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STORMWATER MANAGEMENT REPORT
PROPOSED RESIDENTIAL SUBDIVISION
2050 DUNROBIN ROAD
CITY OF OTTAWA

Submitted to:

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165 Constance Lake Road
Kanata, Ontario
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PROJECT #: 200977

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SUMMARY OF MAJOR REVISIONS

Kollaard Associates Inc. (Kollaard) is pleased to present the following second revision of the stormwater management design for the proposed residential subdivision to be located at 2050 Dunrobin Road. The stormwater management design and associated report has been revised in response to review comments received from the City of Ottawa, the Conservation Authority and peer review.

The following presents a summary of the major revisions to the stormwater management report in point form. The response to the review comments is included in Appendix J.

- Section 2.3 was added to list low impact design practices which are included in the development.
- Section 3.1 was added the 120% 12 hour 100 year Chicago storm as the 20% stress test.
- Section 3.3.1 and associated Appendix A. Revision to CN numbers to include silty clay soil.
- Section 4.2. has been revised. Reference to design tables has been eliminated. The capacity of the Railroad Culvert to accommodate the 100 year flow is now calculated using the Hydroflow Express Extension of Autodesk Civil 3D as opposed to design charts.
- Section 6.2.2 has been added to the report to provide information with respect to the permeability. Permeability is now based on test results rather than theoretical comparison
- Section 6.2.3 has been modified to describe revisions to the low slope swales to include clear stone and subdrain along the bottom of the swales. The time to drain is based on an equation provided in the CVC LID guide.
- Section 7 and 7.1.1 - The stormwater management design has been revised. The original design included controlled and uncontrolled areas. Due to revisions in the time of concentration, increased building size and addition of impervious area in the formerly uncontrolled areas, the report was modified to include secondary control. Flow from the previously uncontrolled areas will also be restricted.
- Section 7.1.2 has been modified. The design of the stormwater storage swale has been revised to be in keeping with a Dry Swale or Bioswale as described by Section 4.9 of the CVC LID Manual.
- Section 7.1.2.2. includes added discussion with respect to the free board requirement of the storm facility in
- Section 7.1.2.3 includes added discussion and calculations with respect to the separation distance between the 100 year flood level and the USF
- Section 7.1.2.4 has been revised to reflect the change in the outlet structure from an orifice to a V-notch Weir.

- Section 7.1.3 is a new section which details the second control structure within the outlet swale to provide additional storage and stormwater detention of previously uncontrolled areas.
- Section 7.3.2 is a new section which was added to discuss the storage requirements within the outlet swale
- Section 8 includes additional discussion of the low impact design techniques.
- Section 9.3 has been revised to clarify the quality control.

LIST OF TABLES and FIGURES

LIST OF APPENDICES

LIST OF DRAWINGS

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1. INTRODUCTION

Mr. Zbigniew Hauderowicz retained Kollaard Associates Inc. to complete a Site Grading and Drainage Plan along with a Stormwater Management Report in support of the City of Ottawa Subdivision Approval Application for the proposed residential subdivision development at 2050 Dunrobin Road in the City of Ottawa, Ontario. The proposed subdivision will occupy a currently undeveloped parcel of land located along the northeast side of Dunrobin Road southeast of Constance Lake Road. The development will be accessed by extending a roadway northeast from Dunrobin Road. The proposed roadway will terminate with a cul-de-sac. The proposed development area will be divided into 8 single family residential estate lots with a block reserved for stormwater management.

For the remainder of this report Dunrobin Road will be considered to be on a north-south axis and the site is considered to be located on the east side of Dunrobin Road.

This report is intended to present the results of a stormwater management design in support of the application for subdivision approval. The report will summarize the stormwater management (SWM) design requirements and proposed works that will address stormwater flows arising from the site under post-development conditions on a level sufficient to ensure that stormwater management facility is adequately designed to meet the criteria for the site.

The total site development area is approximately 8.96 hectares (22 acres). A road will be extended through the development, east from Dunrobin Road, ending in a cul-de-sac on the site. Residential driveways will originate along both sides of the proposed development roadway. The single family dwellings will be serviced by wells, on-site septic leaching beds and side yard swales. The proposed residential development will affect an additional 0.11 hectare portion of City of Ottawa property, in the form of regarding of the roadside between the site and Dunrobin Road.

The report is to be read in conjunction with the stormwater management system design presented in the Kollaard Civil Drawings: 200977 - PRE, 200977 - POST, 200977 – GR-W, 200977 – GR-E, 200977 - ESC, 200977 - PP, 200977 – SVC, 200977 – FC, and 200977 - Details.

1.1. Background

The proposed development has in general a rectangular shape and extends from Dunrobin Road to the former CN railway tracks located along the east side of the site. A narrow portion of the site projects south from the southeast corner of the site along the CN railway. The projection has an average width of about 14.5 metres, a maximum width of about 26.5 metres and extends about 160 metres to the south side of Harwood Creek.

The proposed development site is part of the Harwood Creek watershed. Harwood Creek is a tributary to Constance Lake and is adjacent the southeastern extension of the site. Harwood Creek is a watercourse of record with sufficient size and capacity to receive the runoff from the proposed development. The initial design for the proposed development was completed in 2010 with various revision following. Conditions for Draft plan approval were received in 2015. At the time the initial design was completed and draft plan approval conditions were provided, flood plain mapping had not been completed for the Harwood Creek and no flood plain was identified on site. It is understood that the flood plain modeling for the Harwood Creek was completed in 2020 by MVCA. As a result of the mapping, a backwater flood plain was identified on the eastern portion of the site.

Modeling of the affect of the proposed development on the backwater flood plain was completed by J.F. Sabourin and Associates Inc. (JFSA) and has been presented in a separate report.

1.2. Summary

The proposed stormwater management design directs stormwater runoff to the southeast corner of the site by means of swales, the road side ditches and an outlet swale towards the Harwood Creek.

The proposed stormwater management plan for the subdivision will make use of best management practices in combination with a treatment train approach to meet the requirements for stormwater management on the site. Stormwater from the majority of the developed portion of each lot, including the driveways and dwelling footprints, and from the adjacent roadway will be collect by means of the roadside ditches and directed to the stormwater management swale. The stormwater management swale will consist of a flat bottomed low sloped swale complete with an enhanced topsoil layer on the bottom underlain by a clear stone layer.

The roadside ditches and stormwater management swale will provide stormwater storage and promote sedimentation and infiltration while the vegetated swales will promote infiltration and vegetative filtration in order to achieve the quantity and quality control parameters established by the City of Ottawa, Mississippi Valley Conservation Authority and the Ministry of Environment Conservation and Parks.

1.3. Governing Authorities

This Stormwater Management Report has been prepared to present the design information to satisfy conditions set by the following authorities:

City of Ottawa (City)
Mississippi Valley Conservation Authority (MVCA)
Ministry of Environment, Conservation and Parks (MECP) formerly Ministry of Environment (MOE)

1.4. Guidelines and Manuals

The following guidelines and manuals were utilized in the creation of the stormwater management design and the preparation of this report.

Ottawa Sewer Design Guildelines *(OSDG)*
City of Ottawa, October 2012 as amended.

Stormwater Management Planning and Design Manual *(MOE Manual)*
Ministry of the Environment, March 2003

Visual OTTHYMO V2.0: Reference Manual
Greenland International Consulting Inc., July 2002

CITY OF OTTAWA, Low Impact Development Technical Guidance Report
City of Ottawa, February 2021

Low Impact Development Stormwater Management Planning and Design Guide Version 1.0 **(CVC LID Guide)**
Credit Valley Conservation & Toronto and Region Conservation 2010

MTO Drainage Management Manual
Ontario Ministry of Transportation

Part 650 Hydrology National Engineering Handbook – Chapter 15 Time of Concentration
United States Department of Agriculture (USDA Chapter 15)

Urban Hydrology for Small Watersheds Technical Release 55
United States Department of Agriculture (USDA TR55)

Storm Water Management Model Reference Manual Volume I – Hydrology (Revised)
United States Environmental Protection Agency (US EPA RM)

Low Impact Development Stormwater Management Guidance Manual (Draft January 2022)
Ministry of the Environment Conservation and Parks (MECP LID Guide)

2. STORMWATER MANAGEMENT DESIGN

The subject lands are within the City of Ottawa and the Mississippi Valley Conservation Authority jurisdiction. Stormwater management criteria were established based on the nature and location of the development and on the nature of the receiving watercourse for the stormwater discharge from the site.

2.1. Design Criteria

2.1.1. Quantity Control Criteria

- Post-development peak runoff rates are to be equal to or less than pre-development levels for all design storm events up to and including the 100 year storm event,
- Onsite stormwater storage and flow shall be controlled as to not affect lands adjacent the development site,
- Surface runoff volumes are to be minimized through infiltration techniques,
- Incorporate low impact design techniques.

2.1.2. Quality Control Criteria

- The design shall include enhanced quality treatment to 80% long-term suspended solids removal as recommended by the MOE Manual,
- Downstream sedimentation shall be mitigated at 2050 Dunrobin Road by increasing particle settlement along runoff flow paths within the development.

2.2. Best Management Practices

As indicated in the MOE Manual, the recommended strategy for stormwater management is to provide an integrated treatment train approach to stormwater management. Each element of the treatment train within the development when combined forms the stormwater management facility for the development.

In general, best management practices for stormwater management are divided into three categories: source control, conveyance control and end-of-pipe control. As indicated in the Ministry of Transportation Drainage Management Manual, the priority in applying these BMPs should follow the sequence presented with end of pipe measures applied as the last resort.

The MECP LID Guide provides the following guidance with respect to Lot Impact Design: Low impact development begins with the application of the principles of 'better site design' or best management practices. From a stormwater management perspective, better site design involves considering site-level opportunities and constraints to stormwater management infrastructure from the beginning of the site design process. While not all of the techniques will apply to every development, the goal is to apply as many of them as possible to maximize stormwater reduction benefits before the use of structural LID best management practice.

Better site design techniques applicable to the propose development include:

- Preserving natural areas and natural area conservation;
- Stream and shoreline buffers;
- Disconnecting and distributing runoff;
- Disconnection of surface impervious cover;
- Rooftop disconnection;
- Disconnection of foundation drainage disposal from a municipal stormwater collection system;
- Reduced lot grading;
- Reduced swale slopes and increased swale cross sections where possible;

The BMPs are intended to reduce flow rates and promote filtration and the removal of sediments.

2.3. Low Impact Design Techniques

LID stormwater management practices include source controls and conveyance controls. LID incorporated within the development will include;

- Downspout disconnection;
- Foundation drain disconnection;
- Enhanced Grassed Swales or Vegetated swales;
- Dry Swale or Bioswale;
- Soil Amendments;

3. PROPOSED HYDROLOGIC MODEL

3.1. Design Storm Intensity

Intensity-Duration-Frequency curves derived from Meteorological Services of Canada rainfall data for the MacDonald-Cartier Airport in Ottawa were used to determine the expected rainfall intensity for a given duration and storm frequency.

The IDF formulae obtained from the OSDG are as follows:

100 year Intensity = 1735.688 / (Time in min + 6.014)$^{0.820}$
10 year Intensity = 1174.184 / (Time in min + 6.014)$^{0.816}$
5 year Intensity = 998.071 / (Time in min + 6.053)$^{0.814}$
2 year Intensity = 732.951 / (Time in min + 6.199)$^{0.810}$

The data obtained from the IDF curves for the site was used to generate SCS Type II Design and Storms and Chicago Storms with select durations and return periods up to and including the 100 year storm event. The historical design storms from July 1, 1979 and August 4, 1988 were included in the analysis to verify the sufficiency of the design. The 25 millimeter 4 hour Chicago storm is considered by the Ontario Ministry of Environment Conservation and Parks to be the design storm for quality control purposes and was also included in the analysis. The City of Ottawa requires that the drainage system be stress tested on the basis of a 20% increase to the City's IDF curves rainfall values. The 120% 12 hour 100 Year Chicago storm was also added to the analysis to satisfy this requirement. *Table 3-1* summarizes the selected design storms included for analysis.

Table 3-1: Design Storms Considered

Quantity Control Storm Events	
Simulation 01.	SCS II 6 hr 5 yr
Simulation 02.	SCS II 6 hr 100 yr
Simulation 03.	SCS II 12 hr 5 yr
Simulation 04.	SCS II 12 hr 10 yr
Simulation 05.	SCS II 12 hr 100 yr
Simulation 06.	12 HR 2 YR Chicago
Simulation 07.	12 HR 100 YR Chicago
Simulation 08.	Historical July 1 1979
Simulation 09.	Historical Aug 4 1988
Quality Control Storm Events	
Simulation 10.	25mm 4 hr Chicago
Stress Test	
Simulation 11	120% 12 HR 100 YR Chicago

3.2. Methodology

The hydrologic modeling software, Visual OTTHYMO (V6.2) was used to assess pre- and post-development stormwater conditions at the site.

The pre-development were calculated using the NASHYD watershed command. The post-development conditions were also calculated using the NASHYD watershed command as the average impervious ratio for the Subdivision is less than 20 percent.

The NASHYD hydrograph method uses the Nash instantaneous unit hydrograph which is made of a cascade of 'N' linear reservoirs and is used to model rural areas.

Both the Pre and Post-development conditions were modeled for quantity control purposes utilizing SCS Type II Storm Distributions and Chicago storm distributions listed for Simulations 1 to 9 in Table 3-1 above.

The post-development conditions were modeled using the 25 mm 4 hour Chicago storm for quality control purposes.

The SCS Type II storm data was given priority in the SWM design as the proposed development is a rural residential development. The 12 hour SCS storms are generally applicable to undeveloped or rural basins where peak flow rates are largely influenced by the total volume of rainfall. The SCS Type II storm distribution is generally preferred for both large and small rural areas (OSDG). The Chicago storm is more commonly used for urban areas.

3.3. OTTHYMO Storm Analysis Variables

As previously indicated, the stormwater runoff was calculated using the NASHYD watershed command. The NASHYD command uses the Nash instantaneous unit hydrograph which is made of a cascade of 'N' linear reservoirs and is used to model rural areas.

The NASHYD command uses the following inputs:
DT – Simulation time step increment (min) – must be shorter than TP
Area – Watershed or catchment area (hectares)
DWF – A constant Dry Weather Flow or Baseflow (m3/s) assumed to be 0 (doesn't change from pre to post development)
CN – SCS Modified Curve Number
IA – Initial Abstraction (mm)
N – Number of Linear reservoir used for derivation of the Nash Unit Hydrograph
TP – Unit hydrograph time to peak (hr)

The Storm Analysis Model Variables for each catchment used in the storm water management model are summarized in Appendix A of this report.

3.3.1. Runoff Curve Numbers

The NasHyd hydrograph method which uses the SCS loss method for pervious areas was used to model both the pre- and post development conditions of the proposed subdivision. Runoff Curve Numbers (CN) are utilized in the SCS hydrology method. The Curve Number is a function of soil type, ground cover, and antecedent moisture conditions. With the exception of a portion of the site at about the midpoint of the property line between proposed Lot 7 and proposed Lot 8, the subsurface conditions were found to consist of sand, silty sand and glacial till underlying the topsoil at the site. Test pit TP14, put down at about the property line between proposed Lots 7 and 8, encountered silty clay below about 0.3 metres of topsoil. The Hydrologic soil type was chosen to be Group B for the majority of the site and Group D for the area surrounding Test Pit TP14 in keeping with the Hydrogeological Investigation and Terrain Evaluation Report prepared for the proposed development. A calculation of the CN values for both the pre- and post-development conditions is presented in Appendix A. The difference in soil group classification between Soil Group B (SG B) and Soil Group D (SG D) was accounted for during the weighted average calculation of the CN number for each catchment area.

The CN values used for each catchment area consist of a weighted average value based on the conditions and cover of the ground surface and the soil type in the catchment area. For the purposes of analysis presented in this report, the surface cover was considered to be Open Space (lawns) in good condition (CN = 61 for SG B and 80 for SG D), Woods/brush in good condition (the woods/brush on site is recent re-growth with dense undergrowth) (CN = 55 for SG B and 77 for SG D), Unmaintained and overgrown rear yards and Woods/brush in fair condition (CN = 60 for SG B and 79 for SG D), and Impervious 98. The offsite contributing area to the northwest was considered to be a combination of unmaintained and overgrown rear yards and woods/brush in good condition resulting in a CN of 57.5. The CN values were taken from OSDG Table 5.9 and from the United States Department of Agriculture Urban Hydrology for Small Watersheds Technical Release 55 (USDA TR55).

3.3.2. Impervious Ratio

The impervious ratio for the development consists of the total onsite impervious area divided by the total site area and is equal to 0.836 ha / 8.960 ha = 0.093. The site has an imperviousness of 9.3 percent.

3.3.3. Initial Abstraction and Potential Storage

The initial abstraction includes all losses before runoff begins, and includes water retained in surface depressions, water taken up by vegetation, evaporation, and infiltration. This value is related to characteristics of the soil and the soil cover. Initial abstraction is a function of the potential storage and is generally assumed to be equal to 0.2S where S is the potential storage.

It is considered that for lower CN values, the relationship IA = 0.2S tends to overestimate the initial abstraction resulting in underestimated peak runoff. As such suggested guidelines are as follows:

CN ≤ 70 IA = 0.075S
CN > 70 ≤ 80 IA = 0.10S
CN > 80 ≤ 90 IA = 0.15S
CN > 90 IA = 0.2S

The potential storage S is related to the runoff coefficient as follows:

S = (25400/CN) - 254

The initial abstraction IA and potential storage S values for both the pre- and post-development conditions are also presented in Appendix A.

3.3.4. Time of Concentration and Time to Peak

The time to peak is generally considered to be 2/3rds of the time of concentration of a catchment area. The calculation for the time of concentration of each catchment is summarized in Appendix B. The time of concentration of each catchment was determined using the Velocity method. The velocity method assumes that the time of concentration is the sum of travel times for segments along the hydraulically most distant flow path. The segments used in the velocity method may be of three types: sheet flow T_s, shallow concentrated (overland) flow T_{sc}, and open channel flow T_c. The open channel flow has been modelled using the route Channel Command in OTTHYMO.

3.3.4.1. Travel time for sheet flow

Sheet flow is defined as flow over plane surfaces. Sheet flow usually occurs at the upper end of each individual catchment and typically occurs for no more than 30 metres before transitioning to shallow concentrated flow. The Manning's roughness coefficients used for sheet flow only apply for flow depth of less than 3 cm and vary from those used in shallow concentrated flow and open channel flow.

The travel time for sheet flow is calculated using the simplified Manning's Kinematic solution as follows:

$$T_s = \frac{0.091(nl)^{0.8}}{(P_2)^{0.5}S^{0.4}}$$

Where T_s = travel time, h

n = Manning's roughness coefficient sheet flow

l = sheet flow length,

P_2 = 2-year 24-hour rainfall, = 48 mm

S = Slope of land surface m/m

The Manning's roughness coefficient for sheet flow includes the effects of roughness as well as the effects of raindrop impact, drag over the surface, obstacles such as litter and rocks and transportation of sediment.

The Manning's n for sheet flow ranges from 0.8 for Woods (with dense underbrush and no clearing of deadfall and other detritus) to 0.018 for bare hard packed earth. The Manning's n for grass ranges from 0.15 (short grass prairie or lawn grass with bare patches), 0.24 (dense prairie grasses (long stems grasses)) to 0.41 (Bermuda grass or dense lush lawn grass).

The ground surface conditions during pre-development beginning on the western portion of the site consist of meadow which transitions to deciduous shrub thickets through the center to woodland at the east end of the site. Since the sheet flow occurs at the upper end of the catchment area, the sheet flow during pre-development conditions on site will occur through the meadow portion of the site. As such a Manning's roughness coefficient of 0.24 corresponding to dense prairie grass cover was used for pre-development conditions for the site.

During post-development conditions, The runoff originating on each lot will be divided and will be either directed across the front yard to the roadside ditch or across the back yard to the swale along the rear property lines. Based on the proposed grading plan, it is anticipated that the front yards and the portion of the rear yard beside and immediately behind the proposed dwelling will be completely developed and regraded. These regraded portions of the lot will be surfaced with a maintained lawn upon completion of development. Since the sheet flow portion of the runoff for these catchment areas will occur over the regraded portions of each lot, a Manning's roughness coefficient of 0.4 was used for post-development conditions assuming a maintained lawn with lawn grass in good condition cut to not less than 3 cm in height (It is noted that the average recommended grass height for lawns subjected to cool weather varies from 1.5 to 3 inches or 3 to 7.5 cm).

Shallow concentrated flow was assumed to occur after a maximum of 30 metres on each catchment. The length of sheet flow is expected to end sooner in the catchments were a swale or ditch could intersect the flow.

3.3.4.2. Travel time for shallow concentrated flow

Shallow concentrated flow follows sheet flow and is expected to occur at depths of greater than 3 cm and less than 15 cm. The Manning's roughness coefficients for shallow concentrated or overland flow was obtained from Table 3-5 of the US EPA RM. The flow velocity used to calculate the time of travel for shallow concentrated flow was determined using Table 15-3 and Figure 15-4 of Chapter 15 of the USDA handbook (Included in Appendix B of this Report). Since the ground surface cover descriptions provided on Table 15-3 are agricultural in nature, they do not readily relate to the expected ground surface cover to be encountered in the proposed development. As such, the corresponding Manning's n value provided in Table 15-3 was used to relate the ground surface cover description used in Figure 15-4. From US EPA RM Table 3-5, when considering shallow concentrated flow or overland flow, a Manning's n of 0.075 is used for parks and lawns, 0.09 for dense grass and 0.12 for shrubs and bushes. A Manning's n of 0.202 is used for forest with heavy ground litter and hay meadows.

As previously discussed, it is expected that the shallow concentrated flow during pre-development conditions will occur through shrubs and bushes which corresponds to a Manning's n of 0.12. This value is between the n values corresponding to the descriptions given in Table 15-3 for Minimum tillage and Forest. The flow velocity for both descriptions was obtained from Figure 15-4 for the average slope of the catchment and then liner interpolation was used to determine the flow velocity for a Manning's n of 0.12 as follows:.

Catchment Area C-PRE1 has a slope of 0.9%. From Figure 15-4 the flow velocity assuming minimum tillage n = 0.101 is 0.48 ft/s and for forest n = 0.202 is 0.24 ft/s. Using linear interpolation for n = 0.12 results in a flow velocity of 0.28 ft/s or 0.09 m/s.

During post development conditions, the shallow concentrated flow resulting from runoff generated in the front yards is expected to occur in the side yard swales where the ground surface will be covered with lawn corresponding to a Manning's n of 0.075. Referencing Table 15-4 this n value closely corresponds to the description of Short-grass pasture n = 0.073. The shallow concentrated flow in the rear yards is expected to occur along less defined flow paths than in the front completely regraded portion of each lot. As such, it expected that the grass growth less maintained, will be relatively higher in relation to the flow depth and there will be more litter on the ground surface obstruction the flows. Based on these expected conditions, the Manning's n for the rear yard catchments during post development conditions is expected to be between n = 0.09 and n =0.202. Referencing Table 15-4 an n value of 0.09 closely corresponds to the description of minimum tillage. Flow velocities for minimum tillage and for forest were obtained for each rear yard catchment and averaged to obtain the flow velocity for shallow concentrated flow during post development conditions in the rear yards.

As an example: The slope in Catchment C8 for shallow concentrated flow was determined to be 1.28 m over a distance of 58 m or 0.022. From Figure 15-4 of the USDA Handbook using a slope of 0.022 the velocity is estimated at 0.75 ft/s for minimum tillage and 0.37 ft/sec for forest. Averaging these two values results in a flow velocity of 0.56 ft/s or 0.17 m/s.

$$T_{sc} = \frac{l}{3600\ V}$$

Where T_{sc} = travel time, hrs

l = distance of shallow concentrated flow = 58 m

V = average velocity = 0.17 m/s

T_{sc} = 0.09 hrs

3.3.4.3. Travel time for open channel flow

The open channel flow will be modelled using the route Channel Command in OTTHYMO.

The main channels consist of the roadside ditches and drainage swales. The drainage swales and roadside ditches in the development are channels which were designed to be excavated channels in earth. Further discussion on these channels is included in sections 3.4, 6.2 and 6.3.

3.4. Open Channel Flow

Open Channel Flow will occur in the road side ditches and the storage and conveyance swale extending from the end of the cul-de-sac to Harwood Creek and in the proposed swales along the north, south and east sides of the site.

3.4.1. Conveyance of Offsite Runoff

Sheet flow and shallow concentrated flow from the offsite catchment north of the site will be collected by the proposed shallow swale located along the north side of the proposed development. This flow will be routed along the outside edge of the development to the proposed swale along the east side of the development which will discharge into the outlet swale for the proposed storm water storage facility.

3.4.2. Conveyance of Internal Site Runoff

Internal site runoff will be conveyed along roadside ditches and swales as illustrated on the proposed subdivision grading plans.

3.5. Watershed or Catchment Areas

The catchment areas contributing runoff to the stormwater management works consist of both onsite and offsite catchment areas. The catchment areas used in the design for the proposed subdivision are presented in the attached drawings 200977-PRE and 200977-POST.

3.5.1. Delineation of Offsite Catchment Areas

A review of watershed drainage patterns surrounding the subdivision was completed using the Ministry of Natural Resources and Forestry Ontario Flow Assessment Tool, large scale topographic mapping, the City of Ottawa geoOttawa tool, the Mississippi Valley Conservation Authority Flood Plain Mapping and LIDAR imagery. Based on the information obtained from the above sources it is apparent that runoff is generally directed parallel to the site from Dunrobin Road to the rail corridor east of the site. The flood plain mapping and topographical information provided indicates that there is a 100 year flood plain from the Hardwood Creek which extends onto the lower portion of the site. Runoff is directed towards the flood plain and towards the Harwood Creek. Due to these drainage patterns there are no offsite areas south of the site which contribute runoff to the site.

As indicated by the LIDAR image underlain on the pre-development drawing and topographic information obtained from contours of the adjacent site, a portion of the properties north of the site contribute runoff to the site. The north limit of the off-site catchment, as shown on the pre-development drawing, essentially passes through the high points indicated by the contour lines. Since the north limit is located on the high points, it represents a flow divide with runoff originating north of the line being directed towards Constance Lake Road. Runoff originating on this offsite area south of the high point will be directed towards the site. This offsite area has been delineated on the pre- and post-development drainage plans and is the same for both pre and post conditions.

3.5.2. Delineation of Onsite Catchment Areas

The onsite catchment areas were delineated based on the topography obtained for the site area and on the proposed development. Since the general flow direction during pre-development conditions is from west to east, the onsite pre-development catchment areas were simplified to 2 catchments divided by the approximate centerline of the future roadway.

The catchment areas used in the analysis during post-development conditions for the design of the stormwater management facility are presented in the attached drawing 200977-POST – Post-Development Drainage Plan. These catchment areas have been delineated based on the proposed lot grading and have been divided between front yard and rear yard grading.

4. RECEIVING WATER BODY - HARWOOD CREEK

The headwaters of the Harwood Creek adjacent to the site are located slightly east of the Village of Carp. The Harwood Creek passes through a double barrel box culvert beneath the railway adjacent to the east corner of the site immediately downstream of the site. The proposed stormwater management facility will outlet to the Harwood Creek about 35 metres upstream of the existing box culvert under the former railway. The Harwood Creek outlets to Constance Lake about 1.2 kilometres downstream of the railway culvert. The drainage area of Harwood Creek upstream of the railway culvert was estimated from National Resources Canada Topographic Maps in combination LIDAR imagery and the Ontario Flow Assessment Tool to be about 13 square kilometers.

4.1. Flow Rate and Water Level

The Mississippi Valley Conservation Authority developed a hydraulic (HEC-RAS) model of the Harwood Creek as part of the floodplain mapping works completed for the Harwood Creek. This model was used to determine flood levels at various stations along the Creek. The floodplain mapping shows that the railway culvert is located between River Stations 1023 and 1002 used in the model. The proposed stormwater management facility for the site will discharge into the Harwood Creek between River Stations 1075 and 1023

Flow rates in the Harwood Creek calculated by the model were provided to Kollaard Associates by MVCA for river stations upstream and downstream of the Culvert (Included in Appendix C for Reference). These results indicate that the 100 year flow rate in the Harwood Creek at River Station 1075, upstream of the proposed discharge point for the development, is 14.1 m^3/sec. The 100 year flow rate at River Station 1023, upstream of the railway culvert, is 14.9 m^3/sec and at River Station 1002, downstream of the culvert, is 14.9 m3/sec. The modeled flow depths during the 100 year storm event were 1.38 m, 1.45 m and 1.13 m for River Station 1075, River Station 1023 and River Station 1002 respectively.

The minimum channel elevation determined at time of survey immediately upstream of the box culverts was 72.96 m. The creek channel information available indicates that the average channel slope long the reach of the creek which includes the Railroad culvert is 0.76 percent. Conservatively, a slope of 0.7 percent was assumed for the creek bottom which results in an invert elevation of 72.86 m at the culvert outlet. The above flow depths and channel inverts result in a water surface elevation of 74.41 m upstream of the culvert and 73.99 m downstream of the culvert during a 100 year flow event.

The minimum channel elevation considered in the HEC-RAS Model at River Stations 1023 and 1002 is 73.7 m which is 0.7 m higher than that measured during the topographic surveying. The actual channel elevation determined at the time of survey at River Station 1075 was 73.35 m compared to 73.95 m used in the model.

4.2. Railroad Culvert Capacity

The Harwood Creek passes under the Railroad immediately east of the site between River Stations 1023 and 1002 by means of a double barrel cast-in-place concrete culvert. The existing culvert is a double barreled cast in place “box” culvert with wing walls. The side walls of the culvert are founded on bedrock. The bottom of the barrels consists of native material. The culvert has the following dimensions. Right (south) Barrel 1.6 m high x 2.8 m wide, invert of 72.76, Left (north) barrel 1.4 m high by 2.9 m wide, invert of 72.96, beveled entrance and exits, and 33 degree wing walls. The obverts of the barrels are at an elevation of 74.45 m. This results in an available flow depth of 1.69 m in the south Barrel and 1.49 m in the north Barrel. The centre of the railroad tracks above the culvert is at an elevation of 75.8 m.

The flow capacity of the Box culvert was modeled using the Hydroflow Express Extension of Autodesk Civil 3D. The results of the modeling are included in Appendix C. The culvert was modeled as a double barreled culvert with spans of 2.8 m and a height of 1.4 metres representing the smallest width and height combination of the actual size of the barrels. The above inlet invert and assumed outlet invert results in bottom slope of 0.7 percent. It is noted that the average creek bottom slope along the reach including the railway culvert is 0.76 percent.

The analysis was first completed assuming tailwater conditions equal to 73.99 m. The analysis was repeated assuming normal tailwater conditions.

The analysis completed assuming tailwater conditions equal to 73.99 m results in inlet control with a headwater depth of 1.36 m and a tailwater depth of 1.2 m during a 100 year flow event.

The analysis completed assuming normal tailwater conditions results in inlet control with a headwater depth of 1.36 m and a tailwater depth of 0.9 m during a 100 year flow event.

Both analyses resulted in inlet control with a headwater depth of less than the height of the culvert. This matches the flow depth expectation based on the HEC-RAS Modeling and demonstrates that the existing box culverts have sufficient capacity to accommodate the 100 year flow rate in the Harwood Creek without surcharge and the outlet from the proposed development will not be affected by flow restriction in the downstream box culverts.

4.3. Risk on Development from Flood Levels in the Harwood Creek

4.3.1. Existing Conditions

Information obtained from site reconnaissance and from residents in the surrounding areas indicates that, the lower elevations of the site are subject to flooding during the spring and as a result of damming of the creek by beavers. The existing ground surface elevation at the relatively level lower portion of the site ranges in elevation from about 74.9 to about 75.4 metres and extends southwest of the rear property line some 90 metres along the northeast side of the site and some 110 metres along the southeast side of the site. This lower area is also a backwater of Harwood Creek.

Flood plain mapping obtained from the MVCA indicates that the site is subject to a backwater flood plain from the Harwood Creek that has a 100 year flood plain elevation of 75.48 m. The extent of this flood plain on the site is illustrated on Kollaard Associates drawing 200977-PRE.

4.3.2. Mitigation of Flood Risk

In order to facilitate the proposed development of the two lots affected by the backwater flood plain, fill material will be placed to raise the ground surface to a minimum of 75.5 m within the area proposed for development. The proposed ground surface will slope upward from the minimum grade towards the proposed dwelling and septic area footprints resulting in elevations of 77.20 metres over the septic bed and 77.5 metres adjacent the proposed dwellings. This fill will remove the development area from the flood plain backwater. The existing flow through the flood plain backwater will be re-routed around the south east side of the fill to maintain the drainage of the property and the rear yards of the adjacent properties. A permit for placement of fill within the flood plain will be applied for as part of the development process in order to remove the developed portion of the subdivision from the flood plain.

The proposed dwellings will be constructed with a minimum underside of footing elevation of 75.80 metres. The proposed septic leaching beds should be constructed with a minimum tile elevation of 76.35 metres. The proposed area for development is above an elevation of 75.45 metres. It is intended that wells will be installed on the upslope side of the dwellings adjacent the lower level of the site.

4.4. Effect of Development on Flood Levels in Harwood Creek and Surrounding Area.

4.4.1. Placement of Fill in the Flood Plain

A detailed discussion of the effects of the removal of the backwater flood plain from the Harwood Creek by means of the proposed fill placement has been discussed by JFSA in a separate report and has been included in Appendix D. As indicated in Section 4.1 above, the proposed discharge location from the development is between Harwood Creek River Stations 1075 and 1023 (Station Information is provided on the 37th page of the JFSA document). The next upstream cross section analyzed was at River Station 1214. From the analysis provided by JFSA in Tables A-1 and A-2 the results of the HEC-RAS analysis for both the existing conditions and the conditions following the proposed filling of the backwater flood plain for all three of these river stations are identical. The 100 year water surface elevations varies from 75.48 m at River Station 1214, to 75.36 m at River Station 1130 and 75.15 at River Station 1023 indicating that the 100 year water surface elevation in the Creek is a function of the hydraulic capacity of the creek and not downstream flooding. The results of the analysis indicate that the proposed filling of the backwater flood plain has no negative impact on the existing hydraulic operations of the Creek since the 100 year levels and the 100 year gradient does not change between existing and proposed conditions. This is further indicated by JSFA in their report as quoted below.

In their report, JFSA provided the following conclusions:

> *"JFSA has assessed the potential impacts of filling the area within 2050Dunrobin Road, which is currently mapped as a floodplain in MVCA's recent floodplain mapping study. Based on updated HEC-RAS modelling, which assumes these lands are filled, JFSA has demonstrated that there is no increase in peak water level. It was noted that 1D HEC-RAS models are not well suited to assessing/simulating the complexities of lateral spills, and as such the floodplain storage lost due to filling these lands was approximated using 2020 LiDAR obtained from the City of Ottawa and the MVCA's simulated 100-year water surface elevation over these lands. Based on this analysis, it was found that filling the floodplain bulge on these lands will result in an approximate reduction in storage volume by 1,131 m^3 or 0.36% of the Harwood Creek 100-year floodplain. As such JFSA concludes that the proposed*

filling within the subject property will have no adverse impacts on the existing hydraulic operations of Harwood Creek."

Based on the modeling and calculations completed by JFSA, the placement of the fill within the backwater flood plain will have no negative impact to the Harwood Creek and surrounding properties including the existing wells and septic systems on the surrounding properties.

4.4.2. Affect of the Development During Storm Events

As demonstrated in the following Section 7 of this report, the post-development flow rates will be less than the calculated pre-development flow rates for all design storm events. In addition, as demonstrated in Section 8 of this report, the calculated stormwater runoff volume will be less than pre-development conditions during a normal storm event, negligible during minor storm events and only slightly higher than pre-development conditions during a 100 year storm event. As such, it is considered that the runoff from the proposed development will have no effect on the water level in the Harwood Creek during the design storm events.

Based on the above, it is considered that there will be no flood risk to the proposed development from the Harwood Creek during various storm events up to and including the 100 year storm events provided there are no extraneous circumstances such as damming of the creek downstream of the site. It is also considered that the proposed development will not affect adjacent landowners by increasing flood elevations.

5. PRE-DEVELOPMENT STORMWATER ANALYSIS

5.1. Adjacent Off Site Properties

5.1.1. Delineation of Catchments

As previously indicated, the site is located on the east side of Dunrobin Road in the City of Ottawa. The site is continuously sloped downward from the edge of Dunrobin Road towards the former railway along the east side of the development. The predominate slope is oriented perpendicular to Dunrobin Road. There is a slight cross slope towards the southeast such that the runoff at the east end of the site is directed to the Hardwood Creek located south of the site.

The existing road side ditch between the shoulder of Dunrobin Road and the site is poorly defined with minimal back slope at many locations. As a result, all of the runoff generated from the north bound lane of Dunrobin Road and from the ditch along the east side of the road is considered to travel across the site. Catchment areas C-A and C-B have been used to model the runoff contributed from Dunrobin Road during both pre- and post-development conditions. C-A includes the portion of the east lane and shoulder of Dunrobin Road as well as the east roadside ditch adjacent the site, north of the proposed site entrance. C-B includes the portion of the east lane and shoulder of Dunrobin Road as well as the east roadside ditch adjacent the site, south of the proposed site entrance. C-A and C-B are used to model the contribution to the site from Dunrobin Road during both pre- and post-development conditions.

As indicated by the LiDAR image underlain on the pre-development drawing and topographic information obtained from contours of the adjacent site, a portion of the properties north of the site contribute runoff to the site. The north limit of the off-site catchment as shown on the pre-development drawing essentially passes through the high points indicated by the contour lines. Since the north limit is located on the high points, it represents a flow divide with runoff originating north of the line being directed towards Constance Lake Road. Runoff originating on this offsite area south of the high point will be directed towards the site. This off site area has been delineated on the pre- and post-development drainage plans as catchment area C-OFF1 and is the same for both pre and post conditions.

During pre-development conditions, runoff from C-OFF1 is directed across the site by a shallow swale which outlets to the Harwood Creek. A review of aerial photographic images of this catchment indicates that C-OFF1 is predominately surfaced with a mixture of lawn, unmaintained rear yards (grass/brush) and woods/brush with the upper portion of the catchment consisting of unmaintained rear yards.

Catchment C-OFF1 is indicated in both the pre- and post- development drawings to include the Dunrobin Road allowance to the center of the Roadway. As such the portion of Dunrobin Road north of the site that could contribute runoff to the site is included in Catchment C-OFF1. There is not runoff contributed to the site from Dunrobin Road south of the site. Catchments C-A, C-B and C-OFF1 are considered to include the entire runoff contribution from Dunrobin Road to the Site.

Runoff from the adjacent property to the south flows in a southeasterly direction to the Harwood Creek and does not contribute to the site.

5.1.2. Catchment Area Curve Numbers

As indicated in Section 3 of this report, the analysis was completed using Visual OTTHymo which uses the Runoff Curve Number CN as opposed to the runoff coefficient commonly used in combination with the Rational Method. Also as indicated in Section 3, the hydrologic soil group was considered to be Group B and the various ground surface covers and associated Curve Numbers are considered to be: Open Space (lawns) in good condition 61; Woods/brush in good condition (the woods/brush on site is recent re-growth with dense undergrowth) 55; Unmaintained and overgrown rear yards and Woods/brush in fair condition 60; and Impervious 98. These Runoff Curve Numbers would correspond to runoff coefficients as follows: CN of 61 ≈ n of 28; CN of 60 ≈ n of 25; CN of 55 ≈ n of 14; CN of 98 ≈ n of 0.99.

The Runoff Curve Number for each off site pre-development catchment area was calculated using a weighted average of the ground surface covers within each catchment as shown in the following Table 5-1.

Table 5-1 Pre-Development Runoff Curve Numbers – Offsite Areas

Catchment	Surface	Area Ha	CN	Weighted Average CN
C-OFF1 (1.68 ha)	Unmaintained Rear Yard	0.80	60	59.5
	Wood/brush good cond.	0.88	55	
	Impervious	0.04	98	
C-A (0.17 ha)	Open Space (grass)	0.11	61	73.9
	Impervious	0.06	98	
C-B (0.17 ha)	Open Space (grass)	0.11	61	73.9
	Impervious	0.06	98	

5.2. On Site Pre-Development Catchments

5.2.1. Onsite Conditions

As previously indicated, the property is generally rectangular with an about 160 m long projection towards the southeast along the existing railway corridor.

Historical imagery available on the geoOttawa website indicates that the site was historically occupied by farmland with a dwelling and outbuildings. These images show that no significant agricultural activity was carried out on the site within the last 20 to 30 years or more and that the dwelling has been abandoned. The ground surface across the site has a general downward slope of about 0.3 to 2 percent from the southwest end of the property to the northeast. Current site drainage takes the form of sheet and shallow concentrated flow following the general slope of the site.

The vegetative communities on the southwest portion of the site predominately consisted of Forb Meadow which transitions to Buckthorn Deciduous Shrub Thickets through the central portion of the site. The northeast end of the site adjacent the railway corridor is occupied by fresh-moist poplar deciduous woodland.

Harwood Creek Crosses the eastern most portion of the 160 m long projection of the property. This projection is almost entirely occupied by the 100 year flood plain of the Harwood Creek. A tailwater section of the Flood Plain extends on the site covering a significant portion of the eastern about 100 metres of the site.

5.2.2. Onsite Delineation Catchments and Curve Numbers

As previously indicated, since the general flow direction during pre-development conditions is from west to east, the onsite pre-development catchment areas were simplified to 2 catchments divided by the approximate centerline of the future roadway. Based on the ground surface cover the Runoff Curve Numbers for the onsite pre-development conditions are as shown in Table 5-2.

Table 5-2 Pre-Development Runoff Curve Numbers – Onsite Areas

Catchment	Surface	Area Ha	CN	Weighted Average CN
C-PRE1 (4.31 ha)	Brush fair condition	1.44	60	60.0
	Open Space (grass)	1.43	61	
	Wood/brush good cond.	1.17	55	
	Wood/brush good cond.	0.27	77	
C-PRE2 (4.65 ha)	Brush fair condition	1.55	60	60.1
	Open Space (grass)	1.55	61	
	Wood/brush good cond.	1.25	55	
	Wood/brush good cond.	0.30	77	

5.3. Pre-Development Runoff

As previously indicated, the runoff criteria from a quantity control perspective were given as: post-development peak runoff rates are to be equal to or less than pre-development levels for all quantity control storms up to and including the 100 year storm event; and surface runoff volumes are to be minimized through infiltration techniques.

The pre-development peak runoff rate and runoff volume were calculated using the OTTHYMO model. Table 5-3 summarizes the pre-development peak runoff rate and runoff volumes calculated using the OTTHYMO model. Appendix E contains pre-development OTTHYMO summary output data as well as the detailed output data for the last link in the model. The detailed output data for the last link provides a summary of the predevelopment outflow from the proposed development including off site catchment areas.

Table 5-3: Pre-Development Runoff Rates and Runoff Volumes

Design Storm Event		Pre-Development Runoff Rate	Runoff Volume
		(m^3/s)	(mm)
Sim 1	6 hour 5 year SCS Type II	0.093	6.78
Sim 2	6 hour 100 year SCS Type II	0.333	22.64
Sim 3	12 hour 5 year SCS Type II	0.107	9.18
Sim 4	12 hour 10 year SCS Type II	0.160	13.21
Sim 5	12 hour 100 year SCS Type II	0.351	27.47
Sim 6	12 hour 2 year Chicago	0.039	4.33
Sim 7	12 hour 100 year Chicago	0.325	26.31
Sim 8	Historical Storm July 1, 1979	0.434	21.09
Sim 9	Historical Storm August 4, 1988	0.344	19.38
Sim 10	25mm 4 hour Chicago	0.009	0.78
Sim 11	120% 12hr 100 year Chicago	0.475	37.16

6. POST-DEVELOPMENT MODEL

6.1. Post-Development Catchment Areas

6.1.1. Adjacent Off Site Properties

The offsite catchment areas delineated in section 5.1.1 will not be significantly altered as a result of the proposed development. As such, the offsite catchments delineated to model pre-development conditions were used without alteration in the post-development model.

6.1.2. Onsite Post-Development Catchment Areas

6.1.2.1. Post-development Conditions

The proposed development has a total site area of approximately 9.0 hectares and will be divided into eight residential lots with a minimum lot size of 0.8 hectares for a single family dwelling construction. During post-development conditions, the runoff originating on each lot will be divided and will be either directed across the front yard to the roadside ditch or across the back yard to the swale along the rear property lines. Based on the proposed grading plan, it is anticipated that the front yards and the portion of the rear yard beside and immediately behind the proposed dwelling will be completely developed and regraded. These regraded portions of the lot will be surfaced with a maintained lawn upon completion of development. The remaining areas of the rear yards are expected to be left in a more natural condition resulting in an unmaintained condition.

6.1.2.2. Delineation of Catchments and Runoff Curve Numbers

In order to model the post-development conditions onsite, the proposed development area was divided into a total of 16 catchment areas. These catchments were delineated on a lot by lot basis such that the area of each lot draining towards the proposed road was considered as one catchment and the lot area directing runoff to the rear of the lot was considered as a second catchment for each lot. It is considered that the runoff from the roofs of the proposed dwellings will be split with runoff the back half of the dwelling being directed to the backyard while the runoff from the remainder of the dwelling and garage is directed to the front yard. The half of the road allowance for the proposed roadway immediately adjacent each lot was also included within the front yard catchment.

Based on the ground surface cover the Runoff Curve Numbers for the onsite post-development conditions are as shown in Table 6-1.

Table 6-1: Post-Development Runoff Curve Numbers – Onsite Areas

Catchment	Total Area (ha)	Maintained Lawn CN		Impervious CN=98	Unmaintained Rear Yard CN		Wood Good Cond. CN		Weighted Average CN
		61	80		60	79	55	77	
		Area (ha)		Area (ha)	Area (ha)		Area (ha)		
C1	0.496	0.080	0.0	0.030	0.386	0.0	0.0		62.5
C2	0.503	0.080	0.0	0.030	0.393	0.0	0.0		62.4
C3	0.510	0.080	0.0	0.030	0.400	0.0	0.0		62.4
C4	1.676	0.510	0.035	0.030	0.661	0.190	0.206	0.044	63.4
C5	1.408	0.470	0.075	0.030	0.444	0.203	0.164	0.022	64.6
C6	0.501	0.120	0.0	0.030	0.351	0.0	0.0		62.5
C7	0.501	0.080	0.0	0.030	0.391	0.0	0.0		62.4
C8	0.493	0.080	0.0	0.030	0.383	0.0	0.0		62.5
C9	0.359	0.287	0.0	0.072	0.0	0.0	0.0		68.4
C10	0.376	0.304	0.0	0.072	0.0	0.0	0.0		68.1
C11	0.377	0.305	0.0	0.072	0.0	0.0	0.0		68.1
C12	0.295	0.158	0.055	0.082	0.0	0.0	0.0		74.8
C13	0.340	0.134	0.124	0.082	0.0	0.0	0.0		76.8

C14	0.363	0.291	0.0	0.072	0.0	0.0	0.0		68.3
C15	0.376	0.304	0.0	0.072	0.0	0.0	0.0		68.1
C16	0.387	0.315	0.0	0.072	0.0	0.0	0.0		67.9

6.1.2.3. Comparison of Pre- to Post- Development Onsite Conditions

As previously indicated, the pre-development onsite catchments were divided about the centre of the proposed roadway. The above catchments were combined into two post-development areas matching the pre-development catchments in order to directly compare the pre- and post- development runoff curve numbers to illustrate the affect of the proposed development on the Runoff Curve Numbers. This comparison is provided in Table 6-2.

Table 6-2: Comparison of Pre- to Post-Development Runoff Curve Numbers

Catchment	Total Area (ha)	Maintained Lawn CN = 61 / CN = 80	Impervious CN=98	Unmain. Rear Yard CN = 60 / CN = 79	Wood Good Cond. CN = 55 / CN = 77	Weighted Average CN
		Area (ha)	Area (ha)	Area (ha)	Area (ha)	
North Side						
C-PRE1	4.311	1.437 /	0.000	1.437 /	1.168 / 0.269	60.0
Post	4.311	1.804 / 0.130	0.418	1.569 / 0.203	0.164 / 0.022	65.5
South side						
C-PRE2	4.650	1.550 /	0.000	1.550 /	1.249 / 0.301	60.1
Post	4.650	1.793 / 0.159	0.418	1.839 / 0.190	0.206 / 0.044	65.2

6.2. Stormwater Conveyance

6.2.1. Proposed Swales

Runoff for each lot will be managed as follows: Runoff originating from the front portion of each lot including all the impervious areas resulting from the construction of the driveways, attached garages and front half of the proposed dwellings will be directed to the road side ditches along the subdivision roadway. This runoff will be conveyed to the stormwater storage swale which extends east from the end of the cul-de-sac.

Any disturbed areas in the rear portion of the site will be rehabilitated and leveled to ensure any runoff is in the form of sheet flow. The sheet flow from the rear of the sites along the south side of the development will be directed to a proposed swale along the south side of the site. This swale will discharge into the outlet swale downstream of the outlet control in the stormwater storage swale. Runoff from the rear of the sites along the northwest side of the development as well as from the off-site area northwest of the development will be directed by means of a drainage swale constructed along the rear property lines of these lots. The swale will discharge to the outlet swale extended from the outlet control structure following the stormwater storage swale and will replace the existing swale currently directing this runoff to the Harwood Creek.

6.2.2. Permeability of Native Soils along Proposed Swales

Permeability testing was completed on the native glacial till materials along the north and south sides of the proposed development and within the area of the proposed stormwater storage swale. The test results are included in Appendix F. The test results indicate that the permeability k for the native soils at the site at the north and south sides of the site ranges from 1.26×10^{-6} m/s to 9.44×10^{-7} m/s. The permeability of the native soils in the area of the proposed stormwater storage swale was determined to be 1.64×10^{-7} m/s. It is noted that the permeability of a soil and the hydraulic conductivity of water in the same soil have the same value.

The following table obtained from Appendix C of the CVC LID guide indicates the relationship between the Percolation Time, Coefficient of Permeability and Infiltration Rate.

Table C1: Approximate relationships between hydraulic conductivity, percolation time and infiltration rate

Hydraulic Conductivity, K_{fs} (centimetres/second)	Percolation Time, T (minutes/centimetre)	Infiltration Rate, 1/T (millimetres/hour)
0.1	2	300
0.01	4	150
0.001	8	75
0.0001	12	50
0.00001	20	30
0.000001	50	12

Source: Ontario Ministry of Municipal Affairs and Housing (OMMAH). 1997. Supplementary Guidelines to the Ontario Building Code 1997. SG-6 Percolation Time and Soil Descriptions. Toronto, Ontario.

From the above comparison, the native soils at the site would have an estimated infiltration rate of 30 to 50 mm/hr and a Percolation Time T of 12 to 20 minutes.

6.2.3. Limits to Longitudinal Slope of Swales

The swale along the north side of the proposed development is required to intersect and convey off site runoff occurring during the existing conditions. This means that the bottom of the swale plus a minimum swale depth must be below the existing ground surface. This results in a maximum elevation at the start of the channel section due to actual physical constraints which cannot be altered because the constraints are established by the ground surface elevation of the adjacent private property. The outlet elevation is fixed by the normal flow conditions and bottom elevation of the receiving water course. In a similar manner, the maximum bottom of swale elevation along the south side of the site is also fixed by existing conditions and is limited such that the bottom of the swale is below the existing ground surface in order to receive runoff from the adjacent surface areas.

Due to these limiting constraints there will be sections of the proposed swales with longitudinal slopes of 0.3% which meets the criteria for minimum allowable slope but is less than the minimum recommended longitudinal slope of 0.5%. It is considered that these low slopes in the swales will result in insufficient slope to ensure that there are no localized high or low spots within the swale channel. In order to prevent ponded water in the localized depressions along the bottom of the swale, a 150 mm diameter perforated subdrain complete with clearstone wil be installed along the swale bottoms. The clearstone and perforated drain will have a depth of 0.4 metres below the bottom of the swale. The clearstone and perforated drain will ensure any ponded water within the swale is within the clearstone below the ground surface. The clearstone and subdrain should be installed in the rear yard and side yard swales where the slope is less than 1.0%. The resulting swales will essentially be a design variation of the enhanced grass swales specified in CVC LID guide as they will incorporate a perforated pipe underdrain

A subdrain in keeping with the City of Ottawa Drawing S9 is not considered to be suitable and is not recommended for the swales at the site due to the depth of the S9 profile and the cross sectional design. The minimum profile depth of the section specified by S9 would be about 750 mm which places the subdrain profile in close proximity to or on the underlying bedrock.

Due to the elevation difference between the bottom of the perimeter swales and the receiving water course there will be no outlet for the subdrains. The subdrains are intended to prevent surface ponding and intermittent ponding along the length of the swales. The subdrains will ensure that any ponding is within the clearstone below the bottom of the swales eliminating any standing water along the rear of the lots. Some overflow of the subdrain into the bottom of the swale and potential for ponding water above the subdrain does exist at the outlet end of the swale. This will be within the City of Ottawa Stormwater Block and will be some 70 metres from the closest residential Lot.

6.2.3.1. Duration of Ponding in Swales

Since the clearstone and perforated pipe underdrain below the swales have no outlet, discharge from the clearstone and underdrain will be by infiltration only. The length of time for the water trapped within the clearstone to fully infiltrate can be estimated by rearranging the equation below provided in CVC LID guideline to calculate the maximum thickness of clearstone below subdrains and chamber systems.

$d_{r\ max} = i * t_s/V_r$

where: $d_{r\ max}$ = Maximum stone depth (mm)

i = Infiltration rate for native soils (mm/hr) = 30 mm/hr

V_r = Void space ratio for aggregate used = 0.4

t_s = Time to drain

$d_{r\ max}$ = 400 mm

Conservatively, it has been assumed that the infiltration rate for the soils is equal to the lowest rate determined by the permeability testing and is 30 mm/hr.

With a stone thickness of 400 mm and an infiltration rate of 30 mm/hr, rearranging the above equation results in a time to drain of 5.3 hours.

If there was an additional 150 mm of standing water above the clearstone and underdrain, the additional time to drain could be calculated using the above equation with the void space ratio set to 1. The additional time to drain of 150 mm of standing water above the clearstone would be 5 hours.

The total time for the water to infiltrate following a rainfall event would be less than 24 hours which is less than the time required for one mosquito breeding cycle.

6.2.4. Description of Main Swales

There are five main swales proposed for the site. These swales consist of:

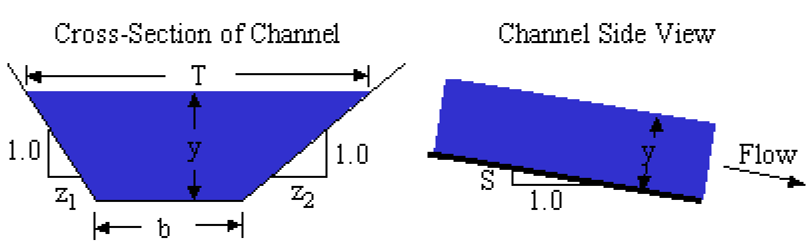
1. The north swale begins near Dunrobin Road and is located along the north side of the site. A review of the proposed grading plan indicates that the flow in the Dunrobin Road ditch adjacent the north half of the site is directed to the proposed roadside ditch along the north side of the proposed roadway. Based on the proposed grading, the flow in the north swale will be negligible at the west end or beginning of the swale and will increase

in magnitude to a maximum at the east end of the swale. The north swale has a bottom width of 1.0 m and a slope which ranges from 2.4% to 0.3%. With the exception of the first about 20 m, the swale depth ranges from about 0.4 m to 0.7 m.

2. The south swale begins near Dunrobin Road and is located along the south side of the site. A review of the proposed grading plan indicates that the flow in the Dunrobin Road ditch adjacent the south half of the site is directed to the proposed roadside ditch along the south side of the proposed roadway. Based on the proposed grading, the flow in the south swale will be negligible at the west end or beginning of the swale and will increase in magnitude to a maximum at the east end of the swale. The south swale has a bottom width of 1.0 m and a slope which ranges from 3.2% to 0.3%. With the exception of the first about 20 m, the swale depth ranges from about 0.32 m to 0.7 m.
3. The east swale continues from the north swale at the northeast corner of the site and discharges into the outlet swale at about the center of the east end of the site. The east swale has a bottom width of 1.0 m and a slope of 0.3%. The swale depth ranges from about 0.49 m to 0.7 m.
4. The stormwater storage swale begins at the east end of the cul-de-sac and discharges into the outlets swale near the east end of the site. The stormwater storage swale will be discussed in detail in Section 7.2.
5. The outlet swale begins at the east end of the storage swale, extends east to the east end of the site then south to discharge into Harwood Creek. The outlet swale receives flow from the storage swale, north swale and south swale at various points along its length. The outlet swale has a bottom width of 1.0 m and a slope which ranges from 1.5% to 0.4%. The swale depth ranges from 0.7 m to 1.5 m.

6.2.5. Capacity and Flow Level in the Main Swales

The capacity and flow depth were determined using the equations for open channel flow shown below. A Manning's roughness coefficient for open channel flow of n = 0.035 was obtained from the OSDG Appendix 6-C assuming an earth channel with a fairly uniform section that will not be maintained resulting in dense weeds and grass. The swales will in general have side slopes of 3H to 1V.



$$Q=VA \qquad V=\frac{k}{n}R^{2/3}S^{1/2} \qquad R=\frac{A}{P} \qquad A=\frac{y}{2}(b+T)$$

$$P=b+y\left(\sqrt{1+z_1^2}+\sqrt{1+z_2^2}\right) \qquad T=b+y(z_1+z_2)$$

$$F=V\sqrt{\frac{T}{gA\cos\theta}} \qquad \theta=Tan^{-1}(S)$$

The design storm events are listed below and abbreviated in the table as follows:

12 hour 2 year SCS Type II - 12-2
12 hour 10 year SCS Type II - 12-10
12 hour 100 year SCS Type II - 12-100

Swale sections are abbreviated in the table as follows:
North swale behind Lot 1 is North 1; South swale behind Lot 2 is South 2; Outlet Swale between Lot 7 and Lot 8 is Outlet 7/8 etc. The swale sections are labelled on the site servicing plan.

The following Table 6-3 provides a summary of the capacity and flow level along the above swales for the 10 year and 100 year SCS Type II design storms.

Table 6-3: Capacity and Flow Level in Main Swales

Swale Section	Storm Event	Contributing Catchment / Swale Section	Flow Rate	Flow Depth	Flow Vel.	Min. Slope	Min. Available Depth	Min Capacity
			m^3/sec	m	m/s	%	m	m^3/sec
North 1	12-10	C8	0.02	0.07	0.26	0.4	0.44	0.77
	12-100		0.04	0.10	0.33			
North 3	12-10	North 1 + C7	0.03	0.08	0.32	0.5	0.55	1.39
	12-100		0.07	0.12	0.42			
North 5	12-10	North 3 + C6	0.04	0.09	0.32	0.4	0.31	0.37
	12-100		0.09	0.15	0.45			
North 7	12-10	North 5 + C5	0.10	0.17	0.39	0.3	0.35	0.41
	12-100		0.22	0.25	0.48			
South 2	12-10	C1	0.02	0.04	0.42	1.8	0.58	2.97
	12-100		0.04	0.06	0.53			
South 4	12-10	South 2 + C2	0.03	0.07	0.36	0.7	0.61	2.07
	12-100		0.07	0.11	0.47			
South 6	12-10	South 4 + C3	0.04	0.10	0.29	0.3	0.48	0.80
	12-100		0.10	0.17	0.39			

South 8	12-10	South 6 + C4	0.08	0.15	0.36	0.3	0.32	0.34
	12-100		0.17	0.22	0.45			
East 7	12-10	North 7	0.10	0.17	0.39	0.3	0.38	0.49
	12-100		0.22	0.26	0.49			
Outlet 7/8	12-2	Storage Swale (SS)	0.01	0.03	0.32	1.5	0.7	4.12
	12-10		0.03	0.06	0.48			
	12-100		0.10	0.11	0.68			
Outlet 8	12-2	East 7 + SS	0.02	0.07	0.27	0.4	0.94	3.78
	12-10		0.12	0.18	0.45			
	12-100		0.29	0.27	0.58			
Outlet SE Corner	12-2	Outlet 8 + South 8	0.04	0.10	0.33	0.4	0.8	2.88
	12-10		0.15	0.20	0.49			
	12-100		0.33	0.29	0.6			

The above summary of results, which indicates the flow depth during various storm events as well as the available depth along each section of the swales, demonstrates that the flow from the 100 year storm event will be conveyed within the drainage swales without overflow.

6.3. Conveyance Along Roadside Ditches

6.3.1. Proposed and Existing Ditches

As previously indicated, the runoff from the front of each lot will be conveyed along the proposed roadside ditches to the stormwater storage swale extending east from the cul-de-sac. The ditch along the north side of the proposed roadway will receive runoff from the section of ditch along the east side of Dunrobin Road immediately west of Lot 1 and from the front of Lots 1, 3, 5 and 7. The ditch along the south side of the proposed roadway will receive runoff the section of ditch along the east side of Dunrobin Road immediately west of Lot 2 and from the front of Lots 2, 4, 6 and 8.

The existing ditch along the east side of Dunrobin Road adjacent the site has a discontinuous longitudinal slope. The height of the back slope along this section varies along the existing ditch from undefined to about 0.3 metres in height. In order to prevent stormwater runoff originating on public property from flowing across private land, the east ditch of Dunrobin Road will be re-sloped adjacent to Lot 1 and Lot 2 to direct the runoff to the ditches along the proposed roadway. The height of the back slope will be increased to a minimum of 0.5 metres to prevent runoff from the public road being directed onto private lands.

The ditches along the proposed roadway have been designed with a “V” shaped bottom and have 3H:1V side slopes. With the exception of the portion of the ditch along the north side of the proposed roadway to Station 0+080 and the ditches around the proposed cul-de-sac, the ditches for the proposed roadway have been designed to have a slope greater than 1%. The slope along the first section of the north ditch was reduced in order to facilitate continuous drainage of the ditch along the east side of Dunrobin Road adjacent to Lot 1. The slope of the ditch around the cul-de-sac has been reduced to between 0.9% and 0.2% in order to maintain a bottom elevation above the 100 year flood level of the backwater flood plain.

The proposed slope of the re-graded ditch bottom along Dunrobin road varies from 0.5% south of the proposed roadway to 0.3% north of the proposed roadway. The bottom slope of the ditch is limited by the existing grades.

6.3.2. Limits to Longitudinal Slope of Ditches

As discussed in Section 6.2.2 above, the constraints cause by existing conditions external to the proposed development will limit the slope of some sections of the ditch to less than 1% and less than 0.5% in some cases. As discussed above, this reduced slope will likely result in some discontinuous positive grading in the downstream direction which in turn will result in localized ponding at the bottom of the ditches. It is considered that the depth of this ponding will be limited by the relative difference between the undulations and that the ponding will occur during any rainfall event of significant magnitude to generate runoff. The duration of the ponding is expected to be limited.

6.3.3. Capacity and Flow Level in the Ditches

The capacity and flow depth were determined using the equations for open channel flow provided above. A Manning's roughness coefficient for open channel flow of n = 0.03 was obtained from the OSDG Appendix 6-C assuming an earth channel with a fairly uniform section that will be moderately maintained resulting in grass, some weeds.

The Ditch sections are abbreviated in the table as follows:
Ditch along the east side of Dunrobin Road west of Lot 1 is Dunrobin 1; The proposed ditch along the south side of the proposed road adjacent to Lot 2 is South D2; The proposed ditch along the north side of the proposed road adjacent to Lot 1 is North D1 etc. The ditch sections are labelled on the site servicing plan.

The following Table 6-4 provides a summary of the capacity and flow level along the proposed and regraded ditches for the 2 year, 10 year and 100 year SCS Type II design storms.

Table 6-4: Capacity and Flow Level in Proposed Ditches

Ditch Section	Storm Event	Contributing Catchment / Ditch Section	Flow Rate	Flow Depth	Flow Vel.	Min. Slope	Min. Avail. Depth	Min Capacity
			m^3/sec	m	m/s	%	m	m^3/sec
Dunrobin 1	12-10	CA	0.01	0.11	0.23	0.3	0.5	0.52
	12-100		0.02	0.14	0.28			
Dunrobin 2	12-10	CB	0.01	0.09	0.27	0.5	0.5	0.68
	12-100		0.02	0.13	0.34			
North D1	12-10	Dunrobin 1 + C9	0.02	0.14	0.28	0.3	0.81	1.89
	12-100		0.04	0.19	0.33			
North D3	12-10	North D1 + C10	0.04	0.14	0.53	1.1	0.82	3.76
	12-100		0.07	0.18	0.62			
North D5	12-2	North D3 + C11	0.02	0.11	0.41	0.9	0.80	4.32
	12-10		0.05	0.16	0.52			
	12-100		0.1	0.22	0.62			
North D7	12-2	North D5 + C12	0.02	0.13	0.34	0.5	0.81	3.31
	12-10		0.06	0.2	0.44			
	12-100		0.13	0.27	0.53			
South D2	12-10	Dunrobin 2 + C16	0.02	0.11	0.46	1.1	0.83	3.88
	12-100		0.05	0.16	0.57			
South D4	12-10	South D2 + C15	0.04	0.14	0.53	1.1	0.84	4.01
	12-100		0.07	0.18	0.62			
South D6	12-2	South D4 + C14	0.02	0.11	0.41	0.9	0.81	4.45
	12-10		0.05	0.16	0.52			
	12-100		0.1	0.22	0.62			
South D8	12-2	South D6 + C13	0.02	0.12	0.36	0.6	0.83	3.84
	12-10		0.07	0.2	0.48			
	12-100		0.14	0.27	0.59			

The above results, which indicate the flow depth for various storm events as well as the minimum available depth along each section of the ditches, demonstrate that the flow from the 100 year storm event is conveyed within the ditches. It is noted that the above Table 6-4 is not intended to indicate the elevation of the 100 year flood level in the ditch resulting from the outlet restriction and subsequent ponding of the downstream stormwater storage swale. The table is intended to illustrate that the roadside ditch has sufficient capacity to convey the flow arising from various storm events within the road right of way.

6.4. Unmitigated Post-Development Runoff

The post-development peak runoff rate and runoff volume were calculated using the OTTHYMO model assuming no mitigation or detention and storage of the runoff. Table 6-5 summarizes the unmitigated post-development peak runoff rate and runoff volumes calculated using the OTTHYMO model.

Table 6-5: Unmitigated Post-Development Runoff Rates and Runoff Volumes

Design Storm Event		**Post-Development Runoff Rate**	**Runoff Volume**
		(m^3/s)	**(mm)**
Sim 1	6 hour 5 year SCS Type II	0.166	8.79
Sim 2	6 hour 100 year SCS Type II	0.574	26.99
Sim 3	12 hour 5 year SCS Type II	0.205	11.62
Sim 4	12 hour 10 year SCS Type II	0.302	16.29
Sim 5	12 hour 100 year SCS Type II	0.637	32.38
Sim 6	12 hour 2 year Chicago	0.081	5.83
Sim 7	12 hour 100 year Chicago	0.630	31.09
Sim 8	Historical Storm July 1, 1979	0.762	25.25
Sim 9	Historical Storm August 4, 1988	0.696	23.32
Sim 10	25mm 4 hour Chicago	0.016	1.31
Sim 11	120% 12hr 100 year Chicago	0.913	43.07

Comparison of the OTTHYMO model results provided in Table 6-5 to the OTTHYMO model results provided in Table 5-3 indicate that the post-development runoff rates and volumes are higher than the pre-development runoff rates and volumes for all storm events if no stormwater management controls are provided during post-development conditions.

7. Post-Development Quantity Control – Flow Rate

As previously indicated, the post-development flow rate will be restricted such that the maximum runoff rate from the subdivision area during post-development conditions will be less than or equal to the pre-development flow rate for each storm event up to and including the 100 year design storm event.

The uncontrolled catchment areas consist of the catchment areas from which runoff exits the site without restriction to the runoff rate. Controlled catchment areas consist of the areas from which the runoff rate is controlled and temporarily detained prior to being released from the site. The total post development runoff is then the sum of the runoff rates from both the uncontrolled and the controlled areas.

For this proposed development, the quantity control consists of restricting the post-development rate to less than or equal to the pre-development rate. If the stormwater management design were completed using a simple calculation method such as the rational method, the allowable discharge from the controlled area would be equal to the pre-development runoff rate minus the discharge from the uncontrolled areas during post development conditions. If the discharge from the uncontrolled areas is too large, the resulting calculation may result in an allowable release rate that is too restrictive or potentially even negative and therefore not feasible or possible to meet.

During previous iterations of the stormwater management design for this site, the onsite catchment areas during post-development conditions were divided into uncontrolled and controlled catchment areas. Due to revisions in the grading plan, redirection of a portion of the runoff from each dwelling to the back of the lot, and a decrease in time of concentration for post development areas, it is no longer possible to meet the runoff criteria using the previously defined Controlled and uncontrolled catchment areas.

In order to meet the stormwater management criteria for the site with respect to runoff rate, temporary flow detention will be provided by means of directing the runoff from the front yards and proposed roadway to the proposed stormwater storage swale at the east end of the cul-de-sac and restricting the discharge rate from the storage swale.

An additional or secondary control weir structure was added within the outlet swale along the east side of the site downstream of the south property line swale. This secondary control weir will provide detention for the previously uncontrolled areas and will provide additional detention for the discharge from the primary stormwater storage facilities.

7.1.1. Post Development Catchment Areas

For the purposes of the stormwater management design, the catchment areas of the site have been divided into primary controlled areas and secondary controlled areas. The primary controlled areas are those areas from which the runoff is collected and directed to the proposed stormwater storage swale. These areas consist of the Dunrobin Road Catchments CA and CB as well as the front yard catchments. The secondary controlled areas consist of the rear yard catchments and the offsite catchment area C-OFF1 north of the proposed development.

The runoff from these areas is collected by the north and south swales, and will be restricted by the additional control weir.

7.1.2. Stormwater Storage Swale – Primary Control

Stormwater storage for the purposes of restricting the post-development runoff rate to the pre-development runoff rate for each storm event from the primary controlled areas will be provided within the stormwater storage swale extending east from the cul-de-sac. The proposed storage swale has been designed in conjunction with the quality control criteria to ensure that both the quantity and quality control criteria will be met.

7.1.2.1. Description and Construction

It is noted that the bottom of the stormwater storage swale will be constructed with no slope at an elevation of 75.45 m which is 3 cm below the 100 year flood level of the backwater flood plain of the Harwood Creek. The invert of the V-notch weir in the outlet structure from the storage swale has been set at 75.60 m or 15 cm above the bottom of the storage swale and 12 cm above the 100 year flood level. As such, the 100 year flood level will have no impact on the discharge from the storage swale.

Since the bottom of the storage swale is 15 cm below the lowest outlet elevation, outlet for the first 72.1 m^3 of stored water will be by infiltration only.

The stormwater storage swale has been designed as follows:

- The bottom of the storage swale extends downward from an elevation of 75.60 m at the bottom of the roadside ditch at the east end of the cul-de-sac at a slope of 1.5 percent for a distance of 13.6 m to the flat portion of the swale.
- The flat portion of the bottom of the storage swale has an elevation of 75.45 metres, a bottom width of 5 metres and a length of 76.5 m.
- The storage swale has been constructed with depth of 0.97 metres and side slopes of about 3 horizontal to 1 vertical.
- Discharge from the swale will be controlled by an outlet structure consisting of a V-notch weir within a weir wall at the east end of the storage swale. Details of the outlet structure are provided in Section 7.3 of this report.
- Overflow from the storage swale will be over top of the weir wall at the east end of the storage swale.
- The topsoil should be removed from below the footprint of the proposed storage swale and stockpiled on the upper third (west third) of the site.
- Once the topsoil has been removed, the bottom of the storage swale is expected to be between 0.4 and 0.8 metres above the subgrade surface. The subgrade should be further

excavated as required to ensure a minimum of 0.45 m of separation between the bottom of the swale and the native subgrade.

- Construction traffic on the foot print of the storage swale should be limited as much as possible to avoid compaction of the underlying soils.
- The subgrade surface should be scarified or ripped using the teeth of an excavator following removal of the topsoil.
- The subgrade should be built up to 0.45 metres below the bottom of the storage swale using a sandy material such as the native silty sand or silty sand glacial till present on site. Alternatively silty sands or sand-silt mixes identified as SM using the United Soils Classification System as illustrated in the Ontario Building Code Supplementary Standard SB-6 could be imported to raise the subgrade to the underside of the storage swale bottom soil structure.
- The storage bottom soil structure should consist of a layer of 150 mm thickness of 20mm clear stone placed on the fill materials used to raise the subgrade, topped with a 300 mm thickness of amended existing site topsoil.
- The existing site topsoil can be stripped and stock piled prior to amending. The site topsoil should be amended by mixing 1 part amendment material with 3 parts by volume of site topsoil. The amendment material shall consist of organic matter primarily leaf, yard and bark waste compost of 20 – 30% by dry weight as determined by Loss-on-ignition. No uncomposted manure should be used.
- The swale shall be seeded with deep rooted grasses and planted with vegetation that can tolerate both wet and dry soil conditions.
- Discharge from the swale below an elevation of 75.60 metres is by infiltration only.
- The outlet control structure is described in Section 7.1.2.4

The physical characteristics of the stormwater storage swale and outlet control will result in the storage - discharge relationship as indicated in Figure 7-1 in section 7.1.3.

7.1.2.2. Freeboard for Storage Swale

It is considered that MOE Manual requires a minimum of 0.3 metres of freeboard between the 100 year flood level in storm pond and the top of bank of the storm pond. A further review of the MOE criteria for a storm pond indicates that a storm pond is suitable for a catchment area having a minimum area of 5 hectares. The contributing area to the proposed stormwater storage swale is 3.2 hectares. As such the contributing area does not meet the minimum criteria with respect to the catchment area for the design constraints of a storm pond to be applied. A review of the MECP LID Guide together with the CVC LID Guide indicates that the proposed storage swale would be appropriately described as a Dry Swale or Bio Swale.

The proposed storage swale has been designed with a freeboard between the 100 year ponding level and the top of the swale of 0.21 metres. The elevation of the top of the storage swale has been limited to reduce the total amount of fill required. Raising the top of swale would result in more loads of fill and more traffic on Dunrobin Road.

The proposed grade of the finished ground surface will continue to slope upwards towards the proposed adjacent dwellings such that the minimum grade around the proposed dwellings will be more than 1.1 metres above the 100 year ponding level. This will ensure that the proposed dwellings are protected in the advent that the 100 year ponding level is exceeded.

The proposed private properties are protected from potential overflow of the side slope of the storage swale by the overflow over the outlet weir. The overflow weir is rectangular in shape and has a bottom width of 6 metres and a minimum depth of 0.1 metres. The overflow weir has a flow capacity of 0.346 m3/sec which exceeds the flow rate into the storage swale generated during a 100 year storm event. The overflow over the weir is also directed into the outlet channel.

Since there is a overflow weir that will ensure flood levels in excess of the design storm event are directed safely away from private property and the actual proposed grade adjacent the proposed dwellings is much higher than the 100 year flood level it is considered that the provided free board is sufficient.

7.1.2.3. Separation Between the 100 Year Flood Level and Building USF

The City of Ottawa sewer design guidelines require that there be a minimum vertical separation between the proposed underside of footing elevations and the 100 year flood level or hydraulic grade line in adjacent infrastructure of 0.3 metres in order to prevent flooding of the dwelling foundation as a result of an elevated ground water level caused by the 100 year flood level.

The proposed underside of footing elevations for the dwellings adjacent the storage swale have been set at about 0.4 metres below the design 100 year flood level. It is however considered that there is no potential risk to the proposed dwelling foundations from the 100 year ponding level for the following reasons:

- The proposed foundation drainage system of each dwelling will be connected to a sump pit which will be discharged to the ground surface by means of a sump pump. There is no connection and no potential for a connection between the 100 year flood level and the foundation drainage system resulting from the storm service.
- The foundation of each dwelling will be separated horizontally from the 100 year ponding level by a distance of at least 14 metres.
- From Section 6.2.2 above, the permeability of the native soils at the site ranges from 1.26×10^{-6} m/s to 1.64×10^{-7} m/s. Referencing Table 2 and Table 3 of MMAH Supplementary Standard SB6 contained in Volume 2 of the Ontario Building Code indicates that soils with permeabilities ranging from $1x10^{-4}$ to $1x10^{-5}$ cm/sec are expected to have a percolation time T of 12 to 20 min/cm. This means that water is expected to take between 12 and 20 min to travel 1 cm through the material. (It is

noted that a direct conversion of $1x10^{-4}$ to $1x10^{-5}$ cm/sec by rearranging units would result in a range of 128 to 1016 min/cm which is not accurate.)

- Since the distance between the underside of footing and the 100 year flood level is at least 14 metres, the time it would take for water to reach the underside of footing from the storage swale would be in the order of 14 m x 100 cm/m x 12 min / cm = 16,800 min = 280 hrs or more than 11.5 days.
- Since this time period is much greater than the draw down time of the 100 year storm event, the water within the storage swale will not be elevated long enough for water to flow from the stormwater storage facility to the underside of footing.

7.1.2.4. Outlet Control and Release Rate

The flow rate from the storage swale will be restricted such that the maximum runoff rate from the proposed development including offsite catchment areas during post-development conditions will be less than or equal to the pre-development flow rate from the proposed development area including the offsite catchment areas during corresponding storm events up to and including the 100 year storm event. The release rate from the stormwater storage swale will be controlled by means of an outlet control structure.

The maximum flow rate that could be discharged from the stormwater storage swale during each storm event such that the total runoff rate from the site during post-development conditions is less than that for pre-development conditions would correspond to the allowable release rate from the controlled catchment areas of the development.

The outlet control structure will consist of V-notch weir in a cast in place concrete weir wall. The cast in place weir wall will have a rectangular cutout above the invert of the ditch that will allow an aluminum weir plate to be installed. The weir plate will have a 30 degree V-notch weir with an invert of 75.60 m. The weir wall construction will be similar in appearance to the illustration in Figure 7-1 included on the following page. Since the flow above the V-notch is overflow, the weir plate will not extend above the pour concrete. Overflow of the storage swale will be over top of the weir wall. The bottom and side slopes on both sides of the weir wall should be protected with Rip-Rap and geotextile. The Rip-Rap should conform to the grading requirements for OPSS 1004 G-10 Gabion Stone. The geotextile should consist of a minimum 6 ounce per square yard non-woven fabric. The Rip-Rap and Geotextile should be placed in keeping with OPSS 511 and OPSD 810.010.

Figure 7-1: V-notch Cast-In-place Concrete Weir Wall Illustration

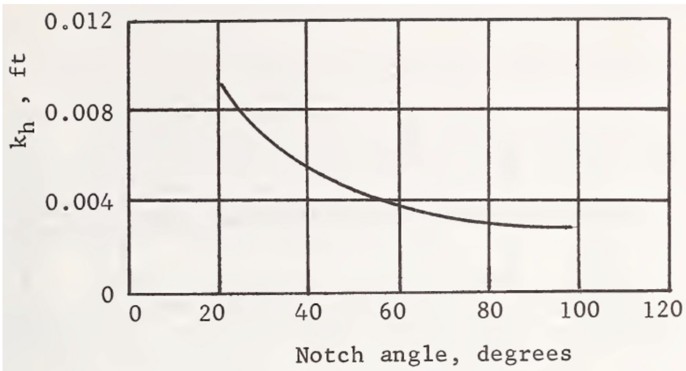
The discharge rate through the V notch weir was calculated using the Kindswater-Shen relationship (Kulin, G and Compton, P., *A Guide to Methods and Standards for the Measurement of Water Flow,* NBS Special Publication 421 May 1975, Institute of Basic Standards, National Bureau of Standards, Washington, D.C. 20234) as the discharge will be passing over the weir in free flow conditions.

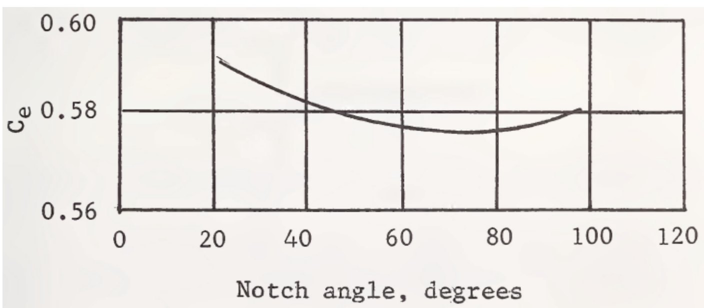
The equation is as follows:

$$Q = 4.28\, C_e \tan\left(\frac{\theta}{2}\right) h_{1e}^{2.5}$$

Where: Q = discharge in cfs
C_e = effective discharge coefficient (see figure copied below)
h_1 = head on the weir (ft)
$h_{1e} = h_1 + k_h$
k_h = head correction factor (ft) (see figure copied below)
θ = angle of V- notch

It is noted that the head on the weir was converted from metres to feet to facilitate the use of the equation and then the results were converted from cfs to m^3/s.





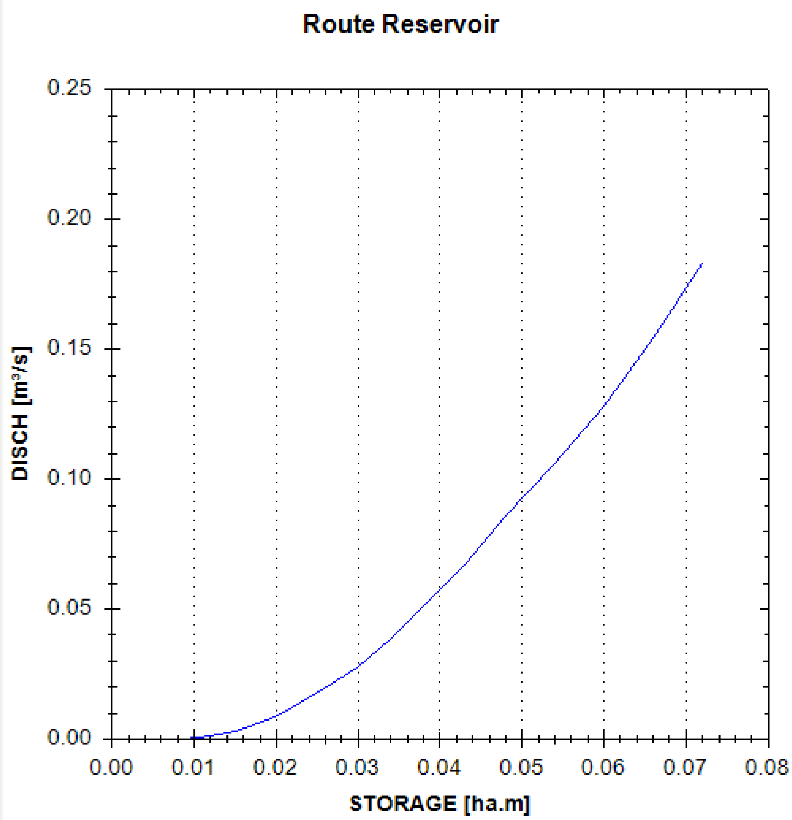
The notch angle was determined by iteration. In a relatively large storm water storage facility, it is generally assumed that the hydraulic gradient is a function of the water surface elevation only. Since the discharge rate Q is a function of the depth of water-head relative to the orifice inverts, the discharge rate will be directly related to the water surface elevation relative to the orifice inverts. The volume of the storage swale is also directly related to the depth of water or water surface elevation. Since the discharge rate and storage swale volume are both related, a Discharge vs Storage curve can be developed. A discharge storage curve was developed in excel and was then programmed into the Route Reservoir block within the OTTHYMO hydrologic model. This process was repeated by varying the notch angle until the model produced post-development peak flow rates less than or equal to pre-development peak flow rates for each design storm up to and including the 100 year event.

The stormwater storage swale and outlet structure are modeled in the OTTHYMO program using a Route Reservoir Hydrograph command inserted between the proposed roadside ditch channels, receiving the runoff from the front yard catchments, and the outlet swale.

The detailed worksheet has been included in Appendix G1. Figure 7-2 below illustrates the storage-discharge relationship that was copied into the Route Reservoir command (NHYD 29) within the OTTHYMO model. The combined storage and detention in the storage swale and the Outlet Swale provide the post-development results summarized in Table 7-1 below.

Figure 7-2: Storage Swale Storage-Discharge Relationship

	DISCH [m³/s]	STORAGE [ha.m]
1	0.000000	0.000000
2	0.000000	0.002000
3	0.000000	0.004000
4	0.000000	0.006700
5	0.000000	0.009000
6	0.001000	0.012000
7	0.003000	0.015000
8	0.007000	0.019000
9	0.012000	0.022000
10	0.019000	0.026000
11	0.027000	0.030000
12	0.038000	0.034000
13	0.051000	0.038000
14	0.067000	0.043000
15	0.085000	0.048000
16	0.105000	0.054000
17	0.128000	0.060000
18	0.154000	0.066000



Discharge from the Outlet control structure will enter the outlet swale where it will merge with the flow from the secondary controlled area which in turn discharges to the Harwood Creek.

7.1.3. Additional Storage in Outlet Swale – Secondary Control

Additional Stormwater storage and flow restriction for the purposes of restricting the post-development runoff rate to the pre-development runoff rate for each storm event for the previously uncontrolled areas as well as the controlled flow from the Stormwater storage Swale will be provided within the Outlet Swale along the east side of the development and within the lower portion of the conveyance swales along the north and south sides of the development. A second control structure will be placed across the outlet swale at the south west corner of the site.

7.1.3.1. Limitations

The proposed outlet control structure and the outlet swale in which the structure will be placed are within the tail water flood plain of the Harwood Creek. As previously indicated, the 100 year tail water flood plain has an elevation of 75.48 m which is 0.28 m over the outlet control weir. The 2 year flood elevation of the Harwood Creek is 74.44 m which is 0.44 m over the bottom of the outlet swale and 0.34 m over the invert of the V-notch weir. There are two scenarios during which the control structure will restrict flows. These scenarios consist of non-coincident events and coincident events.

Non-Coincident Events

Non-coincident events are those where a high intensity rainstorm would result in a significant storm event that affect the site without causing flooding in the Harwood Creek and larger watershed of the Harwood Creek. During this scenario the outlet structure will function as intended by the design presented in Section 7.1.3.2 below and the discharge from the outlet structure in the outlet swale will be as presented below.

Coincident Event

Coincident Events are those where the high intensity storm event that causes runoff in the proposed development also affects the watershed of the Harwood Creek and causes flooding of the Harwood Creek. During these events the rising water levels in the Harwood Creek would cause tail water flooding of the outlet structure reducing the head across the structure. This reduction in head across the structure would reduce the flow rate from the development. Once the flood level overtopped the outlet structure, the tailwater flooding would occur as predicted by the post-development flood plain drawing. With receding flood levels in the Harwood Creek, the outlet structure would begin to function as intended discharging closer to design rates.

Since the intent of the secondary control structure within the outlet swale is to ensure that discharge from the development does not exceed pre--development runoff rates, it is considered that the outlet structure as designed will function as intended . The reduction in runoff rate with elevated tail water or flooding of the Harwood Creek will further ensure that this goal is met during coincident events.

7.1.3.2. Description and Construction

The construction of the Outlet Swale has been described in Section 6.2 above. The additional storage or secondary control will be achieved by constructing a cast in place concrete weir wall complete with a V-notch weir across the Outlet swale at the southeast corner of the site as shown on the proposed Site (East) Grading Plan drawing 200977-GR-E. The cast in place weir wall will have a rectangular cutout above the invert of the ditch that will allow an aluminum weir plate to be installed. The weir plate will have a 30 degree V-Notch weir with an invert of 74.10 m. The cast in place headwall will be sleeved to allow the subdrain in the swale to pass through the wall.

The discharge through the V-Notch weir was calculated using the weir equation provided above. The discharge through the subdrain was calculated using the equation (Vatankhah, A. R., (February 2018) *Discussion of "Flow through Partially Submerged Orifice" by James C.Y. Guo and Ryan P. Stitt* Journal of Irrigation and Drainage Engineering):

$$Q = \frac{0.72\sqrt{2gD^5}}{[(C_w\eta^{1.98})^{-2.14} + (C_d\eta^{0.52})^{-2.14}]^{0.4673}}$$

This is a calculation that unifies flow through a partially full orifice as weir flow with flow through a fully submerged orifice as orifice flow.

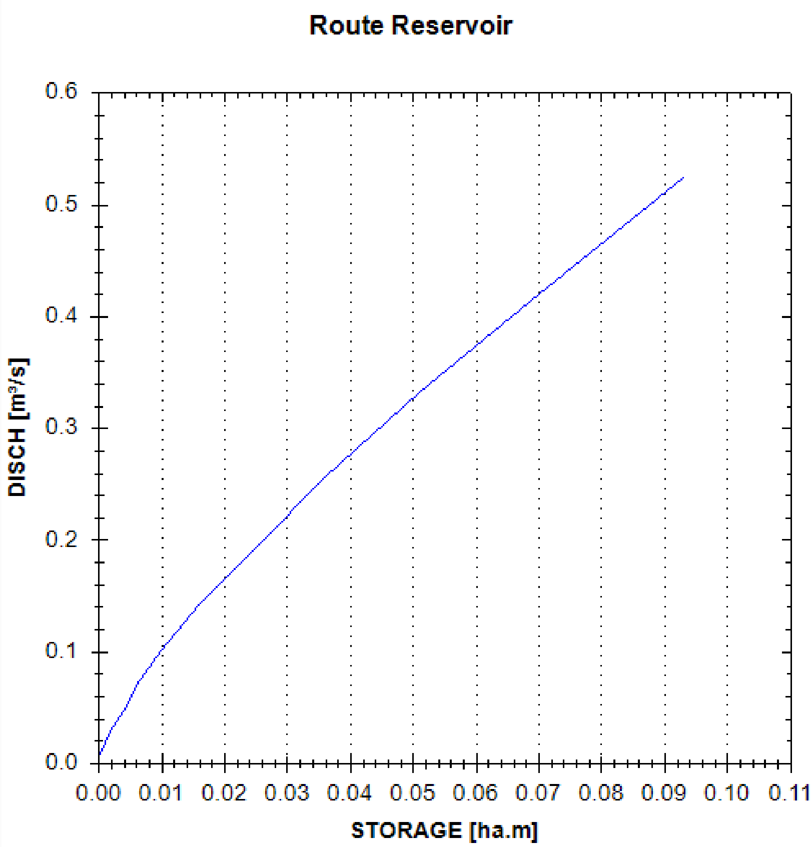
Where Q = flow (cubic meters per second)
C_d = Coefficient of Discharge for a sharp orifice = 0.60
Cw = Coefficient of Discharge for a sharp crested weir = 0.62
D = Orifice diameter (m)
η = y/D
Y = water-head relative to orifice invert (m)
g = acceleration from gravity (9.81 m/s^2)

The diameter of the orifice was set equal to the pipe diameter. As discussed in section 7.1.2.4 above, the notch angle of the weir was varied by iteration until the model produced post-development peak flow rates less than or equal to pre-development peak flow rates for each design storm up to and including the 100 year event.

The detailed worksheet has been included in Appendix G2. Figure 7-3 below illustrates the storage-discharge relationship that was copied into the Route Reservoir command (NHYD 111) within the OTTHYMO model. The combined storage and detention in the storage swale and the Outlet Swale provide the post-development results summarized in Table 7-1 below.

Figure 7-3: Outlet Flow Storage-Discharge Relationship

	DISCH [m³/s]	STORAGE [ha.m]
1	0.000000	0.000000
2	0.007000	0.000000
3	0.018000	0.001000
4	0.029000	0.002000
5	0.046000	0.004000
6	0.069000	0.006000
7	0.100000	0.010000
8	0.141000	0.016000
9	0.193000	0.025000
10	0.256000	0.036000
11	0.332000	0.051000
12	0.420000	0.070000
13	0.523000	0.093000
14		



Discharge from the Outlet control structure will enter the lower reaches of the outlet swale which in turn discharges to the Harwood Creek.

7.2. Mitigated or Controlled Post Development Runoff

The mitigated post-development runoff rate from the proposed development calculated using the OTTHYMO model after the insertion of the Route Reservoir Hydrograph commands to control the runoff rate from the front yards and roadways in the storage swale and from the rear yards in the outlet swale is summarized in Table 7-1. This table also provides a comparison to the pre-development runoff rates.

Table 7-1: Mitigated Post-Development Runoff Rates and Runoff Volumes

Design Storm Event		Post-Development Runoff		Pre-Development Runoff Rate	Post < Pre
		Volume	Rate		
		(mm)	(m^3/s)	(m^3/s)	
Sim 1	6 hour 5 year SCS Type II	7.70	0.089	0.093	Yes
Sim 2	6 hour 100 year SCS Type II	25.53	0.317	0.333	Yes
Sim 3	12 hour 5 year SCS Type II	10.47	0.103	0.107	Yes
Sim 4	12 hour 10 year SCS Type II	15.04	0.151	0.160	Yes
Sim 5	12 hour 100 year SCS Type II	30.82	0.333	0.351	Yes
Sim 6	12 hour 2 year Chicago	4.81	0.037	0.039	Yes
Sim 7	12 hour 100 year Chicago	29.56	0.307	0.325	Yes
Sim 8	Historical Storm July 1, 1979	23.83	0.401	0.434	Yes
Sim 9	Historical Storm Aug. 4, 1988	21.94	0.318	0.344	Yes
Sim 10	25mm 4 hour Chicago	0.70	0.008	0.009	Yes
Sim 11	120% 12 hour 100 year Chicago	41.31	0.440	0.475	Yes

A review of the above table indicates that the proposed stormwater storage swale with its associated outlet structure in combination with the secondary storage in the outlet swale with its outlet control configuration effectively mitigates the post-development runoff rate to less that occurring during pre-development conditions for all storm events.

Appendix H contains post-development OTTHYMO summary output data. Also included in Appendix H is the detailed output data for the last link in the model. The detailed output data for the last link provides a summary of the post-development outflow from the proposed development including off site catchment areas.

7.3. Storage Requirements

7.3.1. Storage Swale – Primary Control

The OTTHYMO model Route Reservoir Report is provided in Appendix I1. The storage requirements for the various storm events, obtained from the from the route reservoir block which models the stormwater storage swale, are shown in the following Table 7-2.

Table 7-2: Storage Requirements – Storage Swale

Design Storm Event		Max. Storage	Max. Ponding Elev.	Storage Drawdown Time	Peak Discharge Rate
		m^3	m	hrs	m^3/s
Sim. 1	6 hour 5 year SCS Type II	244	75.88	52	0.016
Sim. 2	6 hour 100 year SCS Type II	514	76.18	64	0.096
Sim. 3	12 hour 5 year SCS Type II	259	75.90	53.5	0.019
Sim. 4	12 hour 10 year SCS Type II	327	75.98	57.5	0.034
Sim. 5	12 hour 100 yr SCS Type II	531	76.19	64.5	0.102
Sim. 6	12 hour 2 year Chicago	163	75.76	42.5	0.004
Sim. 7	12 hour 100 year Chicago	496	76.13	63.5	0.090
Sim. 8	Historical Storm July 1, 1979	607	76.26	66	0.131
Sim. 9	Historical August 4, 1988	515	76.18	64	0.096
Sim. 10	25mm 4 hour Chicago	67	75.60	16	0.000
Sim 11	120% 12 hour 100 year Chicago	637	76.28	66.5	0.144

The invert of the V-notch outlet weir in the control structure has been set at an elevation of 75.61 meters resulting in a storage volume of 72.1 cubic metres below the outlet. There is a total available quantity storage volume of 722.8 cubic metres within the storage swale below an elevation of 76.35 metres.

The maximum storage requirement of 637 cubic metres occurs during the 120% stress storm event. The maximum storage requirement during a 100 year storm event is 531 cubic metres. The minimum modeled storage requirement is 67 cubic meters during a 25 mm 4 hr Chicago storm. The maximum drawdown time is equal to 66.5 hours during the 120% stress storm event and 64.5 hours during a 100 year storm event. The draw down time of 66.5 hours is less than the time required for mosquitoes to go from the egg to the pupate stage and as such there will be insufficient to for the mosquito breeding cycle.

Since the maximum storage requirement is less than the maximum available storage volume there is sufficient storage volume available within the proposed storage swale.

7.3.2. Outlet Swale – Secondary Control

The OTTHYMO model Route Reservoir Report is provided in Appendix I2. The storage requirements for the various storm events, obtained from the from the route reservoir block which models the stormwater storage swale, are shown in the following Table 7-3.

Table 7-3: Storage Requirements – Outlet Swale

Design Storm Event		Max. Storage	Max. Ponding Elev.	Storage Drawdown Time	Peak Discharge Rate
		m^3	m	hrs	m^3/s
Sim. 1	6 hour 5 year SCS Type II	86	74.56	18.5	0.089
Sim. 2	6 hour 100 year SCS Type II	482	74.98	20.5	0.317
Sim. 3	12 hour 5 year SCS Type II	104	74.59	19	0.103
Sim. 4	12 hour 10 year SCS Type II	178	74.72	19.5	0.151
Sim. 5	12 hour 100 yr SCS Type II	514	75.00	21	0.333
Sim. 6	12 hour 2 year Chicago	30	74.36	18	0.037
Sim. 7	12 hour 100 year Chicago	461	74.96	20.5	0.307
Sim. 8	Historical Storm July 1, 1979	660	75.08	21	0.401
Sim. 9	Historical August 4, 1988	486	74.98	20.5	0.318
Sim. 10	25mm 4 hour Chicago	1	74.10	10	0.008
Sim 11	120% 12 hour 100 year Chicago	746	75.12	21.5	0.440

The invert of the V-notch outlet weir in the control structure has been set at an elevation of 74.10 meters. There is a total available quantity storage volume of 930 cubic metres within the outlet swale below an elevation of 75.20 metres.

The maximum storage requirement of 746 cubic metres occurs during the 120% stress storm event. The maximum storage requirement during a 100 year storm event is 514 cubic metres. The minimum modeled storage requirement is 1 cubic meters during a 25 mm 4 hr Chicago storm. The maximum drawdown time is equal to 21.5 hours during the 120% stress storm event and 21 hours during a 100 year storm event. The draw down time of 21.5 hours is less than the time required for mosquitoes to go from the egg to the pupate stage and as such there will be insufficient to for the mosquito breeding cycle.

Since the maximum storage requirement is less than the maximum available storage volume there is sufficient storage volume available within the proposed secondary storage.

8. Quantity Control – Additional Criteria

The stormwater management criteria from a quantity control perspective also included the following imprecisely defined criteria: Surface runoff volumes are to be minimized through infiltration techniques and incorporate low impact design techniques where possible. Common low impact design practices include: bioretention cells, permeable pavement, infiltration trenches and chambers, enhanced swales, reduced swale slopes, rainwater harvesting and green roofs. Practices such as permeable pavement, rainwater harvesting and green roofs are not practical to enforce or design within the context of privately owned rural residential lots.

A Subwatershed Study was not identified for either the Harwood Creek or Constance Creek watersheds. A review of a number of available subwatershed studies for subwatersheds within Ottawa was completed to determine common goals and objectives of the recommendations for various subwatersheds. From this review of the studies, the common goals were divided into the following categories: 1) Surface water Quantity; 2) Groundwater Quality; 3) Aquatic Resources; 4) Terrestrial Resources. Each category had its own objectives. Reviewing the objectives indicates that the majority of the objectives are centered on reducing flood risk and protecting groundwater supplies and groundwater base flow by reducing runoff, increasing infiltration and maintaining healthy aquatic and terrestrial communities.

8.1. Incorporation of Low Impact Design Techniques

The proposed development has incorporated elements of the common low impact design practices which will result in meeting some of the common objectives of the recommendations in the subwatershed studies. These elements include the low sloped swales along the north, south and east sides of the development. The low slope increases the travel time within the swale promoting infiltration. In addition, the localized shallow ponding caused by undulations along the channel bottoms results in additional infiltration as the ponded water will either infiltrate or evaporate. The addition of the clear stone and subdrain will decrease the potential for long term surface ponding and will promote infiltration.

The stormwater storage swale has been designed, in part, as a bioretention swale or infiltration basin and will retain stored water below the outlet to provide quality control by infiltration. As discussed in Section 9.3.2.6 below, the proposed seeding within the stormwater storage swale is intended for wet meadow or storm pond applications and can withstand emergent and flooding conditions. The vegetation will consist of a mix of native species designed to promote wildlife habitat and a healthy terrestrial community.

Additional low impact design techniques to be incorporated into the development include disconnected foundation drains and disconnected downspouts. The downspouts from the proposed dwellings should be directed to the ground surface. This will allow the runoff from the roofs to be dispersed over the vegetated lawn surfaces and will promote infiltration and evaporation. The foundations drains will also be discharged by means of sump pumps to the ground surface outside of the road allowance as opposed to being directed to a storm sewer.

8.2. Reduction in Volume

Restricting the post-development flow rate to pre-development conditions controls the runoff rate to reduce the impact of the peak flow rate from the site to the receiving watercourse. This reduction in runoff rate is achieved by providing temporary storage on site, which is discharged at a restricted rate over a period of time during and following the storm event. The additional low impact design elements serve to increase the infiltration and reduce the post-development runoff volume from the site. The runoff volumes calculated using the OTTHYMO model during the various conditions of development are presented in the following Table 8-1

Table 8-1: Comparison of Pre- to Post-Development Runoff Volume

Design Storm Event	Pre-Dev. Volume		Mitigated * Post-Dev. Volume (2)		Difference Post- to Pre- (3)
	(mm) (1)	(m^3)	(mm) (1)	(m^3)	(m^3)
6 hour 5 year SCS Type II	6.78	745	7.70	846	101
6 hour 100 year SCS Type II	22.64	2487	25.53	2805	317
12 hour 5 year SCS Type II	9.18	1009	10.47	1150	142
12 hour 10 year SCS Type II	13.21	1451	15.04	1652	201
12 hour 100 yr SCS Type II	27.47	3018	30.82	3386	368
12 hour 2 year Chicago	4.33	476	4.81	528	53
12 hour 100 year Chicago	26.31	2890	29.56	3247	357
Historical Storm July 1, 1979	21.09	2317	23.83	2618	301
Historical August 4, 1988	19.38	2129	21.94	2410	281
25mm 4 hour Chicago	0.78	86	0.70	77	-9
120% 12 hour 100 year Chicago	37.16	4082	41.31	4538	456

* Mitigated post-development volume is the result of the inclusion of the storage swale and outlet swale storage within the model.

1) The runoff volume is calculated by the model in terms of mm per-unit area. The runoff volume from the development area in terms of cubic metres is determined by multiplying

the runoff volume in mm by the entire catchment area used in the model which equals 10.986 hectares including uncontrolled areas.

2) These two columns represent the runoff volume determined during post-development conditions using the OTTHYMO model.

3) This column represents the difference between the pre-development runoff volume and the post-development runoff volume in cubic metres from the total catchment area included in the model. Where the value is negative, the post-development runoff volume is less than the pre-development runoff volume.

The MECP LID Stormwater Management Guidance Manual indicates that the 90th percentile precipitation event for the proposed development area is the 25 to 26 mm storm event. Table 8-1 demonstrates that the proposed stormwater management design successfully reduces the post-development runoff volume such that there will be no additional runoff volume outlet to Harwood Creek as a result of the proposed development during normal rainfall (90th percentile or less) events. There will be negligible additional runoff volume generated during minor storm events such as the 2 year and 5 year design storm events.

The greatest increase in runoff volume occurring during a 12 hour 100 year design storm is 368 m^3. This runoff volume corresponds to a flow rate of 0.009 m^3/sec over the duration of the storm event. This flow rate when compared to the peak flow rate in the Harwood Creek of 14.1 m^3/sec at the river station in proximity to the development outlet is less than 0.07% of the 100 year flow in the Creek.

8.3. Summary

The reduced runoff volume from pre-development conditions during normal rainfall events and negligible increase during minor storm events as demonstrated by the model indicates that the proposed development successfully makes use of low impact design techniques to mitigate the results of the increased impervious area caused by the development. The reduced volume indicates that more runoff will infiltrate which will aid in achieving some of the common recommendations and objectives generally contained within most subwatershed studies. The increased infiltration will reduce flood risk and protect groundwater supplies and groundwater base flow.

9. Quality Control

As previously stated, an enhanced level of treatment is required for the runoff from the site. An enhanced level of treatment corresponds to 80 percent total suspended solids removal. The recommended strategy for stormwater management quality control is to provide an integrated treatment train approach. In general, best management practices for stormwater management quality control are divided into three categories: source control, conveyance control and end-of-pipe control.

9.1. Source Control

The primary source of total suspended solids and associated runoff pollution under post-development conditions is considered to the areas of a site subject to vehicle traffic. At the proposed development, this consists of the driveways and roadways. The vegetated landscaped surfaces and dwelling roofs are typically not considered to be significant sources of suspended solids following the completion of the development and establishment of the vegetation in landscaped areas.

The application of de-icing chemicals including salts and sand can be reduced with a best management plan for the application of these products. BMPs with respect to de-icing chemicals include such measures as timing of application, targeted application, and clearing of snow cover before application.

9.2. Conveyance Control

The proposed driveways and subdivision roadway are within the controlled area of the site. In general, runoff generated from the driveways will be directed across the grass surfaced front yards to the roadside ditch in front of the lots. The runoff from the roadways will also be conveyed along the roadside ditches to the storage swale east of the cul-de-sac. The roadside ditches have been designed with a longitudinal slope of which varies from 1.1% to 0.2% (north side) and 1.1% to 0.4% (south side). The low ditch slopes, in general, occur at the cul-de-sac. Due to the low slope and the vegetation within the ditches, the roadside ditches will provide preliminary treatment removing larger suspended solids.

A Research paper completed by University of Quelph School of Engineering (Authors Dr. Ramesh P Rudra Ph.D., Dr. Hugh R Whiteley Ph.D., Dr. William T Dickinson Ph.D.) Sediment Removal Efficiency of Vegetative Filter Strips indicates that vegetative filters can partially remove sediments and pollutants attached to sediment particles in runoff. Field experiments on vegetative filter strips showed average sediment removal varying from 50 to 98% as flow path length increases from 2.5 to 10 metres. The research indicates that almost all particles larger than 40 microns in diameter are captured within the first five meters of a filter strip provided the flow velocity is limited to less than 0.5 m/s during the quality control storm event. About 50% of the sediments are removed within the first 2.5 m of travel over the vegetative filter flow path. An additional 25% to 45% of sediments are removed within the next 2.5 m of the flow path depending on the flow rate and velocity. The removal efficiency of the vegetative filtration does not significantly increase with a flow path length beyond 10 m.

The MOE Manual considers the quality storm event to be the 4 hr 25 mm Chicago storm. The flow rate and flow velocity determined using the OTTHYMO model during the 4 hr 25 mm Chicago storm in the eastern sections of the proposed roadside ditch are as summarized in the following Table 9-1:

Table 9-1: Flow Rate, Velocity and Depth along Roadside Ditches.

Ditch Section	Flow Rate (m^3/s)	Flow Velocity (m/s)	Flow Depth (m)
North 5	0.003	0.26	0.05
North 7	0.004	0.22	0.06
South 6	0.003	0.26	0.05
South 8	0.005	0.25	0.07

The results in the above table indicate that the flow velocity in the ditches will be well below the critical velocity of 0.5 m/s which means that the ditches will provide effective vegetative filtration.

Section 4.5.9 of the MOE Manual provides the design guidance with respect to the use of Grassed Swales to achieve quality control. The flow criteria has been summarized in the following Table 9-2. A column has been added to indicate how the proposed design conforms to the Criteria.

Table 9-2: Summary of MOE Flow Criteria for Grassed Swales and Conformance

Design Element	Design Objective	Minimum Criteria	Maximum as Designed*
SWALES – OUTLET SWALE			
Flow Criteria	Required to Achieve Quality control		
Peak Flow Velocity	Facilitate Sedimentation and vegetative filtration	< 0.5 m/s	0.49 m/s during 10 year storm
Flow Depth	Promote Vegetative Filtration	< 0.5 m	0.2 m during 10 year storm
Flow Rate	Sedimentation and prevent re-suspension	≤ 0.15 m^3/s	0.15 m^3/s during 10 year storm
DITCHES			
Flow Criteria	Required to Achieve Quality control		
Peak Flow Velocity	Facilitate Sedimentation and vegetative filtration	< 0.5 m/s	0.26 m/s during quality control storm 0.41 m/s during 2 year storm 0.53 m/s during 10 year storm 0.62 m/s during 100 year storm
Flow Depth	Promote Vegetative Filtration	< 0.5 m	0.07 m during quality control storm 0.13 m during 2 year storm 0.20 m during 10 year storm 0.27 m during 100 year storm
Flow Rate	Sedimentation and prevent re-suspension	≤ 0.15 m^3/s	0.005 m^3/s during quality control storm 0.02 m^3/s during 2 year storm 0.07 m^3/s during 10 year storm 0.14 m^3/s during 100 year storm

* It is noted that the maximum velocity, maximum depth and maximum flow rate do not occur along the same section of ditch or swale. That is, a comparatively steeper ditch section will result in higher velocity and lower depth for the same flow rate.

All of the flow criteria are less than the required flow criteria needed to achieve an enhanced level of filtration during both the quality control event and the 2 year storm events.

Table 2.3 of the Ontario Ministry of Natural Resources Technical Guide – River and Stream Systems: Erosion Hazard Limit provides a maximum allowable flow velocity to prevent scour for a bare channel in sand and silt of 0.61 m/s. The allowable flow velocity increases to 0.91 m/s with fair vegetative cover.

The peak velocity during a 2 year storm event is less than 0.5 m/s ensuring that sedimentation will continue to occur during a 2 year design storm event. The peak flow velocities of 0.41 m/s and 0.53 m/s during the 2 year and 10 year storm events are less than the scour velocity assuming a bear channel. The peak flow of 0.62 m/s during a 100 year storm is less than 0.91 m/s ensuring scour will not occur once vegetation is established.

Since the flow velocity during a 2 year design storm is less than the scour velocity of a bare channel there will be no scour or re-suspension of sediment during a normal rainfall event. It is assumed that the vegetation will have a chance to grow through the sediment prior to successive 10 and 100 year storm events resulting in at least a fair vegetative condition in the ditches preventing resuspension of sediment.

9.3. End-of-Pipe Control – Stormwater Storage Swale

Final treatment and Quality Control will be provided by temporary detention of the entire quality control volume, generated from the surfaces in the controlled area, within the storage swale to be discharged by infiltration only. The quality storage swale has been designed to outlet the quality storage volume vertically through an amended topsoil layer into the underlying soils.

The quality control design is completed with the fundamental understanding that the majority of sediment and particulate pollutants are washed from the site surfaces during minor (frequent) storm events. Section 3.3.1 of the MOE Manual indicates that in most cases, quality control design storms range from 12.5 mm to 25 mm. The MOE Manual provides guidance on design for stormwater quality control using infiltration basins in Section 4.6.6 and using filtration in Section 4.6.7.

It is noted that the proposed stormwater storage swale does not meet all of the criteria for an infiltration basin as the stormwater storage swale is also used for quantity control and does not have a bypass for major storm events. Notwithstanding these discrepancies, guidance with respect to the design of the stormwater storage swale was taken from the MOE Manual Sections 4.6.6 and 4.6.7.

9.3.1. Summary of Design Guidance

Section 4.6.6 of the MOE Manual provides the design guidance with respect to the use of an infiltration basin as summarized in Table 9-3 below. A design conformance and a comment column have been added to indicate if the design conforms to the Criteria and to provide comment.

Table 9-3: Infiltration Basin Design Summary Table

Design Element	Design Objective	Minimum Criteria	Design Conformance	Comment
Drainage Area	Infiltration	< 5 hectares	Yes	3.22 hectares
Treatment Volume	Enhance Treatment	Table 3.2 21.4 m^3/ha x 3.22 = 68.9 m^3	Yes 9.3.2.1	72.1 m^3
Percolation Rate	Infiltration	≥ 60 mm/hr	9.3.2.2	Amended Topsoil Soil over a clear stone drainage layer followed by imported soil with a percolation rate of 8 to 20 min/cm
Depth to Water Table	Infiltration	> 1m	Yes	greater than 1 m based on bottom elevation above the existing ground surface.
Depth to Bedrock	Infiltration	> 1m	Yes	greater than 1.4 m
Length to Width Ratio	Spread Inflow	3:1 or greater	Yes	18:1
Storage Depth	Avoid Filter Compaction	< 0.6 m	9.3.2.3	0.74 m during a 100 year storm event for a duration of less than 8 hrs. 0.53 m during a 10 year storm event.
Pre-treatment	Longevity Groundwater protection	Required	9.3.2.4	Best management practices and Pre-treatment by vegetated filtration along ditch bottom, and side slopes
By-Pass	Winter / spring Operation	Required	9.3.2.5	By-Pass by overflow weir.
Maintenance Access	Access for light discing equipment	Provided to approval of municipality	Yes	Maintenance Rd along length of Swale
Landscaping Plan	Enhanced Infiltration Increase porosity	Grasses, deep rooted legumes	9.3.2.6	Grasses, deep rooted legumes as well as other native vegetation

9.3.2. Conformance of Storage Swale

9.3.2.1. Treatment Volume

The water quality storage volume requirement to achieve an enhanced level of treatment using infiltration was determined from the MOE Manual Table 3.2 under infiltration. The impervious ratio for the controlled area of the site is 20.7%. The storage requirement was extrapolated from Table 3.2, considering a 20.7% impervious ratio at an enhanced level of treatment, to be 21.4 m^3/ha.

The total controlled area is 3.22ha. 3.22 ha x 21.4 m^3/ha gives a quality storage requirement of 68.9 m^3. An additional criterion with respect to treatment volume provided in the MOE Manual when considering the use of filtration for treatment is that there is no by-pass of the filter during a 4 hour 15 mm design storm. The 4 hour 15 mm design storm was not included in the OTTHYMO model. In order to ensure that by-pass would not occur below a 4 hr 15 mm design event, the runoff volume calculated for the 4 hr 25 mm quality design storm was considered. The runoff volume generated across the combined primary controlled area of 3.218 ha contributing runoff to the storage swale is 2.08 mm during a 4 hr 25 mm design storm.

A 4hr 25 mm quality storm event will result in a runoff volume of (3.218 ha x 2.08 mm) 66.9 m^3. This volume is less than the quality storage requirement calculated using Table 3.2. As such the maximum quality storage requirement of was determined to be 68.9 m^3 using Table 3.2. There is a total volume of 72.1 m^3 below the lower outlet invert. As such a minimum of 72.1 m^3 will outlet by filtration only.

As such the entire quality control volume required by the MOE MANUAL as calculated by Table 3.2 will be stored below the outlet ICD and no by-pass or overtopping will occur during a 4 hr 15 mm storm event.

9.3.2.2. Percolation Rate

As specified in section 7.1.2 of this report, the bottom of the storm pond will be between 0.4 and 0.8 metres above the existing ground surface once the topsoil has been removed. In addition, the bottom structure will consist of amended topsoil overlying a clear stone drainage layer. The native and imported soils below the bottom structure are expected to have a percolation rate ranging from 30 to 75 mm/hr. The clear stone layer will distribute the infiltration to areas with a greater infiltration rate and will reduce the potential for surficial long term ponding.

Permeability testing completed in the footprint of the proposed swale indicates that the permeability of the native soils is 1.64 x 10-7 m/s. This corresponds to an infiltration rate of 30 mm/hr. The City of Ottawa's guidelines with respect to LID practice make it clear that LIDs can be used when the infiltration rate is over 15 mm/hr.

Section 3.5.1 of the City of Ottawa Low Impact Development Technical Guidance Report February 2021 indicates the following:

> *"The 2003 Stormwater Manual contains guidance for a number of lot level and conveyance controls but specifies that the application of a number of management practices may not be suitable if the native soil has a percolation rate less than 15 mm/hr (see for example Pg. 4-6: Table 4.1: Physical Constraints for SWMP Types - infiltration trenches, reduced lot grading, soakaway pits, rear yard ponding, and pervious pipes)."*
>
> *This has contributed to the limited application of these measures as many of the soils within Ontario do not meet this criterion. The infiltration rate has an obvious effect on the speed with which a facility will be emptied between rainfall events. Thus, LID facilities should be sized for optimum control of water quantity. Area-wide quantity criteria may be achieved through the use of multiple smaller LID facilities distributed over a large area.*
>
> *For example, stormwater management practices such as bioretention and biofiltration use multiple treatment mechanisms including retention, filtration, evaporation and transpiration as well as infiltration. If the lot level and conveyance facilities can be sized such that they empty between events, or will be installed in areas where quantity control is not a primary concern (areas draining directly to a large surface water body like Lake Ontario, for example), LID facilities can be used where the infiltration rate is less than 15 mm/hr to achieve water balance and water quality (including thermal impacts) through retention, filtration, evaporation and transpiration. Thus, the soil infiltration capacity guidance in the manual should not be interpreted as a prohibition. Rather, it should be interpreted as a caution that controls relying primarily on infiltration may not be as effective on soils with low infiltration rates as they would be on soils with higher rates of infiltration."*

9.3.2.3. Storage Depth

It is noted that the MEO Manual in section 4.6.6 under the heading Storage Configuration/ Depth provides the following:

> *"In an infiltration basin, surface storage is used to retain water for infiltration. In monitoring studies (Galli, 1990), one of the causal factors of failure was noted to be the depth of water retained in the basin. The weight of the water is thought to compact the basin decreasing its infiltration potential. The depth of storage should be limited to a maximum of 0.6 metres in order to minimize the compaction of the basin."*

In section 4.6.7 of the MOE manual, the maximum storage depth to prevent compaction of a sand filter is increased to 1.0 metres.

The maximum ponding depth in the proposed storage swale during a 100 year design storm event is 0.74 m. Using the rainfall data from the historical rainfall event of July 1, 1979, the maximum ponding depth would be 0.81 m. It is noted that the draw down time from a maximum ponding depth of 0.81 m to a depth of 0.6 m is about 6 hours. The maximum ponding depth during a 10 year storm event is 0.53 m. This means that the storage swale will only be subjected to ponding depths in excess of 0.6 m during infrequent events for a short duration. Since the excessive ponding depth will be of limited duration and infrequent in occurrence, it is considered that the excessive ponding depth will have minimal effect on the compaction of the soils below the storage swale. In addition, the proposed planting are intended to have a root structure which will aid in reducing the compaction of the soils.

9.3.2.4. Pre-Treatment

The majority of the pre-treatment for the storage swale will take the form of source control and conveyance control as described in sections 8.1 and 8.2 above. In addition to these, the first 14.1 metres of the bottom of the storage swale sloped downward at 1.1 percent. This first 14.1 metres will provide additional filtration prior to the runoff encountering the remainder of the swale. These measures will ensure that the coarse sediment is removed from the runoff prior to main infiltration portion of the storage swale.

9.3.2.5. By Pass

Since the storage swale is being used for quality control purposes, there is no proposed low level by-pass for major storm events. By-pass of the outlet structure will be by means overflow above the V-notch of the weir through the rectangular portion of the weir.

9.3.2.6. Landscaping Plan

The MOE Manual provides the following:

> *"The vegetation in an infiltration basin should be able to withstand periods of ponding and maintain or enhance the pore space in the underlying soils. There is much literature to suggest that deep rooted legumes increase porosity and enhance infiltration compared to other ground covers (e.g., rotation of oat and corn crops with alfalfa) (Bryant et al., 1986; Minnesota Pollution Control Agency, 1989). As such, the planting strategy should include grasses and deep rooted legumes."*

The bottom of the proposed storage swale should be lightly seeded with sweet clover in combination with a mix such as Wet meadow or storm pond seed such as QS Wet Meadow Mixture as supplied by Quality Seeds or Stormpond Native Seed Mixture or Creek Bank Native

Seed Mixtures supplied by OSC Seeds.. The sides slopes of the storage swale should be seeded with a meadow mix such as QS Meadow Mixture as supplied by Quality Seeds. The seed mixes should be sowed at the rates recommended by the supplier. The seed mixes should be sowed in combination with a nurse crop of annual rye or oats which is sowed at a rate of 22-25 kg/ha.

9.3.2.7. Detention Time

The normal recommended detention time for stormwater management facilities ranges from a minimum of 24 hours (12 hrs if in conflict with minimum orifice size) to a preferred time of 48 hours. The proposed storage swale will have a total drawdown time of about 65 hours following the completion of a 100 year storm event. The draw down time following the completion of a 5 year storm event and a 10 year storm event is about 54 hours and 58 hours respectively.

The amount of time for the entire storage volume below the lowest outlet invert to infiltrate will be about 17 hours.

9.3.2.8. Flow velocity

Due to the outlet restriction, the discharge rate during the various design storms will be limited to for the 5 year, 10 year and 100 year storm events. Based on a bottom width of 5 metres, these flow rates would result in flow depths and flow velocities in the storm pond assuming no backwater conditions as shown in the following Table 9-4:

Table 9-4: Flow Velocity and Depth in Storage Swale

Storm Event	Flow Rate (m^3/sec)	Flow Depth (m)	Flow Velocity (m/sec)
5 year	0.095	0.17	0.10
10 year	0.134	0.21	0.11
100 year	0.264	0.31	0.14

The above flow velocities and flow depths represent the theoretical velocity that would occur without the outlet restriction. The ponding caused by the outlet restriction will increase the ponding depth and reduce the flow velocity. Since the flow velocity is much lower than 0.5 m/s during all storm events, the proposed vegetation in the storage swale will effectively provide vegetative filtration and remove sediment. The minimal velocity will also prevent re-suspension and scour of fine sediment.

9.3.3. Summary

The proposed storage swale design meets the majority of the design criteria for an infiltration basin as illustrated above. The swale meets the critical criteria with respect to storage volume and detention time necessary to infiltrate the entire quality control volume. Further, due to the outflow restriction, the flow velocity is minimized such that vegetative filtration will be effective and scour and re-suspension of sediment is unlikely.

Based on the above, the proposed stormwater storage swale will ensure that an enhanced level of treatment will be attained for the proposed development.

10. Driveway Culverts

Table 6-4 above provides the maximum flow rates in the roadside ditches during the 10 year and 100 year design storm events. Table 6-4 also provides the minimum available ditch depth for each section considered.

The driveway culverts are specified as 500 mm diameter 1.6 mm thick (16 gauge) plain galvanized corrugated steel pipe with a 68 x 13 mm helical profile.

The headwater depth for each driveway culvert required to meet the flow demand for each respective ditch section was calculated using the Hydroflow Express extension for Autodesk AutoCAD Civil 3D. The results of the calculations are presented in Table 10-1 below. Summary reports are including in Appendix J.

Table 10-1: Culvert Flow Demand and Capacity

Culvert Number	Culvert Diameter / Embedment (m)	Culvert Capacity (gravity) (m^3/s)	10 year Storm		100 year storm	
			Flow Demand (m^3/s)	Headwater Depth (m)	Flow Demand (m^3/s)	Headwater Depth (m)
Lot 1 & 2	0.5 / 0.05	0.19	0.02	0.13	0.05	0.21
Lot 3 & 4			0.03	0.16	0.07	0.25
Lot 5 & 6			0.05	0.21	0.10	0.32
Lot 7 & 8			0.07	0.26	0.14	0.39

From the above analyses, there is sufficient capacity to convey the maximum flow rate generated during a 100 year design storm in the roadside ditches through the driveway culverts without exceeding the minimum available ditch depth and without surcharging the culverts. It is noted that the purpose of the analysis with the results provided in Table 10-1 above is to demonstrate that the culverts have adequate capacity to convey the flow demand under normal conditions. If the tailwater becomes elevated due to outflow restrictions in the downstream storage swale, any flow restriction is no longer a function of the size of the culvert.

11. Operation and Maintenance

The responsibility for the operation and maintenance of the stormwater management facility in the subdivision is that of the owner/developer until the subdivision is accepted by the City of Ottawa. Once the subdivision is accepted by the City of Ottawa, the operation and maintenance of the stormwater management facility in the subdivision is the responsibility of the City of Ottawa

11.1. Grassed Swales and Roadside Ditches

Short Term

The swales and roadside ditches should be inspected on a weekly basis and after any rain fall event after construction until vegetation is well established. Bare areas should be reseeded as required. Any areas of erosion should be repaired and reseeded as soon as possible. Once the vegetation is well established and during the first year of operation, the swales and roadside ditches should be visually inspected on a bi-monthly basis and following significant storm event. For inspection purposes, a rain fall event of more than 25 mm in 4 hours would be considered to be a significant event.

Long term

The grassed swales and ditches proposed for the development will require occasional maintenance. Periodic grass trimming along the drainage swales and ditches represents the bulk of the maintenance required.

Should excavation be required during maintenance, re-vegetation of disturbed areas should be completed after maintenance operations have been completed. Temporary straw bale check dams should be used to trap the debris and sediment disrupted during ditch cleaning operations.

11.2. Stormwater Management Swale

Short Term

The stormwater management swale should be inspected on a weekly basis and after any rain fall event after construction until vegetation is well established. Once the vegetation is well established and during the first year of operation, the stormwater management swale should be visually inspected on a bi-monthly basis and following significant storm event. For inspection purposes, a rain fall event of more than 25 mm in 4 hours would be considered to be a significant event.

Intermediate (First Year)

Cut the vegetation within the stormwater storage swale to a height of 20 cm twice during the first growing season and once early in the second growing season. Hand remove pockets of aggressive weeds during the establishment period. The specified native seed mixes are intended to grow without maintenance following their establishment in order to provide wildlife habitat.

Long Term

The seed mixtures are intended to be low maintenance and the resulting vegetation is intended to be left in its natural state.

If patches of noxious weeds occur following the establishment of the seed mixture, the patch could be mechanically removed by excavator. The topsoil removed should be replaced with an amended topsoil mix and the area should be reseeded.

Removal of accumulated sediment from the stormwater management swale should be conducted when the accumulation of the sediment begins to significantly affect the quality of the vegetation growth within the storage swale and/or the drainage patterns along the bottom. If the drawdown time becomes significantly extended, the topsoil layer should be tilled or cultivated to reduce the compaction. Additional amending material can also be added at that time.

Following tilling or cultivation, the bottom should be reseeded with the specified seed mixtures. The inspection schedule will be reset to short term following tilling or cultivation and reseeding.

11.3. Outlet Structures

Short Term

The maintenance manhole comprising the outlet control structure of the storage swale should be cleaned following completion of the construction on the storage swale and following establishment of the vegetation in the storage swale.

The grate covering the inlet to the outlet control structure should be observed during each inspection of the storage swale and cleared of debris as necessary.

Long Term

The grate covering the inlet to the outlet control structure should be inspected during any site visit to inspect the remainder of the swale and any debris or obstructions should be removed.

The interior of the control structure should be inspected on a bi-annual basis to verify that sediment and fine debris in the structure remains at least 0.15 m below the level of the weir invert.

12. Mitigation Measures for Construction and Development

The following Mitigation Measures should be incorporated during the construction and development of the site to minimize the impact of the proposed development on the adjacent undeveloped areas:

1) To prevent the introduction and spread of invasive plant species into the study area, equipment utilized during construction should be inspected and cleaned in accordance with the *Clean Equipment Protocol for Industry*
   a) Inspect the vehicle thoroughly inside and out for where dirt, plant material and seeds may be lodged or adhering to interior and exterior surfaces prior to mobilizing equipment onto the site.
   b) Remove any guards, covers or plates that are easy to remove.
   c) Attention should be paid to the underside of the vehicle, radiators, spare tires, foot wells and bumper bars.
   d) If clods of dirt, seed or other plant material are found, removal should take place immediately, using the techniques outlined in the Clean Equipment Protocol For Industry.
2) Except as required to construct the outlet, a minimum of 30 m setback from Harwood Creek should be maintained where no development or clearing should occur.

3) In accordance with the City's of Ottawa's *Protocol for Wildlife Protection during Construction to* reduce potential wildlife usage of the Forb Meadow habitat by mowing/clearing outside of the breeding season (i.e., before April 15), then maintain as mowed grass until on-site work begins.
4) No clearing of any vegetation should occur between April 1 and September 15 of any year, unless a qualified biologist has determined that no bird nesting is occurring within five days of the vegetation clearing event.
5) Should any SAR be discovered during the project works, and/or should any SAR or their habitat be potentially impacted by on-site activities, the MECP shall be contacted immediately and operations modified to avoid any negative impacts to SAR or their habitat, until further direction is provided by the MECP;
6) Any excavation or heavy equipment use in the floodplain or near Harwood Creek within the study area, conducted between May 1 and September 15, has the potential to harm travelling Blanding's Turtles and other SAR turtles that utilize the watercourse. As such, mitigation measures should be employed to protect SAR and their habitat during construction and to maintain compliance with the ESA. Some common mitigations would include working outside the known timing window for active turtle movement from May 1 to September 15 of any year, unless the area has been cleared of turtles by a qualified biologist; as well as temporary turtle exclusion barriers should be installed by May 1, prior to the turtle nesting season surrounding the impacted watercourse or proposed works.

13. SEQUENCING OF DEVELOPMENT AND EROSION AND SEDIMENT CONTROL

13.1. Sequencing of Development and Construction Activities

It is anticipated that the development and construction activities at the site will occur in the following order. There is only one proposed Phase.

1) Construction of Roadway:
    a) Install sediment and erosion control measures;
    b) Strip topsoil and prepare subgrade;
    c) Place raodway granular subbase and base;
    d) Shape ditches and back slope to property lines;
    e) Topsoil and seed ditches;
    f) Construct "Cow path" to support truck traffic;
    g) Following placement of fill in flood plain, remove "Cow path and finish shaping roadway;

2) Place Fill in Flood Plain within the Storm Block:
   a) Install sediment and erosion control measures
   b) All of the fill required to raise the flood plain to the proposed grades should be placed within the proposed storm block.
   c) Construct the maintenance road along the stormwater storage swale;
3) Construct the Stormwater Management Facility and Outlet Swales:
   a) Install sediment and erosion control measures;
   b) Construct the stormwater management swale;
   c) Seed the specified vegetation within the stormwater management swale;
4) Construct the peripheral swales:
   a) Install sediment and erosion control measures;
   b) construct swales by excavation;
   c) cut material to be used as fill and to be placed within the confines of the sediment and erosion control measures;
5) Finish the placement of fill within the flood plain:
   a) Install sediment and erosion control measures
6) Complete individual lot development:
   a) Install sediment and erosion control measures

13.2. Sediment and Erosion Control Measures

The following Sediment and Erosion Control measures are recommended during the various stages of development of the proposed subdivision.

1) Prior to Start of Construction:
   a) Install silt fence, straw bale check dams and mud mat in location shown;
   b) Inspect measures immediately after installation.
2) In General:
   a) Do not locate topsoil piles or fill piles within 2.5 m from any paved or gravel surface area;
   b) Control dust off site by seeding topsoil and soil piles and other disturbed areas watering as necessary if they are to remain unfinished longer than 30 days;
   c) City Roadway to be cleaned of all sediment from vehicular tracking as required;
   d) Provide mud mat where ever vehicular traffic leaves the site from an unpaved egress point;
   e) All erosion control measures should be inspected within 24 hours of a storm event and should be cleaned / repaired / replaced as necessary;

3) During Construction of the Roadway:
   a) Minimize the extend of the disturbed areas outside of the area immediately affected by the road construction;
   b) Install silt fence at the perimeter of the disturbed area;
   c) Ensure straw bale check dams are in place at the discharge point from the Cul-de-Sac;
   d) Equipment used should be sufficient in size and quantity to ensure the construction time is minimized;
   e) Any excess soil material excavated during the construction should be stockpiled on the proposed lots outside of vulnerable areas and outside of the road allowance. The soil should be leveled to rough grade and should be stabilized by seeding;
   f) Cover disturbed areas with minimum 100 mm of topsoil then seed and mulch or hydro seed. The topsoil placement and seeding and mulching / hydro seeding should be completed within 30 days of start of the construction of the roadway;
4) During Placement of the Fill within the Flood Plain Area:
   a) Minimize the extend of the disturbed areas outside of the area immediately affected by the fill placement;
   b) Plan the placement of the fill to reduce the duration of exposure either by ensuring sufficient equipment or by placing the fill in stages;
   c) Install silt fence at the perimeter of the disturbed area or around the perimeter of each phase if not completing the fill placement all at once;
   d) Level the fill to finished grade immediately after placement;
   e) Cover fill with minimum 100 mm of topsoil then seed and mulch or hydro seed. The placement of the fill should be completed in a manner that will allow the placement of the topsoil and seeding and mulching / hydro seeding within 30 days of start of fill placement;
   f) Inspect silt fence within 24 hours of a storm event and clean / repair as necessary;
5) During Construction of the Storm water Management Facility.
   a) Minimize the extend of the disturbed areas outside of the area immediately affected by storm water management facility;
   b) Install silt fence at the perimeter of the disturbed area;
   c) Ensure straw bale check dams are in place downstream of the facility;
   d) Equipment used should be sufficient in size and quantity to ensure the construction time is minimized;
   e) Any excess soil material excavated during the construction should be stockpiled on the proposed lots outside of vulnerable areas and outside of the road allowance. The soil should be leveled to rough grade and should be stabilized by seeding;
   f) Cover disturbed areas with minimum 100 mm of topsoil then seed and mulch or hydro seed. The topsoil placement and seeding and mulching / hydro seeding should be completed within 30 days of start of the construction of the facilities;
6) During Development of Individual Lots
   a) Install silt fence at the perimeter of the disturbed area;

b) Control dust off site by seeding topsoil and other disturbed areas watering as necessary if they are to remain unfinished longer than 30 days;
c) Repair any erosion channels as they occur and redirect surface runoff with the use of berms to promote sheet flow;
d) Cover disturbed areas with minimum 100 mm of topsoil then seed and mulch or hydro seed as soon as possible;

14. STORMWATER MANAGEMENT CONCLUSIONS

- The proposed Dunrobin subdivision covers a total of about 9 hectares. The subdivision will consist of 8 lots proposed for single family residential development.

- The property has been previously used for farming and currently drains to the eastern portion of the site. The proposed development will ensure that the existing overall drainage patterns of the site are not changed.

- Development of the Site and associated filling of the backwater flood plain will have no impact on the adjacent upstream or downstream properties including their wells and septic systems. The elimination of a portion of the backwater flood plain will have no effect on the flow regime in the Harwood Creek.

- The stormwater runoff will be treated using road side ditches, grassed swales and infiltration to ensure that an enhanced level of protection is achieved.

- Runoff will be managed from the site to ensure that the post-development runoff rate does not exceed the pre-development runoff rate for all storm events

- The proposed stormwater management facility will ensure that the development does not increase the runoff volume during normal rainfall events and only negligibly increases the runoff volume during minor storm events ensuring the development will have no measurable effect on the Hardwood Creek flow and flood elevations.

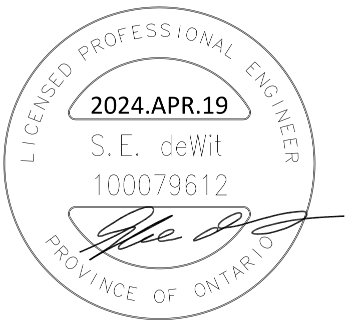
- The proposed stormwater management facility will promote infiltration and promote aquatic and terrain habitat on and adjacent to the site.

- Erosion measures will be placed prior to construction and during development and will remain in place until construction is complete. Disturbed areas will be topsoiled and seeded as soon as reasonably possible.

- Mitigation measures will reduce the impact of the proposed development to adjacent undeveloped areas.

We trust that this report provides sufficient information for your present purposes. If you have any questions concerning this report or if we can be of any further assistance to you on this project, please do not hesitate to contact our office.

Sincerely,
Kollaard Associates Inc.



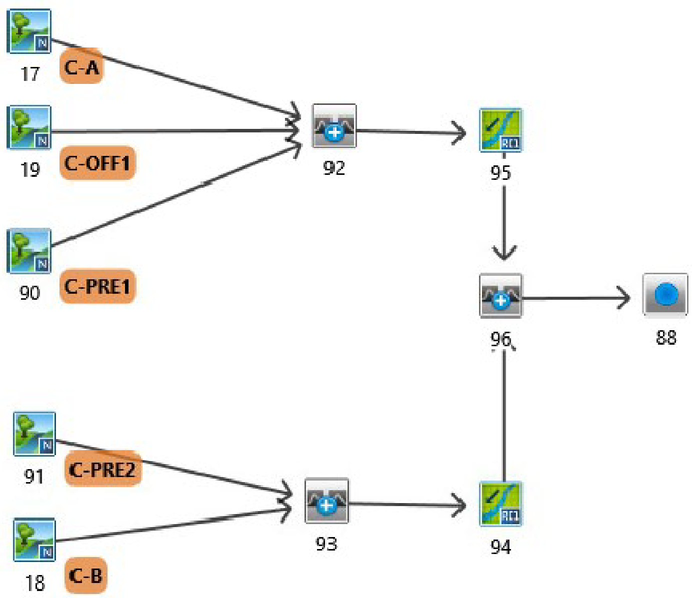
Steven deWit, P.Eng.

APPENDIX A: STORM ANALYSIS MODEL SCHEMATIC AND PARAMETERS

Pre-development OTTHYMO model Schematic and Summary Table

Post-development OTTHYMO model Schematic and Summary Table

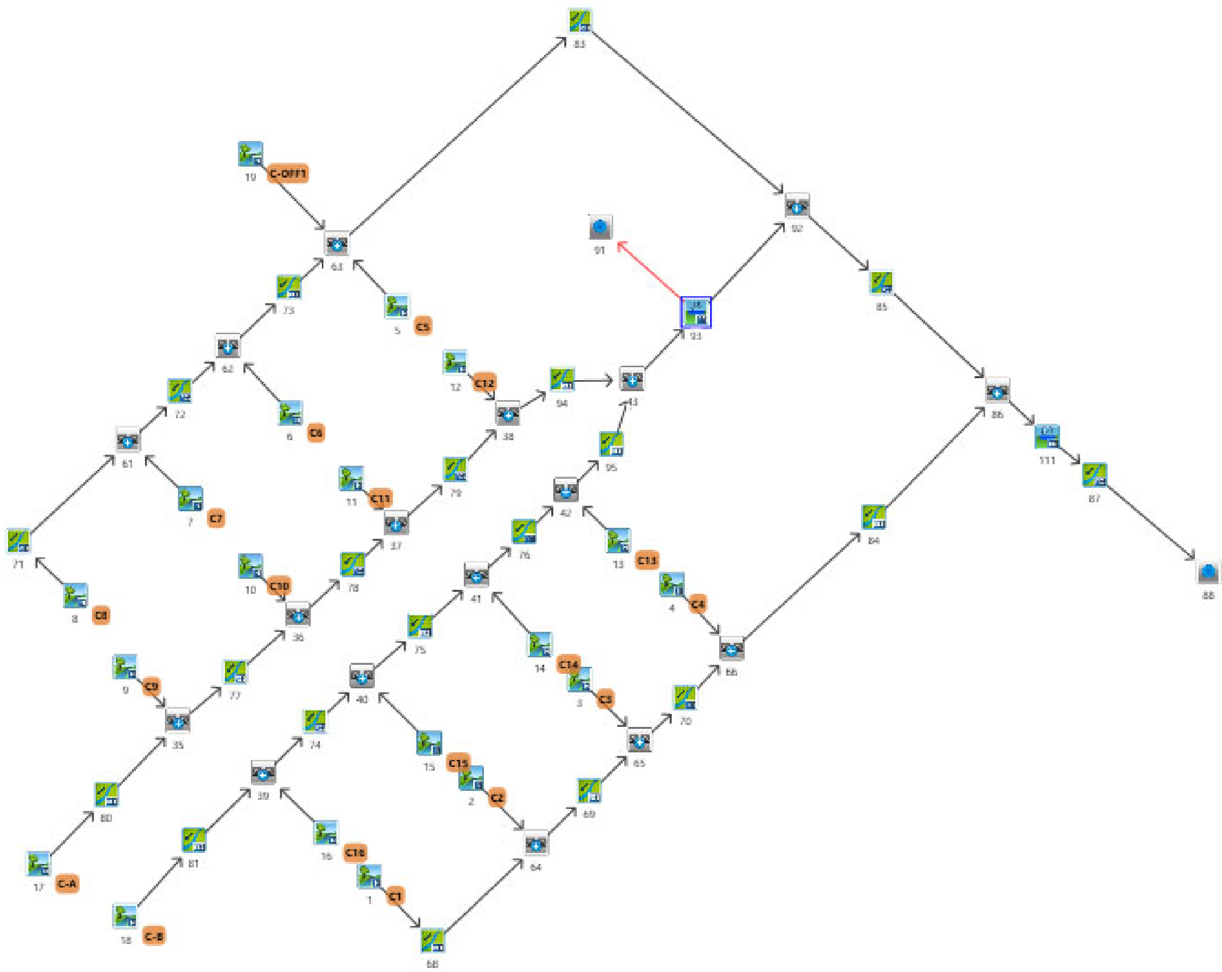
Model Variables for Each Catchment



Pre-Development OTTHYMO model Schematic Summary Table

Hydrograph No.	Model Type	Item Represented	Comment
90	NASHYD	Sub-Catchment C-PRE1	Catchment represents north half of site.
91	NASHYD	Sub-Catchment C-PRE2	Catchment represents south half of site
17	NASHYD	Sub-Catchment C-A	Catchment includes west side of Lot 1 and east half of Dunrobin Road adjacent Lot 1
18	NASHYD	Sub-Catchment C-B	Catchment includes west side of Lot 2 and east half of Dunrobin Road adjacent Lot 2
19	NASHYD	Sub-Catchment C-OFF1	Catchment includes offsite area north of the proposed development
95,96	Route Channel	Open Channel Flow along grassed swale	Models the open channel flow component of the runoff during pre-development conditions along the north and south sides of the site
88	Node	Ends the Model	Ends the Model
30,31,33-46,49,50	NASHYD	Add Hydrograph	Used to add two hydrographs in the routing

Post-Development OTTHYMO model Schematic



Post-Development OTTHYMO model Schematic Summary Table

Hydrograph No.	Model Type	Item Represented	Comment
1	NASHYD	Sub-Catchment C1	Catchment represents rear yard of Lot 2. Uncontrolled.
2	NASHYD	Sub-Catchment C2	Catchment represents rear yard of Lot 4. Uncontrolled.
3	NASHYD	Sub-Catchment C3	Catchment represents rear yard of Lot 6. Uncontrolled.
4	NASHYD	Sub-Catchment C4	Catchment represents rear yard of Lot 8. Uncontrolled.
5	NASHYD	Sub-Catchment C5	Catchment represents rear yard of Lot 7. Uncontrolled.
6	NASHYD	Sub-Catchment C6	Catchment represents rear yard of Lot 5. Uncontrolled.
7	NASHYD	Sub-Catchment C7	Catchment represents rear yard of Lot 3. Uncontrolled.
8	NASHYD	Sub-Catchment C8	Catchment represents rear yard of Lot 1. Uncontrolled.
9	NASHYD	Sub-Catchment C9	Catchment includes front yard of Lot 1 and contains dwelling, driveway and half of road. Controlled
10	NASHYD	Sub-Catchment C10	Catchment includes front yard of Lot 3 and contains dwelling, driveway and half of road. Controlled
11	NASHYD	Sub-Catchment C11	Catchment includes front yard of Lot 5 and contains dwelling, driveway and half of road. Controlled
12	NASHYD	Sub-Catchment C12	Catchment includes front yard of Lot 7 and contains dwelling, driveway and half of road. Controlled
13	NASHYD	Sub-Catchment C13	Catchment includes front yard of Lot 8 and contains dwelling, driveway and half of road. Controlled
14	NASHYD	Sub-Catchment C14	Catchment includes front yard of Lot 6 and contains dwelling, driveway and half of road. Controlled
15	NASHYD	Sub-Catchment C15	Catchment includes front yard of Lot 4 and contains dwelling, driveway and half of road. Controlled

16	NASHYD	Sub-Catchment C16	Catchment includes front yard of Lot 2 and contains dwelling, driveway and half of road. Controlled
17	NASHYD	Sub-Catchment C-A	Catchment includes northwest side of Lot 1 and southeast half of Dunrobin Road Controlled
18	NASHYD	Sub-Catchment C-B	Catchment includes southwest side of Lot 2 and southeast half of Dunrobin Road Controlled
19	NASHYD	Sub-Catchment C-OFF1	Catchment includes offsite area northwest of the proposed development Controlled
71, 72, 73, 83	Route Channel	Open Channel Flow along grassed swale	Models the open channel flow component of the runoff during post-dev. conditions along the north side of the development and along the east side of Lot 7
68, 69, 70, 84,	Route Channel	Open Channel Flow along grassed swale	Models the open channel flow component of the runoff during post-dev. conditions along the south side of the development
77, 78, 79, 94	Route Channel	Open Channel Flow, Road side ditches	Models the open channel flow component of the runoff during post-development conditions along the front of Lots 1, 3, 5 and 7 respectively.
74, 75, 76, 95	Route Channel	Open Channel Flow, Road side ditches	Models the open channel flow component of the runoff during post-development conditions along the front of Lots 2, 4, 6 and 8 respectively.
80, 81	Route Channel	Open Channel Flow, Road side ditches	Models the open channel flow component of the runoff in the ditches along Dunrobin Road.
85, 87	Route Channel	Open Channel Flow, Grassed Swales	Models the open channel flow component of the runoff during post-development conditions following the stormwater management swale to Harwood Creek
93	Route Reservoir	The stormwater management swale	Provides a model of the stormwater storage swale storage and release.
35-43, 61-66, 86, 92	NASHYD	Add Hydrograph	Used to add two hydrographs in the routing
111	Route Reservoir	The stormwater management swale	Provides a model of the outlet swale storage and release.

Catchment Areas and Model Parameters

Refer to Drawing # 200977-PRECA and Drawing # 200977-POST for an illustration of the specified catchment areas.

OTTHYMO NASHYD PARAMETERS											
NHYD #	NAME	OUTLET NHYD#	DT [min]	AREA [ha]	DWF $[m^3/s]$	CN	IA [mm]	N	TP [hr]	STORM INDEX	RAIN [mm/hr]
1	C1	68	5	0.496	0	62.5	12.2	3	0.17	1	0
2	C2	64	5	0.503	0	62.4	12.2	3	0.26	1	0
3	C3	65	5	0.510	0	62.4	12.2	3	0.24	1	0
4	C4	66	5	1.676	0	63.4	11.7	3	0.41	1	0
5	C5	63	5	1.408	0	64.6	11.1	3	0.34	1	0
6	C6	62	5	0.501	0	62.5	12.2	3	0.29	1	0
7	C7	61	5	0.501	0	62.4	12.2	3	0.27	1	0
8	C8	71	5	0.493	0	62.5	12.2	3	0.17	1	0
9	C9	35	5	0.359	0	68.4	9.4	3	0.27	1	0
10	C10	36	5	0.376	0	68.1	9.5	3	0.27	1	0
11	C11	37	5	0.377	0	68.1	9.5	3	0.27	1	0
12	C12	38	5	0.295	0	74.8	8.5	3	0.22	1	0
13	C13	42	5	0.340	0	76.8	7.7	3	0.24	1	0
14	C14	41	5	0.363	0	68.3	9.4	3	0.27	1	0
15	C15	40	5	0.376	0	68.1	9.5	3	0.27	1	0
16	C16	39	5	0.387	0	67.9	9.6	3	0.27	1	0
17	C-A	92	5	0.173	0	73.9	9.0	3	0.17	1	0
18	C-B	93	5	0.172	0	73.9	9.0	3	0.17	1	0
19	C-OFF1	92	5	1.680	0	59.5	13.8	3	0.41	1	0
90	C-PRE1	92	5	4.311	0	60.0	13.5	3	0.58	1	0
91	C-PRE2	93	5	4.650	0	60.1	13.5	3	0.71	1	0

APPENDIX B: TIME OF CONCENTRATION AND TIME TO PEAK CALCULATION

Calculation Table

USDA Chapter 15 – Figure 15-4 and Table 15-3

	Sheet Flow					Shallow Concentrated Flow					
NAME	Mannings n	length Sheet Flow (m)	2 yr 24 Hr Rainfall (mm)	Slope (m/m)	Time of Sheet Flow (hrs)	Flow Length to Major Channel	Average Slope (m/m)	Velocity (m/s)	Time of Shallow Concentrated Flow (hr)	TC min	TP [hr]
C1	0.4	16	48	0.09	0.15	58	0.024	0.18	0.09	15	0.17
C2	0.4	27	48	0.057	0.28	58	0.014	0.14	0.12	24	0.26
C3	0.4	24	48	0.067	0.24	58	0.014	0.14	0.12	21	0.24
C4	0.4	30	48	0.027	0.41	54	0.004	0.07	0.21	37	0.41
C5	0.4	30	48	0.041	0.35	45	0.004	0.07	0.17	31	0.34
C6	0.4	25	48	0.038	0.31	58	0.013	0.13	0.12	26	0.29
C7	0.4	30	48	0.066	0.29	58	0.013	0.13	0.12	24	0.27
C8	0.4	18	48	0.1	0.16	58	0.022	0.17	0.09	15	0.17
C9	0.4	30	48	0.03	0.39	10	0.03	0.37	0.01	24	0.27
C10	0.4	30	48	0.03	0.39	10	0.03	0.37	0.01	24	0.27
C11	0.4	30	48	0.03	0.39	10	0.03	0.37	0.01	24	0.27
C12	0.4	30	48	0.047	0.33	10	0.047	0.46	0.01	20	0.22
C13	0.4	30	48	0.04	0.35	10	0.04	0.42	0.01	21	0.24
C14	0.4	30	48	0.03	0.39	10	0.03	0.37	0.01	24	0.27
C15	0.4	30	48	0.03	0.39	10	0.03	0.37	0.01	24	0.27
C16	0.4	30	48	0.03	0.39	10	0.03	0.37	0.01	24	0.27
C-A	0.011	3	48	0.03	0.00					0	0.17
C-B	0.011	3	48	0.03	0.00					0	0.17
C-OFF1	0.35	30	48	0.01	0.55	30	0.013	0.12	0.07	37	0.41
C-PRE1	0.24	30	48	0.01	0.40	147	0.009	0.09	0.47	53	0.58
C-PRE2	0.24	30	48	0.01	0.40	210	0.006	0.09	0.65	63	0.71

Figure 15–4 Velocity versus slope for shallow concentrated flow

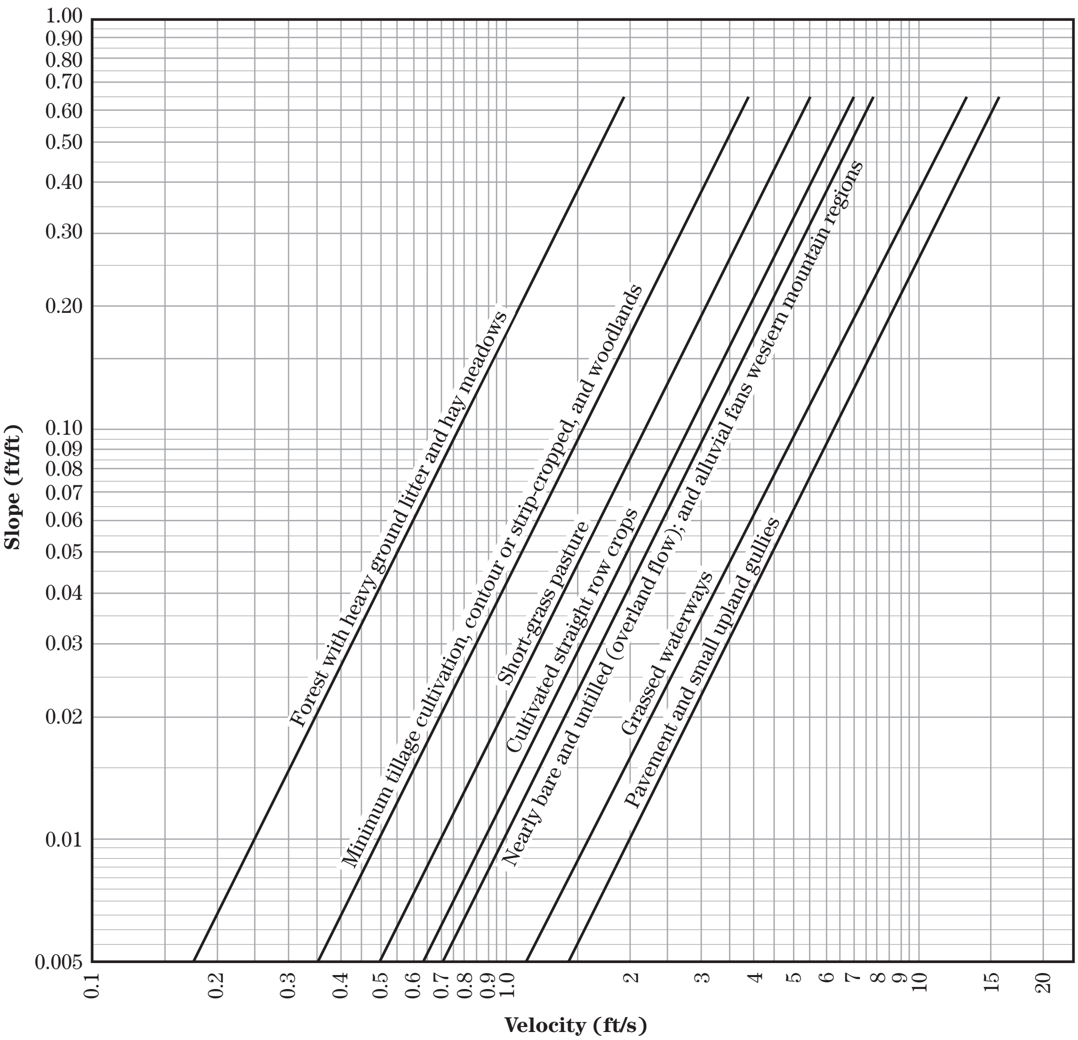


Table 15–3 Equations and assumptions developed from figure 15–4

Flow type	Depth (ft)	Manning's *n*	Velocity equation (ft/s)
Pavement and small upland gullies	0.2	0.025	$V = 20.328(s)^{0.5}$
Grassed waterways	0.4	0.050	$V=16.135(s)^{0.5}$
Nearly bare and untilled (overland flow); and alluvial fans in western mountain regions	0.2	0.051	$V=9.965(s)^{0.5}$
Cultivated straight row crops	0.2	0.058	$V=8.762(s)^{0.5}$
Short-grass pasture	0.2	0.073	$V=6.962(s)^{0.5}$
Minimum tillage cultivation, contour or strip-cropped, and woodlands	0.2	0.101	$V=5.032(s)^{0.5}$
Forest with heavy ground litter and hay meadows	0.2	0.202	$V=2.516(s)^{0.5}$

Table 3-5 Estimates of Manning's roughness coefficient for overland flow

Source	Ground Cover	n	Range
Crawford and Linsley (1966)[a]	Smooth asphalt	0.01	
	Asphalt of concrete paving	0.014	
	Packed clay	0.03	
	Light turf	0.20	
	Dense turf	0.35	
	Dense shrubbery and forest litter	0.4	
Engman (1986)[b]	Concrete or asphalt	0.011	0.010-0.013
	Bare sand	0.010	0.01-0.016
	Graveled surface	0.02	0.012-0.03
	Bare clay-loam (eroded)	0.02	0.012-0.033
	Range (natural)	0.13	0.01-0.32
	Bluegrass sod	0.45	0.39-0.63
	Short grass prairie	0.15	0.10-0.20
	Bermuda grass	0.41	0.30-0.48
Yen (2001)[c]	Smooth asphalt pavement	0.012	0.010-0.015
	Smooth impervious surface	0.013	0.011-0.015
	Tar and sand pavement	0.014	0.012-0.016
	Concrete pavement	0.017	0.014-0.020
	Rough impervious surface	0.019	0.015-0.023
	Smooth bare packed soil	0.021	0.017-0.025
	Moderate bare packed soil	0.030	0.025-0.035
	Rough bare packed soil	0.038	0.032-0.045
	Gravel soil	0.032	0.025-0.045
	Mowed poor grass	0.038	0.030-0.045
	Average grass, closely clipped sod	0.050	0.040-0.060
	Pasture	0.055	0.040-0.070
	Timberland	0.090	0.060-0.120
	Dense grass	0.090	0.060-0.120
	Shrubs and bushes	0.120	0.080-0.180
	Business land use	0.022	0.014-0.035
	Semi-business land use	0.035	0.022-0.050
	Industrial land use	0.035	0.020-0.050
	Dense residential land use	0.040	0.025-0.060
	Suburban residential land use	0.055	0.030-0.080
	Parks and lawns	0.075	0.040-0.120

[a]Obtained by calibration of Stanford Watershed Model.
[b]Computed by Engman (1986) by kinematic wave and storage analysis of measured rainfall-runoff data.
[c]Computed on basis of kinematic wave analysis.

APPENDIX C: HARWOOD CREEK FLOOD LEVEL AND FLOW RATES

Reach	River Sta	Return Period (Yrs)	Q Total (m3/s)	W.S. Elev (m)	E.G. Elev (m)	Vel Left (m/s)	Vel Chnl (m/s)	Vel Right (m/s)
Main	1214	2	2.7	74.89	74.9	0.2	0.83	0.17
Main	1214	5	5.1	75.08	75.09	0.21	0.93	0.14
Main	1214	10	7	75.19	75.2	0.22	0.94	0.13
Main	1214	25	9.7	75.29	75.3	0.24	1.02	0.13
Main	1214	50	11.8	75.39	75.4	0.22	1.02	0.13
Main	1214	100	14.1	75.48	75.49	0.22	0.96	0.14
Main	1130	2	2.7	74.75	74.77	0.16	0.95	0.21
Main	1130	5	5.1	74.93	74.96	0.23	1.24	0.22
Main	1130	10	7	75.04	75.07	0.27	1.39	0.22
Main	1130	25	9.7	75.12	75.17	0.33	1.66	0.24
Main	1130	50	11.8	75.23	75.28	0.33	1.73	0.22
Main	1130	100	14.1	75.36	75.4	0.31	1.62	0.22
Main	1075	2	2.7	74.44	74.6	0.34	1.98	0.31
Main	1075	5	5.1	74.64	74.78	0.37	2.07	0.35
Main	1075	10	7	74.75	74.89	0.36	2.18	0.34
Main	1075	25	9.7	75	75.04	0.28	1.47	0.17
Main	1075	50	11.8	75.17	75.19	0.2	1.14	0.16
Main	1075	100	14.1	75.33	75.34	0.17	0.93	0.14
Main	1023	2	2.8	74.23	74.26	0.22	0.84	0.13
Main	1023	5	5.3	74.48	74.53	0.29	1.04	0.22
Main	1023	10	7.2	74.63	74.7	0.33	1.17	0.27
Main	1023	25	10.2	74.85	74.93	0.39	1.32	0.33
Main	1023	50	12.5	75	75.09	0.42	1.43	0.37
Main	1023	100	14.9	75.15	75.26	0.45	1.51	0.4
Main	1013		Culvert					
Main	1002	2	2.8	74.18	74.22	0.2	0.91	0.18
Main	1002	5	5.3	74.39	74.45	0.29	1.16	0.28
Main	1002	10	7.2	74.5	74.59	0.35	1.34	0.34
Main	1002	25	10.2	74.66	74.78	0.43	1.58	0.41
Main	1002	50	12.5	74.75	74.9	0.48	1.76	0.47
Main	1002	100	14.9	74.83	75.01	0.54	1.94	0.52
Main	900	2	2.8	74.04	74.06	0.15	0.72	0.1
Main	900	5	5.3	74.24	74.28	0.13	0.95	0.17
Main	900	10	7.2	74.36	74.4	0.17	1.06	0.2
Main	900	25	10.2	74.5	74.56	0.21	1.24	0.18
Main	900	50	12.5	74.6	74.66	0.24	1.32	0.21
Main	900	100	14.9	74.69	74.75	0.26	1.39	0.23

Culvert Report

Railroad Box Culvert - Tailwater = Normal

Invert Elev Dn (m)	=	72.8600
Pipe Length (m)	=	20.0000
Slope (%)	=	0.5000
Invert Elev Up (m)	=	72.9600
Rise (mm)	=	1490.0
Shape	=	Box
Span (mm)	=	2800.0
No. Barrels	=	2
n-Value	=	0.023
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

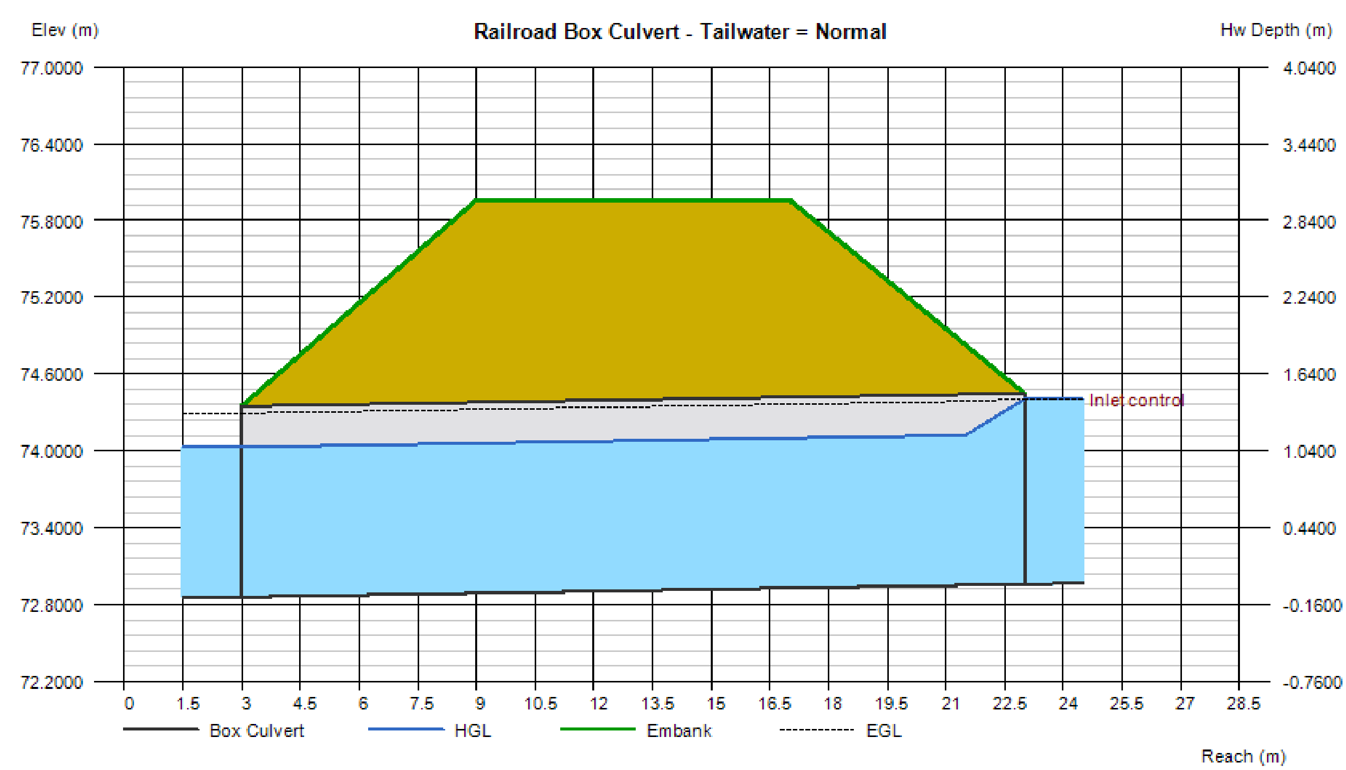
Top Elevation (m)	=	75.9600
Top Width (m)	=	8.0000
Crest Width (m)	=	10.0000

Calculations

Qmin (cms)	=	14.9000
Qmax (cms)	=	14.9000
Tailwater Elev (m)	=	Normal

Highlighted

Qtotal (cms)	=	14.9000
Qpipe (cms)	=	14.9000
Qovertop (cms)	=	0.0000
Veloc Dn (m/s)	=	2.2733
Veloc Up (m/s)	=	2.2715
HGL Dn (m)	=	74.0304
HGL Up (m)	=	74.1313
Hw Elev (m)	=	74.4047
Hw/D (m)	=	0.9696
Flow Regime	=	Inlet Control



Culvert Report

Railroad Box Culvert - Tailwater = 73.99

Invert Elev Dn (m)	=	72.8600
Pipe Length (m)	=	20.0000
Slope (%)	=	0.5000
Invert Elev Up (m)	=	72.9600
Rise (mm)	=	1490.0
Shape	=	Box
Span (mm)	=	2800.0
No. Barrels	=	2
n-Value	=	0.023
Culvert Type	=	Flared Wingwalls
Culvert Entrance	=	30D to 75D wingwall flares
Coeff. K,M,c,Y,k	=	0.026, 1, 0.0347, 0.81, 0.4

Embankment

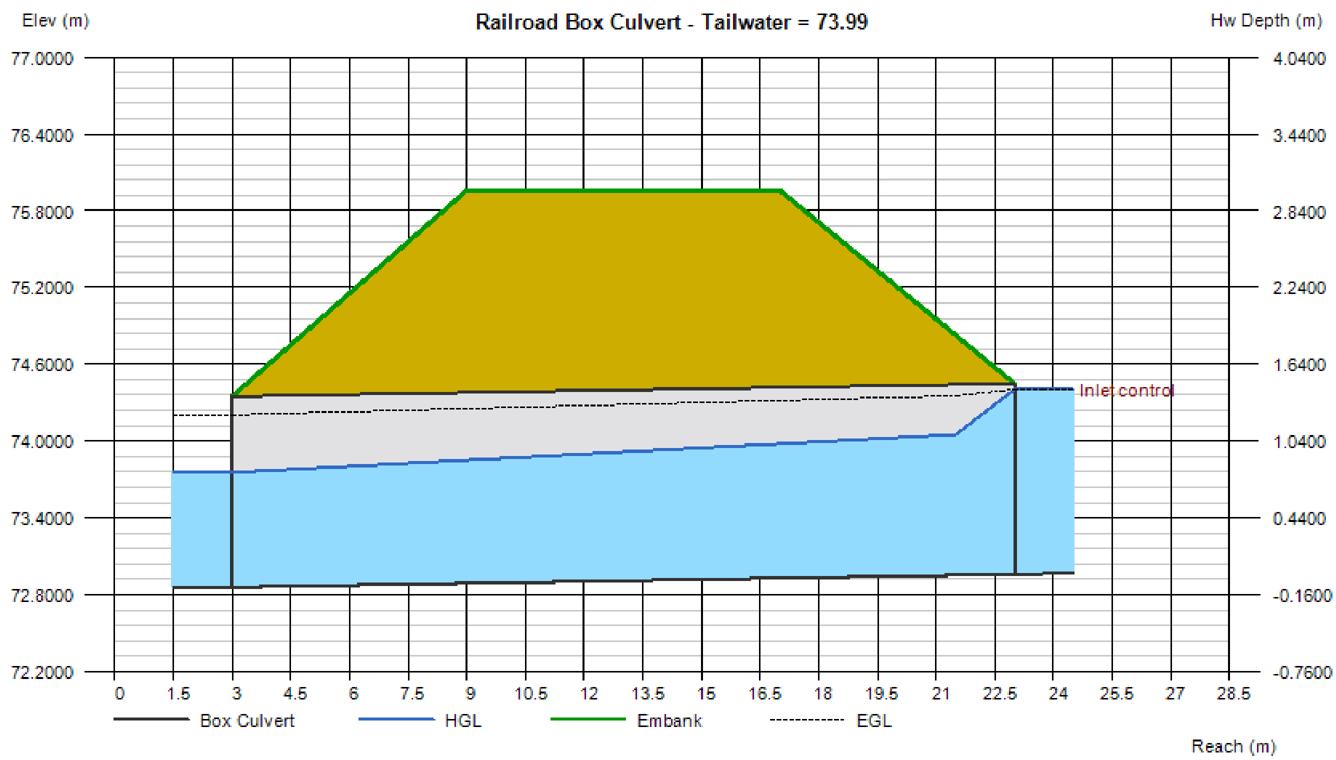
Top Elevation (m)	=	75.9600
Top Width (m)	=	8.0000
Crest Width (m)	=	10.0000

Calculations

Qmin (cms)	=	14.9000
Qmax (cms)	=	14.9000
Tailwater Elev (m)	=	73.99

Highlighted

Qtotal (cms)	=	14.9000
Qpipe (cms)	=	14.9000
Qovertop (cms)	=	0.0000
Veloc Dn (m/s)	=	2.9688
Veloc Up (m/s)	=	2.3842
HGL Dn (m)	=	73.7562
HGL Up (m)	=	74.0760
Hw Elev (m)	=	74.4047
Hw/D (m)	=	0.9696
Flow Regime	=	Inlet Control



APPENDIX D: JFSA – 2050 DUNROBIN ROAD FLOODPLAIN ANALYSIS

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

October 25, 2022 Project Number: 2363-22

Kollaard Associates Inc.
210 Prescot Street, Unit 1,
P.O. Box 189
Kemptville, ON
K0G 1J0

Attention: **William Kollaard, P.Eng.**

Subject: **2050 Dunrobin Road, City of Ottawa – Floodplain Analysis**

Overview

J.F. Sabourin and Associates Inc. (JFSA) has been retained by Kollaard Associates Inc. (Kollaard) to investigate the current floodplain extents on a site located at 2050 Dunrobin Road (hereon referred to as “the subject property”), adjacent to Harwood Creek. Based on the current floodplain mapping of Harwood Creek provided by the Mississippi Valley Conservation Authority (MVCA), as well as the information submitted by MVCA on their review of the Application for Zoning By-law Amendment on June 17, 2022, the subject property is partially located within the floodplain and regulation limit of Harwood Creek. Under proposed conditions, the development area of 8 rural residential lots will de raised to ensure there is no floodplain encroachment on any part of the residential envelope. Additionally, the floodplain is considered a backwater area that does not contribute to the effective conveyance of flows on Harwood Creek. **Figure 1** shows the extent of the floodplain within the subject property for the existing conditions. The following memo assesses the potential flooding on these lands and quantifies the impacts of raising the grades in this location to ensure no encroachment on the residential development envelopes.

Hydraulic Analysis

To support this analysis, JFSA has purchased a copy of the hydraulic (HEC-RAS) model of Harwood Creek developed by MVCA as part of the floodplain mapping works recently undertaken on this watercourse. In addition to this, LiDAR has been obtained from the City of Ottawa which was flown in 2020. **Figure 2** provides an overview of both the HEC-RAS model and the LiDAR obtained for this project.

From the topographic mapping underlaid in **Figure 2**, it is seen that the floodplain bulges out on this site as the product of a lateral spill from Harwood Creek located between model cross-sections (XS) **1130** and **1214**. As the flooding potential on these lands would occur due to lateral spill/backwater conditions, this area provides no benefit to flow conveyance and in turn, cannot impact the conveyance of flows along Harwood Creek. This concept is also proven by comparing the results of the pre- and post-development floodplain analysis, which demonstrates that there are no changes to the inundation boundary along Harwood Creek despite the reduction of the inundated area within the subject lands due to the proposed site alteration. **Figure 3** shows the floodplain overview under proposed conditions and **Figure 4** shows a comparison/overlay between the existing and proposed floodplain conditions, identifying the floodplain removal within the subject lands and showing that there are no changes to the existing floodplain limits along Harwood Creek. Note that from **Figure 3,** none of the proposed units are at risk of flooding.

JFSA has updated the HEC-RAS model with the 2020 LiDAR obtained from the City of Ottawa and the inclusion of the proposed development as per the detailed grading design provided by Kollaard, see **Figure 5** for the proposed details grading plan for this site. **Attachment A** provides a full summary of existing and proposed results, which shows that the filling of these lands has no impact and that the peak water level results are identical. Additionally, by comparing the 100-year water surface elevation of **75.48 m** on Harwood Creek at **XS 1214** with the proposed underside of footing elevation (USF) of **75.80 m** at **Unit 8**, it can be concluded that the USF is above the 100-year water level on Harwood Creek, with a freeboard of **0.32 m**.

It should be noted that 1D HEC-RAS models, although capable of simulating lateral spills, are not well suited to capture the complex hydraulic phenomenon under such situations. As a secondary check, the floodplain storage loss caused by filling these lands has been assessed using simple GIS tools and data available.

Floodplain Storage Volume

Based on MVCA's HEC-RAS modelling, the 100-year water surface elevation on Harwood Creek at **XS 1214** is **75.48 m**. Overlaying this water surface elevation onto the City of Ottawa LiDAR within the subject property and summing up the total depth of flooding in each cell (1.0m x 1.0m cell) determined that the total existing floodplain storage volume at this location is approximately **3,008 m³**. By doing the same process for the proposed condition where a portion of the development is filled, the floodplain storage volume within the subject property is approximately **1,877 m³**. As such, filling this land would reduce the total floodplain storage volume to Harwood Creek by approximately **1,131 m³**. To provide some context, based on MVCA's HEC-RAS model, the total floodplain storage volume within the Harwood Creek for the 100-year event is **312,000 m³**, therefore the floodplain storage volume loss due to the filling within the subject property at 2050 Dunrobin Road equates to a **0.36%** reduction in total floodplain storage within Harwood Creek. As such, it is determined that filling these lands will have no impact on the hydraulic operations of this watercourse.

Conclusion

Based on the above, JFSA has assessed the potential impacts of filling the area within 2050 Dunrobin Road, which is currently mapped as a floodplain in MVCA's recent floodplain mapping study. Based on updated HEC-RAS modelling, which assumes these lands are filled, JFSA has demonstrated that there is no increase in peak water level. It was noted that 1D HEC-RAS models are not well suited to assessing/simulating the complexities of lateral spills, and as such the floodplain storage lost due to filling these lands was approximated using 2020 LiDAR obtained from the City of Ottawa and the MVCA's simulated 100-year water surface elevation over these lands. Based on this analysis, it was found that filling the floodplain bulge on these lands will result in an approximate reduction in storage volume by **1,131 m³** or **0.36%** of the Harwood Creek 100-year floodplain. As such JFSA concludes that the proposed filling within the subject property will have no adverse impacts on the existing hydraulic operations of Harwood Creek.

Yours truly,
J.F Sabourin and Associates Inc.

Jonathon Burnet, B.Eng, P.Eng
Water Resource Engineer

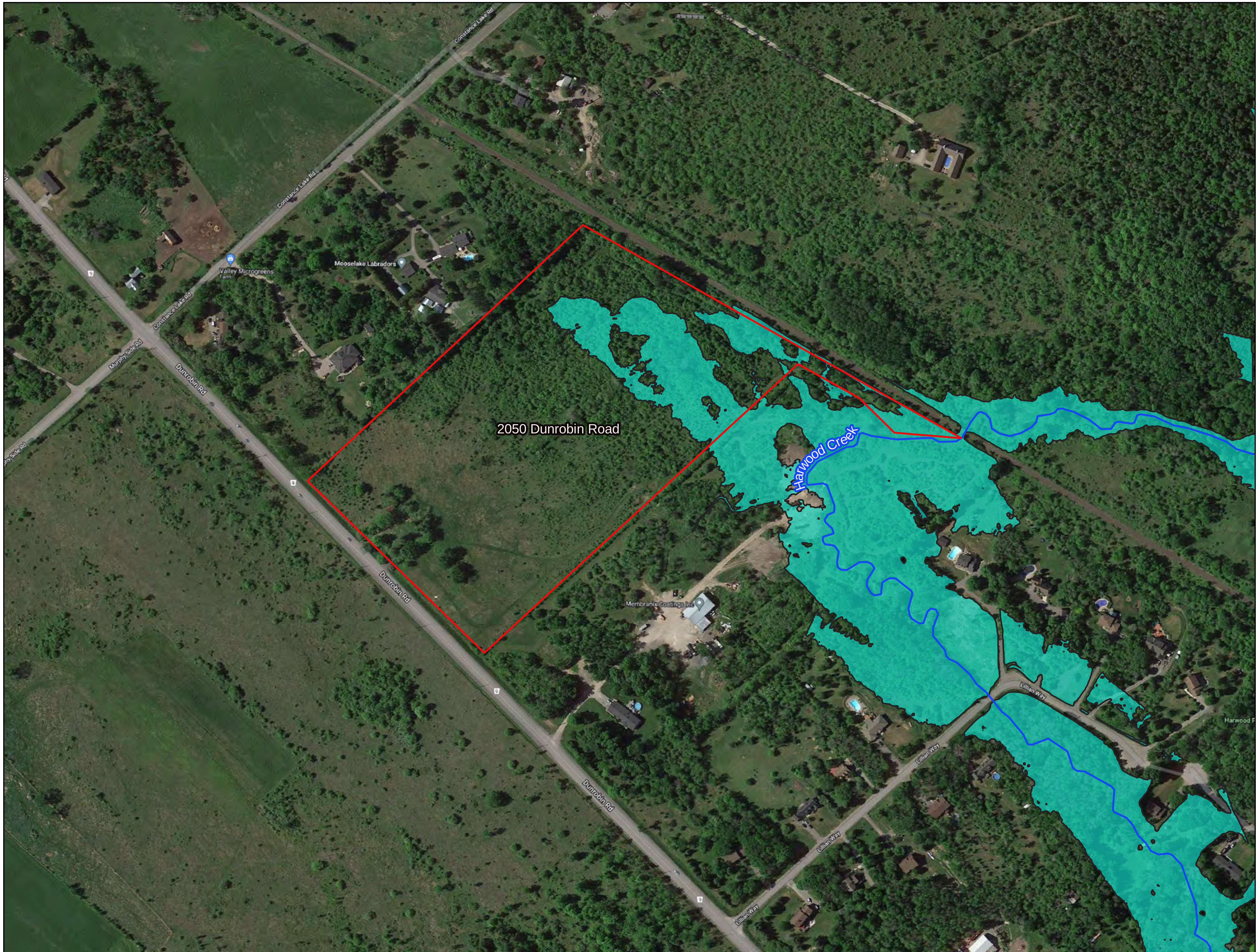
cc: J.F Sabourin, M.Eng, P.Eng
Director of Water Resources Projects

Figures

Figure 1: Existing Conditions 100-Year Floodplain Overview
Figure 2: HEC-RAS Model Overview
Figure 3: Proposed Conditions 100-Year Floodplain Overview
Figure 4: Existing & Proposed Conditions 100-Year Floodplain Comparison
Figure 5: Preliminary Grading Plan for Fill Placement (Kollaard, March 2022)

Attachments

Attachment A: Harwood Creek HEC-RAS Model Results



Legend

- Site Boundary
- Watercourse
- Existing Floodplain City of Ottawa Lidar (NRCan)

SCALE: 1:3500

0 100 200 m

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Kollaard Associates
Engineers

2050 Dunrobin Road
Harwood Creek
Floodplain Analysis

Figure 1: Existing Conditions
100-Year Floodplain Overview

PROJECT	2363-22
DRAWN	PP
DATE	October 2022

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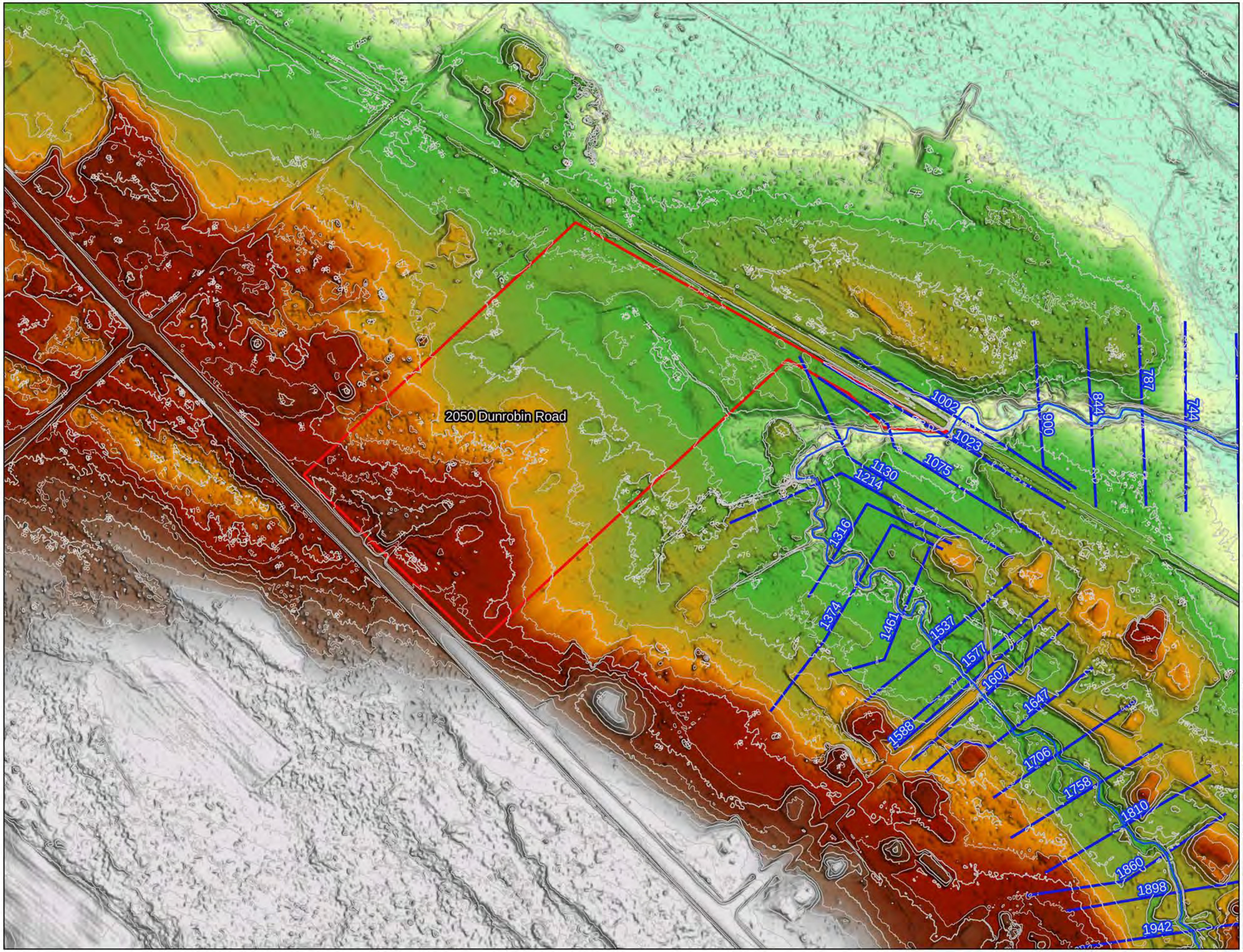

Legend

- Minor Contours (0.5m)
- Major Contours (1.0m)
- HEC-RAS XS
- Site Boundary
- Watercourse

Lidar (m)

- 73
- 74
- 75
- 76
- 77
- 78
- 79
- 80
- 81
- 82

N

SCALE: 1:3500

0 100 200 m

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Engineers

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Floodplain Analysis

Figure 2: HEC-RAS Model Overview

PROJECT	2363-22
DRAWN	PP
DATE	October 2022

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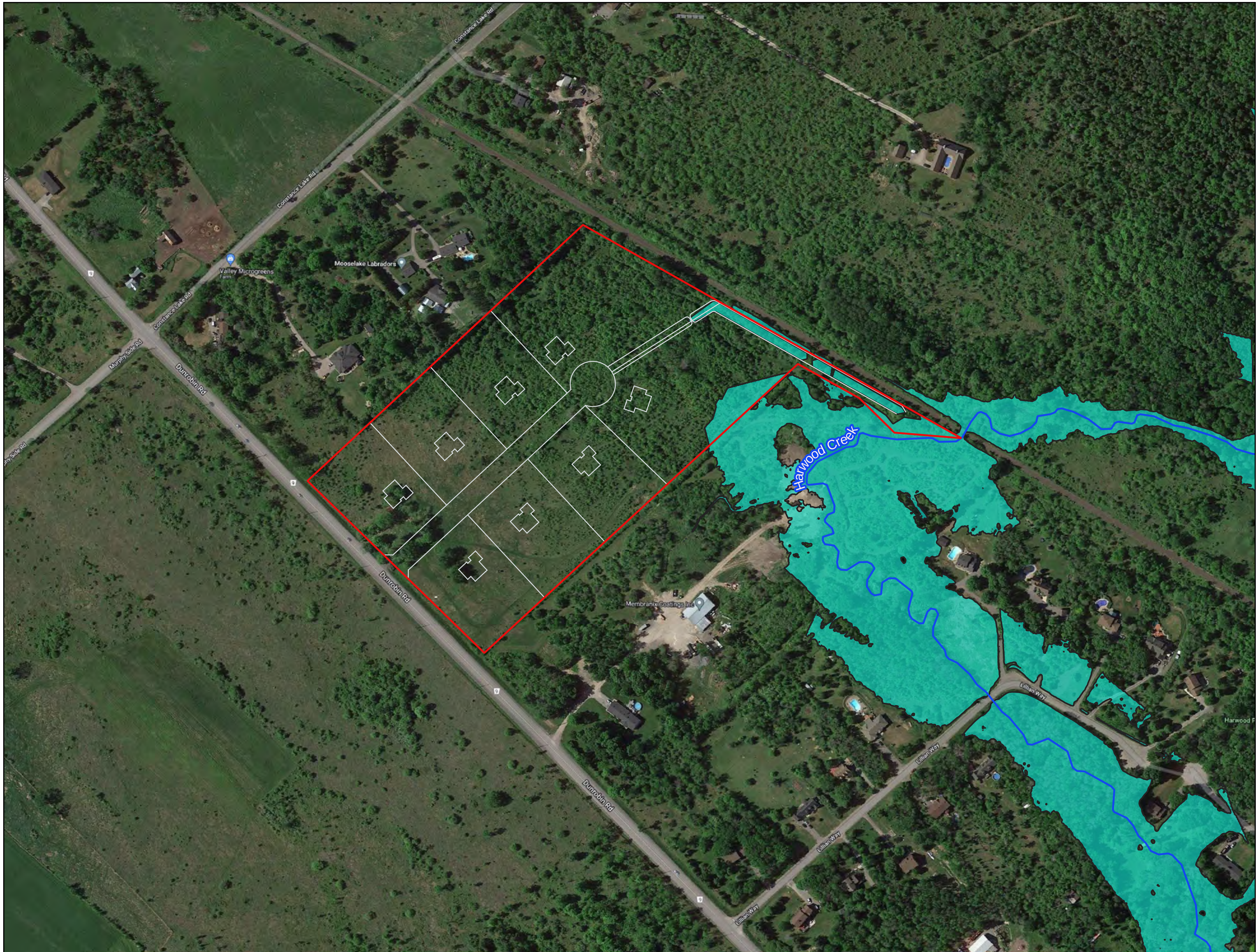

N

Legend

- Site Boundary
- SitePlan
- Watercourse
- 100-Year Floodplain

SCALE: 1:3500

0 100 200 m

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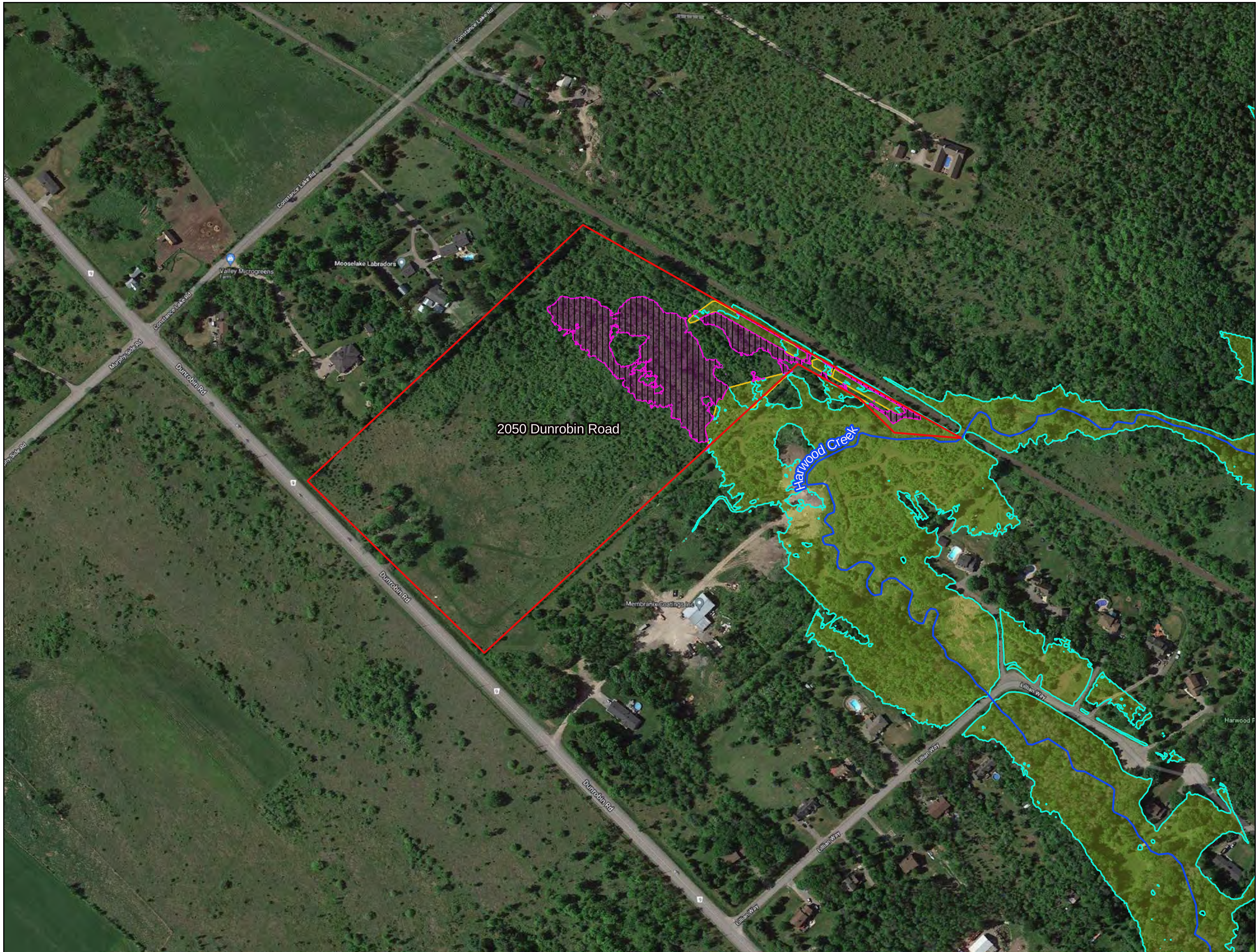
Floodplain Analysis

Figure 3: Proposed Conditions
100-Year Floodplain Overview

PROJECT	2363-22
DRAWN	PP
DATE	October 2022



N

Legend

- Site Boundary
- Watercourse
- Floodplain Removal
- Existing Condition Floodplain
- Proposed Condition Floodplain

SCALE: 1:3500

0 100 200 m

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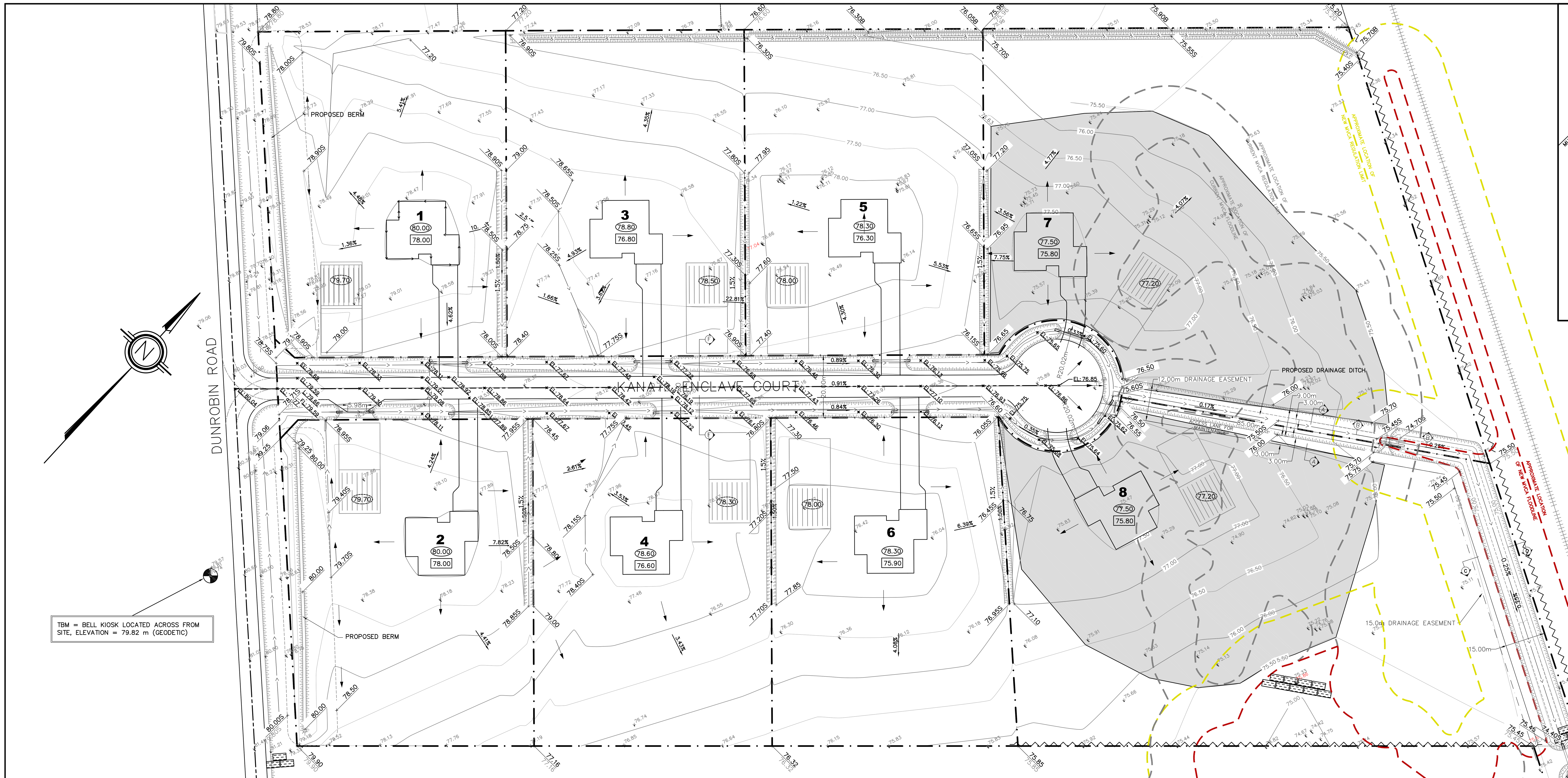
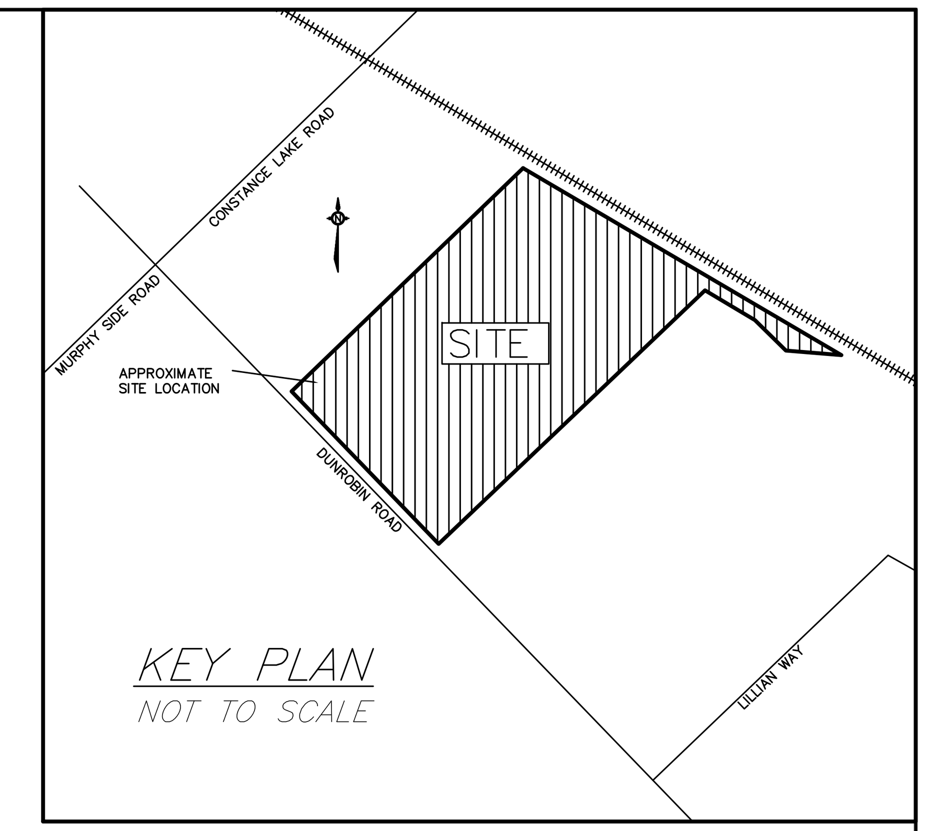
Figure 4: Existing & Proposed Conditions
100-Year Floodplain Comparison

PROJECT	2363-22
DRAWN	PP
DATE	October 2022





GENERAL LEGEND

EXISTING SPOT ELEVATION	POTENTIAL WELL LOCATION
PROPOSED ELEVATION	NO-DEVELOPMENT AREA
EXISTING ELEVATION	FENCELINE
PROPOSED DITCH ELEVATION	PROPERTY LINES
GRADE AREA TO PROMOTE SURFACE RUNOFF	PROPERTY SETBACKS
PROPOSED TERRACING ELEVATION AROUND DWELLING	EDGE OF ROAD
PROPOSED UNDERSIDE OF FOOTING ELEVATION	POTENTIAL DWELLING LOCATION
PROPOSED TOP OF SEPTIC LEACHING BED	POTENTIAL SEPTIC BED LOCATION
	DIRECTION OF FLOW
	TOP OF TERRACING

LEGEND – EROSION & SEDIMENT

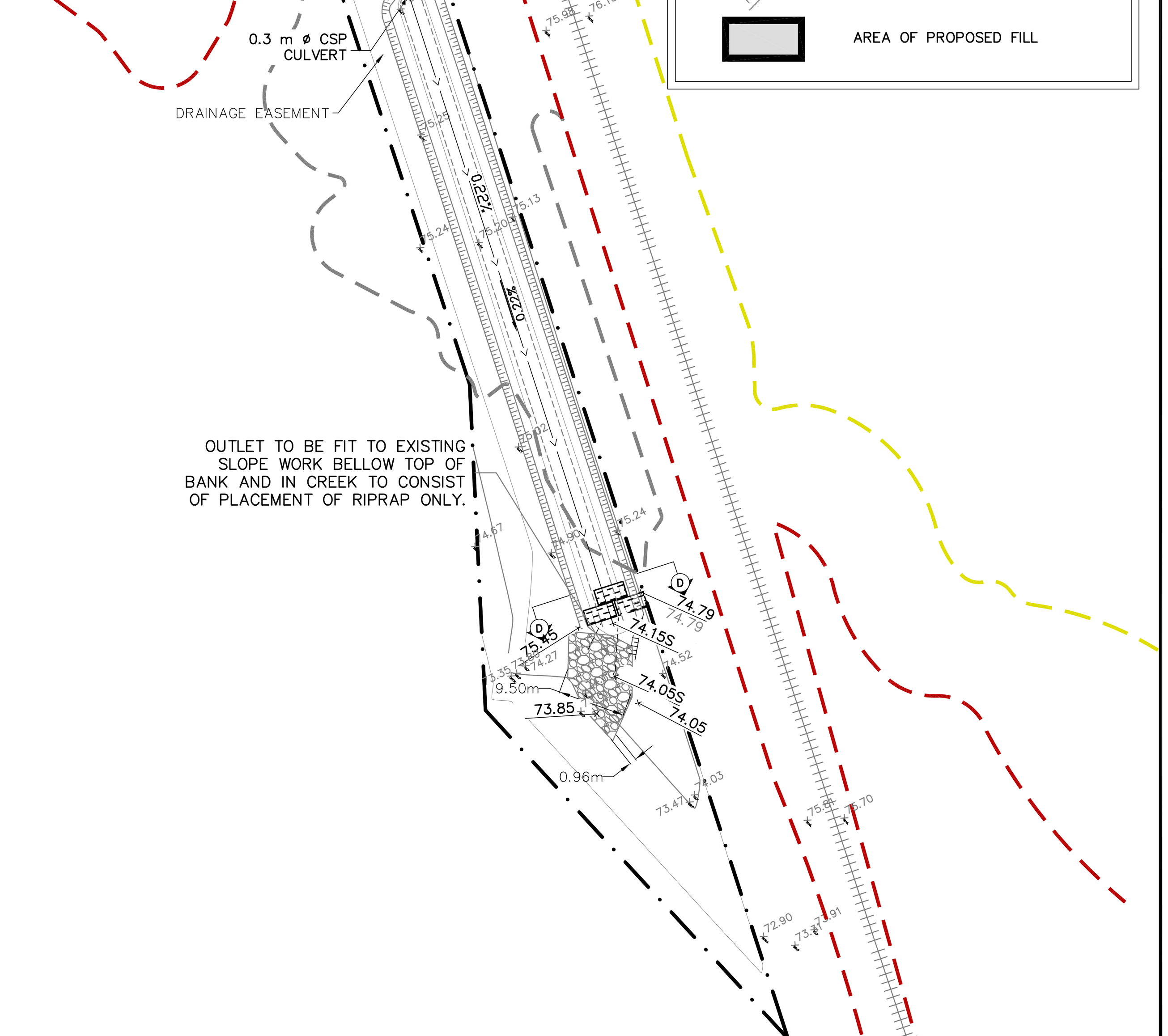
- PROPERTY LINES
- TOP OF TERRACING
- EDGE OF ROAD
- LIGHT DUTY SILT FENCE AS PER OPSD 219.110
- STRAWBALE FLOW BARRIER AS PER OPSD 219.180

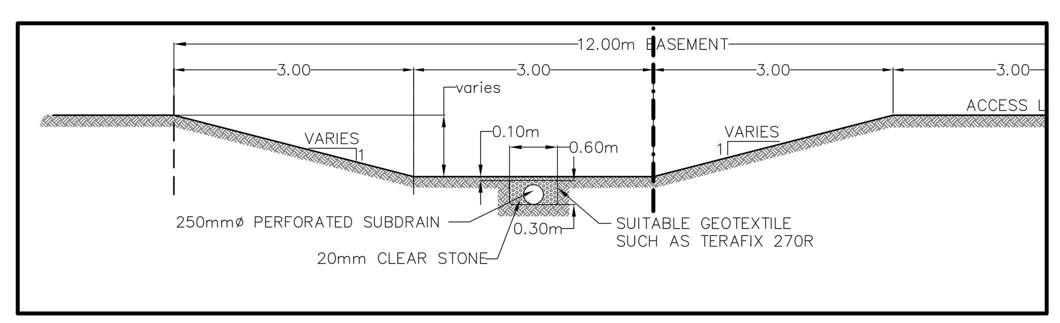
LEGEND – FILL PLACEMENT

- MVCA FLOODLINE
- MVCA REGULATION LIMIT
- PROPOSED GRADE ELEVATION
- AREA OF PROPOSED FILL

PRELIMINARY GRADING PLAN FOR FILL PLACEMENT

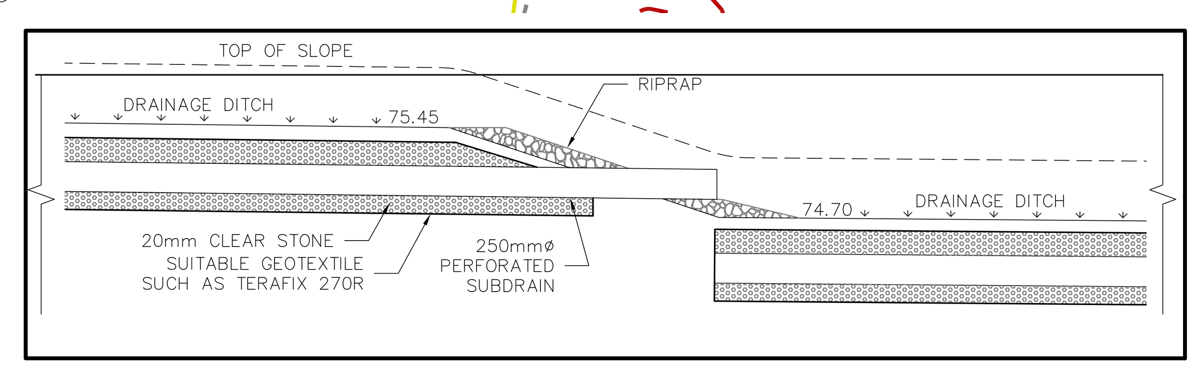
SCALE = 1:750





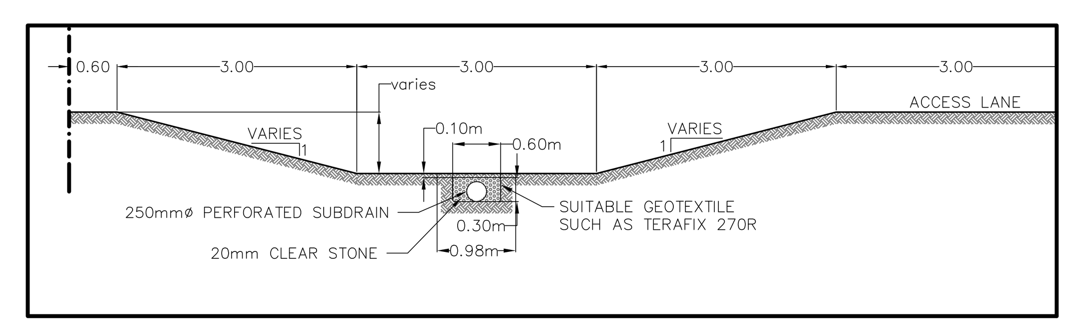
"A–A" PROPOSED DRAINAGE DITCH SECTION

NOT TO SCALE



"B–B" PROPOSED DRAINAGE DITCH PROFILE

NOT TO SCALE

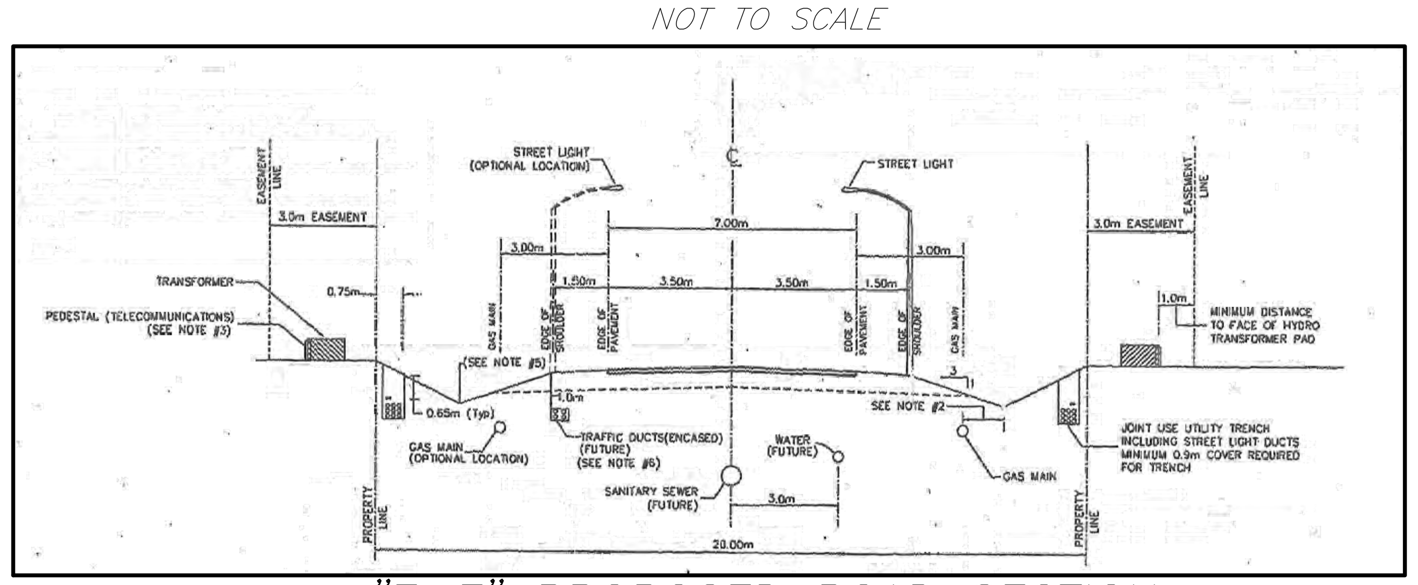


"C–C" PROPOSED DRAINAGE DITCH SECTION

NOT TO SCALE

GRADING & DRAINAGE NOTES

1. Finished grade to slope away from proposed and existing buildings at a minimum of 2% grade for the first 5.0 metres from building. Grade elevations are as indicated.
2. All roadside ditches, swales and exposed drainage channels to be treated with 75mm of topsoil and seeded/mulched or hydroseeded as soon as possible. (Unless noted otherwise)
3. All materials and construction methods to be in accordance with the City of Ottawa.
4. All disturbed areas to be reinstated to the satisfaction of the engineer and the City of Ottawa.
5. The owner (and/or Contractor) agrees to prepare and implement an erosion and sediment control plan at least equal to the stated minimum requirements and to the satisfaction of the City of Ottawa and the Mississippi Conservation, appropriate to the site conditions, prior to undertaking any site alterations (filling, grading, removal of vegetaiton, etc…) and during all phases of site preparation and construction in accordance with the current Best Management Practices for Erosion and Sediment Control such as but not limited to installing a light duty silt fence barrier as shown of Kollaard Associates Inc. dwg. No. 070415-3 (Erosion & Sediment Control Plan).
6. Match existing elevations at all exterior property lines. Ensure positive drainage whether indicated or not.
7. All lots to be graded to allow positive drainage away from tile beds and dwellings consistent with the drainage patterns outlined on this plan. All isolated low areas are to be eliminated.
8. Undersides of footing and terrace elevations have been set for grading drainage purposes only. Builders should consult the geotechnical report for the subdivision prior to construction. Builders should obtain a subgrade inspection report from qualified engineer prior to concrete placement.
9. Driveway entrance culverts to will consist of non-perforated 12.00 METRE ~ 600mm Ø Corragated Steel Pipel.
10. Roadway subgrade shall be inspected by a licensed Geotechnical engineer prior to the placement of granulars.
11. All drainage easements, road side ditches, and property line swales with slopes one percent (1%) or less require a subdrain (see typical detail).
12. Subdrain cover material to consist of a sand/peat mixture capable of supporting vegetative growth.



"F–F" PROPOSED ROAD SECTION

NOT TO SCALE

NOTE:

1. All dimensions are in metres.
2. All elevations are in metres and are based on a geodetic benchmark. TBM = Bell kiosk located sout/westh side of Dunrobin Road, across from proposed lot #2 , elevation = 79.82 m (geodetic)
3. This drawing does not represent a legal survey.
4. Finished grade to slope away from proposed building at a minimum of 2%. Grade elevations are as indicated.
5. All dimensions to be verified on site by contractor prior to construction.
6. All materials and construction methods to be in accordance with City of Ottawa Standards and Ontario Provincial Standards and Specifications.
7. All disturbed areas to be reinstated to the satisfaction of the engineer and the City of Ottawa.
8. The owner (and/or Contractor) agrees to prepare and implement an erosion and sediment control plan at least equal to the stated minimum requirements and to the satisfaction of the City of Ottawa, appropriate to the site conditions, prior to undertaking any site alterations (filling, grading, removal of vegetation, etc.) and during all phases of site preparation and construction in accordance with the current Best Management Practices for Erosion and Sediment Control
9. Any changes made to this plan must be verified and approved by Kollaard Associates Inc.

No.	REVISION	DATE	BY
1	ISSUED FOR MVCA PERMIT	MAY.06.2021	ML
0	ISSUED FOR CITY AND MVCA REVIEW	MAR.09.2021	ML

Kollaard Associates
Engineers

BOX 189
210 PRESCOTT STREET
KEMPTVILLE, ONTARIO
K0G 1J0
FACSIMILE (613) 258–0475

(613) 860–0923

DESIGN	KL/SD/WK
CHECKED	SD
DRAWN	PV/RR/ML
CHECKED	SD
APPROVED	SD

SCALE 1:750

PROJECT LOCATION	2050 DUNROBIN ROAD, CITY OF OTTAWA, ONTARIO
CLIENT NAME	ZBIGNIEW HAUDEROWICZ
PROJECT NAME	PROPOSED RESIDENTIAL SUBDIVISION
DRAWING	PRELIMARY GRADING PLAN FOR FILL PLACEMENT
PROJECT No.	200977
DRAWING No.	200977–GRF
DATE	MARCH 09, 2021
SHEET SET	FIGURE 5

APPENDIX E: PRE-DEVELOPMENT OTTHYMO MODEL RESULTS

Pre-development Summary Output

Detailed Output from Last Link

```
      V    V   I    SSSSS  U   U    A    L            (v 6.2.2015)
      V    V   I    SS     U   U   A A   L
       V  V    I     SS    U   U  AAAAA  L
       V  V    I      SS   U   U  A   A  L
        VV     I    SSSSS  UUUUU  A   A  LLLLL

       OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
      O   O    T      T    H   H   Y Y   MM MM  O   O
      O   O    T      T    H   H    Y    M   M  O   O
       OOO     T      T    H   H    Y    M   M   OOO

                  *****  S U M M A R Y   O U T P U T  *****

  ************************************************
  ** SIMULATION : 1. SCS II 6hr 5yr Ottawa      **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                   min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.01  3.08  13.03 0.26   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.02  3.58   6.40 0.13   0.000
    [CN=59.5         ]
    [ N = 3.0:Tp 0.41]
*
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0090  1  5.0    4.31    0.04  3.75   6.61 0.13   0.000
    [CN=60.0         ]
    [ N = 3.0:Tp 0.58]
*
    ADD [  0017+  0019]  0092  3  5.0    1.85    0.02  3.50   7.02  n/a   0.000
*
    ADD [  0092+  0090]  0092  1  5.0    6.16    0.06  3.67   6.73  n/a   0.000
*
    CHANNEL[ 2:  0092]   0095  1  5.0    6.16    0.06  3.75   6.73  n/a   0.000
*
    READ STORM                 30.0
```

```
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.01  3.08  13.03 0.26   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0091  1  5.0    4.65    0.04  3.92   6.63 0.13   0.000
    [CN=60.1         ]
    [ N = 3.0:Tp 0.71]
*
    ADD [  0018+  0091]  0093  3  5.0    4.82    0.04  3.92   6.86  n/a   0.000
*
    CHANNEL[ 2:  0093]   0094  1  5.0    4.82    0.04  4.00   6.86  n/a   0.000
*
    ADD [  0094+  0095]  0096  3  5.0   10.99    0.09  3.83   6.78  n/a   0.000
*
===============================================================================

  ************************************************
  ** SIMULATION : 2. SCS II 6hr 100yr Ottawa    **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                  min     ha   '  cms   hrs     mm           cms

      START @  0.00 hrs
      --------------------
    READ STORM                 30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.02  3.00  36.15 0.42   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    READ STORM                 30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.06  3.42  21.77 0.25   0.000
    [CN=59.5         ]
    [ N = 3.0:Tp 0.41]
*
    READ STORM                 30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\2561705c-3809-4f45-a1ef-af05b6
```

```
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0090  1  5.0    4.31    0.14  3.67  22.25 0.26   0.000
    [CN=60.0         ]
    [ N = 3.0:Tp 0.58]
*
    ADD [  0017+  0019]  0092  3  5.0    1.85    0.07  3.33  23.11  n/a   0.000
*
    ADD [  0092+  0090]  0092  1  5.0    6.16    0.20  3.58  22.51  n/a   0.000
*
    CHANNEL[ 2:  0092]   0095  1  5.0    6.16    0.20  3.67  22.51  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.02  3.00  36.15 0.42   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    READ STORM                 30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0091  1  5.0    4.65    0.13  3.83  22.31 0.26   0.000
    [CN=60.1         ]
    [ N = 3.0:Tp 0.71]
*
    ADD [  0018+  0091]  0093  3  5.0    4.82    0.14  3.75  22.80  n/a   0.000
*
    CHANNEL[ 2:  0093]   0094  1  5.0    4.82    0.14  3.83  22.80  n/a   0.000
*
    ADD [  0094+  0095]  0096  3  5.0   10.99    0.33  3.67  22.64  n/a   0.000
*
===============================================================================

  ************************************************
  ** SIMULATION : 3. SCS II 12hr 5yr Ottawa     **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                  min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.01  6.00  16.78 0.29   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    READ STORM                 30.0
```

```
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.02  6.42   8.71 0.15   0.000
    [CN=59.5          ]
    [ N = 3.0:Tp 0.41]
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0090  1  5.0    4.31    0.04  6.67   8.96 0.16   0.000
    [CN=60.0          ]
    [ N = 3.0:Tp 0.58]
*
    ADD [  0017+  0019]  0092  3  5.0    1.85    0.02  6.25   9.46  n/a   0.000
*
    ADD [  0092+  0090]  0092  1  5.0    6.16    0.07  6.58   9.11  n/a   0.000
*
    CHANNEL[ 2:  0092]   0095  1  5.0    6.16    0.07  6.58   9.11  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.01  6.00  16.78 0.29   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0091  1  5.0    4.65    0.04  6.83   8.99 0.16   0.000
    [CN=60.1          ]
    [ N = 3.0:Tp 0.71]
*
    ADD [  0018+  0091]  0093  3  5.0    4.82    0.04  6.75   9.27  n/a   0.000
*
    CHANNEL[ 2:  0093]   0094  1  5.0    4.82    0.04  6.83   9.27  n/a   0.000
*
    ADD [  0094+  0095]  0096  3  5.0   10.99    0.11  6.67   9.18  n/a   0.000
*
===============================================================================

  ***********************************************
  ** SIMULATION : 4. SCS II 12hr 10yr Ottawa    **
  ***********************************************

  W/E COMMAND             HYD ID   DT    AREA   ' Qpeak Tpeak   R.V. R.C.
Qbase
                                  min     ha    '  cms   hrs     mm          cms
```

```
      START @  0.00 hrs
      --------------------
    READ STORM                 30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD          0017  1  5.0    0.17    0.01  6.00  22.82 0.34   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    READ STORM                 30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD          0019  1  5.0    1.68    0.03  6.33  12.60 0.19   0.000
    [CN=59.5          ]
    [ N = 3.0:Tp 0.41]
*
    READ STORM                 30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD          0090  1  5.0    4.31    0.07  6.58  12.93 0.19   0.000
    [CN=60.0          ]
    [ N = 3.0:Tp 0.58]
*
    ADD [  0017+  0019]  0092  3  5.0    1.85    0.04  6.25  13.55  n/a   0.000
*
    ADD [  0092+  0090]  0092  1  5.0    6.16    0.10  6.50  13.12  n/a   0.000
*
    CHANNEL[ 2:  0092]   0095  1  5.0    6.16    0.10  6.58  13.12  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD          0018  1  5.0    0.17    0.01  6.00  22.82 0.34   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    READ STORM                 30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD          0091  1  5.0    4.65    0.06  6.75  12.97 0.19   0.000
    [CN=60.1          ]
    [ N = 3.0:Tp 0.71]
*
    ADD [  0018+  0091]  0093  3  5.0    4.82    0.07  6.75  13.32  n/a   0.000
*
    CHANNEL[ 2:  0093]   0094  1  5.0    4.82    0.07  6.83  13.32  n/a   0.000
```

```
*
    ADD [  0094+  0095]  0096  3  5.0   10.99    0.16  6.67  13.21  n/a   0.000
*
================================================================================

  ************************************************
  ** SIMULATION : 5. SCS II 12hr 100yr correct  **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                  min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.02  6.00  42.68 0.44   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.07  6.33  26.48 0.28   0.000
    [CN=59.5          ]
    [ N = 3.0:Tp 0.41]
*
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0090  1  5.0    4.31    0.15  6.58  27.03 0.28   0.000
    [CN=60.0          ]
    [ N = 3.0:Tp 0.58]
*
    ADD [  0017+  0019]  0092  3  5.0    1.85    0.08  6.25  28.00  n/a   0.000
*
    ADD [  0092+  0090]  0092  1  5.0    6.16    0.22  6.50  27.32  n/a   0.000
*
    CHANNEL[ 2:  0092]   0095  1  5.0    6.16    0.21  6.50  27.32  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.02  6.00  42.68 0.44   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
```

```
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0091  1  5.0    4.65    0.14  6.75  27.10 0.28   0.000
    [CN=60.1         ]
    [ N = 3.0:Tp 0.71]
*
    ADD [  0018+  0091]  0093  3  5.0    4.82    0.14  6.67  27.66  n/a   0.000
*
    CHANNEL[ 2:  0093]   0094  1  5.0    4.82    0.14  6.75  27.66  n/a   0.000
*
    ADD [  0094+  0095]  0096  3  5.0   10.99    0.35  6.58  27.47  n/a   0.000
*
===============================================================================

  ************************************************
  ** SIMULATION : 6. Chi 12hr 2yr               **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                   min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.00  4.17   9.00 0.21   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.01  4.58   4.04 0.10   0.000
    [CN=59.5         ]
    [ N = 3.0:Tp 0.41]
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0090  1  5.0    4.31    0.02  4.92   4.20 0.10   0.000
    [CN=60.0         ]
    [ N = 3.0:Tp 0.58]
*
    ADD [  0017+  0019]  0092  3  5.0    1.85    0.01  4.50   4.51  n/a   0.000
*
    ADD [  0092+  0090]  0092  1  5.0    6.16    0.02  4.75   4.29  n/a   0.000
*
    CHANNEL[ 2:  0092]   0095  1  5.0    6.16    0.02  4.92   4.29  n/a   0.000
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.00  4.17   9.00 0.21   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
```

```
*
    CHIC STORM                   10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD          0091  1  5.0    4.65    0.02  5.08   4.21 0.10   0.000
    [CN=60.1          ]
    [ N = 3.0:Tp 0.71]
*
    ADD [  0018+  0091]  0093  3  5.0    4.82    0.02  5.08   4.38  n/a   0.000
*
    CHANNEL[ 2:  0093]   0094  1  5.0    4.82    0.02  5.17   4.38  n/a   0.000
*
    ADD [  0094+  0095]  0096  3  5.0   10.99    0.04  5.00   4.33  n/a   0.000
*
```

```
  ***********************************************
  ** SIMULATION : 7. Chi 12hr 100yr            **
  ***********************************************

  W/E COMMAND              HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                    min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    CHIC STORM                   10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0017  1  5.0    0.17    0.02  4.08  41.13 0.44   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    CHIC STORM                   10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0019  1  5.0    1.68    0.06  4.50  25.36 0.27   0.000
    [CN=59.5          ]
    [ N = 3.0:Tp 0.41]
*
    CHIC STORM                   10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0090  1  5.0    4.31    0.13  4.67  25.88 0.28   0.000
    [CN=60.0          ]
    [ N = 3.0:Tp 0.58]
*
    ADD [  0017+  0019]  0092  3  5.0    1.85    0.08  4.42  26.83  n/a   0.000
*
    ADD [  0092+  0090]  0092  1  5.0    6.16    0.20  4.58  26.17  n/a   0.000
*
    CHANNEL[ 2:  0092]   0095  1  5.0    6.16    0.20  4.67  26.17  n/a   0.000
*
    CHIC STORM                   10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0018  1  5.0    0.17    0.02  4.08  41.13 0.44   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    CHIC STORM                   10.0
    [ Ptot= 93.90 mm ]
```

```
*
 ** CALIB NASHYD         0091  1  5.0    4.65    0.13  4.83  25.96 0.28   0.000
    [CN=60.1          ]
    [ N = 3.0:Tp 0.71]
*
    ADD [  0018+  0091]  0093  3  5.0    4.82    0.13  4.83  26.50  n/a   0.000
*
    CHANNEL[ 2:  0093]   0094  1  5.0    4.82    0.13  4.92  26.50  n/a   0.000
*
    ADD [  0094+  0095]  0096  3  5.0   10.99    0.32  4.75  26.31  n/a   0.000
*
```

```
  **********************************************
  ** SIMULATION : 8. Historical July 1 1979     **
  **********************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                  min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    READ STORM                  5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.02  1.67  34.02 0.41   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    READ STORM                  5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.09  2.00  20.26 0.24   0.000
    [CN=59.5          ]
    [ N = 3.0:Tp 0.41]
*
    READ STORM                  5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0090  1  5.0    4.31    0.18  2.17  20.72 0.25   0.000
    [CN=60.0          ]
    [ N = 3.0:Tp 0.58]
*
    ADD [  0017+  0019]  0092  3  5.0    1.85    0.10  1.92  21.55  n/a   0.000
*
    ADD [  0092+  0090]  0092  1  5.0    6.16    0.27  2.08  20.97  n/a   0.000
*
    CHANNEL[ 2:  0092]   0095  1  5.0    6.16    0.27  2.17  20.97  n/a   0.000
*
    READ STORM                  5.0
    [ Ptot= 83.99 mm ]
```

```
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.02  1.67  34.02 0.41   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    READ STORM                  5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0091  1  5.0    4.65    0.17  2.25  20.78 0.25   0.000
    [CN=60.1         ]
    [ N = 3.0:Tp 0.71]
*
    ADD [  0018+  0091]  0093  3  5.0    4.82    0.17  2.25  21.25  n/a   0.000
*
    CHANNEL[ 2:  0093]   0094  1  5.0    4.82    0.17  2.33  21.25  n/a   0.000
*
    ADD [  0094+  0095]  0096  3  5.0   10.99    0.43  2.17  21.09  n/a   0.000
*
```

```
  ************************************************
  ** SIMULATION : 9. Historical Aug 4 1988      **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                   min     ha   '  cms   hrs     mm           cms

      START @  0.00 hrs
      --------------------
    READ STORM                  5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.02  2.08  31.64 0.39   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    READ STORM                  5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.07  2.25  18.60 0.23   0.000
    [CN=59.5         ]
    [ N = 3.0:Tp 0.41]
*
    READ STORM                  5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
```

```
 ** CALIB NASHYD         0090  1  5.0    4.31    0.14  2.42  19.03 0.24   0.000
    [CN=60.0         ]
    [ N = 3.0:Tp 0.58]
*
    ADD [  0017+  0019]  0092  3  5.0    1.85    0.09  2.17  19.82  n/a   0.000
*
    ADD [  0092+  0090]  0092  1  5.0    6.16    0.22  2.25  19.26  n/a   0.000
*
    CHANNEL[ 2:  0092]   0095  1  5.0    6.16    0.22  2.33  19.26  n/a   0.000
*
    READ STORM                  5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.02  2.08  31.64 0.39   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    READ STORM                  5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0091  1  5.0    4.65    0.13  2.50  19.08 0.24   0.000
    [CN=60.1         ]
    [ N = 3.0:Tp 0.71]
*
    ADD [  0018+  0091]  0093  3  5.0    4.82    0.13  2.50  19.53  n/a   0.000
*
    CHANNEL[ 2:  0093]   0094  1  5.0    4.82    0.13  2.50  19.53  n/a   0.000
*
    ADD [  0094+  0095]  0096  3  5.0   10.99    0.34  2.42  19.38  n/a   0.000

===============================================================================

  ************************************************
  ** SIMULATION : 10. 25mm4hrChicago            **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                   min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.00  1.75   2.41 0.10   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
```

```
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.00  3.00   0.68 0.03   0.000
    [CN=59.5          ]
    [ N = 3.0:Tp 0.41]
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0090  1  5.0    4.31    0.00  3.42   0.73 0.03   0.000
    [CN=60.0          ]
    [ N = 3.0:Tp 0.58]
*
    ADD [  0017+  0019]  0092  3  5.0    1.85    0.00  2.83   0.84  n/a   0.000
*
    ADD [  0092+  0090]  0092  1  5.0    6.16    0.01  3.25   0.76  n/a   0.000
*
    CHANNEL[ 2:  0092]   0095  1  5.0    6.16    0.01  3.50   0.76  n/a   0.000
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.00  1.75   2.41 0.10   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\7ee18800-9dc3-40e3-85a0-
4ea81b961b41\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0091  1  5.0    4.65    0.00  3.75   0.73 0.03   0.000
    [CN=60.1          ]
    [ N = 3.0:Tp 0.71]
*
    ADD [  0018+  0091]  0093  3  5.0    4.82    0.00  3.67   0.79  n/a   0.000
*
    CHANNEL[ 2:  0093]   0094  1  5.0    4.82    0.00  3.92   0.79  n/a   0.000
*
    ADD [  0094+  0095]  0096  3  5.0   10.99    0.01  3.67   0.78  n/a   0.000
*
===============================================================================

  ************************************************
  ** SIMULATION : 100 year 12 hr Chi 120 percent **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                  min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
```

```
     --------------------
   CHIC STORM                     5.0
   [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.03  4.17  55.39 0.49   0.000
   [CN=73.9          ]
   [ N = 3.0:Tp 0.17]
*
   CHIC STORM                     5.0
   [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.10  4.50  35.97 0.32   0.000
   [CN=59.5          ]
   [ N = 3.0:Tp 0.41]
*
   CHIC STORM                     5.0
   [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0090  1  5.0    4.31    0.20  4.75  36.63 0.33   0.000
   [CN=60.0          ]
   [ N = 3.0:Tp 0.58]
*
   ADD [  0017+  0019]   0092  3  5.0    1.85    0.11  4.42  37.79  n/a   0.000
*
   ADD [  0092+  0090]   0092  1  5.0    6.16    0.30  4.58  36.98  n/a   0.000
*
   CHANNEL[ 2:  0092]    0095  1  5.0    6.16    0.29  4.67  36.98  n/a   0.000
*
   CHIC STORM                     5.0
   [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.03  4.17  55.39 0.49   0.000
   [CN=73.9          ]
   [ N = 3.0:Tp 0.17]
*
   CHIC STORM                     5.0
   [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0091  1  5.0    4.65    0.19  4.92  36.73 0.33   0.000
   [CN=60.1          ]
   [ N = 3.0:Tp 0.71]
*
   ADD [  0018+  0091]   0093  3  5.0    4.82    0.19  4.83  37.40  n/a   0.000
*
   CHANNEL[ 2:  0093]    0094  1  5.0    4.82    0.19  4.92  37.40  n/a   0.000
*
   ADD [  0094+  0095]   0096  3  5.0   10.99    0.47  4.75  37.16  n/a   0.000
*
 FINISH
```

```
*****************************************
** SIMULATION:1. SCS II 6hr 5yr Ottawa **
*****************************************

--------------------
| ADD HYD  (  0096)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0094):     4.82   0.038     4.00      6.86
      + ID2= 2 (  0095):     6.16   0.056     3.75      6.73
        ====================================================
        ID = 3 (  0096):    10.99   0.093     3.83      6.78

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
*******************************************
** SIMULATION:2. SCS II 6hr 100yr Ottawa **
*******************************************

--------------------
| ADD HYD  (  0096)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0094):     4.82   0.135     3.83     22.80
      + ID2= 2 (  0095):     6.16   0.202     3.67     22.51
        ====================================================
        ID = 3 (  0096):    10.99   0.333     3.67     22.64

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
******************************************
** SIMULATION:3. SCS II 12hr 5yr Ottawa **
******************************************

--------------------
| ADD HYD  (  0096)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0094):     4.82   0.044     6.83      9.27
      + ID2= 2 (  0095):     6.16   0.065     6.58      9.11
        ====================================================
        ID = 3 (  0096):    10.99   0.107     6.67      9.18

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
*******************************************
** SIMULATION:4. SCS II 12hr 10yr Ottawa **
*******************************************

--------------------
| ADD HYD  (  0096)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0094):     4.82   0.065     6.83     13.32
      + ID2= 2 (  0095):     6.16   0.097     6.58     13.12
        ====================================================
        ID = 3 (  0096):    10.99   0.160     6.67     13.21

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
-------------------------------------------------------------------------------
```

```
*********************************************
** SIMULATION:5. SCS II 12hr 100yr correct **
*********************************************

--------------------
| ADD HYD  (  0096)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0094):     4.82   0.142     6.75    27.66
      + ID2= 2 (  0095):     6.16   0.214     6.50    27.32
        ===================================================
        ID = 3 (  0096):    10.99   0.351     6.58    27.47

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
************************************
** SIMULATION:6. Chi 12hr 2yr     **
************************************

--------------------
| ADD HYD  (  0096)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0094):     4.82   0.016     5.17     4.38
      + ID2= 2 (  0095):     6.16   0.024     4.92     4.29
        ===================================================
        ID = 3 (  0096):    10.99   0.039     5.00     4.33

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
************************************
** SIMULATION:7. Chi 12hr 100yr   **
************************************

--------------------
| ADD HYD  (  0096)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0094):     4.82   0.130     4.92    26.50
      + ID2= 2 (  0095):     6.16   0.201     4.67    26.17
        ===================================================
        ID = 3 (  0096):    10.99   0.325     4.75    26.31

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
******************************************
** SIMULATION:8. Historical July 1 1979 **
******************************************

--------------------
| ADD HYD  (  0096)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0094):     4.82   0.171     2.33    21.25
      + ID2= 2 (  0095):     6.16   0.268     2.17    20.97
        ===================================================
        ID = 3 (  0096):    10.99   0.434     2.17    21.09

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
```

```
*****************************************
** SIMULATION:9. Historical Aug 4 1988 **
*****************************************

--------------------
| ADD HYD  (  0096)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0094):     4.82   0.132     2.50    19.53
      + ID2= 2 (  0095):     6.16   0.217     2.33    19.26
        ===================================================
        ID = 3 (  0096):    10.99   0.344     2.42    19.38

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
```

```
***********************************
** SIMULATION:10. 25mm4hrChicago **
***********************************

--------------------
| ADD HYD  (  0096)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0094):     4.82   0.004     3.92     0.79
      + ID2= 2 (  0095):     6.16   0.005     3.50     0.76
        ===================================================
        ID = 3 (  0096):    10.99   0.009     3.67     0.78

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
***********************************************
** SIMULATION:100 year 12 hr Chi 120 percent **
***********************************************

--------------------
| ADD HYD  (  0096)|
|   1 +  2 =  3    |         AREA    QPEAK    TPEAK     R.V.
--------------------         (ha)    (cms)    (hrs)     (mm)
        ID1= 1 (  0094):     4.82   0.190     4.92    37.40
      + ID2= 2 (  0095):     6.16   0.294     4.67    36.98
        ===================================================
        ID = 3 (  0096):    10.99   0.475     4.75    37.16

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.
--------------------------------------------------------------------------------
```

APPENDIX F: PERMEABILITY TEST RESULTS

SoilMoisture
Soil Hydrology Instruments for Research Since 1955

Guelph Permeameter

Input

Result

Test #1

Reservoir Cross-sectional area in cm^2
(enter "35.22" for Combined and "2.16" for Inner reservoir): **35.22**
Enter water Head Height ("H" in cm): **15**
Enter the Borehole Radius ("a" in cm): **6**

Enter the soil texture-structure category (enter one of the below numbers): **2**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

Steady State Rate of Water Level Change ("R" in cm/min): **0.1000**

Res Type 35.22
H 15
a 6
H/a 2.5
a* 0.04
C0.01 1.033
C0.04 1.085
C0.12 1.063
C0.36 1.063
C 1.085
R 0.100
Q 0.059
pi 3.142

α^* = 0.04 cm^{-1}

C = 1.08468
Q = 0.0587

K_{fs} = 1.64E-05 *cm/sec*
9.81E-04 *cm/min*
1.64E-07 *m/sec*
3.86E-04 *inch/min*
6.44E-06 *inch/sec*

Φ_m = 4.09E-04 cm^2/min

Test #2

Reservoir Cross-sectional area in cm^2
(enter "35.22" for Combined and "2.16" for Inner reservoir): **35.22**
Enter water Head Height ("H" in cm): **5**
Enter the Borehole Radius ("a" in cm): **6**

Enter the soil texture-structure category (enter one of the below numbers): **2**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

Steady State Rate of Water Level Change ("R" in cm/min): **0.3000**

Res Type 35.22
H 5
a 6
H/a 0.83333
a* 0.04
C0.01 0.52372
C0.04 0.53755
C0.12 0.48911
C0.36 0.48911
C 0.53755
R 0.300
Q 0.1761
pi 3.1415

α^* = 0.04 cm^{-1}

C = 0.53755
Q = 0.1761

K_{fs} = 9.44E-05 *cm/sec*
5.66E-03 *cm/min*
9.44E-07 *m/ses*
2.23E-03 *inch/min*
3.71E-05 *inch/sec*

Φ_m = 2.36E-03 cm^2/min

Test #3

Reservoir Cross-sectional area in cm^2
(enter "35.22" for Combined and "2.16" for Inner reservoir): **35.22**
Enter water Head Height ("H" in cm): **5**
Enter the Borehole Radius ("a" in cm): **6**

Enter the soil texture-structure category (enter one of the below numbers): **2**

1. Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.
2. Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.
3. Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.
4. Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macropors, etc

Steady State Rate of Water Level Change ("R" in cm/min): **0.4000**

Res Type 3.52E+01
H 5
a 6
H/a 0.833333333
a* 0.04
C0.01 0.523723554
C0.04 0.537554004
C0.12 0.489114302
C0.36 0.489114302
C 0.537554004
R 0.400
Q 2.35E-01
pi 3.1415

α^* = 0.04 cm^{-1}

C = 0.53755
Q = 2.35E-01

K_{fs} = 0.00013 *cm/sec*
7.55E-03 *cm/min*
1.26E-06 *m/ses*
2.97E-03 *inch/min*
4.95E-05 *inch/sec*

Φ_m = 3.15E-03 cm^2/min

Calculation formulas related to shape factor (C). Where H_1 is the first water head height (cm), H_2 is the second water head height (cm), a is borehole radius (cm) and α^* is microscopic capillary length factor which is decided according to the soil texture-structure category. For one-head method, only C_1 needs to be calculated while for two-head method, C_1 and C_2 are calculated (Zang et al., 1998).

Soil Texture-Structure Category	$\alpha^*(cm^{-1})$	Shape Factor
Compacted, Structure-less, clayey or silty materials such as landfill caps and liners, lacustrine or marine sediments, etc.	0.01	$C_1 = \left(\frac{H_2/a}{2.081 + 0.121(H_2/a)}\right)^{0.672}$
Soils which are both fine textured (clayey or silty) and unstructured; may also include some fine sands.	0.04	$C_1 = \left(\frac{H_1/a}{1.992 + 0.091(H_1/a)}\right)^{0.683}$ $C_2 = \left(\frac{H_2/a}{1.992 + 0.091(H_2/a)}\right)^{0.683}$
Most structured soils from clays through loams; also includes unstructured medium and fine sands. The category most frequently applicable for agricultural soils.	0.12	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$
Coarse and gravely sands; may also include some highly structured soils with large and/or numerous cracks, macro pores, etc.	0.36	$C_1 = \left(\frac{H_1/a}{2.074 + 0.093(H_1/a)}\right)^{0.754}$ $C_2 = \left(\frac{H_2/a}{2.074 + 0.093(H_2/a)}\right)^{0.754}$

Calculation formulas related to one-head and two-head methods. Where R is steady-state rate of fall of water in reservoir (cm/s), K_{fs} is Soil saturated hydraulic conductivity (cm/s), Φ_m is Soil matric flux potential (cm²/s), α^* is Macroscopic capillary length parameter (from Table 2), a is Borehole radius (cm), H_1 is the first head of water established in borehole (cm), H_2 is the second head of water established in borehole (cm) and C is Shape factor (from Table 2).

One Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$	$K_{fs} = \frac{C_1 \times Q_1}{2\pi H_1^2 + \pi a^2 C_1 + 2\pi\left(\frac{H_1}{\alpha^*}\right)}$ $\Phi_m = \frac{C_1 \times Q_1}{(2\pi H_1^2 + \pi a^2 C_1)\alpha^* + 2\pi H_1}$
One Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$	
Two Head, Combined Reservoir	$Q_1 = \bar{R}_1 \times 35.22$ $Q_2 = \bar{R}_2 \times 35.22$	$G_1 = \frac{H_2 C_1}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_2 = \frac{H_1 C_2}{\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $K_{fs} = G_2Q_2 - G_1Q_1$ $G_3 = \frac{(2H_2^2 + a^2C_2)C_1}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $G_4 = \frac{(2H_1^2 + a^2C_1)C_2}{2\pi(2H_1H_2(H_2 - H_1) + a^2(H_1C_2 - H_2C_1))}$ $\Phi_m = G_3Q_1 - G_4Q_2$
Two Head, Inner Reservoir	$Q_1 = \bar{R}_1 \times 2.16$ $Q_2 = \bar{R}_2 \times 2.16$	

APPENDIX G1: STAGE STORAGE WORKSHEET – STORAGE SWALE

APPENDIX G1: STORMWATER STORAGE SWALE

Stage Storage Discharge Worksheet

Client: Hauderowicz, Zbigniew and Teresa
Job No.: 200977
Location: 2050 Dunrobin Road
Date: April 19, 2024

V Notch Weir		Rectangular Weir	
Weir Invert	75.6	Weir Invert	76.3
Notch Angle	30	Weir Length	4
Cw	0.59	Cw	0.62
	0.007		

Stage, WSE Elev (m)	Comment	Layer Thickness [m]	Incremental [m^3]	V-notch Weir			Rectancular Weir Flow		Total Outflow (m^3/sec)	Storage (Ha.m)	Storage (m3)
				Flow Depth (m)	Head Feet (ft)	Weir Flow (m^3/sec)	Flow Depth (m)	Weir Flow (m^3/sec)			
76.40		0.05	64.31	0.800	2.632	0.2153	0.100	0.079	0.215	0.0787	787
76.35		0.05	65.31	0.750	2.468	0.1833	0.050	0.028	0.183	0.0723	723
76.30		0.05	61.58	0.700	2.304	0.1543	0.000	0.000	0.154	0.0658	658
76.25		0.05	57.95	0.650	2.140	0.1283			0.128	0.0596	596
76.20		0.05	54.47	0.600	1.976	0.1051			0.105	0.0538	538
76.15		0.05	51.15	0.550	1.811	0.0846			0.085	0.0484	484
76.10		0.05	48.05	0.500	1.647	0.0667			0.067	0.0432	432
76.05		0.05	45.10	0.450	1.483	0.0513			0.051	0.0384	384
76.00		0.05	42.28	0.400	1.319	0.0383			0.038	0.0339	339
75.95		0.05	39.63	0.350	1.155	0.0275			0.027	0.0297	297
75.90		0.05	37.12	0.300	0.991	0.0187			0.019	0.0257	257
75.85		0.05	34.75	0.250	0.827	0.0119			0.012	0.0220	220
75.80		0.05	32.54	0.200	0.663	0.0069			0.007	0.0185	185
75.75		0.05	30.50	0.150	0.499	0.0034			0.003	0.0153	153
75.70		0.05	28.60	0.100	0.335	0.0012			0.001	0.0122	122
75.65		0.05	26.84	0.050	0.171	0.0002			0.000	0.0094	94
75.60		0.05	24.74	0.000	0.007	0.0000			0.000	0.0067	67
75.55		0.05	22.24	#N/A	#N/A	#N/A			0.000	0.0042	42
75.50		0.05	19.96	#N/A	#N/A	#N/A			0.000	0.0020	20
75.45		0.00	0.00	#N/A	#N/A	#N/A			0.000	0.0000	0

APPENDIX G2: STAGE STORAGE WORKSHEET – OUTLET SWALE

APPENDIX F: STORMWATER STORAGE SWALE

Stage Storage Discharge Worksheet

Client: Hauderowicz, Zbigniew and Teresa
Job No.: 200977
Location: 2050 Dunrobin Road
Date: April 19, 2024

V Notch Weir		9
Weir Invert	74.1	10
Notch Angle	30	11
		12
Cw	0.59	13
		14
		15

Subdrain	
Dia (m):	0.150
Area (m2.):	0.0177
Orifice Coeff, C_d:	0.60
Orifice Coeff , C_w:	0.62
Orifice Top (m):	73.75
Orifice Cen (m):	73.68
Orifice Inv (m):	73.60

Stage, WSE Elev (m)	Comment	Layer Area		Layer Thickness [m]	Incremental [m^3]	V-notch Weir			Subdrain Flow			Total Outflow (m^3/sec)	Storage (Ha.m)
						Flow Depth (m)	Head Feet (ft)	Weir Flow (m^3/sec)	Head (m)	n	Flow (m^3/sec)		
	100 year 75.48												
75.20		2477	228.1277	0.10	228.13	1.100	3.609	0.4741	1.200	8.00	0.049	0.523	0.093
75.10		2091	189.4721	0.10	189.47	1.000	3.281	0.3736	1.100	7.33	0.047	0.420	0.070
75.00		1705	150.7877	0.10	150.79	0.900	2.953	0.2871	1.000	6.67	0.045	0.332	0.051
74.90		1319	114.5311	0.10	114.53	0.800	2.625	0.2138	0.900	6.00	0.042	0.256	0.036
74.80		980	83.66142	0.10	83.66	0.700	2.297	0.1531	0.800	5.33	0.040	0.193	0.025
74.70	10 year 74.75	701	58.75576	0.10	58.76	0.600	1.969	0.1042	0.700	4.67	0.037	0.141	0.016
74.60	5 year 74.63	481	40.09958	0.10	40.10	0.500	1.640	0.0660	0.600	4.00	0.034	0.100	0.010
74.50		326	27.82016	0.10	27.82	0.400	1.312	0.0378	0.500	3.33	0.031	0.069	0.006
74.40	2 year 74.44	233	18.94417	0.10	18.94	0.300	0.984	0.0184	0.400	2.67	0.027	0.046	0.004
74.30		149	11.32304	0.10	11.32	0.200	0.656	0.0067	0.300	2.00	0.023	0.029	0.002
74.20		80.9	5.247239	0.10	5.25	0.100	0.328	0.0012	0.200	1.33	0.017	0.018	0.001
74.10		28.5	0.95	0.10	0.95	0.000	0.000	0.0000	0.100	0.67	0.007	0.007	0.000
74.00		0		0.00		0	0	0	0.000	0.00	0.000	0.000	0.000
	bottom 73.95												

APPENDIX H: POST-DEVELOPMENT OTTHYMO MODEL RESULTS

Post-Development OTTHYMO summary output file

Post-Development Detailed Output file Last Link before Harwood Creek

```
================================================================================

       V    V   I    SSSSS  U   U    A    L             (v 6.2.2015)
       V    V   I    SS     U   U   A A   L
        V  V    I     SS    U   U  AAAAA  L
        V  V    I      SS   U   U  A   A  L
         VV     I    SSSSS  UUUUU  A   A  LLLLL

        OOO   TTTTT  TTTTT  H   H  Y   Y  M   M   OOO    TM
       O   O    T      T    H   H   Y Y   MM MM  O   O
       O   O    T      T    H   H    Y    M   M  O   O
        OOO     T      T    H   H    Y    M   M   OOO

                   *****  S U M M A R Y   O U T P U T  *****

  ************************************************
  ** SIMULATION : 1. SCS II 6hr 5yr Ottawa      **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                  min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD          0001  1  5.0    0.50    0.01  3.08   7.63 0.15   0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0001]   0068  1  5.0    0.50    0.01  3.08   7.63  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD          0002  1  5.0    0.50    0.01  3.17   7.63 0.15   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.26]
*
    ADD [  0002+  0068]  0064  3  5.0    1.00    0.02  3.17   7.63  n/a   0.000
*
    CHANNEL[ 2:  0064]   0069  1  5.0    1.00    0.02  3.17   7.63  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD          0003  1  5.0    0.51    0.01  3.17   7.63 0.15   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.24]
*
    ADD [  0003+  0069]  0065  3  5.0    1.51    0.02  3.17   7.63  n/a   0.000
```

```
*
    CHANNEL[ 2:  0065]   0070  1  5.0    1.51    0.02  3.25    7.62  n/a   0.000
*
    READ STORM                30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0004  1  5.0    1.68    0.02  3.50    8.08 0.16   0.000
    [CN=63.4          ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0004+  0070]  0066  3  5.0    3.18    0.04  3.33    7.87  n/a   0.000
*
    CHANNEL[ 2:  0066]   0084  1  5.0    3.18    0.04  3.50    7.86  n/a   0.000
*
    READ STORM                30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0005  1  5.0    1.41    0.02  3.33    8.65 0.17   0.000
    [CN=64.6          ]
    [ N = 3.0:Tp 0.34]
*
    READ STORM                30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0006  1  5.0    0.50    0.01  3.25    7.66 0.15   0.000
    [CN=62.5          ]
    [ N = 3.0:Tp 0.29]
*
    READ STORM                30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0007  1  5.0    0.50    0.01  3.25    7.63 0.15   0.000
    [CN=62.4          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0008  1  5.0    0.49    0.01  3.08    7.63 0.15   0.000
    [CN=62.5          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0008]   0071  1  5.0    0.49    0.01  3.08    7.63  n/a   0.000
*
    ADD [  0007+  0071]  0061  3  5.0    0.99    0.02  3.17    7.63  n/a   0.000
*
    CHANNEL[ 2:  0061]   0072  1  5.0    0.99    0.02  3.17    7.63  n/a   0.000
```

```
*
    ADD [  0006+  0072]  0062  3  5.0    1.49    0.02  3.17   7.64  n/a   0.000
*
    CHANNEL[ 2:  0062]   0073  1  5.0    1.49    0.02  3.25   7.64  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.02  3.58   6.40 0.13   0.000
    [CN=59.5         ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0019+  0005]  0063  3  5.0    3.09    0.04  3.50   7.43  n/a   0.000
*
    ADD [  0063+  0073]  0063  1  5.0    4.58    0.06  3.33   7.50  n/a   0.000
*
    CHANNEL[ 2:  0063]   0083  1  5.0    4.58    0.06  3.58   7.49  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0009  1  5.0    0.36    0.01  3.17  10.61 0.21   0.000
    [CN=68.4         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.01  3.08  13.03 0.26   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0017]   0080  1  5.0    0.17    0.01  3.17  13.02  n/a   0.000
*
    ADD [  0080+  0009]  0035  3  5.0    0.53    0.01  3.17  11.40  n/a   0.000
*
    CHANNEL[ 2:  0035]   0077  1  5.0    0.53    0.01  3.17  11.39  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0010  1  5.0    0.38    0.01  3.17  10.46 0.21   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0010+  0077]  0036  3  5.0    0.91    0.02  3.17  11.01  n/a   0.000
*
    CHANNEL[ 2:  0036]   0078  1  5.0    0.91    0.02  3.25  11.01  n/a   0.000
*
    READ STORM                 30.0
```

```
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0011  1  5.0    0.38    0.01  3.17  10.46 0.21   0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0011+  0078]  0037  3  5.0    1.28    0.03  3.25  10.85  n/a   0.000
*
    CHANNEL[ 2:  0037]   0079  1  5.0    1.28    0.03  3.25  10.85  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0012  1  5.0    0.29    0.01  3.08  13.76 0.27   0.000
    [CN=74.8          ]
    [ N = 3.0:Tp 0.22]
*
    ADD [  0012+  0079]  0038  3  5.0    1.58    0.04  3.25  11.39  n/a   0.000
*
    CHANNEL[ 2:  0038]   0094  1  5.0    1.58    0.04  3.25  11.39  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0013  1  5.0    0.34    0.01  3.08  15.26 0.30   0.000
    [CN=76.8          ]
    [ N = 3.0:Tp 0.24]
*
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0014  1  5.0    0.36    0.01  3.17  10.58 0.21   0.000
    [CN=68.3          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0015  1  5.0    0.38    0.01  3.17  10.46 0.21   0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
```

```
*
 ** CALIB NASHYD         0016  1  5.0    0.39    0.01  3.17  10.34 0.21   0.000
    [CN=67.9          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  30.0
    [ Ptot= 50.41 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\efd79b53-4367-4bd5-a2ba-ef6554
    remark: SCS II 6hr 5yr Ottawa
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.01  3.08  13.03 0.26   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0018]   0081  1  5.0    0.17    0.01  3.08  13.03  n/a   0.000
*
    ADD [  0016+  0081]  0039  3  5.0    0.56    0.01  3.17  11.17  n/a   0.000
*
    CHANNEL[ 2:  0039]   0074  1  5.0    0.56    0.01  3.17  11.17  n/a   0.000
*
    ADD [  0015+  0074]  0040  3  5.0    0.94    0.02  3.17  10.88  n/a   0.000
*
    CHANNEL[ 2:  0040]   0075  1  5.0    0.94    0.02  3.25  10.88  n/a   0.000
*
    ADD [  0014+  0075]  0041  3  5.0    1.30    0.03  3.17  10.80  n/a   0.000
*
    CHANNEL[ 2:  0041]   0076  1  5.0    1.30    0.03  3.25  10.80  n/a   0.000
*
    ADD [  0013+  0076]  0042  3  5.0    1.64    0.04  3.17  11.72  n/a   0.000
*
    CHANNEL[ 2:  0042]   0095  1  5.0    1.64    0.04  3.25  11.72  n/a   0.000
*
    ADD [  0094+  0095]  0043  3  5.0    3.22    0.08  3.25  11.56  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0093  1  5.0    3.22    0.02  4.83   8.52  n/a   0.000
*
    ADD [  0083+  0093]  0092  3  5.0    7.80    0.06  3.67   7.91  n/a   0.000
*
    CHANNEL[ 2:  0092]   0085  1  5.0    7.80    0.06  3.67   7.91  n/a   0.000
*
    ADD [  0084+  0085]  0086  3  5.0   10.99    0.10  3.58   7.90  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0111  1  5.0   10.99    0.09  3.92   7.90  n/a   0.000
*
    CHANNEL[ 2:  0111]   0087  1  5.0   10.99    0.09  4.00   7.90  n/a   0.000
*
===============================================================================

  ************************************************
  ** SIMULATION : 2. SCS II 6hr 100yr Ottawa    **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                  min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    READ STORM                  30.0
```

```
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0001  1  5.0    0.50    0.03  3.00  24.54 0.28   0.000
    [CN=62.5          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0001]   0068  1  5.0    0.50    0.03  3.08  24.54  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0002  1  5.0    0.50    0.03  3.17  24.54 0.28   0.000
    [CN=62.4          ]
    [ N = 3.0:Tp 0.26]
*
    ADD [  0002+  0068]  0064  3  5.0    1.00    0.06  3.08  24.54  n/a   0.000
*
    CHANNEL[ 2:  0064]   0069  1  5.0    1.00    0.06  3.08  24.54  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0003  1  5.0    0.51    0.03  3.08  24.53 0.28   0.000
    [CN=62.4          ]
    [ N = 3.0:Tp 0.24]
*
    ADD [  0003+  0069]  0065  3  5.0    1.51    0.09  3.08  24.54  n/a   0.000
*
    CHANNEL[ 2:  0065]   0070  1  5.0    1.51    0.09  3.17  24.53  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0004  1  5.0    1.68    0.07  3.42  25.55 0.29   0.000
    [CN=63.4          ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0004+  0070]  0066  3  5.0    3.18    0.15  3.25  25.06  n/a   0.000
*
    CHANNEL[ 2:  0066]   0084  1  5.0    3.18    0.15  3.33  25.06  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0005  1  5.0    1.41    0.07  3.25  26.78 0.31   0.000
    [CN=64.6          ]
    [ N = 3.0:Tp 0.34]
```

```
*
    READ STORM                  30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD          0006  1  5.0    0.50    0.03  3.17  24.61 0.28   0.000
    [CN=62.5        ]
    [ N = 3.0:Tp 0.29]
*
    READ STORM                  30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD          0007  1  5.0    0.50    0.03  3.17  24.54 0.28   0.000
    [CN=62.4        ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD          0008  1  5.0    0.49    0.03  3.00  24.54 0.28   0.000
    [CN=62.5        ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0008]    0071  1  5.0    0.49    0.03  3.08  24.54  n/a   0.000
*
    ADD [  0007+  0071]   0061  3  5.0    0.99    0.06  3.08  24.54  n/a   0.000
*
    CHANNEL[ 2:  0061]    0072  1  5.0    0.99    0.06  3.17  24.54  n/a   0.000
*
    ADD [  0006+  0072]   0062  3  5.0    1.49    0.08  3.17  24.56  n/a   0.000
*
    CHANNEL[ 2:  0062]    0073  1  5.0    1.49    0.08  3.17  24.56  n/a   0.000
*
    READ STORM                  30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD          0019  1  5.0    1.68    0.06  3.42  21.77 0.25   0.000
    [CN=59.5        ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0019+  0005]   0063  3  5.0    3.09    0.13  3.33  24.05  n/a   0.000
*
    ADD [  0063+  0073]   0063  1  5.0    4.58    0.21  3.25  24.22  n/a   0.000
*
    CHANNEL[ 2:  0063]    0083  1  5.0    4.58    0.20  3.33  24.21  n/a   0.000
*
    READ STORM                  30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
```

```
*
 ** CALIB NASHYD         0009  1  5.0    0.36    0.02  3.17  30.87 0.35   0.000
    [CN=68.4         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.02  3.00  36.15 0.42   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0017]   0080  1  5.0    0.17    0.02  3.08  36.13  n/a   0.000
*
    ADD [  0080+  0009]  0035  3  5.0    0.53    0.04  3.08  32.58  n/a   0.000
*
    CHANNEL[ 2:  0035]   0077  1  5.0    0.53    0.04  3.17  32.58  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0010  1  5.0    0.38    0.03  3.17  30.55 0.35   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0010+  0077]  0036  3  5.0    0.91    0.07  3.17  31.74  n/a   0.000
*
    CHANNEL[ 2:  0036]   0078  1  5.0    0.91    0.07  3.17  31.74  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0011  1  5.0    0.38    0.03  3.17  30.55 0.35   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0011+  0078]  0037  3  5.0    1.28    0.09  3.17  31.39  n/a   0.000
*
    CHANNEL[ 2:  0037]   0079  1  5.0    1.28    0.09  3.17  31.39  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0012  1  5.0    0.29    0.03  3.08  37.51 0.43   0.000
    [CN=74.8         ]
    [ N = 3.0:Tp 0.22]
*
    ADD [  0012+  0079]  0038  3  5.0    1.58    0.12  3.17  32.53  n/a   0.000
*
    CHANNEL[ 2:  0038]   0094  1  5.0    1.58    0.12  3.17  32.52  n/a   0.000
```

```
*
    READ STORM                  30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0013  1  5.0    0.34    0.03  3.08  40.26 0.46   0.000
    [CN=76.8         ]
    [ N = 3.0:Tp 0.24]
*
    READ STORM                  30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0014  1  5.0    0.36    0.02  3.17  30.78 0.35   0.000
    [CN=68.3         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0015  1  5.0    0.38    0.03  3.17  30.55 0.35   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0016  1  5.0    0.39    0.03  3.17  30.32 0.35   0.000
    [CN=67.9         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  30.0
    [ Ptot= 87.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\2561705c-3809-4f45-a1ef-af05b6
    remark: SCS II 6hr 100yr Ottawa
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.02  3.00  36.15 0.42   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0018]   0081  1  5.0    0.17    0.02  3.08  36.14  n/a   0.000
*
    ADD [  0016+  0081]  0039  3  5.0    0.56    0.04  3.08  32.11  n/a   0.000
*
    CHANNEL[ 2:  0039]   0074  1  5.0    0.56    0.04  3.08  32.11  n/a   0.000
*
    ADD [  0015+  0074]  0040  3  5.0    0.94    0.07  3.17  31.48  n/a   0.000
*
    CHANNEL[ 2:  0040]   0075  1  5.0    0.94    0.07  3.17  31.48  n/a   0.000
*
    ADD [  0014+  0075]  0041  3  5.0    1.30    0.09  3.17  31.29  n/a   0.000
```

```
*
    CHANNEL[ 2:  0041]   0076  1  5.0    1.30    0.09  3.17  31.28  n/a   0.000
*
    ADD [  0013+  0076]  0042  3  5.0    1.64    0.12  3.17  33.15  n/a   0.000
*
    CHANNEL[ 2:  0042]   0095  1  5.0    1.64    0.12  3.17  33.15  n/a   0.000
*
    ADD [  0094+  0095]  0043  3  5.0    3.22    0.24  3.17  32.84  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0093  1  5.0    3.22    0.10  3.92  29.81  n/a   0.000
*
    ADD [  0083+  0093]  0092  3  5.0    7.80    0.27  3.58  26.52  n/a   0.000
*
    CHANNEL[ 2:  0092]   0085  1  5.0    7.80    0.27  3.58  26.52  n/a   0.000
*
    ADD [  0084+  0085]  0086  3  5.0   10.99    0.40  3.50  26.10  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0111  1  5.0   10.99    0.32  3.92  26.10  n/a   0.000
*
    CHANNEL[ 2:  0111]   0087  1  5.0   10.99    0.32  4.00  26.10  n/a   0.000
*
===============================================================================

  ************************************************
  ** SIMULATION : 3. SCS II 12hr 5yr Ottawa     **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                  min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    READ STORM                30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0001  1  5.0    0.50    0.01  6.00  10.22 0.18   0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0001]   0068  1  5.0    0.50    0.01  6.08  10.22  n/a   0.000
*
    READ STORM                30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0002  1  5.0    0.50    0.01  6.17  10.22 0.18   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.26]
*
    ADD [  0002+  0068]  0064  3  5.0    1.00    0.02  6.08  10.22  n/a   0.000
*
    CHANNEL[ 2:  0064]   0069  1  5.0    1.00    0.02  6.17  10.22  n/a   0.000
*
    READ STORM                30.0
```

```
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0003  1  5.0    0.51    0.01  6.08  10.21 0.18   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.24]
*
    ADD [  0003+  0069]  0065  3  5.0    1.51    0.03  6.17  10.22  n/a   0.000
*
    CHANNEL[ 2:  0065]   0070  1  5.0    1.51    0.03  6.17  10.21  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0004  1  5.0    1.68    0.03  6.33  10.77 0.19   0.000
    [CN=63.4         ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0004+  0070]  0066  3  5.0    3.18    0.05  6.25  10.51  n/a   0.000
*
    CHANNEL[ 2:  0066]   0084  1  5.0    3.18    0.05  6.33  10.51  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0005  1  5.0    1.41    0.03  6.25  11.47 0.20   0.000
    [CN=64.6         ]
    [ N = 3.0:Tp 0.34]
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0006  1  5.0    0.50    0.01  6.17  10.25 0.18   0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.29]
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0007  1  5.0    0.50    0.01  6.17  10.22 0.18   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
```

```
*
 ** CALIB NASHYD         0008  1  5.0    0.49    0.01  6.00  10.22 0.18   0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0008]   0071  1  5.0    0.49    0.01  6.08  10.22  n/a   0.000
*
    ADD [  0007+  0071]  0061  3  5.0    0.99    0.02  6.08  10.22  n/a   0.000
*
    CHANNEL[ 2:  0061]   0072  1  5.0    0.99    0.02  6.17  10.22  n/a   0.000
*
    ADD [  0006+  0072]  0062  3  5.0    1.49    0.03  6.17  10.23  n/a   0.000
*
    CHANNEL[ 2:  0062]   0073  1  5.0    1.49    0.03  6.17  10.23  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.02  6.42   8.71 0.15   0.000
    [CN=59.5         ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0019+  0005]  0063  3  5.0    3.09    0.05  6.25   9.97  n/a   0.000
*
    ADD [  0063+  0073]  0063  1  5.0    4.58    0.07  6.25  10.05  n/a   0.000
*
    CHANNEL[ 2:  0063]   0083  1  5.0    4.58    0.07  6.42  10.05  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0009  1  5.0    0.36    0.01  6.17  13.83 0.24   0.000
    [CN=68.4         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.01  6.00  16.78 0.29   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0017]   0080  1  5.0    0.17    0.01  6.08  16.77  n/a   0.000
*
    ADD [  0080+  0009]  0035  3  5.0    0.53    0.02  6.08  14.78  n/a   0.000
*
    CHANNEL[ 2:  0035]   0077  1  5.0    0.53    0.02  6.17  14.78  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
```

```
*
 ** CALIB NASHYD         0010  1  5.0    0.38    0.01  6.17  13.64 0.24   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0010+  0077]  0036  3  5.0    0.91    0.03  6.17  14.31  n/a   0.000
*
    CHANNEL[ 2:  0036]   0078  1  5.0    0.91    0.03  6.17  14.31  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0011  1  5.0    0.38    0.01  6.17  13.64 0.24   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0011+  0078]  0037  3  5.0    1.28    0.04  6.17  14.11  n/a   0.000
*
    CHANNEL[ 2:  0037]   0079  1  5.0    1.28    0.04  6.17  14.11  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0012  1  5.0    0.29    0.01  6.08  17.64 0.31   0.000
    [CN=74.8         ]
    [ N = 3.0:Tp 0.22]
*
    ADD [  0012+  0079]  0038  3  5.0    1.58    0.05  6.17  14.77  n/a   0.000
*
    CHANNEL[ 2:  0038]   0094  1  5.0    1.58    0.05  6.17  14.76  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0013  1  5.0    0.34    0.01  6.08  19.39 0.34   0.000
    [CN=76.8         ]
    [ N = 3.0:Tp 0.24]
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0014  1  5.0    0.36    0.01  6.17  13.78 0.24   0.000
    [CN=68.3         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
```

```
*
 ** CALIB NASHYD         0015  1  5.0    0.38    0.01  6.17  13.64 0.24   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0016  1  5.0    0.39    0.01  6.17  13.50 0.24   0.000
    [CN=67.9         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 30.0
    [ Ptot= 57.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\00e1f214-ae56-47d3-be2b-e27864
    remark: SCS II 12hr 5yr Ottawa
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.01  6.00  16.78 0.29   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0018]   0081  1  5.0    0.17    0.01  6.08  16.78  n/a   0.000
*
    ADD [  0016+  0081]  0039  3  5.0    0.56    0.02  6.08  14.51  n/a   0.000
*
    CHANNEL[ 2:  0039]   0074  1  5.0    0.56    0.02  6.17  14.51  n/a   0.000
*
    ADD [  0015+  0074]  0040  3  5.0    0.94    0.03  6.17  14.16  n/a   0.000
*
    CHANNEL[ 2:  0040]   0075  1  5.0    0.94    0.03  6.17  14.16  n/a   0.000
*
    ADD [  0014+  0075]  0041  3  5.0    1.30    0.04  6.17  14.05  n/a   0.000
*
    CHANNEL[ 2:  0041]   0076  1  5.0    1.30    0.04  6.17  14.05  n/a   0.000
*
    ADD [  0013+  0076]  0042  3  5.0    1.64    0.05  6.17  15.16  n/a   0.000
*
    CHANNEL[ 2:  0042]   0095  1  5.0    1.64    0.05  6.17  15.16  n/a   0.000
*
    ADD [  0094+  0095]  0043  3  5.0    3.22    0.10  6.17  14.96  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0093  1  5.0    3.22    0.02  7.50  11.93  n/a   0.000
*
    ADD [  0083+  0093]  0092  3  5.0    7.80    0.07  6.58  10.82  n/a   0.000
*
    CHANNEL[ 2:  0092]   0085  1  5.0    7.80    0.07  6.58  10.82  n/a   0.000
*
    ADD [  0084+  0085]  0086  3  5.0   10.99    0.12  6.42  10.73  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0111  1  5.0   10.99    0.10  6.83  10.73  n/a   0.000
*
    CHANNEL[ 2:  0111]   0087  1  5.0   10.99    0.10  6.83  10.73  n/a   0.000
*
```

```
================================================================================

  ************************************************
  ** SIMULATION : 4. SCS II 12hr 10yr Ottawa    **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                   min     ha   '  cms   hrs     mm           cms

      START @  0.00 hrs
      --------------------
    READ STORM                 30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD          0001  1  5.0    0.50    0.02  6.00  14.53 0.22   0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0001]   0068  1  5.0    0.50    0.02  6.08  14.53  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD          0002  1  5.0    0.50    0.01  6.08  14.53 0.22   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.26]
*
    ADD [  0002+  0068]  0064  3  5.0    1.00    0.03  6.08  14.53  n/a   0.000
*
    CHANNEL[ 2:  0064]   0069  1  5.0    1.00    0.03  6.17  14.53  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD          0003  1  5.0    0.51    0.01  6.08  14.53 0.22   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.24]
*
    ADD [  0003+  0069]  0065  3  5.0    1.51    0.04  6.17  14.53  n/a   0.000
*
    CHANNEL[ 2:  0065]   0070  1  5.0    1.51    0.04  6.17  14.52  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD          0004  1  5.0    1.68    0.04  6.33  15.24 0.23   0.000
    [CN=63.4         ]
    [ N = 3.0:Tp 0.41]
*
```

```
    ADD [  0004+  0070]  0066  3  5.0    3.18    0.08  6.25  14.90  n/a   0.000
*
    CHANNEL[ 2:  0066]   0084  1  5.0    3.18    0.08  6.33  14.90  n/a   0.000
*
    READ STORM                30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD         0005  1  5.0    1.41    0.04  6.25  16.11 0.24   0.000
    [CN=64.6          ]
    [ N = 3.0:Tp 0.34]
*
    READ STORM                30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD         0006  1  5.0    0.50    0.01  6.17  14.58 0.22   0.000
    [CN=62.5          ]
    [ N = 3.0:Tp 0.29]
*
    READ STORM                30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD         0007  1  5.0    0.50    0.01  6.17  14.53 0.22   0.000
    [CN=62.4          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD         0008  1  5.0    0.49    0.02  6.00  14.53 0.22   0.000
    [CN=62.5          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0008]   0071  1  5.0    0.49    0.02  6.08  14.53  n/a   0.000
*
    ADD [  0007+  0071]  0061  3  5.0    0.99    0.03  6.08  14.53  n/a   0.000
*
    CHANNEL[ 2:  0061]   0072  1  5.0    0.99    0.03  6.17  14.53  n/a   0.000
*
    ADD [  0006+  0072]  0062  3  5.0    1.49    0.04  6.17  14.55  n/a   0.000
*
    CHANNEL[ 2:  0062]   0073  1  5.0    1.49    0.04  6.17  14.55  n/a   0.000
*
    READ STORM                30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.03  6.33  12.60 0.19   0.000
    [CN=59.5          ]
```

```
    [ N = 3.0:Tp 0.41]
*
    ADD [  0019+  0005]  0063  3  5.0    3.09    0.07  6.25  14.20  n/a   0.000
*
    ADD [  0063+  0073]  0063  1  5.0    4.58    0.11  6.25  14.31  n/a   0.000
*
    CHANNEL[ 2:  0063]   0083  1  5.0    4.58    0.10  6.33  14.31  n/a   0.000
*
    READ STORM                30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD         0009  1  5.0    0.36    0.01  6.08  19.06 0.28   0.000
    [CN=68.4         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.01  6.00  22.82 0.34   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0017]   0080  1  5.0    0.17    0.01  6.08  22.80  n/a   0.000
*
    ADD [  0080+  0009]  0035  3  5.0    0.53    0.02  6.08  20.28  n/a   0.000
*
    CHANNEL[ 2:  0035]   0077  1  5.0    0.53    0.02  6.17  20.28  n/a   0.000
*
    READ STORM                30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD         0010  1  5.0    0.38    0.01  6.08  18.83 0.28   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0010+  0077]  0036  3  5.0    0.91    0.04  6.17  19.68  n/a   0.000
*
    CHANNEL[ 2:  0036]   0078  1  5.0    0.91    0.04  6.17  19.68  n/a   0.000
*
    READ STORM                30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD         0011  1  5.0    0.38    0.01  6.08  18.83 0.28   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0011+  0078]  0037  3  5.0    1.28    0.05  6.17  19.43  n/a   0.000
*
    CHANNEL[ 2:  0037]   0079  1  5.0    1.28    0.05  6.17  19.43  n/a   0.000
*
```

```
    READ STORM                  30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD         0012  1  5.0    0.29    0.02  6.08  23.85 0.35   0.000
    [CN=74.8          ]
    [ N = 3.0:Tp 0.22]
*
    ADD [  0012+  0079]  0038  3  5.0    1.58    0.06  6.17  20.25  n/a   0.000
*
    CHANNEL[ 2:  0038]   0094  1  5.0    1.58    0.06  6.17  20.25  n/a   0.000
*
    READ STORM                  30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD         0013  1  5.0    0.34    0.02  6.08  25.96 0.39   0.000
    [CN=76.8          ]
    [ N = 3.0:Tp 0.24]
*
    READ STORM                  30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD         0014  1  5.0    0.36    0.01  6.08  19.00 0.28   0.000
    [CN=68.3          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD         0015  1  5.0    0.38    0.01  6.08  18.83 0.28   0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD         0016  1  5.0    0.39    0.01  6.08  18.66 0.28   0.000
    [CN=67.9          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  30.0
    [ Ptot= 67.20 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f6f44053-9f17-4948-819d-f46d03
    remark: SCS II 12hr 10yr Ottawa
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.01  6.00  22.82 0.34   0.000
    [CN=73.9          ]
```

```
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0018]   0081  1  5.0    0.17    0.01  6.08  22.81  n/a   0.000
*
    ADD [  0016+  0081]  0039  3  5.0    0.56    0.02  6.08  19.94  n/a   0.000
*
    CHANNEL[ 2:  0039]   0074  1  5.0    0.56    0.02  6.17  19.94  n/a   0.000
*
    ADD [  0015+  0074]  0040  3  5.0    0.94    0.04  6.17  19.49  n/a   0.000
*
    CHANNEL[ 2:  0040]   0075  1  5.0    0.94    0.04  6.17  19.49  n/a   0.000
*
    ADD [  0014+  0075]  0041  3  5.0    1.30    0.05  6.17  19.35  n/a   0.000
*
    CHANNEL[ 2:  0041]   0076  1  5.0    1.30    0.05  6.17  19.35  n/a   0.000
*
    ADD [  0013+  0076]  0042  3  5.0    1.64    0.07  6.17  20.72  n/a   0.000
*
    CHANNEL[ 2:  0042]   0095  1  5.0    1.64    0.07  6.17  20.72  n/a   0.000
*
    ADD [  0094+  0095]  0043  3  5.0    3.22    0.13  6.17  20.49  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0093  1  5.0    3.22    0.03  7.17  17.46  n/a   0.000
*
    ADD [  0083+  0093]  0092  3  5.0    7.80    0.11  6.50  15.61  n/a   0.000
*
    CHANNEL[ 2:  0092]   0085  1  5.0    7.80    0.12  6.50  15.61  n/a   0.000
*
    ADD [  0084+  0085]  0086  3  5.0   10.99    0.19  6.42  15.40  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0111  1  5.0   10.99    0.15  6.83  15.40  n/a   0.000
*
    CHANNEL[ 2:  0111]   0087  1  5.0   10.99    0.15  6.92  15.40  n/a   0.000
*
===============================================================================

  ***********************************************
  ** SIMULATION : 5. SCS II 12hr 100yr correct  **
  ***********************************************

  W/E COMMAND            HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                  min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    READ STORM               30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0001  1  5.0    0.50    0.04  6.00  29.62 0.31   0.000
    [CN=62.5        ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0001]   0068  1  5.0    0.50    0.04  6.08  29.62  n/a   0.000
*
    READ STORM               30.0
    [ Ptot= 96.00 mm ]
```

```
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD          0002  1  5.0    0.50    0.03  6.08  29.63 0.31   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.26]
*
    ADD [  0002+  0068]  0064  3  5.0    1.00    0.07  6.08  29.63  n/a   0.000
*
    CHANNEL[ 2:  0064]   0069  1  5.0    1.00    0.07  6.08  29.63  n/a   0.000
*
    READ STORM                  30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD          0003  1  5.0    0.51    0.03  6.08  29.62 0.31   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.24]
*
    ADD [  0003+  0069]  0065  3  5.0    1.51    0.10  6.08  29.62  n/a   0.000
*
    CHANNEL[ 2:  0065]   0070  1  5.0    1.51    0.10  6.17  29.62  n/a   0.000
*
    READ STORM                  30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD          0004  1  5.0    1.68    0.08  6.25  30.77 0.32   0.000
    [CN=63.4         ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0004+  0070]  0066  3  5.0    3.18    0.17  6.17  30.22  n/a   0.000
*
    CHANNEL[ 2:  0066]   0084  1  5.0    3.18    0.17  6.25  30.22  n/a   0.000
*
    READ STORM                  30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD          0005  1  5.0    1.41    0.08  6.17  32.16 0.33   0.000
    [CN=64.6         ]
    [ N = 3.0:Tp 0.34]
*
    READ STORM                  30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD          0006  1  5.0    0.50    0.03  6.17  29.72 0.31   0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.29]
*
    READ STORM                  30.0
    [ Ptot= 96.00 mm ]
```

```
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0007  1  5.0    0.50    0.03  6.08  29.63 0.31   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0008  1  5.0    0.49    0.04  6.00  29.62 0.31   0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0008]   0071  1  5.0    0.49    0.04  6.08  29.62  n/a   0.000
*
    ADD [  0007+  0071]  0061  3  5.0    0.99    0.06  6.08  29.63  n/a   0.000
*
    CHANNEL[ 2:  0061]   0072  1  5.0    0.99    0.07  6.08  29.63  n/a   0.000
*
    ADD [  0006+  0072]  0062  3  5.0    1.49    0.09  6.08  29.66  n/a   0.000
*
    CHANNEL[ 2:  0062]   0073  1  5.0    1.49    0.09  6.17  29.66  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.07  6.33  26.48 0.28   0.000
    [CN=59.5         ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0019+  0005]  0063  3  5.0    3.09    0.15  6.25  29.07  n/a   0.000
*
    ADD [  0063+  0073]  0063  1  5.0    4.58    0.24  6.17  29.26  n/a   0.000
*
    CHANNEL[ 2:  0063]   0083  1  5.0    4.58    0.22  6.25  29.25  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0009  1  5.0    0.36    0.03  6.08  36.75 0.38   0.000
    [CN=68.4         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.02  6.00  42.68 0.44   0.000
    [CN=73.9         ]
```

```
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0017]   0080  1  5.0    0.17    0.02  6.08  42.67  n/a   0.000
*
    ADD [  0080+  0009]  0035  3  5.0    0.53    0.04  6.08  38.67  n/a   0.000
*
    CHANNEL[ 2:  0035]   0077  1  5.0    0.53    0.04  6.08  38.67  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0010  1  5.0    0.38    0.03  6.08  36.39 0.38   0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0010+  0077]  0036  3  5.0    0.91    0.07  6.08  37.73  n/a   0.000
*
    CHANNEL[ 2:  0036]   0078  1  5.0    0.91    0.07  6.17  37.73  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0011  1  5.0    0.38    0.03  6.08  36.39 0.38   0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0011+  0078]  0037  3  5.0    1.28    0.10  6.17  37.33  n/a   0.000
*
    CHANNEL[ 2:  0037]   0079  1  5.0    1.28    0.10  6.17  37.33  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0012  1  5.0    0.29    0.03  6.08  44.18 0.46   0.000
    [CN=74.8          ]
    [ N = 3.0:Tp 0.22]
*
    ADD [  0012+  0079]  0038  3  5.0    1.58    0.13  6.17  38.61  n/a   0.000
*
    CHANNEL[ 2:  0038]   0094  1  5.0    1.58    0.13  6.17  38.60  n/a   0.000
*
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0013  1  5.0    0.34    0.04  6.08  47.20 0.49   0.000
    [CN=76.8          ]
    [ N = 3.0:Tp 0.24]
*
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
```

```
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0014  1  5.0    0.36    0.03  6.08  36.65 0.38   0.000
    [CN=68.3          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0015  1  5.0    0.38    0.03  6.08  36.39 0.38   0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0016  1  5.0    0.39    0.03  6.08  36.13 0.38   0.000
    [CN=67.9          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 30.0
    [ Ptot= 96.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\5f0b7bb1-f676-48d3-8e28-cd9bf2
    remark: SCS II 12hr 100yr Ottawa
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.02  6.00  42.68 0.44   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0018]   0081  1  5.0    0.17    0.02  6.08  42.67  n/a   0.000
*
    ADD [  0016+  0081]  0039  3  5.0    0.56    0.05  6.08  38.14  n/a   0.000
*
    CHANNEL[ 2:  0039]   0074  1  5.0    0.56    0.05  6.08  38.14  n/a   0.000
*
    ADD [  0015+  0074]  0040  3  5.0    0.94    0.07  6.08  37.44  n/a   0.000
*
    CHANNEL[ 2:  0040]   0075  1  5.0    0.94    0.07  6.17  37.44  n/a   0.000
*
    ADD [  0014+  0075]  0041  3  5.0    1.30    0.10  6.08  37.22  n/a   0.000
*
    CHANNEL[ 2:  0041]   0076  1  5.0    1.30    0.10  6.17  37.22  n/a   0.000
*
    ADD [  0013+  0076]  0042  3  5.0    1.64    0.13  6.17  39.29  n/a   0.000
*
    CHANNEL[ 2:  0042]   0095  1  5.0    1.64    0.14  6.17  39.29  n/a   0.000
*
    ADD [  0094+  0095]  0043  3  5.0    3.22    0.26  6.17  38.95  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0093  1  5.0    3.22    0.10  6.83  35.92  n/a   0.000
*
    ADD [  0083+  0093]  0092  3  5.0    7.80    0.29  6.42  32.00  n/a   0.000
```

```
*
    CHANNEL[ 2:  0092]   0085  1  5.0    7.80    0.29  6.42  32.00  n/a   0.000
*
    ADD [  0084+  0085]  0086  3  5.0   10.99    0.45  6.33  31.49  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0111  1  5.0   10.99    0.33  6.83  31.49  n/a   0.000
*
    CHANNEL[ 2:  0111]   0087  1  5.0   10.99    0.33  6.92  31.49  n/a   0.000
*
==============================================================================

  ***********************************************
  ** SIMULATION : 6. Chi 12hr 2yr              **
  ***********************************************

  W/E COMMAND              HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                    min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    CHIC STORM                  10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0001  1  5.0    0.50    0.00  4.17   4.96 0.12   0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0001]   0068  1  5.0    0.50    0.00  4.25   4.96  n/a   0.000
*
    CHIC STORM                  10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0002  1  5.0    0.50    0.00  4.33   4.96 0.12   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.26]
*
    ADD [  0002+  0068]  0064  3  5.0    1.00    0.01  4.25   4.96  n/a   0.000
*
    CHANNEL[ 2:  0064]   0069  1  5.0    1.00    0.01  4.33   4.96  n/a   0.000
*
    CHIC STORM                  10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0003  1  5.0    0.51    0.00  4.33   4.95 0.12   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.24]
*
    ADD [  0003+  0069]  0065  3  5.0    1.51    0.01  4.33   4.96  n/a   0.000
*
    CHANNEL[ 2:  0065]   0070  1  5.0    1.51    0.01  4.42   4.95  n/a   0.000
*
    CHIC STORM                  10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0004  1  5.0    1.68    0.01  4.58   5.30 0.13   0.000
    [CN=63.4         ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0004+  0070]  0066  3  5.0    3.18    0.02  4.50   5.13  n/a   0.000
*
```

```
    CHANNEL[ 2:  0066]   0084  1  5.0    3.18    0.02  4.67    5.13  n/a    0.000
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0005  1  5.0    1.41    0.01  4.42    5.73 0.14    0.000
    [CN=64.6         ]
    [ N = 3.0:Tp 0.34]
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0006  1  5.0    0.50    0.00  4.42    4.97 0.12    0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.29]
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0007  1  5.0    0.50    0.00  4.33    4.96 0.12    0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.27]
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0008  1  5.0    0.49    0.00  4.17    4.96 0.12    0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0008]   0071  1  5.0    0.49    0.00  4.25    4.96  n/a    0.000
*
    ADD [  0007+  0071]  0061  3  5.0    0.99    0.01  4.25    4.96  n/a    0.000
*
    CHANNEL[ 2:  0061]   0072  1  5.0    0.99    0.01  4.33    4.96  n/a    0.000
*
    ADD [  0006+  0072]  0062  3  5.0    1.49    0.01  4.33    4.96  n/a    0.000
*
    CHANNEL[ 2:  0062]   0073  1  5.0    1.49    0.01  4.42    4.96  n/a    0.000
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.01  4.58    4.04 0.10    0.000
    [CN=59.5         ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0019+  0005]  0063  3  5.0    3.09    0.02  4.50    4.81  n/a    0.000
*
    ADD [  0063+  0073]  0063  1  5.0    4.58    0.03  4.50    4.86  n/a    0.000
*
    CHANNEL[ 2:  0063]   0083  1  5.0    4.58    0.03  4.67    4.86  n/a    0.000
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0009  1  5.0    0.36    0.00  4.33    7.22 0.17    0.000
    [CN=68.4         ]
    [ N = 3.0:Tp 0.27]
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
```

```
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.00  4.17   9.00 0.21   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0017]   0080  1  5.0    0.17    0.00  4.25   8.99  n/a   0.000
*
    ADD [  0080+  0009]  0035  3  5.0    0.53    0.01  4.33   7.79  n/a   0.000
*
    CHANNEL[ 2:  0035]   0077  1  5.0    0.53    0.01  4.33   7.79  n/a   0.000
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0010  1  5.0    0.38    0.00  4.33   7.10 0.17   0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0010+  0077]  0036  3  5.0    0.91    0.01  4.33   7.51  n/a   0.000
*
    CHANNEL[ 2:  0036]   0078  1  5.0    0.91    0.01  4.33   7.50  n/a   0.000
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0011  1  5.0    0.38    0.00  4.33   7.10 0.17   0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0011+  0078]  0037  3  5.0    1.28    0.02  4.33   7.39  n/a   0.000
*
    CHANNEL[ 2:  0037]   0079  1  5.0    1.28    0.02  4.42   7.38  n/a   0.000
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0012  1  5.0    0.29    0.01  4.25   9.58 0.23   0.000
    [CN=74.8          ]
    [ N = 3.0:Tp 0.22]
*
    ADD [  0012+  0079]  0038  3  5.0    1.58    0.02  4.33   7.79  n/a   0.000
*
    CHANNEL[ 2:  0038]   0094  1  5.0    1.58    0.02  4.42   7.79  n/a   0.000
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0013  1  5.0    0.34    0.01  4.25  10.76 0.25   0.000
    [CN=76.8          ]
    [ N = 3.0:Tp 0.24]
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0014  1  5.0    0.36    0.00  4.33   7.19 0.17   0.000
    [CN=68.3          ]
    [ N = 3.0:Tp 0.27]
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0015  1  5.0    0.38    0.00  4.33   7.10 0.17   0.000
```

```
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0016  1  5.0    0.39    0.00  4.33   7.01 0.17   0.000
    [CN=67.9          ]
    [ N = 3.0:Tp 0.27]
*
    CHIC STORM                 10.0
    [ Ptot= 42.34 mm ]
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.00  4.17   9.00 0.21   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0018]   0081  1  5.0    0.17    0.00  4.25   9.00  n/a   0.000
*
    ADD [  0016+  0081]  0039  3  5.0    0.56    0.01  4.25   7.62  n/a   0.000
*
    CHANNEL[ 2:  0039]   0074  1  5.0    0.56    0.01  4.33   7.62  n/a   0.000
*
    ADD [  0015+  0074]  0040  3  5.0    0.94    0.01  4.33   7.41  n/a   0.000
*
    CHANNEL[ 2:  0040]   0075  1  5.0    0.94    0.01  4.33   7.41  n/a   0.000
*
    ADD [  0014+  0075]  0041  3  5.0    1.30    0.02  4.33   7.35  n/a   0.000
*
    CHANNEL[ 2:  0041]   0076  1  5.0    1.30    0.02  4.42   7.35  n/a   0.000
*
    ADD [  0013+  0076]  0042  3  5.0    1.64    0.02  4.33   8.06  n/a   0.000
*
    CHANNEL[ 2:  0042]   0095  1  5.0    1.64    0.02  4.42   8.05  n/a   0.000
*
    ADD [  0094+  0095]  0043  3  5.0    3.22    0.04  4.42   7.92  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0093  1  5.0    3.22    0.00  8.25   4.89  n/a   0.000
*
    ADD [  0083+  0093]  0092  3  5.0    7.80    0.03  4.67   4.87  n/a   0.000
*
    CHANNEL[ 2:  0092]   0085  1  5.0    7.80    0.02  4.75   4.87  n/a   0.000
*
    ADD [  0084+  0085]  0086  3  5.0   10.99    0.04  4.67   4.95  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0111  1  5.0   10.99    0.04  5.00   4.95  n/a   0.000
*
    CHANNEL[ 2:  0111]   0087  1  5.0   10.99    0.04  5.17   4.95  n/a   0.000
*
```

```
===============================================================================

  **********************************************
  ** SIMULATION : 7. Chi 12hr 100yr           **
  **********************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                   min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    CHIC STORM                 10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0001  1  5.0    0.50    0.04  4.17  28.41 0.30   0.000
    [CN=62.5          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0001]    0068  1  5.0    0.50    0.04  4.17  28.41  n/a   0.000
*
    CHIC STORM                 10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0002  1  5.0    0.50    0.03  4.25  28.41 0.30   0.000
    [CN=62.4          ]
    [ N = 3.0:Tp 0.26]
*
    ADD [  0002+  0068]   0064  3  5.0    1.00    0.07  4.17  28.41  n/a   0.000
*
    CHANNEL[ 2:  0064]    0069  1  5.0    1.00    0.07  4.25  28.41  n/a   0.000
*
    CHIC STORM                 10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0003  1  5.0    0.51    0.03  4.25  28.41 0.30   0.000
    [CN=62.4          ]
    [ N = 3.0:Tp 0.24]
*
    ADD [  0003+  0069]   0065  3  5.0    1.51    0.10  4.25  28.41  n/a   0.000
*
    CHANNEL[ 2:  0065]    0070  1  5.0    1.51    0.10  4.25  28.40  n/a   0.000
*
    CHIC STORM                 10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0004  1  5.0    1.68    0.08  4.42  29.52 0.31   0.000
    [CN=63.4          ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0004+  0070]   0066  3  5.0    3.18    0.17  4.33  28.99  n/a   0.000
*
    CHANNEL[ 2:  0066]    0084  1  5.0    3.18    0.16  4.42  28.99  n/a   0.000
*
    CHIC STORM                 10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0005  1  5.0    1.41    0.08  4.33  30.88 0.33   0.000
    [CN=64.6          ]
    [ N = 3.0:Tp 0.34]
*
    CHIC STORM                 10.0
```

```
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD         0006  1  5.0    0.50    0.03  4.33  28.50 0.30   0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.29]
*
    CHIC STORM                 10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD         0007  1  5.0    0.50    0.03  4.25  28.42 0.30   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.27]
*
    CHIC STORM                 10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD         0008  1  5.0    0.49    0.04  4.17  28.41 0.30   0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0008]   0071  1  5.0    0.49    0.04  4.17  28.41  n/a   0.000
*
    ADD [  0007+  0071]  0061  3  5.0    0.99    0.06  4.17  28.41  n/a   0.000
*
    CHANNEL[ 2:  0061]   0072  1  5.0    0.99    0.07  4.25  28.41  n/a   0.000
*
    ADD [  0006+  0072]  0062  3  5.0    1.49    0.09  4.25  28.44  n/a   0.000
*
    CHANNEL[ 2:  0062]   0073  1  5.0    1.49    0.09  4.25  28.44  n/a   0.000
*
    CHIC STORM                 10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.06  4.50  25.36 0.27   0.000
    [CN=59.5         ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0019+  0005]  0063  3  5.0    3.09    0.14  4.42  27.87  n/a   0.000
*
    ADD [  0063+  0073]  0063  1  5.0    4.58    0.23  4.33  28.06  n/a   0.000
*
    CHANNEL[ 2:  0063]   0083  1  5.0    4.58    0.21  4.42  28.05  n/a   0.000
*
    CHIC STORM                 10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD         0009  1  5.0    0.36    0.03  4.25  35.35 0.38   0.000
    [CN=68.4         ]
    [ N = 3.0:Tp 0.27]
*
    CHIC STORM                 10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.02  4.08  41.13 0.44   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0017]   0080  1  5.0    0.17    0.02  4.17  41.12  n/a   0.000
*
    ADD [  0080+  0009]  0035  3  5.0    0.53    0.05  4.25  37.23  n/a   0.000
*
    CHANNEL[ 2:  0035]   0077  1  5.0    0.53    0.05  4.25  37.23  n/a   0.000
```

```
*
    CHIC STORM                   10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0010  1  5.0    0.38    0.03  4.25  35.00 0.37   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0010+  0077]   0036  3  5.0    0.91    0.08  4.25  36.31  n/a   0.000
*
    CHANNEL[ 2:  0036]    0078  1  5.0    0.91    0.08  4.25  36.31  n/a   0.000
*
    CHIC STORM                   10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0011  1  5.0    0.38    0.03  4.25  35.00 0.37   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0011+  0078]   0037  3  5.0    1.28    0.10  4.25  35.92  n/a   0.000
*
    CHANNEL[ 2:  0037]    0079  1  5.0    1.28    0.10  4.25  35.92  n/a   0.000
*
    CHIC STORM                   10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0012  1  5.0    0.29    0.03  4.17  42.60 0.45   0.000
    [CN=74.8         ]
    [ N = 3.0:Tp 0.22]
*
    ADD [  0012+  0079]   0038  3  5.0    1.58    0.14  4.25  37.17  n/a   0.000
*
    CHANNEL[ 2:  0038]    0094  1  5.0    1.58    0.13  4.25  37.16  n/a   0.000
*
    CHIC STORM                   10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0013  1  5.0    0.34    0.04  4.17  45.56 0.49   0.000
    [CN=76.8         ]
    [ N = 3.0:Tp 0.24]
*
    CHIC STORM                   10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0014  1  5.0    0.36    0.03  4.25  35.26 0.38   0.000
    [CN=68.3         ]
    [ N = 3.0:Tp 0.27]
*
    CHIC STORM                   10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0015  1  5.0    0.38    0.03  4.25  35.00 0.37   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    CHIC STORM                   10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD          0016  1  5.0    0.39    0.03  4.25  34.75 0.37   0.000
    [CN=67.9         ]
    [ N = 3.0:Tp 0.27]
*
```

```
    CHIC STORM                  10.0
    [ Ptot= 93.90 mm ]
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.02  4.08  41.13 0.44   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0018]   0081  1  5.0    0.17    0.02  4.17  41.13  n/a   0.000
*
    ADD [  0016+  0081]  0039  3  5.0    0.56    0.05  4.17  36.71  n/a   0.000
*
    CHANNEL[ 2:  0039]   0074  1  5.0    0.56    0.05  4.25  36.71  n/a   0.000
*
    ADD [  0015+  0074]  0040  3  5.0    0.94    0.08  4.25  36.02  n/a   0.000
*
    CHANNEL[ 2:  0040]   0075  1  5.0    0.94    0.08  4.25  36.02  n/a   0.000
*
    ADD [  0014+  0075]  0041  3  5.0    1.30    0.11  4.25  35.81  n/a   0.000
*
    CHANNEL[ 2:  0041]   0076  1  5.0    1.30    0.11  4.25  35.81  n/a   0.000
*
    ADD [  0013+  0076]  0042  3  5.0    1.64    0.14  4.25  37.83  n/a   0.000
*
    CHANNEL[ 2:  0042]   0095  1  5.0    1.64    0.14  4.25  37.83  n/a   0.000
*
    ADD [  0094+  0095]  0043  3  5.0    3.22    0.28  4.25  37.50  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0093  1  5.0    3.22    0.09  5.00  34.47  n/a   0.000
*
    ADD [  0083+  0093]  0092  3  5.0    7.80    0.27  4.58  30.70  n/a   0.000
*
    CHANNEL[ 2:  0092]   0085  1  5.0    7.80    0.27  4.58  30.70  n/a   0.000
*
    ADD [  0084+  0085]  0086  3  5.0   10.99    0.42  4.50  30.20  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0111  1  5.0   10.99    0.31  5.00  30.21  n/a   0.000
*
    CHANNEL[ 2:  0111]   0087  1  5.0   10.99    0.31  5.00  30.21  n/a   0.000
*
===============================================================================

  ************************************************
  ** SIMULATION : 8. Historical July 1 1979     **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                  min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    READ STORM                   5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0001  1  5.0    0.50    0.04  1.67  22.90 0.27   0.000
    [CN=62.5          ]
    [ N = 3.0:Tp 0.17]
```

```
*
    CHANNEL[ 2:  0001]   0068  1  5.0    0.50    0.04  1.67  22.90  n/a   0.000
*
    READ STORM                   5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0002  1  5.0    0.50    0.04  1.75  22.90 0.27   0.000
    [CN=62.4          ]
    [ N = 3.0:Tp 0.26]
*
    ADD [  0002+  0068]  0064  3  5.0    1.00    0.08  1.75  22.90  n/a   0.000
*
    CHANNEL[ 2:  0064]   0069  1  5.0    1.00    0.08  1.75  22.90  n/a   0.000
*
    READ STORM                   5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0003  1  5.0    0.51    0.04  1.75  22.90 0.27   0.000
    [CN=62.4          ]
    [ N = 3.0:Tp 0.24]
*
    ADD [  0003+  0069]  0065  3  5.0    1.51    0.11  1.75  22.90  n/a   0.000
*
    CHANNEL[ 2:  0065]   0070  1  5.0    1.51    0.11  1.75  22.90  n/a   0.000
*
    READ STORM                   5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0004  1  5.0    1.68    0.10  2.00  23.87 0.28   0.000
    [CN=63.4          ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0004+  0070]  0066  3  5.0    3.18    0.21  1.83  23.41  n/a   0.000
*
    CHANNEL[ 2:  0066]   0084  1  5.0    3.18    0.20  1.92  23.41  n/a   0.000
*
    READ STORM                   5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0005  1  5.0    1.41    0.10  1.83  25.04 0.30   0.000
    [CN=64.6          ]
    [ N = 3.0:Tp 0.34]
*
    READ STORM                   5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0006  1  5.0    0.50    0.03  1.83  22.98 0.27   0.000
```

```
    [CN=62.5         ]
    [ N = 3.0:Tp 0.29]
*
    READ STORM                  5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0007  1  5.0    0.50    0.04  1.75  22.91 0.27   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0008  1  5.0    0.49    0.04  1.67  22.90 0.27   0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0008]   0071  1  5.0    0.49    0.04  1.67  22.90  n/a   0.000
*
    ADD [  0007+  0071]  0061  3  5.0    0.99    0.08  1.75  22.91  n/a   0.000
*
    CHANNEL[ 2:  0061]   0072  1  5.0    0.99    0.08  1.75  22.91  n/a   0.000
*
    ADD [  0006+  0072]  0062  3  5.0    1.49    0.11  1.75  22.93  n/a   0.000
*
    CHANNEL[ 2:  0062]   0073  1  5.0    1.49    0.11  1.75  22.93  n/a   0.000
*
    READ STORM                  5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.09  2.00  20.26 0.24   0.000
    [CN=59.5         ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0019+  0005]  0063  3  5.0    3.09    0.18  1.92  22.44  n/a   0.000
*
    ADD [  0063+  0073]  0063  1  5.0    4.58    0.28  1.83  22.60  n/a   0.000
*
    CHANNEL[ 2:  0063]   0083  1  5.0    4.58    0.27  1.92  22.59  n/a   0.000
*
    READ STORM                  5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0009  1  5.0    0.36    0.03  1.75  28.97 0.34   0.000
    [CN=68.4         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  5.0
    [ Ptot= 83.99 mm ]
```

```
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.02  1.67  34.02 0.41   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0017]   0080  1  5.0    0.17    0.02  1.67  34.01  n/a   0.000
*
    ADD [  0080+  0009]  0035  3  5.0    0.53    0.05  1.75  30.61  n/a   0.000
*
    CHANNEL[ 2:  0035]   0077  1  5.0    0.53    0.05  1.75  30.60  n/a   0.000
*
    READ STORM                    5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0010  1  5.0    0.38    0.03  1.75  28.66 0.34   0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0010+  0077]  0036  3  5.0    0.91    0.08  1.75  29.80  n/a   0.000
*
    CHANNEL[ 2:  0036]   0078  1  5.0    0.91    0.08  1.75  29.80  n/a   0.000
*
    READ STORM                    5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0011  1  5.0    0.38    0.03  1.75  28.66 0.34   0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0011+  0078]  0037  3  5.0    1.28    0.12  1.75  29.46  n/a   0.000
*
    CHANNEL[ 2:  0037]   0079  1  5.0    1.28    0.12  1.83  29.46  n/a   0.000
*
    READ STORM                    5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0012  1  5.0    0.29    0.03  1.67  35.33 0.42   0.000
    [CN=74.8          ]
    [ N = 3.0:Tp 0.22]
*
    ADD [  0012+  0079]  0038  3  5.0    1.58    0.15  1.75  30.56  n/a   0.000
*
    CHANNEL[ 2:  0038]   0094  1  5.0    1.58    0.15  1.83  30.55  n/a   0.000
*
    READ STORM                    5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
```

```
 ** CALIB NASHYD         0013  1  5.0    0.34    0.04  1.75  38.00 0.45   0.000
    [CN=76.8          ]
    [ N = 3.0:Tp 0.24]
*
    READ STORM                  5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0014  1  5.0    0.36    0.03  1.75  28.89 0.34   0.000
    [CN=68.3          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0015  1  5.0    0.38    0.03  1.75  28.66 0.34   0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0016  1  5.0    0.39    0.03  1.75  28.44 0.34   0.000
    [CN=67.9          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  5.0
    [ Ptot= 83.99 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\d7f4048b-1af6-49f3-b4b8-e4e455
    remark: Ottawa July 1 1979
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.02  1.67  34.02 0.41   0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0018]   0081  1  5.0    0.17    0.02  1.67  34.02  n/a   0.000
*
    ADD [  0016+  0081]  0039  3  5.0    0.56    0.05  1.75  30.15  n/a   0.000
*
    CHANNEL[ 2:  0039]   0074  1  5.0    0.56    0.05  1.75  30.15  n/a   0.000
*
    ADD [  0015+  0074]  0040  3  5.0    0.94    0.09  1.75  29.55  n/a   0.000
*
    CHANNEL[ 2:  0040]   0075  1  5.0    0.94    0.09  1.75  29.55  n/a   0.000
*
    ADD [  0014+  0075]  0041  3  5.0    1.30    0.12  1.75  29.36  n/a   0.000
*
    CHANNEL[ 2:  0041]   0076  1  5.0    1.30    0.12  1.75  29.36  n/a   0.000
*
    ADD [  0013+  0076]  0042  3  5.0    1.64    0.16  1.75  31.16  n/a   0.000
*
    CHANNEL[ 2:  0042]   0095  1  5.0    1.64    0.16  1.75  31.15  n/a   0.000
*
```

```
    ADD [  0094+  0095]  0043  3  5.0    3.22    0.31  1.83  30.86  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0093  1  5.0    3.22    0.13  2.33  27.83  n/a   0.000
*
    ADD [  0083+  0093]  0092  3  5.0    7.80    0.37  2.08  24.75  n/a   0.000
*
    CHANNEL[ 2:  0092]   0085  1  5.0    7.80    0.37  2.08  24.75  n/a   0.000
*
    ADD [  0084+  0085]  0086  3  5.0   10.99    0.56  2.00  24.36  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0111  1  5.0   10.99    0.40  2.42  24.36  n/a   0.000
*
    CHANNEL[ 2:  0111]   0087  1  5.0   10.99    0.40  2.50  24.36  n/a   0.000
*
===============================================================================

  ************************************************
  ** SIMULATION : 9. Historical Aug 4 1988      **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                   min     ha   '  cms   hrs     mm           cms

      START @  0.00 hrs
      --------------------
    READ STORM                  5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0001  1  5.0    0.50    0.04  2.08  21.10 0.26   0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0001]   0068  1  5.0    0.50    0.04  2.08  21.10  n/a   0.000
*
    READ STORM                  5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0002  1  5.0    0.50    0.03  2.08  21.09 0.26   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.26]
*
    ADD [  0002+  0068]  0064  3  5.0    1.00    0.08  2.08  21.09  n/a   0.000
*
    CHANNEL[ 2:  0064]   0069  1  5.0    1.00    0.07  2.17  21.09  n/a   0.000
*
    READ STORM                  5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0003  1  5.0    0.51    0.04  2.08  21.09 0.26   0.000
    [CN=62.4         ]
```

```
    [ N = 3.0:Tp 0.24]
*
    ADD [  0003+  0069]  0065  3  5.0    1.51    0.11  2.08  21.09  n/a   0.000
*
    CHANNEL[ 2:  0065]   0070  1  5.0    1.51    0.11  2.17  21.09  n/a   0.000
*
    READ STORM                   5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0004  1  5.0    1.68    0.09  2.25  22.00 0.27   0.000
    [CN=63.4          ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0004+  0070]  0066  3  5.0    3.18    0.19  2.17  21.57  n/a   0.000
*
    CHANNEL[ 2:  0066]   0084  1  5.0    3.18    0.18  2.25  21.57  n/a   0.000
*
    READ STORM                   5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0005  1  5.0    1.41    0.09  2.17  23.12 0.29   0.000
    [CN=64.6          ]
    [ N = 3.0:Tp 0.34]
*
    READ STORM                   5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0006  1  5.0    0.50    0.03  2.17  21.16 0.26   0.000
    [CN=62.5          ]
    [ N = 3.0:Tp 0.29]
*
    READ STORM                   5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0007  1  5.0    0.50    0.03  2.08  21.10 0.26   0.000
    [CN=62.4          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                   5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0008  1  5.0    0.49    0.04  2.08  21.10 0.26   0.000
    [CN=62.5          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0008]   0071  1  5.0    0.49    0.04  2.08  21.10  n/a   0.000
*
```

```
    ADD [  0007+  0071]  0061  3  5.0    0.99    0.07  2.08  21.10  n/a   0.000
*
    CHANNEL[ 2:  0061]   0072  1  5.0    0.99    0.07  2.17  21.10  n/a   0.000
*
    ADD [  0006+  0072]  0062  3  5.0    1.49    0.10  2.17  21.12  n/a   0.000
*
    CHANNEL[ 2:  0062]   0073  1  5.0    1.49    0.11  2.17  21.12  n/a   0.000
*
    READ STORM                    5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.07  2.25  18.60 0.23   0.000
    [CN=59.5         ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0019+  0005]  0063  3  5.0    3.09    0.16  2.17  20.66  n/a   0.000
*
    ADD [  0063+  0073]  0063  1  5.0    4.58    0.26  2.17  20.81  n/a   0.000
*
    CHANNEL[ 2:  0063]   0083  1  5.0    4.58    0.24  2.25  20.80  n/a   0.000
*
    READ STORM                    5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0009  1  5.0    0.36    0.03  2.08  26.85 0.33   0.000
    [CN=68.4         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                    5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.02  2.08  31.64 0.39   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0017]   0080  1  5.0    0.17    0.02  2.08  31.63  n/a   0.000
*
    ADD [  0080+  0009]  0035  3  5.0    0.53    0.05  2.08  28.40  n/a   0.000
*
    CHANNEL[ 2:  0035]   0077  1  5.0    0.53    0.05  2.17  28.40  n/a   0.000
*
    READ STORM                    5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0010  1  5.0    0.38    0.03  2.08  26.56 0.33   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0010+  0077]  0036  3  5.0    0.91    0.08  2.17  27.64  n/a   0.000
*
```

```
    CHANNEL[ 2:  0036]   0078  1  5.0    0.91    0.08  2.17  27.64  n/a   0.000
*
    READ STORM                   5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0011  1  5.0    0.38    0.03  2.08  26.56 0.33   0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0011+  0078]  0037  3  5.0    1.28    0.11  2.17  27.32  n/a   0.000
*
    CHANNEL[ 2:  0037]   0079  1  5.0    1.28    0.11  2.17  27.32  n/a   0.000
*
    READ STORM                   5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0012  1  5.0    0.29    0.03  2.08  32.90 0.41   0.000
    [CN=74.8          ]
    [ N = 3.0:Tp 0.22]
*
    ADD [  0012+  0079]  0038  3  5.0    1.58    0.14  2.17  28.36  n/a   0.000
*
    CHANNEL[ 2:  0038]   0094  1  5.0    1.58    0.14  2.17  28.35  n/a   0.000
*
    READ STORM                   5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0013  1  5.0    0.34    0.04  2.08  35.46 0.44   0.000
    [CN=76.8          ]
    [ N = 3.0:Tp 0.24]
*
    READ STORM                   5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0014  1  5.0    0.36    0.03  2.08  26.77 0.33   0.000
    [CN=68.3          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                   5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0015  1  5.0    0.38    0.03  2.08  26.56 0.33   0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                   5.0
    [ Ptot= 80.57 mm ]
```

```
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0016  1  5.0    0.39    0.03  2.08  26.34 0.33   0.000
    [CN=67.9         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  5.0
    [ Ptot= 80.57 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\3c6051d3-683f-4b2d-95ad-68862a
    remark: Ottawa Aug 4 1988
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.02  2.08  31.64 0.39   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0018]   0081  1  5.0    0.17    0.02  2.08  31.64  n/a   0.000
*
    ADD [  0016+  0081]  0039  3  5.0    0.56    0.05  2.08  27.97  n/a   0.000
*
    CHANNEL[ 2:  0039]   0074  1  5.0    0.56    0.05  2.17  27.97  n/a   0.000
*
    ADD [  0015+  0074]  0040  3  5.0    0.94    0.08  2.17  27.40  n/a   0.000
*
    CHANNEL[ 2:  0040]   0075  1  5.0    0.94    0.08  2.17  27.40  n/a   0.000
*
    ADD [  0014+  0075]  0041  3  5.0    1.30    0.11  2.17  27.23  n/a   0.000
*
    CHANNEL[ 2:  0041]   0076  1  5.0    1.30    0.11  2.17  27.23  n/a   0.000
*
    ADD [  0013+  0076]  0042  3  5.0    1.64    0.15  2.17  28.93  n/a   0.000
*
    CHANNEL[ 2:  0042]   0095  1  5.0    1.64    0.15  2.17  28.93  n/a   0.000
*
    ADD [  0094+  0095]  0043  3  5.0    3.22    0.29  2.17  28.65  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0093  1  5.0    3.22    0.10  2.58  25.62  n/a   0.000
*
    ADD [  0083+  0093]  0092  3  5.0    7.80    0.31  2.33  22.79  n/a   0.000
*
    CHANNEL[ 2:  0092]   0085  1  5.0    7.80    0.31  2.33  22.79  n/a   0.000
*
    ADD [  0084+  0085]  0086  3  5.0   10.99    0.49  2.25  22.43  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0111  1  5.0   10.99    0.32  2.67  22.43  n/a   0.000
*
    CHANNEL[ 2:  0111]   0087  1  5.0   10.99    0.32  2.67  22.43  n/a   0.000
```

```
===============================================================================

  ************************************************
  ** SIMULATION : 10. 25mm4hrChicago            **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                  min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD          0001  1  5.0    0.50    0.00  2.00   0.99 0.04   0.000
    [CN=62.5          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0001]   0068  1  5.0    0.50    0.00  2.08   0.99  n/a   0.000
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD          0002  1  5.0    0.50    0.00  2.25   0.98 0.04   0.000
    [CN=62.4          ]
    [ N = 3.0:Tp 0.26]
*
    ADD [  0002+  0068]  0064  3  5.0    1.00    0.00  2.17   0.99  n/a   0.000
*
    CHANNEL[ 2:  0064]   0069  1  5.0    1.00    0.00  2.25   0.99  n/a   0.000
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD          0003  1  5.0    0.51    0.00  2.17   0.99 0.04   0.000
    [CN=62.4          ]
    [ N = 3.0:Tp 0.24]
*
    ADD [  0003+  0069]  0065  3  5.0    1.51    0.00  2.25   0.99  n/a   0.000
*
    CHANNEL[ 2:  0065]   0070  1  5.0    1.51    0.00  2.42   0.98  n/a   0.000
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD          0004  1  5.0    1.68    0.00  2.58   1.10 0.04   0.000
    [CN=63.4          ]
    [ N = 3.0:Tp 0.41]
*
```

```
    ADD [  0004+  0070]  0066  3  5.0    3.18    0.00  2.50   1.05  n/a   0.000
*
    CHANNEL[ 2:  0066]   0084  1  5.0    3.18    0.00  2.75   1.05  n/a   0.000
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0005  1  5.0    1.41    0.00  2.33   1.26 0.05   0.000
    [CN=64.6         ]
    [ N = 3.0:Tp 0.34]
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0006  1  5.0    0.50    0.00  2.33   0.99 0.04   0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.29]
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0007  1  5.0    0.50    0.00  2.33   0.99 0.04   0.000
    [CN=62.4         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0008  1  5.0    0.49    0.00  2.00   0.99 0.04   0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0008]   0071  1  5.0    0.49    0.00  2.08   0.99  n/a   0.000
*
    ADD [  0007+  0071]  0061  3  5.0    0.99    0.00  2.17   0.99  n/a   0.000
*
    CHANNEL[ 2:  0061]   0072  1  5.0    0.99    0.00  2.25   0.99  n/a   0.000
*
    ADD [  0006+  0072]  0062  3  5.0    1.49    0.00  2.25   0.99  n/a   0.000
*
    CHANNEL[ 2:  0062]   0073  1  5.0    1.49    0.00  2.33   0.99  n/a   0.000
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.00  3.00   0.68 0.03   0.000
    [CN=59.5         ]
```

```
    [ N = 3.0:Tp 0.41]
*
    ADD [  0019+  0005]  0063  3  5.0    3.09    0.00  2.58   0.94  n/a   0.000
*
    ADD [  0063+  0073]  0063  1  5.0    4.58    0.01  2.50   0.96  n/a   0.000
*
    CHANNEL[ 2:  0063]   0083  1  5.0    4.58    0.00  3.08   0.95  n/a   0.000
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0009  1  5.0    0.36    0.00  2.00   1.83 0.07   0.000
    [CN=68.4         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.00  1.75   2.41 0.10   0.000
    [CN=73.9         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0017]   0080  1  5.0    0.17    0.00  1.92   2.40  n/a   0.000
*
    ADD [  0080+  0009]  0035  3  5.0    0.53    0.00  2.00   2.01  n/a   0.000
*
    CHANNEL[ 2:  0035]   0077  1  5.0    0.53    0.00  2.00   2.01  n/a   0.000
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0010  1  5.0    0.38    0.00  2.00   1.78 0.07   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0010+  0077]  0036  3  5.0    0.91    0.00  2.00   1.92  n/a   0.000
*
    CHANNEL[ 2:  0036]   0078  1  5.0    0.91    0.00  2.08   1.92  n/a   0.000
*
    READ STORM                 10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0011  1  5.0    0.38    0.00  2.00   1.78 0.07   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0011+  0078]  0037  3  5.0    1.28    0.00  2.08   1.88  n/a   0.000
*
    CHANNEL[ 2:  0037]   0079  1  5.0    1.28    0.00  2.17   1.88  n/a   0.000
*
```

```
    READ STORM                  10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0012  1  5.0    0.29    0.00  1.83   2.66 0.11   0.000
    [CN=74.8         ]
    [ N = 3.0:Tp 0.22]
*
    ADD [  0012+  0079]  0038  3  5.0    1.58    0.00  2.08   2.02  n/a   0.000
*
    CHANNEL[ 2:  0038]   0094  1  5.0    1.58    0.00  2.17   2.02  n/a   0.000
*
    READ STORM                  10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0013  1  5.0    0.34    0.00  1.83   3.18 0.13   0.000
    [CN=76.8         ]
    [ N = 3.0:Tp 0.24]
*
    READ STORM                  10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0014  1  5.0    0.36    0.00  2.00   1.82 0.07   0.000
    [CN=68.3         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0015  1  5.0    0.38    0.00  2.00   1.78 0.07   0.000
    [CN=68.1         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0016  1  5.0    0.39    0.00  2.00   1.75 0.07   0.000
    [CN=67.9         ]
    [ N = 3.0:Tp 0.27]
*
    READ STORM                  10.0
    [ Ptot= 25.00 mm ]
    fname : C:\Users\hymo\AppData\Local\Temp\0218615a-6655-4d82-a18d-
5a97c331b20f\f1a0f5d7-8021-40d9-8279-55016d
    remark: twentyfive mm 4 hr chicago storm
*
 ** CALIB NASHYD         0018  1  5.0    0.17    0.00  1.75   2.41 0.10   0.000
    [CN=73.9         ]
```

```
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0018]   0081  1  5.0    0.17    0.00  1.83   2.41  n/a   0.000
*
    ADD [  0016+  0081]  0039  3  5.0    0.56    0.00  1.92   1.95  n/a   0.000
*
    CHANNEL[ 2:  0039]   0074  1  5.0    0.56    0.00  2.00   1.95  n/a   0.000
*
    ADD [  0015+  0074]  0040  3  5.0    0.94    0.00  2.00   1.88  n/a   0.000
*
    CHANNEL[ 2:  0040]   0075  1  5.0    0.94    0.00  2.08   1.88  n/a   0.000
*
    ADD [  0014+  0075]  0041  3  5.0    1.30    0.00  2.08   1.86  n/a   0.000
*
    CHANNEL[ 2:  0041]   0076  1  5.0    1.30    0.00  2.17   1.86  n/a   0.000
*
    ADD [  0013+  0076]  0042  3  5.0    1.64    0.00  2.08   2.14  n/a   0.000
*
    CHANNEL[ 2:  0042]   0095  1  5.0    1.64    0.00  2.08   2.13  n/a   0.000
*
    ADD [  0094+  0095]  0043  3  5.0    3.22    0.01  2.17   2.08  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0093  1  5.0    3.22    0.00  0.00   0.00  n/a   0.000
*
    ADD [  0083+  0093]  0092  3  5.0    7.80    0.00  3.08   0.56  n/a   0.000
*
    CHANNEL[ 2:  0092]   0085  1  5.0    7.80    0.00  3.08   0.56  n/a   0.000
*
    ADD [  0084+  0085]  0086  3  5.0   10.99    0.01  2.92   0.70  n/a   0.000
*
 ** Reservoir
    OUTFLOW:             0111  1  5.0   10.99    0.01  3.25   0.70  n/a   0.000
*
    CHANNEL[ 2:  0111]   0087  1  5.0   10.99    0.01  3.33   0.70  n/a   0.000
*
================================================================================

  ************************************************
  ** SIMULATION : 100 year 12 hr Chi 120 percen **
  ************************************************

  W/E COMMAND             HYD ID   DT    AREA  ' Qpeak Tpeak   R.V. R.C.
Qbase
                                   min     ha   '  cms   hrs     mm          cms

      START @  0.00 hrs
      --------------------
    CHIC STORM                  5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0001  1  5.0    0.50    0.06  4.17  39.78 0.35   0.000
    [CN=62.5         ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0001]   0068  1  5.0    0.50    0.06  4.17  39.78  n/a   0.000
*
    CHIC STORM                  5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0002  1  5.0    0.50    0.04  4.33  39.80 0.35   0.000
    [CN=62.4         ]
```

```
    [ N = 3.0:Tp 0.26]
*
    ADD [  0002+  0068]  0064  3  5.0    1.00    0.10  4.25  39.79  n/a   0.000
*
    CHANNEL[ 2:  0064]   0069  1  5.0    1.00    0.10  4.25  39.79  n/a   0.000
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0003  1  5.0    0.51    0.05  4.25  39.79 0.35   0.000
    [CN=62.4          ]
    [ N = 3.0:Tp 0.24]
*
    ADD [  0003+  0069]  0065  3  5.0    1.51    0.15  4.25  39.79  n/a   0.000
*
    CHANNEL[ 2:  0065]   0070  1  5.0    1.51    0.14  4.25  39.78  n/a   0.000
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0004  1  5.0    1.68    0.11  4.50  41.18 0.37   0.000
    [CN=63.4          ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0004+  0070]  0066  3  5.0    3.18    0.24  4.33  40.52  n/a   0.000
*
    CHANNEL[ 2:  0066]   0084  1  5.0    3.18    0.24  4.42  40.52  n/a   0.000
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0005  1  5.0    1.41    0.11  4.42  42.85 0.38   0.000
    [CN=64.6          ]
    [ N = 3.0:Tp 0.34]
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0006  1  5.0    0.50    0.04  4.33  39.91 0.35   0.000
    [CN=62.5          ]
    [ N = 3.0:Tp 0.29]
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0007  1  5.0    0.50    0.04  4.33  39.80 0.35   0.000
    [CN=62.4          ]
    [ N = 3.0:Tp 0.27]
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0008  1  5.0    0.49    0.06  4.17  39.78 0.35   0.000
    [CN=62.5          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0008]   0071  1  5.0    0.49    0.06  4.17  39.78  n/a   0.000
*
    ADD [  0007+  0071]  0061  3  5.0    0.99    0.10  4.25  39.79  n/a   0.000
*
    CHANNEL[ 2:  0061]   0072  1  5.0    0.99    0.10  4.25  39.79  n/a   0.000
*
```

```
    ADD [  0006+  0072]  0062  3  5.0    1.49    0.14  4.25  39.83  n/a    0.000
*
    CHANNEL[ 2:  0062]   0073  1  5.0    1.49    0.14  4.25  39.83  n/a    0.000
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0019  1  5.0    1.68    0.10  4.50  35.97 0.32    0.000
    [CN=59.5          ]
    [ N = 3.0:Tp 0.41]
*
    ADD [  0019+  0005]  0063  3  5.0    3.09    0.21  4.42  39.11  n/a    0.000
*
    ADD [  0063+  0073]  0063  1  5.0    4.58    0.33  4.33  39.34  n/a    0.000
*
    CHANNEL[ 2:  0063]   0083  1  5.0    4.58    0.31  4.50  39.34  n/a    0.000
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0009  1  5.0    0.36    0.04  4.33  48.32 0.43    0.000
    [CN=68.4          ]
    [ N = 3.0:Tp 0.27]
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0017  1  5.0    0.17    0.03  4.17  55.39 0.49    0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0017]   0080  1  5.0    0.17    0.03  4.25  55.38  n/a    0.000
*
    ADD [  0080+  0009]  0035  3  5.0    0.53    0.07  4.25  50.61  n/a    0.000
*
    CHANNEL[ 2:  0035]   0077  1  5.0    0.53    0.07  4.25  50.61  n/a    0.000
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0010  1  5.0    0.38    0.04  4.33  47.89 0.43    0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0010+  0077]  0036  3  5.0    0.91    0.11  4.25  49.49  n/a    0.000
*
    CHANNEL[ 2:  0036]   0078  1  5.0    0.91    0.11  4.25  49.49  n/a    0.000
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0011  1  5.0    0.38    0.04  4.33  47.89 0.43    0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    ADD [  0011+  0078]  0037  3  5.0    1.28    0.15  4.25  49.02  n/a    0.000
*
    CHANNEL[ 2:  0037]   0079  1  5.0    1.28    0.15  4.33  49.02  n/a    0.000
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
```

```
 ** CALIB NASHYD         0012  1  5.0     0.29     0.04  4.25  57.12 0.51    0.000
    [CN=74.8          ]
    [ N = 3.0:Tp 0.22]
*
    ADD [  0012+  0079]  0038  3  5.0     1.58     0.19  4.25  50.53  n/a    0.000
*
    CHANNEL[ 2:  0038]   0094  1  5.0     1.58     0.19  4.33  50.52  n/a    0.000
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0013  1  5.0     0.34     0.05  4.25  60.60 0.54    0.000
    [CN=76.8          ]
    [ N = 3.0:Tp 0.24]
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0014  1  5.0     0.36     0.04  4.33  48.20 0.43    0.000
    [CN=68.3          ]
    [ N = 3.0:Tp 0.27]
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0015  1  5.0     0.38     0.04  4.33  47.89 0.43    0.000
    [CN=68.1          ]
    [ N = 3.0:Tp 0.27]
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0016  1  5.0     0.39     0.04  4.33  47.59 0.42    0.000
    [CN=67.9          ]
    [ N = 3.0:Tp 0.27]
*
    CHIC STORM                    5.0
    [ Ptot=112.68 mm ]
*
 ** CALIB NASHYD         0018  1  5.0     0.17     0.03  4.17  55.39 0.49    0.000
    [CN=73.9          ]
    [ N = 3.0:Tp 0.17]
*
    CHANNEL[ 2:  0018]   0081  1  5.0     0.17     0.03  4.17  55.38  n/a    0.000
*
    ADD [  0016+  0081]  0039  3  5.0     0.56     0.07  4.25  49.99  n/a    0.000
*
    CHANNEL[ 2:  0039]   0074  1  5.0     0.56     0.07  4.25  49.99  n/a    0.000
*
    ADD [  0015+  0074]  0040  3  5.0     0.94     0.11  4.25  49.14  n/a    0.000
*
    CHANNEL[ 2:  0040]   0075  1  5.0     0.94     0.11  4.25  49.14  n/a    0.000
*
    ADD [  0014+  0075]  0041  3  5.0     1.30     0.15  4.25  48.88  n/a    0.000
*
    CHANNEL[ 2:  0041]   0076  1  5.0     1.30     0.15  4.33  48.88  n/a    0.000
*
    ADD [  0013+  0076]  0042  3  5.0     1.64     0.20  4.25  51.31  n/a    0.000
*
    CHANNEL[ 2:  0042]   0095  1  5.0     1.64     0.20  4.33  51.31  n/a    0.000
*
    ADD [  0094+  0095]  0043  3  5.0     3.22     0.39  4.33  50.92  n/a    0.000
```

```
*
 ** Reservoir
    OUTFLOW:              0093  1  5.0    3.22    0.14  4.92  47.89  n/a   0.000
*
    ADD [  0083+  0093]  0092  3  5.0    7.80    0.41  4.58  42.87  n/a   0.000
*
    CHANNEL[ 2:  0092]   0085  1  5.0    7.80    0.41  4.58  42.87  n/a   0.000
*
    ADD [  0084+  0085]  0086  3  5.0   10.99    0.64  4.50  42.18  n/a   0.000
*
 ** Reservoir
    OUTFLOW:              0111  1  5.0   10.99    0.44  5.00  42.19  n/a   0.000
*
    CHANNEL[ 2:  0111]   0087  1  5.0   10.99    0.44  5.08  42.19  n/a   0.000
*
 FINISH

================================================================================
```

```
*****************************************
** SIMULATION:1. SCS II 6hr 5yr Ottawa **
*****************************************

  --------------------------
  | Junction Command(0088) |
  --------------------------

                           AREA     QPEAK   TPEAK     R.V.
                           (ha)     (cms)    (hrs)    (mm)
  INFLOW : ID= 1(  0087)   10.99     0.09    4.00     7.90
  OUTFLOW: ID= 2(  0088)   10.99     0.09    4.00     7.90

  -----------------------------------------------------------------------------
--
*******************************************
** SIMULATION:2. SCS II 6hr 100yr Ottawa **
*******************************************

  --------------------------
  | Junction Command(0088) |
  --------------------------

                           AREA     QPEAK   TPEAK     R.V.
                           (ha)     (cms)    (hrs)    (mm)
  INFLOW : ID= 1(  0087)   10.99     0.32    4.00    26.10
  OUTFLOW: ID= 2(  0088)   10.99     0.32    4.00    26.10

  -----------------------------------------------------------------------------
--
******************************************
** SIMULATION:3. SCS II 12hr 5yr Ottawa **
******************************************

  --------------------------
  | Junction Command(0088) |
  --------------------------

                           AREA     QPEAK   TPEAK     R.V.
                           (ha)     (cms)    (hrs)    (mm)
  INFLOW : ID= 1(  0087)   10.99     0.10    6.83    10.73
  OUTFLOW: ID= 2(  0088)   10.99     0.10    6.83    10.73

  -----------------------------------------------------------------------------
--
*******************************************
** SIMULATION:4. SCS II 12hr 10yr Ottawa **
*******************************************

  --------------------------
  | Junction Command(0088) |
  --------------------------

                           AREA     QPEAK   TPEAK     R.V.
                           (ha)     (cms)    (hrs)    (mm)
  INFLOW : ID= 1(  0087)   10.99     0.15    6.92    15.40
  OUTFLOW: ID= 2(  0088)   10.99     0.15    6.92    15.40

  -----------------------------------------------------------------------------
--
```

```
*********************************************
** SIMULATION:5. SCS II 12hr 100yr correct **
*********************************************

  --------------------------
  | Junction Command(0088) |
  --------------------------

                              AREA     QPEAK   TPEAK     R.V.
                              (ha)     (cms)    (hrs)    (mm)
  INFLOW : ID= 1(  0087)    10.99      0.33    6.92    31.49
  OUTFLOW: ID= 2(  0088)    10.99      0.33    6.92    31.49

  ------------------------------------------------------------------------------
--
************************************
** SIMULATION:6. Chi 12hr 2yr     **
************************************

  --------------------------
  | Junction Command(0088) |
  --------------------------

                              AREA     QPEAK   TPEAK     R.V.
                              (ha)     (cms)    (hrs)    (mm)
  INFLOW : ID= 1(  0087)    10.99      0.04    5.17     4.95
  OUTFLOW: ID= 2(  0088)    10.99      0.04    5.17     4.95

  ------------------------------------------------------------------------------
--
************************************
** SIMULATION:7. Chi 12hr 100yr   **
************************************

  --------------------------
  | Junction Command(0088) |
  --------------------------

                              AREA     QPEAK   TPEAK     R.V.
                              (ha)     (cms)    (hrs)    (mm)
  INFLOW : ID= 1(  0087)    10.99      0.31    5.00    30.21
  OUTFLOW: ID= 2(  0088)    10.99      0.31    5.00    30.21

  ------------------------------------------------------------------------------
--
******************************************
** SIMULATION:8. Historical July 1 1979 **
******************************************

  --------------------------
  | Junction Command(0088) |
  --------------------------

                              AREA     QPEAK   TPEAK     R.V.
                              (ha)     (cms)    (hrs)    (mm)
  INFLOW : ID= 1(  0087)    10.99      0.40    2.50    24.36
  OUTFLOW: ID= 2(  0088)    10.99      0.40    2.50    24.36

  ------------------------------------------------------------------------------
--
```

```
*****************************************
** SIMULATION:9. Historical Aug 4 1988 **
*****************************************

  --------------------------
  | Junction Command(0088) |
  --------------------------

                           AREA     QPEAK   TPEAK     R.V.
                           (ha)     (cms)    (hrs)    (mm)
  INFLOW : ID= 1(  0087)   10.99     0.32    2.67    22.43
  OUTFLOW: ID= 2(  0088)   10.99     0.32    2.67    22.43

  -----------------------------------------------------------------------------
--
***********************************
** SIMULATION:10. 25mm4hrChicago **
***********************************

  --------------------------
  | Junction Command(0088) |
  --------------------------

                           AREA     QPEAK   TPEAK     R.V.
                           (ha)     (cms)    (hrs)    (mm)
  INFLOW : ID= 1(  0087)   10.99     0.01    3.33     0.70
  OUTFLOW: ID= 2(  0088)   10.99     0.01    3.33     0.70

  -----------------------------------------------------------------------------
--
***********************************************
** SIMULATION:100 year 12 hr Chi 120 percent **
***********************************************

  --------------------------
  | Junction Command(0088) |
  --------------------------

                           AREA     QPEAK   TPEAK     R.V.
                           (ha)     (cms)    (hrs)    (mm)
  INFLOW : ID= 1(  0087)   10.99     0.44    5.08    42.19
  OUTFLOW: ID= 2(  0088)   10.99     0.44    5.08    42.19

  -----------------------------------------------------------------------------
```

APPENDIX I1: OTTHYMO MODEL ROUTE RESERVOIR REPORT – STORAGE SWALE

```
*****************************************
** SIMULATION:1. SCS II 6hr 5yr Ottawa **
*****************************************
--------------------
| RESERVOIR(  0093)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0270      0.0300
                          0.0000     0.0020   |   0.0380      0.0340
                          0.0000     0.0040   |   0.0510      0.0380
                          0.0000     0.0067   |   0.0670      0.0430
                          0.0000     0.0090   |   0.0850      0.0480
                          0.0010     0.0120   |   0.1050      0.0540
                          0.0030     0.0150   |   0.1280      0.0600
                          0.0070     0.0190   |   0.1540      0.0660
                          0.0120     0.0220   |   0.1830      0.0720
                          0.0190     0.0260   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0043)      3.218      0.079      3.25      11.56
   OUTFLOW: ID= 1 (  0093)      3.218      0.016      4.83       8.52
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =      0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 20.71
                   TIME SHIFT OF PEAK FLOW         (min)= 95.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0244

--------------------------------------------------------------------------------
*******************************************
** SIMULATION:2. SCS II 6hr 100yr Ottawa **
*******************************************
--------------------
| RESERVOIR(  0093)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0270      0.0300
                          0.0000     0.0020   |   0.0380      0.0340
                          0.0000     0.0040   |   0.0510      0.0380
                          0.0000     0.0067   |   0.0670      0.0430
                          0.0000     0.0090   |   0.0850      0.0480
                          0.0010     0.0120   |   0.1050      0.0540
                          0.0030     0.0150   |   0.1280      0.0600
                          0.0070     0.0190   |   0.1540      0.0660
                          0.0120     0.0220   |   0.1830      0.0720
                          0.0190     0.0260   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0043)      3.218      0.241      3.17      32.84
   OUTFLOW: ID= 1 (  0093)      3.218      0.096      3.92      29.81
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =      0
```

```
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 40.07
                   TIME SHIFT OF PEAK FLOW         (min)= 45.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0514

--------------------------------------------------------------------------------
******************************************
** SIMULATION:3. SCS II 12hr 5yr Ottawa **
******************************************
--------------------
| RESERVOIR(  0093)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0270     0.0300
                          0.0000     0.0020   |   0.0380     0.0340
                          0.0000     0.0040   |   0.0510     0.0380
                          0.0000     0.0067   |   0.0670     0.0430
                          0.0000     0.0090   |   0.0850     0.0480
                          0.0010     0.0120   |   0.1050     0.0540
                          0.0030     0.0150   |   0.1280     0.0600
                          0.0070     0.0190   |   0.1540     0.0660
                          0.0120     0.0220   |   0.1830     0.0720
                          0.0190     0.0260   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0043)      3.218      0.095      6.17      14.96
   OUTFLOW: ID= 1 (  0093)      3.218      0.019      7.50      11.93
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 19.63
                   TIME SHIFT OF PEAK FLOW         (min)= 80.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0259

--------------------------------------------------------------------------------
```

```
******************************************
** SIMULATION:4. SCS II 12hr 10yr Ottawa **
******************************************
--------------------
| RESERVOIR(  0093)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0270     0.0300
                          0.0000     0.0020   |   0.0380     0.0340
                          0.0000     0.0040   |   0.0510     0.0380
                          0.0000     0.0067   |   0.0670     0.0430
                          0.0000     0.0090   |   0.0850     0.0480
                          0.0010     0.0120   |   0.1050     0.0540
                          0.0030     0.0150   |   0.1280     0.0600
                          0.0070     0.0190   |   0.1540     0.0660
                          0.0120     0.0220   |   0.1830     0.0720
                          0.0190     0.0260   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0043)      3.218      0.134      6.17      20.49
   OUTFLOW: ID= 1 (  0093)      3.218      0.034      7.17      17.46
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 25.74
                   TIME SHIFT OF PEAK FLOW         (min)= 60.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0327

--------------------------------------------------------------------------------
*********************************************
** SIMULATION:5. SCS II 12hr 100yr correct **
*********************************************
--------------------
| RESERVOIR(  0093)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0270     0.0300
                          0.0000     0.0020   |   0.0380     0.0340
                          0.0000     0.0040   |   0.0510     0.0380
                          0.0000     0.0067   |   0.0670     0.0430
                          0.0000     0.0090   |   0.0850     0.0480
                          0.0010     0.0120   |   0.1050     0.0540
                          0.0030     0.0150   |   0.1280     0.0600
                          0.0070     0.0190   |   0.1540     0.0660
                          0.0120     0.0220   |   0.1830     0.0720
                          0.0190     0.0260   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0043)      3.218      0.264      6.17      38.95
   OUTFLOW: ID= 1 (  0093)      3.218      0.102      6.83      35.92
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
```

```
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 38.61
                   TIME SHIFT OF PEAK FLOW         (min)= 40.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0531

--------------------------------------------------------------------------------

************************************
** SIMULATION:6. Chi 12hr 2yr     **
************************************
--------------------
| RESERVOIR(  0093)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0270      0.0300
                          0.0000     0.0020   |   0.0380      0.0340
                          0.0000     0.0040   |   0.0510      0.0380
                          0.0000     0.0067   |   0.0670      0.0430
                          0.0000     0.0090   |   0.0850      0.0480
                          0.0010     0.0120   |   0.1050      0.0540
                          0.0030     0.0150   |   0.1280      0.0600
                          0.0070     0.0190   |   0.1540      0.0660
                          0.0120     0.0220   |   0.1830      0.0720
                          0.0190     0.0260   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0043)      3.218      0.044      4.42       7.92
   OUTFLOW: ID= 1 (  0093)      3.218      0.004      8.25       4.89
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 10.16
                   TIME SHIFT OF PEAK FLOW         (min)=230.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0165

--------------------------------------------------------------------------------
```

```
************************************
** SIMULATION:7. Chi 12hr 100yr   **
************************************
--------------------
| RESERVOIR(  0093)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0270     0.0300
                          0.0000     0.0020   |   0.0380     0.0340
                          0.0000     0.0040   |   0.0510     0.0380
                          0.0000     0.0067   |   0.0670     0.0430
                          0.0000     0.0090   |   0.0850     0.0480
                          0.0010     0.0120   |   0.1050     0.0540
                          0.0030     0.0150   |   0.1280     0.0600
                          0.0070     0.0190   |   0.1540     0.0660
                          0.0120     0.0220   |   0.1830     0.0720
                          0.0190     0.0260   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0043)      3.218      0.277      4.25      37.50
   OUTFLOW: ID= 1 (  0093)      3.218      0.090      5.00      34.47
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 32.54
                   TIME SHIFT OF PEAK FLOW         (min)= 45.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0496

-------------------------------------------------------------------------------
******************************************
** SIMULATION:8. Historical July 1 1979 **
******************************************
--------------------
| RESERVOIR(  0093)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0270     0.0300
                          0.0000     0.0020   |   0.0380     0.0340
                          0.0000     0.0040   |   0.0510     0.0380
                          0.0000     0.0067   |   0.0670     0.0430
                          0.0000     0.0090   |   0.0850     0.0480
                          0.0010     0.0120   |   0.1050     0.0540
                          0.0030     0.0150   |   0.1280     0.0600
                          0.0070     0.0190   |   0.1540     0.0660
                          0.0120     0.0220   |   0.1830     0.0720
                          0.0190     0.0260   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0043)      3.218      0.306      1.83      30.86
   OUTFLOW: ID= 1 (  0093)      3.218      0.131      2.33      27.83
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
```

```
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 42.72
                   TIME SHIFT OF PEAK FLOW         (min)= 30.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0607

--------------------------------------------------------------------------------
*****************************************
** SIMULATION:9. Historical Aug 4 1988 **
*****************************************
--------------------
| RESERVOIR(  0093)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0270      0.0300
                          0.0000     0.0020   |   0.0380      0.0340
                          0.0000     0.0040   |   0.0510      0.0380
                          0.0000     0.0067   |   0.0670      0.0430
                          0.0000     0.0090   |   0.0850      0.0480
                          0.0010     0.0120   |   0.1050      0.0540
                          0.0030     0.0150   |   0.1280      0.0600
                          0.0070     0.0190   |   0.1540      0.0660
                          0.0120     0.0220   |   0.1830      0.0720
                          0.0190     0.0260   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0043)      3.218      0.287      2.17      28.65
   OUTFLOW: ID= 1 (  0093)      3.218      0.096      2.58      25.62
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 33.44
                   TIME SHIFT OF PEAK FLOW         (min)= 25.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0515
```

```
--------------------------------------------------------------------------------
***********************************
** SIMULATION:10. 25mm4hrChicago **
***********************************
--------------------
| RESERVOIR(  0093)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0270     0.0300
                          0.0000     0.0020   |   0.0380     0.0340
                          0.0000     0.0040   |   0.0510     0.0380
                          0.0000     0.0067   |   0.0670     0.0430
                          0.0000     0.0090   |   0.0850     0.0480
                          0.0010     0.0120   |   0.1050     0.0540
                          0.0030     0.0150   |   0.1280     0.0600
                          0.0070     0.0190   |   0.1540     0.0660
                          0.0120     0.0220   |   0.1830     0.0720
                          0.0190     0.0260   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0043)      3.218      0.009      2.17       2.08
   OUTFLOW: ID= 1 (  0093)      3.218      0.000      0.00       0.00
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00       0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)=  0.00
                   TIME SHIFT OF PEAK FLOW         (min)=******
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0067

--------------------------------------------------------------------------------
```

```
*********************************************
** SIMULATION:100 year 12 hr Chi 120 percent **
*********************************************
--------------------
| RESERVOIR(  0093)|     OVERFLOW IS ON
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.0270      0.0300
                          0.0000     0.0020   |   0.0380      0.0340
                          0.0000     0.0040   |   0.0510      0.0380
                          0.0000     0.0067   |   0.0670      0.0430
                          0.0000     0.0090   |   0.0850      0.0480
                          0.0010     0.0120   |   0.1050      0.0540
                          0.0030     0.0150   |   0.1280      0.0600
                          0.0070     0.0190   |   0.1540      0.0660
                          0.0120     0.0220   |   0.1830      0.0720
                          0.0190     0.0260   |   0.0000      0.0000

                                AREA      QPEAK      TPEAK       R.V.
                                (ha)      (cms)      (hrs)       (mm)
   INFLOW : ID= 2 (  0043)      3.218      0.389      4.33       50.92
   OUTFLOW: ID= 1 (  0093)      3.218      0.144      4.92       47.89
   OVERFLOW:ID= 3 (  0003)      0.000      0.000      0.00        0.00

                   TOTAL NUMBER OF SIMULATION OVERFLOW  =     0
                   CUMULATIVE TIME OF OVERFLOW  (HOURS) =  0.00
                   PERCENTAGE OF TIME OVERFLOWING   (%) =  0.00

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 37.00
                   TIME SHIFT OF PEAK FLOW         (min)= 35.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0637

-------------------------------------------------------------------------------
```

APPENDIX I2: OTTHYMO MODEL ROUTE RESERVOIR REPORT – OUTLET SWALE

```
*****************************************
** SIMULATION:1. SCS II 6hr 5yr Ottawa **
*****************************************
--------------------
| RESERVOIR(  0111)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1410     0.0160
                          0.0070     0.0000   |   0.1930     0.0250
                          0.0180     0.0010   |   0.2560     0.0360
                          0.0290     0.0020   |   0.3320     0.0510
                          0.0460     0.0040   |   0.4200     0.0700
                          0.0690     0.0060   |   0.5230     0.0930
                          0.1000     0.0100   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0086)     10.986     0.102      3.58       7.90
   OUTFLOW: ID= 1 (  0111)     10.986     0.089      3.92       7.90

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 86.81
                   TIME SHIFT OF PEAK FLOW         (min)= 20.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0086

--------------------------------------------------------------------------------
*******************************************
** SIMULATION:2. SCS II 6hr 100yr Ottawa **
*******************************************
--------------------
| RESERVOIR(  0111)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1410     0.0160
                          0.0070     0.0000   |   0.1930     0.0250
                          0.0180     0.0010   |   0.2560     0.0360
                          0.0290     0.0020   |   0.3320     0.0510
                          0.0460     0.0040   |   0.4200     0.0700
                          0.0690     0.0060   |   0.5230     0.0930
                          0.1000     0.0100   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0086)     10.986     0.402      3.50      26.10
   OUTFLOW: ID= 1 (  0111)     10.986     0.317      3.92      26.10

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 78.89
                   TIME SHIFT OF PEAK FLOW         (min)= 25.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0482

--------------------------------------------------------------------------------
```

```
******************************************
** SIMULATION:3. SCS II 12hr 5yr Ottawa **
******************************************
--------------------
| RESERVOIR(  0111)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1410     0.0160
                          0.0070     0.0000   |   0.1930     0.0250
                          0.0180     0.0010   |   0.2560     0.0360
                          0.0290     0.0020   |   0.3320     0.0510
                          0.0460     0.0040   |   0.4200     0.0700
                          0.0690     0.0060   |   0.5230     0.0930
                          0.1000     0.0100   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0086)     10.986     0.122     6.42      10.73
   OUTFLOW: ID= 1 (  0111)     10.986     0.103     6.83      10.73

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 84.28
                   TIME SHIFT OF PEAK FLOW        (min)= 25.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0104

--------------------------------------------------------------------------------
*******************************************
** SIMULATION:4. SCS II 12hr 10yr Ottawa **
*******************************************
--------------------
| RESERVOIR(  0111)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1410     0.0160
                          0.0070     0.0000   |   0.1930     0.0250
                          0.0180     0.0010   |   0.2560     0.0360
                          0.0290     0.0020   |   0.3320     0.0510
                          0.0460     0.0040   |   0.4200     0.0700
                          0.0690     0.0060   |   0.5230     0.0930
                          0.1000     0.0100   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0086)     10.986     0.188     6.42      15.40
   OUTFLOW: ID= 1 (  0111)     10.986     0.151     6.83      15.40

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 80.57
                   TIME SHIFT OF PEAK FLOW        (min)= 25.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0178

--------------------------------------------------------------------------------
```

```
*********************************************
** SIMULATION:5. SCS II 12hr 100yr correct **
*********************************************
--------------------
| RESERVOIR(  0111)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1410      0.0160
                          0.0070     0.0000   |   0.1930      0.0250
                          0.0180     0.0010   |   0.2560      0.0360
                          0.0290     0.0020   |   0.3320      0.0510
                          0.0460     0.0040   |   0.4200      0.0700
                          0.0690     0.0060   |   0.5230      0.0930
                          0.1000     0.0100   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0086)     10.986     0.446      6.33      31.49
   OUTFLOW: ID= 1 (  0111)     10.986     0.333      6.83      31.49

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 74.64
                   TIME SHIFT OF PEAK FLOW         (min)= 30.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0514

--------------------------------------------------------------------------------
************************************
** SIMULATION:6. Chi 12hr 2yr     **
************************************
--------------------
| RESERVOIR(  0111)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1410      0.0160
                          0.0070     0.0000   |   0.1930      0.0250
                          0.0180     0.0010   |   0.2560      0.0360
                          0.0290     0.0020   |   0.3320      0.0510
                          0.0460     0.0040   |   0.4200      0.0700
                          0.0690     0.0060   |   0.5230      0.0930
                          0.1000     0.0100   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0086)     10.986     0.044      4.67       4.95
   OUTFLOW: ID= 1 (  0111)     10.986     0.037      5.00       4.95

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 84.80
                   TIME SHIFT OF PEAK FLOW         (min)= 20.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0030

--------------------------------------------------------------------------------
```

```
************************************
** SIMULATION:7. Chi 12hr 100yr   **
************************************
--------------------
| RESERVOIR(  0111)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1410      0.0160
                          0.0070     0.0000   |   0.1930      0.0250
                          0.0180     0.0010   |   0.2560      0.0360
                          0.0290     0.0020   |   0.3320      0.0510
                          0.0460     0.0040   |   0.4200      0.0700
                          0.0690     0.0060   |   0.5230      0.0930
                          0.1000     0.0100   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0086)     10.986     0.422      4.50      30.20
   OUTFLOW: ID= 1 (  0111)     10.986     0.307      5.00      30.21

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 72.74
                   TIME SHIFT OF PEAK FLOW         (min)= 30.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0461

-------------------------------------------------------------------------------
******************************************
** SIMULATION:8. Historical July 1 1979 **
******************************************
--------------------
| RESERVOIR(  0111)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1410      0.0160
                          0.0070     0.0000   |   0.1930      0.0250
                          0.0180     0.0010   |   0.2560      0.0360
                          0.0290     0.0020   |   0.3320      0.0510
                          0.0460     0.0040   |   0.4200      0.0700
                          0.0690     0.0060   |   0.5230      0.0930
                          0.1000     0.0100   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0086)     10.986     0.563      2.00      24.36
   OUTFLOW: ID= 1 (  0111)     10.986     0.401      2.42      24.36

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 71.32
                   TIME SHIFT OF PEAK FLOW         (min)= 25.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0660

-------------------------------------------------------------------------------
```

```
*****************************************
** SIMULATION:9. Historical Aug 4 1988 **
*****************************************
--------------------
| RESERVOIR( 0111)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1410     0.0160
                          0.0070     0.0000   |   0.1930     0.0250
                          0.0180     0.0010   |   0.2560     0.0360
                          0.0290     0.0020   |   0.3320     0.0510
                          0.0460     0.0040   |   0.4200     0.0700
                          0.0690     0.0060   |   0.5230     0.0930
                          0.1000     0.0100   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0086)     10.986     0.486      2.25      22.43
   OUTFLOW: ID= 1 (  0111)     10.986     0.318      2.67      22.43

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 65.48
                   TIME SHIFT OF PEAK FLOW         (min)= 25.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0486
-------------------------------------------------------------------------------

***********************************
** SIMULATION:10. 25mm4hrChicago **
***********************************
--------------------
| RESERVOIR( 0111)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1410     0.0160
                          0.0070     0.0000   |   0.1930     0.0250
                          0.0180     0.0010   |   0.2560     0.0360
                          0.0290     0.0020   |   0.3320     0.0510
                          0.0460     0.0040   |   0.4200     0.0700
                          0.0690     0.0060   |   0.5230     0.0930
                          0.1000     0.0100   |   0.0000     0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0086)     10.986     0.009      2.92       0.70
   OUTFLOW: ID= 1 (  0111)     10.986     0.008      3.25       0.70

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 98.15
                   TIME SHIFT OF PEAK FLOW         (min)= 20.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0001

-------------------------------------------------------------------------------
```

```
**********************************************
** SIMULATION:100 year 12 hr Chi 120 percent **
**********************************************
--------------------
| RESERVOIR(  0111)|     OVERFLOW IS OFF
| IN= 2---> OUT= 1 |
| DT=  5.0 min     |     OUTFLOW    STORAGE   |  OUTFLOW    STORAGE
--------------------      (cms)     (ha.m.)   |   (cms)     (ha.m.)
                          0.0000     0.0000   |   0.1410      0.0160
                          0.0070     0.0000   |   0.1930      0.0250
                          0.0180     0.0010   |   0.2560      0.0360
                          0.0290     0.0020   |   0.3320      0.0510
                          0.0460     0.0040   |   0.4200      0.0700
                          0.0690     0.0060   |   0.5230      0.0930
                          0.1000     0.0100   |   0.0000      0.0000

                                AREA     QPEAK     TPEAK       R.V.
                                (ha)     (cms)     (hrs)       (mm)
   INFLOW : ID= 2 (  0086)     10.986     0.636      4.50      42.18
   OUTFLOW: ID= 1 (  0111)     10.986     0.440      5.00      42.19

                   PEAK   FLOW   REDUCTION [Qout/Qin](%)= 69.16
                   TIME SHIFT OF PEAK FLOW        (min)= 30.00
                   MAXIMUM  STORAGE   USED       (ha.m.)=  0.0746

-------------------------------------------------------------------------------
```

APPENDIX J: CULVERT ANALYSIS AND HYDRAFLOW EXPRESS ANALYSIS RESULTS

Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. — Wednesday, Apr 3 2024

Lot 1 & 2 - 10 Year

Invert Elev Dn (m)	=	78.0000
Pipe Length (m)	=	12.0000
Slope (%)	=	0.3000
Invert Elev Up (m)	=	78.0360
Rise (mm)	=	500.0
Shape	=	Circular
Span (mm)	=	500.0
No. Barrels	=	1
n-Value	=	0.024
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

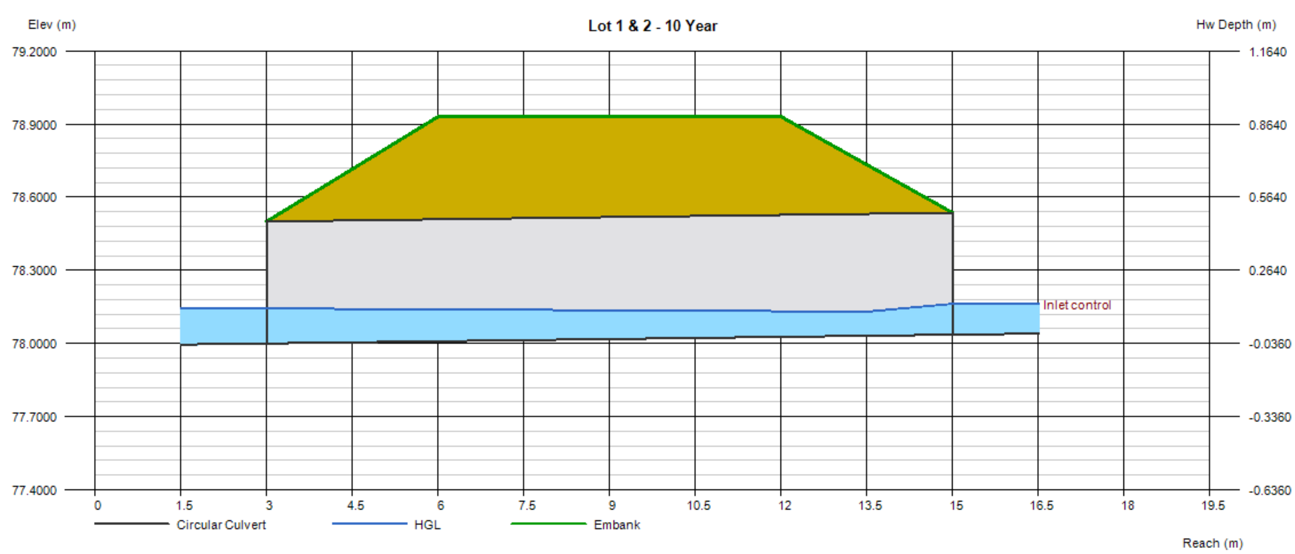
Top Elevation (m)	=	78.9300
Top Width (m)	=	6.0000
Crest Width (m)	=	3.0000

Calculations

Qmin (cms)	=	0.0200
Qmax (cms)	=	0.0200
Tailwater Elev (m)	=	Normal

Highlighted

Qtotal (cms)	=	0.0200
Qpipe (cms)	=	0.0200
Qovertop (cms)	=	0.0000
Veloc Dn (m/s)	=	0.4300
Veloc Up (m/s)	=	0.7970
HGL Dn (m)	=	78.1433
HGL Up (m)	=	78.1288
Hw Elev (m)	=	78.1627
Hw/D (m)	=	0.2533
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Apr 3 2024

Lot 1 & 2 - 100 Year

Invert Elev Dn (m)	=	78.0000
Pipe Length (m)	=	12.0000
Slope (%)	=	0.3000
Invert Elev Up (m)	=	78.0360
Rise (mm)	=	500.0
Shape	=	Circular
Span (mm)	=	500.0
No. Barrels	=	1
n-Value	=	0.024
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

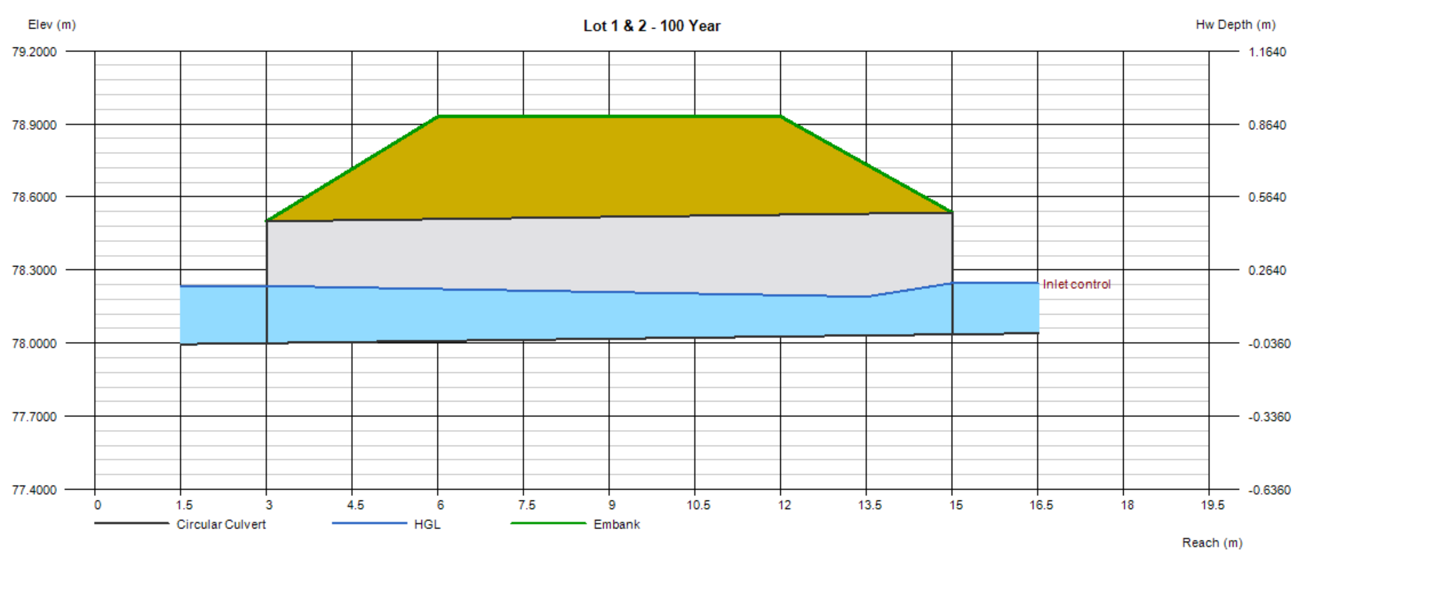
Top Elevation (m)	=	78.9300
Top Width (m)	=	6.0000
Crest Width (m)	=	3.0000

Calculations

Qmin (cms)	=	0.0500
Qmax (cms)	=	0.0500
Tailwater Elev (m)	=	Normal

Highlighted

Qtotal (cms)	=	0.0500
Qpipe (cms)	=	0.0500
Qovertop (cms)	=	0.0000
Veloc Dn (m/s)	=	0.5520
Veloc Up (m/s)	=	1.0250
HGL Dn (m)	=	78.2348
HGL Up (m)	=	78.1843
Hw Elev (m)	=	78.2461
Hw/D (m)	=	0.4202
Flow Regime	=	Inlet Control



Culvert Report

Lot 3 & 4 - 10 Year

Invert Elev Dn (m)	=	77.0000
Pipe Length (m)	=	12.0000
Slope (%)	=	1.1000
Invert Elev Up (m)	=	77.1320
Rise (mm)	=	500.0
Shape	=	Circular
Span (mm)	=	500.0
No. Barrels	=	1
n-Value	=	0.024
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

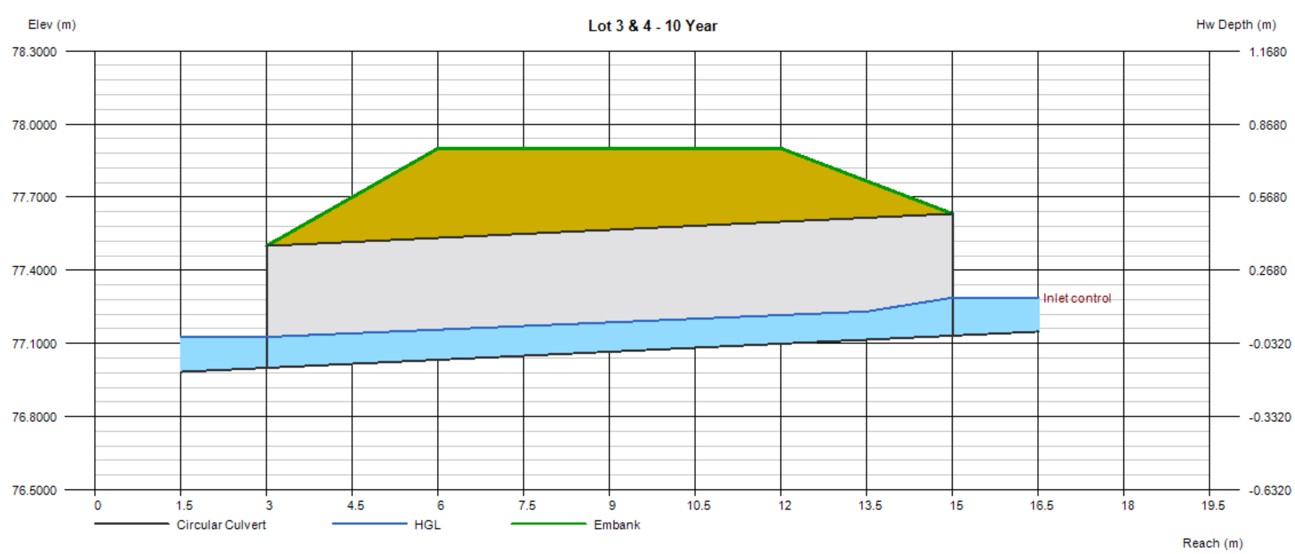
Top Elevation (m)	=	77.9000
Top Width (m)	=	6.0000
Crest Width (m)	=	3.0000

Calculations

Qmin (cms)	=	0.0300
Qmax (cms)	=	0.0300
Tailwater Elev (m)	=	Normal

Highlighted

Qtotal (cms)	=	0.0300
Qpipe (cms)	=	0.0300
Qovertop (cms)	=	0.0000
Veloc Dn (m/s)	=	0.7668
Veloc Up (m/s)	=	0.8893
HGL Dn (m)	=	77.1267
HGL Up (m)	=	77.2461
Hw Elev (m)	=	77.2879
Hw/D (m)	=	0.3117
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. — Wednesday, Apr 3 2024

Lot 3 & 4 - 100 Year

Invert Elev Dn (m)	=	77.0000
Pipe Length (m)	=	12.0000
Slope (%)	=	1.1000
Invert Elev Up (m)	=	77.1320
Rise (mm)	=	500.0
Shape	=	Circular
Span (mm)	=	500.0
No. Barrels	=	1
n-Value	=	0.024
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

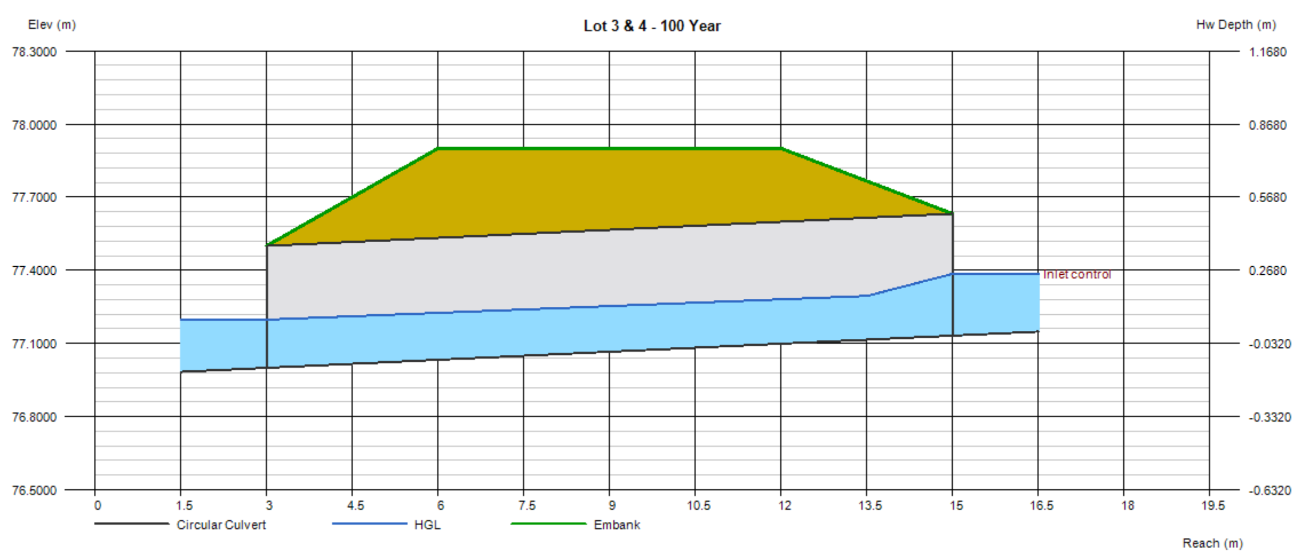
Top Elevation (m)	=	77.9000
Top Width (m)	=	6.0000
Crest Width (m)	=	3.0000

Calculations

Qmin (cms)	=	0.0700
Qmax (cms)	=	0.0700
Tailwater Elev (m)	=	Normal

Highlighted

Qtotal (cms)	=	0.0700
Qpipe (cms)	=	0.0700
Qovertop (cms)	=	0.0000
Veloc Dn (m/s)	=	0.9694
Veloc Up (m/s)	=	1.1295
HGL Dn (m)	=	77.1977
HGL Up (m)	=	77.3085
Hw Elev (m)	=	77.3857
Hw/D (m)	=	0.5074
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Apr 3 2024

Lot 5 & 6 - 10 Year

Invert Elev Dn (m)	=	76.0000
Pipe Length (m)	=	12.0000
Slope (%)	=	0.9000
Invert Elev Up (m)	=	76.1080
Rise (mm)	=	500.0
Shape	=	Circular
Span (mm)	=	500.0
No. Barrels	=	1
n-Value	=	0.024
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

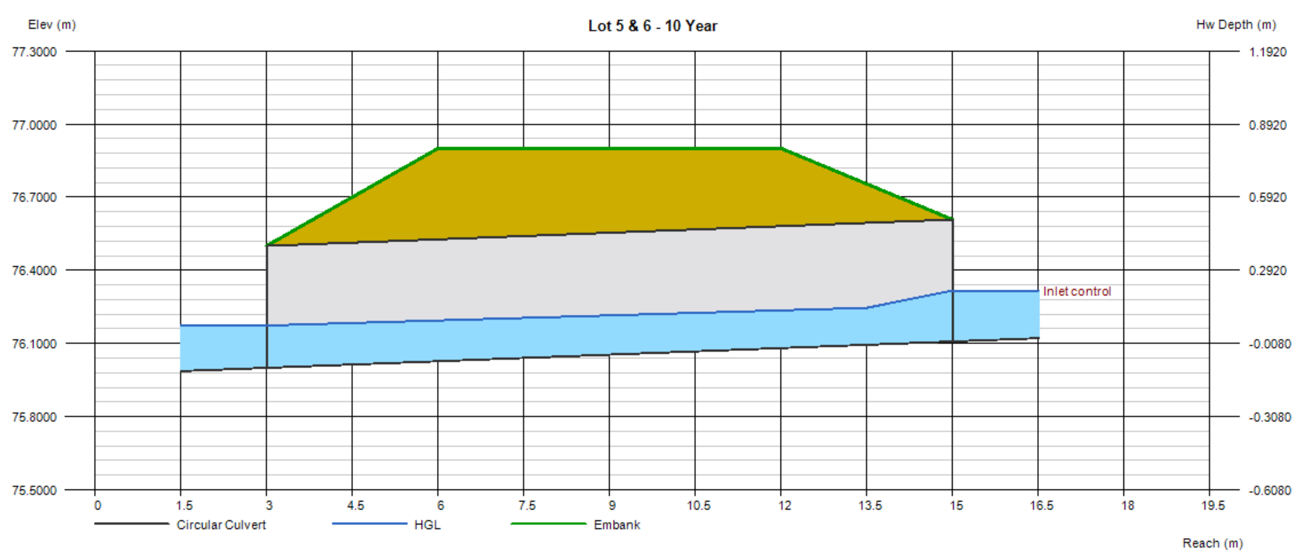
Top Elevation (m)	=	76.9000
Top Width (m)	=	6.0000
Crest Width (m)	=	3.0000

Calculations

Qmin (cms)	=	0.0500
Qmax (cms)	=	0.0500
Tailwater Elev (m)	=	Normal

Highlighted

Qtotal (cms)	=	0.0500
Qpipe (cms)	=	0.0500
Qovertop (cms)	=	0.0000
Veloc Dn (m/s)	=	0.8257
Veloc Up (m/s)	=	1.0250
HGL Dn (m)	=	76.1736
HGL Up (m)	=	76.2563
Hw Elev (m)	=	76.3166
Hw/D (m)	=	0.4173
Flow Regime	=	Inlet Control



Culvert Report

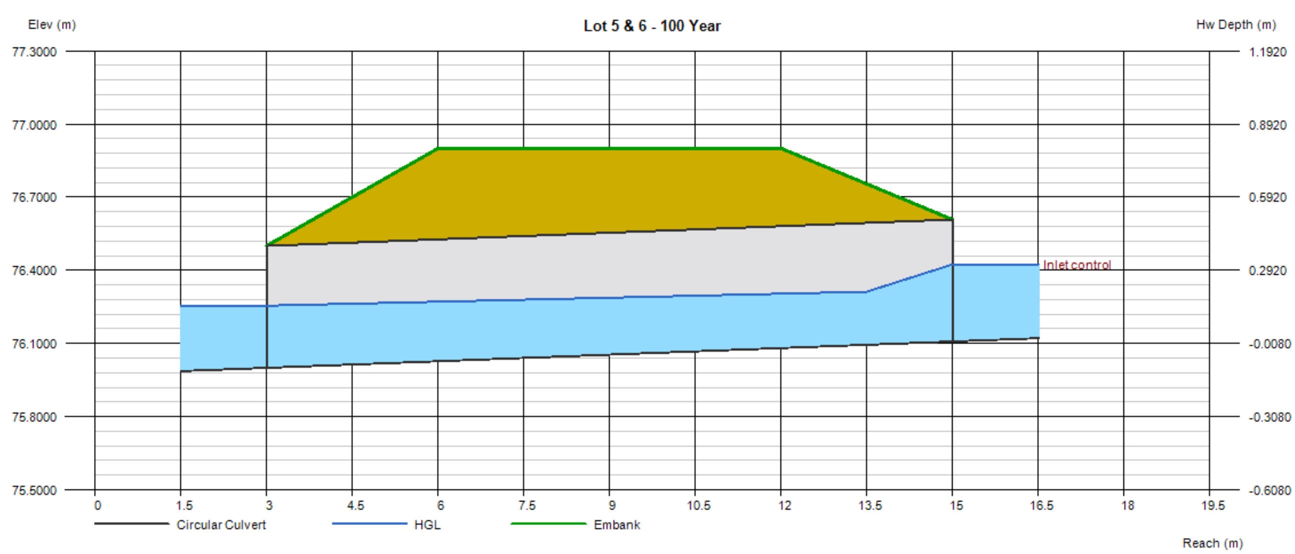
Lot 5 & 6 - 100 Year

Invert Elev Dn (m) = 76.0000
Pipe Length (m) = 12.0000
Slope (%) = 0.9000
Invert Elev Up (m) = 76.1080
Rise (mm) = 500.0
Shape = Circular
Span (mm) = 500.0
No. Barrels = 1
n-Value = 0.024
Culvert Type = Circular Corrugate Metal Pipe
Culvert Entrance = Projecting
Coeff. K,M,c,Y,k = 0.034, 1.5, 0.0553, 0.54, 0.9

Embankment
Top Elevation (m) = 76.9000
Top Width (m) = 6.0000
Crest Width (m) = 3.0000

Calculations
Qmin (cms) = 0.1000
Qmax (cms) = 0.1000
Tailwater Elev (m) = Normal

Highlighted
Qtotal (cms) = 0.1000
Qpipe (cms) = 0.1000
Qovertop (cms) = 0.0000
Veloc Dn (m/s) = 0.9943
Veloc Up (m/s) = 1.2584
HGL Dn (m) = 76.2548
HGL Up (m) = 76.3204
Hw Elev (m) = 76.4243
Hw/D (m) = 0.6326
Flow Regime = Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Apr 3 2024

Lot 7 & 8 - 10 Year

Invert Elev Dn (m)	=	75.6000
Pipe Length (m)	=	12.0000
Slope (%)	=	0.5000
Invert Elev Up (m)	=	75.6600
Rise (mm)	=	500.0
Shape	=	Circular
Span (mm)	=	500.0
No. Barrels	=	1
n-Value	=	0.024
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

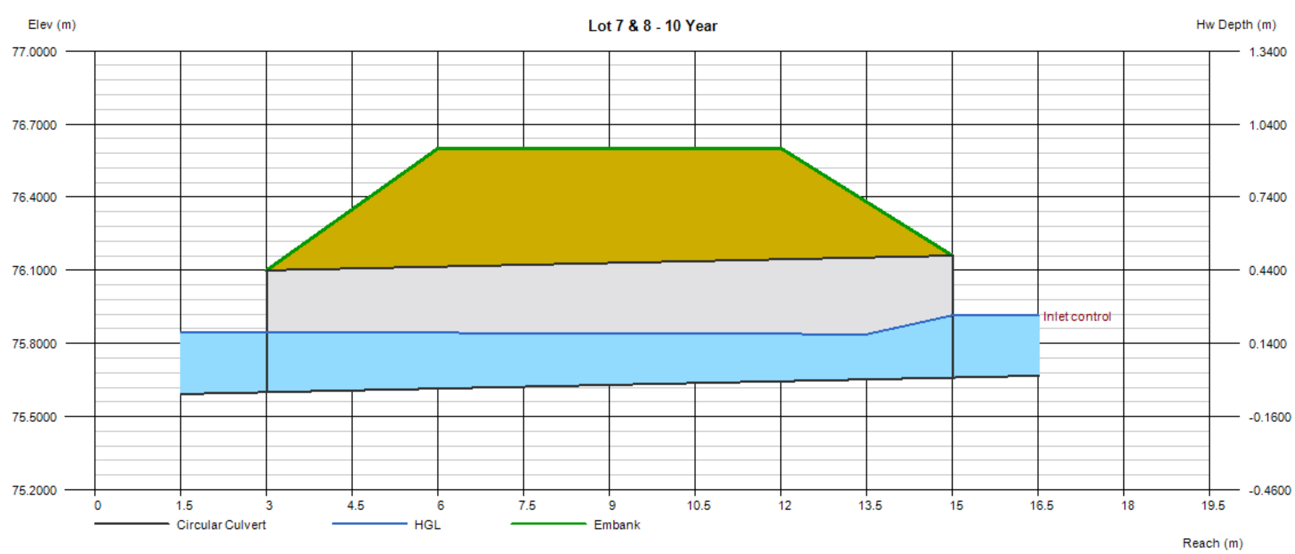
Top Elevation (m)	=	76.6000
Top Width (m)	=	6.0000
Crest Width (m)	=	3.0000

Calculations

Qmin (cms)	=	0.0700
Qmax (cms)	=	0.0700
Tailwater Elev (m)	=	Normal

Highlighted

Qtotal (cms)	=	0.0700
Qpipe (cms)	=	0.0700
Qovertop (cms)	=	0.0000
Veloc Dn (m/s)	=	0.7276
Veloc Up (m/s)	=	1.1295
HGL Dn (m)	=	75.8461
HGL Up (m)	=	75.8365
Hw Elev (m)	=	75.9152
Hw/D (m)	=	0.5104
Flow Regime	=	Inlet Control



Culvert Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Apr 3 2024

Lot 7 & 8 - 100 Year

Invert Elev Dn (m)	=	75.6000
Pipe Length (m)	=	12.0000
Slope (%)	=	0.5000
Invert Elev Up (m)	=	75.6600
Rise (mm)	=	500.0
Shape	=	Circular
Span (mm)	=	500.0
No. Barrels	=	1
n-Value	=	0.024
Culvert Type	=	Circular Corrugate Metal Pipe
Culvert Entrance	=	Projecting
Coeff. K,M,c,Y,k	=	0.034, 1.5, 0.0553, 0.54, 0.9

Embankment

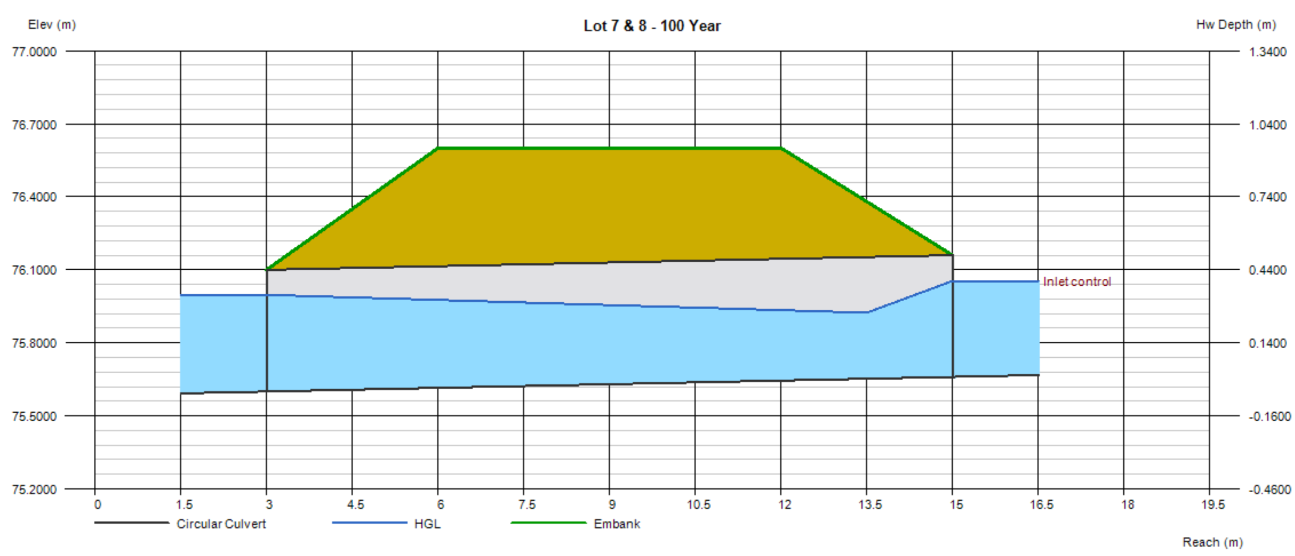
Top Elevation (m)	=	76.6000
Top Width (m)	=	6.0000
Crest Width (m)	=	3.0000

Calculations

Qmin (cms)	=	0.1400
Qmax (cms)	=	0.1400
Tailwater Elev (m)	=	Normal

Highlighted

Qtotal (cms)	=	0.1400
Qpipe (cms)	=	0.1400
Qovertop (cms)	=	0.0000
Veloc Dn (m/s)	=	0.8371
Veloc Up (m/s)	=	1.4016
HGL Dn (m)	=	75.9971
HGL Up (m)	=	75.9134
Hw Elev (m)	=	76.0543
Hw/D (m)	=	0.7887
Flow Regime	=	Inlet Control



APPENDIX K: RESPONSES TO REVIEW COMMENTS

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Kollaard File # 200977
City of Ottawa File No. D02-02-22-0018
MVCA File No. PMRZA-43

April 19, 2024

ATTN: Kelly Livingstone Planner 2
Development Review, Planning, Infrastructure and Economic Development
City of Ottawa

Re: City of Ottawa Comments - 2050 Dunrobin Road, City of Ottawa
Application for Zoning By-Law Amendment
Application for Subdivision Approval

The following review comments were received August 14, 2023 Kollaard Associates Inc.'s response is provided in italics immediately after each comment for clarity:

Development Review Comments – Derek Kulyk (Project Manager)

I. Topographic plan of Survey:
- Proper Topographic Plan of survey needs to be submitted to the City. It needs to be officially sealed and signed by an OLS, needs to provide a note that references the horizontal and vertical datums that were used and tied into to complete the project (geodetic datum). It should also show the existing road ROW. Survey needs to extend to the railway downstream culvert and show inverts and culvert details. Quality of the former railway culvert needs also to be noted. The survey should extend minimum 10 m to within the adjacent properties, as per City Servicing and grading plan requirements - comment was not addressed.

The horizontal reference is provided on the Draft Plan by the OLS. The reference is illustrated in the image copied below.

OBSERVED REFERENCE POINTS (ORP): MTM ZONE 9, NAD 83 (ORIGINAL)		
POINT IDENTIFICATION	NORTHING	EASTING
ORP A	5028566.28	345388.51
ORP B	5028168.82	345295.66

COORDINATES SHOWN TO RURAL ACCURACY IN ACCORDANCE WITH O.REG 216/10, SECTIONS 14, AND 31 TO 35 (BOTH INCLUSIVE).

The vertical reference was obtained from the Cosine Monument Station 001197OU245 CGVD 28:78 Elev. 120.549m Described as: Tablet on Wall – Christ Anglican Church, In Northeast section of the crossroad junction of Carp Road and McGee Side Rd, along road between Old stittsville and Carp, 3.1 km southeast from intersection with Highway No. 17, Tablet is 67 cm from southwest or front wall, between 1st and 2nd course of stone, on the northwest side wall. The vertical datum is CGVD28:78.

The civil drawing has been shifted to coincide with the above vertical and horizontal references.

Topographic information has been obtained from the adjacent properties where we were permitted without trespassing. The ground surface elevations in proximity to the site, beyond the surveyed areas, were observed to be consistent with the surveyed areas. It is also noted that the LiDAR imagery available supports the that the slope of the ground surfaces adjacent the site are consistent with the information obtained from the topographic survey. The LiDAR imagery is included in drawing 200977-PRE

The topographic survey which forms the basis for the subdivision design was completed in April of 2021. Additional surveying to obtain information beyond the property lines where possible was completed in February of 2023. Additional surveying of the materials placed on site and the development works completed to date have not been obtained. For the purposes of the design, it is assumed that the design will have to accommodate the pre-development conditions. The fill materials and development will have to be moved or redone as required to meet the design requirements.

II. Civil plans:

a) Pre-Development conditions plan (PRE); prepared by Kollaard Associates, Engineers, dated and sealed May 05, 2023.

1. Legend line type and/or scale do not match the lines on the plan.
   The legend has been revised to relate to the pre- and post- development drawings only.

2. C-Pre 1 and C-Pre 3 weighted average CN numbers do not match the report Table 5-2.
   Revised on drawing.

b) Post-Development conditions plan (POST); prepared by Kollaard Associates, Engineers, dated and sealed May 05, 2023.

1. Legend line type and/or scale do not match the lines on the plan.
   The legend has been revised to relate to the pre- and post- development drawings only.

2. C-4 and C-5 weighted average CN numbers do not match the report Table 6-1.
   Revised on drawing.

3. It is not clear what the thin dashed lines within each property, running parallel with the property lines represent.
   The thin dashed lines represent zoning setbacks. They have been removed from the post-development drawing.

4. The plan shows private proposed wells, however it does not show the proposed City monitoring well.
   The City monitoring well has been added to the drawing

c) Site (West) grading plan (GR-W); prepared by Kollaard Associates, Engineers, dated and sealed May 05, 2023.

1. Legend line type and/or scale do not match the lines on the plan.

Revised on drawings where the scale discrepancy was significant. Discrepancies in line type were corrected.

The legend line type is the same as the line type on the drawings. The scale is close enough that it is reasonable to assume that referencing the line types in the drawing to those in the legend can be easily accomplished by most viewers of the drawings.

2. Rear yard/side yard swales with slopes lower than 1.5 % needs to be designed as per ditched pipe storm sewer installation, in accordance with the City of Ottawa Drawing S9.

The side yard swales will be sloped at between 1.2 and 2.2 %. The rear yard swales will be sloped such that there is a minimum slope of 0.3 %.

Discussion has been added to section 6.2.2, 6.2.3 and 6.2.4 to discuss the installation of a subdrain below the rear yard and side yard swales and dress concerns with respect to the low slope of the swales.

The rear yard swales and side yard swales have been designed with a clearstone subdrain and perforated pipe which will distribute the water within the swale ensuring that any ponded water is below the ground surface.

Specified in Section 6.2.3 of the storm report

3. All site peripheral swales and roadway ditches with slopes lower than 0.5 % need to be designed as per ditched pipe storm sewer installation, in accordance with the City of Ottawa Drawing S9, with an allowed minimum slope of 0.3%.

The slope of the roadside ditches around the cul-de-sac have been revised to have a minimum slope of 0.5 percent. The slope of the roadside ditch along Dunrobin Road and along the north side of Kanata Enclave Court between Dunrobin Road and station 0+070 remains at 0.3% to accommodate the existing grading of the Dunrobin Road ditch. The Drainage from Dunrobin Road was directed by design across private property with little to no longitudinal slope along the existing roadside ditch. This existing physical condition restricts the grading of the proposed ditch as the proposed ditch is required to accept the runoff from Dunrobin Road. The slope along the swales has been adjusted to have a minimum of 0.3%.

It is not practical to design the first section of the ditch in accordance with the City of Ottawa Drawing S9 as there would be no outlet for the storm pipe.

Additional discussion has been added to section 6.2.3 of the storm report.

4. The noise barrier for lots 3, 5, and 7 (along the northwest property line, as per Environmental Noise Impact Assessment 2050 Dunrobin Road prepared for Zbigniew Hauderowicz, (Prepared by Arcadis IBI Group, dated May 20,2022; updated June 21, 2022; updated November 11, 2022) complete design needs to be provided on the plan (detail design of 2m tall noise barrier with 20 kg/m^2 density, including footing/foundation wall, posts, including barrier cross-section with the adjacent ground elevations showing drainage direction and the swale).

The barrier fence has been added to the grading plan. A section showing the interaction with the barrier fence and the existing grade and proposed swale has also been added.

A drainage gap of 10 cm will be placed below the noise barrier to allow sheet drainage from the adjacent property under the barrier into the rear yard swales.

Detailed design of 2m tall noise barrier fence (20 kg/m_2 density, including footing/foundation wall, posts etc) *are not part of the Civil Engineering Design for this project. Notes have been added to reference the design detail of the noise barrier fence prepared by others.*

5. The noise barrier's footing needs to be shown within the development property in such a way that there is a minimum of 0.3 m offset between the edge of the footing and the property line.
Shown on the drawing

6. The side yard swales, peripheral swales along the back of the properties and the noise barrier need to be registered on titles of all the affected properties, to ensure the future owners' shared responsibility of maintaining it.

Noted

7. Road station 0+000 shows elevation identified with question marks.
Revised on drawings.

8. It is not clear if the Terrace elevation shown within the footprint of the proposed dwellings is equivalent of the minimum Finished floor elevation.
Terrace elevation refers to the ground surface elevation immediately adjacent the dwelling. Finished floor elevation is typically referenced as finished floor elevation.

9. Chain-link fencing should be provided behind the community mailbox, along the property line, some distance beyond the ends of the culvert, to prevent unauthorized access from Kanata enclave Court to property #3. The fence needs to be 0.15 m inside the property line on the private property.
It is acknowledged that this is a creative idea to eliminate the potential for the mail box area to be used as an entrance to the property. However, after review of the draft plan conditions with respect to Canada Post, the design for the community mailbox area has been revised completely.

10. Beginning of the ditch elevations are not clear in the very south corner of the property, immediately adjacent to Dunrobin Road. Centre of the swale elevation (79.45) appears to be higher than the top of the east bank (79.40).
Revised on drawing to show the centerline of swale elevation (79.35) is lower than the top of east bank (79.40).
It is noted that the roadside ditch along Dunrobin Road is not intended to be directed into the south swale. The roadside ditch is intended to be directed to the roadside ditch along the proposed street.

11. It is not clear why the property #1, 2, 3, 5, 7 and 8, future expansion, septic field areas were specified very close to the property line. OSSO requires minimum setback from the property line to be 3 m plus the elevation factor for the raised component of the septic bed.
The minimum setbacks have been maintained. The setback requirements are to the distribution pipe. The typical description labels have been added to the septic bed outline to further define the respective parts of the septic bed area.

12. The plan needs to provide a note that references the horizontal and vertical datums that were used and tied into to complete the project (Horizontal Datum: MTM Zone 9, NAD 83 (Original) and Vertical Datum of 1928 (CGVD28).

Revised on drawings. See response to I. Topographic plan of Survey:

13. Ditch grading (cut), at the front of the Lot #1, encroaches into private property.

No modifications are proposed to address this comment.

It is standard practice and in keeping with City of Ottawa R-27 for the backslope of a ditch to extend into the adjacent property. It is noted that the works will be completed when the entire site is private property including the future road allowance. The adjacent lot 1 will not be occupied as an individual lot until after the ditch is constructed in which case it will be an existing condition of the lot. As shown on the drawing, the center of the ditch and 100 year flood line are contained completely within the road allowance.

14. All private driveway entrance corner radii need to be 3 m at the interface with the public road (as per City Standard drawing S-26).

Revised on drawings.

15. Ditch and road grades, approximately 10 meters (or more if deemed necessary), to the northwest and southeast of the proposed development, along Dunrobin Road, need to be shown, to adequately define the existing drainage conditions outside of the proposed subdivision.

Additional information added to the pre-development drawing. The survey along the roadside ditches was extended beyond the edges of the subdivision past the point at which there was no defined back slope to the roadside ditch along Dunrobin Road. Since there is not defined back slope and the existing ground surface is continuously drained towards the east, the existing survey is sufficient to indicate the drainage patterns.

d) Site (East) grading plan (GR-E); prepared by Kollaard Associates, Engineers, dated and sealed May 05, 2023.

1. Legend line type and/or scale do not match the lines on the plan.

See response to Comments Section c) Note 1.

2. It is not clear why the property # 7, future expansion, septic field area was specified very close to the property line. OSSO requires minimum setback from the property line to be 3 m plus the elevation factor for the raised component of the septic bed.

See response to comment C11. The Ontario Building Code requires that the setback from the property line to the distribution pipe be a minimum of 3 m plus 2 times the grade raise (elevation difference between the distribution pipe and the original grade below the pipe). An allowance of 6 metres has been made to accommodate this setback.

3. The plan needs to provide a note that references the horizontal and vertical datums that were used and tied into to complete the project (Horizontal Datum: MTM Zone 9, NAD 83 (Original) and Vertical Datum of 1928 (CGVD28).

Revised on drawings. See response to I. Topographic plan of Survey:

4. City will require a SWM block allocation for the infiltration trench and downstream ditch, up to the culvert outlet, at the former railway. Access road will need to be extended to the mentioned culvert. The minimum width of the block needs to be not less than 15m.

Revised on drawings.

5. Grades allowing to identify the maximum typical slope, immediately adjacent to the SWM access road, were not provided. It might be provided in a cross-section view for improves clarity.
Revised on drawings.

6. 80 m zoning set-back needs to be shown and dimensioned on the plan and the clause also needs to be registered on the applicable titles (lots 7 and 8).
Revised on drawings.

7. Typical rural road cross section, as per Rural local Roadway Cross-section over earth (drawing R-27) requires a minimum of 1.5 m shoulder. Cul-de-sac appears to have the shoulder of approximately 1.0 m.
A review of R-27 indicates that this detail does not provide any detail for a cul-de-sac. The detail indicates that there is 5 metres of space between the property line and the edge of shoulder. The property lines adjacent the Cul-de-sac has been shifted outwards to provide space for the 1.5 shoulder and maintain the 5 metres space for the ditch.

8. It is not clear why the lot 7 driveway cross-fall is shown as 3.7% and the calculated value is 4.5% steep (according to elevations) and the lot 8 cross-fall is shown as 2.9% but the calculated value is 0.2%. It appears that the road surface from the cul-de-sac might be draining towards driveways 7 and 8. Please provide grading elevations at the edge of the road to ensure that stormwater is diverted away from the driveways.
Revised on drawings.

9. All private driveway entrance corner radii need to be 3 m at the interface with the public road (as per City Standard drawing S-26).
Revised on drawings.

e) Site Servicing plan (SVC); prepared by Kollaard Associates, Engineers, dated and sealed May 05, 2023.

1. Legend line type and/or scale do not match the lines on the plan.
See response to Comments Section c) Note 1.

2. It is not clear what the thin dashed lines within each property, running parallel with the property lines represent. If these are the set-back envelope, then the septic fields need to be moved outside of the set-back zone.
The thin dashed lines were zoning setback lines to a proposed building. The only part of the septic system that needs to be outside of this setback line is the distribution pipe.

3. Notes on the plan need to be coordinated with the latest Hydrogeological and terrain report recommendations and the Menu of Conditions for Draft Approval extended from October 06, 2021 to October 6, 2024.

It was noted that the stated Conditions require the wells to be constructed with the minimum of 12 m of casing, instead of 6 meters, as stated in the notes.

Notes have been revised.

4. The SWM access road needs to be extended to the culvert under the former railway to provide maintenance access within the entire SWM block. The access road needs to be shown on the plan to its conclusion at the box culvert.

Revised on drawings.

It is noted that the access road will stop before the top of bank for the Harwood Creek in order to prevent impact from the access road to the creek. As such the access road will not extend to the box culvert. It is further noted that the box culvert is not connected to the site.

5. The SWM block for the 5m wide access road, infiltration trench and the downstream ditch is not shown and identified on the plan. It needs to be shown and labelled, starting at the cul-de-sac and ending at the culvert under the former railway. The, as minimum, 15 m wide SWM Block needs to be dimensioned.

Revised on drawings. It is noted that the SWM Block has been widened to 20 metres to facilitate a revised swale width and the access road to the monitoring well.

6. The SWM Block will need to be adjusted (expanded) around the proposed Water Monitoring well, so it can be drilled on the City property with adequate access around it (as minimum 3.0 m from any property line, and enough access for a drilling rig for future maintenance).

Revised on drawings

7. 0.3 m reserves at the front of all the lots need to be provided and shown on the plans, in order to ensure that the water well specific design requirements, listed in the consultant's hydrogeological report (i.e.:12 m casings, locations that maximize separation, etc.) are met in the future.

Revised on drawings.

8. Geotechnical investigation report recommends the use of sump pumps for foundation drainage. The matter needs to be addressed with applicable notes on the plan and the acceptable cross-section, as per Technical bulletin ISTB-2019-02, drawing P01, with outlet to the ground surface or the ditch, instead of a storm sewer (comment is also provided in the Details section)

Sump detail added to details pages.

Notes added to Grading plan.

9. 80 m zoning set-back needs to be shown on the Servicing plan.

Revised on drawings. It is emphasized that this 80 m setback is a requirement to the dwelling from the former Rail line to address noise. It is not applicable to the septic system.

10. Future expansion septic field areas were specified very close to the property line. OSSO requires minimum setback from the property line to be 3 m plus the elevation factor for the raised component of the septic bed.

See Response to comment D2

11. Dunrobin Road widening, property line offset, should be dimensioned on the plan.

Revised on drawing.

12. Test well #3, on lot #1, proposed to be decommissioned, is within the footprint of the proposed septic bed. It is of concern that this configuration, in a case of a potentially inadequate seal, might pose a contamination opportunity. It would be advisable to move the leaching bed to the east

(closer to the driveway), so it is not placed on top of the abandoned well. It is important to ensure that the required separation to the proposed water well is provided.
OSSO should be consulted regarding this matter and communication provided to Development Review.

The septic bed location has been shifted so that the distribution pipe is no longer over the former well location.
The water well will be abandoned by a licensed well driller. This includes removing the casing, grouting the well hole in the bedrock and sealing the well opening above the bedrock. There is no potential for an inadequate seal resulting in contamination when this operation is completed in accordance with the MECP standards.

13. Peripheral swale along the southeast limit of the property interferes with the Test well 2 proposed to be decommissioned. Swale location should be adjusted to avoid this location.

Revised on drawing. The swale location was adjusted.

14. Please provide dimensions for all shown septic beds and notes that identify future maintenance requirements in scope of responsibilities to the City (as per Hydrogeological report, tertiary treatment systems were suggested on this site, due to aquifer vulnerability). Please show set-back dimensions between septic beds and the proposed water wells. Please provide notes that will clearly outline Hydrogeological study requirements pertaining to water and sanitary services. No 'flipping' or moving of wells nor septic systems will be allowed for this development.

Revised on drawing. Notes added to drawing.
Setback dimensions for the septic beds have been added to the drawing.
The exact dimensions of the septic beds is determined by the specific septic design for the proposed dwelling and can not be set at this time.

The Septic Office requires that every home owner with tertiary system known in the Ontario Building Code as Level 4 system has to have a service agreement with a maintenance provider certified by the manufacture of the particular system. A copy of the maintenance agreement must be filed with the CBO of Part 8 of the OBC.

15. Please dimension the minimum required separation between the structures and the proposed wells (3.0 m).

A 3 metre radius has been indicated around each well. It is noted that there is also a 15 m radius around the well. This indicates minimum setback distance from a septic system.

f) Plan and Profile (PP); prepared by Kollaard Associates, Dated May 05, 2023.

1. Legend line type and/or scale do not match the lines on the plan.

See response to Comments Section c) Note 1.

2. Question marks at the horizontal alignment at Sta. 0+000.

Revised on drawings.

g) Erosion and Sediment Control plan (ESC); prepared by Kollaard Associates, Dated May 05, 2023.

1. Legend line type and/or scale do not match the lines on the plan.
See response to Comments Section c) Note 1.

2. Notes, need to additionally address the phasing of the entire site, especially concerning the construction sequence of the global and critical operations. They need to suggest the preferred order of construction activities (such as: flood plain filling, roads, swales, temporary swales or final infiltration/storage trench) in order to address the interim conditions with the interim measures.
Please note that the completion of the large and critical construction operations, for the entire subdivision, might not happen in one phase and not planning the phasing adequately might lead to uncontrolled stormwater conditions and damage to the infrastructure or adjacent properties during the interim stages, especially in regard to operations such as flood plain work, road work, peripheral swales and SWM outlet construction.
Sequencing of development has been added within the Notes on the Sediment and Erosion control plan.

3. Please add the silt fence along Dunrobin Road. It is not clear when the low berm will be constructed.
Revised on drawings.

4. It might be valuable to add additional check dam before entrance to the infiltration trench in both ditches, just upstream of the trench, at the cul-de-sac, in order to capture more sediment before entering the infiltration trench.
It is also advisable to propose check dams along all the upstream ditches and swales and at the culvert inlets, to allow localized capture of eroded material along the way, instead of allowing it to flow extended distances and settle uncontrollably along the ditches and within the ditch culverts.
Revised on drawings. Temporary Straw bale Check dams will be placed within the roadside ditches upstream of each proposed driveway culvert location and at the outlet of the side yard swales. Additional check dams have been added to the perimeter swales as well

h) Details (DET); prepared by Kollaard Associates, Dated May 05, 2023.
1. Dry ponds should have a freeboard of 0.3 m between the 100-year water elevation and the overflow elevation. Details drawing appears to show the freeboard being less than the requirement in the infiltration trench.

Additional discussion has been added to the report in Section 7.1.2.2. The outlet structure has been modified to consist of a V-notch weir complete with overflow.

2. Question marks at the horizontal alignment at Sta. 0+000.

Revised on drawing

3. Design of the retaining wall (Headwall), including the footing detail, needs to be shown and adequately labelled. Elevations need to be provided.
The headwall has been eliminated in favor of an outlet structure comprised of a maintenance hole complete with inlet and outlet storm pipes. The maintenance hole will contain and protect

the inlet control device and will allow maintenance of the ICD. The ICD will consist of a v-notch weir.

4. Cross-section of the noise barrier design, including the footing detail and the immediately surrounding ground, needs to be shown and the details need to be adequately labelled and dimensioned. Please see the Environmental Noise Impact Assessment report for requirements.

The location of the noise barrier has been added to the grading plan and details page.

The design of the noise barrier is not part of the Civil or Geotechnical Engineering mandate. Reference to the noise barrier design requirements provided in the Environmental Noise Impact Assessment report has been added to the drawing.

5. Swale/road ditch cross-sections are not referenced on the plans. Please show the section lines and the letter descriptions on the corresponding plans.
Revised on drawings.

6. Provided ditch/swale cross-sections need to show the 100-year ponding elevations.

7. Typical SWM grassed service road cross-section needs to be shown on the plan in accordance with the Stormwater Management Facility Design Guidelines, Figure 7.3, by IBI Group, April 2012.
This detail has been added to our drawing set.
However:
A review of the typical cross section provided on Figure 7.3 indicates that this road structure would consist of 100 mm of topsoil with grass over top of 300 mm of Granular B Type II. It is considered that this section is not adequate or appropriate to be used for the portion of the service road that will be used for access of the Monitoring Well. This section would not result in a road of sufficient structure to support a vehicle except in ideal conditions. The compacted granular material would result in poor drainage of the topsoil layer ensuring that the 100 mm surface would be soft following a rainfall event. The grass would need regular maintenance in order to ensure that the road is usable. It is considered that this road could be used for the portion of the service road which extends beyond the Monitoring Well.

8. Please provide a cross-section for the proposed berm along Dunrobin Road.
Detail added to sheet DETAILS (2)
The proposed berm is intended to ensure that there is a sufficient backslope on the roadside ditch to keep runoff from public property entering private property during all storm events up to and including the 100 year storm event.

9. Typical Ditched Pipe Storm Sewer Installation detail, as per City of Ottawa Drawing S9, needs to be shown.
Detail not added to drawing. The subdrained swale have not been designed in accordance with this detail. Additional Explanation has been added to the Storm Report in Section 6.3

10. Typical Private Entrance rural detail needs to be shown, as per City of Ottawa Drawing S26.
Ottawa Drawing S26 added to details page (sheet Detail 2)

11. The notes need to reference the Standard Notes Road Allowance Drawing Number: ROW-NOTES, revised September 2022.

Reference added to drawing

12. Proposed road cross-section detail recommends 300 mm of Granular B, while the City of Ottawa Rural Local Roadway Cross-Section Over Earth, Drawing Number R-27, March 2016, specifies minimum Granular B layer of 400 mm. The Standard also specifies the Performance Graded Asphalt cement. The roadway design needs to be as per City standard Drawing R-27 (Note #1 shall be disregarded) unless the proposed design can be justified as exceeding the City minimum requirements presented on the mentioned drawing.

Road cross section has been revised to be in keeping with Drawing R-27

13. Typical sump pump application for the proposed foundation drainage needs to be shown in a cross-section, as per Technical bulletin ISTB-2019-02, drawing P01, with outlet to the ground surface or the ditch, instead of a storm sewer.

A typical sump pump detail has been added to the details drawings. The drawing P01 is not appropriate as drawing P01 reflects primary discharge to the storm sewer with backup discharge in the event of surcharge to the surface. When there is only one discharge option which is to the surface, no part of this detail is really relevant.

14. Section E-E is labelled as Outlet to Barnes Creek.

Corrected and Revised on drawing

15. Infiltration trench, section F-F does not show the 525 mm pipe with the ICD's. Also, infiltration filter cross section needs to be added, dimensioned, and labelled.

The detail has been revised. It is noted that the detail has changed as a result of revisions to the outlet structure.

16. Street lighting needs to be shown in the Typical Road cross-section.

Drawing Revised

i) Floodplain Comparison (FP); prepared by Kollaard Associates, Dated May 05, 2023.

1. The pre-development condition shows a significant flood plain on the adjacent property to the south, however the post-development plan shows the flood plain ending at the south property limit and along the east narrow strip of the property being developed. Does this mean that the adjacent property's flood plain was relocated in its entirety to the north, as shown on the post-development plan?

Drawing has been revised.

III. Submitted reports:

a) Stormwater Management Report, Proposed Residential Subdivision, 2050 Dunrobin Road, City of Ottawa (prepared by Kollaard Associates, dated May 5, 2023); project 200977.

1. *SWM modelling comments are provided under separate cover.*

Noted

2. *Infiltration trench design review is provided under Section V of the comments.*

Noted

3. Section 2.1.1. of the report states proposed Low Impact design techniques where possible – the report needs to be more specific, as to what techniques were proposed.

Section 2.3 has been added to the report to provide clarification to this.

4. MECP approval is required for SWM treatment facility and outlet to a watercourse – comment is to be addressed at a later stage.

Noted.

5. City of Ottawa Sewer Design Guidelines, Second Edition, SDG002, October 2012, with bulletins, Section 8.3.11.5 states that Dry ponds should have a freeboard of 0.3 m between the 100-year water elevation and the overflow elevation. Details drawing appears to show the freeboard being less than the requirement.

Discussion with respect to this comment has been provided in section 7.1.2.2.

It is noted that the stormwater storage facility would be more appropriately labelled a Dry Swale (Bioswale) or Bioretention area in keeping with the MECP LID Guide and the CVC LID Guide

6. Section 4.1 of the report, page 13, last sentence contains repeated word.

Corrected

7. Section 4.2 of the report, page 15, first sentence at the top of the page contains misspelled word.

Corrected

8. The section 4.4.1 of the report quotes, from “2050 Dunrobin Road, City of Ottawa – Floodplain Analysis, by J.F Sabourin and Associates Inc., dated October 2022”, that there are no negative impacts anticipated to the proposed development and the hydraulic operations of the watercourse, as a result of reduction in the floodplain volume.

It is not clear, however, if the effect of the floodplain storage volume loss was considered in reference to the immediately upstream residences (to southeast) and any localized potential effects were considered, knowing that historically this area is prone to localized flooding.

Additional discussion has been added to the report in section 4.4.1.

The analysis completed by JFSA indicates that the 100 year levels in the Creek do not change between existing and proposed conditions at the stations analyzed. The analyses also indicate the Hydraulic Gradient in the Creek is not affected by the filling of the backwater flood plain. As such the analysis is clear that there will be no impact to the upstream residences.

9. Table 6 -1 of the report for Catchment C4 shows weighted avg. CN = 59.6, while the Post-Development Conditions plan shows CN = 60.3; discrepancy was also noted for Catchment C5.

The calculations have been revised to accommodate additional soil types. The discrepancies have been corrected.

10. Section 6.2.2. of the report, describing the proposed swale at the northwest limit of the property, did not consider the required noise barrier that will need to be installed along the northwest perimeter and measures to be implemented in order not to obstruct the existing drainage from the adjacent property.

The proposed noise barrier will have a 0.1 m gap between the ground surface and the bottom of the barrier to prevent obstruction of the drainage.

11. Section 6.2.3 of the report proposes swales with longitudinal slopes of approximately 0.2 %, in some locations, including around the cul-de-sac within the road ROW.

The slope of the roadside ditches around the cul-de-sac have been revised to have a minimum slope of 0.5 percent. The slope of the roadside ditch along Dunrobin Road and along the north side of Kanata Enclave Court between Dunrobin Road and station 0+070 remains at 0.3% to accommodate the existing grading of the Dunrobin Road ditch. The Drainage from Dunrobin Road was formerly directed by design across private property with little to no longitudinal slope along the existing roadside ditch. This existing physical condition restricts the grading of the proposed ditch as the proposed ditch is required to accept the runoff from Dunrobin Road. The slope along the swales has been adjusted to have a minimum of 0.3%.

It was noted that some slopes start at over 3% and end with 0.2%; the report needs to investigate potential for longitudinal grades adjustments upstream of the cul-de-sac in order not to decrease any slopes below the required minimum of 0.5%. In the process the swale/ditch depths along the considered grade adjustment need to be verified for required capacity.

As shown in Table 6-3 and Table 6-4, the capacity of each section of swale and ditch has been verified. .

It appears from Table 6-4, in the report, that the 100 – year return storm contributes to the generation of flows in the roadside ditches that range from 30%-50% full flows, with grades varying between 1.1 % and 0.2 %, indicating that some slope adjustments might be possible to improve the condition. Please note that the ditch and the road profiles do not necessarily need to be parallel.

50% full flow in a ditch during a 100 year return storm is acceptable. It is noted that by MTO standards, culverts are designed for a 10 year storm event for roads of this level.

If the report can objectively justify that the slope greater than 0.5 % cannot be achieved, then the design needs to implement the design recommendations as per City Standard drawing S9 for ditched pipe storm sewer installation.

The slope of the roadside ditches between Dunrobin Road and Station 180 is above 1 percent. This slope decreases to 0.9 percent and then 0.5 percent. Adjusting the ditch slope to "average" the slope such that the minimum slope is higher would require raising the bottom of the ditch beyond station 160 by as much as is metres. It is noted that the elevation difference between the edge of the pavement and the ditch invert has already been minimized. This adjustment would result in more fill required beneath the roadway and in the ditches. The increase in the ditch elevation would result in a corresponding increase in underside of footing level required to ensure that the footings meet the minimum required elevation above the ditch bottom. The increase in USF will result in the requirement for additional landscape fill around the dwellings. The extra fill would result in additional excess traffic along Dunrobin Road.

12. Section 6.2.4 of the report makes a reference to specific swale names, however these names are not identified on any submitted plans. Please provide on the Servicing or Grading plans.

Swale names added to the Servicing Plan

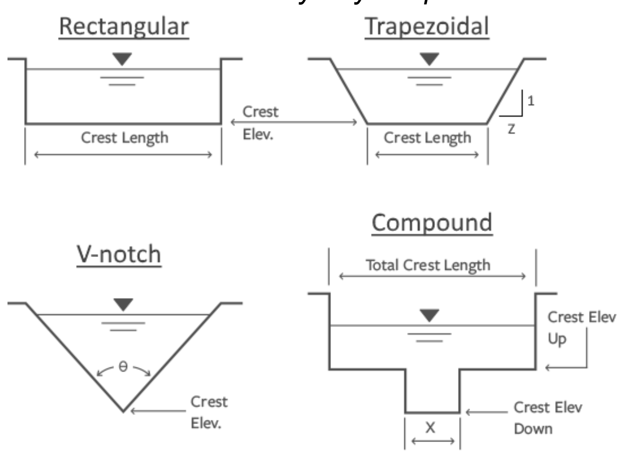
13. Section 7.1.3 provides an equation that defines the discharge rate through the orifices. Please show that the equation, found on page 33 (pdf sheet 38) fulfills the criteria of use. It is not clear how this formula applies in this case.

Reference to the equation has been provided.

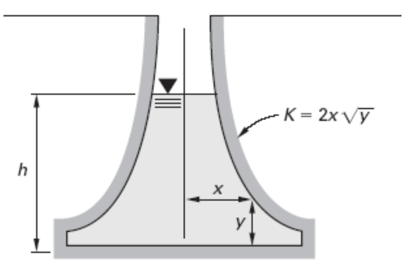
The following explanation has not been added to the report as it providing information that should be common knowledge.

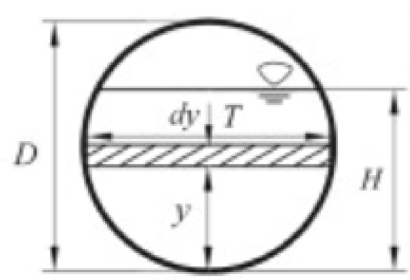
Flow through a circular orifice when the orifice is not fully submerged cannot be calculated using an orifice equation as orifice flow does not occur till after the orifice is completely submerged. The stormwater management models use storage discharge curves to calculate the discharge rate from a stormwater management pond often referenced as a reservoir in the model. The storage discharge curve covers the full range from when the SWP is empty to full. If the outlet control is by means of an orifice which is at or above the bottom of the pond, there will be period when the flow level is less lower than the top of the orifice and the orifice is not fully submerged. During this period, the orifice acts as a weir.

A weir can be of virtually any shape.



See also proportional weir and circular weir





It is acknowledged that the equation used is not completely accurate having a maximum error of up to 2.4 percent between the value derived using the provided equation and the values obtained when using separate equations to calculate orifice flow and weir flow. The peak discharge during the 100 year storm event is in the order of 70 L/s. A 2.4 percent error would indicate this number could vary from 68.6 to 71.4 L/s. This error is not significant when considering that the post-development runoff during a 100 year storm event is more than 15 L/s less than the pre-development runoff rate.

14. Section 9 (Quality Control) of the report is not clear how the surface runoff quality is proposed to be achieved and subsequently controlled/maintained (for suspended automotive oils, fuels, any other contaminants related to roadside drainage, etc.), especially considering that the ditches outlet directly to a watercourse onsite.

The MECP LID Stormwater Management Guidance Manual provides the following:

The 90th Percentile precipitation event for the proposed development area is a 25 to 26 mm storm event.

The Runoff Volume Control Target hierarchy has the following order:

- *Control hierarchy priority 1 (Retention) - LID retention practices which utilize the mechanisms of infiltration, evapotranspiration;*
- *Control hierarchy priority 2 (LID filtration), - LID technologies which utilize appropriate filter media (e.g., per the TRCA, CVC, 2010, LID Stormwater Planning and Design Guide). The controlled volume is filtered and released to the municipal sewer networks or surface waters at a reduced rate and volume;*
- *Control hierarchy priority 3 (Conventional treatment) - Other stormwater technologies which utilize filtration, hydrodynamic separation and or sedimentation (i.e. end-of-pipe facilities) to detain and treat runoff*

Stormwater management BMPs which achieve the Runoff Volume Control Target (the control of the regionally specific 90th percentile precipitation event) may be considered to have achieved Enhanced Protection (sometimes referred to as Level 1) for the respective contributing drainage area. Treating the runoff from one hundred percent of the 90th percentile precipitation events (and an equivalent rainfall depth for all events larger than the 90th percentile precipitation event) from a respective contributing drainage area will provide a high level of contaminant load reduction. With LID BMPs, it can be assumed that essentially all suspended solids are being captured for all events up to the 90th percentile precipitation event.

The proposed design uses both priority 1 and priority 2 practices. This means that providing treatment for all of the runoff, for all of the storm events which result in a total rainfall of less than or equal to 26 mm areas, from all of the surface areas which are considered to be sources of contamination is considered by the MECP to provide an enhanced level of treatment.

Also please refer to the following:
TRCA, CVC, 2010, LID Stormwater Planning and Design Guide section 4.6.1 for guidance on the use of vegetated filter strips for the removal of pollutants from road runoff.
MECP Draft LID Stormwater Management Guidance Manual Section 3.3

15. Please reference the source of the equation found on page 33 (pdf sheet 38).
The equation

$$Q = \frac{0.72\sqrt{2gD^5}}{[(C_w\eta^{1.98})^{-2.14} + (C_d\eta^{0.52})^{-2.14}]^{0.4673}}$$

was obtained from Vatankhah, A. R., (February 2018) Discussion of “Flow through Partially Submerged Orifice” by James C.Y. GUo and Ryan P. Stitt Journal of Irrigation and Drainage Engineering: Reference was added to report

16. Table 7-1, found on page 35 (pdf sheet 40) does not include the 20 % stress test.
20% Stress test added to the model and is represented by the 120% 100 year 12 hour Chicago Storm.

17. Section 8.3 of the report is not clear as to what subwatershed study is being referenced regarding the achieved recommended infiltration objectives.
The wording of the report has been revised to "which will aid in achieving some of the common recommendations and objectives generally contained within most subwatershed studies".

As discussed in the beginning of Section 8 a subwatershed study was not identified for either Harwood Creek or Constance Creek. As such a review of available subwatershed studies for subwatersheds within Ottawa was completed to determine common objectives and recommendations. As such Section 8.3 references the beginning of Section 8.

18. Section 9.2 of the report quotes field experiments and research without references to specific documents from which information was obtained.
Reference added to report

19. Table 9-3 identifies imported soil infiltration rate, within proposed trench, to be 30 mm/hr – 75 mm/hr. The minimum MECP criterion is larger or equal to 60 mm/hr. While some of the proposed soil's upper infiltration range is within the acceptable MECP range (60 -75) it is not clear how the infiltration rate assumption for this soil was made and what percentage of the soil will have the lower infiltration capacity (30 mm/hr). The existing soil's infiltration/percolation capacity does not appear to have been studied and it appears to be assumed – please provide more rationale that will confirm that the expected infiltration will be as per MECP objectives?

Permeability testing completed in the footprint of the proposed swale indicates that the permeability of the native soils is 1.64 x 10-7 m/s. This corresponds to an infiltration rate of 30 mm/hr. The City of Ottawa's guidelines with respect to LID practice make it clear that LIDs can be used when the infiltration rate is over 15 mm/hr.

Section 3.5.1 of the City of Ottawa Low Impact Development Technical Guidance Report February 2021 indicates the following:
"The 2003 Stormwater Manual contains guidance for a number of lot level and conveyance controls but specifies that the application of a number of management practices may not be suitable if the native soil has a percolation rate less than 15 mm/hr (see for example Pg. 4-6: Table 4.1: Physical Constraints for SWMP Types - infiltration trenches, reduced lot grading, soakaway pits, rear yard ponding, and pervious pipes)."

This has contributed to the limited application of these measures as many of the soils within Ontario do not meet this criterion. The infiltration rate has an obvious effect on the speed with which a facility will be emptied between rainfall events. Thus, LID facilities should be sized for optimum control of water quantity. Area-wide quantity criteria may be achieved through the use of multiple smaller LID facilities distributed over a large area.

For example, stormwater management practices such as bioretention and biofiltration use multiple treatment mechanisms including retention, filtration, evaporation and transpiration as *well as infiltration. If the lot level and conveyance facilities can be sized such that they empty between events, or will be installed in areas where quantity control is not a primary concern (areas draining directly to a large surface water body like Lake Ontario, for example), LID facilities can be used where the infiltration rate is less than 15 mm/hr to achieve water balance and water quality (including thermal impacts) through retention, filtration, evaporation and transpiration. Thus, the soil infiltration capacity guidance in the manual should not be interpreted as a prohibition. Rather, it should be interpreted as a caution that controls relying primarily on infiltration may not be as effective on soils with low infiltration rates as they would be on soils with higher rates of infiltration."*

It is recommended that the practitioner acknowledge that there shall be no minimum native soil infiltration rate for the implementation of LID, provided the native soil infiltration rate is > 0mm/hr. If the in-situ native soil infiltration rates are less than 15mm/hr, the Low Impact Development Stormwater Management Planning and Design Guide (wiki.sustainabletechnologies.ca) recommends that an underdrain is required and the LID shall be a 'partial-infiltration' design.

20. Table 9-3 specifies the storage depth at less than 0.6 m. The proposed storage is identified between 0.51 m to 077 m (10-year to 100-year event). While under everyday conditions it should not reach the MECP limit, please provide a maintenance direction for the occurrence when this limit might be exceeded (case of a potentially plugged orifice, etc.).

If the occurrence when the depth of 0.6 metres is exceeded is a direct result of a 100 year storm event or a storm event of similar magnitude, then simply waiting will be sufficient for the water level to subside to below a depth of 0.6 metres. In the advent that the exceedance is caused by plugging of the outlet structure, then the outlet structure can be cleaned to unplug it. Maintenance directives have been added to the report. The outlet structure has been revised to reduce the potential for plugging of the orifice and to protect the orifice.

21. The report needs to additionally address the phasing of the entire site, especially concerning the sequence of the global and critical construction operations. It needs to suggest the preferred order of construction activities (such as: flood plain filling, roads, swales, temporary swales or final infiltration/storage trench) in order to address the interim conditions with the interim measures.

Please note that the completion of the large and critical construction operations, for the entire subdivision, might not happen in one phase and not planning the phasing adequately might lead to uncontrolled stormwater conditions and damage to the infrastructure and adjacent properties during the interim stages, especially in regard to operations such as flood plain work, road work, peripheral swales and SWM outlet construction.

The proposed development will be completed in one phase. Construction sequencing has been added to the report in Section 13.

22. The reporting is not clear as to how the post-development surface runoff from the substantially uncontrolled area will meet the criterion of 100-year peak flow reduction or matching the 100-year pre-development peak flow.

Allowable release rate = Total allowable runoff - uncontrolled runoff. The total allowable runoff is determined by the stormwater management criteria. For this development the total allowable runoff during a 100 year storm is equal to the 100 year predevelopment flow for the same design storm event. As such, the 100 year allowable release rate = 100 year pre-development runoff rate – uncontrolled runoff rate during 100 year design storm.

Rearranging this simple equation provides: The 100 year allowable release rate + uncontrolled runoff is <= 100 year pre-development runoff. The calculations show the total runoff during post development condition in relation to the pre-development runoff. As such, the report is completely clear.

23. SWM Infiltration trench ICD's (orifices) are not acceptable, and the outlet structure needs to be redesigned to use weirs, instead of orifices, due to future operational and maintenance concerns (prone to clogging)

The outlet structure has been redesigned to use a V-Notch weir.

b) 2050 Dunrobin Road, City of Ottawa – **Floodplain Analysis**, by J.F Sabourin and Associates Inc., dated October 2022

Response by others.

c) Geotechnical Investigation, Proposed Residential Subdivision; Part 1, Plan 5R-10184, 2050 Dunrobin Road, West Carleton Ward, City of Ottawa, Ontario; prepared by Kollaard Associates, dated Nov 12, 2021, Revision 1 – dated May 5, 2023.

1. (Originally Comment #4) Please identify potential long term low groundwater level and how it was considered in the overall permitted ground raise and its contribution to consolidation and potential ground settlement, including for the proposed subdivision road, due to soil's shear strength loss - comment was not addressed as requested, report needs to be updated directly. Response to the original comment, from Kollaard Associates, dated May 5, 2023, is acceptable but the rationale needs to be added to the revised report, not as an external commentary.

The response was added to the report in section 5.2.6.

2. Section 5.5.2 Pavement Structure recommends 300 mm of Granular B, while the City of Ottawa Rural Local Roadway Cross-Section Over Earth, Drawing Number R-27, March 2016, specifies minimum Granular B layer of 400 mm.

The cross section has been modified in the report and on the drawings.

3. Section 4.8 of the report makes a reference to Attachment C following the report, however none of the attachments are labelled.

The wording has been modified to read "The laboratory results are presented in the Attachments following the text of this report"

4. Concrete retaining wall (headwall) is proposed on site, however the report makes no reference to its geotechnical design and construction requirements. Slope Stability Assessment needs to be provided that addresses the global stability of the proposed wall.

The outlet has been modified. The outlet control will consist of a V-notch weir in a cast in place concrete wall. Geotechnical recommendations with respect to the weir wall have been added to the report.

A slope stability assessment does not need to be provided for the weir walls as the soil height on either side of the wall is similar which means that the weir walls are not acting as retaining walls.

The footing of the proposed structure appears to be below the GWT which was identified in TP 14 as 0.8 m below ground surface. Footing/foundation geotechnical considerations need to be provided.

Please see response to comment 1 above, (original question 4.) The geotechnical report already provides recommendations related to excavation, construction dewatering, subgrade preparation, backfill and site services. A separate section in the report to provide the same information again is not necessary.

5. Environmental Noise Impact Assessment 20 Dunrobin Road prepared for Zbigniew Hauderowicz (Prepared by Arcadis IBI Group, dated May 20,2022; updated June 21, 2022; updated November 11, 2022), proposed 2m tall noise barrier with 20 kg/m2 density at the north limit of the site to mitigate the kennel noise for lots 3, 5 and 7, however the Geotechnical report did not provide ant geotechnical considerations for the proposed structure.

Section added to report

I V. **Additional Infiltration Swale comments** (by the City Hydrogeologist):

1. TP14 is located in the area of the proposed infiltration swale. This test pit indicates the presence of silty clay down to 1.22 m below existing ground. These soils are not appropriate for infiltration-based LID practices (for e.g., see the City's Low Impact Development Technical Guidance Report, Feb 2021).

Permeability testing completed in the footprint of the proposed swale indicates that the permeability of the native soils is 1.64 x 10-7 m/s. This corresponds to an infiltration rate of 30 mm/hr. The City's LID Guide makes it clear that LIDs can be used when the infiltration rate is over 15 mm/hr.

Section 3.5.1 of the City of Ottawa Low Impact Development Technical Guidance Report February 2021 indicates the following:
"The 2003 Stormwater Manual contains guidance for a number of lot level and conveyance controls but specifies that the application of a number of management practices may not be suitable if the native soil has a percolation rate less than 15 mm/hr (see for example Pg. 4-6: Table 4.1: Physical Constraints for SWMP Types - infiltration trenches, reduced lot grading, soakaway pits, rear yard ponding, and pervious pipes)."

This has contributed to the limited application of these measures as many of the soils within Ontario do not meet this criterion. The infiltration rate has an obvious effect on the speed with which a facility will be emptied between rainfall events. Thus, LID facilities should be sized for optimum control of water quantity. Area-wide quantity criteria may be achieved through the use of multiple smaller LID facilities distributed over a large area.

For example, stormwater management practices such as bioretention and biofiltration use multiple treatment mechanisms including retention, filtration, evaporation and transpiration as well as infiltration. If the lot level and conveyance facilities can be sized such that they empty between events, or will be installed in areas where quantity control is not a primary concern (areas draining directly to a large surface water body like Lake Ontario, for example), LID facilities can be used where the infiltration rate is less than 15 mm/hr to achieve water balance and water quality (including thermal impacts) through retention, filtration, evaporation *and transpiration. Thus, the soil infiltration capacity guidance in the manual should not be interpreted as a prohibition. Rather, it should be interpreted as a caution that controls relying primarily on infiltration may not be as effective on soils with low infiltration rates as they would be on soils with higher rates of infiltration."*

It is noted that the primary release for the storage swale above a storage depth which is 0.2 metres above the bottom of the swale is by means of the outlet structure. It is only the bottom 0.2 metres that will be discharged by infiltration only.

2. Section 6.2.2 of the SMW report states that the expected hydraulic conductivity is in the order of 4x10-5 m/s, based on the sandy silt and glacial till soils. The soil is however silty clay, as shown in TP14. It is also not clear where the value for the hydraulic conductivity was obtained. Later in the calculation the value of 1x10-3 cm/s (1x10-5 m/s) is used, which is a slightly different value.

Due to additions to the report, section 6.2.2 is now section 6.2.3

Please note that section 6.2.2 was labeled Limits of longitudinal slope of swales and discussed the slope of the perimeter swales which are not close to TP14. The soil conditions along the perimeter swale are best described by test pits TP9-TP11, TP5-TP7. These test pits indicate that the subsurface conditions along the perimeter swales vary from silty sand to glacial till.

Permeability testing completed in the footprints of the perimeter swales indicates that the permeability of the native soils along the north and south sides of the site is in the order of 1 x 10^{-6} m/s. This corresponds to an infiltration rate of 50 mm/hr. The report has been revised to use this value.

3. The conceptual analytical model used to calculate the time for infiltration does not appear to be applicable to the setting. Using a Darcy gradient of 1.33 over a distance of 0.3 m would only be valid if the bottom of the soil column were free draining, which it is not in this case (it is also noted that the infiltration rate would reduce as the ponding depth reduces). For this reason, it is usual to measure the infiltration rate in the field using a permeameter or a infiltrometer. Field saturated hydraulic conductivities can then be converted to infiltration rates, or measured directly if using an infiltrometer.

The context of this specific calculation was determining the approximate time it would take for puddles that formed in the bottom of the perimeter swales as a result of the low longitudinal slope to infiltrate following the end of the storm. Since the puddle depth was estimated at a maximum of 0.1 metres, there is more than sufficient voids within the sandy materials below to accommodate this volume.

Section 6.2.3 of the report has been modified.

See response to comment 2 immediately above.

4. The maintenance of the swale, as described, is excessive—once a week and after every rainfall until the vegetation is established, and subsequently by-monthly and after every significant storm event.

The maintenance section for the swale has been revised to clarify the inspection and maintenance requirements and to separate short term (first weeks), intermediate (first year) and long term requirements.

5. For the reasons described in the above comments (1 – 4), the infiltration swale is not acceptable.
The infiltration swale has been revised. Based on permeability testing completed at the site and Section 3.5.1 of the City of Ottawa LID guide, the infiltration swale is acceptable.

The following comments are the result of reviews that were undertaken by GM BluePlan Engineering and city of Ottawa Asset Management Branch of the Stormwater Management Design Brief and drawings for the Proposed Subdivision at 2050 Dunrobin Road (Kollaard Associates Engineers May 5, 2023).

Stormwater Management Report and Modeling:

1. Please provide Visual OTTHYMO modeling data for the unmitigated post-development rates

The storm water model for the unmitigated post-development rate is the same model with the reservoirs bypassed. A separate model was not generated.

The purpose of providing the unmitigated post-development flow rates section 6.4 is simply to confirm that a do nothing approach is not sufficient. That is, if no means of quantity control are implemented, then the post-development flows would greatly exceed the pre-development flows. The provided values have no other significance and do not merit a separate model.

2. The time of concentrations should be reviewed. We note that even though the area of the catchments in predevelopment conditions are larger than the areas of post-development conditions, the time of concentrations in post-development conditions are larger. For instance, the area of Catchment C4 in post-development conditions is 1.676 hectares which is about 2.5 times smaller than the area of Catchment C-PRE2. However, the time of concentration for catchment C4 is bigger than C-PRE2. Please review and update.

The time of concentration is defined as the time it takes for the runoff to flow from the furthest most point in the catchment to the outlet.

The post development conditions consist of a subdivision development with the stormwater outlet at the same location as the predevelopment conditions.

The method of conveyance of the runoff is also the same: First sheet flow then shallow concentrated flow. During pre-development conditions, the sheet flow occurs near Dunrobin Road with shallow concentrated flow following. The shallow concentrated flow will makes its way along preferred channels to the outlet.

A review of the information contained within the report indicates that the maximum length of travel for shallow concentrated flow was limited at 30 metres for both pre and post development conditions. A review of the formula for shallow concentrated flow indicates that *the travel time is directly related to the flow velocity. If the velocity is doubled, the travel time would be reduced by 50 percent.*

The slopes of the side yard swales have been revised. This has significantly altered the travel time for the shallow concentrated flow and has resulted in shorter post development times of concentrations.

The calculations have been revised.

3. Please review and ensure that the slopes applied for the calculation of the time of concertation in the post-development conditions (especially, for catchment C2, C3, C4, C5, C6, C7 and C8) are aligned with the proposed grading plan. The slopes used in calculating the time of concentrations for the proposed conditions do not align with the proposed grading plan. For instance, Catchment C4's slope of 0.001 was utilized, leading to a time of concentration of 0.69 hours. Please review and update.

The time of concentration calculations have been reviewed and revised. The slope for the shallow concentrated flow has been revised to reflect the slopes in the side yard swales except for C4 and C5. It noted that the longest path of travel for shallow concentrated flow in these two catchments is from the bottom of the fill placed in the flood plain to the swales along the outside of the lot. The slope used reflects the actual slope in the areas outside of the fill envelope.

4. Please review and discuss the lengths utilized in the time of concentration calculation in the post-development conditions. The lengths of the rear yard (For instance, Catchment C1) from the north end of the catchment to the proposed rear yard swale are about 59 m based on measurements from the drawings. However, in post-development calculations for the time of concentration, the total flow length including the length of sheet flow and major channel exceeds this length, which may result in a longer time of concentration.

The longest distance of travel is not straight along the side yard swale from the high point in the swale to the rear property line swale. The longest distance of travel includes the flow from the building envelope to the side yard swale. For instance, Catchment C1 from the distance from the dwelling to the side swale is 16 metres which coincides with the length used for sheet flow. The distance used for shallow concentrated flow was 58 metres which is 1 metre less than the measurement of 59 metres obtained from the drawing.

5. The following assumption (page 21) should not be made *"It is considered that the runoff from the roofs of the proposed dwellings will be directed towards the front yard by means of downspouts."* Therefore, in Table 6-1, Catchments C1 through C8 should have included half the roof impervious area. The CN values in Table 6.1, were do they come from? There is only a difference of 1 in the CN value between maintained rear yard and non maintained? Please review and update as necessary.

The rear catchment areas were revised to include half of the dwellings.

The CN values were taken from OSDG Table 5.9 and from the United States Department of Agriculture Urban Hydrology for Small Watersheds Technical Release 55 (USDA TR55).

Section 3 of the report provides the following:

For the purposes of analysis presented in this report, the surface cover was considered to be Open Space (lawns) in good condition (CN = 61 for SG B and 80 for SG D), Woods/brush in good condition (the woods/brush on site is recent re-growth with dense undergrowth) (CN = 55 for SG B and 77 for SG D), Unmaintained and overgrown rear yards and Woods/brush in fair condition (CN = 60 for SG B and 79 for SG D).

Reducing the curve number lower than CN = 60 for the rear yards would result in decreased runoff during post development conditions.

6. Please confirm how the house area was determined. Is this the maximum possible house size that will be constructed on these lots? Please include calculation of imperviousness for post development conditions.

The proposed house area is 700 m^2 or approximately 7000 square feet. This is an assumed foot print for a large dwelling and is approximately 200 m^2 larger than the largest residential dwelling in the areas surrounding the site.

Imperviousness for the site has been added to the report. The imperviousness for the site is 9.3 percent.

7. Page 1 section 1 says a block for SWM will be provided however the draft plan only shows an easement. Please revise draft plan to include a Block for the SWM that will be conveyed to the city upon registration. The city does not want to own SWM works on land that they don't own.

Block designated on the drawing set

8. Page 14, please review the statements on the interpretation of the data in the table. Table 4.1 shows that the culvert is only operating at inlet control during the lower flows somewhere between 73.7 m to 73.8 m. The 14.9 cms occurs between 74.7 and 74.8 (outlet control). Please review and revise as necessary

The culverts in question are operating under inlet control.

During outlet control, it is more difficult for flow to get through the barrel than to get into the barrel. Culverts without elevated tail water rarely act under outlet control unless the ratio of the length of the culvert compared to the diameter is sufficiently large to cause enough head loss to restrict the flow in the culvert. To suggest that this is occurring at the culverts in question is ridiculous.

Unless there is a physical characteristic within the creek downstream of the culvert, such as a dam or other flow constriction that would cause the water downstream of the culvert to backup and become elevated, there is no mechanism to cause outlet control in the culverts in question given the length and barrel area of the culverts in question below the railway.

Section 4.2 was revised. The capacity of the existing culverts to convey the 100 year flow level was verified using the Hydroflow Express Extension of Autodesk Civil 3D.

9. Silty clay was also found. Please provide a table that shows Soil group B acceptable for the three types of soils identified.

The calculations in the appendix to determine the weighted average CN number for each catchment area have been revised for those catchment areas impacted by the silty clay soils encountered. Explanation has been added to section 3.3.1 and the calculations have been revised in Appendix A

10. At what point in the storm water system are the flows in table 6-5 taken?

The flows in Table 6-5 are taken at the outlet of the subdivision assuming no form of quantity control has been implemented. The purpose of section 6.4 is simply to confirm that if no means of quantity control are implemented, then the post-development flows would greatly exceed the pre-development flows.

11. Need to do stress test.

The City of Ottawa sewer design guideline provides the following:

In addition to the evaluation of the performance drainage systems under Historical Storms, drainage systems shall be stress tested using design storms calculated on the basis of a 20 % increase of the City's IDF curves rainfall values. Modifications to the drainage system would be required if severe flooding to properties are identified.

In keeping with the above, the 12 hour 100 year Chicago design storm was modified to increase the storm intensity by 20%.

12. The orifice(s) need to be protected from litter and debris.

The outlet control structure has been modified. The outlet control structure now consists of a V-notch weir in a cast-in-place concrete weir..

13. Page 32, the overflow from the pond should not be onto private property as currently proposed.

The outlet structure has been modified to consist of a V-notch weir complete with a rectangular overflow which will ensure that any overflow is restrict to the outlet swale channel.

14. Page 38, table 8-1, how is it that for the 25 mm storm the post development runoff is less than predevelopment when all but one storm shows more in the last column.

The 25mm 4 hour Chicago storm is a quality control event. The runoff volume generated during this event is very small in both pre- and post- development conditions when compared to the remaining storm events. Since the total runoff volume during a 25 mm post development event *is relatively small there is sufficient volume below the outlet of the storm swale to cause post-development flow rate for the 25 mm storm to be less than the pre-development event.*

15. The seeding type should be on the drawings and securities taken. Detail drawing should show the proposed pond bottom materials as described in section 7.1.2 of the report.

Revised on drawings

16. Monitoring plan of infiltration basin required. City will not take it over until monitoring data shows that the function properly and drawdown time for the infiltration is similar to what was proposed.

The design of the stormwater management swale has been revised.
A monitoring and inspection plan will be prepared under separate document.

17. The report makes note of specialized fill requirement for the infiltration basin area. Please mark on the drawing.

Notes regarding the construction of the storage swale have been added to the Grading Plan GR-2

18. The water from the SWM pond will back up into the roadside ditches and onto the proposed swales on private property. The city would prefer this not to be the case. We should not be storing water on private property nor in the ditch ROW. Table 6-5 does not appear to consider the backwater effect from the pond. For example, south 8 shows 0.28 m for 100-year storm. The invert of the channel is shown as 75.65 m which would mean a water surface elevation of 75.93 m. However, the 100-year level due to the pond is 76.22 m which is a foot higher. This also applies to the culvert report which assumes normal depth downstream. Please review and revise as necessary.

Table 6-5 is not intended to indicate the elevation of the 100 year flood level in the ditch as a result of the outlet restriction in the stormwater storage swale.

Table 6-5 shows the 100 year level as a result of ***conveyance****. Once the stormwater backs up from the pond (backwater effect) the ditch is no longer conveying the water. The 100 year flood line on the drawing reflects this.*

The culvert report is intended to indicate that the culverts are adequately designed to convey the flows from the design storm event.

If the flow cannot make it through the culvert due to elevated tailwater, then the flow restriction is not a function of the size of the culvert but of the downstream flood level.

19. There is some mention of sediment and erosion controls for the SWM channel. However, it should be revised to clearly point out how important it is to protect the infiltration area during construction.

A note was added to section 7.1.2.1 to indicate construction traffic should be avoided within the footprint of the storage swale bottom.

20. In stream erosion and sediment control measures should be included for in water works where the drainage outlet connects with Harwood creek.

The outlet will connect above the normal low water level in the Harwood Creek. The connection should be made at low water levels.

21. There should be a minimum clearance of 0.3 m between the 100-year SWM pond water elevation (76.22m) and the usf. Currently the usf is 0.42 m lower than the 100-year level at two of the proposed homes while two others are close but do not meet the minimum.

Section 7.1.2.3 has been added to the report to address this comment. This requirement is based on urban development not rural development.

22. The rainfall hyetograph, the hydrographs and the routing should all use the same time step. Please confirm

Most rainfall distributions use their own time step to define the internal rainfall data. This value is independent of the time step used for hydrograph generation and routing.
The time step for the hydrograph generation and routing were both set to 5 min.

23. Please note the City of Ottawa's Transfer of Review (ToR) agreement with the MECP does not cover designs that have infiltration in the same areas where there are drinking water wells.

There are no infiltration areas proposed in the areas surrounding the proposed drinking water wells. The well located within the area of an infiltration area or swale is being decommissioned and the swale has been relocated away from the well.

Drawings:
1. Based on Minimum Grading and Servicing Plan Specifications Infill Serviced Lots, "Grade in excess of 7% will require terracing at a maximum of 3:1." It is our understanding that there are some places where exceed grade in excess of 7% in lot 1,3,5, and 8. Please revise grading plan to align with the specifications.

These are not infill serviced lots. It is unclear as to why this guideline is being referenced when it is not applicable.

Side slopes of 4H:1V or 25 percent are considered to be acceptable by the Ontario Building Code adjacent to septic beds because they are considered to be stable, support grass growth and be readily maintainable. A side slope of 21.2 % is less than 25 % and is much less than 3H:1V or 33.3 % terracing. Maintenance of lawns in a rural development is generally completed using a ride on lawn mower. The side slopes have been left as *proposed in order to facilitate safe maintenance of the lawns by the equipment expected to be used.*

If the City of Ottawa wishes to take the liability associated with the expected maintenance requirements related to the steep portions of the lawn resulting from the suggested 3H:1V terracing, we can revise the drawing accordingly.

2. Based on Minimum Grading and Servicing Plan Specifications Infill Serviced Lots, a minimum 150 mm clearance between the proposed top of foundation elevation and the finished grade at the structure is required. The finished proposed elevations around the proposed building shall be clarified.

Clarification added to drawings.
Terracing elevation is the elevation immediately adjacent the dwelling. TOF elevation is the elevation at the top of the foundation. These two elevations are separated by 0.6 metres on every lot. Since 0.6 m is greater than 0.15 metres, this criteria is met.

3. Based on Minimum Grading and Servicing Plan Specifications Infill Serviced Lots, "Swales with average gradients of less than 2% will require a rigid perforated (100 mm dia.) subdrain with a 25 mm clear stone bedding and backfill, with the clear stone wrapped in geotextile were permitted to do so by the Infrastructure Approvals Division." The slope in the most proposed swales is less than 2%. Please revised the slopes of the proposed swales or please revised proposed swales design to includes the rigid perforated subdrain. Also one segment of road ditch is proposed at 0.2%.

See response to comment 11 Stormwater Management Report above.
Additional discussion added to Section 6.2 of the storm report.

4. Based on the Kanata Enclave Court Profile on Drawing No PP and Site (West) Grading Plan: Drawing No GR-W, it is our understanding that runoff from Dunrobin Road will be directed to the proposed property. However, the discussion with respect to the runoff from the Dunrobin Road in the catchment area of the post-development conditions and storm water management report was not found. Please includes the discussion for the runoff from the Dunrobin Road. Are there Catchments beyond CA and CB areas that flow along Dunrobin to the site?

It is the understanding of the Stormwater Management report that Catchments CA and CB include the Dunrobin Road Allowance up to the center line of the road. There Is no flow from the west side of Dunrobin Road to the east side of Dunrobin Road in proximity to the site.

A review of both the pre-development drawing and the post-development drawing clearly indicates that Catchment C-OFF1 also extends west to the center of Dunrobin Road.

As such the flow from Dunrobin Road is accounted for in the design. A definitive statement has been added to Section 5.1.1 of the report for clarity.

5. Based on Compendium Edition of the 2012 Building Code (O.Reg 332/12) Table 8.2.1.6B Minimum Clearances for distribution piping and leaching chambers, 15 m clearances from the stream is required. Please clarify that the proposed leaching bed has 15m clearance from the proposed swale.

The swales are not watercourses or streams. As such this does not apply.

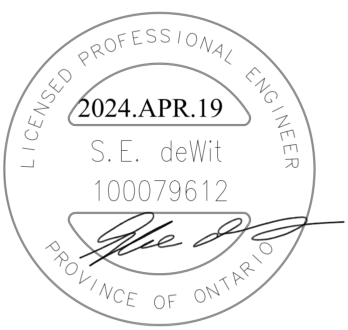
6. Cannot find the plan view that shows the locations of the cross sections shown on the detail plan. Section F-F should show annual high-water table. More information on F-F is required from outlet to downstream channel. The lowest orifice is it 75.61 m dropping to 74.70m in a short distance then relatively steep slope 1.7%. At higher flows water will discharge the orifice like a jet how will this energy be dispersed? Should there be some special channel lining in this area? Cross section H-H should extend beyond the access road point to the lowest proposed grade.

The outlet control structure has been modified to consist of a V-notch weir in a cast in place weir wall. Riprap has been added adjacent to the wall to protect from erosion.

Cross Section H-H has been extended

We trust that this response provides sufficient information for your present purposes. If you have any questions concerning this response please do not hesitate to contact our office.

Sincerely,



Steven deWit, P.Eng.
Kollaard Associates Inc

PRE–DEVELOPMENT CONDITIONS
SCALE = 1:1000

NOTES:
1. ALL DIMENSIONS ARE IN METRES, UNLESS OTHERWISE SPECIFIED; ALL ELEVATIONS ARE IN METRES.
2. THIS IS NOT A LEGAL SURVEY.
3. EXISTING SERVICES INFORMATION SHOWN ARE BASED ON BEST CURRENT INFORMATION. CONTRACTOR TO VERIFY EXACT LOCATION AND REPORT ANY DISCREPANCIES TO KOLLAARD ASSOCIATES INC.
4. CLIENT IS RESPONSIBLE FOR ACQUIRING ALL NECESSARY PERMITS.
5. CONTRACTOR TO VERIFY THAT APPROPRIATE PERMITS HAVE BEEN ACQUIRED PRIOR TO ANY CONSTRUCTION.
6. CONTRACTOR IS RESPONSIBLE FOR LOCATION AND PROTECTION OF UTILITIES.
7. ALL DIMENSIONS TO BE VERIFIED ON SITE BY CONTRACTOR PRIOR TO CONSTRUCTION.
8. THIS DRAWING IS NOT FOR CONSTRUCTION UNTIL ALL APPROVALS HAVE BEEN GRANTED.
9. INSPECTION OF ROUGH GRADE BY KOLLAARD ASSOCIATES INC. AND MUNICIPALITY MUST BE CONDUCTED PRIOR TO PLACEMENT OF TOPSOIL OR SOD.
10. HYDRO SERVICE TO BE INSTALLED ACCORDING TO THE SPECIFICATIONS OF SERVICE PROVIDER AND THE MECHANICAL ENGINEER.
11. ALL MATERIALS AND CONSTRUCTION TO BE IN ACCORDANCE WITH MUNICIPAL STANDARDS AND ONTARIO PROVINCIAL STANDARDS AND SPECIFICATIONS.
12. ANY CHANGES MADE TO THIS PLAN MUST BE VERIFIED AND APPROVED BY KOLLAARD ASSOCIATES, INC.
13. THIS DRAWING IS PART OF KOLLAARD ASSOCIATES DESIGN REPORT #200977.

No.	REVISION	DATE	BY
1	RESPONSE TO SECOND REVIEW COMMENTS	2024 APR 19	SD

CONSULTANTS

Kollaard Associates
Engineers
(613) 860-0923

LICENSED PROFESSIONAL ENGINEER
2024.APR.19
S.E. deWit
100079612
PROVINCE OF ONTARIO

CLIENT NAME: ZBIGNIEW HAUDEROWICZ
PROJECT NAME: PROPOSED RESIDENTIAL SUBDIVISION
PROJECT LOCATION: 2050 DUNROBIN ROAD OTTAWA, ONTARIO
DRAWING: PRE–DEVELOPMENT CONDITIONS
SCALE: 1:1000
DRAWING NO.: PRE

NOTES:
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No.	REVISION	DATE	BY
1.	RESPONSE TO SECOND REVIEW COMMENTS	2024.APR.19	SD

CONSULTANTS

Kollaard Associates
Engineers
(613) 860-0923

DESIGN	AJ/SD
DRAWN	AJ
CHECKED	SD
APPROVED	SD

STAMP: LICENSED PROFESSIONAL ENGINEER — 2024.APR.19 — S.E. deWit — 100079612 — PROVINCE OF ONTARIO

CLIENT NAME	ZBIGNIEW HAUDEROWICZ	PROJECT No.	200977
PROJECT NAME	PROPOSED RESIDENTIAL SUBDIVISION	DATE	2023/05/05
PROJECT LOCATION	2050 DUNROBIN ROAD OTTAWA, ONTARIO	SCALE	1:1000
DRAWING	POST–DEVELOPMENT CONDITIONS	DRAWING No.	POST

002-02-22-0005

SEQUENCING OF DEVELOPMENT

1)Construction of Roadway:

a) Install sediment and erosion control measures;
b) Strip topsoil and prepare subgrade;
c) Place roadway granular subbase and base;
d) Shape ditches and back slope to property lines;
e) Topsoil and seed ditches;
f)Construct "Cow path" to support truck traffic;
g) Following placement of fill in flood plain, remove "Cow path and finish shaping roadway;

2) Place Fill in Flood Plain within the Storm Block:

a) Install sediment and erosion control measures
b) All of the fill required to raise the flood plain to the proposed grades should be placed within the proposed storm block.
c) Construct the maintenance road along the stormwater storage swale;

3) Construct the Stormwater Management Facility and Outlet Swales:

a) Install sediment and erosion control measures;
b) Construct the stormwater management swale;
c) Seed the specified vegetation within the stormwater management swale;

4) Construct the peripheral swales:

a) Install sediment and erosion control measures;
b) construct swales by excavation;
c) cut material to be used as fill and to be placed within the confines of the sediment and erosion control measures;

5) Finish the placement of fill within the flood plain:

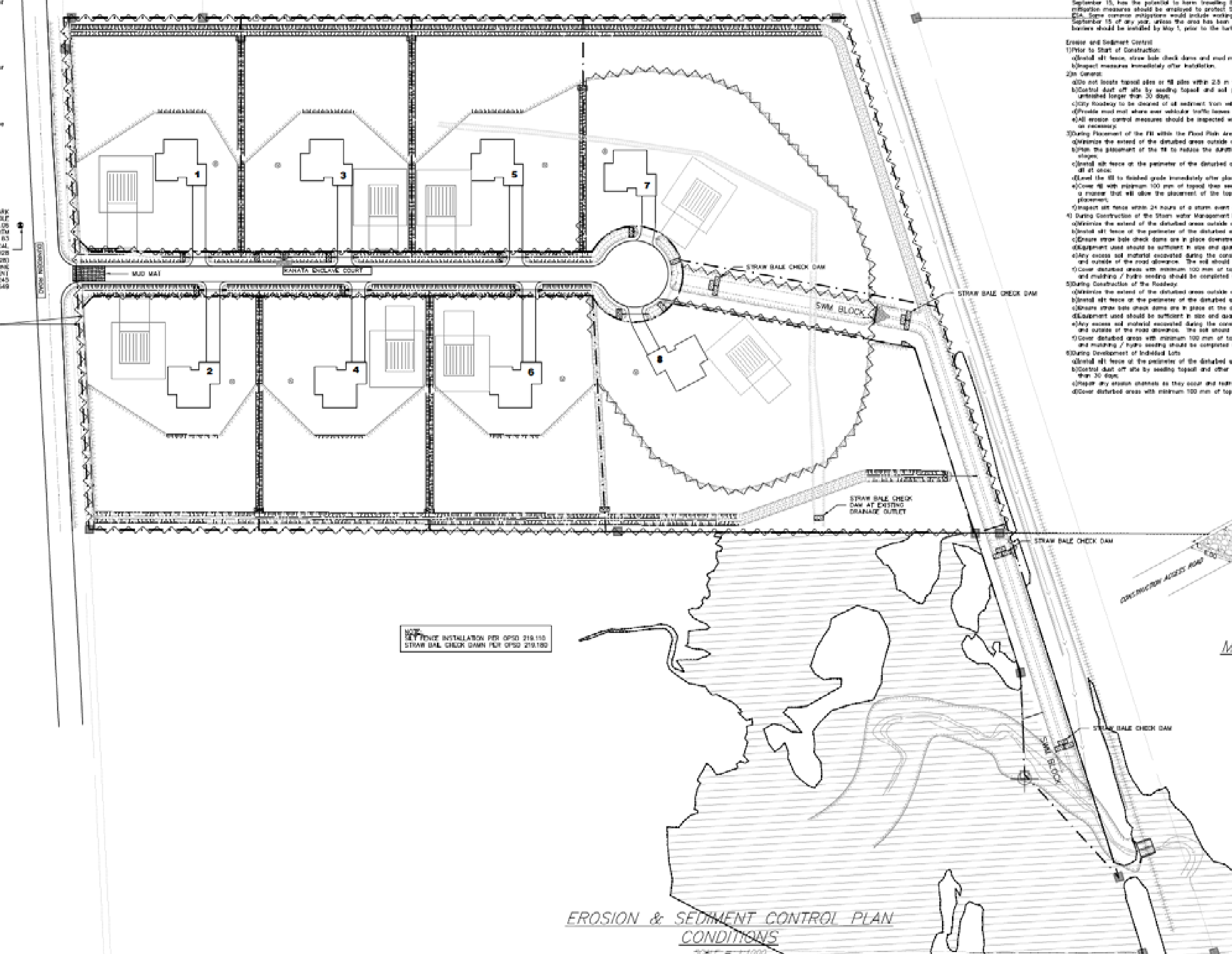
a) Install sediment and erosion control measures

6) Complete individual lot development:

a) Install sediment and erosion control measures

SITE BENCHMARK
NAIL IN HYDRO POLE
ELEV = 79.05
HORIZONTAL DATUM: MTM ZONE 9, NAD 83 (ORIGINAL) AND VERTICAL DATUM OF 1928 (CGVD28)
REFERENCED TO COSINE MONUMENT STATION:00119703245
CGVD28 78 ELEV 120.549

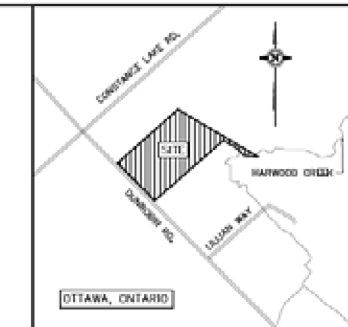
OLD PROPERTY LINE REPLACED WITH NEW SETBACK 15m FROM CENTRELINE OF ROAD WITH 0.3m RESERVE



Mitigation Measures for Construction and Development

1)To prevent the introduction and spread of invasive plant species into the study area, equipment utilized during construction should be inspected and cleaned in accordance with the Clean Equipment Protocol for Industry.
a)Inspect the vehicle thoroughly inside and out for where dirt, plant material and seeds may be lodged or adhering to interior and exterior surfaces prior to mobilizing equipment onto the site.
b)Remove any guards, covers or plates that are easy to remove.
c)Attention should be paid to the underside of the vehicle, radiators, spare tires, foot wells and bumper bars.
d)If clods of dirt, seed or other plant material are found, removal should take place immediately using the techniques outlined in the Clean Equipment Protocol For Industry.
2)Except as required to construct the outlet, a minimum of 30 m setback from Harwood Creek should be maintained where no development or clearing should occur.
3)In accordance with the City's of Ottawa's Protocol for Wildlife Protection during Construction to reduce potential wildlife usage of the Forb Meadow habitat by mowing/clearing outside of the breeding season (i.e., before April 15), then maintain as mowed grass until on-site work begins.
4)No clearing of any vegetation should occur between April 1 and September 15 of any year, unless a qualified biologist has determined that no bird nesting is occurring within five days of the vegetation clearing event.
5)Should any SAR be discovered during the project works, and/or should any SAR or their habitat be potentially impacted by on-site activities, the MECP shall be contacted immediately and operations modified to avoid any negative impacts to SAR or their habitat, until further direction is provided by the MECP;
6)Any excavation or heavy equipment use in the floodplain or near Harwood Creek within the study area, conducted between May 1 and September 15, has the potential to harm travelling Blanding's Turtles and other SAR turtles that utilize the watercourse. As such, mitigation measures should be employed to protect SAR and their habitat during construction and to maintain compliance with the ESA. Some common mitigations would include working outside the known timing window for active turtle movement from May 1 to September 15 of any year, unless the area has been cleared of turtles by a qualified biologist; as well as temporary turtle exclusion barriers should be installed by May 1, prior to the turtle nesting season surrounding the impacted watercourse or proposed works.

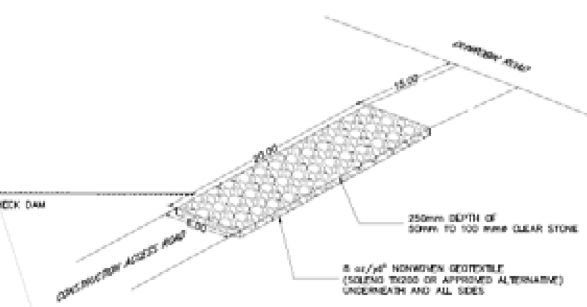
Erosion and Sediment Control
1)Prior to Start of Construction:
a)Install silt fence, straw bale check dams and mud mat in location shown;
b)Inspect measures immediately after installation.
2)In General:
a)Do not locate topsoil piles or fill piles within 2.5 m from any paved or gravel surface area;
b)Control dust off site by seeding topsoil and soil piles and other disturbed areas watering as necessary if they are to remain unfinished longer than 30 days;
c)City Roadway to be cleaned of all sediment from vehicular tracking as required;
d)Provide mud mat where ever vehicular traffic leaves the site from an unpaved egress point;
e)All erosion control measures should be inspected within 24 hours of a storm event and should be cleaned / repaired / replaced as necessary.
3)During Placement of the Fill within the Flood Plain Area:
a)Minimize the extend of the disturbed areas outside of the area immediately affected by the fill placement;
b)Plan the placement of the fill to reduce the duration of exposure either by ensuring sufficient equipment or by placing the fill in stages;
c)Install silt fence on the perimeter of the disturbed area or around the perimeter of each phase if not completing the fill placement all at once;
d)Level the fill to finished grade immediately after placement;
e)Cover fill with minimum 100 mm of topsoil then seed and mulch or hydro seed. The placement of the fill should be completed in a manner that will allow the placement of the topsoil and seeding and mulching / hydro seeding within 30 days of start of fill placement;
f)Inspect silt fence within 24 hours of a storm event and clean / repair as necessary.
4) During Construction of the Storm water Management Facility.
a)Minimize the extend of the disturbed areas outside of the area immediately affected by storm water management facility;
b)Install silt fence at the perimeter of the disturbed area;
c)Ensure straw bale check dams are in place downstream of the facility;
d)Equipment used should be sufficient in size and quantity to ensure the construction time is minimized;
e)Any excess soil material excavated during the construction should be stockpiled on the proposed lots outside of vulnerable areas and outside of the road allowance. The soil should be leveled to rough grade and should be stabilized by seeding;
f)Cover disturbed areas with minimum 100 mm of topsoil then seed and mulch or hydro seed. The topsoil placement and seeding and mulching / hydro seeding should be completed within 30 days of start of the construction of the facilities;
5)During Construction of the Roadway:
a)Minimize the extend of the disturbed areas outside of the area immediately affected by the road construction;
b)Install silt fence at the perimeter of the disturbed area;
c)Ensure straw bale check dams are in place at the discharge point from the Cul-de-Sac;
d)Equipment used should be sufficient in size and quantity to ensure the construction time is minimized;
e)Any excess soil material excavated during the construction should be stockpiled on the proposed lots outside of vulnerable areas and outside of the road allowance. The soil should be leveled to rough grade and should be stabilized by seeding;
f)Cover disturbed areas with minimum 100 mm of topsoil then seed and mulch or hydro seed. The topsoil placement and seeding and mulching / hydro seeding should be completed within 30 days of start of the construction of the roadway;
6)During Development of Individual Lots
a)Install silt fence at the perimeter of the disturbed area;
b)Control dust off site by seeding topsoil and other disturbed areas watering as necessary if they are to remain unfinished longer than 30 days;
c)Repair any erosion channels as they occur and redirect surface runoff with the use of berms to promote sheet flow;
d)Cover disturbed areas with minimum 100 mm of topsoil then seed and mulch or hydro seed as soon as possible.



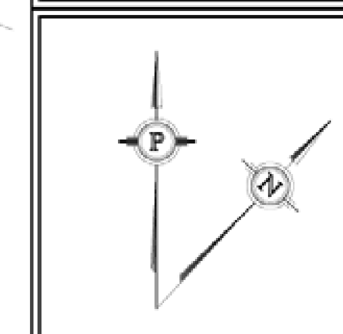
0 40 80
SCALE 1:1000 METERS

LEGEND – ESC

- PROPERTY LINE
- TOP OF SLOPE
- SILT FENCE
- MUD MAT
- BOTTOM OF SLOPE
- STRAW BALE CHECK DAMN
- LOT RESERVE LINE



MUD MAT DETAIL
SCALE = N.T.S.



NOTE:
SILT FENCE INSTALLATION PER OPSD 219.110
STRAW BAIL CHECK DAMN PER OPSD 219.180

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No.	REVISION	DATE	BY
1.	RESPONSE TO SECOND REVIEW COMMENTS	2024.APR.19	SD

CONSULTANTS

Kollaard Associates
Engineers
(613) 860-0923

DESIGN	AJ/SD
DRAWN	AJ
CHECKED	SD
APPROVED	SD

STAMP: LICENSED PROFESSIONAL ENGINEER 2024.APR.19 S.E. deWit 100079612 PROVINCE OF ONTARIO

CLIENT NAME	ZBIGNIEW HAUDEROWCZ
PROJECT NAME	PROPOSED RESIDENTIAL SUBDIVISION
PROJECT LOCATION	2050 DUNROBIN ROAD OTTAWA, ONTARIO
DRAWING	EROSION & SEDIMENT CONTROL PLAN

PROJECT No.	200977
DATE	2023/05/05
SCALE	1:1000
DRAWING No.	ESC

002-02-22-0016

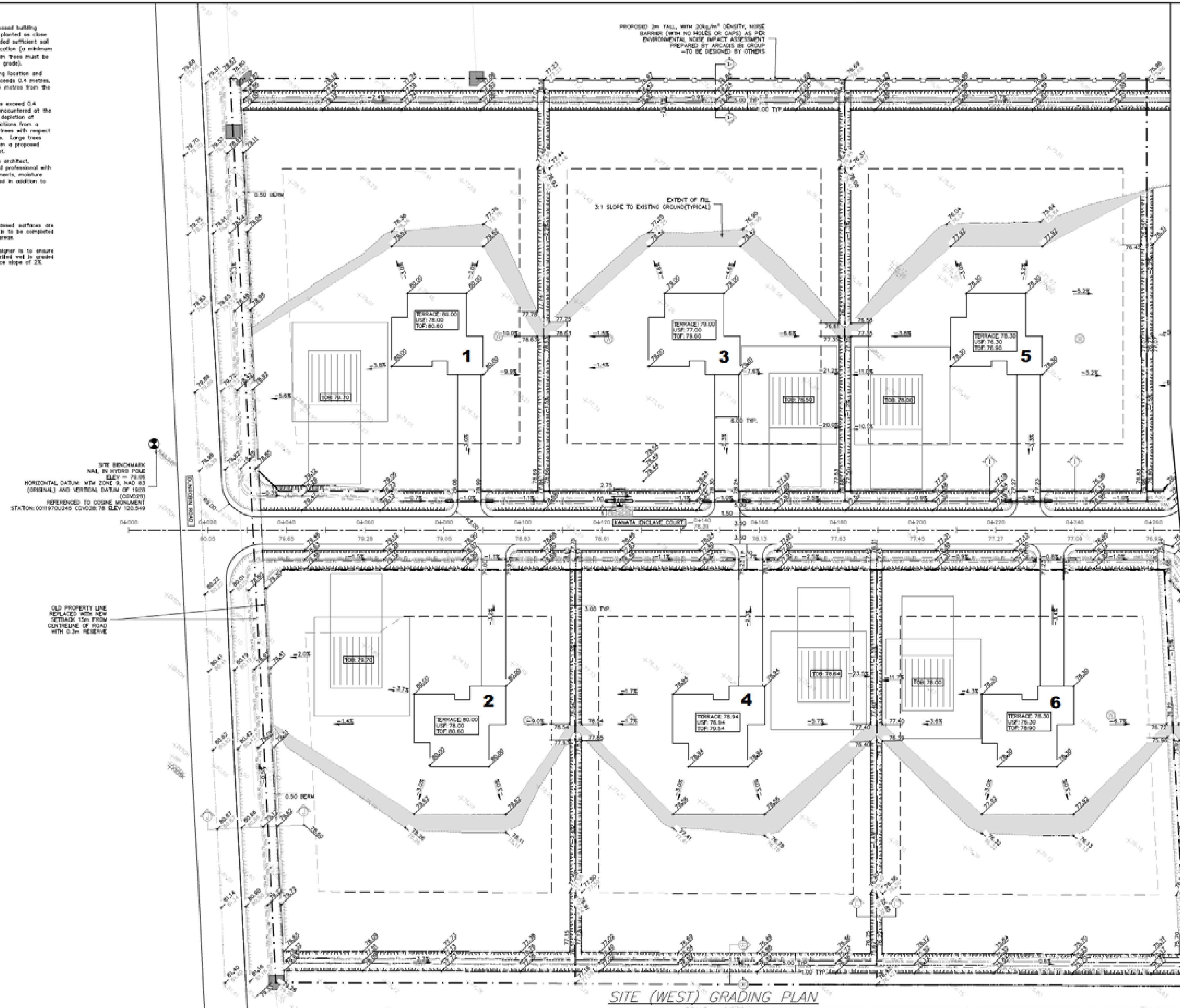
Tree planting Guidelines

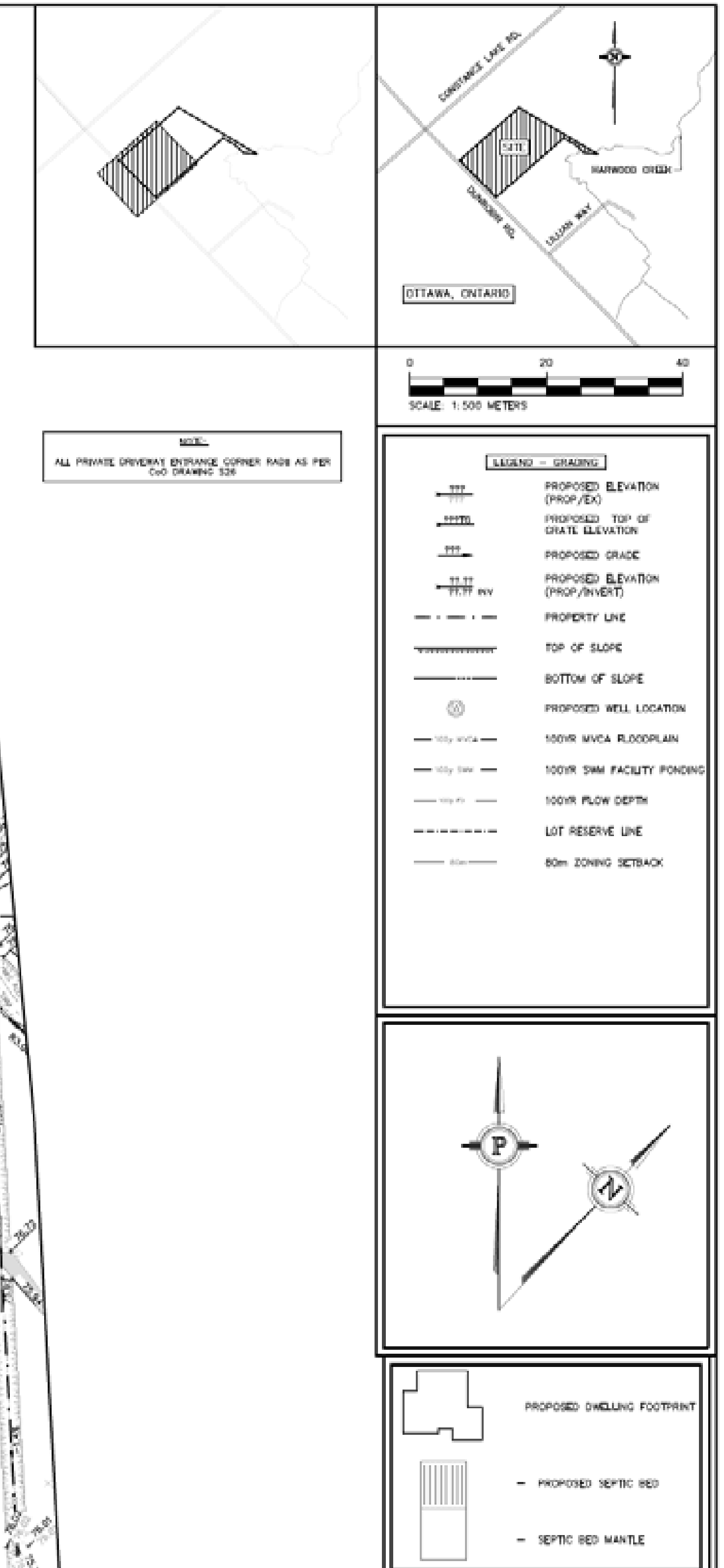
1. Where silty clay soils are encountered at a proposed building location, small and medium sized trees can be planted as close as 4.5 metres from the proposed dwelling provided sufficient soil volume is available around the proposed tree location (a minimum of 25 m^3 for small trees and 30 m^3 for medium trees must be available in the upper 1.5 metres below finished grade).
2. Where silty clay is present at a proposed building location and where the thickness of the silty clay deposit exceeds 0.4 metres, large trees should be planted no closer than 15 metres from the proposed building.
3. Excluding the areas where the silty clay deposits exceed 0.4 metres, the remainder of the subsurface soils encountered at the site are not considered particularly sensitive to depletion of moisture by trees. There are no planting restrictions from a geotechnical perspective for small and medium trees with respect to planting distance from the proposed buildings. Large trees should be planted no closer than 10 metres from a proposed dwelling where no silty clay is present on the lot.
4. Tree planting guidelines provided by a landscape architect, arborist, urban forest manager or other qualified professional with respect to species, distance to building requirements, moisture requirements etc should be obtained and followed in addition to the geotechnical recommendations.

General Grading Notes:

All grade elevations shown on softscaped or grassed surfaces are finished grades including topsoil. Rough grading is to be completed to allow for 100 mm of Topsoil on all disturbed areas.

During detailed grading of individual lots, the designer is to ensure that the area within 3 metres of the proposed drilled well is graded away from the well with a minimum ground surface slope of 2%.





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CONSULTANTS

Kollaard Associates
Engineers

(613) 860-0923

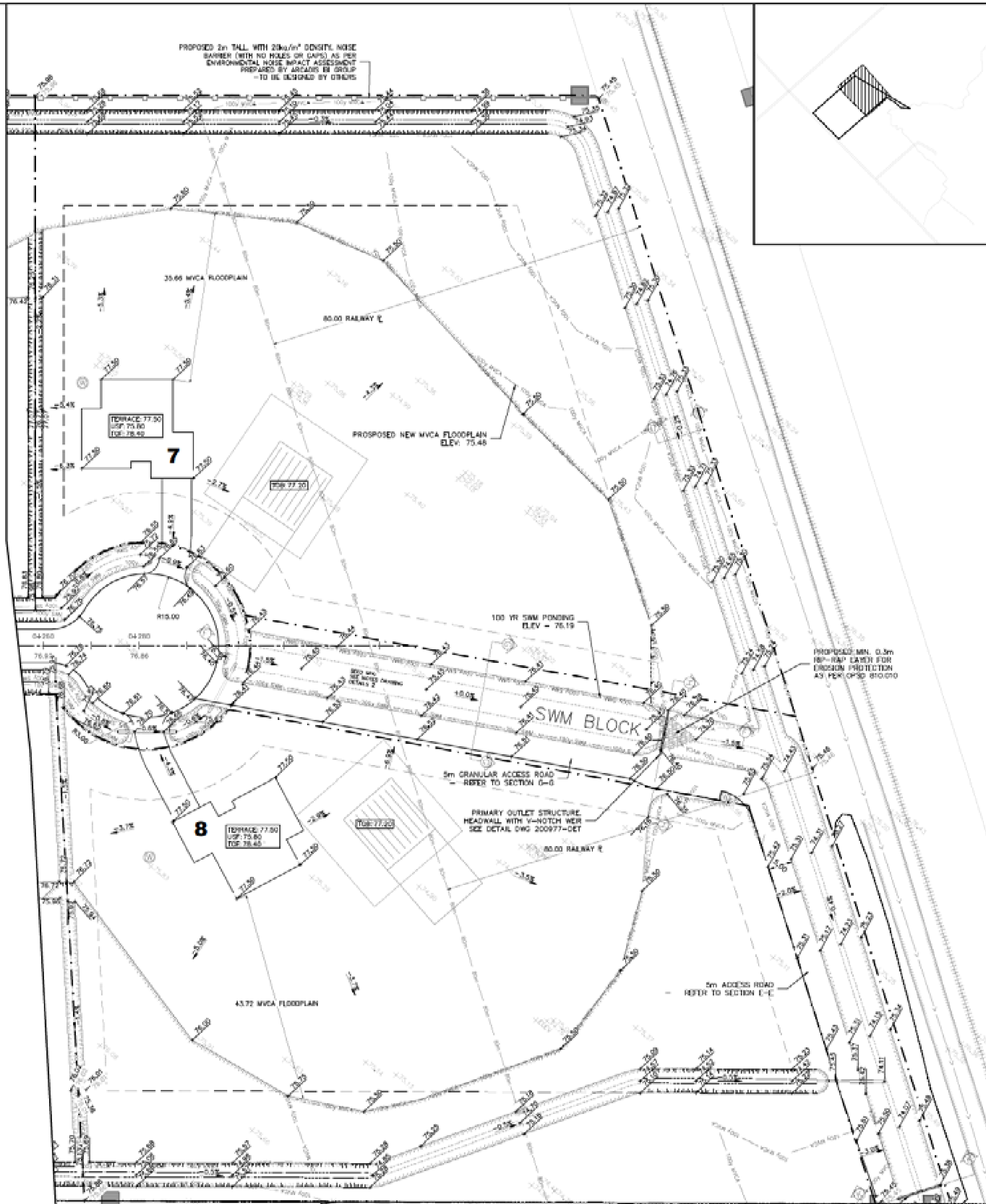
LICENSED PROFESSIONAL ENGINEER
2024.APR.19
S.E. deWit
100079612
PROVINCE OF ONTARIO

CLIENT NAME: ZBIGNIEW HAUDEROWCZ

PROJECT NAME: PROPOSED RESIDENTIAL SUBDIVISION

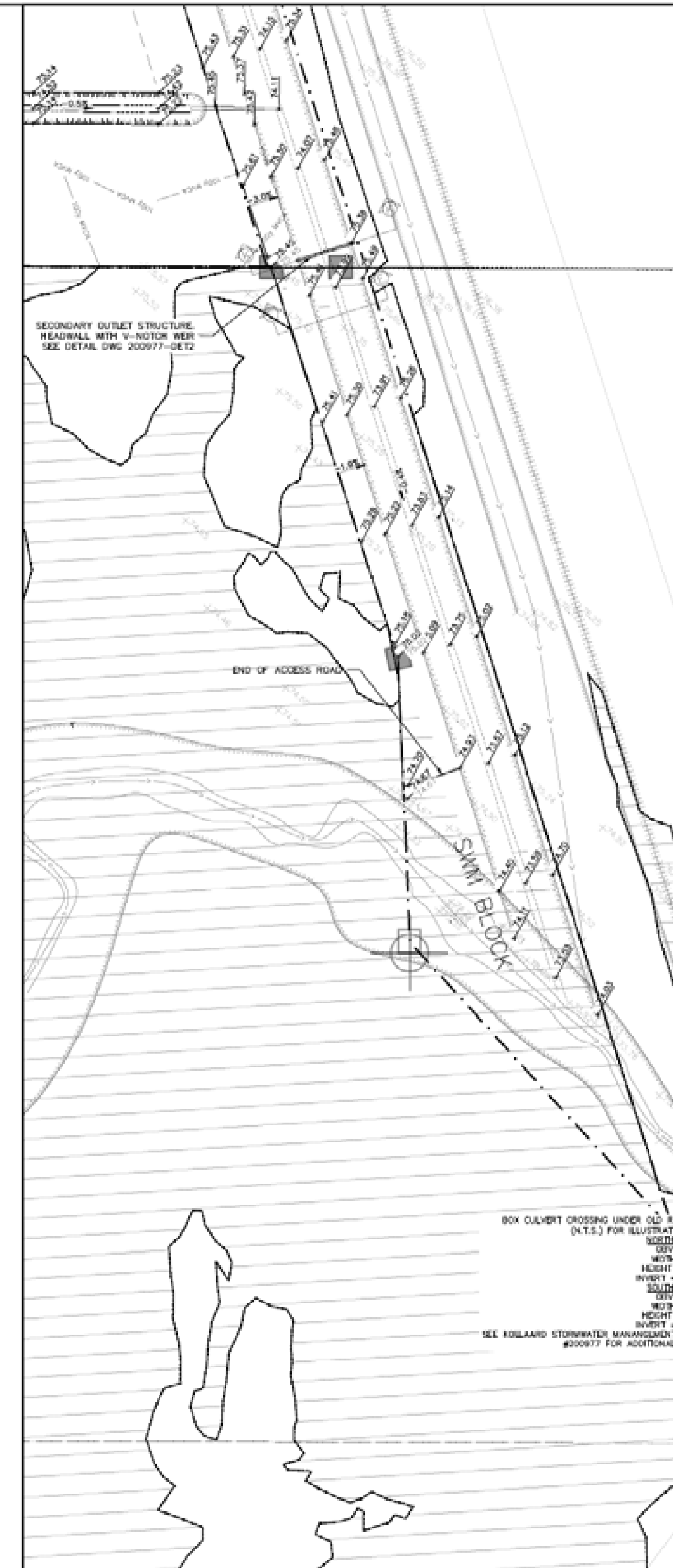
PROJECT LOCATION: 2050 DUNROBIN ROAD OTTAWA, ONTARIO

DRAWING: SITE (WEST) GRADING PLAN



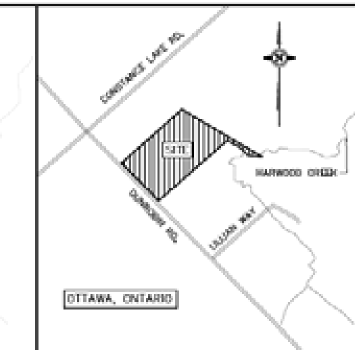
SITE (EAST) GRADING PLAN

SCALE = 1:500



SITE (HARWOOD CREEK) GRADING PLAN

SCALE = 1:500



NOTE:

REFERENCED TO COSINE MONUMENT STATION:00119700245
CGVD28:78 ELEV 120.548
HORIZONTAL DATUM: MTM ZONE 9, NAD 83 (ORIGINAL)

NOTE:

ALL PRIVATE DRIVEWAY ENTRANCE CORNER RADII AS PER CoO DRAWING 535

NOTE:

100 YEAR FLOOD LEVEL IN HARWOOD CREEK AT RIVER STATION 1214 IS 75.48m

SWM STORAGE SWALE NOTES:

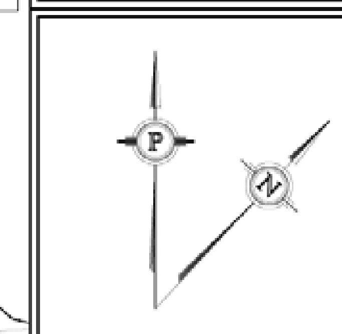
- The topsoil should be removed from below the footprint of the proposed storage swale and stockpiled on the upper third (west third) of the site.
- Once the topsoil has been removed, the bottom of the storage swale is expected to be between 0.4 and 0.8 metres above the subgrade surface. The subgrade should be further excavated as required to ensure a minimum of 0.45 m of separation between the bottom of the swale and the native subgrade.
- Construction traffic on the foot print of the storage swale should be limited as much as possible to avoid compaction of the underlying soils.
- The subgrade surface should be scarified or ripped using the teeth of an excavator following removal of the topsoil.
- The subgrade should be built up to 0.45 metres below the bottom of the storage swale using a sandy material such as the native silty sand or silty sand glacial till present on site. Alternatively silty sands or sand/silt mixes identified as SW using the United Soils Classification System as illustrated in the Ontario Building Code Supplementary Standard SB-6 could be imported to raise the subgrade to the underside of the storage swale bottom soil structure.
- The storage bottom soil structure should consist of a layer of 150 mm thickness of 20mm clear stone placed on the fill materials used to raise the subgrade, topped with a 300 mm thickness of amended existing site topsoil.
- The existing site topsoil can be stripped and stock piled prior to amending. The site topsoil should be amended by mixing 1 part amendment material with 4 parts by volume of site topsoil. The amendment material shall consist of organic matter primarily leaf, yard and back waste compost of 20 - 30% by dry weight as determined by Loss-on-ignition. No uncomposted manure should be used.
- The swale shall be seeded with deep rooted grasses and planted with vegetation that can tolerate both wet and dry soil conditions.
- Discharge from the swale below an elevation of 75.60 metres is by infiltration only.

0 — 20 — 40

SCALE: 1:500 METERS

LEGEND - GRADING

- PROPOSED ELEVATION (PROP/EX)
- PROPOSED TOP OF GRATE ELEVATION
- PROPOSED GRADE
- PROPOSED ELEVATION (PROP/INVERT)
- PROPERTY LINE
- TOP OF SLOPE
- BOTTOM OF SLOPE
- PROPOSED WELL LOCATION
- 100YR MVCA FLOODPLAIN
- 100YR SWM FACILITY PONDING
- 100YR FLOW DEPTH
- LOT RESERVE LINE
- 80m ZONING SETBACK



- PROPOSED DWELLING FOOTPRINT
- PROPOSED SEPTIC BED
- SEPTIC BED MANTLE

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1.	RESPONSE TO SECOND REVIEW COMMENTS	2024.APR.19	SD

CONSULTANTS

Kollaard Associates
Engineers
(613) 860-0923

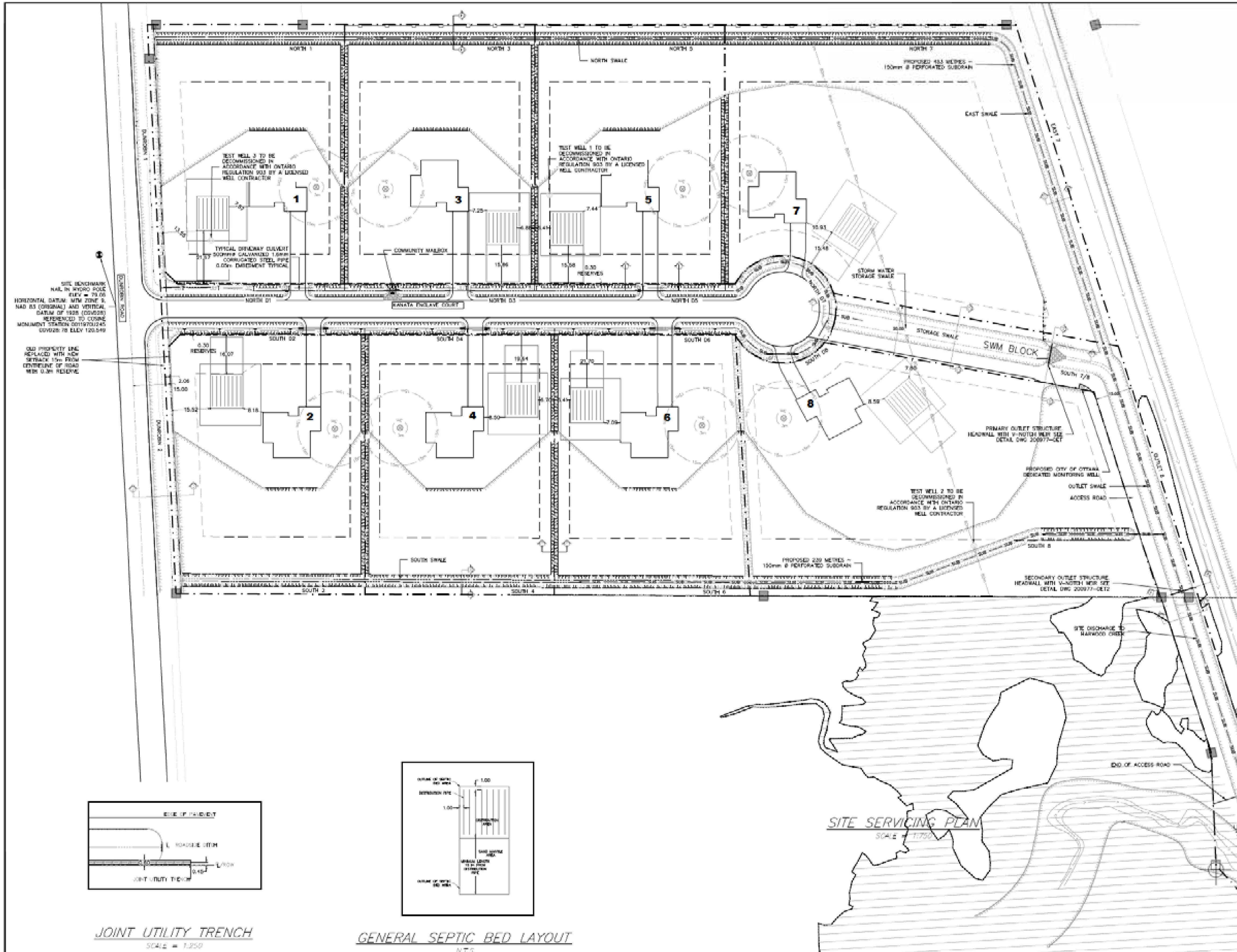
DESIGN	AJ/SD
DRAWN	AJ
CHECKED	SD
APPROVED	SD

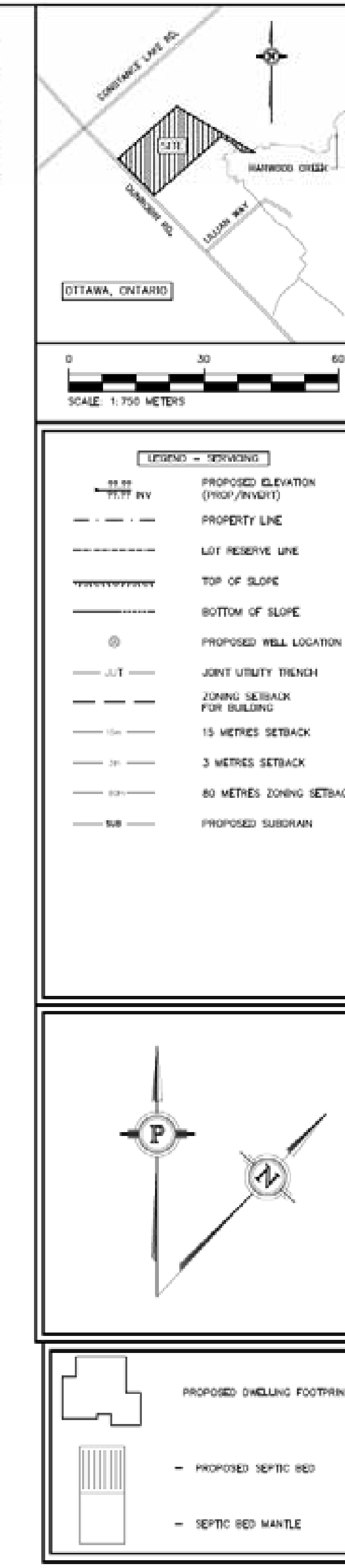
STAMP: LICENSED PROFESSIONAL ENGINEER — 2024.APR.19 — S.E. deWit — 100079612 — PROVINCE OF ONTARIO

CLIENT NAME	ZBIGNIEW HAUDEROWCZ
PROJECT NAME	PROPOSED RESIDENTIAL SUBDIVISION
PROJECT LOCATION	2050 DUNROBIN ROAD OTTAWA, ONTARIO
DRAWING	SITE (EAST) GRADING PLAN

PROJECT No.	200977
DATE	2023/05/05
SCALE	1:500
DRAWING No.	GR-E

002-02-22-0018





Well Construction

- Future wells drilled on the site should be constructed with a minimum 12.0 metres length of casing through the overburden and set at least 1 metre into the sound bedrock, whichever is greater.
- The steel casing placed in the boreholes should be pressure grouted or displacement grouted into place. The material used to seal the annular space could consist of either a cement grout or a commercially available bentonite grout product. Cement grout mixtures should be allowed to set for a minimum two day period for normal cement or twelve hours for a high early strength cement prior to advancing the well further into bedrock. If a bentonite grout product is used, drilling need only be suspended for a few hours depending on the product used. Bentonite grout has the additional advantage of remaining flexible when set and therefore will not crack or shrink thereby ensuring as well as possible that surface water or shallow groundwater will not migrate along the annular space and into the well bore.
- Once the casing has been sealed, the well should be advanced uncased in the bedrock until a water supply of sufficient quantity and quality is encountered. Wells should encounter sufficient water and be completed to depths of less than about 55 metres.
- The completed well should then be developed to maximize the yield.
- The well casings should be completed at least 400 millimetres above the highest point on the finished ground surface within three metres radially from the well after surface drainage is directed away from the well.
- The casing should be fitted with a pitless adapter at a minimum depth of 1.8 metres below the finished ground surface to facilitate below ground plumbing and electrical connections.

Well Decommissioning

- The existing test wells are poorly located with respect to the proposed development. These well are indicated to be decommissioned or abandoned in accordance with Ontario Regulation 903.
- This work should be carried out before any development or infilling of the backwater flood plain.
- Records of abandonment of to be provided to the Ministry of the Environment.

Septic Systems

- Septic systems must meet the requirements of Part 8 of the Ontario Building Code and a Permit must be obtained prior to installation.
- Septic envelopes should be located as much as possible on topographically lower areas with the wells in topographically higher areas.
- The separation distances between the properly constructed wells and the distribution pipe within the septic system should be 15 m plus twice the grade raise.
- Septic systems should be located 35 to 40 metres from down gradient wells on adjacent properties.
- Flipping or moving of wells and septic systems is not permitted in this development.

NOTE:
SUMP PUMPS TO BE UTILIZED FOR FOUNDATION DRAINAGE AS PER TECHNICAL BULLETIN ISTB-2019-02, DRAWING P01 & KOLLAARD GEOTECHNICAL REPORT 200977.
– REFER TO DETAILS (2) FOR TYPICAL DETAIL

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CONSULTANTS

Kollaard Associates Engineers
(613) 860-0923

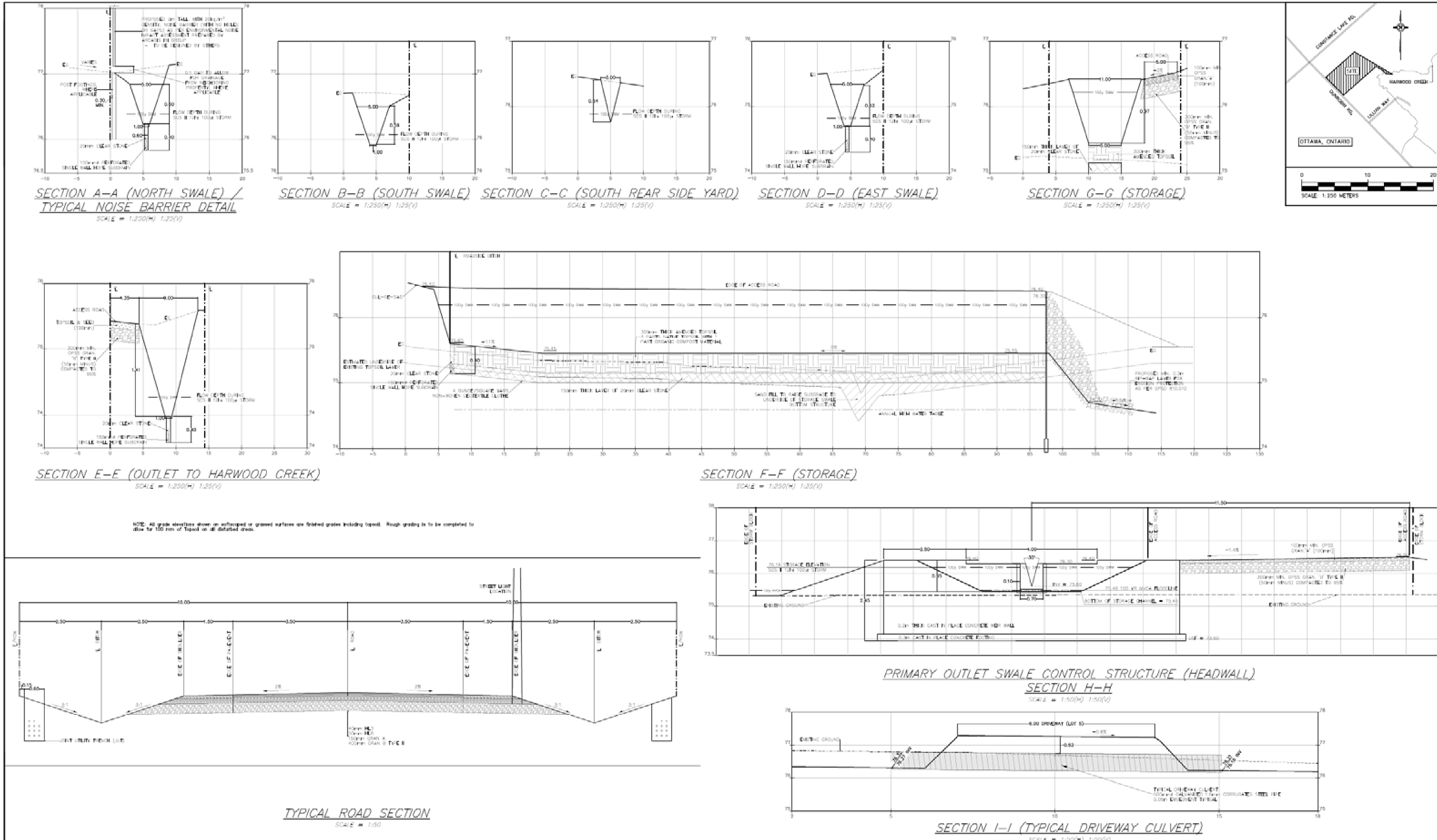
DESIGN	AJ/SD
DRAWN	AJ
CHECKED	SD
APPROVED	SD

STAMP: LICENSED PROFESSIONAL ENGINEER — 2024.APR.19 — S.E. deWit — 100079612 — PROVINCE OF ONTARIO

CLIENT NAME	ZBIGNIEW HAUDEROWICZ
PROJECT NAME	PROPOSED RESIDENTIAL SUBDIVISION
PROJECT LOCATION	2050 DUNROBIN ROAD OTTAWA, ONTARIO
DRAWING	SITE SERVICING PLAN

PROJECT No.	200977
DATE	2023/05/05
SCALE	1:750
DRAWING No.	SVC

002-02-22-0018



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Engineers

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APPROVED	SD

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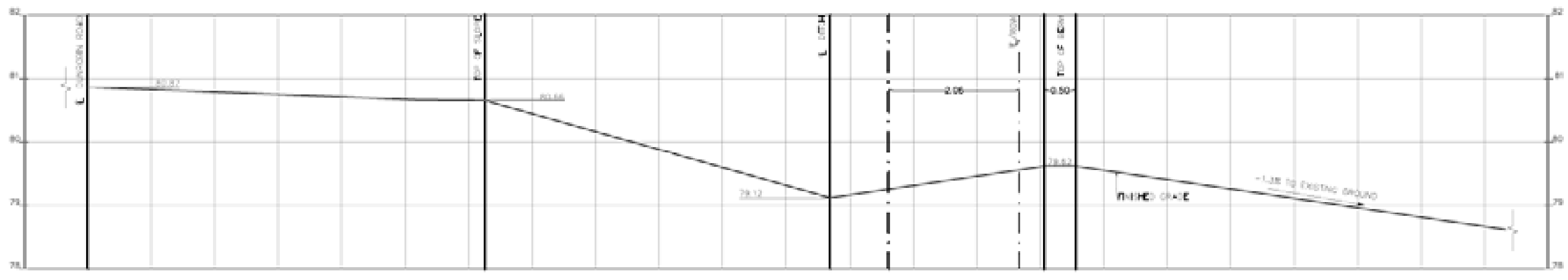
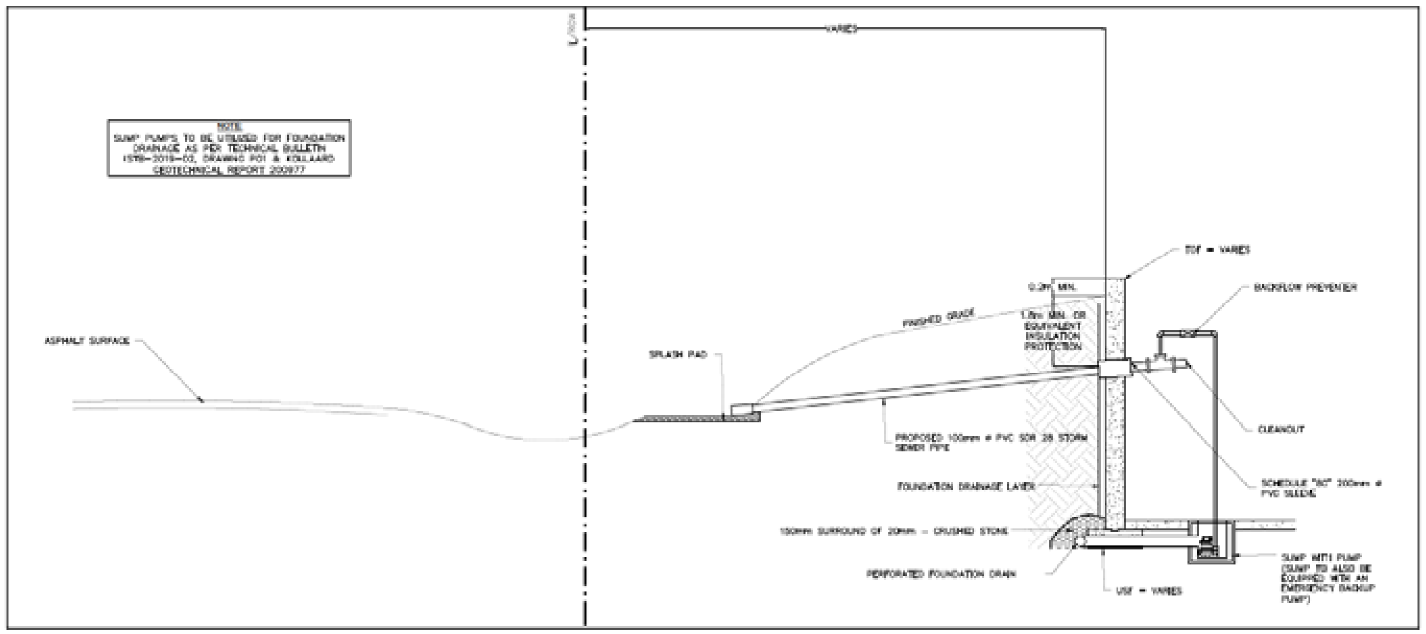
CLIENT NAME	ZBIGNIEW HAUDEROWICZ	PROJECT No.	200977
PROJECT NAME	PROPOSED RESIDENTIAL SUBDIVISION	DATE	2023/05/05
PROJECT LOCATION	2050 DUNROBIN ROAD OTTAWA, ONTARIO	SCALE	AS NOTED
DRAWING	DETAILS	DRAWING No.	DET

002-02-22-0016



SECTION J–J

N.T.S.



TYPICAL FOUNDATION DRAIN AND SUMP DETAIL

N.T.S.

SEEDING – GENERAL

THE SEED MIXES BELOW SHOULD BE SOWED AT THE RATES RECOMMENDED BY THE SUPPLIER.

THE SEED MIXES SHOULD BE SOWED IN COMBINATION WITH A NURSE CROP OF ANNUAL RYE OR OATS WHICH IS SOWED AT A RATE OF 22–25 KG/HA

THE FOLLOWING SEED MIXES ARE INTENDED TO RESULT IN A VEGETATIVE COVER THAT REQUIRES NO MAINTENANCE. THE NATURALLY UN-MAINTAINED CONDITION WILL PROVIDE HEALTHY AND ADEQUATE COVER TO PROTECT THE SURFACES FROM EROSION, FACILITATE VEGETATIVE FILTRATION AND WILL PROVIDE NATURAL HABITAT FOR WILDLIFE.

STORAGE SWALE SEEDING

THE BOTTOM OF THE PROPOSED STORAGE SWALE SHOULD BE LIGHTLY SEEDED WITH SWEET CLOVER IN COMBINATION WITH A MIX SUCH AS WET MEADOW OR STORM POND SEED SUCH AS OS WET MEADOW MIXTURE AS SUPPLIED BY QUALITY SEEDS OR STORMPOND NATIVE SEED MIXTURE OR CREEK BANK NATIVE SEED MIXTURES SUPPLIED BY OSC SEEDS.

THE SIDES SLOPES OF THE STORAGE SWALE SHOULD BE SEEDED WITH A MEADOW MIX SUCH AS OS MEADOW MIXTURE AS SUPPLIED BY QUALITY SEEDS.

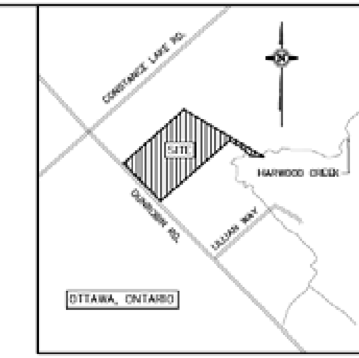
PERIMETER AND OUTLET SWALE SEEDING

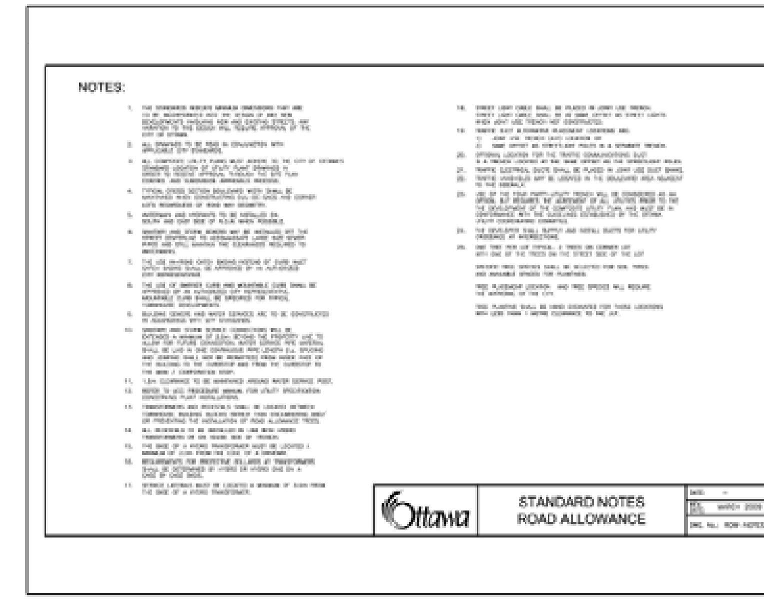
WHERE THE PROPOSED LONGITUDINAL SLOPE OF THE PERIMETER SWALES IS A MINIMUM OF 0.6 PERCENT, BOTH THE SIDES AND BOTTOM OF THE THE PERIMETER SWALES SHOULD BE SEEDED WITH A NATIVE MEADOW MIX SUCH AS OS MEADOW MIXTURE AS SUPPLIED BY QUALITY SEEDS.

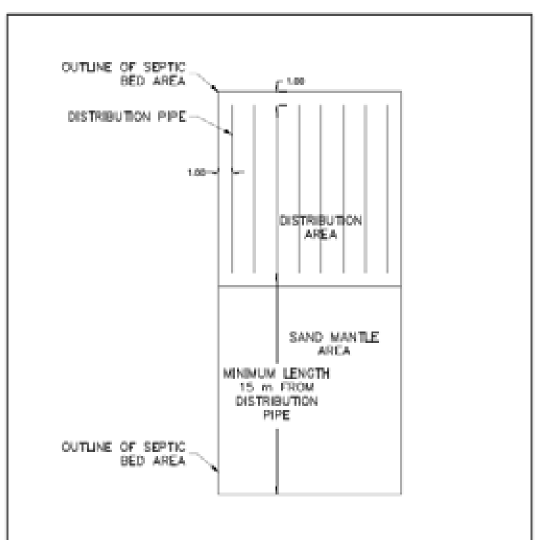
WHERE THE PROPOSED LONGITUDINAL SLOPE OF THE PERIMETER AND OUTLET SWALES IS LESS THAN 0.6 PERCENT, THE BOTTOMS OF THE PERIMETER SWALES SHOULD BE SEEDED WITH A NATIVE MIX SUCH AS WET MEADOW OR STORM POND SEED SUCH AS OS WET MEADOW MIXTURE AS SUPPLIED BY QUALITY SEEDS.

DISTURBED AND UNMAINTAINED REAR YARD AREAS

THE DISTURBED AND PROPOSED UNMAINTAINED AREAS IN THE REAR YARDS SHOULD BE LEVELED AND SEEDED WITH A NATIVE MEADOW MIX SUCH AS OS MEADOW MIXTURE AS SUPPLIED BY QUALITY SEEDS.

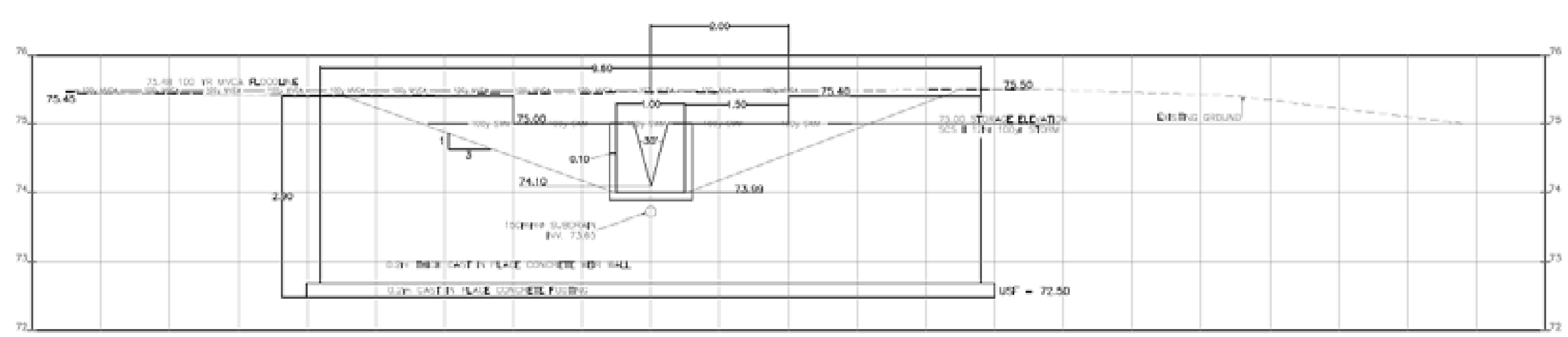






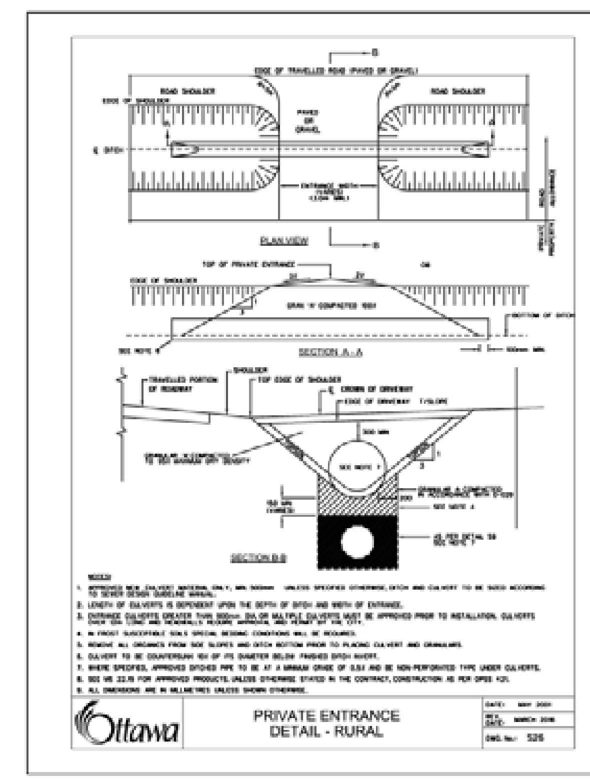
SEPTIC BED LEGEND

N.T.S.



SECONDARY OUTLET SWALE CONTROL STRUCTURE (HEADWALL)
SECTION K–K

SCALE = 1:50(H) 1:50(V)



NOTES:
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No.	REVISION	DATE	BY
1	RESPONSE TO SECOND REVIEW COMMENTS	2024 APR.19	SD

CONSULTANTS

Kollaard Associates Engineers

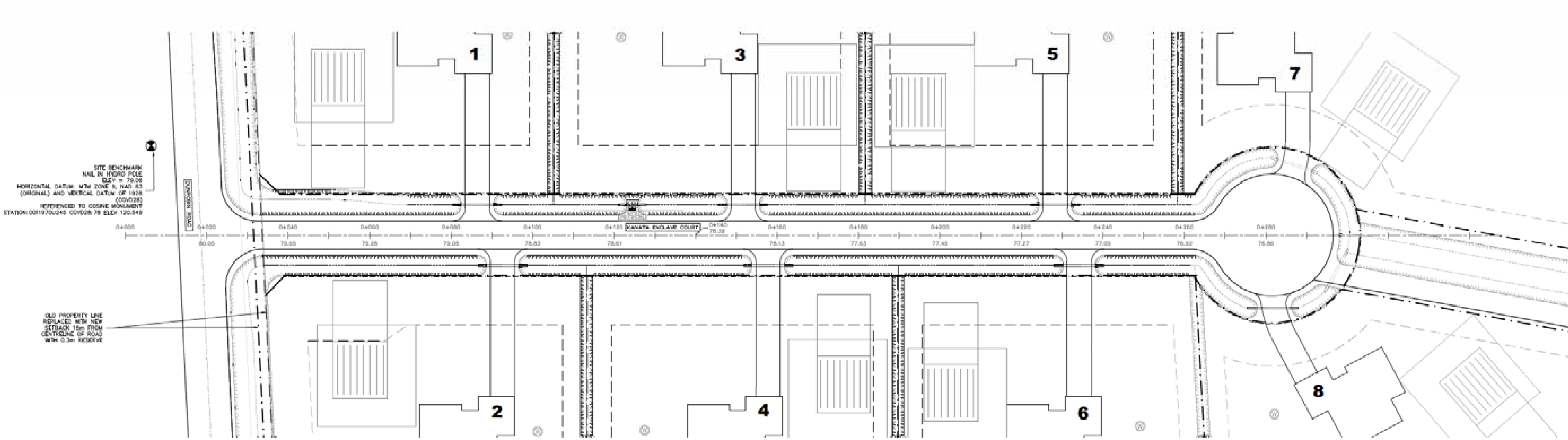
(613) 860-0923

DESIGN	AJ/SD
DRAWN	JR
CHECKED	SD
APPROVED	SD

STAMP: LICENSED PROFESSIONAL ENGINEER — 2024.APR.19 — S.E. deWit — 100079612 — PROVINCE OF ONTARIO

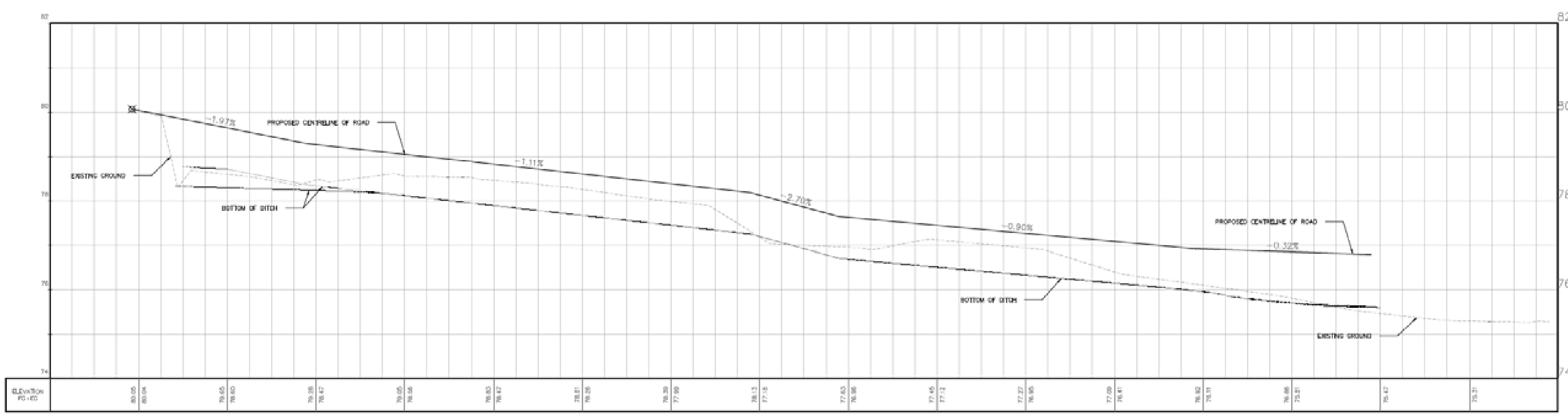
CLIENT NAME	ZBIGNIEW HAUDEROWICZ
PROJECT NAME	PROPOSED RESIDENTIAL SUBDIVISION
PROJECT LOCATION	2050 DUNROBIN ROAD OTTAWA, ONTARIO
DRAWING	DETAILS (2)

PROJECT No.	200977
DATE	2023/05/05
SCALE	AS NOTED
DRAWING No.	DET(2)



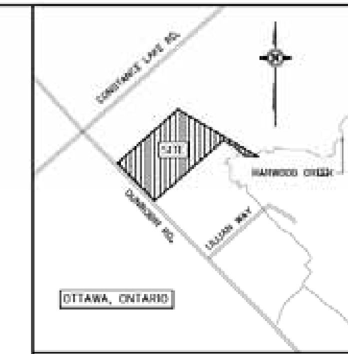
KANATA ENCLAVE COURT PLAN

SCALE = 1:500(H) 1:50(V)



KANATA ENCLAVE COURT PROFILE

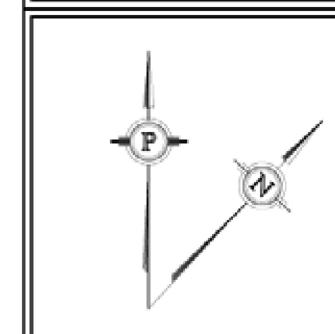
SCALE = 1:500(H) 1:50(V)



SCALE: 1:500 METERS

LEGEND — PP

- PROPERTY LINE
- TOP OF SLOPE
- BOTTOM OF SLOPE
- PROPOSED CULVERT
- LOT RESERVE LINE
- ZONING SETBACK FOR BUILDING



- PROPOSED DWELLING FOOTPRINT
- PROPOSED SEPTIC BED
- SEPTIC BED MANTLE

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CONSULTANTS

Kollaard Associates Engineers
(613) 860-0923

DESIGN	AJ/SD
DRAWN	AJ
CHECKED	SD
APPROVED	SD

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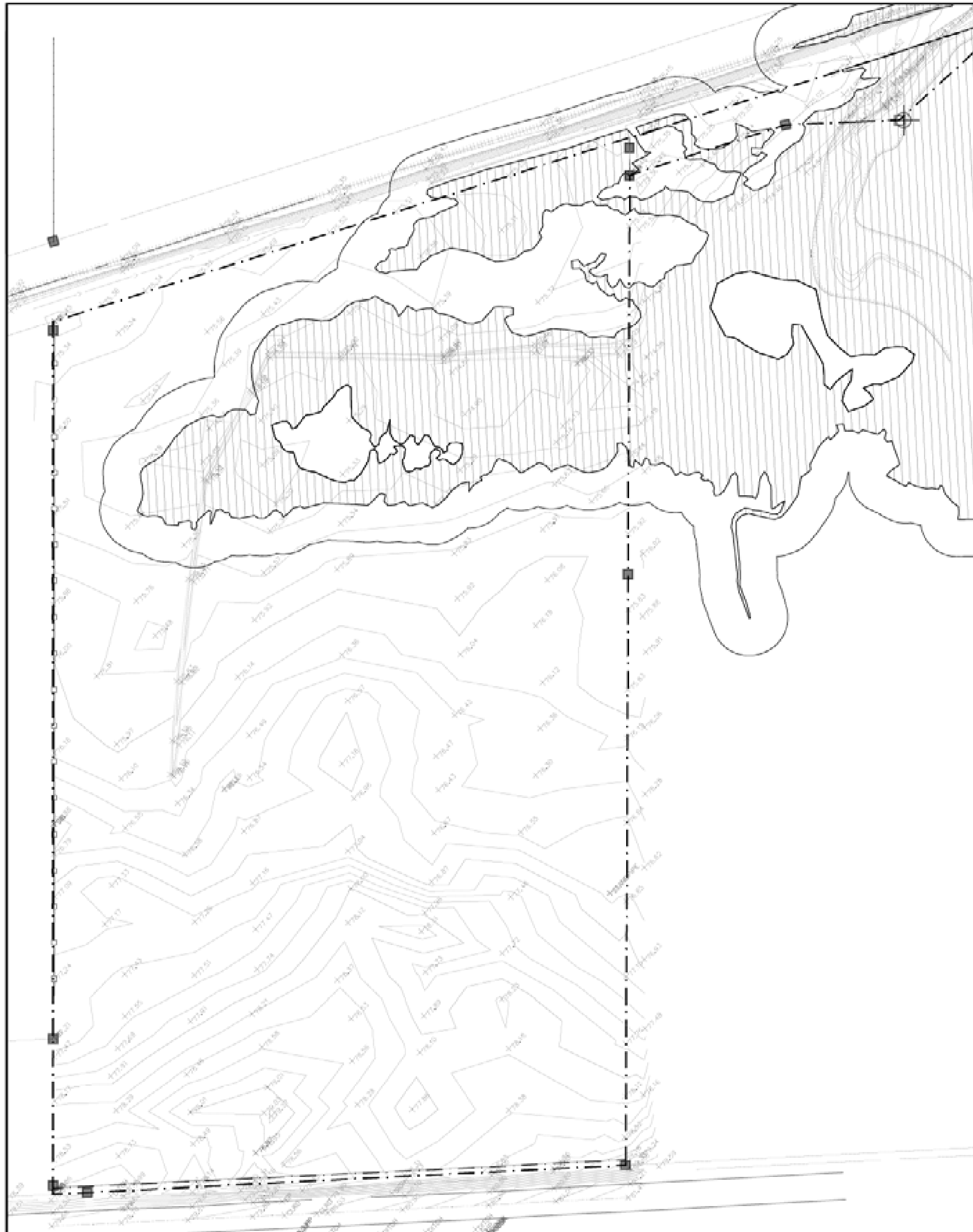
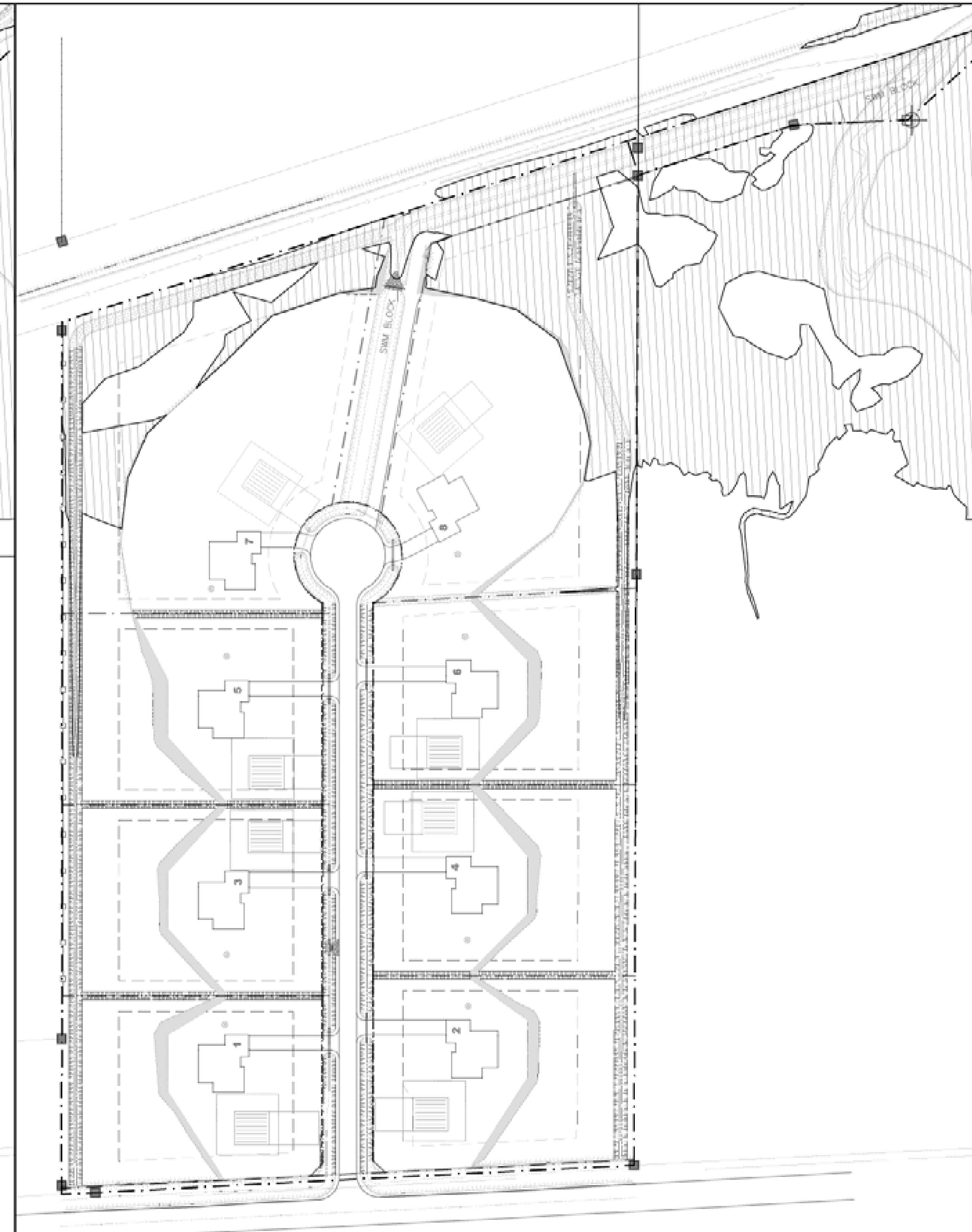
CLIENT NAME	ZBIGNIEW HAUDEROWICZ
PROJECT NAME	PROPOSED RESIDENTIAL SUBDIVISION
PROJECT LOCATION	2050 DUNROBIN ROAD OTTAWA, ONTARIO
DRAWING	PLAN AND PROFILE
PROJECT No.	200977
DATE	2023/05/05
SCALE	1:500
DRAWING No.	PP

002-02-22-0018



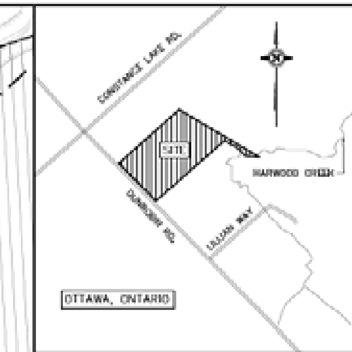
PRE-DEVELOPMENT 100YR FLOODPLAIN (JFSA)

SCALE = 1:1000



POST-DEVELOPMENT 100YR FLOODPLAIN

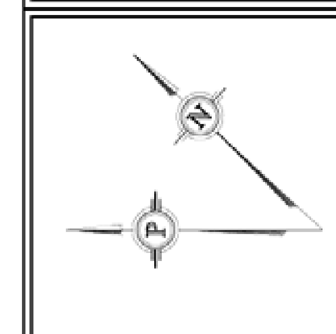
SCALE = 1:1000



SCALE 1:1000 METERS (0 – 40 – 80)

LEGEND – GRADING

- PROPOSED ELEVATION (PROP/EX)
- PROPOSED TOP OF GRATE ELEVATION
- PROPOSED GRADE
- PROPOSED ELEVATION (PROP/INVERT)
- PROPERTY LINE
- TOP OF SLOPE
- BOTTOM OF SLOPE
- PROPOSED WELL LOCATION
- 100YR MVCA FLOODPLAIN
- 100YR SWM FACILITY PONDING
- 100YR FLOW DEPTH
- LOT RESERVE LINE
- 80m ZONING SETBACK



- PROPOSED DWELLING FOOTPRINT
- PROPOSED SEPTIC BED
- SEPTIC BED MANTLE

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CONSULTANTS

Kollaard Associates
Engineers
(613) 860-0923

DESIGN	AJ/SD
DRAWN	AJ
CHECKED	SD
APPROVED	SD

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CLIENT NAME	ZBIGNIEW HAUDEROWICZ	PROJECT No.	200977
PROJECT NAME	PROPOSED RESIDENTIAL SUBDIVISION	DATE	2023/05/05
PROJECT LOCATION	2050 DUNROBIN ROAD OTTAWA, ONTARIO	SCALE	1:1000
DRAWING	FLOODPLAIN COMPARISON	DRAWING No.	FP