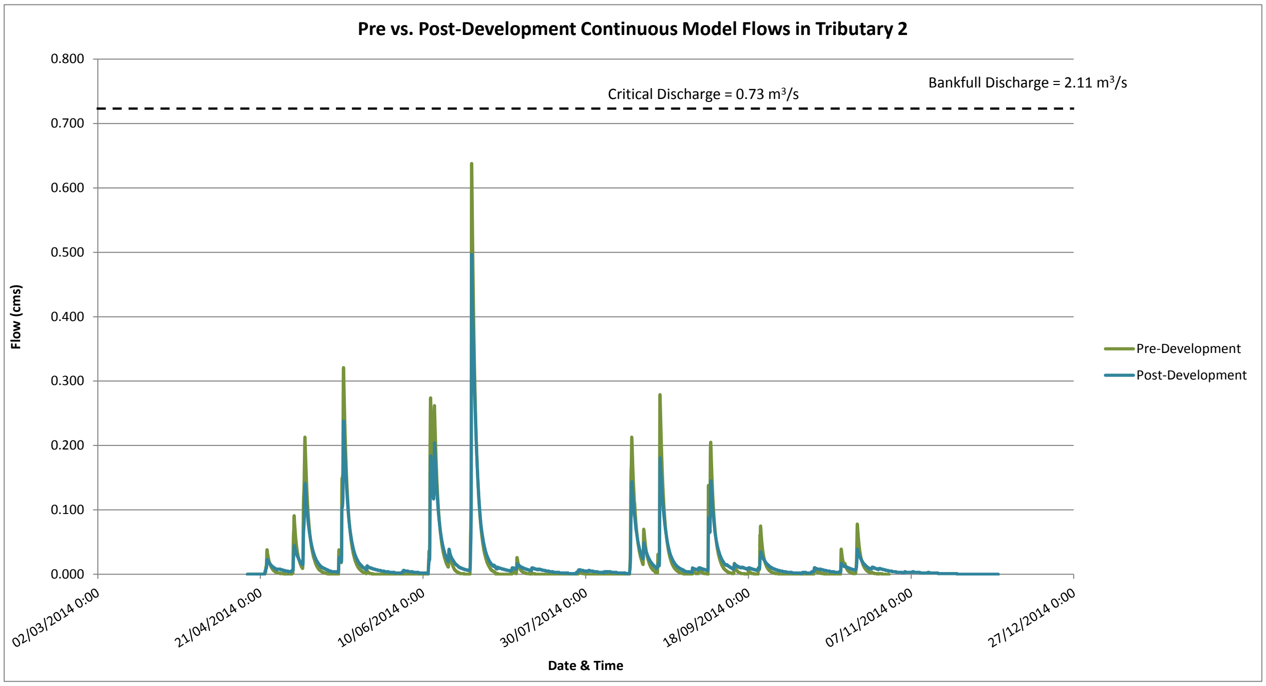


Figure 7.6: Pre vs. Post Development Flow - Tributary 2 D/S of Pond 1 (April – November 2014)

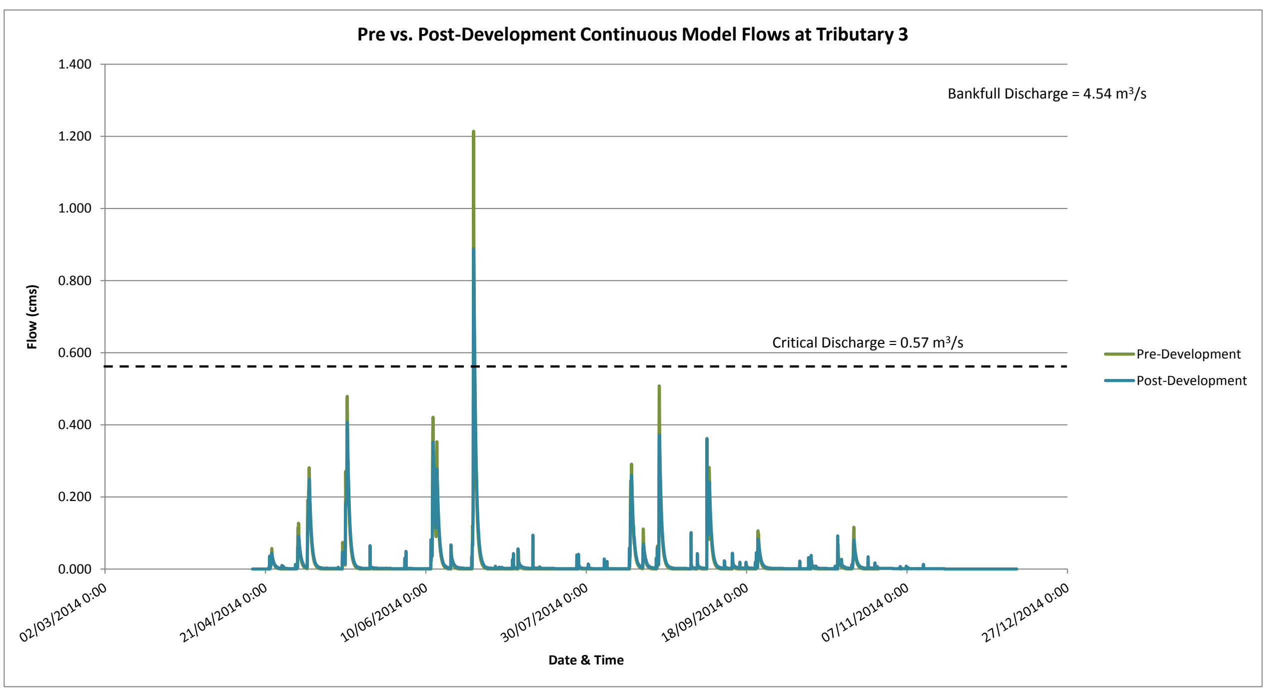


Figure 7.7: Pre vs. Post Development Flow - Tributary 3 D/S of Pond 2 (April – November 2014)

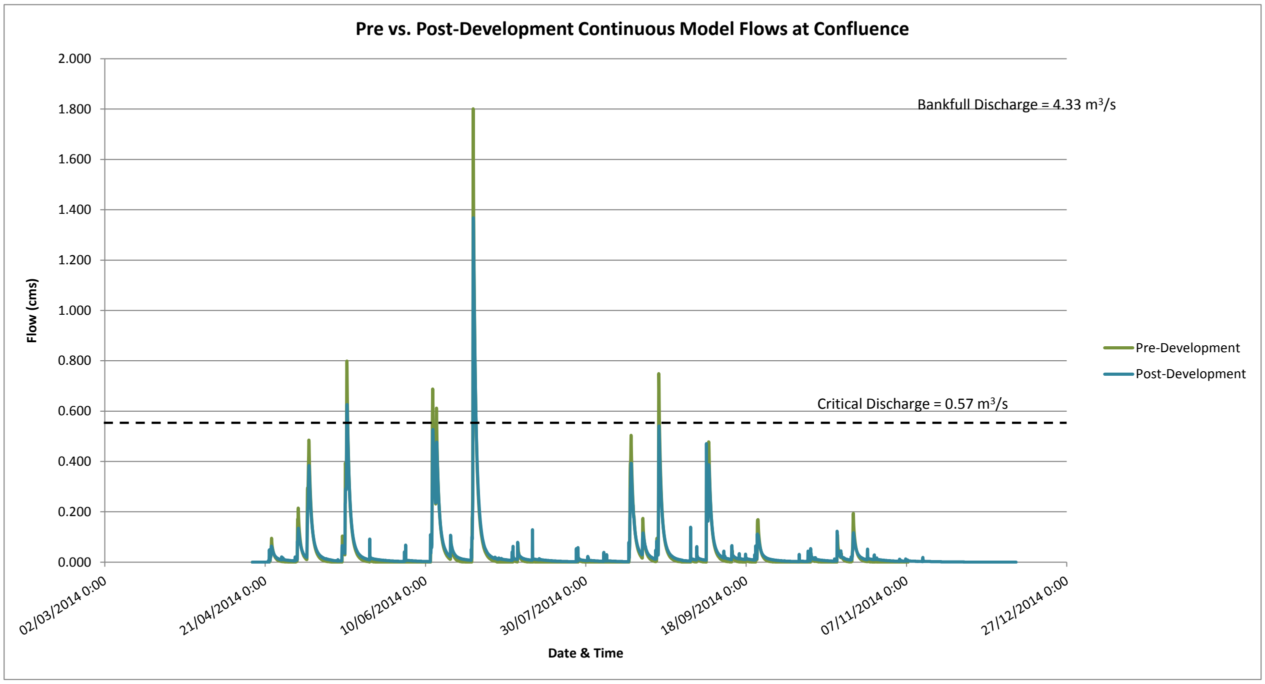


Figure 7.8: Pre vs. Post Development Flow - Confluence of Tributaries 2 & 3 (April – November 2014)

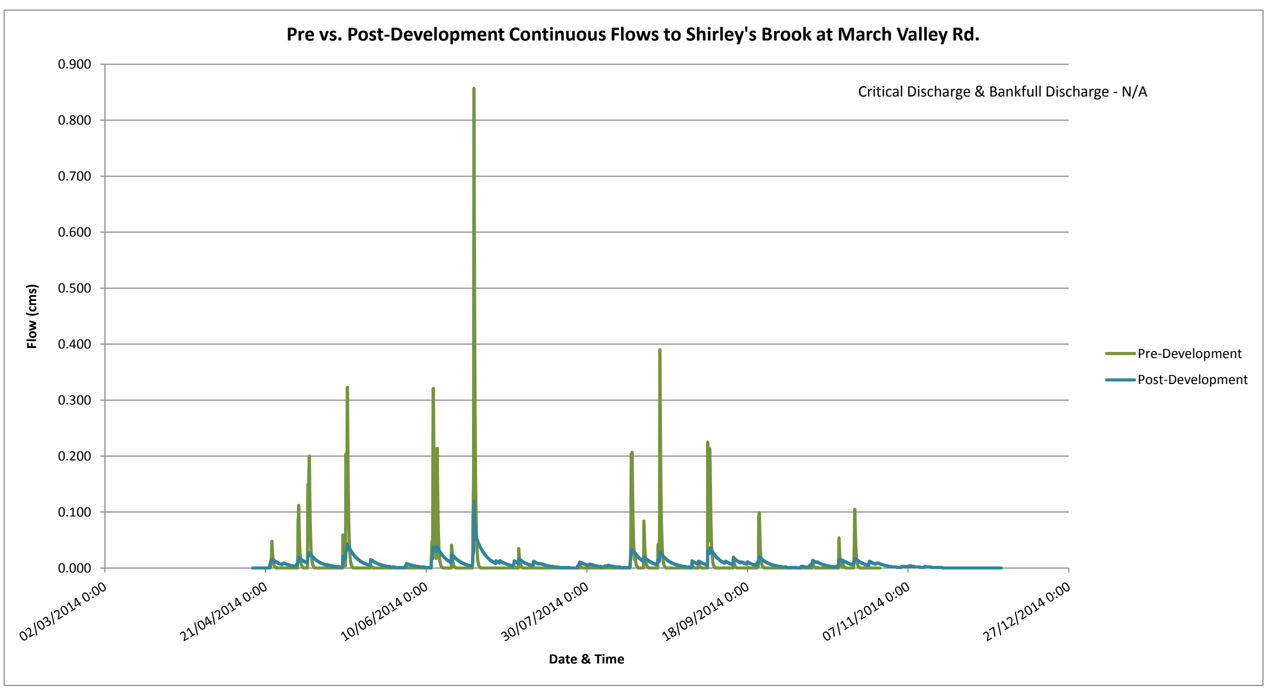


Figure 7.9: Pre vs. Post Development Flow - Pond 3 Outlet to Shirley's Brook Main Branch (April – November 2014)

7.4 Erosion Analysis

To address the increase in erosion potential resulting from higher runoff volumes following development of the KNUEA, erosion threshold targets have been established for reaches of Shirley's Brook in the vicinity of the proposed SWM facility outlets (Parish Aquatic Services, 2016). The critical discharge indicates the minimum flowrate required to initiate sediment movement of the bed material. If flows exceeding this value are sustained for a prolonged period of time, then excessive erosion could occur.

The continuous hydrologic model was used to evaluate the duration of flow above the erosion threshold (critical flow) at three locations:

1. Shirley's Brook Tributary 2 at March Road (SBT-4)
2. Shirley's Brook Tributary 3 at March Road (SBT-5)
3. Confluence of Tributaries 2, 3, and 4 just east of March Road. (SBT-7B)

For Location 3 (SBT-7B), values for critical discharge and bankfull discharge were not provided. As this location is just downstream from SBT-5, the critical discharge and average bankfull discharge from SBT-5 was used for the erosion analysis.

Table 7.4: Pre vs. Post-Development Erosion Analysis (April – November 2014)

Location	Reach ID	Critical Discharge	Bankfull Discharge	Hours of Exceedance (hrs)		Peak Flow (m^3/s)		Average Flow (m^3/s)	
		(m^3/s)	(m^3/s)	Pre	Post	Pre	Post	Pre	Post
1	SBT-4	0.73	2.11	0.0	0.0	0.640	0.497	0.200	0.016
2	SBT-5	0.57	4.54	9.5	11.0	1.214	0.896	0.016	0.013
3	SBT-7B	0.57	4.33	44.5	28.0	1.802	1.368	0.037	0.033

<u>Results</u>

The results of the erosion analysis (**Table 7.4**) indicate that the attenuation and storage provided by the proposed SWM facilities will ensure that there will be no adverse erosion impacts resulting from development of the KNUEA.

At Location 2 (Tributary 3 / SBT-5) the post-development model results indicate a slight increase in the duration of flow above the erosion threshold (1.5 hours over a period of 217 days). While this increase is negligible, the underlying cause has been investigated and can be attributed to the following factors:

- The total increase in post-development flow above the erosion threshold is results from a single large storm (June 24, 2014), which was roughly equivalent to a 50-year return period event.
- The post-development peak flow is approximately 0.30 m^3/s lower than the pre-development peak, but the duration of flow is extended by the attenuation and storage provided by pond 2, as shown in **Figure 7.10**.

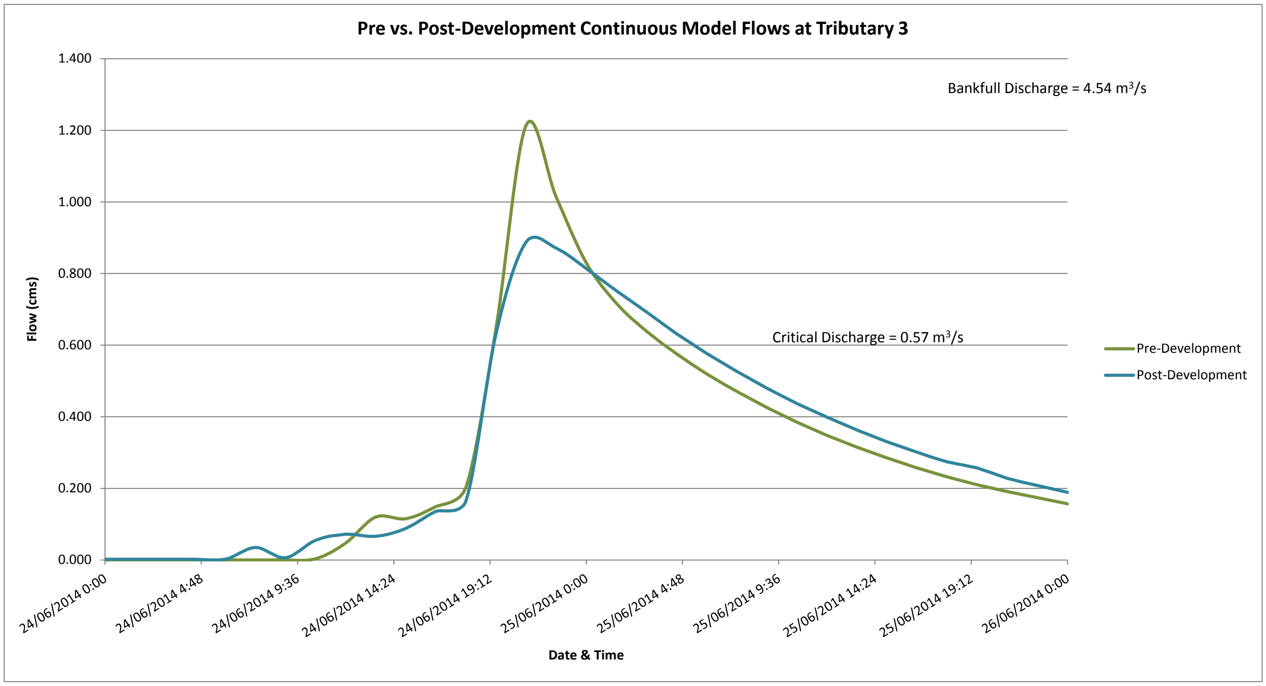


Figure 7.10: Pre vs. Post Development Flow - Tributary 3 D/S of Pond 2 Erosive Event (June 24-26, 2014)

Section 8.0 Water Budget

8.1 Introduction

A site specific water budget analysis was completed for the KNUEA, consisting of a review of the natural environmental systems and the development of a water budget model to evaluate the impacts of development on the hydrologic cycle and provide recommendations for minimizing adverse impacts. Please refer to the following report (located in **Volume 3**, **Appendix O**) for detailed information and supporting calculations:

- *Kanata North Urban Expansion Study Geomorphic Assessment* (Parish Aquatic Services, February 2016)

Supporting calculations for the Water Budget analysis can be found in **Volume 2**, **Appendix G**.

8.2 Purpose

Development is typically associated with an increase in impervious surfaces in a watershed, resulting in changes to the existing hydrologic functions. Natural features and private drinking wells that rely on surface water and groundwater resources can potentially be impacted by development.

The water budget approach aims to identify the connection between surface water and groundwater resources. As specified in the Ontario Clean Water Act (2006), a water budget measures the components of the hydrologic cycle (water balance) and characterizes water flow pathways within the watershed.

8.3 KNUEA Water Budget Model

8.3.1 Land use

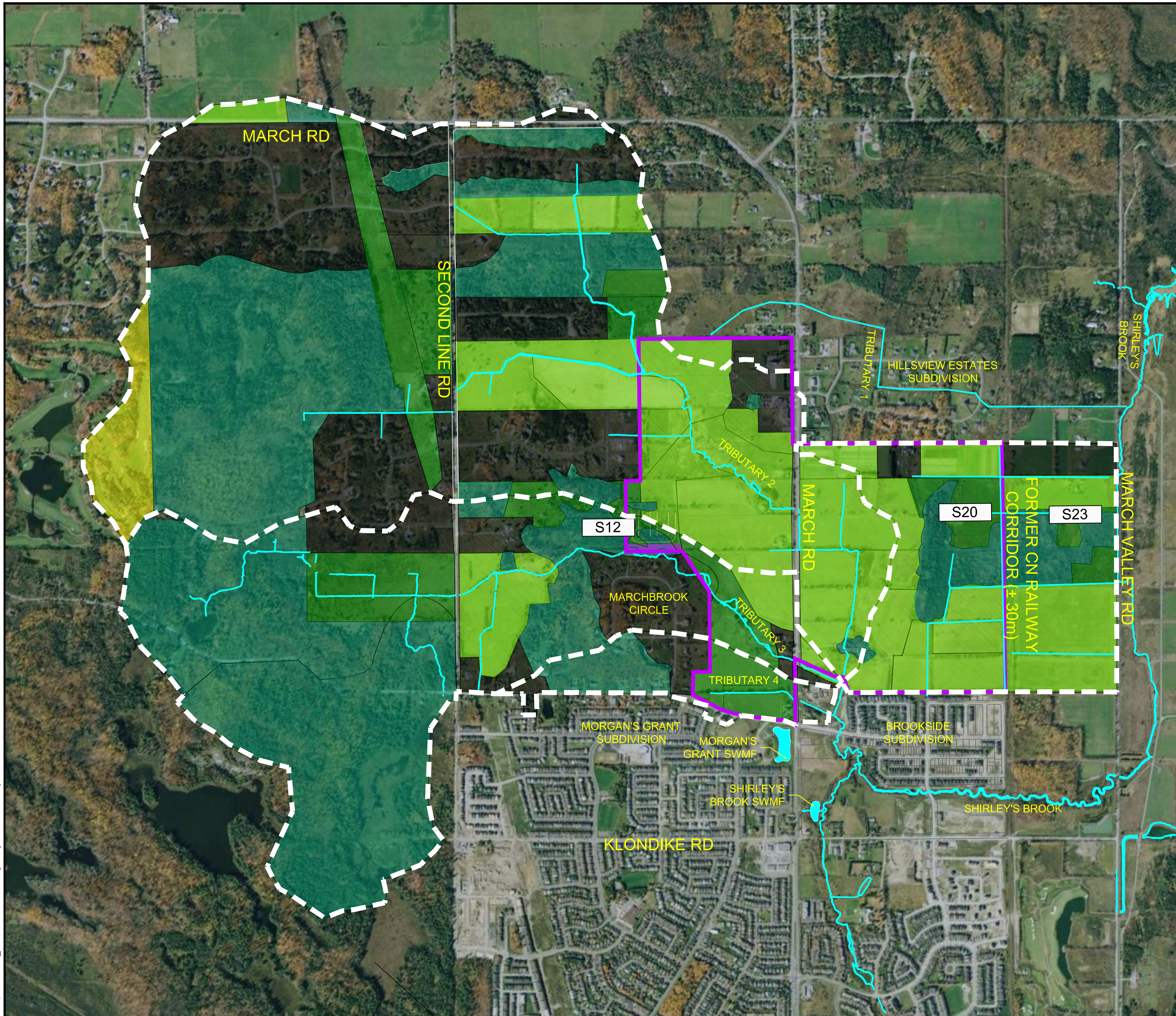
The proposed Kanata North Urban Expansion Area (KNUEA) currently consists of a rural landscape, which includes an existing school, church, cemetery and sparse residential homes within agricultural lands and pockets of forested areas. The KNUEA is bounded by existing residential housing to the southwest and southeast. The western and eastern portions of the site are primarily open fields with some forested areas. The proposed development will consist of street-oriented and multi-unit residential areas with schools, parks and commercial areas. Existing and proposed land uses are shown on the following figures:

- **Figure 8.1** Existing Land Cover
- **Figure 8.2** Proposed Conditions Land Cover
  Based on Preferred Demonstration Plan (Figure 11.1)

8.3.2 Methodology

The water budget analysis for the KNUEA characterizes the various components of the hydrologic cycle: precipitation, evapotranspiration, runoff and infiltration. A combination of the Thornthwaite and Mather (1957) and MOECC (2003) approaches are used in the calculations. The site specific water budget does incorporate changes in storage, but other components such as groundwater and surface water inflow and outflow, and water takings and returns are not taken into account due to the lack of available data.

Water budget calculations have been prepared using 30-years (1971-2000) of monthly precipitation and evaporation data recorded at the Environment Canada meteorological station at



LEGEND

- KNUEA
- WATER COURSE
- SUBCATCHMENT DRAINAGE BOUNDARIES
- EXISTING RESIDENTIAL
- PASTURE/MEADOW
- ROW CROPS
- FOREST/WETLAND
- GOLF COURSE
- S12 WOOD LOT

KANATA NORTH

COMMUNITY DESIGN PLAN

FIGURE NO. 8.1

EXISTING CONDITIONS
LAND COVER

DATE
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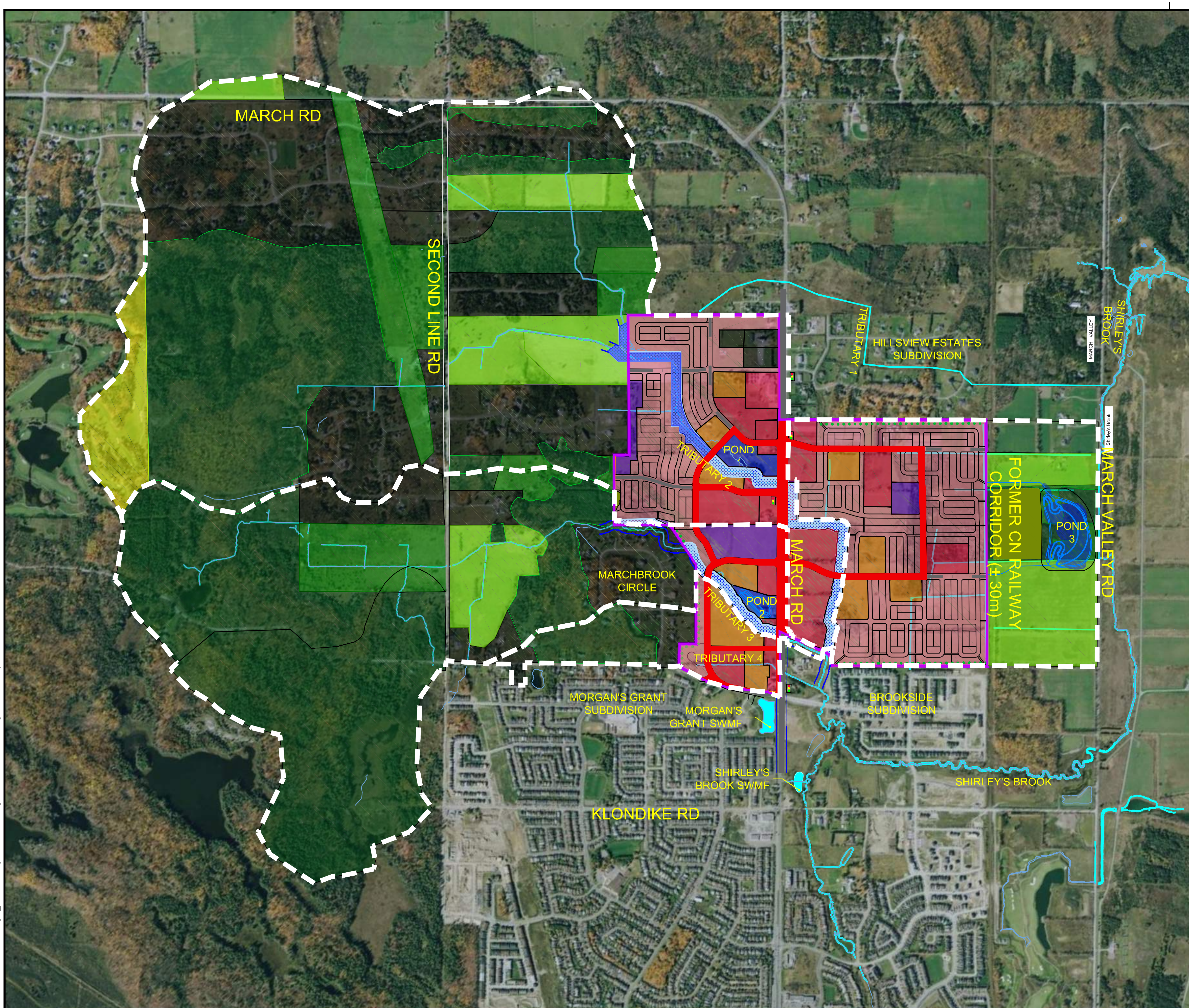

LEGEND

- KNUEA
- DRAINAGE CHANNEL
- ARTERIAL & COLLECTOR ROADS
- SUBCATCHMENT DRAINAGE BOUNDARIES
- EXISTING RESIDENTIAL / INSTITUTIONAL
- PASTURE/MEADOW
- ROW CROPS
- FOREST/WETLAND
- GOLF COURSE
- 50% - 65% IMPERVIOUS DEVELOPMENT
  - RESIDENTIAL STREET ORIENTED
- 65% - 85% IMPERVIOUS DEVELOPMENT
  - RESIDENTIAL MULTI-UNIT
- 85% - 100% IMPERVIOUS DEVELOPMENT
  - COMMUNITY MIXED USE
  - NEIGHBOURHOOD MIXED USE
  - SERVICE MIXED USE
  - SCHOOL
  - FIRE HALL
  - PARK & RIDE
- PARKS & NATURAL HERITAGE FEATURES
- SWMF/SHIRLEY'S BROOK WATERCOURSE

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KANATA NORTH
COMMUNITY DESIGN PLAN

FIGURE NO. 8.2
PROPOSED CONDITIONS
LAND COVER

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the Ottawa Macdonald Cartier International Airport (Environment Canada Station ID: 6106001). This period of data was chosen as there is corresponding mean daily lake evaporation data provided with this time period.

The water budget model integrates a GIS approach by combining land use, surficial soils, and topography information into homogeneous hydrologic units. Calculations are performed on each hydrologic unit and area weighted to provide a summary for the catchment or area being modeled.

8.4 Monthly Changes to Hydrologic Cycle

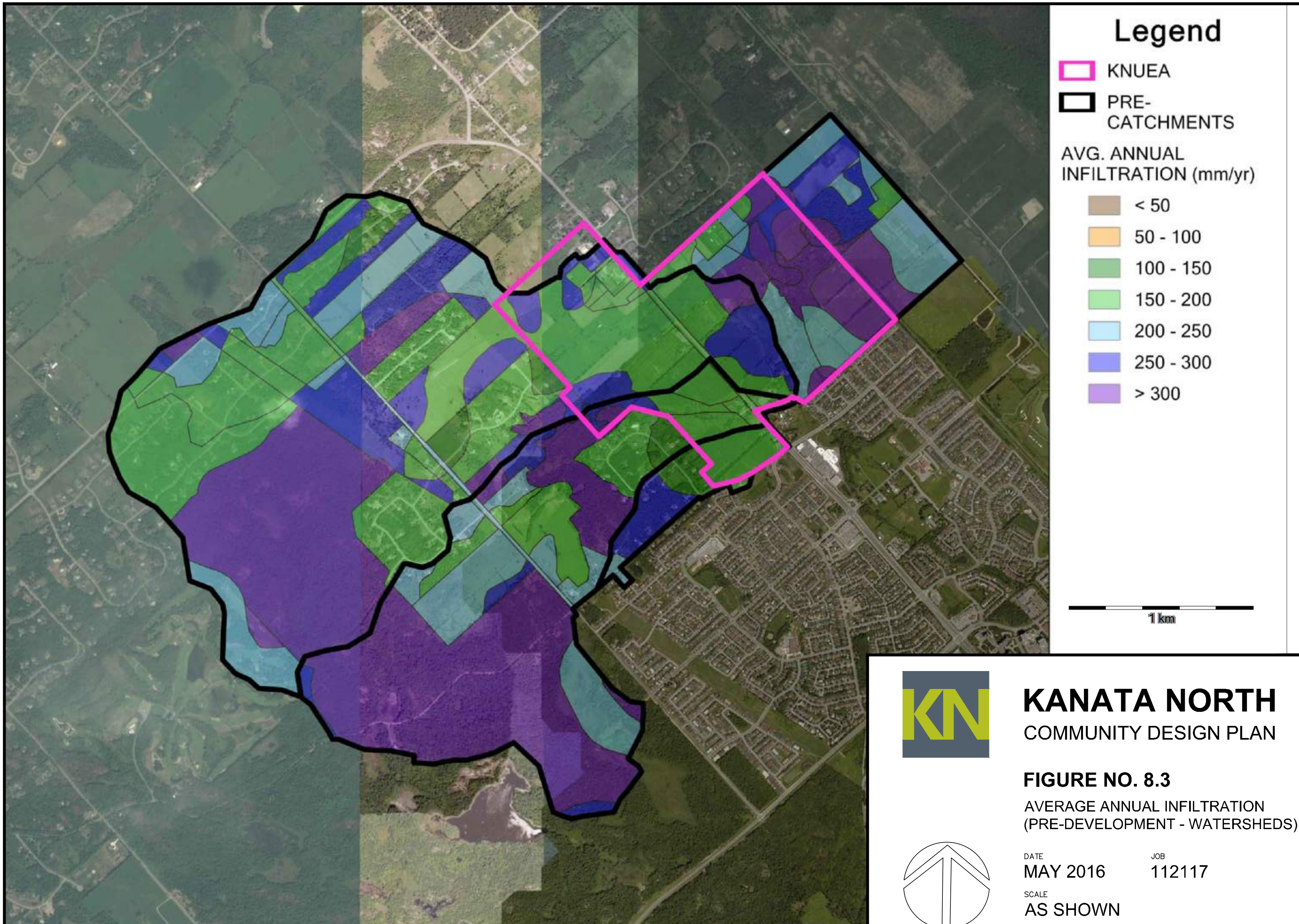
The water budget analysis was completed to characterize the anticipated monthly changes to the hydrologic cycle for the following areas:

- KNUEA overall (no external areas)
- Tributary 2 west of March Road (including area upstream of KNUEA)
- Tributary 3 west of March Road (including area upstream of KNUEA)
- Tributary 2 / 3 Confluence (including area upstream of KNUEA)
- Tributary 4 west of March Road (including area upstream of KNUEA)
- KNUEA Headwater Channels East of March Road (no external areas)

The monthly results are summarized in **Tables 8.1 – 8.6** and **Figures 8.3 – 8.8.**

Table 8.1: Monthly Water Balance summary - KNUEA

Month	Total Precipitation (mm/month)	KNUEA (187 ha)					
		Infiltration (mm/month)		Runoff (mm/month)		Evapotranspiration (mm/month)	
		PRE	POST	PRE	POST	PRE	POST
January	64.2	24.5	14.3	24.7	34.8	0.0	0.0
February	51.6	26.2	15.3	26.4	37.2	0.0	0.0
March	64.9	48.3	28.3	48.7	68.7	0.0	0.0
April	67.7	36.5	21.1	36.8	51.2	10.4	11.8
May	81.0	11.7	6.5	11.8	16.5	75.7	66.1
June	91.2	3.5	4.8	3.7	13.7	109.8	77.2
July	88.9	0.7	3.3	0.9	10.2	103.0	74.6
August	87.6	2.5	6.1	2.8	17.0	80.2	63.6
September	86.8	5.5	9.0	6.0	23.4	34.5	44.0
October	79.1	23.3	14.5	24.1	34.5	14.7	26.9
November	77.0	32.8	19.4	33.3	46.9	1.6	3.3
December	74.1	24.7	14.5	25.0	35.3	0.0	0.0
Annual Total	***914.2 mm***	***240.2 mm***	***157.2 mm***	***244.2 mm***	***389.5 mm***	***429.9 mm***	***367.4 mm***



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KANATA NORTH

COMMUNITY DESIGN PLAN

FIGURE NO. 8.3

AVERAGE ANNUAL INFILTRATION
(PRE-DEVELOPMENT - WATERSHEDS)

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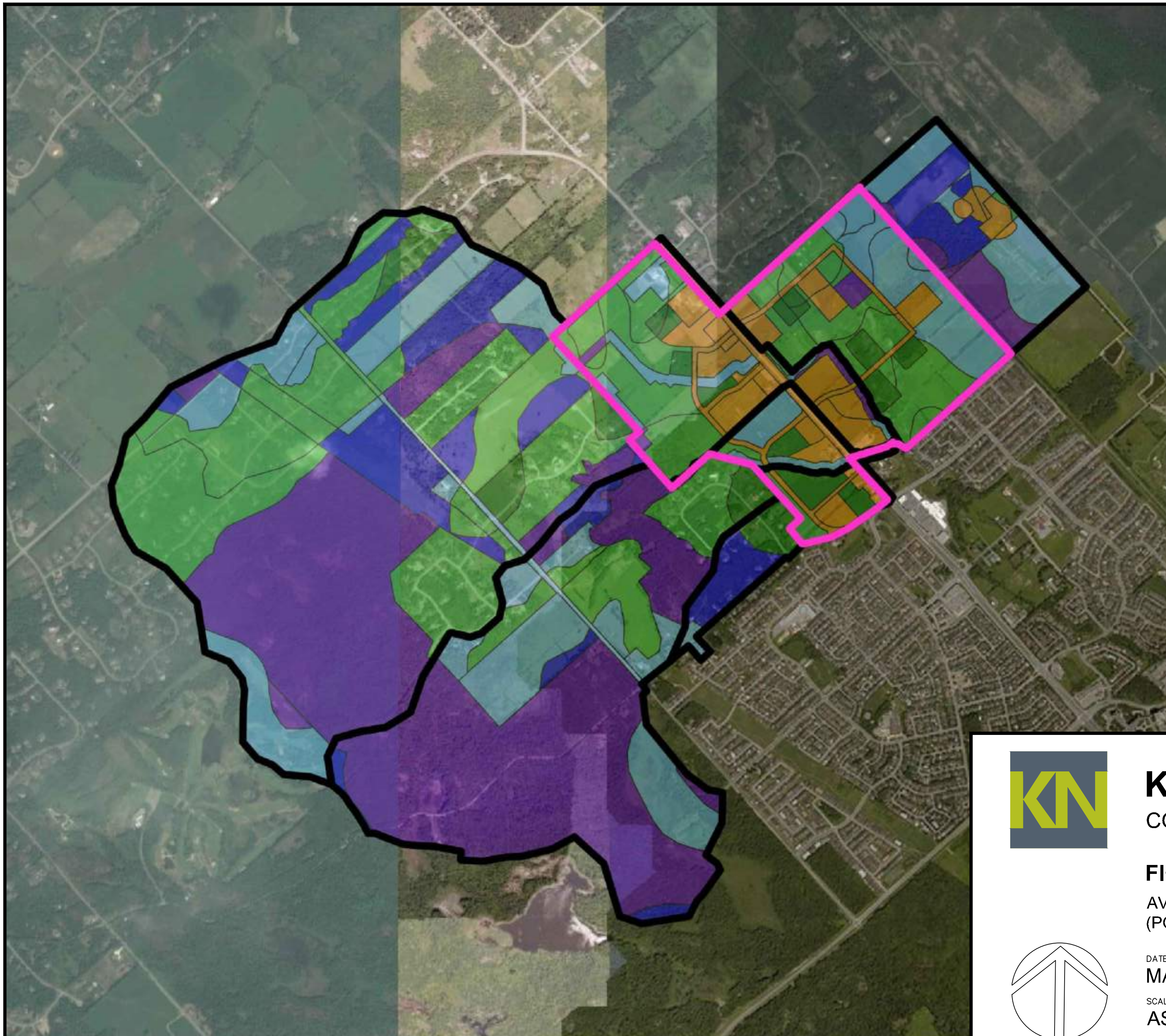

Legend

- KNUEA
- POST-CATCHMENTS

AVG. ANNUAL INFILTRATION (mm/yr)

- < 50
- 50 - 100
- 100 - 150
- 150 - 200
- 200 - 250
- 250 - 300
- > 300

KANATA NORTH
COMMUNITY DESIGN PLAN

FIGURE NO. 8.4

AVERAGE ANNUAL INFILTRATION
(POST-DEVELOPMENT - WATERSHEDS)

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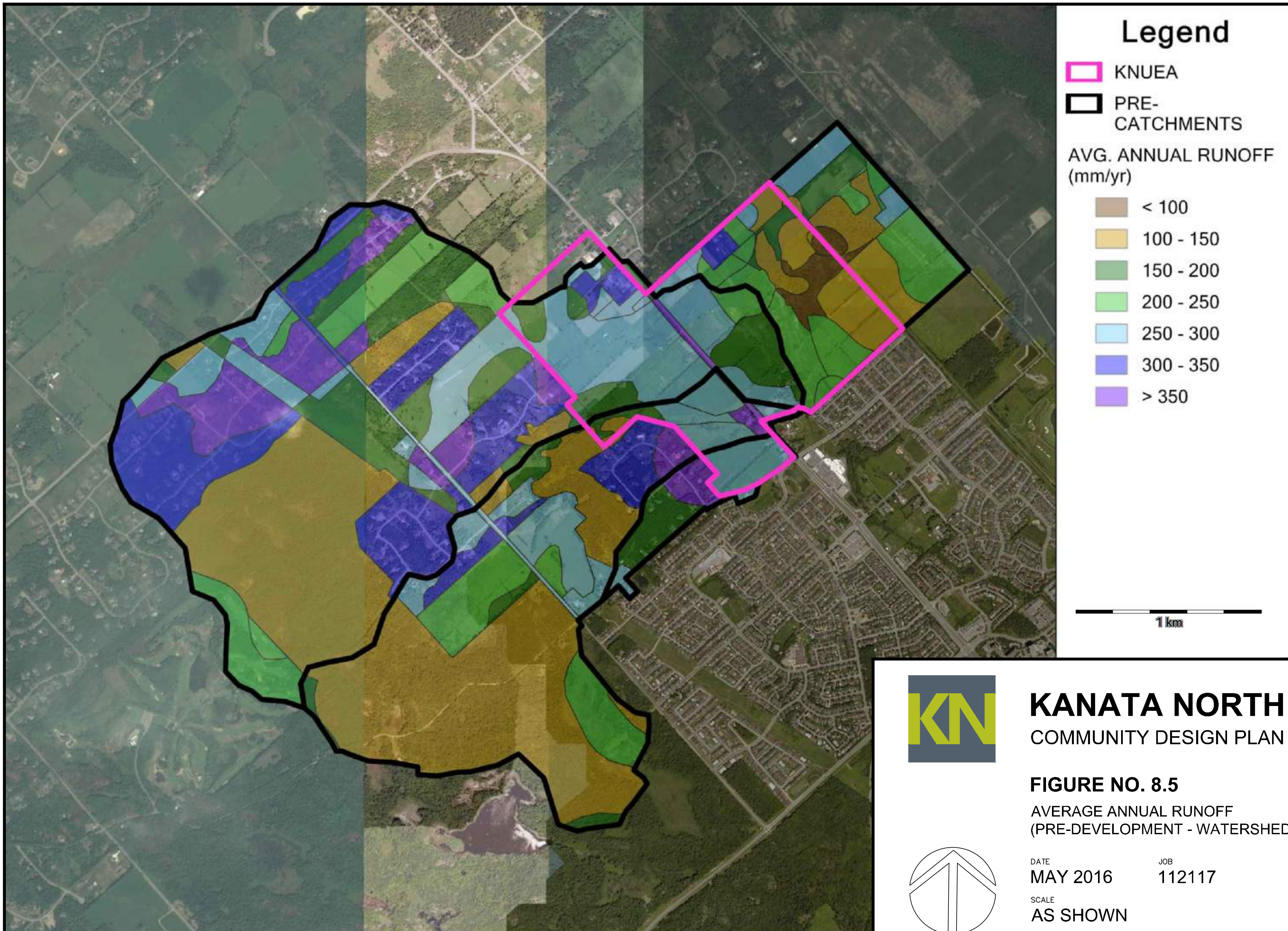

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COMMUNITY DESIGN PLAN

FIGURE NO. 8.5

AVERAGE ANNUAL RUNOFF
(PRE-DEVELOPMENT - WATERSHEDS)

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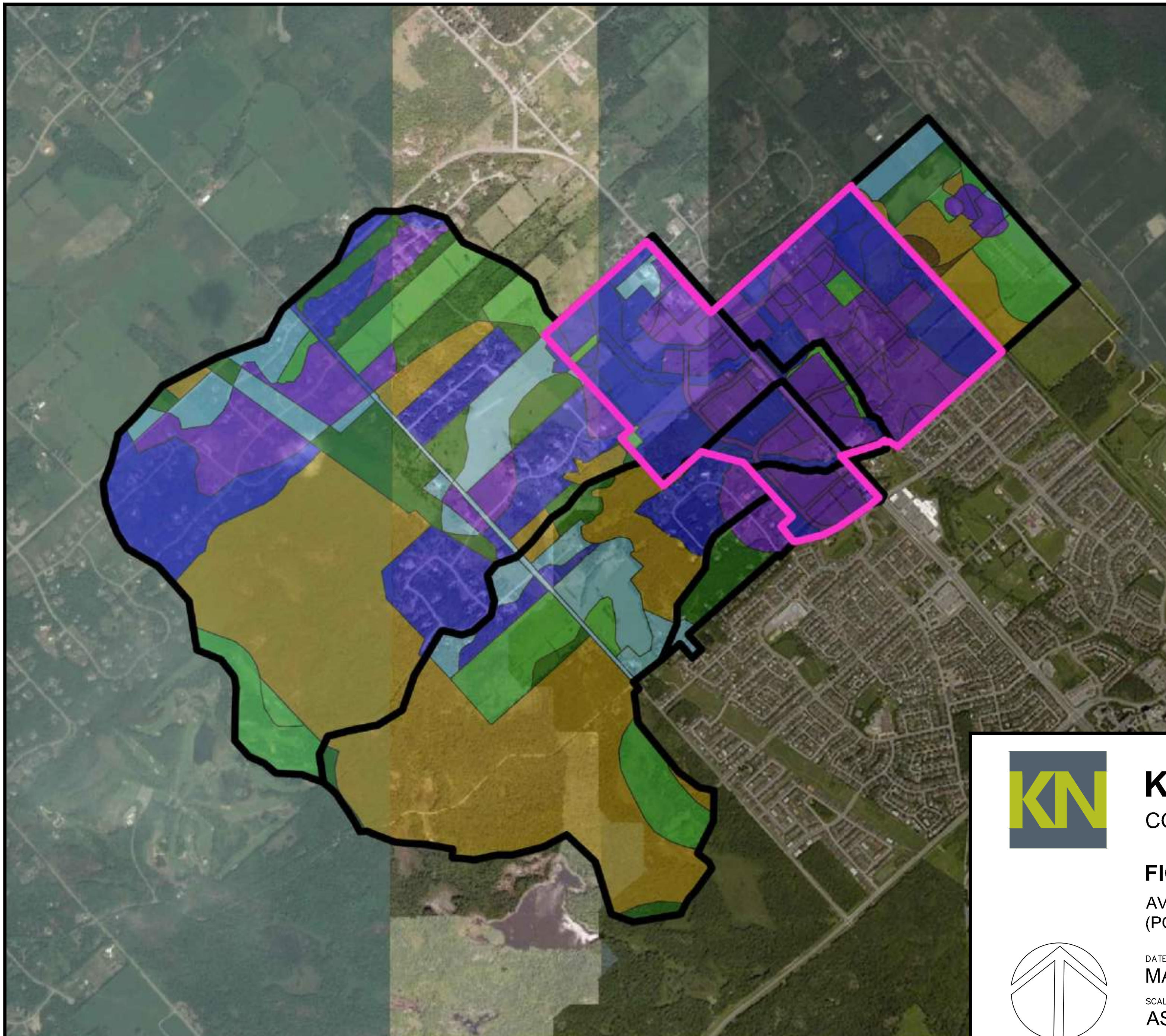

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KANATA NORTH
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FIGURE NO. 8.6

AVERAGE ANNUAL RUNOFF (POST-DEVELOPMENT - WATERSHEDS)

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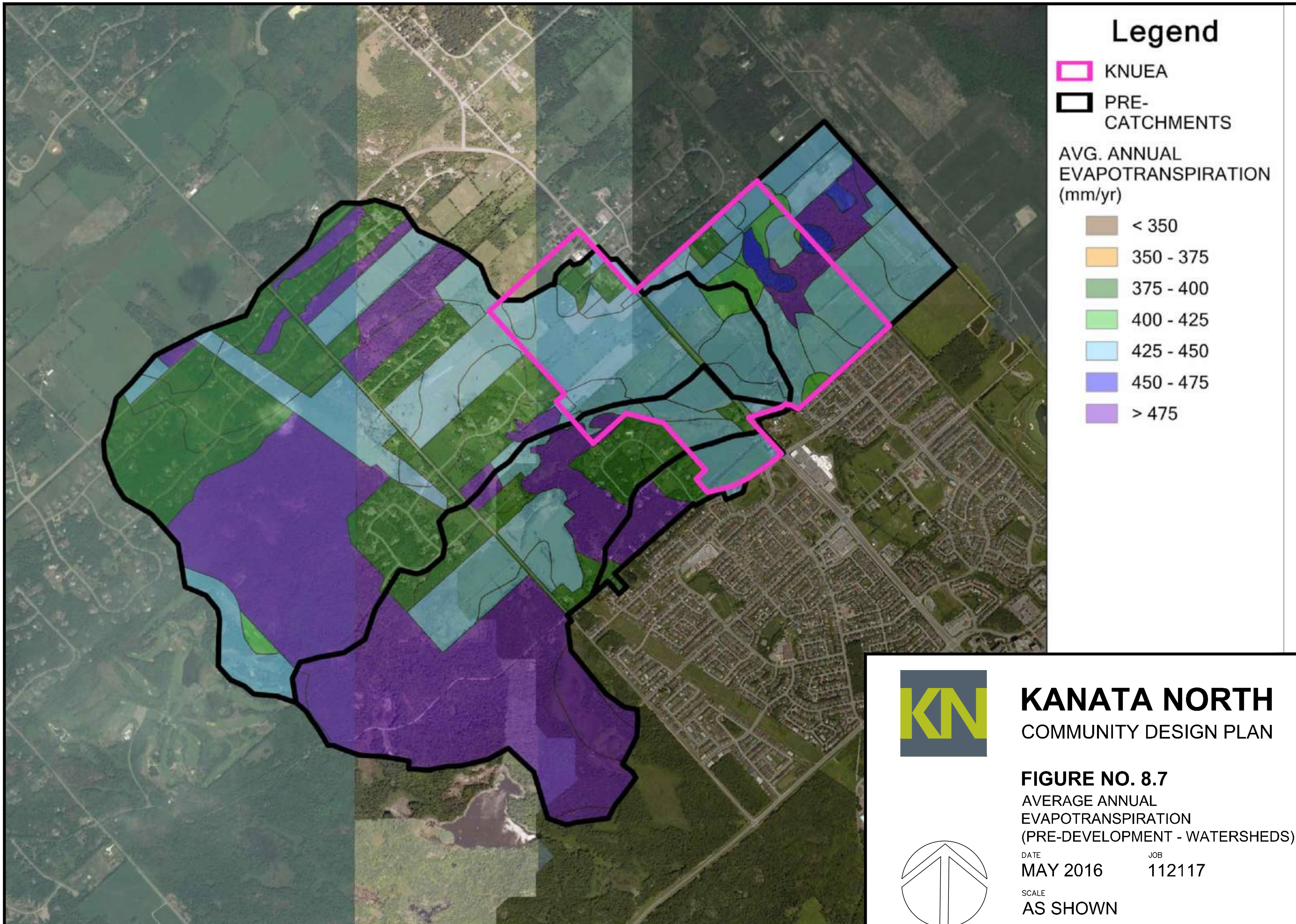

KANATA NORTH

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FIGURE NO. 8.7

AVERAGE ANNUAL EVAPOTRANSPIRATION (PRE-DEVELOPMENT - WATERSHEDS)

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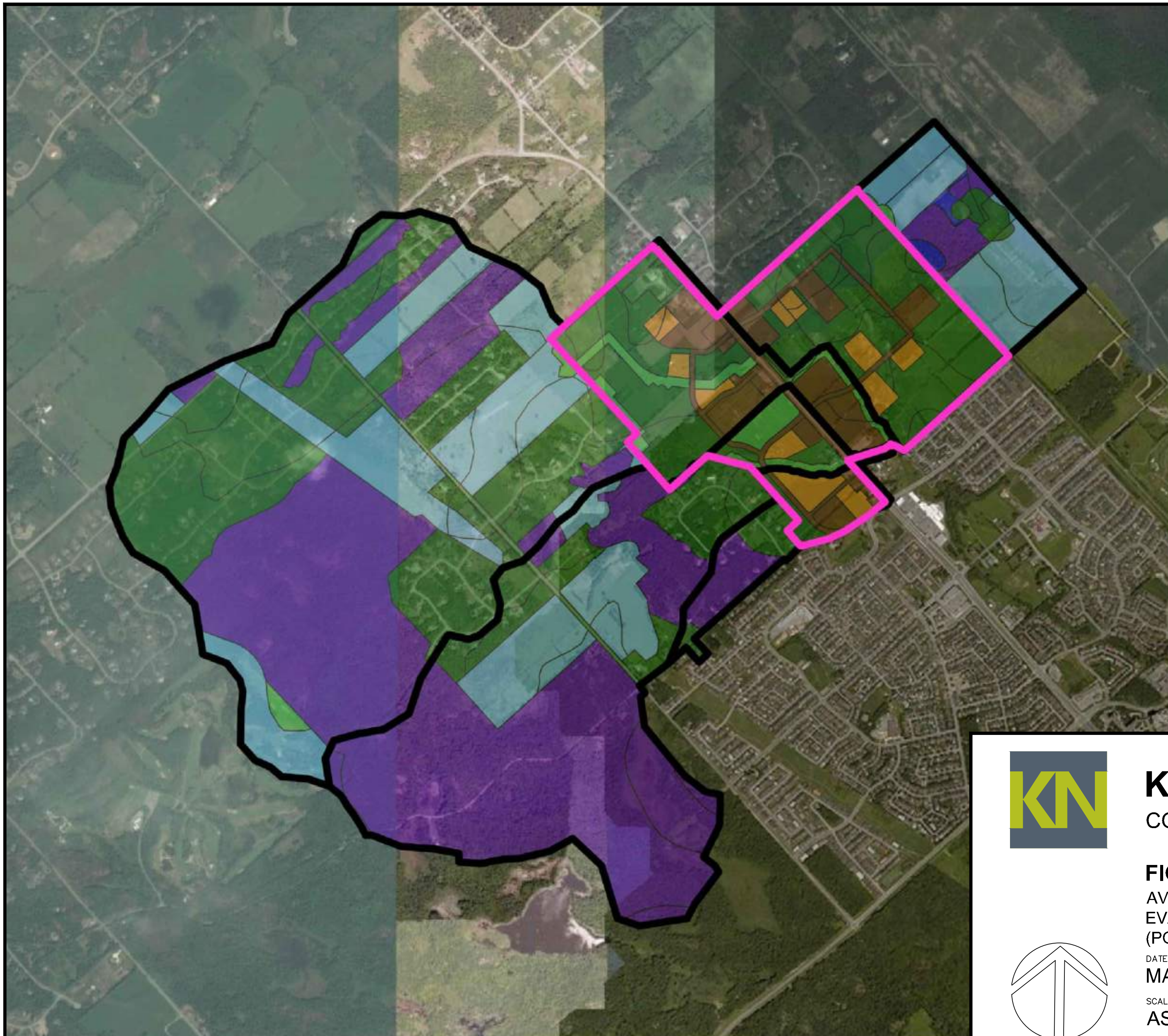

KANATA NORTH
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FIGURE NO. 8.8
AVERAGE ANNUAL EVAPOTRANSPIRATION (POST-DEVELOPMENT - WATERSHEDS)

DATE: MAY 2016
JOB: 112117
SCALE: AS SHOWN

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Table 8.2: Monthly Water Balance Summary – Tributary 2

Month	Total Precipitation (mm/month)	Shirley's Brook Northwest Branch: Tributary 2 – West of March Road (466 ha)					
		Infiltration (mm/month)		Runoff (mm/month)		Evapotranspiration (mm/month)	
		PRE	POST	PRE	POST	PRE	POST
January	64.2	24.6	23.2	24.6	26.0	0.0	0.0
February	51.6	26.3	24.8	26.3	27.8	0.0	0.0
March	64.9	48.5	45.7	48.4	51.3	0.0	0.0
April	67.7	36.6	34.4	36.5	38.5	10.9	11.1
May	81.0	11.2	10.5	11.1	11.8	77.0	75.2
June	91.2	3.4	3.7	4.0	5.8	108.8	103.1
July	88.9	0.9	1.3	1.3	3.0	103.0	98.2
August	87.6	2.9	3.5	4.1	6.7	80.5	77.8
September	86.8	5.9	6.4	7.9	10.9	34.7	36.9
October	79.1	20.1	18.4	22.8	24.0	16.4	18.7
November	77.0	31.8	29.7	32.6	34.5	1.9	2.2
December	74.1	24.7	23.2	24.7	26.2	0.0	0.0
Annual Total	***914.2 mm***	***236.8 mm***	***224.8 mm***	***244.3 mm***	***266.4 mm***	***433.2 mm***	***423.0 mm***

Table 8.3: Monthly Water Balance Summary – Tributary 3

Month	Total Precipitation (mm/month)	Shirley's Brook Northwest Branch: Tributary 3 – West of March Road (253 ha)					
		Infiltration (mm/month)		Runoff (mm/month)		Evapotranspiration (mm/month)	
		PRE	POST	PRE	POST	PRE	POST
January	64.2	28.9	28.6	20.3	20.6	0.0	0.0
February	51.6	30.9	30.5	21.7	22.0	0.0	0.0
March	64.9	57.0	56.3	40.0	40.7	0.0	0.0
April	67.7	43.0	42.5	30.2	30.7	10.7	10.8
May	81.0	13.1	12.9	9.3	9.4	78.8	78.5
June	91.2	3.4	3.4	2.8	3.3	118.4	117.1
July	88.9	0.6	0.6	0.7	1.2	113.9	112.6
August	87.6	2.0	2.1	2.3	3.0	86.0	85.2
September	86.8	4.3	4.6	4.3	5.3	32.4	32.1
October	79.1	18.3	18.1	15.0	15.6	14.4	14.7
November	77.0	35.5	35.0	25.6	26.1	1.6	1.7
December	74.1	28.7	28.4	20.3	20.6	0.0	0.0
Annual Total	***914.2 mm***	***265.7 mm***	***262.9 mm***	***192.4 mm***	***198.5 mm***	***456.2 mm***	***452.8 mm***

Table 8.4: Monthly Water Balance Summary – Shirley's Brook Northwest Branch

Month	Total Precipitation (mm/month)	Shirley's Brook Northwest Branch: Confluence of Tributaries 2 & 3 (719 ha)					
		Infiltration (mm/month)		Runoff (mm/month)		Evapotranspiration (mm/month)	
		PRE	POST	PRE	POST	PRE	POST
January	64.2	26.1	25.1	23.1	24.1	0.0	0.0
February	51.6	27.9	26.8	24.6	25.8	0.0	0.0
March	64.9	51.5	49.4	45.5	47.5	0.0	0.0
April	67.7	38.9	37.3	34.3	35.7	10.8	11.0
May	81.0	11.8	11.3	10.4	11.0	77.6	76.3
June	91.2	3.4	3.6	3.6	4.9	112.2	108.0
July	88.9	0.8	1.1	1.1	2.4	106.9	103.3
August	87.6	2.6	3.0	3.4	5.4	82.5	80.4
September	86.8	5.3	5.8	6.7	8.9	33.9	35.2
October	79.1	19.4	18.3	20.0	21.0	15.7	17.3
November	77.0	33.1	31.6	30.2	31.5	1.8	2.0
December	74.1	26.1	25.0	23.2	24.2	0.0	0.0
Annual Total	***914.2 mm***	***247.0 mm***	***238.2 mm***	***226.0 mm***	***242.5 mm***	***441.3 mm***	***433.5 mm***

Table 8.5: Monthly Water Balance Summary – Tributary 4

Month	Total Precipitation (mm/month)	Shirley's Brook Northwest Branch: Tributary 4 – West of March Road (27.5 ha)					
		Infiltration (mm/month)		Runoff (mm/month)		Evapotranspiration (mm/month)	
		PRE	POST	PRE	POST	PRE	POST
January	64.2	21.5	16.9	27.7	32.2	0.0	0.0
February	51.6	23.0	18.1	29.6	34.4	0.0	0.0
March	64.9	42.4	33.4	54.6	63.5	0.0	0.0
April	67.7	32.0	25.1	41.2	47.5	10.6	11.5
May	81.0	10.1	7.6	13.1	15.1	75.7	70.6
June	91.2	3.2	3.7	4.8	10.9	109.0	92.4
July	88.9	0.7	2.1	1.4	7.8	105.6	89.1
August	87.6	2.4	3.9	4.4	12.9	82.7	71.5
September	86.8	3.8	6.1	6.9	18.1	40.4	38.8
October	79.1	14.6	12.8	21.6	29.3	17.5	22.5
November	77.0	26.9	21.5	35.6	42.5	1.9	2.7
December	74.1	21.5	17.0	27.9	32.5	0.0	0.0
Annual Total	***914.2 mm***	***202.1 mm***	***168.3 mm***	***268.8 mm***	***346.8 mm***	***443.2 mm***	***399.2 mm***

Table 8.6: Monthly Water Balance Summary – KNUEA East Headwater Channels

Month	Total Precipitation (mm/month)	KNUEA East: Headwater Channels Tributary to Main Branch (114 ha)					
		Infiltration (mm/month)		Runoff (mm/month)		Evapotranspiration (mm/month)	
		PRE	POST	PRE	POST	PRE	POST
January	64.2	29.2	20.0	20.0	29.2	0.0	0.0
February	51.6	31.2	21.4	21.4	31.2	0.0	0.0
March	64.9	57.6	39.4	39.4	57.6	0.0	0.0
April	67.7	43.5	29.6	29.8	43.0	10.5	11.5
May	81.0	13.6	9.1	9.3	13.4	77.2	71.0
June	91.2	3.7	4.5	2.7	9.1	114.0	91.1
July	88.9	0.6	2.4	0.5	6.1	107.3	87.3
August	87.6	2.4	4.9	1.9	11.0	82.3	71.1
September	86.8	5.7	8.0	4.3	16.0	32.3	39.9
October	79.1	25.6	18.3	18.5	28.0	13.9	22.5
November	77.0	38.1	26.3	26.5	39.0	1.5	2.7
December	74.1	29.3	20.1	20.1	29.5	0.0	0.0
Annual Total	***914.2 mm***	***280.7 mm***	***203.9 mm***	***194.4 mm***	***313.2 mm***	***439.1 mm***	***397.2 mm***

The water budget model correlates well with the data obtained from the streamflow monitoring program (**Section 3.9**). The seasonal fluctuations characterized by the monthly water budget are consistent with the hydrologic response of a typical clay-dominated watershed in Eastern Ontario. Due to the low evapotranspiration rates in the winter, spring and fall the soil moisture storage is full, which increases the water surplus. During the summer months, evapotranspiration rates are higher, while runoff and infiltration rates decrease as rainfall is used to replenish the storage available in the surficial soils.

8.4.1 Winter and early spring

Soils are fully saturated, the upstream wetlands are full and evapotranspiration / sublimation rates are low; therefore, precipitation and snowmelt during the spring freshet result in water surplus that contributes directly to storm runoff. Streamflows in the Northwest Branch Tributaries are sustained by the storage provided by the wetlands in the upper portions of the watershed.

8.4.2 Summer

Soil moisture storage becomes depleted as evapotranspiration exceeds precipitation. The water holding capacity of the predominantly clay soil is relatively high, and little to no runoff is generated from small storm events (< 5mm). Streamflow in the tributaries becomes intermittent without the sustained flow contribution from groundwater or the upstream wetland areas. Stream response to large storm events (>25mm) is relatively quick. Summer streamflow is primarily derived from rainfall, and there is no significant contribution to/from groundwater, apart from interflow in the surficial soil layers.

8.4.3 Autumn

Evapotranspiration rates decrease, allowing precipitation to gradually replenish the water within the soil moisture storage zone. This increases the hydrologic response of the watershed, resulting in more frequent and sustainted streamflow following precipitation events.

8.5 Annual Changes to Hydrologic Cycle

Table 8.7 provides a summary of the annual changes to the hydrologic cycle following development of the KNUEA.

Table 8.7: Annual Changes to Hydrologic Cycle

Land Use	Infiltration (mm/yr)	Runoff (mm/yr)	Evapotranspiration (mm/yr)
KNUEA (187 ha)			
Pre	240.2 mm	244.2 mm	429.9 mm
Post	157.2 mm	389.5 mm	367.4 mm
Difference	-83.0	145.3	-62.5
% Change	-35%	60%	-15%
Tributary 2 – West of March Road (466 ha)			
Pre	236.8 mm	244.3 mm	433.2 mm
Post	224.8 mm	266.4 mm	423.0 mm
Difference	-12.0	22.1	-10.2
% Change	-5%	9%	-2%
Tributary 3 – West of March Road (253 ha)			
Pre	265.7 mm	192.4 mm	456.2 mm
Post	262.9 mm	198.5 mm	452.8 mm
Difference	-2.8	6.1	-3.4
% Change	-1%	3%	-1%
Shirley's Brook Northwest Branch - Confluence of Tributary 2/3 (719 ha)			
Pre	247.0 mm	226.0 mm	441.3 mm
Post	238.2 mm	242.5 mm	433.5 mm
Difference	-8.8	16.5	7.8
% Change	-4%	7%	-2%
Tributary 4 - West of March Road (27.5 ha)			
Pre	202.1 mm	268.8 mm	443.2 mm
Post	168.3 mm	346.8 mm	399.2 mm
Difference	-33.8	78	-44
% Change	-20%	22%	-11%
Headwater Drainage Channels – East of March Road (114 ha)			
Pre	280.7 mm	194.4 mm	439.1 mm
Post	203.9 mm	313.2 mm	397.2 mm
Difference	-76.8	118.8	-41.9
% Change	-27%	61%	-10%

8.5.1 Infiltration

The proposed development will reduce annual infiltration from the KNUEA by approximately 35%, but this will only translate to a reduction of approximately 4% over the Shirley's Brook Northwest Branch drainage area (719 ha).

Based on the findings of the hydrogeologic investigation, the water surplus categorized as "infiltration" will consist primarily of shallow groundwater interflow through the weathered bedrock, which will contribute to baseflow in the watercourses, but will provide minimal contribution to groundwater recharge of the underlying aquifer.

8.5.2 Runoff

Annual runoff from the KNUEA will increase by 60% under post-development conditions. Due to the size of the Northwest Branch watershed (719 ha), the total annual runoff volume to the Northwest Branch of Shirley's Brook will only increase by approximately 7%.

The increase in runoff to the Main Branch of Shirley's Brook at March Valley Road will be less than 1%, as the upstream area (1,767 ha) is already heavily urbanized.

8.5.3 Evapotranspiration

Under pre-development conditions, the crop cover coefficient (used to calculate actual evapotranspiration) for vegetated lands will fluctuate over the course of the year during the dormant season and growing season. Under post-development conditions, the impervious surfaces increase the potential evapotranspiration rates during the dormant season and at the beginning and end of the growing season. However, this increase in annual potential evapotranspiration is offset by the reduction in soil moisture storage, leaving less available water for evapotranspiration.

8.6 Summary

Based on the findings of the hydrogeologic investigation, the streamflow monitoring program, and the site-specific water balance model, development of the KNUEA is not anticipated to have any significant impact on groundwater resources.

- The dominant surficial soil type is silty clay / glacial till, which have low infiltration potential.
- Bedrock outcrops of the March and Oxford Formations are assumed to have low infiltration potential as they have not exhibited the presence of karst features.
- No high recharge areas have been identified. An alluvial soils deposit is present in the vicinity of March Road, but it is underlain by stiff silty clay and does not provide any significant groundwater recharge/discharge function.
- The fish species and aquatic / terrestrial species identified within the site are not particularly sensitive to changes in the anticipated changes in the flow regime.

There is no planned future development upstream of the KNUEA. As such, the model results for post-development conditions in the KNUEA represent the total anticipated change to the hydrologic cycle in the Shirley's Brook Northwest Branch subwatershed in the foreseeable future.

Section 9.0 Conceptual SWM Design

Conceptual designs for SWM servicing of the KNUEA have been completed based on the preferred servicing options using the SWM criteria outlined in **Section 7.0**. The recommended areas for SWM blocks have been designed to service the KNUEA as shown on the Preferred Demonstration Plan (refer to **Figure 11.1** in **Section 11.0**), with flexibility in the configuration of the SWM facilities as it relates to available lands and participating landowners. The SWMHYMO hydrologic model has been used to confirm the required sizes for the proposed facilities.

The conceptual designs presented herein are intended to demonstrate the feasibility of implementing the recommended SWM strategy. The pond layouts are subject to change based on future revisions to the land use plan, grading plan, and/or servicing plans. Conceptual design drawings for the three proposed SWM facilities are provided on **Figures 9.1 through 9.4**. Refer to **Volume 2**, **Appendix F** for detailed pond design spreadsheets.

All SWM facilities are to conform to the *Stormwater Management Planning and Design Manual* (MOECC, 2003) and the *City of Ottawa Draft Stormwater Management Facility Design Guidelines and Standards* (October, 2012).

9.1 SWM Facilities (General)

Three SWM facilities are proposed to provide water quality, erosion, and peak flow control for the proposed KNUEA development. Pond 1 is located immediately west of March Road and drains to Tributary 2. Pond 2 is located immediately west of March Road and drains to Tributary 3. Pond 3 is located to the east of the KNUEA and drains directly to Shirley's Brook just west of March Valley Road. The preservation and enhancement of Tributary 2 and Tributary 3, along with the existing topography and depth to bedrock were factors in determining the number of SWM facilities required to service this area.

9.1.1 Grading & Layout

The detailed designs of the facilities should avoid rectangular and/or linear shapes, and be landscaped with natural features to maximize their amenity values. The extensive use of retaining walls should be avoided. Sediment management areas should be sized such that they have the same areal coverage as the sediment forebay of the pond. Access roads and pathways should be located such that the entire sediment forebay can be easily accessed by a regular, or long-stick excavator (approximately 15m reach).

The conceptual layouts of the recommended stormwater management facilities provided on **Figures 9.1 to 9.4** are intended to demonstrate the approximate size and configuration of the Pond Block for the purposes of the Community Design Plan. The size and layout of the facilities are subject to change prior to Draft Plan Approval to ensure the Pond Blocks are appropriately sized to the satisfaction of the City.

9.1.2 Rock Excavation

Bedrock excavation will be required for the ponds west of March Road. The conceptual designs for the ponds incorporate measures to reduce the quantity of rock excavation, but the pond elevations are governed by other factors including the elevation of the receiving watercourses (Tributaries 2 and 3), and the overall grading and servicing design as outlined in the Master Servicing Study.

9.1.3 Pond Liner

The SWM facilities should ideally be constructed with native material. If the native material is not suitable due to hydraulic permeability, the bottom of the detention cells must be sealed with clay.

A geotechnical investigation is required for every SWM facility in the City of Ottawa. If it is determined that a liner is required, the appropriate bottom treatment will be recommended in the geotechnical report. Acceptable pond liner options include:

- A layer of compacted clay;
- A geosynthetic liner, covered by a layer of suitable fill (minimum depth 0.3 m);
- Bentonite; or,
- Other suitable materials approved by regulatory authorities.

Ponds 1 and 2 will require impermeable liners as the ponds will be excavated into rock. The requirement for a liner in Pond 3 will be determined at the detailed design stage based on recommendations from the geotechnical consultant.

Groundwater levels will need to be considered when designing the pond liners. Depending on the groundwater elevations, it may be necessary to install a perimeter drain around the facility to ensure the pond liner is not compromised or displaced by hydrostatic pressure from the surrounding water table.

9.1.4 SWMF Outlet Structures

Pond 1 and Pond 2 have been sized to control outflows to match the existing flows in their respective tributaries. Pond 3 is sized to match post-development peak flows to pre-development levels for the contributing drainage area. A conceptual outlet configuration is provided as **Figure 9.5** which should be considered in the detail design of each pond. The outlet structure is comprised of:

- A perforated pipe outlet to a French drain to provide baseflow enhancement;
- A bottom draw extended detention outlet to provide quality control;
- A high flow outlet to attenuate peak flows to the allowable release rates;
- An overflow spillway to limit flood risk for events exceeding the available storage.

9.1.5 Temperature Mitigation

Urbanization commonly results in an increase in the temperature of storm runoff, most often due to extended detention within stormwater management facilities. Wet ponds have been found increase the temperature of runoff by approximately 5.1ºC (MOECC, 2003).

Incorporating the following mitigation measures into the design of the proposed SWM ponds will result in reduced thermal impacts from the SWM facilities:

- SWM facilities should be designed using narrow pond configurations with bank plantings to promote shading and inhibit temperature increases;
- Baseflows should be routed through a stone-filled subsurface trench: The length of the trench should be maximized to increase the opportunity for heat transfer from the water to the stone (refer to conceptual SWMF outlet design provided as Figure 10.5).
- Establishing / preserving riparian cover for outlet watercourses will further help to reduce the temperature of runoff.

9.2 Pond 1

Pond 1 is wet pond SWM facility located in the northwest quadrant of the KNUEA on the north side of Tributary 2 (**Figure 9.1**). This pond would have a tributary drainage area of approximately 54.1 ha with a 5-year peak inflow of 10.6 m^3/s. The pond is oriented roughly perpendicular to March Road and has a total volume of nearly 43,000 m^3 at a depth of 3.15 m. The total area of the pond block is approximately 2.5 ha and includes provisions for grading, access roads, and sediment management.

<u>Design Considerations</u>

Pond 1 has been designed to service lands in the northwest quadrant of the KNUEA. Runoff from the lands in the northwest quadrant south of Tributary 2 will be directed underneath Tributary 2 through a storm sewer to the proposed SWM facility. The proposed undercrossing will not significantly increase the required rock excavation, as there will also be sanitary and water crossings at this location. The proposed storm crossing also has the benefit of maintaining pre-development drainage areas to Tributary 2. Further information on the tributary crossing can be found in the Master Servicing Study for the KNUEA.

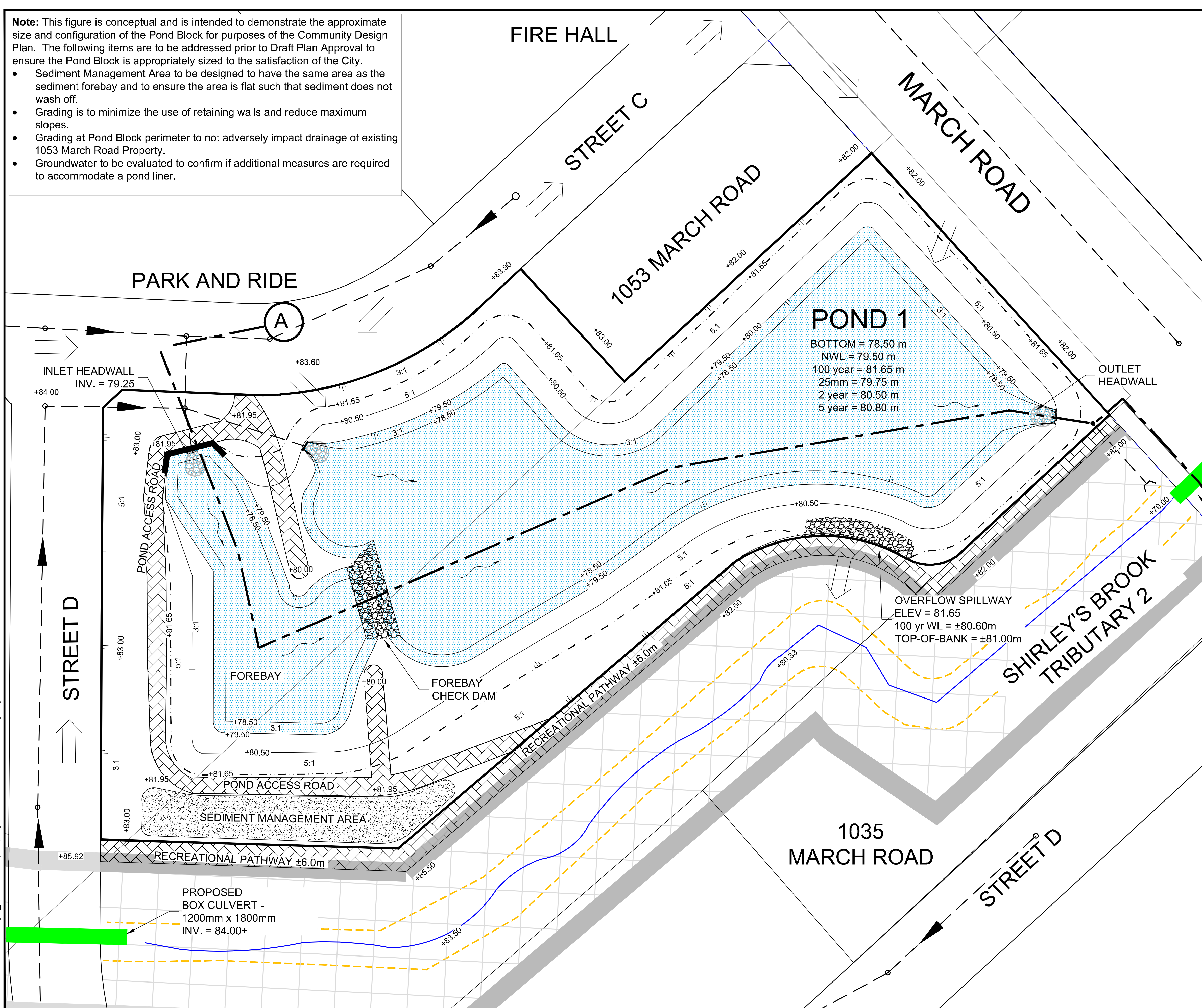
Bedrock elevations in the area of the proposed pond are quite high and the construction of Pond 1 will require bedrock excavation and a pond liner. Conceptual design details for Pond 1 are provided in **Table 9.1** and on **Figure 9.1**.

Table 9.1 Pond 1 Design Information

Area of SWM Block	2.5 ha		
Drainage Area to SWMF	54.1 ha	(62% Impervious)	
Quality Control	Enhanced	(80% TSS Removal)	
	8605 m^3	Req. Perm. Pool Volume	
	2165 m^3	Req. Extended Detention Volume	
Quantity Control	100 year	(Allowable flow to Tributary 2)	
	0.276 m^3/s	Target 100-year release rate	
Stage	**Elevation (m)**	**Volume (Total) (m^3)**	**Release Rate (L/s)**
Bottom	78.50	0	0
Normal Water Level	79.50	10,080	0
Extended Detention Storage	79.75	13,056	16
2-year	80.50	23,401	57
5-year	80.80	28,012	107
100-year	81.65	42,569	270

Note: This figure is conceptual and is intended to demonstrate the approximate size and configuration of the Pond Block for purposes of the Community Design Plan. The following items are to be addressed prior to Draft Plan Approval to ensure the Pond Block is appropriately sized to the satisfaction of the City.

- Sediment Management Area to be designed to have the same area as the sediment forebay and to ensure the area is flat such that sediment does not wash off.
- Grading is to minimize the use of retaining walls and reduce maximum slopes.
- Grading at Pond Block perimeter to not adversely impact drainage of existing 1053 March Road Property.
- Groundwater to be evaluated to confirm if additional measures are required to accommodate a pond liner.



LEGEND

- RIGHT OF WAYS
- POND BLOCK
- EXISTING CREEK CORRIDOR
- PROPOSED CREEK CORRIDOR
- PERMANENT POOL
- ACCESS ROAD/PATHWAY
- ROCK WALL CHECK DAM
- MAJOR OVERLAND FLOW DIRECTION
- DIRECTION OF POND FLOW
- HEADWALL C/W RIPRAP
- +81.50 PROPOSED GRADE
- 3:1 TERRACING (MAX. SLOPE)
- 100YR WATER LEVEL
- STORM SEWER
- PROPOSED CULVERT
- FLOODPLAIN LIMITS (APPROXIMATE)

KANATA NORTH
COMMUNITY DESIGN PLAN

FIGURE NO. 9.1
POND 1
CONCEPTUAL LAYOUT

DATE JUN 2016 JOB 112117
SCALE 1:1000 0 5m 10m 20m

NOVATECH
Engineers, Planners & Landscape Architects

M:\2012\112117\CAD\Design_EMP\MEMO (KJA)\Figure 9.1 Pond 1 Functional.dwg, Figure 9.1 - Pond 1, Jun 24, 2016 - 9:23am, kbanks

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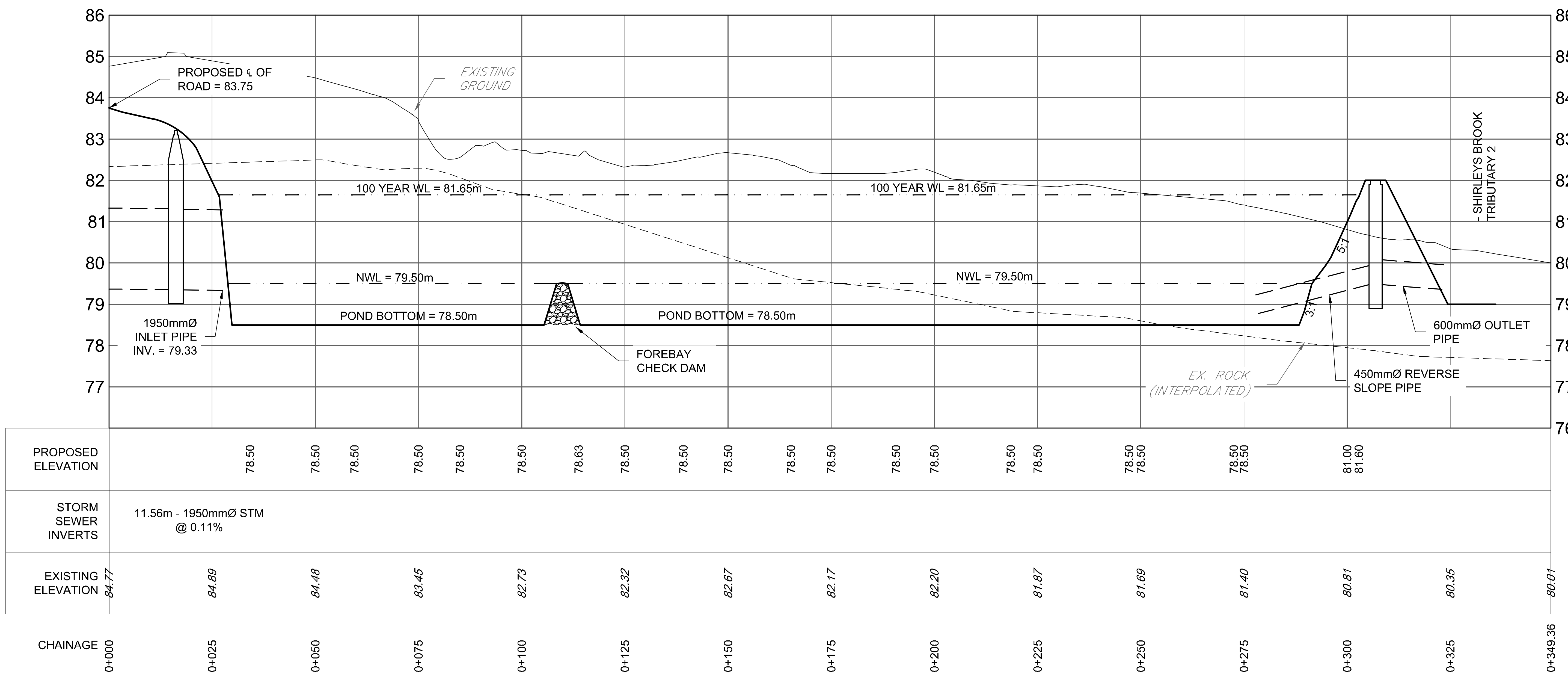

KANATA NORTH
COMMUNITY DESIGN PLAN

FIGURE NO. 9.1A
POND 1
CROSS SECTION A-A'

DATE	JOB
MAY 2016	112117

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9.3 Pond 2

Pond 2 is a wet pond SWM facility located in the southwest quadrant of the KNUEA on the north side of Tributary 3 (**Figure 9.2**). This pond would have a tributary drainage area of approximately 17.6 ha with a 5-year peak inflow of 3.4 m^3/s. The pond is oriented roughly perpendicular to March Road and has a total volume of approximately 14,000 m^3 at a depth of 3.0 m. The total area of the pond block is approximately 1.7 ha and includes provisions for grading, access roads, and sediment management.

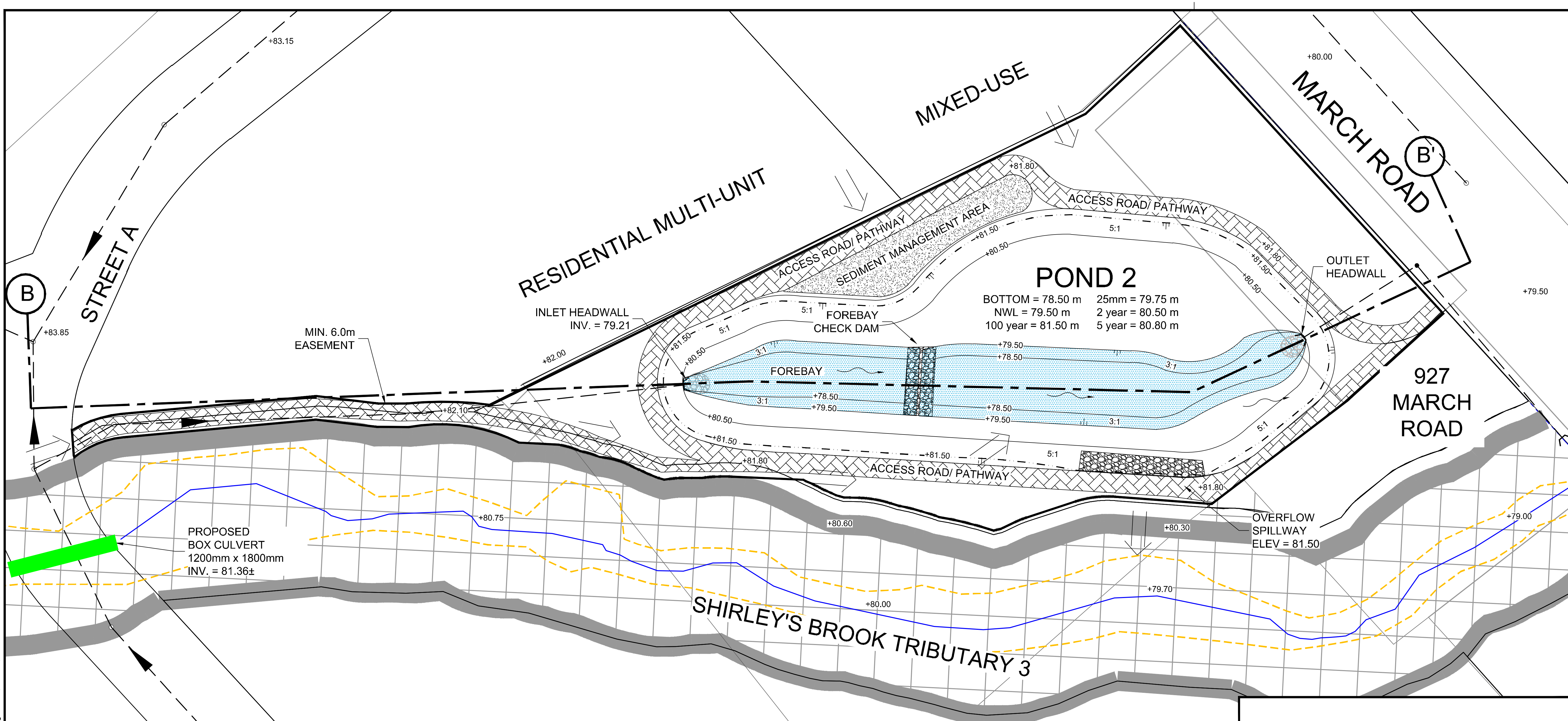
Design Considerations

Pond 2 would service the residential lands and Community Park in the southwest quadrant of the KNUEA. Runoff from the single family residential area south of Tributary 3 (adjacent to Marchbrook Circle) will be directed under Tributary 3 through a storm sewer to the SWM facility. The proposed storm crossing of Tributary 3 will not significantly increase rock excavation requirements, as there will also be crossings for water and sanitary services. The proposed crossing allows the single family residential areas to be serviced by the SWM facility and reduces the area requiring on-site control.

Further information on the tributary crossing can be found in the Master Servicing Study for the KNUEA. Bedrock elevations in the area of the proposed pond are high and the construction of Pond 2 will require bedrock excavation and a pond liner. Conceptual design information for Pond 2 is provided in **Table 9.2** and on **Figure 9.2**.

Table 9.2: Pond 2 Design Information

Area of SWM Block	1.7 ha		
Drainage Area to SWMF	17.6 ha	(41% Impervious)	
Quality Control	Enhanced	(80% TSS Removal)	
	1915 m^3	Req. Perm. Pool Volume	
	704 m^3	Req. Extended Detention Volume	
Quantity Control	100 year	(Allowable flow to Tributary 3)	
	0.084 m^3/s	Target 100-year release rate	
Stage	**Elevation (m)**	**Volume (m^3)**	**Release Rate (L/s)**
Bottom	78.50	0	0
Normal Water Level	79.50	1991	0
Extended Detention Storage	79.75	2891	3
2-year	80.50	6923	11
5-year	80.80	8819	21
100-year	81.50	13,905	58



Note: This figure is conceptual and is intended to demonstrate the approximate size and configuration of the Pond Block for purposes of the Community Design Plan. The following items are to be addressed prior to Draft Plan Approval to ensure the Pond Block is appropriately sized to the satisfaction of the City.

- Sediment Management Area to be designed to have the same area as the sediment forebay.
- Dry shelf to be above 5-year water level elevation
- Clearance between pond top-of-bank and adjacent development is to be ±8m.
- Overland flow path will be graded to direct flows to Main Cell of pond.
- Groundwater to be evaluated to confirm if additional measures are required to accommodate a pond liner

LEGEND

- RIGHT OF WAYS
- POND BLOCK
- EXISTING CREEK CORRIDOR
- PERMANENT POOL
- ACCESS ROAD/PATHWAY
- ROCK WALL CHECK DAM
- MAJOR OVERLAND FLOW DIRECTION
- FLOODPLAIN LIMITS (APPROXIMATE)

LEGEND

- DIRECTION OF POND FLOW
- HEADWALL C/W RIPRAP
- +81.50 PROPOSED GRADE
- 3:1 TERRACING (MAX. SLOPE)
- 100YR WATER LEVEL

KN

KANATA NORTH
COMMUNITY DESIGN PLAN

FIGURE NO. 9.2
POND 2 CONCEPTUAL LAYOUT

DATE
JUN 2016

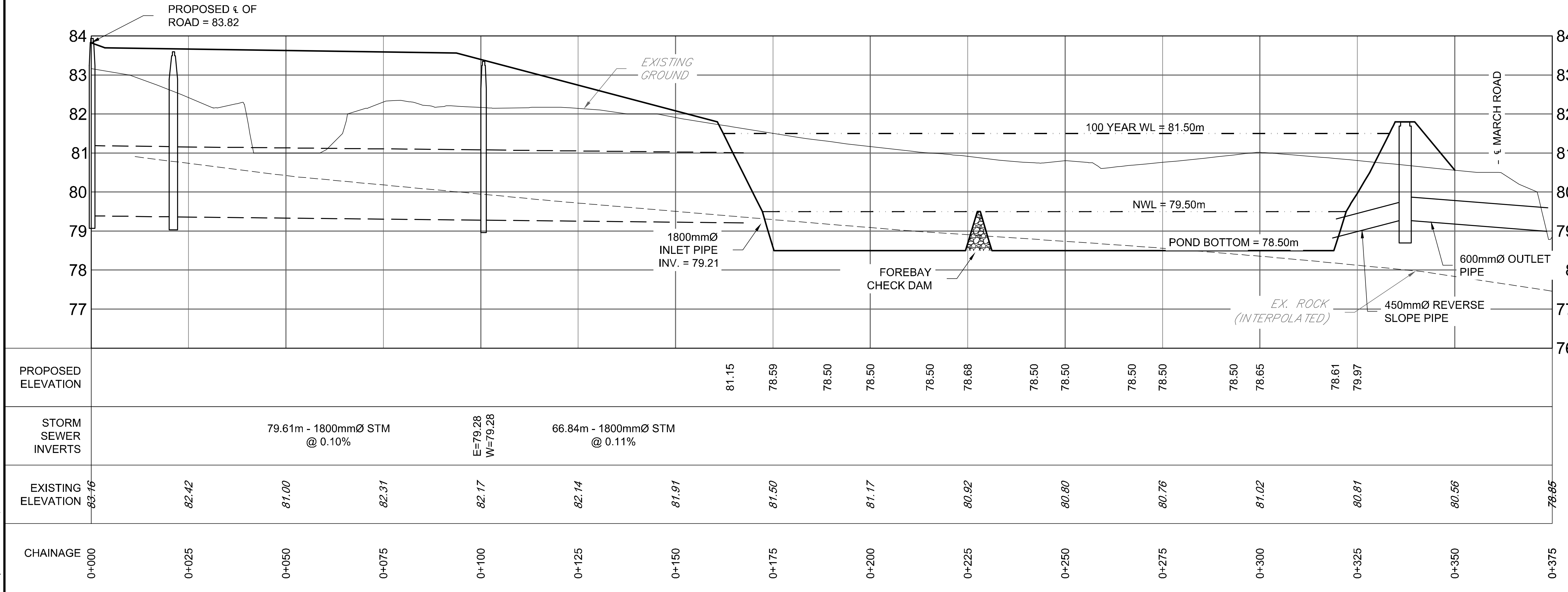
JOB
112117

SCALE
1:1000

0 5m 10m 20m

NOVATECH
Engineers, Planners & Landscape Architects

M:\2012\112117\CAD\Design_EMP\MEMO (KJA)\Figure 9.2 Pond 2 Functional.dwg, Figure 9.2, Jun 24, 2016 - 10:14am, kbanks



KANATA NORTH

COMMUNITY DESIGN PLAN

FIGURE NO. 9.2A

POND 2

CROSS SECTION B-B'

DATE: MAY 2016

JOB: 112117

SCALE: 1:1000

0 5m 10m 20m

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M:\2012\112117\CAD\Design_EMP\MEMO (KJA)\Figure 9.2 Pond 2 Functional.dwg, Figure 9.2A, May 17, 2016 - 5:37pm, kbanks

9.4 Pond 2A

Pond 2 is located on lands that are not currently controlled by the KNLOG. In the event that land cannot be acquired for the preferred option (Pond 2) prior to development proceeding, Pond 2A (**Figure 9.3**) represents a feasible alternative which could be developed on an interim or permanent basis.

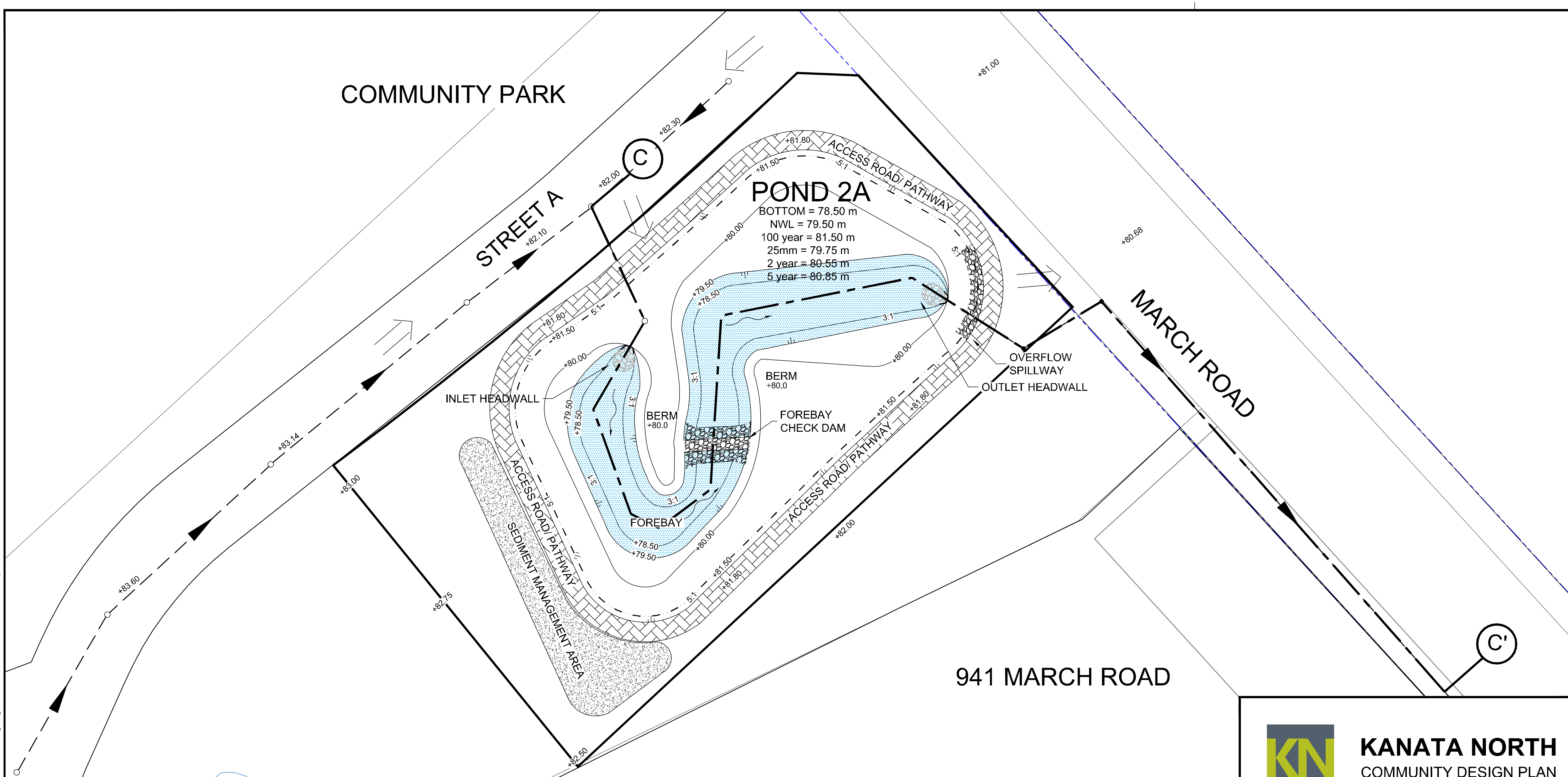
Pond 2A, like Pond 2, is a wet pond SWM facility located in the southwest quadrant of the KNUEA on the north side of Tributary 3 (**Figure 9.2**). This pond would have a tributary drainage area of approximately 17.6 ha with a 5-year peak inflow of 3.4 m^3/s. The pond is oriented roughly parallel to March Road and has a total volume of approximately 14,000 m^3 at a depth of 3.0 m. The total area of the pond block is approximately 1.6 ha and includes provisions for grading, access roads, and sediment management. While the release rates and tributary drainage area are the same, the topography and shape of the pond block differs, which results in slight differences to the required storage volumes compared with the Pond 2 option.

<u>Design Considerations</u>

Pond 2A would service the same area as Pond 2, and design considerations for Pond 2A are generally the same as Pond 2. One notable difference is the routing of emergency overland flows (from storms exceeding the available storage in Pond 2A). It is not possible to provide a direct overflow from Pond 2A to Tributary 3. In the event of a storm with runoff volumes exceeding the available storage, overflows from Pond 2A would spill onto the March Road right-of-way and flow south to Tributary 3. Conceptual design information for Pond 2A is provided in **Table 9.3** and on **Figure 9.3**.

Table 9.3: Pond 2A Design Information

Area of SWM Block	1.4 ha		
Drainage Area to SWMF	17.6 ha	(41% Impervious)	
Quality Control	Enhanced	(80% TSS Removal)	
	1915 m^3	Req. Perm. Pool Volume	
	704 m^3	Req. Extended Detention Volume	
Quantity Control	100 year	(Allowable flow to Tributary 3)	
	0.084 m^3/s	Target 100-year release rate	
Stage	**Elevation (m)**	**Volume (m^3)**	**Release Rate (L/s)**
Bottom	78.50	0	0
Normal Water Level	79.50	2106	0
Extended Detention Storage	79.75	2948	3
2-year	80.55	7092	11
5-year	80.85	9100	21
100-year	81.50	13,966	58



Note: This figure is conceptual and is intended to demonstrate the approximate size and configuration of the Pond Block for purposes of the Community Design Plan. The following items are to be addressed prior to Draft Plan Approval to ensure the Pond Block is appropriately sized to the satisfaction of the City.

- Sediment Management Area to be designed to have the same area as the sediment forebay.
- Dry shelf to be above 5-year water level elevation
- Clearance between pond top-of-bank and adjacent development is to be ±8m.
- Overland flow path will be graded to direct flows to Main Cell of pond.
- Groundwater to be evaluated to confirm if additional measures are required to accommodate a pond liner

LEGEND

- RIGHT OF WAYS
- POND BLOCK
- EXISTING CREEK CORRIDOR
- PERMANENT POOL
- ACCESS ROAD/PATHWAY
- ROCK WALL CHECK DAM
- MAJOR OVERLAND FLOW DIRECTION
- STORM SEWER

LEGEND

- DIRECTION OF POND FLOW
- HEADWALL C/W RIPRAP
- +81.50 PROPOSED GRADE
- 3:1 TERRACING (MAX. SLOPE)
- 100YR WATER LEVEL

KANATA NORTH
COMMUNITY DESIGN PLAN

FIGURE NO. 9.3
POND 2A
CONCEPTUAL LAYOUT

DATE JUN 2016
JOB 112117
SCALE 1:1000
0 5m 10m 20m

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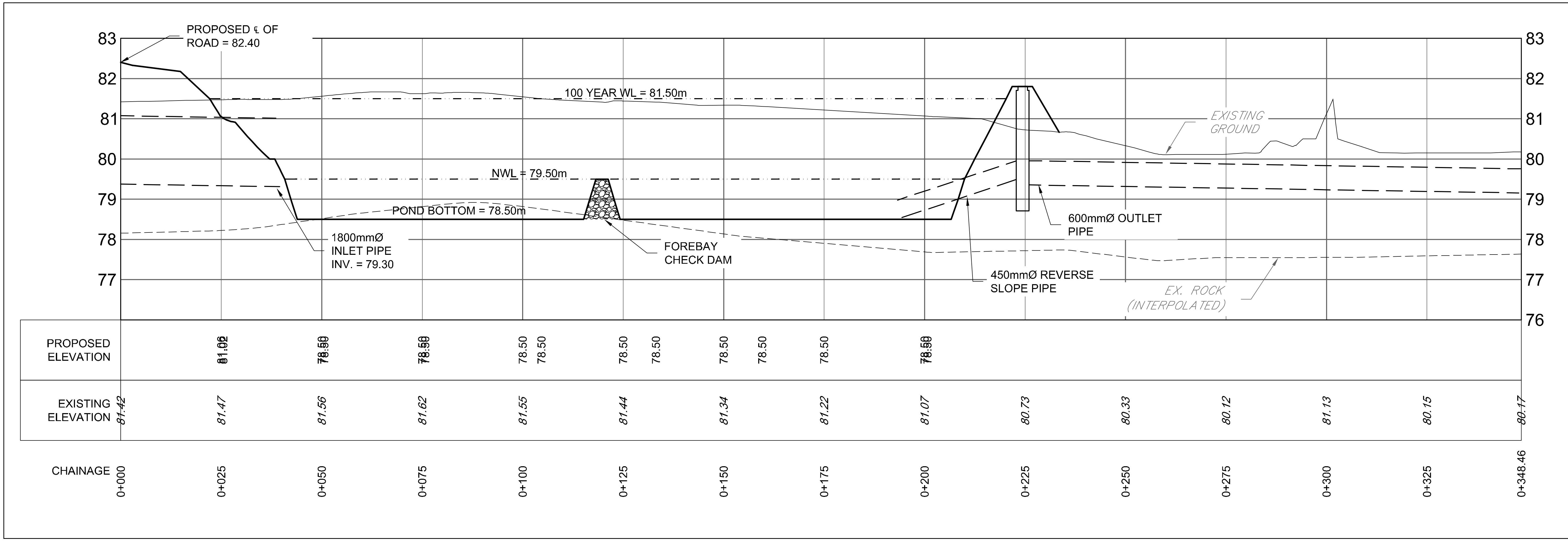

KANATA NORTH
COMMUNITY DESIGN PLAN

FIGURE NO. 9.3A
POND 2A
CROSS SECTION C-C'

DATE
MAY 2016

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9.5 Pond 3

Pond 3 is a wet pond SWM facility with two forebays located east of the KNUEA outside the urban boundary adjacent to March Valley Road (**Figure 9.4**). This pond would have a tributary drainage area of approximately 95.6 ha with a 5-year peak inflow of 15.2 m^3/s. The pond is oriented roughly perpendicular to March Valley Road and has a total volume of approximately 84,000 m^3 at a depth of 2.5 m. The total area of the pond block is approximately 11.8 ha and includes provisions for grading, access roads, pathway linkages, and sediment management. The permanent pool elevation has been set to 65.5 m, which is approximately 0.9m above the 2-year water level in Shirley's Brook at the outlet of the pond (64.61) as documented in the Shirley's Brook Phase 2 Subwatershed Study (AECOM 2013).

Design Considerations

Pond 3 would service the residential lands in the northeast and southeast quadrants of the KNUEA, with each of the two quadrants directing stormwater runoff to a separate forebay. Two forebays would increase servicing flexibility and reduce the required size of the inlet trunk sewers (compared to a single pond inlet). The pond would be connected to the KNUEA by a pathway system. Bedrock elevations in the area of the proposed pond are relatively deep and the bottom of the pond is expected to be above the underlying bedrock. Conceptual design information for Pond 3 is provided in **Table 9.4** and **Figure 9.4**.

Two new crossings of the abandoned CN Rail line would be required for the proposed trunk storm sewers (minor system). The existing culverts crossing the CN Rail line would be used to convey major system flow. East of the CN Rail line, two new ditches on either side of Woodlot S23 would convey both major and minor system runoff from the KNUEA lands east of March Road to the proposed SWM facility. Additional details and supporting calculations for the CN rail culverts are provided in the *Kanata North Community Design Plan Master Servicing Study* – refer to **MSS Section 5.4.2** Major System Drainage Areas and **MSS Appendix B, Table B4**.

The proposed inlet channels will be outside the limits of Woodlot S23. The required setbacks for the channel corridors will be established at the Plan of Subdivision stage as part of the Environmental Impact Statement (EIS) and Tree Conservation Reports (TCR). At the detailed design stage, inlet channels are to be designed to avoid sharp 90 degree bends.

The proposed SWM facility must not create a net loss to the Shirley's Brook floodplain. Any proposed encroachment into the floodplain will require a cut/fill balance and approval from the MVCA.

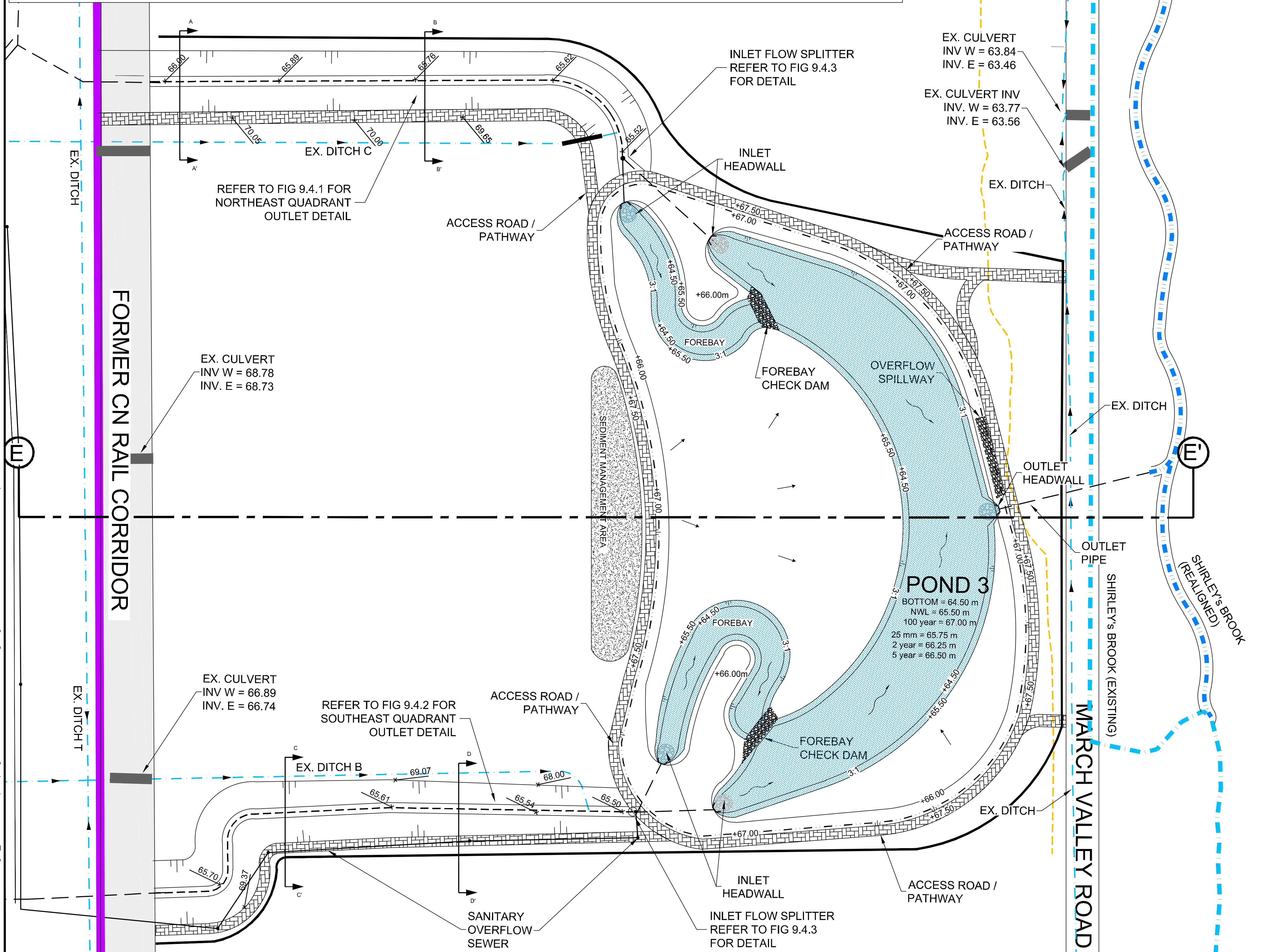
Quantity Control

Given the location of Pond 3 in the lower end of the Shirley's Brook watershed, the detailed design should also revisit the requirement for full quantity control and whether the pond footprint can be reduced and therefore lessen the impact on existing features within the area currently identified for the pond block. This analysis could be completed by updating the SWMHYMO model developed as part of the *Shirley's Brook Phase 2 Subwatershed Study* (AECOM, 2013) to reflect post-development conditions in Kanata North.

Confirmation will also be required regarding what level of control for more frequent events may still be required to avoid erosion impacts on the relocated brook. These considerations should be undertaken in consultation with the City and NCC prior to the commencement of detailed design for pond 3.

Note: This figure is conceptual and is intended to demonstrate the approximate size and configuration of the Pond Block for purposes of the Community Design Plan. The following items are to be addressed prior to Draft Plan Approval to ensure the Pond Block is appropriately sized to the satisfaction of the City.

- Dry shelf to be above 5-year water level elevation
- Sediment management area to be sized to have the same area as sediment forebays



LEGEND

	KNUEA
	POND BLOCK
	RIGHT OF WAYS
	SHIRLEY'S BROOK 100-YEAR FLOODPLAIN (~65.0m) (EXISTING - TO BE CONFIRMED FOLLOWING RE-ALIGNMENT OF SHIRLEY'S BROOK)
	EXISTING WATERCOURSES
	PROPOSED REALIGNED WATERCOURSE
	EXISTING CULVERT
	PERMANENT POOL
	ACCESS ROAD/PATHWAY
	ROCK WALL CHECK DAM
	DITCH SIDE SLOPES
	DIRECTION OF POND FLOW
	HEADWALL C/W RIPRAP
+81.50	PROPOSED GRADE
3:1	TERRACING (MAX. SLOPE)
	100YR WATER LEVEL
	℄ FLOW IN DITCH
	DIRECTION OF SLOPE
69.07	ELEVATIONS ALONG INLET AND OUTLET DITCHES
	STORM SEWER

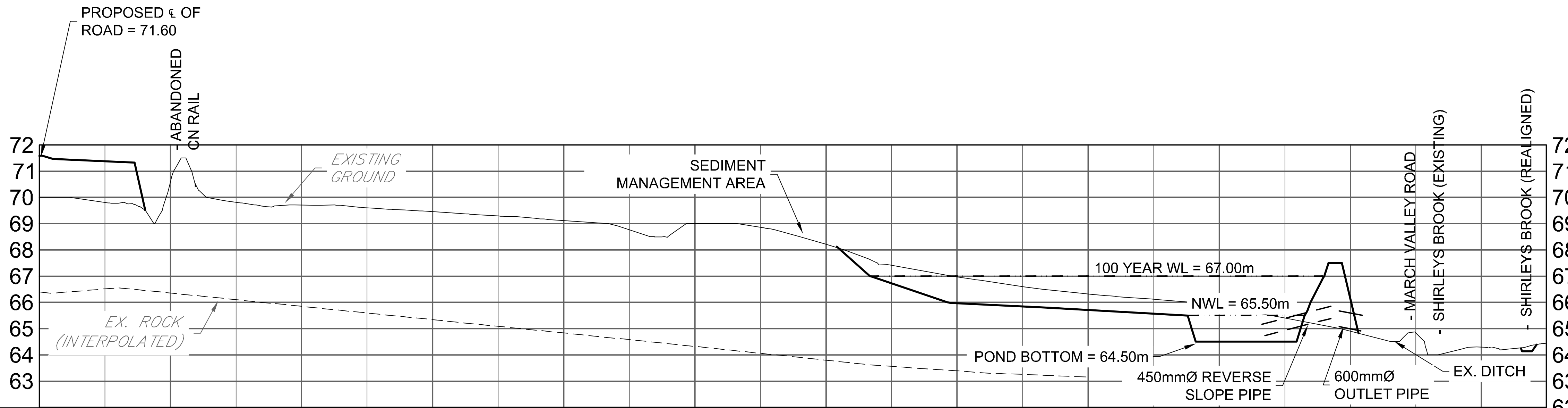
KN

KANATA NORTH
COMMUNITY DESIGN PLAN

FIGURE NO. 9.4
POND 3
CONCEPTUAL LAYOUT

DATE JUN 2016
JOB 112117
SCALE 1:2000

NOVATECH
Engineers, Planners & Landscape Architects



CHAINAGE	PROPOSED ELEVATION	EXISTING ELEVATION
0+000		70.00
0+025		69.81
0+050		70.58
0+075		69.81
0+100		69.70
0+125		69.60
0+150		69.45
0+175		69.29
0+200		69.12
0+225		68.76
0+250		69.00
0+275		68.86
0+300		68.21
0+325	66.73	67.42
0+350	65.96	66.98
0+375	65.84	66.60
0+400	65.71	66.32
0+425	65.56	66.12
0+450	64.50	65.83
0+475	64.50	65.40
0+500		64.91
0+525		64.83
0+550		64.30
0+574.76		64.45

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KANATA NORTH
COMMUNITY DESIGN PLAN

FIGURE NO. 9.4A
POND 3
CROSS SECTION D-D'

DATE
MAY 2016

JOB
112117

SCALE
1:2000

0 10m 20m 40m

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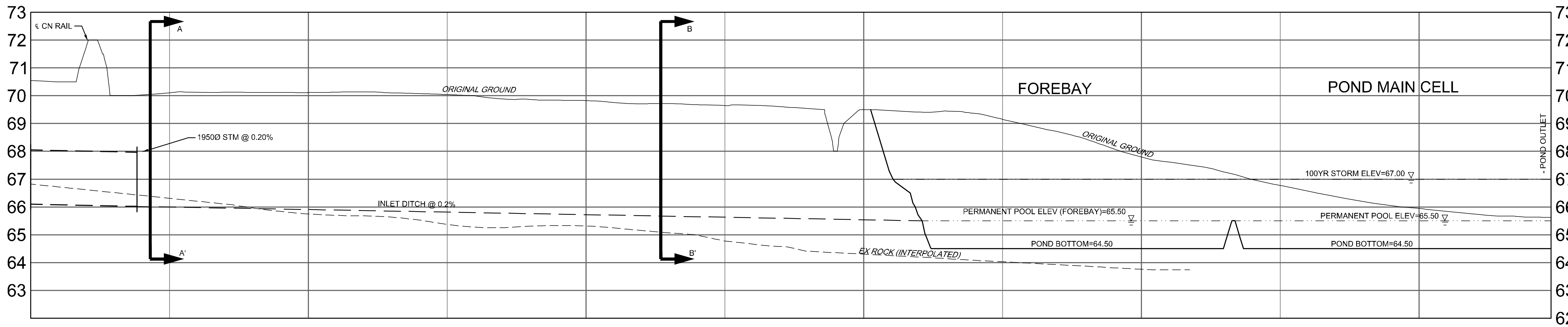
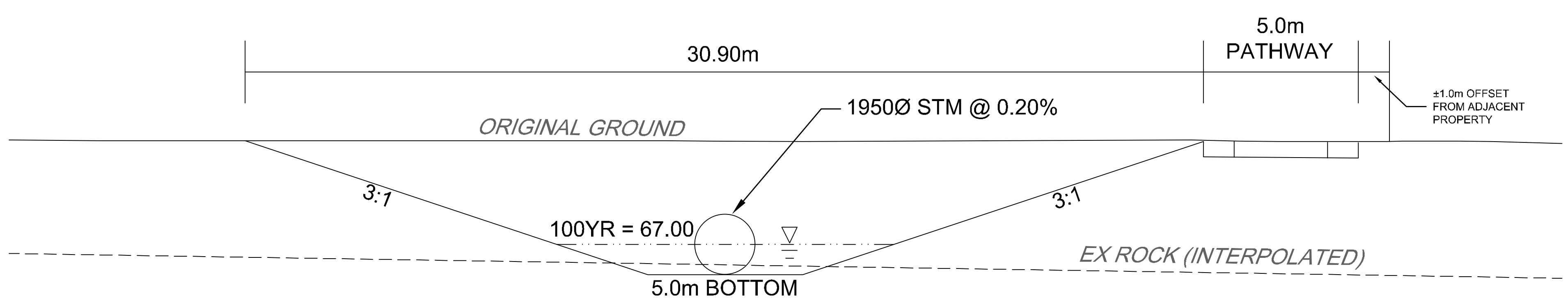


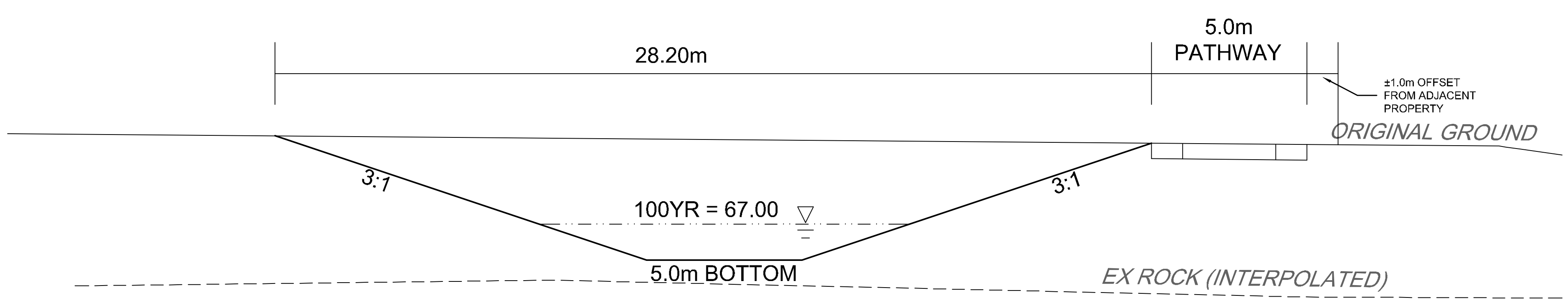
NORTH EAST QUADRANT OUTLET

SCALE 1:1500



SECTION A-A'

SCALE 1:200



SECTION B-B'

SCALE 1:200

KANATA NORTH

COMMUNITY DESIGN PLAN

FIGURE NO. 9.4.1

NORTHEAST
QUADRANT OUTLET

DATE
JUN 2016

JOB
112117

SCALE
(AS NOTED)

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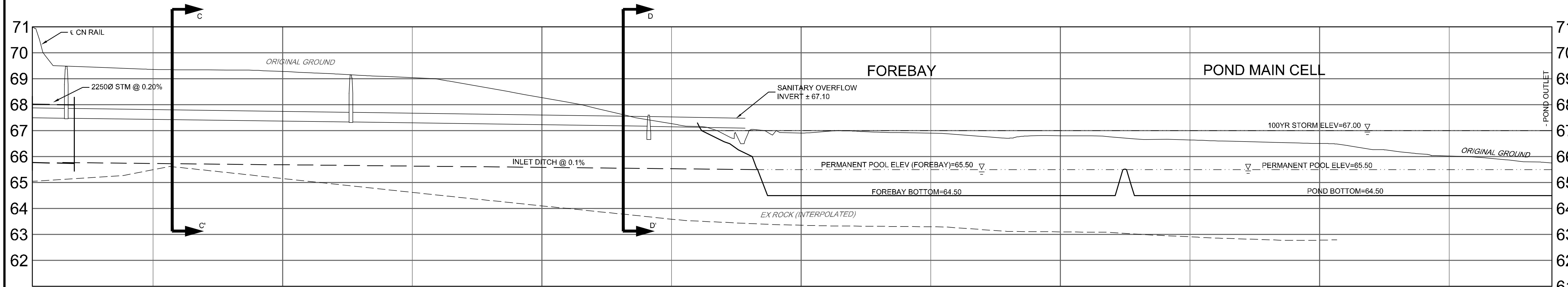
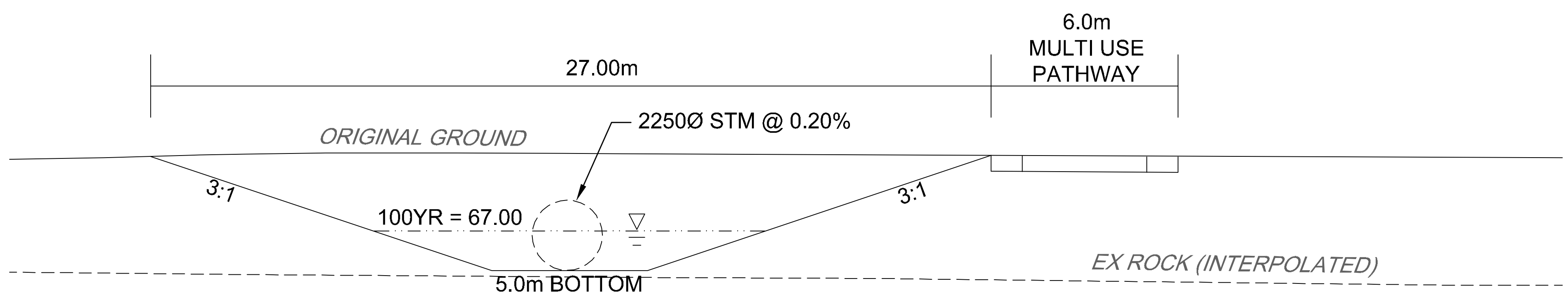
M:\2012\112117\CAD\Design_MSS\112117-east - SWMF.dwg, E-SWMF-NE, Jun 23, 2016 - 4:13pm, kbanks

SHT11x17.DWG - 279mmx432mm



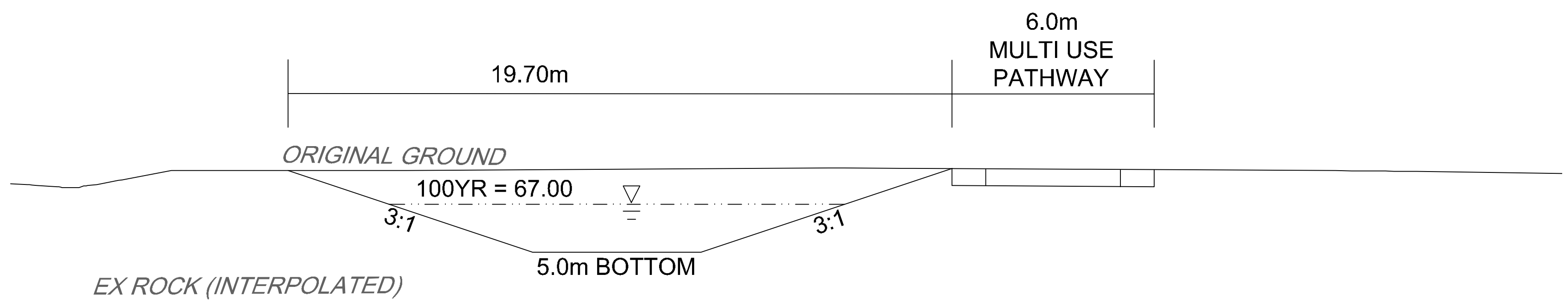
SOUTH EAST QUADRANT OUTLET

SCALE 1:1500



SECTION C-C'

SCALE 1:200



SECTION D-D'

SCALE 1:200

KANATA NORTH

COMMUNITY DESIGN PLAN

FIGURE NO. 9.4.2

SOUTHEAST
QUADRANT OUTLET

DATE
MAY 2016

JOB
112117

SCALE
(AS NOTED)

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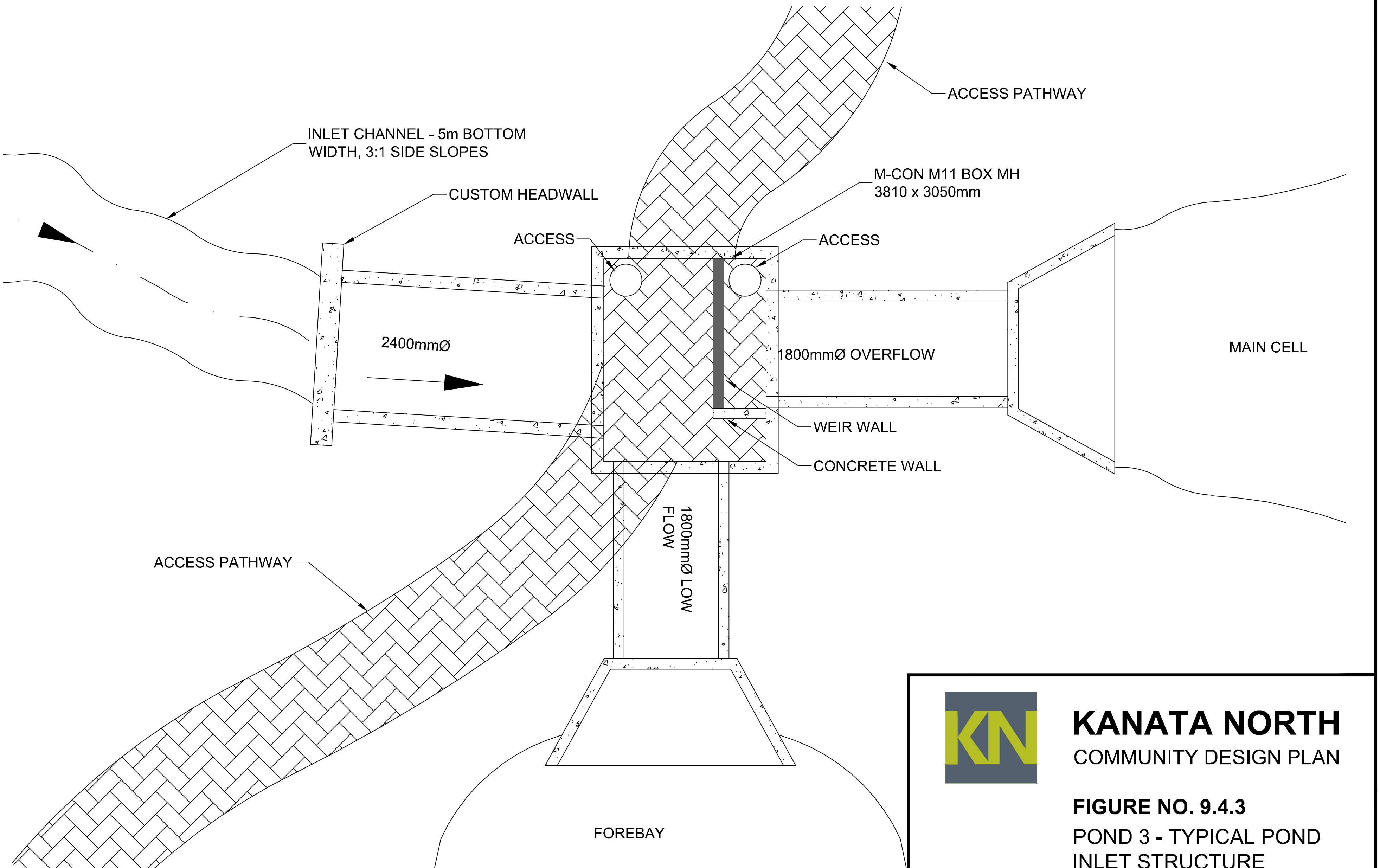
M:\2012\112117\CAD\Design_EMP\MEMO (KJA)\Figure 9.4 Pond 3 Functional.dwg, Figure 9.4.3 - DETAILS, May 19, 2016 - 11:14am, kbanks



KANATA NORTH
COMMUNITY DESIGN PLAN

FIGURE NO. 9.4.3

POND 3 - TYPICAL POND INLET STRUCTURE

DATE	JOB
JUN 2016	112117

SCALE
1:100
0 .5m 1m 2m

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Outlet Configuration

Outflows from Pond 3 will be directed into the Main Branch of Shirley's Brook at March Valley Road. The conceptual design for Pond 3 (**Figure 9.4**) shows a new piped outlet under March Valley Road to the proposed realigned section of Shirley's Brook. However, other outlet configurations will be considered at the detailed design stage.

- A direct piped connection to the realigned section of Shirley's Brook would require the construction of a new crossing of March Valley Road and the removal of additional trees on the east side of March Valley Road, but would ensure the safe and efficient conveyance of the concentrated urban flows from pond 3 to Shirley's Brook, and ultimately provide more flexibility for future improvements to March Valley Road.
- Outflows could also be directed to the existing roadside ditch on the west side of March Valley Road and routed through the existing culverts crossing March Valley Road north of Pond 3. The existing culverts have sufficient capacity to convey the post-development flows, and this approach avoids the requirement to construct a new crossing of March Valley Road.

Table 9.4: Pond 3 Design Details

Area of SWM Block	11.8 ha		
Drainage Area to SWMF	95.6 ha	(68% Impervious)	
Quality Control	Enhanced	(80% TSS Removal)	
	17,688m^3	Req. Perm. Pool Volume	
	3824m^3	Req. Extended Detention Volume	
Quantity Control	100 year	(Allowable flow to Shirley's Brook Main Branch)	
	1.045 m^3/s	Target 100-year release rate	
Stage	**Elevation (m)**	**Volume (m^3)**	**Release Rate (L/s)**
Bottom	64.50	0	0
Normal Water Level	65.50	17,914	0
Extended Detention Storage	65.75	25,499	190
2-year	66.25	46,999	220
5-year	66.50	58,710	402
100-year	67.00	83,785	1,045