D. G. Biddle & Associates Limited
consulting engineers and planners

PRELIMINARY STORMWATER DRAINAGE AND FUNCTIONAL SERVICING REPORT

FOR THE VELTRI GROUP

DRAFT PLAN OF SUBDIVISION VELTRI WEST LANDS

VILLAGE OF MILLBROOK TOWNSHIP OF CAVAN-MONAGHAN

PROJECT NO. 115040 **DATE: OCT 2018**

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October 17, 2018

Township of Cavan Monaghan
988 County Road 10
Millbrook ON L0A 1G0

Attention: Ms. Karen Ellis, Director of Planning

**Re: Preliminary Functional Servicing & Stormwater Management Report
Veltri West Lands
Turner Street
Millbrook (Township of Cavan-Monaghan) ON
Our File: 115040**

Dear Ms. Ellis:

In support of the application for Draft Plan of Subdivision on the above referenced property, we respectfully submit the following Preliminary Functional Servicing and Stormwater Management Report.

This report is intended to be reviewed by the Township of Cavan Monaghan and the Otanabee Regional Conservation Authority to confirm that the necessary infrastructure is available to service the subject lands. It will also discuss how stormwater runoff for the development will be treated prior to its discharge to a tributary of Little Creek. Upon review of the report, we believe the approval agencies will be in a position to issue positive comments and conditions of draft approval for the Plan of Subdivision.

Please contact our office at your convenience, should you have any questions or require additional information on the enclosed report.

Yours truly,

D.G. BIDDLE & ASSOCIATES LIMITED

G.M. Cook, B.A.Sc.
E.I.T.

M. B. Carswell, P.Eng.
Municipal Design Engineer, Associate

LICENSED PROFESSIONAL ENGINEER
M. B. CARSWELL
PROVINCE OF ONTARIO

MBC/GMC/gmc
Encl.

\\FSHR\Staff\Job Files\115000\115040 Veltri Centre Street\115040 Reports\115040 Turner Street\115040 Preliminary FSR&SWM.doc

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1.0 INTRODUCTION

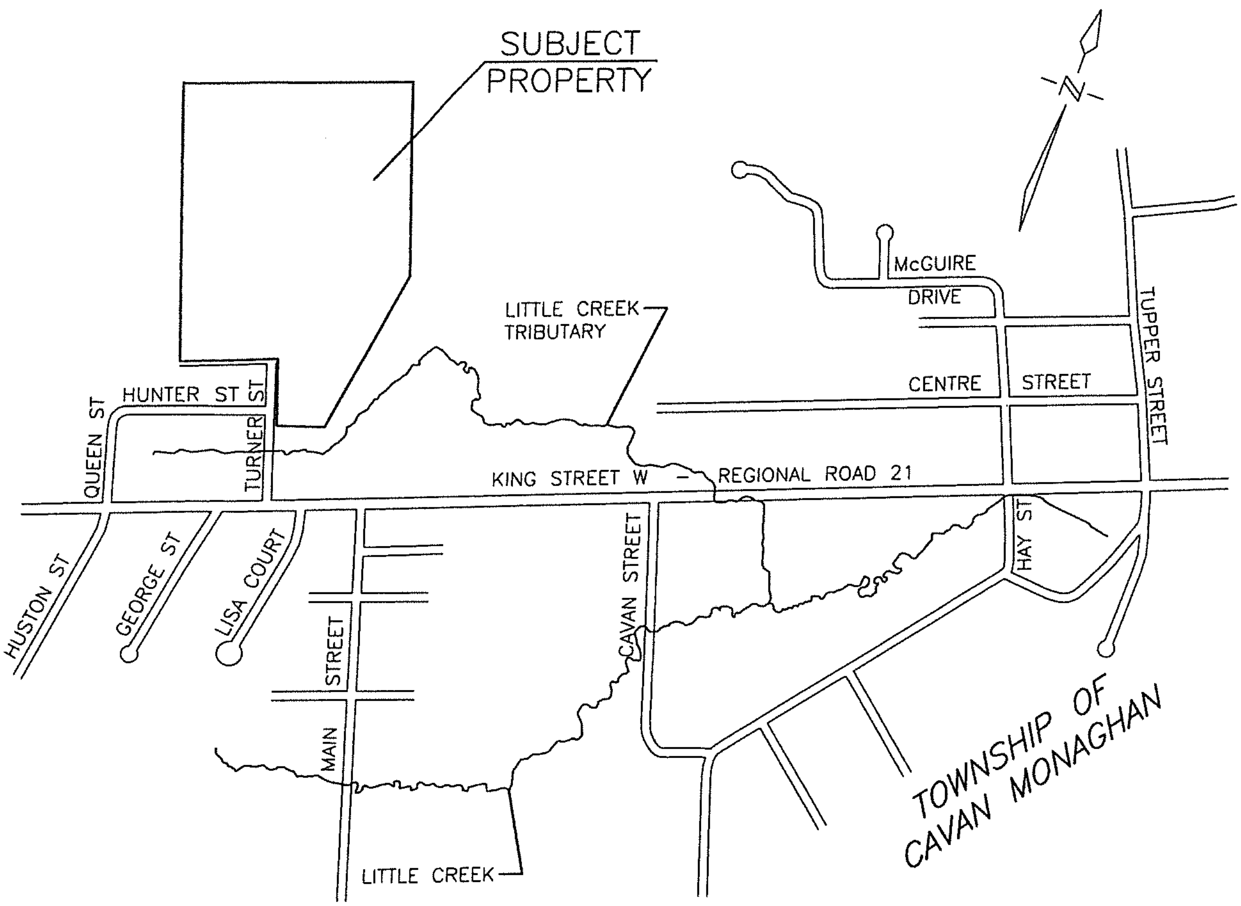
1.1 Purpose

This Preliminary Functional Servicing and Stormwater Management Report has been prepared to review the infrastructure requirements to provide services for the proposed Draft Plan of Subdivision. It will address sanitary sewer services, watermain services, and storm water drainage works required to proceed with the development. This report will also discuss the storm water quality and quantity control objectives for a tributary of Little Creek in accordance with the requirements of the Otanabee Regional Conservation Authority.

1.2 Site Location and Description

The study area forms part of Lot 13, Concession 5, in the former Geographic Township of Cavan, now the Township of Cavan-Monaghan, and County of Peterborough. The development is bound on the north by vegetated/forest lands, on the west by the demolished correctional facility, on the east by vegetated/forest lands and abandoned rail corridor and on the south by existing residential lands. A Site Location Plan, Figure 1, illustrates the site in relation to the surrounding areas. A copy of the Draft Plan of Subdivision is attached at the end of this report as drawing 115040 DP-1.

The current site consists primarily of a sloped open field with a total relief of approximately 28m. The majority of the site drains primarily in an easterly direction to a tributary of Little Creek. Locally, a small portion of land drains to the existing ditch on Turner Street before discharging to the Little Creek tributary.



VELTRI WEST LANDS — TURNER STREET

SITE LOCATION PLAN

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SCALE	N.T.S.	PROJECT	115040
DRAWN	G.M.C.	DWG	FIG 1
DESIGN	M.B.C.		
CHECKED	M.B.C.		
DATE	MAR 2018		

2.0 SITE SERVICING

2.1 Water Distribution System

The existing water distribution infrastructure consists of a 150mm watermain located at the existing limit of Turner Street road allowance. The Municipality recently upgraded the watermain on King Street to 250mm. The proposal is to connect to the new 250mm main on King Street and extend a 200mm watermain to the subdivision, replacing the existing 150mm main on Turner Street. The proposed 200mm watermain connection is illustrated on the Conceptual Site Servicing Plan, drawing 115040 SS-1, attached at the end of this report.

2.2 Sanitary Sewers

Currently, there is an existing 200mm sanitary sewer located at the southern limit of the development on Turner Street. This existing system will be utilized to service the proposed development. A 200mm sanitary sewer system is proposed to convey the sanitary drainage south and connect to the existing sanitary sewer on Turner Street.

The internal sanitary sewer will be sized in accordance with the Township of Cavan Monaghan design criteria, with consideration on minimum and maximum grades, depths and velocity. The minimum sewer diameter will be 200mm, with all terminal legs having a minimum grade of 1.00%. All service laterals will be 100mm diameter at 2.00% minimum grade. The proposed internal sanitary sewer network is illustrated on the Conceptual Site Servicing Plan, drawing 115040 SS-1, attached at the end of this report.

2.3 Storm Sewers and Major Overland Flow

A proposed storm sewer system will be designed as per Township of Cavan-Monaghan standards, based on a 5-year return frequency event. Foundation drains from the proposed basements will be connected to the proposed storm sewer system through sump pumps. The drainage system will accommodate minor flows in the storm sewers and major overland flows will be accommodated within the streets during storm events in excess of the 5-year flow.

Storm flows for the minor events will be conveyed through one of two quality control oil/grit separators (Stormceptor) for treatment of the runoff, one upon exiting a proposed Stormwater Management Dry Pond and the other before being discharged to the existing Turner Street ditch. The stormwater management features are located at the eastern limit of the proposed development area. The proposed Stormwater Management Dry Pond will outfall to the existing wetland area, east of the development.

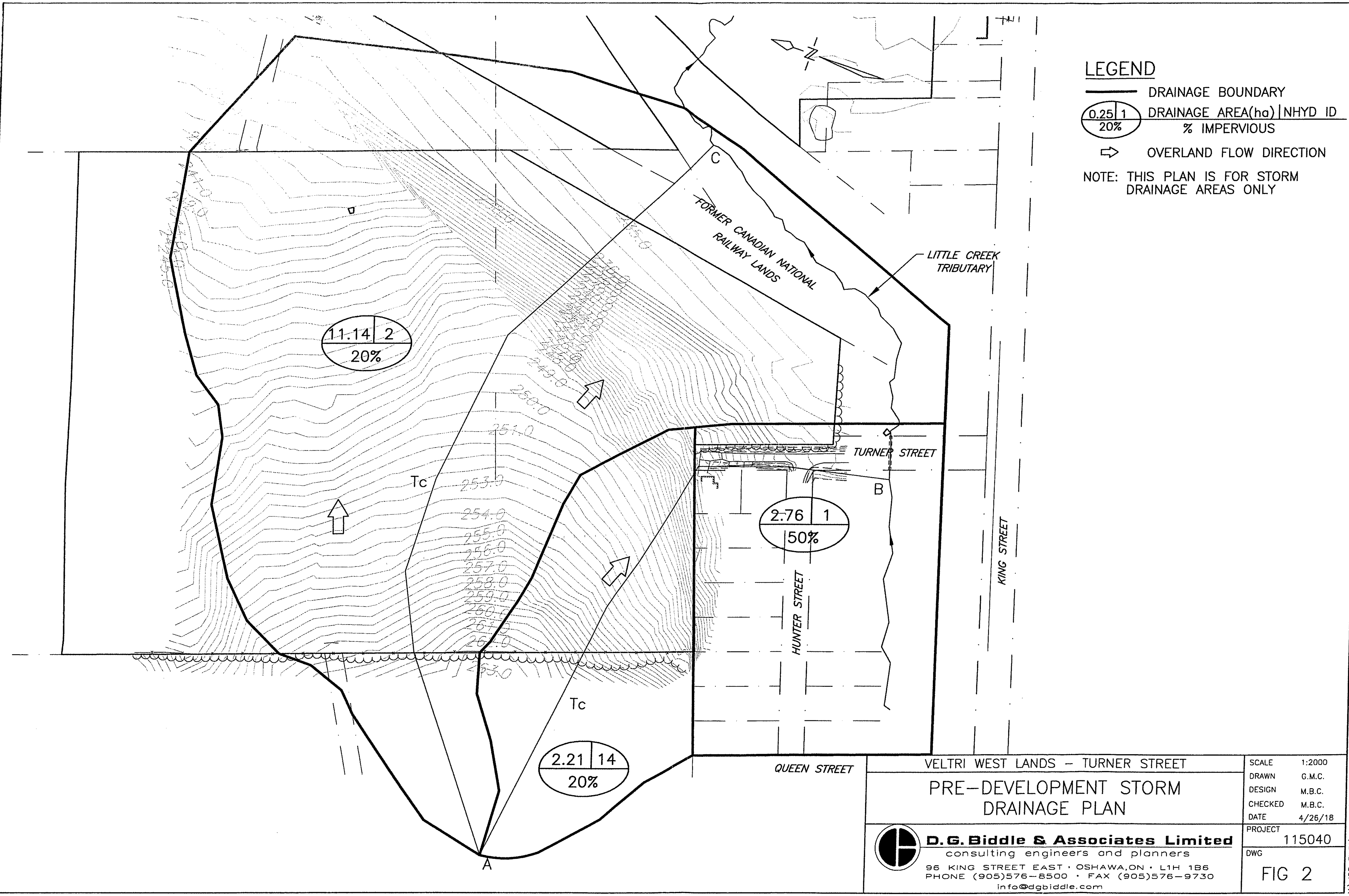
The quality control Stormceptors will provide Enhanced Protection quality control through the treatment train process. The dry pond will be the primary means of providing post-development to pre-development quantity control. Conceptual details of the facilities are described in Section 3.0 below. The storm sewer drainage network is illustrated on the Conceptual Site Servicing Plan, drawing 115040 SS-1. The Conceptual Site Grading Plan illustrates the proposed road grades for the major system and is attached as drawing 115040 SG-1.

3.0 STORMWATER QUANTITY CONTROLS

As noted above, the majority of the site drains in an easterly direction, while a small portion of the site drains to the existing ditch on Turner Street, both eventually discharging to a tributary of Little Creek. The Pre-Development Storm Drainage Scheme is attached, drawing 115040 Figure 2. The post-development conditions reflect a similar drainage divide, sending the majority of the flow to a proposed Quantity Control Dry Pond before discharging east. It is proposed that storm drainage be conveyed by a dual drainage system. The minor storm sewer system will be designed to accommodate minor flows (1 in 5 years), while major storm flows will be conveyed by a surface system of swales and roadways to convey overland flows to the proposed dry pond. A small portion of the site will convey the major flows overland south to the existing ditch on Turner Street.

3.1 Stormwater Quantity Controls – Eastern Drainage

We have reviewed the post-development watershed using the DESIGN STANDHYD Sub-Routine of the computer model Visual Otthymo 3.0. For a direct comparison, the pre-development and post-development watersheds for the subject site have been modelled using a 6-hour AES, 6-hour SCS, 12-hour SCS and 12-hour Chicago distribution rainfall event for the 2, 5, 10, 25, 50 and 100-year events. The 6-hour SCS storm event generated the greatest runoff peak flows and volumes for both pre-development and post-development conditions, therefore this design storm was used to simulate rainfall events for the site. The rainfall intensity-duration values for Peterborough Airport were used to compute the peak flows. Input parameters for time to peak values for the computer model were calculated using the MTO Drainage Manual equations. The calculations are attached in Schedule 1. The input parameters for the curve numbers were estimated based on the MTO drainage manual design charts 1.08 and 1.09, which are included in Schedule 1. It has been assumed that the native soils in the area are in the Hydrologic Soil Group C (silt/clay). This will have to be verified upon completion of the Geotechnical Investigation during detail design.



VELTRI WEST LANDS - TURNER STREET

PRE-DEVELOPMENT STORM DRAINAGE PLAN

SCALE	1:2000
DRAWN	G.M.C.
DESIGN	M.B.C.
CHECKED	M.B.C.
DATE	4/26/18
PROJECT	115040
DWG	FIG 2

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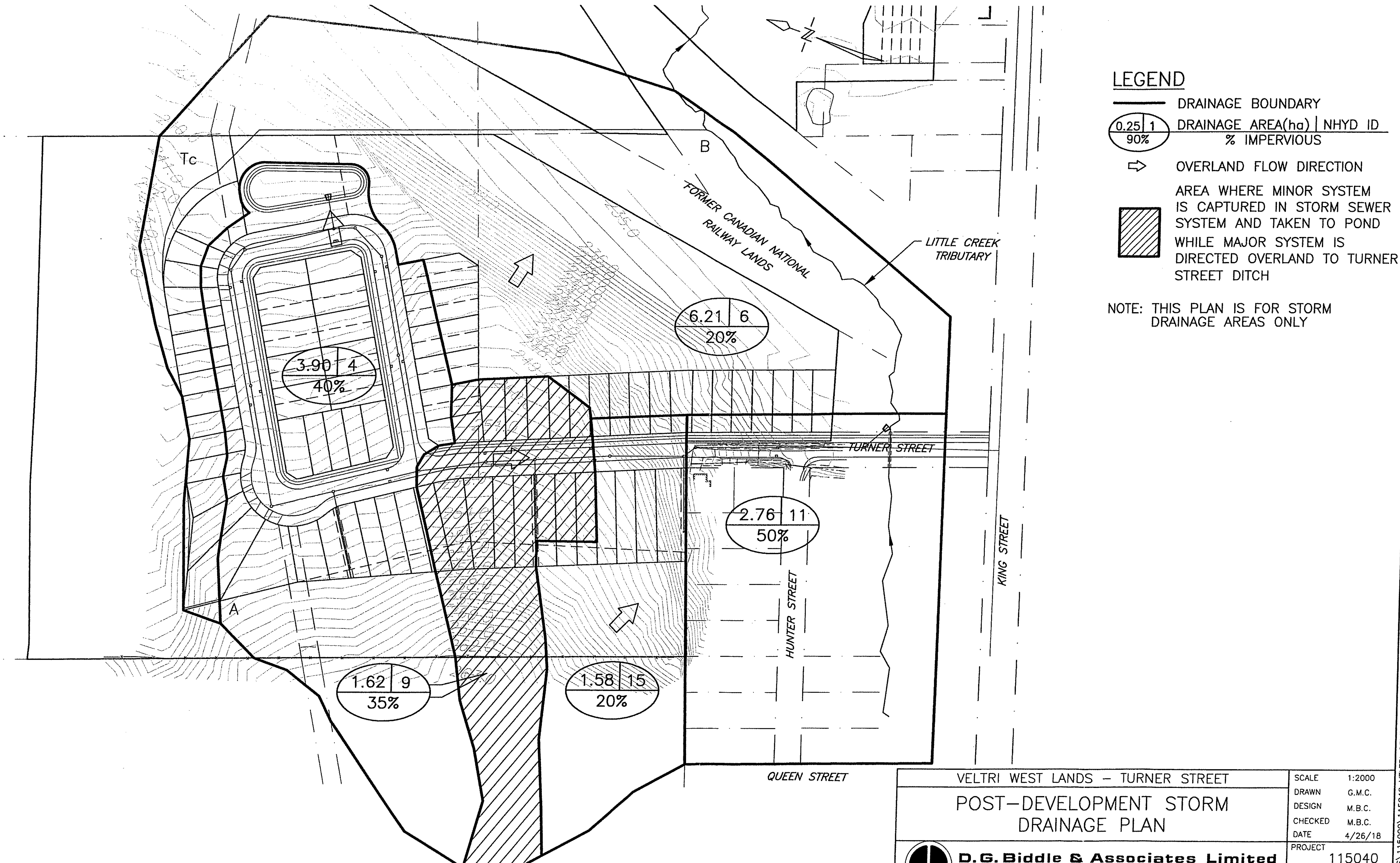
Y:\JOB FILES\115000\115040 VELTRI CENTRE STREET\115040 DRAWINGS CIVIL\115040 CONCEPTUAL DEVELOPMENT AND PRELIMINARY ENGINEERING\115040-SWM FIGS.DWG

The quantity control storage volume of approximately 2400m^3 is achieved through the berming and excavation of the facility from an elevation of 241.00m to 243.00m. This provides greater than 300mm freeboard above the maximum anticipated 100-year water surface elevation in the facility. Through the introduction of a 450mm outlet pipe discharging to a manhole, located within the maintenance access of a pond, with a 190mm orifice control plate, the proposed stormwater dry pond will attenuate post-development peak flows to pre-development levels. The Post-Development Storm Drainage Scheme is illustrated on drawing 115040 Figure 3. The ROUTE RESERVOIR Sub-Routine was used to simulate the performance of the pond. A comparison of the pre-development and routed post-development peak flows are tabulated below. The Visual Otthymo summary files are attached in Schedule 2.

TABLE 1: PEAK FLOWS TO EAST

RETURN FREQUENCY (Years)	TOTAL PRE-DEV. PEAK FLOW TO EAST (L/s)	POND INLET POST-DEV PEAK FLOW (L/s)	ROUTED POND OUTFALL FLOW (L/s)	TOTAL POST-DEV. FLOW TO EAST (L/s)	POND WSE (m)
2	211	324	54	149	241.61
5	388	511	69	243	241.93
10	524	609	77	315	242.13
25	712	808	85	410	242.35
50	863	926	91	486	242.53
100	1020	1047	96	564	242.68

As is reported above, post-development peak flows are less than pre-development levels; therefore, no adverse impact to the existing storm drainage network is anticipated. The post-development peak flows have been over-attenuated in order to compensate for the inability to attenuate post-development peak flows to pre-development levels on Turner Street.



VELTRI WEST LANDS – TURNER STREET

POST–DEVELOPMENT STORM DRAINAGE PLAN

SCALE	1:2000
DRAWN	G.M.C.
DESIGN	M.B.C.
CHECKED	M.B.C.
DATE	4/26/18
PROJECT	115040
DWG	FIG 3

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3.2 Stormwater Quantity Control – Turner Street Outfall

Currently, 4.96ha of the site drains to an existing ditch on Turner Street before discharging to the tributary of Little Creek. With the proposed development, 4.37ha of the site will drain to the ditch at an impervious level of 30%. Also, the major flows from 1.62ha of the development will drain south to the ditch. The DuHyd Sub-Routine was used to simulate the split of minor flows to the pond and major flows to Turner Street. The inlet capacity of these catch basins has been designed to capture up to the 5 year storm event.

Due to the steep road grade required to meet the existing ground at the southern limit of the development, these flows cannot be captured or attenuated in the stormwater quality facility. Tabulated below is a comparison of the post-development peak flows to pre-development levels for the Turner Street outlet.

TABLE 2: PEAK FLOWS TO TURNER STREET

RETURN FREQUENCY (YEARS)	PRE-DEV. PEAK FLOW (L/s)	POST-DEV. PEAK FLOW (L/s)
2	203	220
5	329	357
10	423	539
25	600	770
50	711	936
100	824	1107

As is reported above, post-development peak flows are not less than pre-development levels; therefore, it is proposed that the existing ditch and road be improved in order to convey the increase in peak flows to the Little Creek tributary. This will be completed in the detail engineering design stage.

3.3 Stormwater Quantity Controls – Little Creek

Due to the fact that the post-development peak flows tributary to the existing ditch on Turner Street are greater than pre-development levels, an analysis of the overall post-development drainage from the site is required. Tabulated below is a comparison of the total post-development peak flows to pre-development levels tributary to Little Creek.

TABLE 3: PEAK FLOWS TO LITTLE CREEK

RETURN FREQUENCY (YEARS)	PRE-DEV. PEAK FLOW (L/s)	POST-DEV. PEAK FLOW (L/s)
2	360	301
5	645	497
10	862	720
25	1131	1009
50	1363	1222
100	1498	1440

As is reported above, overall post-development peak flows are less than pre-development levels; therefore, no adverse impact to the tributary of Little Creek or the existing storm drainage network is anticipated.

4.0 STORMWATER QUALITY CONTROLS

As noted in above, the subject site is tributary to Little Creek, which is a regulated watercourse as administered by Otanabee Regional Conservation Authority (ORCA). Little Creek provides habitat for cold water fish species, thereby requiring protection from increased erosion, sedimentation and degradation of water quality. Therefore Level 1 Enhanced protection is required.

4.1 Quality Controls – East Drainage

The Storm Water Management Practices Planning and Design Manual (March 2003) recommends end of pipe facilities for areas larger than 5ha. Although an area of approximately 5.52ha is tributary to the pond, a large portion of this is to remain undeveloped land, which is essentially clean water. The proposed service area tributary to the pond does not encompass a significant area, being approximately 3.42ha in size. Due to the relatively small size of the development and service area, a wet pond is not recommended as it is unlikely to maintain a permanent pool. The dry pond facility's primary purpose is for the attenuation of post-development peak flows, and will not provide the necessary quality controls.

The Storm Water Management Practices Planning and Design Manual (March 2013) also recommends oil/grit separators for areas less than 2ha. Due to grading constraints, other recommended quality controls are not achievable. It is noted that the actual impervious areas tributary to the pond is less than 2ha. Therefore, stormwater quality treatment for the proposed development is proposed to be provided through the implementation of a Stormceptor STC-2000. It will be installed downstream of the proposed dry pond, ensuring the volume of stormwater treated is maximized. Sizing calculations are attached at the end of this report.

4.2 Quality Controls – Turner Street Outlet

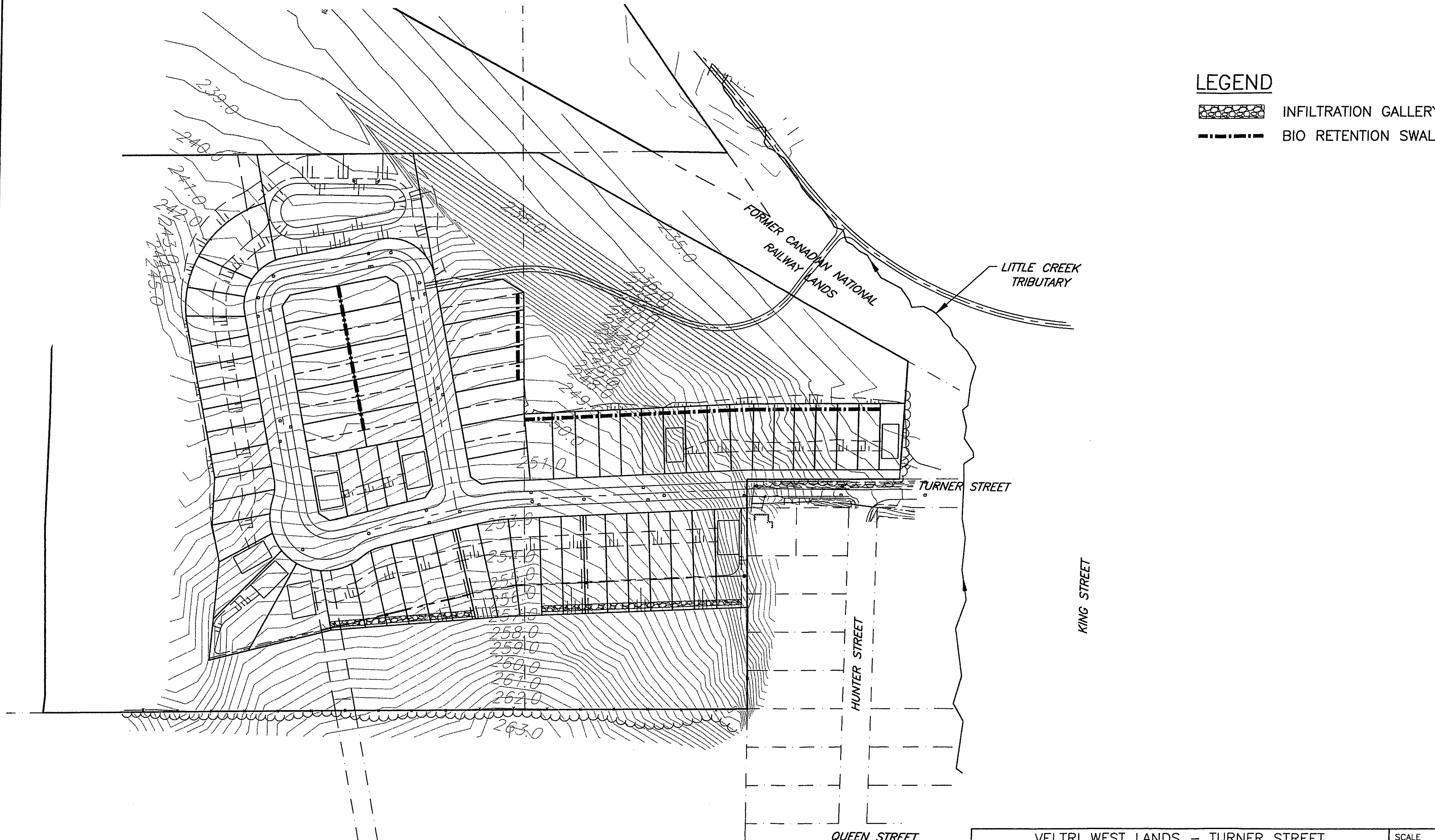
Similar to the development area tributary to the pond, the proposed development area tributary to the Turner Street outlet is approximately 2.47ha. Therefore, stormwater quality treatment for the proposed development is proposed to be provided through the implementation of a Stormceptor STC-4000. It will be installed prior to the outlet to the Little Creek Tributary on Turner Street. It would also service the existing Hunter Street development thereby improving the water quality for both existing and proposed development lands. Sizing calculations are attached at the end of this report.

4.3 Low Impact Development Techniques

Low Impact Development Techniques (LIDs) are required to promote infiltration towards maintaining a post development water balance. Figure 5 illustrates locations where opportunities for Low Impact Development Techniques can be provided for the following measures.

To promote water filtering and infiltration on the individual residential building lots, roof water leaders will be discharged to grade and lots will be dressed with 300mm of topsoil. Discharging roof water leaders to grade will lengthen the time available for run off to infiltrate into the topsoil before entering the storm sewer system. The sub-grade material below the topsoil should be graded at 2.0% grade minimum prior to placing topsoil. The will assist in preventing surface water being trapped at the interface of the topsoil and less pervious sub-grade material.

In addition to disconnected downspouts and increased topsoil depth, bio-retention swales and infiltration galleries are proposed throughout the plan. Bio-retention swales are proposed along the rear yard of the single units at various locations of the site. Since there are no rear yard catch basins where the bio-retention swales will be located, an underdrain is not proposed as there will not be a connection location available. The bio-retention swale will intercept rear yard drainage, as well as the rear portion of building rooftops. They will be sized to infiltrate up to 10mm of run-off from the



VELTRI WEST LANDS – TURNER STREET

POTENTIAL LOW IMPACT DEVELOPMENT TECHNIQUE LOCATIONS

SCALE	1:2000
DRAWN	D.D.M.
DESIGN	M.B.C.
CHECKED	D.D.M.
DATE	10/17/18
PROJECT	115040
DWG	FIG 5

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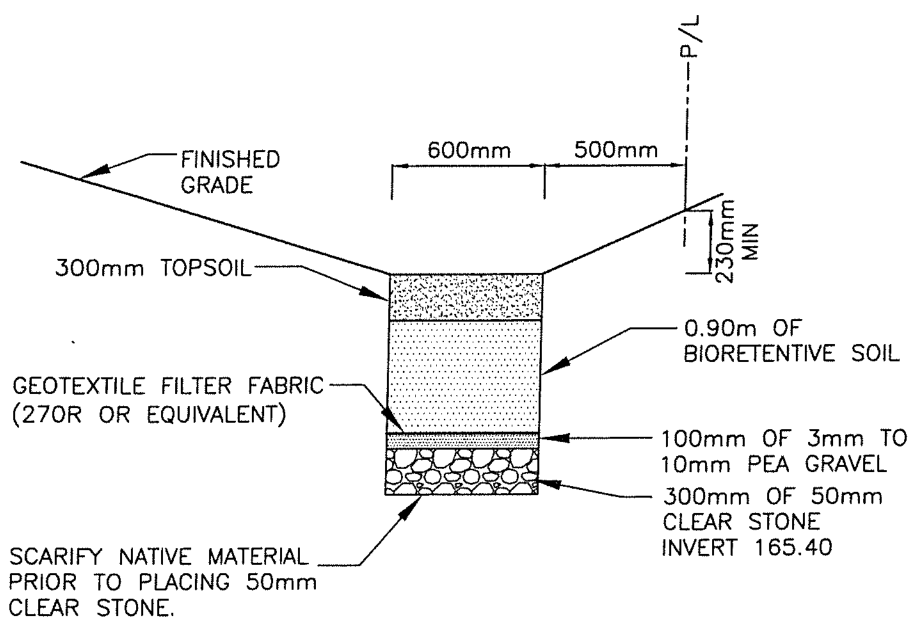
\\FSHR\STAFF\JOB FILES\115000\115040 VELTRI CENTRE STREET\115040 DRAWINGS CIVIL\115040 CONCEPTUAL DEVELOPMENT AND PRELIMINARY ENGINEERING\115040 CONCEPTUAL ENGINEERING\115040-SWM FIGS – TURNER STREET.DWG contributing area. Conceptual locations for the bio-retention swales are illustrated in Figure 5, with a detail provided on Figure 6. The suitability of these locations will need to be verified at the detail design stage.

The single lots on the western side of the subject property will have rear yard swale conveying stormwater to rear lot catchbasins. In these locations, we are proposing the implementation of infiltration trenches. The infiltration trench will be filled with 50mm diameter stone, wrapped in filter cloth with an underdrain. Similar to the bio-retention swale, it will be sized to accommodate 5mm of run-off from the contributing area. Stormwater intercepted by the rear lot catchbasin from offsite areas, will flood the underdrain and stone. An overflow will be provided as a positive outlet to the catchbasin sewer lead, once the infiltration trench volume has been reached. Conceptual locations for the infiltration trenches are illustrated in Figure 5, with a detail provided on Figure 7. The suitability of these locations will need to be verified at the detail design stage.

The extent of the LIDs listed above will need to be coordinated with the final Hydrogeological Report to ensure a reasonable water balance is achieved.

4.3 Quality Controls During Construction

As set out in the Storm Water Management Practices Planning and Design Manual (March 2003), a new development is required to provide temporary storm water quality controls during construction. In this regard, during the detailed engineering design stage, a Sediment and Erosion Control Plan will be developed to ensure that sediment does not impact the receiving watercourse during the construction stage of the development. The Sediment and Erosion Control Plan will detail control measures such as temporary sediment ponds, enviro fencing, mud mats, and catchbasin filters. These measures are intended to provide protection from sediment impacting Little Creek.



BIORETENTIVE SOIL
85% SAND
10% FINE SOIL
5% ORGANIC MATERIAL

VELTRI WEST LANDS – TURNER STREET

TYPICAL BIO RETENTION SWALE DETAIL

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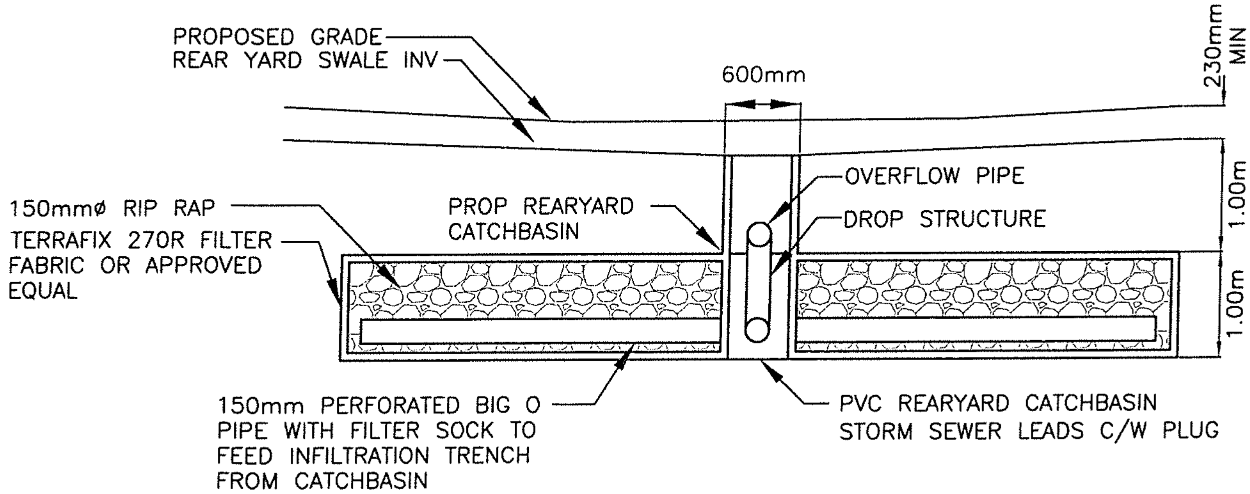
SCALE	N.T.S.
DRAWN	D.D.M.
DESIGN	D.D.M.
CHECKED	M.B.C.
DATE	OCT 2018
PROJECT	115040
DWG	FIG 6



VELTRI WEST LANDS – TURNER STREET

TYPICAL INFILTRATION TRENCH SECTION

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SCALE	N.T.S.	PROJECT	115040
DRAWN	D.D.M.		
DESIGN	D.D.M.	DWG	FIG 7
CHECKED	M.B.C.		
DATE	OCT 2018		

5.0 CONCLUSIONS

The above Preliminary Stormwater Drainage and Functional Servicing Report has been prepared in support of the proposed Draft Plan of Subdivision to identify the servicing requirements to proceed with the development. The following is a summary of the servicing investigation which has been prepared in the preceding text.

- A 200mm watermain will be extended from King Street to service the entire subdivision and replace the existing watermain on Turner Street. It will connect to the existing 250mm watermain on King Street.
- A conventional sanitary system will service the entire subdivision. Sanitary sewage will be conveyed south and connect to the existing sanitary sewer on Turner Street.
- A conventional storm sewer system will service the entire subdivision. The majority of the stormwater drainage will be conveyed to a proposed stormwater dry pond facility at the northeastern corner of the development. The remainder of the development will be conveyed south on Turner Street and outfall into a tributary of Little Creek.
- Enhanced water quality protection of Little Creek from the development can be provided through the implementation of a Stormceptor STC-2000 downstream of the dry pond and a Stormceptor STC-4000 on Turner Street.
- Low Impact Development and appropriate areas have been identified in the report. Measures such as roof water leaders discharging to grade, 300mm of topsoil, bio retention swales and infiltration galleries will be proposed on the detailed engineering drawings. The extent of the LIDs will need to be coordinated with the final Hydrogeological Report to ensure a reasonable water balance is achieved.

- Overall post-development flows to a tributary of Little Creek will be attenuated to pre-development levels for all storm events, up to and including the 100-year event.

- Sediment control measures for construction will need to be provided during the detailed engineering design for the Plan of Subdivision.

SCHEDULE 1

STAGE - STORAGE – DISCHARGE CALCULATIONS
STORMCEPTOR SIZING OUTPUT AND TIME OF CONCENTRATION CALCULATIONS

Job Number: 115040
Date: 12-Apr-18

Dry Pond

Elevation (m)	End Area (m2)	Avg. Area (m2)	Depth (m)	Volume (m3)	Cum. Volume (m3)
241.00	757.05				0.00
		861.27	0.50	430.63	
241.50	965.48				430.63
		1076.76	0.50	538.38	
242.00	1188.04				969.01
		1307.89	0.50	653.94	
242.50	1427.73				1622.96
		1551.65	0.50	775.83	
243.00	1675.57				2398.78

ORIFICE DISCHARGE

ORIFICE

-------->	COEFF	0.61	
-------->	DIA	190	mm
	AREA	0.02835287	m^2
	GRAV	9.81	m/s^2
	CL ELEV	241.10	m
	INV	241.00	
	EQN	0.0766084	SQRT(H)

Elevation (m)	HEAD (m)	DISCHAR((m^3/s)	DISCHARGE (L/s)
241.10	0.00	0.00000	0.00
241.50	0.40	0.04845	48.45
242.00	0.90	0.07268	72.68
242.50	1.40	0.09064	90.64
243.00	1.90	0.10560	105.60

COEFF

0.61 FOR PLATE

0.8 FOR SHORT TUBE (FOR MTO)

Job Number: 115040
Date: 12-Apr-18

TOTAL STAGE-STORAGE-DISCHARGE

CL ORIFICE = 241.10 m
DIAMETER = 190 mm

ELEVATION (m)	HEAD (m)	STORAGE (m3)	ORIFICE DISCHARGE (m3/s)	TOTAL DISCHARGE (L/s)
241.10	0.00	0.00	0.00000	0.00
241.50	0.40	430.63	0.04845	48.45
242.00	0.90	969.01	0.07268	72.68
242.50	1.40	1622.96	0.09064	90.64
243.00	1.90	2398.78	0.10560	105.60

[illegible]			
Project Name	Veltri West Lands - East Drainage	**Project Number**	115040
City		**State/ Province**	Ontario
Country	Canada	**Date**	4/16/2018
[illegible]		[illegible]	
Name	Gillian Cook	**Name**	
Company	D.G. Biddle	**Company**	
Phone #	905-576-8500	**Phone #**	
Email	gillian.cook@dgbiddle.com	**Email**	

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

[illegible]	Veltri West Lands
[illegible]	80
[illegible]	80
[illegible]	STC 2000

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

[illegible]	
Stormceptor Model	**% TSS Removal Provided**
STC 300	67
STC 750	77
STC 1000	78
STC 1500	78
STC 2000	80
STC 3000	81
STC 4000	84
STC 5000	84
STC 6000	86
STC 9000	89
STC 10000	89
STC 14000	91
StormceptorMAX	Custom

FORTERRA

[illegible]			
Project Name	Veltri West Lands - Turner Street Outlet	**Project Number**	115040
City		**State/ Province**	Ontario
Country	Canada	**Date**	4/26/2018
[illegible]		[illegible]	
Name	Gillian Cook	**Name**	
Company	D.G. Biddle	**Company**	
Phone #	905-576-8500	**Phone #**	
Email	gillian.cook@dgbiddle.com	**Email**	

Stormwater Treatment Recommendation

The recommended Stormceptor Model(s) which achieve or exceed the user defined water quality objective for each site within the project are listed in the below Sizing Summary table.

[illegible]	Veltri West Lands
[illegible]	80
[illegible]	80
[illegible]	STC 4000

The recommended Stormceptor Model achieves the water quality objectives based on the selected inputs, historical rainfall records and selected particle size distribution.

[illegible]	
Stormceptor Model	**% TSS Removal Provided**
STC 300	55
STC 750	67
STC 1000	69
STC 1500	69
STC 2000	74
STC 3000	76
STC 4000	80
STC 5000	81
STC 6000	83
STC 9000	87
STC 10000	87
STC 14000	90
StormceptorMAX	Custom

Total Area (ha)	4.37
Imperviousness %	30.0

Station Name	PETERBOROUGH A
State/Province	Ontario
Station ID #	6418
Years of Records	32
Latitude	44°14'N
Longitude	78°22'W

TSS Removal (%)	80.0
Runoff Volume Capture (%)	
Oil Spill Capture Volume (L)	
Peak Conveyed Flow Rate (L/s)	
Water Quality Flow Rate (L/s)	

Storage (ha-m)	Discharge (cms)
0.000	0.000

Max. Flow to Stormceptor (cms)	

Fine Distribution		
Particle Diameter (microns)	Distribution %	Specific Gravity
20.0	20.0	1.30
60.0	20.0	1.80
150.0	20.0	2.20
400.0	20.0	2.65
2000.0	20.0	2.65

- Stormceptor performance estimates are based on simulations using PCSWMM for Stormceptor, which uses the EPA Rainfall and Runoff modules.
- Design estimates listed are only representative of specific project requirements based on total suspended solids (TSS) removal defined by the selected PSD, and based on stable site conditions only, after construction is completed.
- For submerged applications or sites specific to spill control, please contact your local Stormceptor representative for further design assistance.

For Stormceptor Specifications and Drawings Please Visit:
http://www.imbriumsystems.com/technical-specifications

Time of Concentration Calculations

NHYD 1 (Refer to Fig 2)

A to B:

Length= 444.79 m

Slope= $\frac{265 - 231}{444.79}$ = 7.64%

C= 0.3

Airport Formula (See Attached Example 8.5: Calculation of Time of Concentration)

$$t_c = \frac{3.26 * (1.1 - C) * L^{0.5}}{S^{0.33}}$$

tc= 28.12 min

tp= 0.67*tc

tp= 0.314 hr

NHYD 2 (Refer to Fig 2)

A to C:

Length= 482.89 m

Slope= $\frac{265 - 231}{482.89}$ = 7.04%

C= 0.3

Airport Formula (See Attached Example 8.5: Calculation of Time of Concentration)

$$t_c = \frac{3.26 * (1.1 - C) * L^{0.5}}{S^{0.33}}$$

tc= 30.10 min

tp= 0.67*tc

tp= 0.336 hr

Design Chart 1.08: Hydrologic Soil Groups

- Based on Surficial Geology Maps

Map Ref.No.	Soil Type or Texture	Hydrologic Soil Group (Tentative)
	Ground Moraine	
1a	Usually sandy till, stony, varying depth. (Most widespread type in Shield).	Usually B (shallow); may be A or AB
1b	Clayey till, varying depth.	BC-C
	End or Interlobate Moraine	
2a	Sand & stones, deep. (May be rough topography).	A
2b	Sand & stones capped by till, deep.	A-C depending on type of till.
2c	Sand & stones, deep. (Smoother topography).	A
	Kames & Eskers	
3a	Sand & stones, deep. (May be rough topography).	A
3b	Sand & stones capped by till, deep.	A-C depending on type of till.
3c	Sand & stones, deep. (Smoother topography).	A
	Lacustrine	
4a	Clay & silt, in lowlands.	BC-C
4b	Fine sand, in lowlands.	AB-B
4c	Sand, in lowlands.	AB
4d	Sand (deltas & valley trains).	A-AB
	Outwash	
5	Sand, some gravel, deep.	A
	Aeolian	
6	Very fine sand & silt, shallow. (Loess)	B
	Bedrock	
7	Bare bedrock (normally negligible areas).	Varies according to rock type.

Source: Ministry of Natural Resources - MNR

Design Chart 1.08: Hydrologic Soil Groups (Continued)

- Based on Soil Texture

Sands, Sandy Loams and Gravels	
- overlying sand, gravel or limestone bedrock, very well drained	A
- ditto, imperfectly drained	AB
- shallow, overlying Precambrian bedrock or clay subsoil	B
Medium to Coarse Loams	
- overlying sand, gravel or limestone, well drained	AB
- shallow, overlying Precambrian bedrock or clay subsoil	B
Medium Textured Loams	
- shallow, overlying limestone bedrock	B
- overlying medium textured subsoil	BC
Silt Loams, Some Loams	
- with good internal drainage	BC
- with slow internal drainage and good external drainage	C
Clays, Clay Loams, Silty Clay Loams	
- with good internal drainage	C
- with imperfect or poor external drainage	C
- with slow internal drainage and good external drainage	D

Source: U.S. Department of Agriculture (1972)

Design Chart 1.09: Soil/Land Use Curve Numbers

Land Use	Treatment or Practice	Hydrologic Condition[4]	Hydrologic Soil Group A	B	C	D
Fallow	Straight row	—	77	86	91	94
Row crops	"	Poor	72	81	88	91
	"	Good	67	78	85	89
	Contoured	Poor	70	79	84	88
	"	Good	65	75	82	86
	" and terraced	Poor	66	74	8	82
	" " "	Good	62	71	78	81
Small grain	Straight row	Poor	65	76	84	88
		Good	63	75	83	87
	Contoured	Poor	63	74	82	85
		Good	61	73	81	84
	" and terraced	Poor	61	72	79	82
		Good	59	70	78	81
Close-seeded legumes[2] or rotation meadow	Straight row	Poor	66	77	85	89
	" "	Good	58	72	81	85
	Contoured	Poor	64	75	83	85
	"	Good	55	69	78	83
	" and terraced	Poor	63	73	80	83
	" and terraced	Good	51	67	76	80
Pasture or range		Poor	68	79	86	89
		Fair	49	69	79	84
	Contoured	Good	39	61	74	80
	"	Poor	47	67	81	88
	"	Fair	25	59	75	83
		Good	6	35	70	79
Meadow		Good	30	58	71	78
Woods		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	25	55	70	77
Farmsteads		—	59	74	82	86
		—	72	82	87	89
		—	74	84	90	92

For average antecedent soil moisture condition (AMC II)

[2] Close-drilled or broadcast.

[4] The hydrologic condition of cropland is good if a good crop rotation practice is used; it is poor if one crop is grown continuously.

Source: U.S. Department of Agriculture (1972)

SCHEDULE 2

INPUT PARAMTERS AND
VISUAL OTTHYMO 3.0 OUTPUT FILES

POST-DEVELOPMENT DRAINAGE

NHYD 4 - POST-DEV ATTENUATED TO EAST

ITEM	AREA (m^2)	% IMPERVIOUS	
LOTS	24794.54	60%	(ASSUMED)
DRY POND	1153.56	70%	(ASSUMED)
LANDSCAPE	13085.08	0%	
	39033.18		

% IMPERVIOUS

→ BASED ON WEIGHTED AVERAGE

$$= \frac{24794.54}{39033.18} \times 60\% + \frac{1153.56}{39033.18} \times 70\%$$

$$= 40.1\% \approx 40\%$$

NHYD 6 - POST-DEV UNATTENUATED TO EAST

ITEM	AREA (m^2)	% IMPERVIOUS	
LOT BACKYARDS	9490.31	35%	(ASSUMED)
LANDSCAPE	52596.58	0%	
	62086.89		

% IMPERVIOUS

$$= \frac{9490.31}{62086.89} \times 35\%$$

$$= 5.35\%$$

∴ USE NASHYD IN MODEL

NHYD 9 - POST-DEV MINOR TO EAST, MAJOR TO TURNER ST.

ITEM	AREA (m^2)	% IMPERVIOUS
LOTS	9358.38	60%
LANDSCAPE	6838.05	0%
	16196.43	

% IMPERVIOUS

$$= \frac{9358.38}{16196.43} \times 60\%$$

$$= 34.7\% \approx 35\%$$

NHYD 11 - EXISTING HUNTER STREET DEVELOPMENT

ASSUME 50%

DIRECTLY CONNECTED DRAINAGE

BASED ON TOWNSHIP OF CAVAN-MONAGHAN DESIGN STANDARDS

NHYD 4 - POST-DEV ATTENUATED TO EAST

ITEM	AREA (m^2)
DRIVEWAYS	3033
SIDEWALKS	556.17
ROAD	3757.83
TOTAL AREA	39033.18

% IMPERVIOUS

→ BASED ON WEIGHTED AVERAGE

$$= \frac{(3033 + 556.17 + 3757.83)}{39033.18} \times 100\%$$

$= 18.8\% \approx 19\%$ ∴ USE 21% IN MODEL (MIN)

NHYD 9 - POST-DEV MINOR TO EAST, MAJOR TO TURNER ST

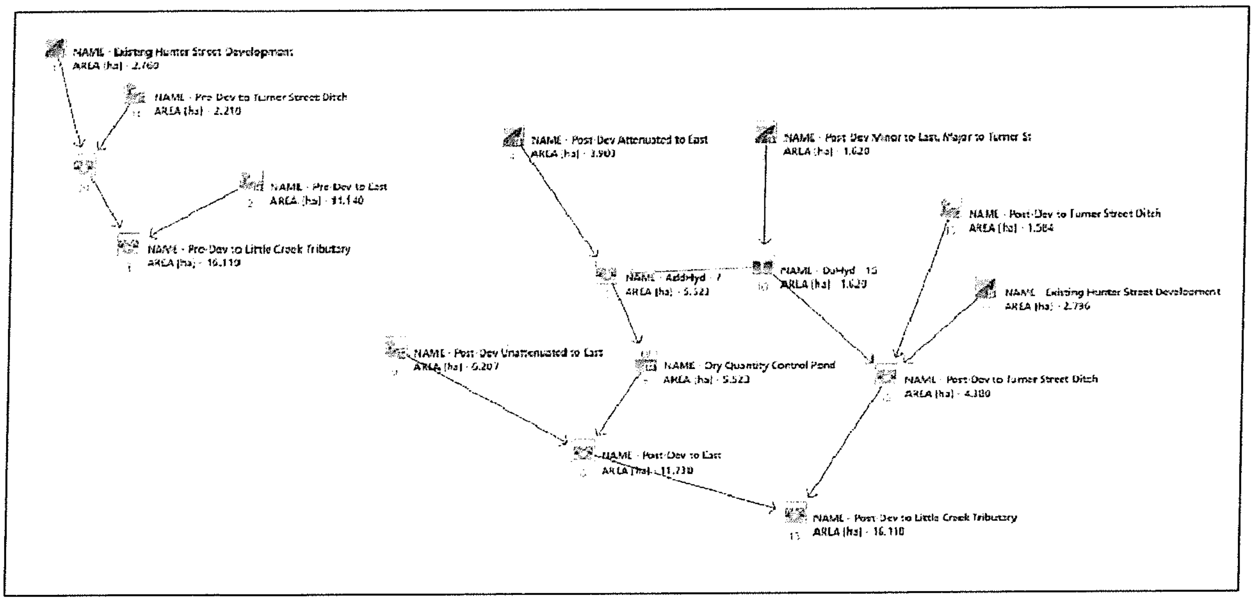
ITEM	AREA (m^2)
DRIVEWAYS	891
SIDEWALKS	139.01
ROAD	1401.52
TOTAL AREA	16196.43

% IMPERVIOUS

$$= \frac{(891 + 139.01 + 1401.52)}{16196.43} \times 100\%$$

$= 12\%$

∴ USE 21% IN MODEL (MIN)



VELTRI WEST LANDS – TURNER STREET

VISUAL OTTHYMO SCHEME

D.G. Biddle & Associates Limited
consulting engineers and planners
96 KING STREET EAST · OSHAWA, ON · L1H 1B6
PHONE (905)576-8500 · FAX (905)576-9730
info@dgbiddle.com

SCALE	N.T.S.	PROJECT	115040
DRAWN	G.M.C.		
DESIGN	G.M.C.	DWG	FIG 4
CHECKED	M.B.C.		
DATE	MAR 2018		

```
       V     V    I    SSSSS  U    U     A     L
       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
```

Developed and Distributed by Civica Infrastructure

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

```
Input   filename: C:\Program Files (x86)\VH Suite 3.0\VO2\voin.dat
Output  filename: C:\Users\gillian.cook\AppData\Local\Temp\34af328d-4b37-406c-8861-9e5bca8b67fa\Scenario.o
Summary filename: C:\Users\gillian.cook\AppData\Local\Temp\34af328d-4b37-406c-8861-9e5bca8b67fa\Scenario.s
```

DATE: 04-26-2018 TIME: 03:48:35

USER:

COMMENTS: SCS 6-HOUR

```
****************************
** SIMULATION NUMBER:   1 **   2 YEAR
****************************

 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                      15.0
     [ Ptot= 38.75 mm ]
     fname : C:\Users\gillian.cook\AppData\Local\Temp\34af328d-4b37-406c-8861-9e5bca8b67fa\a61a5d36-a703-47
     remark: SCS 2-YEAR STORM (6 HRS)

 ** CALIB NASHYD            0006  1   5.0    6.21    0.10   3.58    8.28 0.21    0.000
    [CN=71.0          ]
    [ N = 3.0:Tp 0.44]

 *  CALIB STANDHYD          0004  1   5.0    3.90    0.23   3.25   17.53 0.45    0.000
    [I%=21.0:S%= 2.00]

 *  CALIB STANDHYD          0009  1   5.0    1.62    0.09   3.25   16.97 0.44    0.000
    [I%=21.0:S%= 2.00]

    DUHYD                   0010  1   5.0    1.62    0.09   3.25   16.97  n/a    0.000
       MAJOR SYSTEM:        0010  2   5.0    0.00    0.00   0.00    0.00  n/a    0.000
       MINOR SYSTEM:        0010  3   5.0    1.62    0.09   3.25   16.97  n/a    0.000

    ADD [0010 + 0004]       0005  3   5.0    5.52    0.32   3.25   17.36  n/a    0.000

    RESRVR [ 2 : 0005]      0007  1   5.0    5.52    0.05   4.08   17.32  n/a    0.000
    {ST=  0.05 ha.m }

    ADD [0006 + 0007]       0008  3   5.0   11.73    0.15   3.67   12.54  n/a    0.000

 *  CALIB STANDHYD          0011  1   5.0    2.80    0.18   3.25   18.84 0.49    0.000
    [I%=21.0:S%= 2.00]

 *  CALIB NASHYD            0015  1   5.0    1.58    0.04   3.33    8.27 0.21    0.000
    [CN=71.0          ]
    [ N = 3.0:Tp 0.20]

    ADD [0010 + 0011]       0012  3   5.0    2.80    0.18   3.25   18.84  n/a    0.000

    ADD [0012 + 0015]       0012  1   5.0    4.38    0.22   3.25   15.01  n/a    0.000

    ADD [0012 + 0008]       0013  3   5.0   16.11    0.30   3.25   13.21  n/a    0.000

 *  CALIB NASHYD            0002  1   5.0   11.14    0.21   3.50    8.28 0.21    0.000
    [CN=71.0          ]
```

```
   [ N = 3.0:Tp 0.34]
*
 *   CALIB STANDHYD      0001  1  5.0     2.76     0.17   3.25   18.84 0.49     0.000
     [I%=21.0:S%= 2.00]
*
 *   CALIB NASHYD        0014  1  5.0     2.21     0.04   3.42    8.28 0.21     0.000
     [CN=71.0          ]
     [ N = 3.0:Tp 0.31]
*
     ADD [0001 + 0014]   0020  3  5.0     4.97     0.20   3.25   14.14  n/a     0.000
*
     ADD [0002 + 0020]   0003  3  5.0    16.11     0.36   3.42   10.09  n/a     0.000
*
 *****************************
 ** SIMULATION NUMBER:   2 **     5 YEAR
 *****************************

 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                    15.0
     [ Ptot= 52.44 mm ]
     fname : C:\Users\gillian.cook\AppData\Local\Temp\34af328d-4b37-406c-8861-9e5bca8b67fa\ab61d37e-7ede-48
     remark: SCS 5-YEAR STORM (6 HRS)
*
 **  CALIB NASHYD        0006  1  5.0     6.21     0.18   3.58   14.89 0.28     0.000
     [CN=71.0          ]
     [ N = 3.0:Tp 0.44]
*
 *   CALIB STANDHYD      0004  1  5.0     3.90     0.36   3.25   26.79 0.51     0.000
     [I%=21.0:S%= 2.00]
*
 *   CALIB STANDHYD      0009  1  5.0     1.62     0.15   3.25   25.97 0.50     0.000
     [I%=21.0:S%= 2.00]
*
     DUHYD               0010  1  5.0     1.62     0.15   3.25   25.97  n/a     0.000
        MAJOR SYSTEM:    0010  2  5.0     0.00     0.00   3.25   25.97  n/a     0.000
        MINOR SYSTEM:    0010  3  5.0     1.62     0.15   3.25   25.97  n/a     0.000
*
     ADD [0010 + 0004]   0005  3  5.0     5.52     0.51   3.25   26.55  n/a     0.000
*
     RESRVR [ 2 : 0005]  0007  1  5.0     5.52     0.07   4.08   26.51  n/a     0.000
     {ST=  0.09 ha.m }
*
     ADD [0006 + 0007]   0008  3  5.0    11.73     0.24   3.67   20.36  n/a     0.000
*
 *   CALIB STANDHYD      0011  1  5.0     2.80     0.29   3.25   28.68 0.55     0.000
     [I%=21.0:S%= 2.00]
*
 *   CALIB NASHYD        0015  1  5.0     1.58     0.08   3.33   14.86 0.28     0.000
     [CN=71.0          ]
     [ N = 3.0:Tp 0.20]

     ADD [0010 + 0011]   0012  3  5.0     2.80     0.29   3.25   28.68  n/a     0.000

     ADD [0012 + 0015]   0012  1  5.0     4.38     0.36   3.25   23.68  n/a     0.000

     ADD [0012 + 0008]   0013  3  5.0    16.11     0.50   3.25   21.26  n/a     0.000

 *   CALIB NASHYD        0002  1  5.0    11.14     0.39   3.50   14.88 0.28     0.000
     [CN=71.0          ]
     [ N = 3.0:Tp 0.34]

 *   CALIB STANDHYD      0001  1  5.0     2.76     0.27   3.25   28.68 0.55     0.000
     [I%=21.0:S%= 2.00]

 *   CALIB NASHYD        0014  1  5.0     2.21     0.08   3.42   14.88 0.28     0.000
     [CN=71.0          ]
     [ N = 3.0:Tp 0.31]

     ADD [0001 + 0014]   0020  3  5.0     4.97     0.33   3.25   22.55  n/a     0.000

     ADD [0002 + 0020]   0003  3  5.0    16.11     0.64   3.42   17.25  n/a     0.000

 *****************************
 ** SIMULATION NUMBER:   3 **     10 YEAR
 *****************************

 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                    15.0
      [ Ptot= 61.60 mm ]
      fname : C:\Users\gillian.cook\AppData\Local\Temp\34af328d-4b37-406c-8861-9e5bca8b67fa\dc938a67-d69b-4c
      remark: SCS 10-YEAR STORM (6 HRS)
 *
  ** CALIB NASHYD           0006  1  5.0     6.21     0.24  3.58  19.98 0.32    0.000
      [CN=71.0            ]
      [ N = 3.0:Tp 0.44]
 *
  *   CALIB STANDHYD        0004  1  5.0     3.90     0.46  3.25  33.46 0.54    0.000
      [I%=21.0:S%= 2.00]
 *
  *   CALIB STANDHYD        0009  1  5.0     1.62     0.19  3.25  32.48 0.53    0.000
      [I%=21.0:S%= 2.00]
 *
      DUHYD                 0010  1  5.0     1.62     0.19  3.25  32.48  n/a    0.000
         MAJOR SYSTEM:      0010  2  5.0     0.04     0.04  3.25  32.48  n/a    0.000
         MINOR SYSTEM:      0010  3  5.0     1.58     0.15  3.17  32.48  n/a    0.000
 *
      ADD [0010 + 0004]     0005  3  5.0     5.48     0.61  3.25  33.18  n/a    0.000
 *
      RESRVR [ 2 : 0005]    0007  1  5.0     5.48     0.08  4.25  33.14  n/a    0.000
      {ST=  0.11 ha.m }
 *
      ADD [0006 + 0007]     0008  3  5.0    11.69     0.32  3.58  26.15  n/a    0.000
 *
  *   CALIB STANDHYD        0011  1  5.0     2.80     0.40  3.25  35.73 0.58    0.000
      [I%=21.0:S%= 2.00]
 *
  *   CALIB NASHYD          0015  1  5.0     1.58     0.11  3.33  19.94 0.32    0.000
      [CN=71.0            ]
      [ N = 3.0:Tp 0.20]
 *
      ADD [0010 + 0011]     0012  3  5.0     2.84     0.44  3.25  35.68  n/a    0.000
 *
      ADD [0012 + 0015]     0012  1  5.0     4.42     0.54  3.25  30.04  n/a    0.000
 *
      ADD [0012 + 0008]     0013  3  5.0    16.11     0.72  3.25  27.22  n/a    0.000
 *
  *   CALIB NASHYD          0002  1  5.0    11.14     0.52  3.50  19.97 0.32    0.000
      [CN=71.0            ]
      [ N = 3.0:Tp 0.34]
 *
  *   CALIB STANDHYD        0001  1  5.0     2.76     0.35  3.25  35.73 0.58    0.000
      [I%=21.0:S%= 2.00]
 *
  *   CALIB NASHYD          0014  1  5.0     2.21     0.11  3.42  19.97 0.32    0.000
      [CN=71.0            ]
      [ N = 3.0:Tp 0.31]
 *
      ADD [0001 + 0014]     0020  3  5.0     4.97     0.42  3.25  28.72  n/a    0.000
 *
      ADD [0002 + 0020]     0003  3  5.0    16.11     0.86  3.42  22.67  n/a    0.000
 *
 ****************************
 ** SIMULATION NUMBER:   4 **   25 YEAR
 ****************************

 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                    15.0
     [ Ptot= 72.90 mm ]
     fname : C:\Users\gillian.cook\AppData\Local\Temp\34af328d-4b37-406c-8861-9e5bca8b67fa\77c033ec-8e2c-45
     remark: SCS 25-YEAR STORM (6 HRS)

 ** CALIB NASHYD           0006  1  5.0     6.21     0.33  3.58  26.86 0.37    0.000
     [CN=71.0            ]
     [ N = 3.0:Tp 0.44]

 *   CALIB STANDHYD        0004  1  5.0     3.90     0.66  3.25  42.12 0.58    0.000
     [I%=21.0:S%= 2.00]

 *   CALIB STANDHYD        0009  1  5.0     1.62     0.27  3.25  40.93 0.56    0.000
     [I%=21.0:S%= 2.00]

     DUHYD                 0010  1  5.0     1.62     0.27  3.25  40.93  n/a    0.000
        MAJOR SYSTEM:      0010  2  5.0     0.18     0.12  3.25  40.93  n/a    0.000
        MINOR SYSTEM:      0010  3  5.0     1.44     0.15  3.08  40.93  n/a    0.000

     ADD [0010 + 0004]     0005  3  5.0     5.34     0.81  3.25  41.80  n/a    0.000
```

```
   RESRVR [ 2 : 0005] 0007  1  5.0    5.34    0.09  4.25  41.76  n/a    0.000
   {ST=  0.14 ha.m }
*
   ADD [0006 + 0007]  0008  3  5.0   11.55    0.41  3.58  33.75  n/a    0.000
*
 * CALIB STANDHYD     0011  1  5.0    2.80    0.52  3.25  44.82 0.61    0.000
   [I%=21.0:S%= 2.00]
*
 * CALIB NASHYD       0015  1  5.0    1.58    0.15  3.33  26.81 0.37    0.000
   [CN=71.0         ]
   [ N = 3.0:Tp 0.20]
*
   ADD [0010 + 0011]  0012  3  5.0    2.98    0.64  3.25  44.58  n/a    0.000
*
   ADD [0012 + 0015]  0012  1  5.0    4.56    0.77  3.25  38.41  n/a    0.000
*
   ADD [0012 + 0008]  0013  3  5.0   16.11    1.01  3.25  35.07  n/a    0.000
*
 * CALIB NASHYD       0002  1  5.0   11.14    0.71  3.50  26.85 0.37    0.000
   [CN=71.0         ]
   [ N = 3.0:Tp 0.34]
*
 * CALIB STANDHYD     0001  1  5.0    2.76    0.49  3.25  44.82 0.61    0.000
   [I%=21.0:S%= 2.00]
*
 * CALIB NASHYD       0014  1  5.0    2.21    0.15  3.42  26.85 0.37    0.000
   [CN=71.0         ]
   [ N = 3.0:Tp 0.31]
*
   ADD [0001 + 0014]  0020  3  5.0    4.97    0.60  3.25  36.83  n/a    0.000
*
   ADD [0002 + 0020]  0003  3  5.0   16.11    1.13  3.33  29.93  n/a    0.000
*
 ****************************
 ** SIMULATION NUMBER:   5 **      50 YEAR
 ****************************

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                   15.0
   [ Ptot= 81.47 mm ]
   fname : C:\Users\gillian.cook\AppData\Local\Temp\34af328d-4b37-406c-8861-9e5bca8b67fa\0df70418-d390-48
   remark: SCS 50-YEAR STORM (6 HRS)

** CALIB NASHYD       0006  1  5.0    6.21    0.40  3.58  32.45 0.40    0.000
   [CN=71.0         ]
   [ N = 3.0:Tp 0.44]

*  CALIB STANDHYD     0004  1  5.0    3.90    0.78  3.25  48.94 0.60    0.000
   [I%=21.0:S%= 2.00]

*  CALIB STANDHYD     0009  1  5.0    1.62    0.32  3.25  47.61 0.58    0.000
   [I%=21.0:S%= 2.00]

   DUHYD              0010  1  5.0    1.62    0.32  3.25  47.61  n/a    0.000
      MAJOR SYSTEM:   0010  2  5.0    0.25    0.17  3.25  47.61  n/a    0.000
      MINOR SYSTEM:   0010  3  5.0    1.37    0.15  3.08  47.61  n/a    0.000

   ADD [0010 + 0004]  0005  3  5.0    5.27    0.93  3.25  48.59  n/a    0.000

   RESRVR [ 2 : 0005] 0007  1  5.0    5.27    0.09  4.33  48.55  n/a    0.000
   {ST=  0.17 ha.m }

   ADD [0006 + 0007]  0008  3  5.0   11.48    0.49  3.58  39.84  n/a    0.000

*  CALIB STANDHYD     0011  1  5.0    2.80    0.61  3.25  51.94 0.64    0.000
   [I%=21.0:S%= 2.00]

*  CALIB NASHYD       0015  1  5.0    1.58    0.18  3.33  32.39 0.40    0.000
   [CN=71.0         ]
   [ N = 3.0:Tp 0.20]

   ADD [0010 + 0011]  0012  3  5.0    3.05    0.78  3.25  51.58  n/a    0.000

   ADD [0012 + 0015]  0012  1  5.0    4.63    0.94  3.25  45.02  n/a    0.000

   ADD [0012 + 0008]  0013  3  5.0   16.11    1.22  3.25  41.33  n/a    0.000

*  CALIB NASHYD       0002  1  5.0   11.14    0.86  3.50  32.44 0.40    0.000
   [CN=71.0         ]
```

```
   [ N = 3.0:Tp 0.31]
*
  *    CALIB STANDHYD      0001  1   5.0     2.76     0.58  3.25  51.94 0.64    0.000
       [I%=21.0:S%= 2.00]
*
  *    CALIB NASHYD        0014  1   5.0     2.21     0.18  3.42  32.44 0.40    0.000
       [CN=71.0          ]
       [ N = 3.0:Tp 0.31]
*
       ADD [0001 + 0014]   0020  3   5.0     4.97     0.71  3.25  43.27  n/a    0.000
*
       ADD [0002 + 0020]   0003  3   5.0    16.11     1.36  3.33  35.78  n/a    0.000
*
 FINISH

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

```
V     V   I    SSSSS  U    U     A     L
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
```

Developed and Distributed by Civica Infrastructure

***** DETAILED OUTPUT *****

Input filename: C:\Program Files (x86)\VH Suite 3.0\V02\voin.dat
Output filename: C:\Users\gillian.cook\AppData\Local\Temp\5225bb17-392f-44ca-b91c-49ae66f43941\Scenario.o
Summary filename: C:\Users\gillian.cook\AppData\Local\Temp\5225bb17-392f-44ca-b91c-49ae66f43941\Scenario.s

DATE: 04-26-2018 TIME: 03:48:53

USER:

COMMENTS: ______________________________

****
** SIMULATION NUMBER: 6 ** 100 YEAR
****

READ STORM	
	Filename: C:\Users\gillian.cook\AppData\Local\Temp\5225bb17-392f-44ca-b91c-49ae66f43941\fb7a95c4
Ptotal= 89.93 mm	Comments: SCS 100-YEAR STORM (6 HRS)

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.25	0.00	2.00	9.00	3.75	19.80	5.50	3.60
0.50	3.60	2.25	9.00	4.00	9.00	5.75	3.60
0.75	3.60	2.50	10.80	4.25	9.00	6.00	3.60
1.00	5.40	2.75	10.80	4.50	7.20	6.25	3.60
1.25	5.40	3.00	53.90	4.75	7.20		
1.50	5.40	3.25	140.20	5.00	5.40		
1.75	5.40	3.50	19.80	5.25	5.40		

CALIB		
NASHYD (0006)	Area (ha)= 6.21	Curve Number (CN)= 71.0
ID= 1 DT= 5.0 min	Ia (mm)= 5.00	# of Linear Res.(N)= 3.00
	U.H. Tp(hrs)= 0.44	

NOTE: RAINFALL WAS TRANSFORMED TO 5.0 MIN. TIME STEP.

---- TRANSFORMED HYETOGRAPH ----

TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr	TIME hrs	RAIN mm/hr
0.083	0.00	1.667	5.40	3.250	140.20	4.83	5.40
0.167	0.00	1.750	5.40	3.333	19.80	4.92	5.40
0.250	0.00	1.833	9.00	3.417	19.80	5.00	5.40
0.333	3.60	1.917	9.00	3.500	19.80	5.08	5.40
0.417	3.60	2.000	9.00	3.583	19.80	5.17	5.40
0.500	3.60	2.083	9.00	3.667	19.80	5.25	5.40
0.583	3.60	2.167	9.00	3.750	19.80	5.33	3.60
0.667	3.60	2.250	9.00	3.833	9.00	5.42	3.60
0.750	3.60	2.333	10.80	3.917	9.00	5.50	3.60
0.833	5.40	2.417	10.80	4.000	9.00	5.58	3.60
0.917	5.40	2.500	10.80	4.083	9.00	5.67	3.60
1.000	5.40	2.583	10.80	4.167	9.00	5.75	3.60
1.083	5.40	2.667	10.80	4.250	9.00	5.83	3.60
1.167	5.40	2.750	10.80	4.333	7.20	5.92	3.60

```
    1.250     5.40 | 2.833   53.90 | 4.417      7.20 |  6.00      3.60
    1.333     5.40 | 2.917   53.90 | 4.500      7.20 |  6.08      3.60
    1.417     5.40 | 3.000   53.90 | 4.583      7.20 |  6.17      3.60
    1.500     5.40 | 3.083  140.20 | 4.667      7.20 |  6.25      3.60
    1.583     5.40 | 3.167  140.20 | 4.750      7.20 |

  Unit Hyd Qpeak  (cms)=   0.540

  PEAK FLOW       (cms)=   0.473 (i)
  TIME TO PEAK    (hrs)=   3.583
  RUNOFF VOLUME    (mm)=  38.223
  TOTAL RAINFALL   (mm)=  89.925
  RUNOFF COEFFICIENT   =   0.425

  (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD  (0004)   |   Area     (ha)=   3.90
|ID= 1 DT= 5.0 min   |   Total Imp(%)=  40.00   Dir. Conn.(%)=  21.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
   Surface Area     (ha)=       1.56         2.34
   Dep. Storage     (mm)=       1.00         1.50
   Average Slope     (%)=       5.00         2.00
   Length            (m)=     161.31        40.00
   Mannings n           =      0.013        0.250

   Max.Eff.Inten.(mm/hr)=     140.20       117.89
             over (min)         5.00        10.00
   Storage Coeff.   (min)=      1.83 (ii)    8.44 (ii)
   Unit Hyd. Tpeak  (min)=      5.00        10.00
   Unit Hyd. peak   (cms)=      0.32         0.12
                                                         *TOTALS*
   PEAK FLOW        (cms)=      0.32         0.58          0.900 (iii)
   TIME TO PEAK     (hrs)=      3.25         3.25           3.25
   RUNOFF VOLUME     (mm)=     88.93        47.04          55.83
   TOTAL RAINFALL    (mm)=     89.93        89.93          89.93
   RUNOFF COEFFICIENT   =       0.99         0.52           0.62

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  71.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| STANDHYD  (0009)   |   Area     (ha)=   1.62
|ID= 1 DT= 5.0 min   |   Total Imp(%)=  35.00   Dir. Conn.(%)=  21.00
--------------------
                             IMPERVIOUS    PERVIOUS (i)
   Surface Area     (ha)=       0.57         1.05
   Dep. Storage     (mm)=       1.00         1.50
   Average Slope     (%)=       5.00         2.00
   Length            (m)=     103.91        40.00
   Mannings n           =      0.013        0.250

   Max.Eff.Inten.(mm/hr)=     140.20       104.80
             over (min)         5.00        10.00
   Storage Coeff.   (min)=      1.41 (ii)    8.34 (ii)
   Unit Hyd. Tpeak  (min)=      5.00        10.00
   Unit Hyd. peak   (cms)=      0.33         0.13
                                                         *TOTALS*
   PEAK FLOW        (cms)=      0.13         0.23          0.365 (iii)
   TIME TO PEAK     (hrs)=      3.25         3.25           3.25
   RUNOFF VOLUME     (mm)=     88.93        45.19          54.37
   TOTAL RAINFALL    (mm)=     89.93        89.93          89.93
   RUNOFF COEFFICIENT   =       0.99         0.50           0.60

**** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  71.0    Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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```
| DUHYD      (0010) |
| Inlet Cap.=0.147  |
| #of Inlets=     1 |
| Total(cms)=  0.1  |        AREA       QPEAK       TPEAK      R.V.
---------------------         (ha)       (cms)       (hrs)      (mm)
      TOTAL HYD.(ID= 1):     1.62        0.36        3.25      54.37
      ==========================================================
      MAJOR SYS.(ID= 2):     0.31        0.22        3.25      54.37
      MINOR SYS.(ID= 3):     1.30        0.15        3.08      54.37

      NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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

 --------------------
 | ADD HYD    (0005) |
 |   1 +  2 =  3     |          AREA      QPEAK      TPEAK       R.V.
 --------------------           (ha)      (cms)      (hrs)       (mm)
            ID1= 1 (0010):      1.30     0.147       3.08       54.37
          + ID2= 2 (0004):      3.90     0.900       3.25       55.83
            =================================================
            ID = 3 (0005):      5.21     1.047       3.25       55.47

      NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

 -------------------------------------------------------------------------------
 --------------------
 | RESERVOIR (0007) |
 | IN= 2---> OUT= 1 |
 | DT=  5.0 min     |       OUTFLOW     STORAGE   |   OUTFLOW     STORAGE
 --------------------        (cms)      (ha.m.)   |    (cms)      (ha.m.)
                             0.0000      0.0000   |    0.0906      0.1623
                             0.0485      0.0431   |    0.1056      0.2399
                             0.0727      0.0969   |    0.0000      0.0000

                                  AREA       QPEAK       TPEAK         R.V.
                                  (ha)       (cms)       (hrs)         (mm)
    INFLOW : ID= 2 (0005)         5.208       1.047        3.25         55.47
    OUTFLOW: ID= 1 (0007)         5.208       0.096        4.42         55.43

                  PEAK    FLOW    REDUCTION [Qout/Qin](%)=  9.19
                  TIME SHIFT OF PEAK FLOW           (min)= 70.00
                  MAXIMUM   STORAGE   USED        (ha.m.)=  0.1909

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

 --------------------
  ADD HYD    (0008) |
    1 +  2 =  3     |          AREA      QPEAK      TPEAK       R.V.
 --------------------          (ha)      (cms)      (hrs)       (mm)
           ID1= 1 (0006):      6.21     0.473       3.58       38.22
         + ID2= 2 (0007):      5.21     0.096       4.42       55.43
           =================================================
           ID = 3 (0008):     11.42     0.564       3.58       46.07

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

 -------------------------------------------------------------------------------
 -------------------
  CALIB             |
  STANDHYD  (0011)  |   Area     (ha)=    2.80
 ID= 1 DT= 5.0 min  |   Total Imp(%)=   50.00   Dir. Conn.(%)=  21.00
 -------------------
                              IMPERVIOUS    PERVIOUS (i)
    Surface Area     (ha)=       1.40          1.40
    Dep. Storage     (mm)=       1.00          1.50
    Average Slope     (%)=       5.00          2.00
    Length            (m)=     136.52         40.00
    Mannings n           =      0.013         0.250

    Max.Eff.Inten.(mm/hr)=     140.20        153.01
               over (min)        5.00         10.00
    Storage Coeff.  (min)=       1.66 (ii)     7.61 (ii)
    Unit Hyd. Tpeak (min)=       5.00         10.00
    Unit Hyd. peak  (cms)=       0.32          0.13
                                                           *TOTALS*
    PEAK FLOW       (cms)=       0.23          0.47          0.699 (iii)
    TIME TO PEAK    (hrs)=       3.25          3.25           3.25
    RUNOFF VOLUME    (mm)=      88.92         51.19          59.12
    TOTAL RAINFALL   (mm)=      89.93         89.93          89.93
    RUNOFF COEFFICIENT   =       0.99          0.57           0.66

*** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!
```

```
          CN*  =  71.0     Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ------------------------------------------------------------------------------
 --------------------
 | CALIB              |
 | NASHYD     (0015)  |   Area     (ha)=    1.58   Curve Number   (CN)= 71.0
 |ID= 1 DT= 5.0 min   |   Ia       (mm)=    5.00   # of Linear Res.(N)= 3.00
 --------------------   U.H. Tp(hrs)=    0.20

     Unit Hyd Qpeak  (cms)=   0.303

     PEAK FLOW       (cms)=   0.208 (i)
     TIME TO PEAK    (hrs)=   3.333
     RUNOFF VOLUME    (mm)=  38.154
     TOTAL RAINFALL   (mm)=  89.925
     RUNOFF COEFFICIENT   =   0.424

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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

 --------------------
 | ADD HYD    (0012) |
 |   1 +  2 =  3     |         AREA     QPEAK     TPEAK      R.V.
 --------------------          (ha)     (cms)     (hrs)      (mm)
           ID1= 1 (0010):      0.31    0.218      3.25     54.37
         + ID2= 2 (0011):      2.80    0.699      3.25     59.12
           ===================================================
           ID = 3 (0012):      3.11    0.916      3.25     58.64

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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

 --------------------
 | ADD HYD    (0012) |
 |   3 +  2 =  1     |         AREA     QPEAK     TPEAK      R.V.
 --------------------          (ha)     (cms)     (hrs)      (mm)
           ID1= 3 (0012):      3.11    0.916      3.25     58.64
         + ID2= 2 (0015):      1.58    0.208      3.33     38.15
           ===================================================
           ID = 1 (0012):      4.69    1.107      3.25     51.73

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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

 --------------------
  ADD HYD    (0013) |
    1 +  2 =  3     |          AREA     QPEAK     TPEAK      R.V.
 --------------------          (ha)     (cms)     (hrs)      (mm)
           ID1= 1 (0012):      4.69    1.107      3.25     51.73
         + ID2= 2 (0008):     11.42    0.564      3.58     46.07
           ===================================================
           ID = 3 (0013):     16.11    1.440      3.25     47.72

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

 ------------------------------------------------------------------------------
 -------------------
  CALIB              |
  NASHYD     (0002)  |   Area     (ha)=   11.14   Curve Number   (CN)= 71.0
 ID= 1 DT= 5.0 min   |   Ia       (mm)=    5.00   # of Linear Res.(N)= 3.00
 -------------------     U.H. Tp(hrs)=    0.34

     Unit Hyd Qpeak  (cms)=   1.266

     PEAK FLOW       (cms)=   1.019 (i)
     TIME TO PEAK    (hrs)=   3.500
     RUNOFF VOLUME    (mm)=  38.217
     TOTAL RAINFALL   (mm)=  89.925
     RUNOFF COEFFICIENT   =   0.425

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

 ------------------------------------------------------------------------------
 -------------------
 CALIB               |
 STANDHYD   (0001)   |   Area     (ha)=    2.76
 D= 1 DT= 5.0 min    |   Total Imp(%)=   50.00   Dir. Conn.(%)=  21.00
```

```
--------------------
                            IMPERVIOUS    PERVIOUS (i)
     Surface Area     (ha)=     1.38         1.38
     Dep. Storage     (mm)=     1.00         1.50
     Average Slope     (%)=     1.00         2.00
     Length            (m)=   135.64        40.00
     Mannings n          =    0.013        0.250

     Max.Eff.Inten.(mm/hr)=   140.20       153.01
               over (min)       5.00        10.00
     Storage Coeff.  (min)=     2.68 (ii)    8.63 (ii)
     Unit Hyd. Tpeak (min)=     5.00        10.00
     Unit Hyd. peak  (cms)=     0.29         0.12
                                                       *TOTALS*
     PEAK FLOW       (cms)=     0.23         0.44        0.670 (iii)
     TIME TO PEAK    (hrs)=     3.25         3.25         3.25
     RUNOFF VOLUME    (mm)=    88.92        51.19        59.12
     TOTAL RAINFALL   (mm)=    89.93        89.93        89.93
     RUNOFF COEFFICIENT   =     0.99         0.57         0.66

***** WARNING: STORAGE COEFF. IS SMALLER THAN TIME STEP!

       (i) CN PROCEDURE SELECTED FOR PERVIOUS LOSSES:
           CN*  =  71.0     Ia = Dep. Storage  (Above)
      (ii) TIME STEP (DT) SHOULD BE SMALLER OR EQUAL
           THAN THE STORAGE COEFFICIENT.
     (iii) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

--------------------------------------------------------------------------------
--------------------
| CALIB              |
| NASHYD    (0014)   |   Area     (ha)=   2.21   Curve Number    (CN)= 71.0
|ID= 1 DT= 5.0 min   |   Ia       (mm)=   5.00   # of Linear Res.(N)= 3.00
--------------------     U.H. Tp(hrs)=    0.31

     Unit Hyd Qpeak  (cms)=    0.269

     PEAK FLOW       (cms)=    0.214 (i)
     TIME TO PEAK    (hrs)=    3.417
     RUNOFF VOLUME    (mm)=   38.214
     TOTAL RAINFALL   (mm)=   89.925
     RUNOFF COEFFICIENT   =    0.425

     (i) PEAK FLOW DOES NOT INCLUDE BASEFLOW IF ANY.

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

--------------------
| ADD HYD   (0020)   |
|   1 +  2 =  3      |          AREA     QPEAK     TPEAK      R.V.
--------------------            (ha)     (cms)     (hrs)      (mm)
          ID1= 1 (0001):        2.76     0.670      3.25     59.12
        + ID2= 2 (0014):        2.21     0.214      3.42     38.21
          ==================================================
          ID = 3 (0020):        4.97     0.824      3.25     49.82

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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

--------------------
| ADD HYD   (0003)   |
|   1 +  2 =  3      |          AREA     QPEAK     TPEAK      R.V.
--------------------            (ha)     (cms)     (hrs)      (mm)
          ID1= 1 (0002):       11.14     1.019      3.50     38.22
        + ID2= 2 (0020):        4.97     0.824      3.25     49.82
          ==================================================
          ID = 3 (0003):       16.11     1.604      3.33     41.80

     NOTE:  PEAK FLOWS DO NOT INCLUDE BASEFLOWS IF ANY.

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FINISH
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