ENGINEERING LIMITED

April 22nd, 2021

Updated: June 24, 2021

SERVICING BRIEF

LOT 1 DISTRICT LOT 1605 CARIBOO DISTRICT PLAN 30863, EXCEPT PLANS 34562 PGP38585 PGP41824 PGP46265, PGP46269, BCP25534, BCP36464 AND EPP41947 SOUTHRIDGE AVENUE, PRINCE GEORGE, BC PID#: 005-287-391

Client: Ridgecrest Development Group Inc.

L&M Project No.: 1432-08

L&M Engineering Limited
1210 Fourth Avenue, Prince George, BC V2L 3J4
Phone: (250) 562-1977

Table of Contents

1.0 INTRODUCTION

On behalf of Ridgecrest Development Group Inc., we are pleased to provide you with this servicing brief and supporting calculations in support of the concurrent Rezoning Application (RZ100649) and OCP Amendment (CP100169).

The subject property located at the southern terminus of Southridge Avenue and the western terminus of Vista Ridge Drive, is approximately 33.94 hectares (ha) in size and is entirely located within the municipal boundaries of the City of Prince George. The subject property is currently split zoned AF: Agriculture and Forestry, AG: Greenbelt, RS2: Single Residential, RM3: Multiple Residential, and P1: Parks and Recreation in the City of Prince George Zoning Bylaw No. 7850, 2007 and is currently designated a mix of Neighbourhood Residential and Parks & Open Space Future Land Use in the City of Prince George Official Community Plan Bylaw No. 8383, 2011.

The current Rezoning Application and OCP Amendment proposes to rezone two subject areas located within the subject property's boundary. Area 1 is approximately 1.07ha in size and is proposed to be rezoned from P1: Parks and Recreation to RS2: Single Residential to facilitate the addition of new single family residential lots via extensions of Vista Ridge Drive. Area 2 is approximately 1.76 ha in size and is proposed to be rezoned from RS2: Single Residential to RM3: Multiple Residential, in order to facilitate a new medium density multi-family development to be accessed via a planned extension to Southridge Avenue.

The property owner wishes to subdivide a 4.74 ha portion of land at the end of Southridge Avenue to facilitate the next phase of development. The proposed phase would create a total of 22 single-family lots and one multi-family lot for future residential strata development, mentioned above as Area 2. The subdivision is to be serviced with full municipal services including underground water, storm sewer, and sanitary sewer.

This servicing brief is being written to address the site servicing requirements and demonstrate that the existing infrastructure has the capacity to support the proposed Rezoning Application and OCP Amendment. Refer to Appendix A, for the Site Servicing Plan.

2.0 BACKGROUND DATA AND REPORTS

L&M Engineering has reviewed the following background data and reports concerning the development of the subject area:

- City of Prince George – 2017 Sanitary Sewer Services Master Plan prepared by AECOM;
- City of Prince George – 2001 Sanitary Sewer Study prepared by McElhanney;
- City of Prince George – 2014 Water Service Network Plan prepared by Opus Dayton Knight;
- City of Prince George – Development Services Department: Design Guidelines;
- PG Map;
- Ospika South Neighbourhood Plan prepared by Eric Vance & Associates;
- Ospika South Neighbourhood Storm Water Management Plan prepared by L&M Engineering Limited;
- Rainfall IDF Curves - Prince George Airport Data (1960 – 2017)

3.0 WATER DISTRIBUTION SYSTEM

L&M conducted a review of the existing municipal water main infrastructure in the vicinity of the subject property. The water main system in the vicinity of proposed rezoning Area 2, consists of a 250mm diameter watermain that terminates at the current end of Southridge Avenue. The Southridge Avenue watermain connects to multiple network loops and is fed by the Lalonde Reservoir, asset ID PW824 (TWL=682m), on North Street.

The anticipated water demands for the proposed next phase of development (23 Lots at the end of Southridge Avenue) are outlined in Table 2. The Average Daily Demand (ADD), Maximum Daily Demand (MMD), and Peak Hour Demand (PHD) were calculated using the City of Prince George's Draft Design Guidelines and the estimated population.

Table 2: Estimated Water Demands					
Location	**Zoning**	**ADD (L/s)**	**MDD (L/s)**	**PHD (L/s)**	**Node Elevation (m)**
Node 1	RS2	0.14	0.44	0.61	677.00
Node 2	RS2	0.25	0.77	1.05	679.00
Node 3	RM3	0.85	2.62	3.60	685.00

**Refer to Section 4.0 for Design Population calculation.*

In addition to the domestic water demand, an allowance for fire protection must be made. According to the City of Prince George's Draft Design Guidelines, the recommended fire flows for a single-family development and a multi-family development are 60 L/s and 125 L/s, respectively. The document titled Water Supply for Public Fire Protection produced by the Fire Underwriters Survey (FUS) is the de-facto standard in Canada for establishing fire protection requirements in municipal water works system design. This document presents a fire flow estimate that accounts for factors such as building construction, total floor area, material combustibility, automatic sprinkling, building separation, and occupancy. Preliminary FUS calculations were completed for the multi-family townhouse development (Rezoning Area 2) to determine what the required fire flow is based on the FUS calculations. Based on a maximum 2,200 ft^2 unit with firewalls and the minimum setbacks, a fire flow of 83 L/s is required. Since the fire flow values indicated by the City of Prince George Guidelines are recommendations, the FUS calculations should be used to determine the required fire flow on a site-specific basis. Refer to Appendix C for the FUS calculations.

L&M Engineering submitted design parameters to the City of Prince George for water modelling. The City's Water Model was analyzed under Average Day Demand (ADD), Maximum Day Demand (MDD) and Peak Hour Demand (PHD) conditions. Maximum Day conditions represent the highest recorded daily demand on the water system and Peak Hour flow conditions represent the highest demand on the system during the course of a day.

The results of the City's water modelling in conjunction with L&M Engineering's calculations showed that the proposed development would require the extension of the existing 250mm diameter watermain to service the development. During the MDD + fire flow scenario, the available fire flows along the continuation of Southridge Avenue would be 116 L/s. The City's water model analyzed the multi-family portion of the site (Rezoning Area 2) using a 200mm diameter watermain. During the MDD + fire flow scenario, the available fire flow at the end of the multi-family water service is 98 L/s.

L&M Engineering utilized EPANET 2.0 software in conjunction with the hydrant curve, provided in the CoPG water modelling results, to determine the available fire flow at the end of the multi-family service if a 250mm diameter service is installed. The modelling conducted by L&M indicates that a 250mm diameter service can achieve an available fire flow of 108L/s at the end of the multi-family service, while maintaining a residual pressure of 20psi.

Since the multi-family site cannot achieve the recommended fire flow (125 L/s) outlined in the City Design Guidelines, the developer has two options to provide adequate fire flows to the site. One option is to loop the offsite watermains from North Street to Grayshell Road, as indicated in the City of Prince George Water Modelling results. This option would provide benefit to the entire water system network in the surrounding area and therefore could be cost shared with the City of Prince George.

Another option would be to place a covenant on the property limiting the size of the future buildings to satisfy the Fire Underwriters Survey recommendations. The future buildings should then be planned and constructed to ensure that the required fire flow does not exceed 108 L/s, as indicated by the water modelling for the multi-family site. To satisfy the City of Prince George concerns with regards to density of the proposed multi-family land-use, the developer has already offered to place the following covenants on the proposed multi-family zoned land:

- Limit the overall residential density of the RM3 zone from 60 du/ha to 40 du/ha
- Limit the number of units permitted in a building to 6
- Limit the maximum number of townhouse units on the site to 50 units
- Limit the maximum number of duplex units on the site to 10 units

This covenant could also include additional language outlining the requirements to satisfy fire flow requirements even though these are already requirements of the BC Building Code.

Further modelling or adjustments will be required at the time of detailed design to account for the building elevations and friction losses. Refer to Appendix C for the City of Prince George Water Modelling Results.

The proposed rezoning Area 1, at the end of Vista Ridge Drive, will accommodate 6 single family lots due to the configuration of the parcel. Six single family lots will have negligible impacts on the existing water system and the existing fire flow within the current water system can accommodate the recommended 60 L/s flow rate.

4.0 SANITARY COLLECTION SYSTEM

The Ospika South Neighbourhood Plan (2006) mentions that there are future plans to install a diversion sewer line from the sanitary lift station (PW125) at the east end of Park Drive to the existing sanitary main on Southridge Avenue. The diversion line would be installed through the subject property, along the future Glen Lyon Way and Southridge Avenue road alignments.

The 2017 Sanitary Sewer Services Master Plan indicates that PW125 should be decommissioned, and a gravity line should be installed from PW125 to Southridge Avenue. This is identified as Short Term Upgrade E-2 in the Master Plan. The diversion line is recommended to be installed since PW125 does not have sufficient capacity under existing loading conditions and the current downstream pipe infrastructure (Highway Frontage Rd & Marleau Rd.) does not have the required capacity during the OCP loading condition. The Master Plan also identifies a long-term upgrade project (O-23) downstream of the proposed infrastructure. The O-23 upgrade consists of upsizing all of the sanitary mains along Southridge Avenue and St. Mary's Crescent to 450mmø pipes.

L&M Engineering reviewed the *City of Prince George 2017 Sanitary Sewer Services Master Plan (prepared by AECOM)*, the *City of Prince George 2001 Sanitary Sewer Study* (prepared by McElhanney), the *Ospika South Neighbourhood Plan* (prepared by L&M) and PGMap for information related to the capacity of the existing downstream sanitary system and the proposed flows from the subject property. The 2017 report indicates that during the existing loading scenario all the downstream pipes, between the subject site and the Prince George Wastewater Treatment Facility, have available capacity.

Based on the Neighbourhood Plan the subject property will include approximately 220 multi-family dwellings and 260 single-family dwellings. The number of dwellings was adjusted to reflect the current rezoning application. The City of Prince George Draft Design Guidelines (Section 4.2) outline the procedure required to determine the design flow based on a design population of 3.2 people per dwelling. Table 3 summarizes the sanitary design flow for the full build-out of the subject property.

Table 3: Estimated Sewage Design Flow (PID: 005-287-391)			
Variable	**Result**		**Notes**
Population	1536	people	People per Unit, 2.10.1 CoPG Design Guidelines
Domestic Avg Daily per Capita	380	l/d	Refer to Section 4.2.2.6 CoPG Design Guidelines
Total Avg. Daily Flow	583,680	l/d	= Population * Avg. Flow per Capita
Peak Factor	3.67		Harman Equation
Total Peak Design Flow (Qs)	2,142,106	l/d	=Total Avg. Daily Design Flow * Peak Factor
Total Peak Design Flow (Qs)	24.8	l/s	=Total Avg. Daily Design Flow * Peak Factor
Infiltration and Inflow			
Development Area	33	ha	
Infiltration Rate	11,200	l/ha/d	Refer to section 4.2.2.4 (11,200 L/ha)
Infiltration (Qi)	369,600	l/d	= Development Area x Infiltration Rate
Infiltration (Qi)	4.3	l/s	= Development Area x Infiltration Rate
Total Design Flow (Qs + Qi)	2,511,706	l/d	(Qs + Qi)
Total Design Flow (Qs + Qi)	**29.1**	**l/s**	**(Qs + Qi)**

Based on the calculations, the subject property alone will produce a sanitary flow of 29.1 L/s. All of the pipes located downstream of the subject property can accommodate the additional 29.1 L/s that will be generated by the subject property at full build-out. Therefore, the development of subject property will not trigger the long-term upgrade (O-23) identified in the 2017 Master Plan.

Currently, there is a large amount of undeveloped land between the subject property and PW125. There are still numerous unknowns in terms of exactly how these lands will be serviced and how much of the undeveloped lands will flow toward the Southridge mains once the entire area is developed. To remain consistent with the O-23 upgrade project it is recommended to install 450mmø pipes within the next phase of development at the south end of Southridge. Installing 450mmø pipes rather than matching the existing 300mmø pipes at the south end of Southridge should ensure that the proposed pipes will not be over capacity once the upstream lands are developed. It is unconventional to have a smaller pipe downstream of a larger pipe; however, once the O-23 upgrade project is completed all of the pipes along Southridge and St. Mary's will be the same size (450mmø).

5.0 STORMWATER SYSTEM

When the Ospika South Neighbourhood residential area was originally rezoned, a Storm Water Management Plan (SWMP) was produced by L&M Engineering to outline the catchment areas and determine the future locations and sizes of storm detention ponds. The SWMP indicates that both areas (Area 1 and Area 2) subject to rezoning are proposed to drain to the existing storm detention pond (AssetID: 28) located in the Glen Lyon Park

between Southridge Avenue and Vista Ridge Drive. This plan remains the same, the only difference is that the areas being rezoned will generate a slightly higher runoff flow and volume due to the increased density of the developments.

Utilizing HydroCAD 10.0 software, the hydrograph method was used to model a 10-year and 100-year, 24-hour return period storm event. These models were used to compare the difference in runoff flow and volume between the current zoning and the proposed zoning for the two subject areas. Below is a summary of the following key HydroCAD model input parameters used for the modelling of the stormwater system:

- Runoff Curve Numbers (CN)

In order to develop an accurate model, each sub-catchment area must be characterized by land use and corresponding impervious and pervious area identified as a runoff curve number (CN). These values dictate how much of the rainfall is absorbed back into the ground vs. captured and conveyed by storm infrastructure.

- Times of Concentration

The individual inlet times of concentrations for the post development conditions in the developed areas were determined based on slopes and flow lengths with travel times calculated based on estimated storm sewer lengths, grades, and velocities.

- Rainfall Intensity

Rainfall intensity duration frequency information for the 10-year and 100-year return periods were based on the Rainfall IDF Curves from the Prince George Airport Data from 1960 to 2017. This data was provided by the City of Prince George.

The results and comparisons between the current zoning and the proposed zoning are summarized in Table 4.

Table 4: Storm Flows 10-year Storm				
Zoning	**10-Yr Runoff Flow (m^3/s)**	**10-Yr Runoff Volume (m^3)**	**100-Yr Runoff Flow (m^3/s)**	**100-Yr Runoff Volume (m^3)**
Area 1 (1.07ha)				
Current Zoning (P1)	0.012	62	0.045	137
Proposed Zoning (RS2)	0.025	92	0.069	183
Area 2 (1.76ha)				
Current Zoning (RS2)	0.071	218	0.164	394
Proposed Zoning (RM3)	0.126	332	0.243	540
Combined Total (Area 1 + Area 2)				
Current Zoning	0.083	280	0.209	531
Proposed Zoning	0.151	424	0.312	723
Difference	**0.068**	**144**	**0.103**	**192**

Table 4, indicates that rezoning Area 1 and Area 2 will result in an additional runoff volume of 144m^3 during a 10-year storm event and 192m^3 during a 100-year storm event. The additional runoff volume would be discharged into the storm detention pond (AssetID: 28), which flows into the City's piped storm network downstream of the pond. According to the SWMP, the detention pond was designed with a storage volume of 11,500m^3. The 100-year model in the SWMP indicates that the required storage volume for the detention pond is 11,015m^3. This results in the pond having 485m^3 in excess storage during a 100-year storm event. The subject rezoning only increases the post-development runoff volume by 192m^3 during a 100-year event, therefore the existing storm pond has the available capacity to accommodate the additional storm runoff as a result of the rezoning. A copy of the HydroCAD modelling results is enclosed in Appendix D.

The proposed plan is to install storm mains along the extensions of Southridge Avenue and Vista Ridge Drive to collect the storm runoff from the future developments. These storm mains should flow toward and discharge into the storm detention pond (AssetID: 28).

A copy of the Ospika South Neighbourhood Storm Water Management Plan is enclosed in Appendix E.

6.0 SUMMARY

In summary, the subject areas located at the current ends of Southridge Avenue and Vista Ridge, in Prince George BC, appear to be situated such that they can be adequately serviced with the nearby municipal water and sanitary sewer infrastructure. Stormwater would be directed to the existing stormwater detention pond that was designed for the proposed and future developments and the existing stormwater detention pond has been adequately sized and constructed and can handle this additional flow. The proposed water mains could tie into the existing 250mm diameter watermain at the end of Southridge Avenue and the 200mm diameter watermain at the end of Vista Ridge Drive. The proposed rezoning at the end of Southridge Avenue would require either offsite pipe upgrades or a covenant limiting the size of the dwellings on the property to limit required fire flows to the available fire flow rate of 108 L/s. The subject areas can also be serviced with municipal sanitary sewer servicing from the sanitary main stubs at the end of Southridge Avenue and Vista Ridge Drive. The report provides two options for thefuture sanitary servicing along Southridge Avenue. Option 1 is to design all of the pipes to be 300mm diameter mains. If this option is chosen, then the pipes will be design to utilize a maximum internal pipe depth of 85%. The City's Guidelines state that a pipe shall be designed to utilize a maximum internal pipe depth of 50%. Option 2 would be to install 450mm diameter pipes in the sections of Southridge that have less than 3.8% grade. This option satisfies the City's 50% internal pipe depth guideline.

7.0 CLOSURE

This Servicing Brief has been prepared for the City of Prince George and Ridgecrest Development Group Inc as the intended users. Any use which a third party makes of this report or any reliance on or decisions to be made based on it are the responsibility of such third parties. L&M Engineering Limited accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this study. The information and data contained within this document represent L&M Engineering Limited's professional judgement in accordance with the knowledge and information available to L&M Engineering Limited at the time of the report preparation. No other warranty, expressed or implied, is made.

Sincerely,

L&M ENGINEERING LTD

Prepared by:

Tanner Fjellstrom, P. Eng
Project Engineer

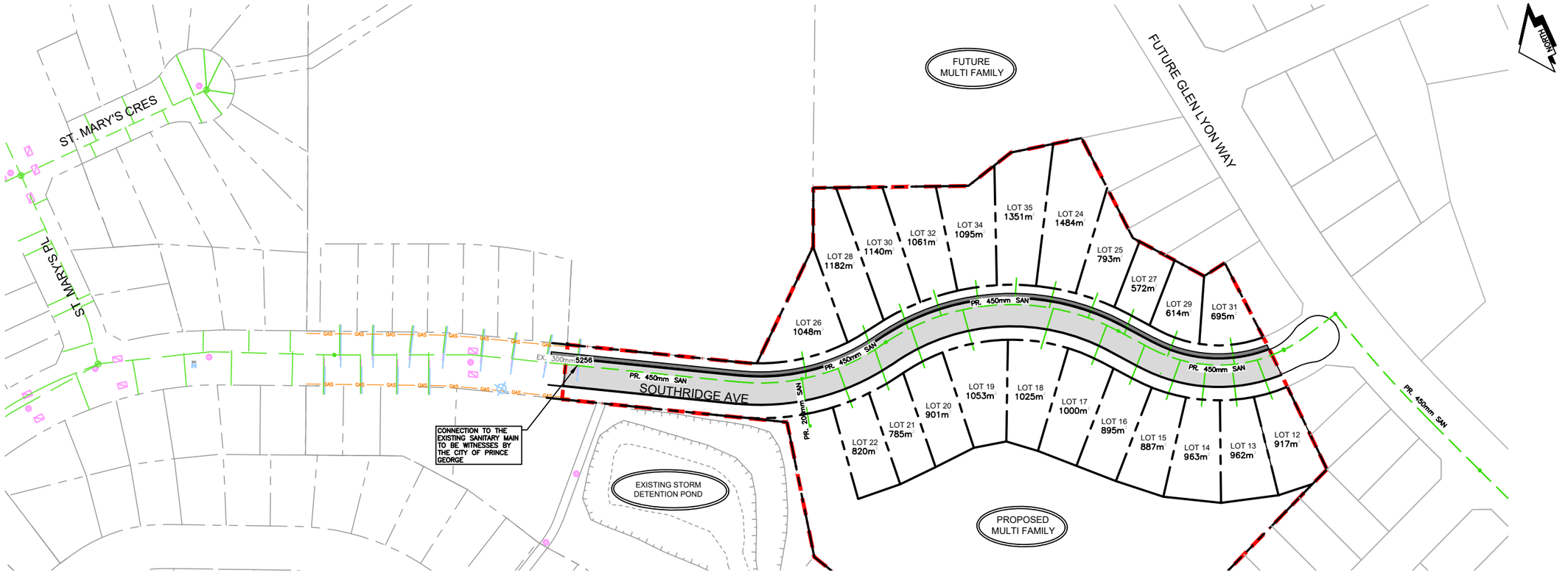
Reviewed by:

Jason R. Boyes, P.Eng.
Principal

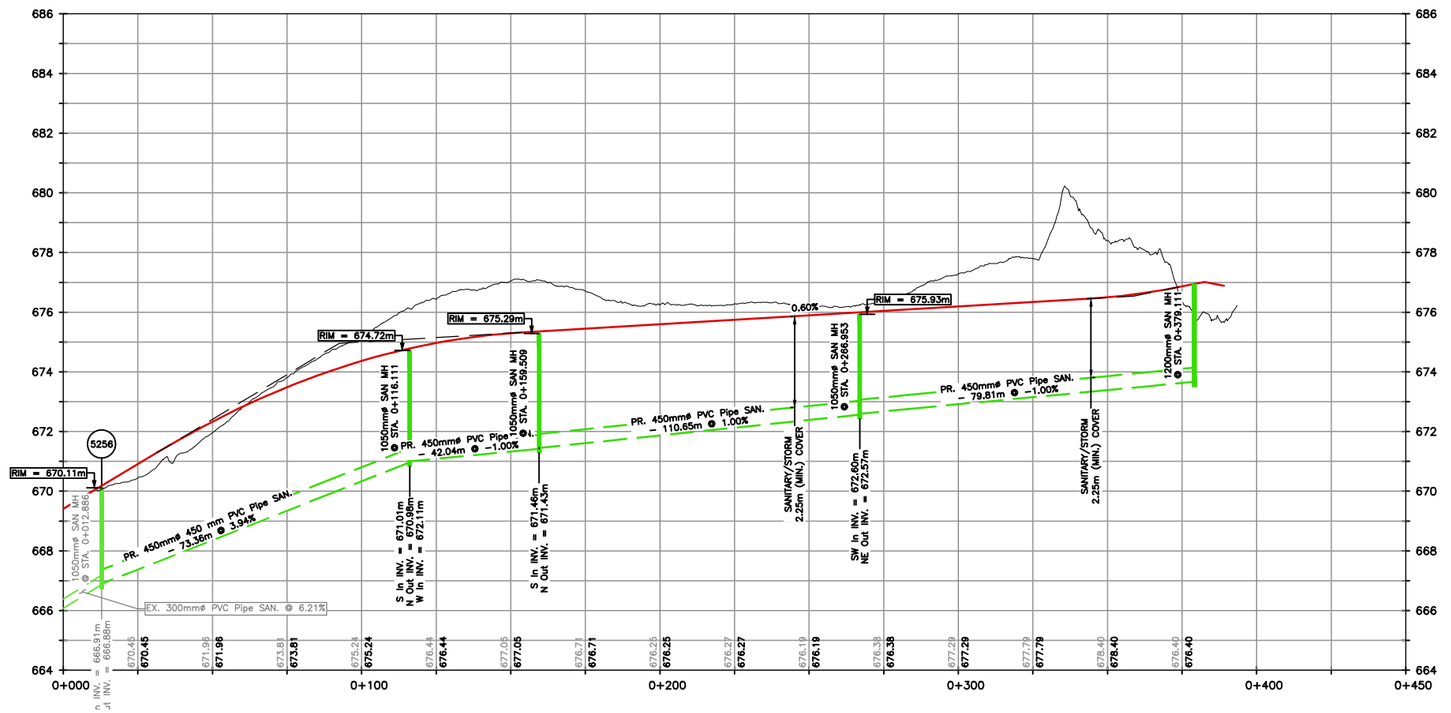
G:\Job Files\1400\1432 - 657180 BC Ltd - Mo Golam\08 - St Lawrence Ave Rezoning\Servicing Brief\1432-08 Servicing Brief - TF Edits (Autorecovered).Docx

APPENDIX A

SANITARY SERVICING PLAN



PROFILE - SOUTHRIDGE AVE



LEGEND

EXISTING

- EX. LEGAL LINE
- EX. LEGAL R.O.W. & EASEMENT
- EX. SANITARY MANHOLE
- EX. STORM MANHOLE
- EX. SINGLE & DOUBLE CATCHBASIN
- EX. CATCHBASIN MANHOLE
- EX. FIRE HYDRANT & VALVE ASSEMBLY
- EX. WATER VALVE
- EX. ROAD & SIDEWALK
- EX. ROAD SIGN(s)
- EX. SHOULDER
- EX. TOP OF SLOPE
- EX. TOE OF SLOPE
- EX. FENCE

PROPOSED

- PR. LEGAL LINE
- PR. LEGAL R.O.W. & EASEMENT
- PR. SANITARY MANHOLE
- PR. SAN MAIN
- PR. ASPHALT
- PR. CURB & SIDEWALK

NO.	DATE (D/M/Y)	REVISION	BY
–	–	–	–

NOT FOR CONSTRUCTION

L&M ENGINEERING LIMITED

CITY OF PRINCE GEORGE
Development Services

CONSULTANTS PROJECT No.:	1432-08
DRAWN:	BBB
CHECKED:	JRB
ENGINEER:	JRB
DATE:	APRIL 2021
SCALES:	HORZ. 1:1000
SCALES:	VERT. 1:100

RIDGECREST DEVELOPMENT GROUP INC.
SOUTHRIDGE AVENUE
SANITARY WORKS PLAN
& PROFILE
STA. 0+000 TO 0+393.46

DRAWING No.
SAN

0 30 60 Meters

G:\Job Files\1400\1432 - 697180 BC Ltd - Mr Gidden\08 - St Lawrence Ave Rezoning\Design\[2021-1432-08_Revs_450mm San Change.dwg

APPENDIX B

WATER MODELLING RESULTS

CITY OF PRINCE GEORGE
Infrastructure and Public Works

1100 Patricia Boulevard, Prince George, BC V2L 3V9
Telephone (250) 561-7511 Fax (250) 612-5603

MEMO

To: **Tanner Fjellstrom, EIT**
L&M Engineering Limited
tanner@lmengineering.bc.ca

From: **Shane Castle, EIT**
250-561-7546
Shane.Castle@princegeorge.ca

Date: **November 27, 2020**

Subject: **WM000095 Water Modelling For the Southridge Avenue Extension**
Total number of pages (including this sheet): 6 Original WILL NOT follow by mail.

Mr. Fjellstrom,

Water modelling has been carried out for the Southridge Avenue Extension under the conditions provided by Tanner Fjellstrom via email on October 26, 2020 and subsequent phone calls. As noted in this email, there are 19 single family dwellings and 48 row housing units proposed.

The results of the modelling are outlined in Table 1 and the design fire flows meet the requirements for single family residents but do not meet fire flows for apartments/townhouses. Hydrant curves for all node locations are attached. Please note that these curves show available fire flow where as design fire flow is the flow available while maintaining 20 PSI in the water network.

Table 1: Modelling Scenarios for the Southridge Avenue Extension (250 mm from Node 1 - Node 2, 200 mm from Node 1 – Node 3)

Node	Modelling Node #	Pressure During PHD	Pressure During ADD	Design Fire Flow During MDD
Node 1	1741	540.34 kPa (78.37 PSI)	569.02 kPa (82.53 PSI)	116.47 l/s
Node 2	1745	520.69 kPa (75.52 PSI)	549.37 kPa (79.68 PSI)	116.93 l/s
Node 3	1746	461.74 kPa (66.97 PSI)	490.56 kPa (71.15 PSI)	98.57 l/s

Neither upsizing the watermains nor looping into the 200 mm stub on St Patrick Ave will provide the additional flow requirements for apartments/townhouses. To meet these flow requirements, watermain looping from North Street to Grayshell Road is required.

Keep in mind that the values provided are at the proposed main and any losses within the service connections must be taken into account by the designer.

If you have any questions please contact me.

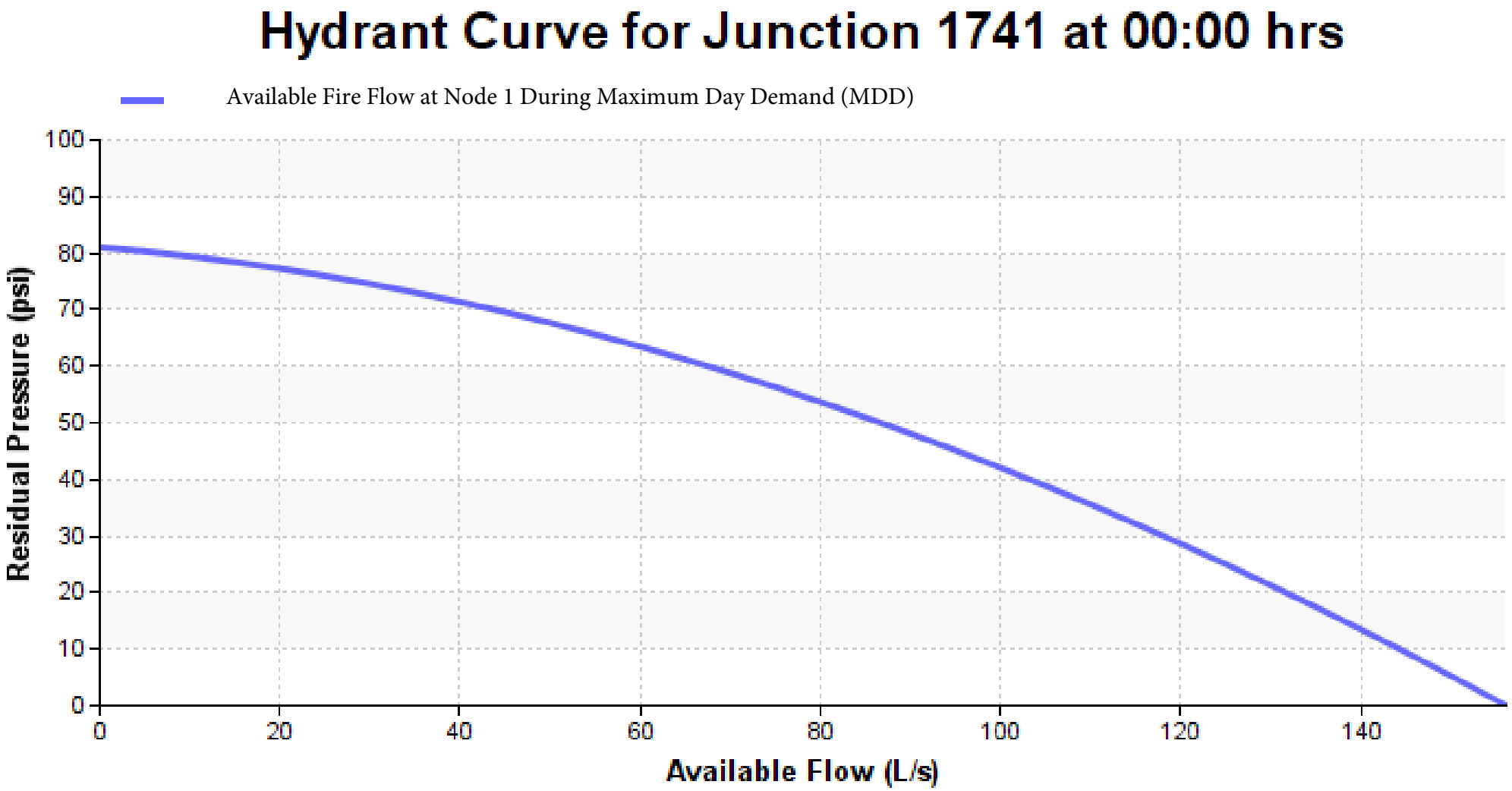
Modelling has been carried out using the most recent version of the City's water model, analyzed under Average Day Demands (ADD), Maximum Day Demands (MDD), and Peak Hour Demands (PHD). Average Day represents the expected average demand over the entire year. Maximum Day represents the average demand during the expected highest demand day of the year. Peak Hour represents the expected highest single-hour average demand with a 3-year return period. Fire Flows given are Design Fire Flows, representing the highest flow that can be drawn from a hydrant under Maximum Day Demand, without reducing pressure at any point in the network below 20 PSI.

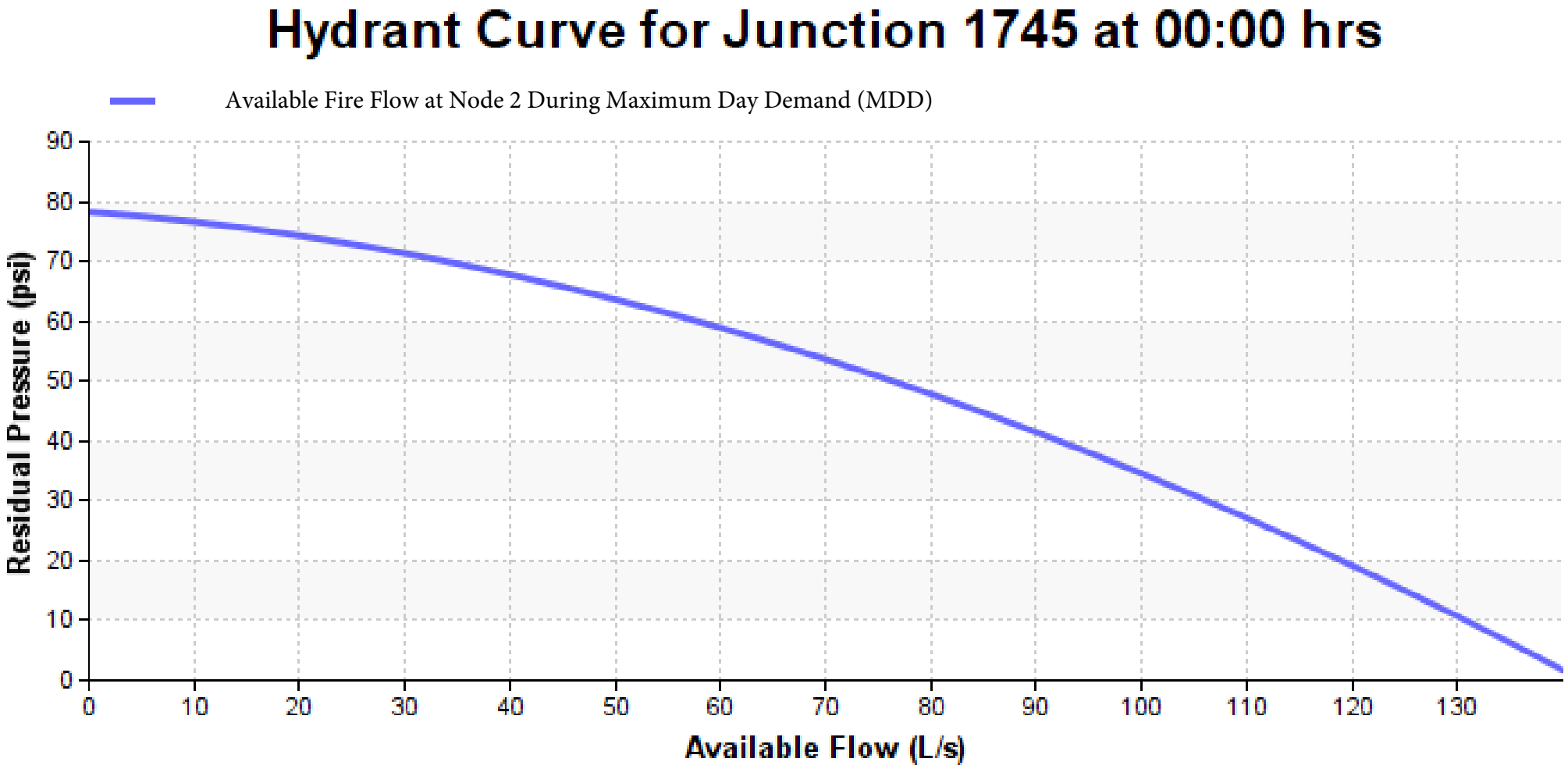
Regards,

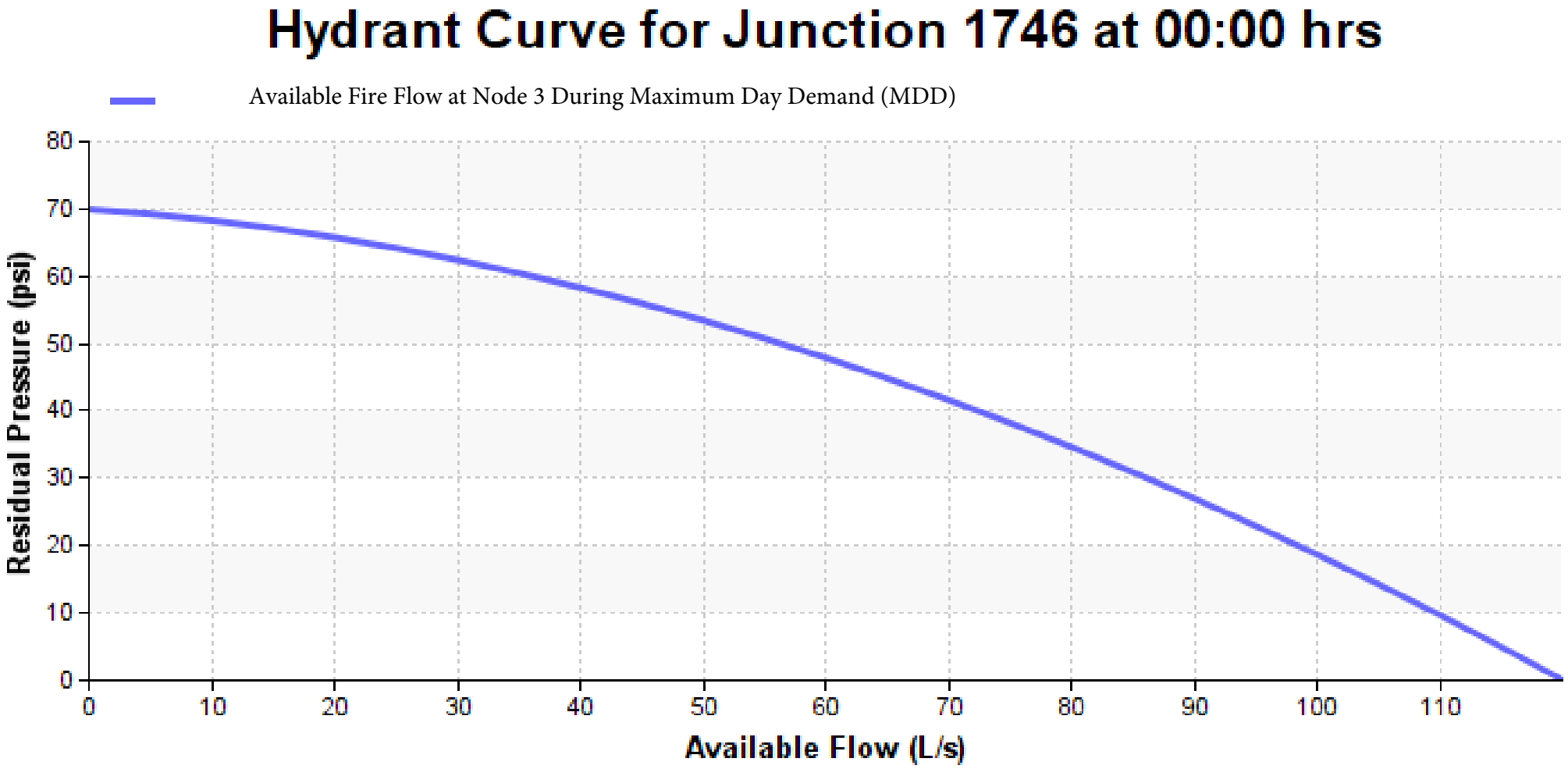
Prepared by
Shane Castle, EIT
Engineering Assistant
1-250-561-7546
shane.castle@princegeorge.ca

Reviewed by
Al Clark, P.Eng
Infrastructure Engineer

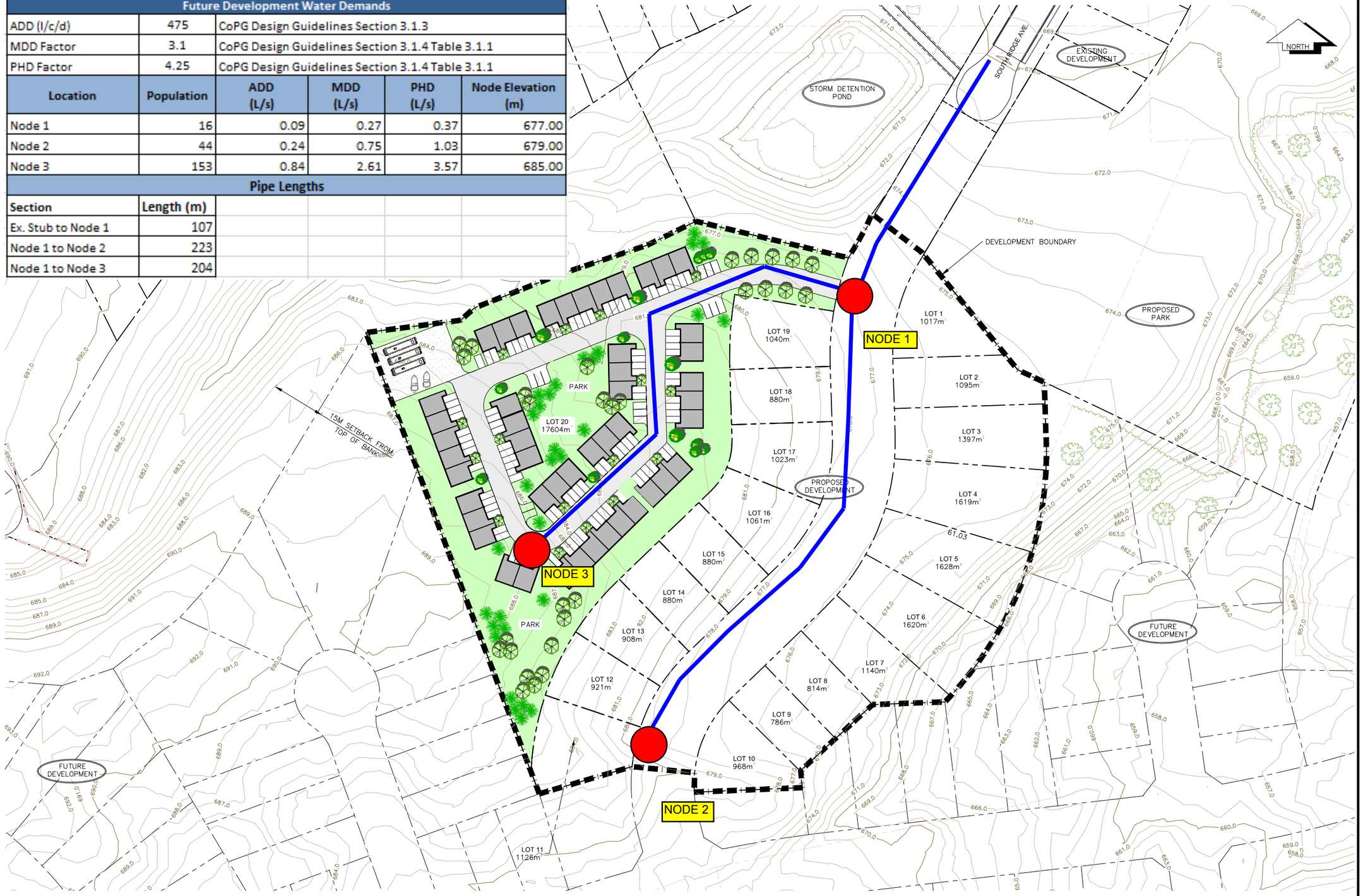
CC: Wil Wedel, AScT, RTMgr, Utilities Manager
Natalie Payne, Supervisor of Subdivision and Building Inspection


Hydrant Curve for Junction 1741 at 00:00 hrs
Available Fire Flow at Node 1 During Maximum Day Demand (MDD)
Residual Pressure (psi)
100
90
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
Available Flow (L/s)


Hydrant Curve for Junction 1745 at 00:00 hrs
Available Fire Flow at Node 2 During Maximum Day Demand (MDD)
Residual Pressure (psi)
90
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Available Flow (L/s)


Hydrant Curve for Junction 1746 at 00:00 hrs
Available Fire Flow at Node 3 During Maximum Day Demand (MDD)
Residual Pressure (psi)
80
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
70
80
90
100
110
Available Flow (L/s)

Southridge Avenue Extension					
Future Development Water Demands					
ADD (l/c/d)	475	CoPG Design Guidelines Section 3.1.3			
MDD Factor	3.1	CoPG Design Guidelines Section 3.1.4 Table 3.1.1			
PHD Factor	4.25	CoPG Design Guidelines Section 3.1.4 Table 3.1.1			
Location	**Population**	**ADD (L/s)**	**MDD (L/s)**	**PHD (L/s)**	**Node Elevation (m)**
Node 1	16	0.09	0.27	0.37	677.00
Node 2	44	0.24	0.75	1.03	679.00
Node 3	153	0.84	2.61	3.57	685.00
Pipe Lengths					
Section	**Length (m)**				
Ex. Stub to Node 1	107				
Node 1 to Node 2	223				
Node 1 to Node 3	204				



LEGEND

DEVELOPMENT BOUNDARY

NO.	DATE	REVISION	DR.

CITY OF
PRINCE GEORGE
Development Services

DRAWN:	DDA
CHECKED:	JRB
ENGINEER:	JRB
SURVEY FILE:	
DRAWING FILE:	C3D13-1106-11-02BASEJR
CORRESPONDENCE:	CPG
GRID:	
DATE:	11/27/2014
SCALES:	HORZ. 1:750

CENTURY GROUP
GLEN LYON CASCADES
PHASE 3 – 20 LOTS
CONCEPTUAL SUBDIVISION PLAN

CONSULTANTS PROJECT No.
1106-11-02
DRAWING No.
C001-A

SHEET No.	REV. No.
1 OF 1	0

L&M ENGINEERING LIMITED
1210 FOURTH AVENUE
PRINCE GEORGE, B.C.
V2L 3J4
TEL. (250) 562-1977
FAX (250) 562-1967

G:\Job Files\1100\1106 - Century Holdings Ltd\12 - Glen Lyon Ph 3\Southridge Ave Earthwork\C3D13-1106-11-02BASE_REB.dwg

APPENDIX C

FUS Calculations

FIRE UNDERWRITERS SURVEY
FIRE FLOW ESTIMATE

PRELIMINARY

City: Prince George
Date: 11-Mar-21
Engineer: TF
Job No: 1432-08

Project: Southridge Multifamily

Address: Southridge

Fire Area Considered

Types of Construction: Wood Frame
C: 1.5

Ground floor area (ft^2): 1100 **No. of Stories:** 2
(m^2): 102
Total floor area (m^2): 204
Fire flow from table (=220*C*$A^{0.5}$): 4718 L/m (a)
Occupancy: Limited Combustable **Add or Subtract** -25 % -1179.4
Sub Total 3538 L/m (b)
Automatic sprinklers: No Subtract 0 % x b = 0
Sub Total 3538 L/m

Exposures :	**Exposure Distance (m)**			
1. Front	15	Add	15	%
2. Left	4.5		10	%
3. Rear	6		20	%
4. Right	4.5		10	%
		Total	55	%
		Use	55	% x b = 1946 L/m
			Total	5484 L/m

Fire Flow Required(Rounded to the nearest 1000 L/m) 5000 L/m

83 L/s

Notes and/or calculations:

APPENDIX D

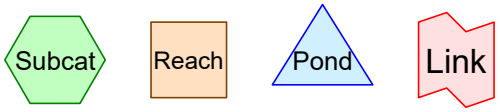
HYDROCAD STORM MODELLING

Current Zoning RS2
-1.76ha

Proposed Zoning RM3
-1.76ha

Current Zoning P1
-1.07ha

Proposed Zoning RS2
-1.07ha



Routing Diagram for Rezoning Difference
Prepared by {enter your company name here}, Printed 2021-04-15

Area Listing (all nodes)

Area (hectares)	CN	Description (subcatchment-numbers)
2.8300	87	1/4 acre lots, 38% imp, HSG D (35S, 38S)
1.7600	92	1/8 acre lots, 65% imp, HSG D (36S)
1.0700	79	Woods, Fair, HSG D (37S)
5.6600	**87**	**TOTAL AREA**

Soil Listing (all nodes)

Area (hectares)	Soil Group	Subcatchment Numbers
0.0000	HSG A	
0.0000	HSG B	
0.0000	HSG C	
5.6600	HSG D	35S, 36S, 37S, 38S
0.0000	Other	
5.6600		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (hectares)	HSG-B (hectares)	HSG-C (hectares)	HSG-D (hectares)	Other (hectares)	Total (hectares)	Ground Cover	Subcatchment Numbers
0.0000	0.0000	0.0000	2.8300	0.0000	2.8300	1/4 acre lots, 38% imp	35S, 38S
0.0000	0.0000	0.0000	1.7600	0.0000	1.7600	1/8 acre lots, 65% imp	36S
0.0000	0.0000	0.0000	1.0700	0.0000	1.0700	Woods, Fair	37S
0.0000	**0.0000**	**0.0000**	**5.6600**	**0.0000**	**5.6600**	**TOTAL AREA**	

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 35S: Current Zoning Runoff Area=17,600.0 m² 38.00% Impervious Runoff Depth>12 mm
Tc=10.0 min CN=87 Runoff=0.0710 m³/s 0.218 Ml

Subcatchment 36S: Proposed Zoning Runoff Area=17,600.0 m² 65.00% Impervious Runoff Depth>19 mm
Tc=10.0 min CN=92 Runoff=0.1262 m³/s 0.332 Ml

Subcatchment 37S: Current Zoning P1 Runoff Area=10,700.0 m² 0.00% Impervious Runoff Depth>6 mm
Tc=10.0 min CN=79 Runoff=0.0117 m³/s 0.062 Ml

Subcatchment 38S: Proposed Zoning Runoff Area=10,700.0 m² 38.00% Impervious Runoff Depth>12 mm
Tc=10.0 min CN=87 Runoff=0.0432 m³/s 0.133 Ml

Total Runoff Area = 5.6600 ha Runoff Volume = 0.744 Ml Average Runoff Depth = 13 mm
60.79% Pervious = 3.4406 ha 39.21% Impervious = 2.2194 ha

Summary for Subcatchment 35S: Current Zoning RS2 -1.76ha

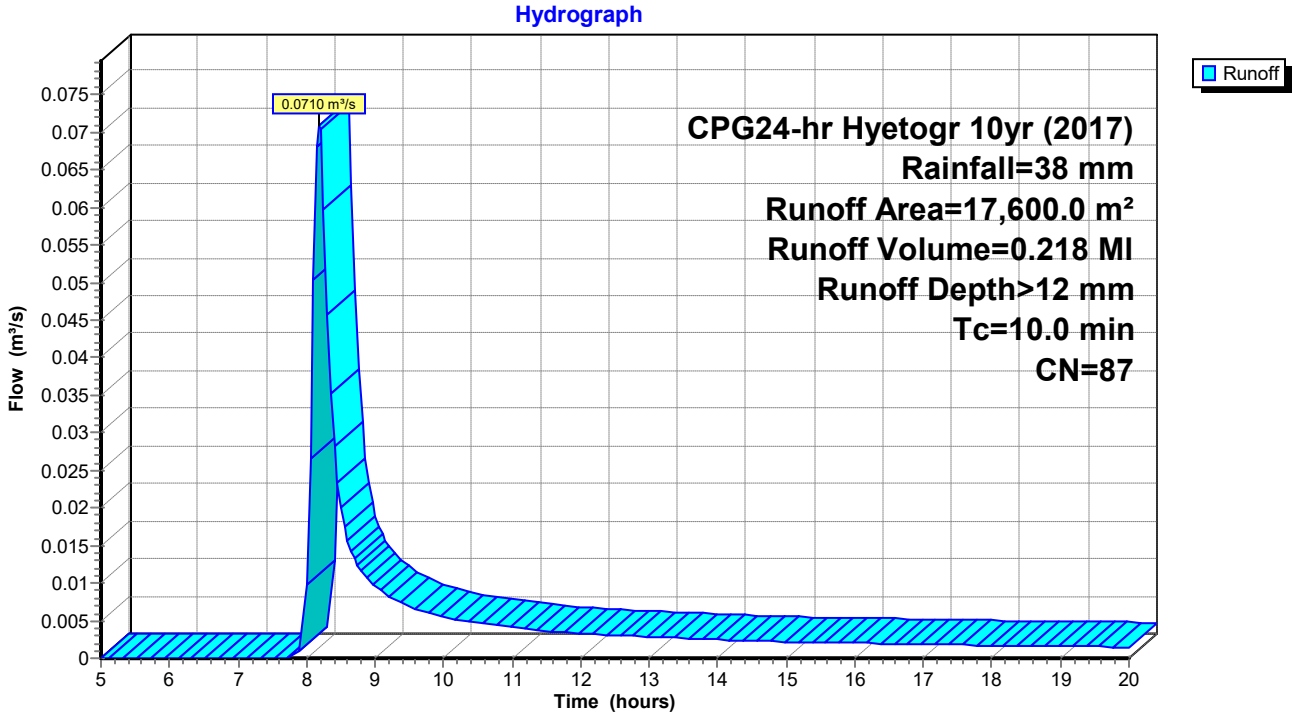
Runoff = 0.0710 m³/s @ 8.18 hrs, Volume= 0.218 Ml, Depth> 12 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
CPG24-hr Hyetogr 10yr (2017) Rainfall=38 mm

Area (m²)	CN	Description
17,600.0	87	1/4 acre lots, 38% imp, HSG D
10,912.0		62.00% Pervious Area
6,688.0		38.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 35S: Current Zoning RS2 -1.76ha



Summary for Subcatchment 36S: Proposed Zoning RM3 -1.76ha

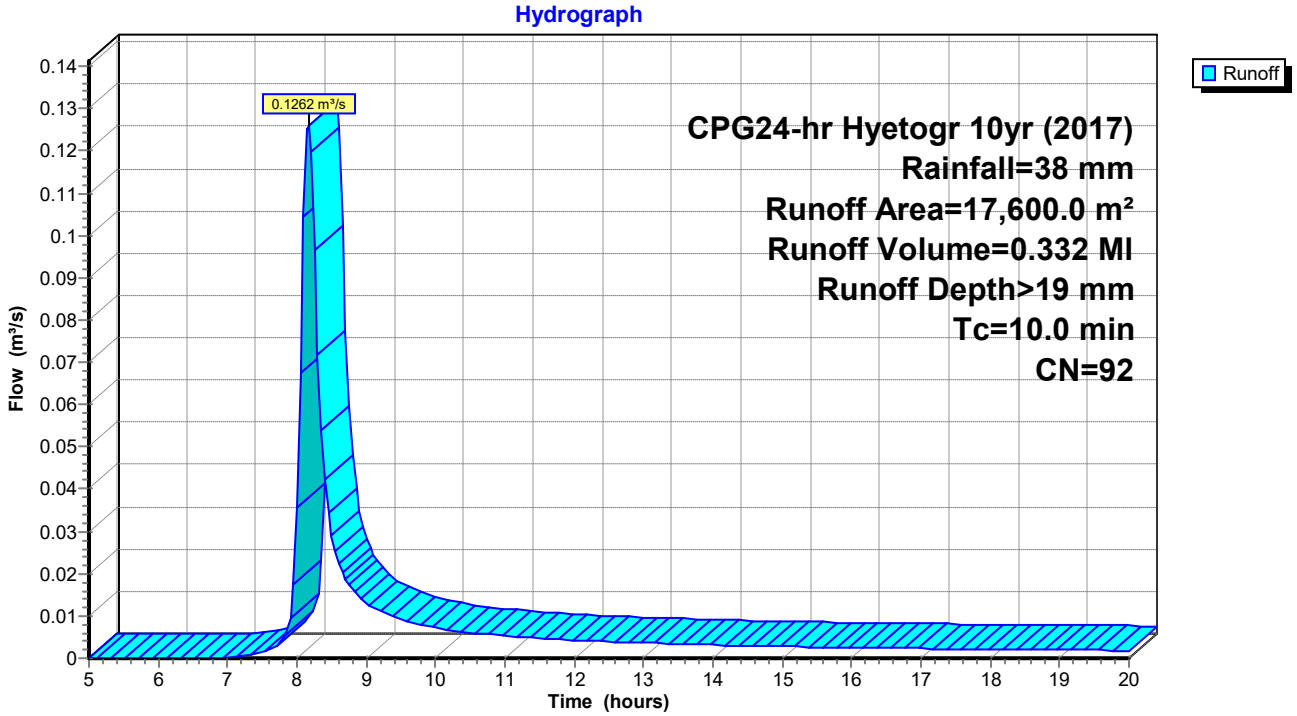
Runoff = 0.1262 m³/s @ 8.16 hrs, Volume= 0.332 Ml, Depth> 19 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
CPG24-hr Hyetogr 10yr (2017) Rainfall=38 mm

Area (m²)	CN	Description
17,600.0	92	1/8 acre lots, 65% imp, HSG D
6,160.0		35.00% Pervious Area
11,440.0		65.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 36S: Proposed Zoning RM3 -1.76ha



Summary for Subcatchment 37S: Current Zoning P1 -1.07ha

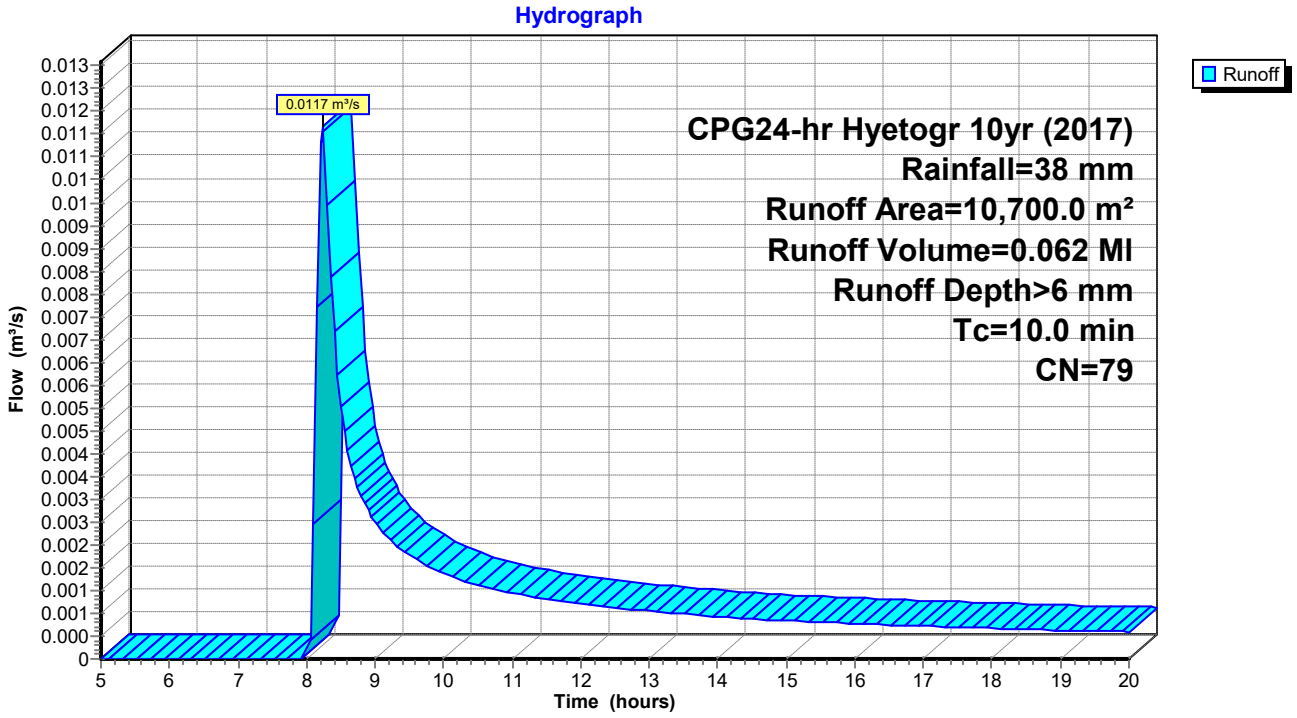
Runoff = 0.0117 m³/s @ 8.23 hrs, Volume= 0.062 Ml, Depth> 6 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
CPG24-hr Hyetogr 10yr (2017) Rainfall=38 mm

Area (m²)	CN	Description
10,700.0	79	Woods, Fair, HSG D
10,700.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 37S: Current Zoning P1 -1.07ha



Summary for Subcatchment 38S: Proposed Zoning RS2 -1.07ha

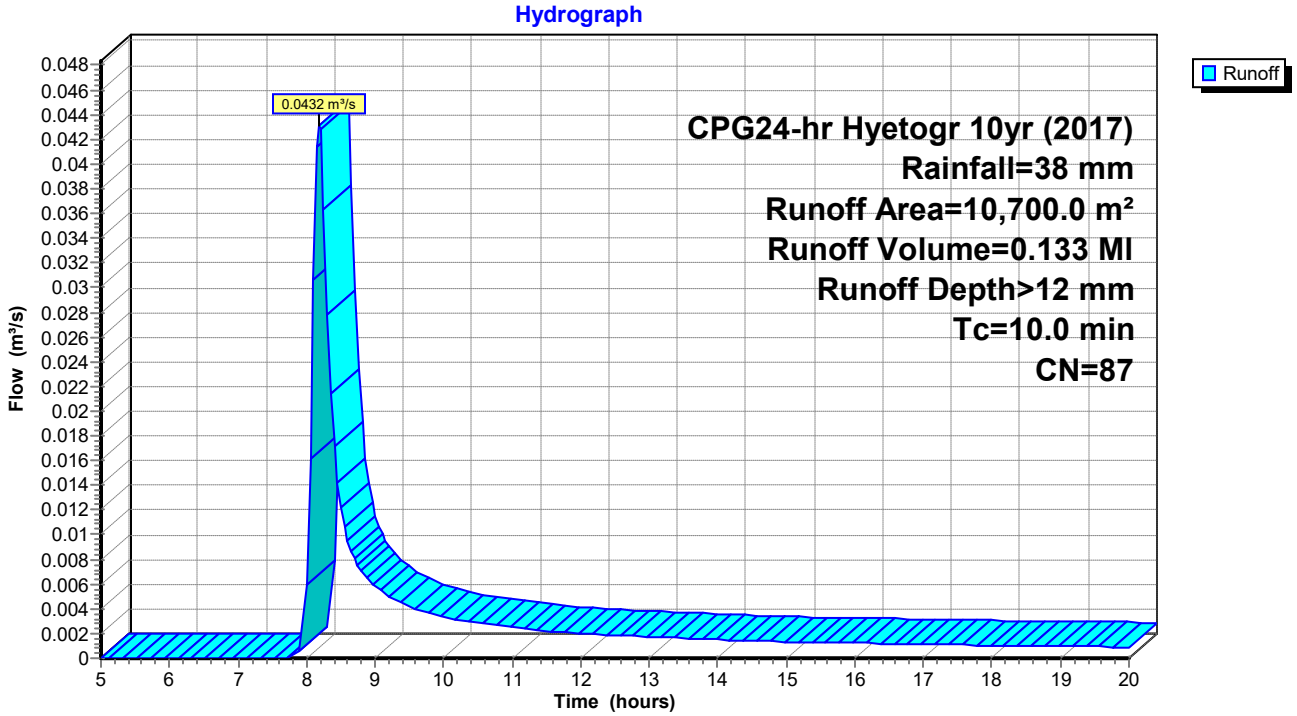
Runoff = 0.0432 m³/s @ 8.18 hrs, Volume= 0.133 Ml, Depth> 12 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
CPG24-hr Hyetogr 10yr (2017) Rainfall=38 mm

Area (m²)	CN	Description
10,700.0	87	1/4 acre lots, 38% imp, HSG D
6,634.0		62.00% Pervious Area
4,066.0		38.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 38S: Proposed Zoning RS2 -1.07ha

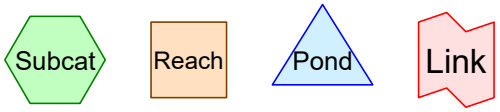


Current Zoning RS2
-1.76ha

Proposed Zoning RM3
-1.76ha

Current Zoning P1
-1.07ha

Proposed Zoning RS2
-1.07ha



Routing Diagram for Rezoning Difference
Prepared by {enter your company name here}, Printed 2021-04-15

Area Listing (all nodes)

Area (hectares)	CN	Description (subcatchment-numbers)
2.8300	87	1/4 acre lots, 38% imp, HSG D (35S, 38S)
1.7600	92	1/8 acre lots, 65% imp, HSG D (36S)
1.0700	79	Woods, Fair, HSG D (37S)
5.6600	**87**	**TOTAL AREA**

Soil Listing (all nodes)

Area (hectares)	Soil Group	Subcatchment Numbers
0.0000	HSG A	
0.0000	HSG B	
0.0000	HSG C	
5.6600	HSG D	35S, 36S, 37S, 38S
0.0000	Other	
5.6600		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (hectares)	HSG-B (hectares)	HSG-C (hectares)	HSG-D (hectares)	Other (hectares)	Total (hectares)	Ground Cover	Subcatchment Numbers
0.0000	0.0000	0.0000	2.8300	0.0000	2.8300	1/4 acre lots, 38% imp	35S, 38S
0.0000	0.0000	0.0000	1.7600	0.0000	1.7600	1/8 acre lots, 65% imp	36S
0.0000	0.0000	0.0000	1.0700	0.0000	1.0700	Woods, Fair	37S
0.0000	**0.0000**	**0.0000**	**5.6600**	**0.0000**	**5.6600**	**TOTAL AREA**	

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 35S: Current Zoning Runoff Area=17,600.0 m² 38.00% Impervious Runoff Depth>22 mm
Tc=10.0 min CN=87 Runoff=0.1641 m³/s 0.394 Ml

Subcatchment 36S: Proposed Zoning Runoff Area=17,600.0 m² 65.00% Impervious Runoff Depth>31 mm
Tc=10.0 min CN=92 Runoff=0.2425 m³/s 0.540 Ml

Subcatchment 37S: Current Zoning P1 Runoff Area=10,700.0 m² 0.00% Impervious Runoff Depth>13 mm
Tc=10.0 min CN=79 Runoff=0.0454 m³/s 0.137 Ml

Subcatchment 38S: Proposed Zoning Runoff Area=10,700.0 m² 38.00% Impervious Runoff Depth>22 mm
Tc=10.0 min CN=87 Runoff=0.0997 m³/s 0.239 Ml

Total Runoff Area = 5.6600 ha Runoff Volume = 1.311 Ml Average Runoff Depth = 23 mm
60.79% Pervious = 3.4406 ha 39.21% Impervious = 2.2194 ha

Summary for Subcatchment 35S: Current Zoning RS2 -1.76ha

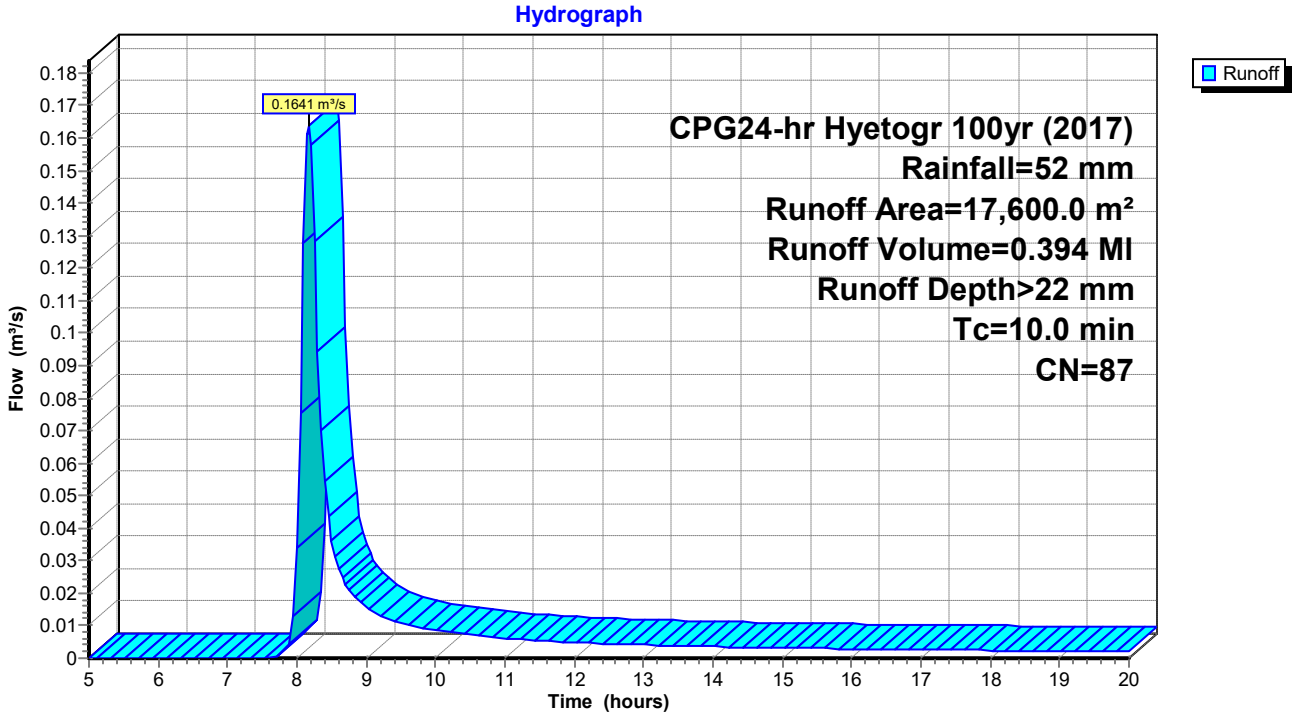
Runoff = 0.1641 m³/s @ 8.17 hrs, Volume= 0.394 Ml, Depth> 22 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
CPG24-hr Hyetogr 100yr (2017) Rainfall=52 mm

Area (m²)	CN	Description
17,600.0	87	1/4 acre lots, 38% imp, HSG D
10,912.0		62.00% Pervious Area
6,688.0		38.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 35S: Current Zoning RS2 -1.76ha



Summary for Subcatchment 36S: Proposed Zoning RM3 -1.76ha

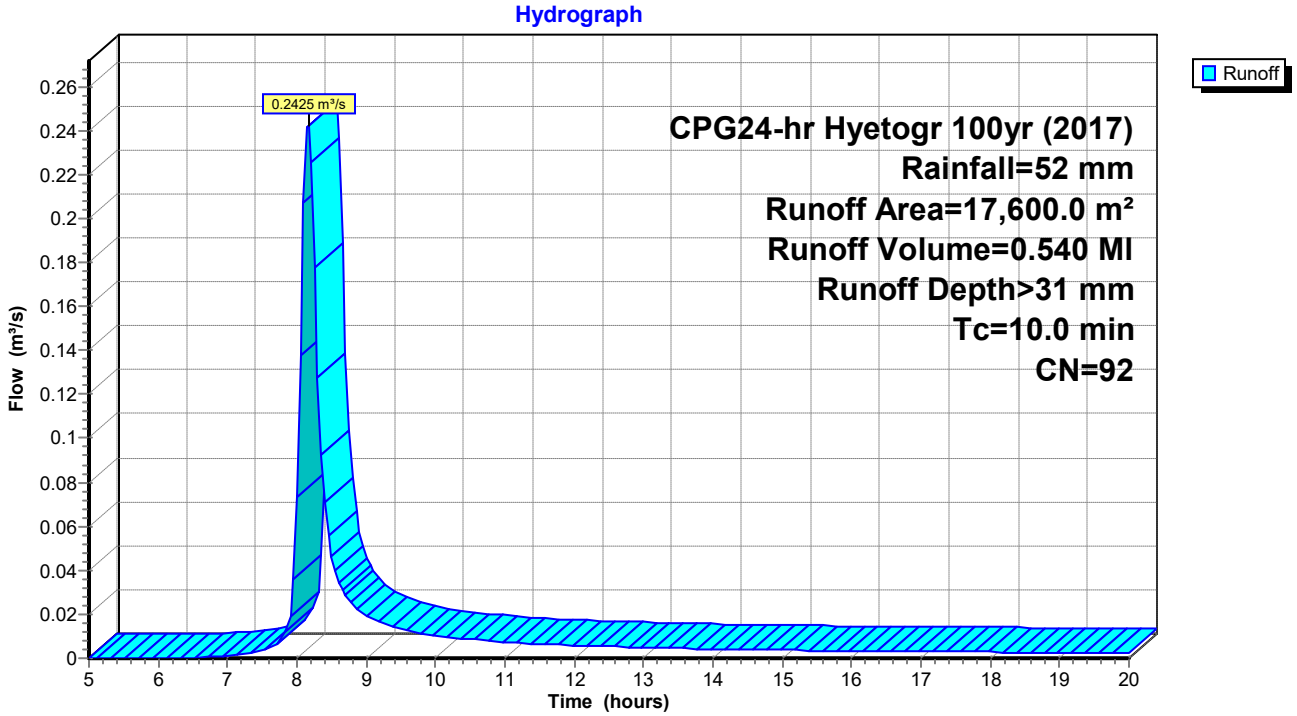
Runoff = 0.2425 m³/s @ 8.16 hrs, Volume= 0.540 Ml, Depth> 31 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
CPG24-hr Hyetogr 100yr (2017) Rainfall=52 mm

Area (m²)	CN	Description
17,600.0	92	1/8 acre lots, 65% imp, HSG D
6,160.0		35.00% Pervious Area
11,440.0		65.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 36S: Proposed Zoning RM3 -1.76ha



Summary for Subcatchment 37S: Current Zoning P1 -1.07ha

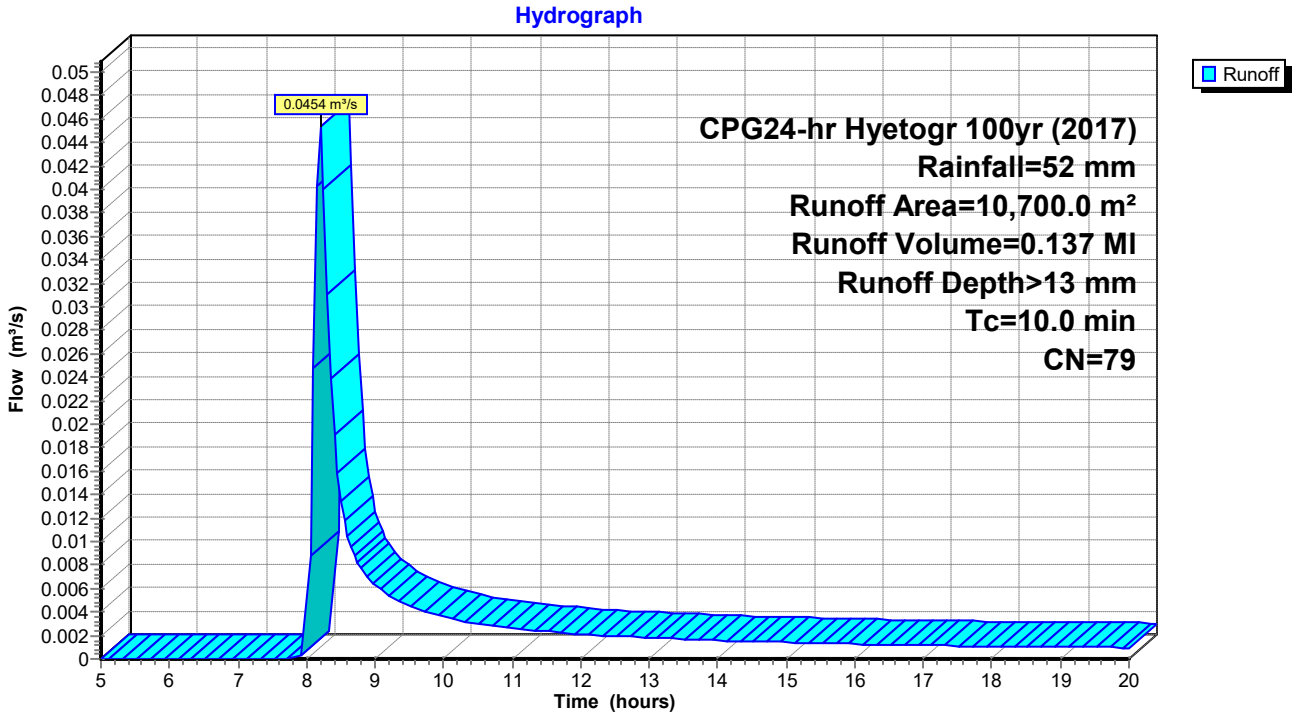
Runoff = 0.0454 m³/s @ 8.20 hrs, Volume= 0.137 Ml, Depth> 13 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
CPG24-hr Hyetogr 100yr (2017) Rainfall=52 mm

Area (m²)	CN	Description
10,700.0	79	Woods, Fair, HSG D
10,700.0		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 37S: Current Zoning P1 -1.07ha



Summary for Subcatchment 38S: Proposed Zoning RS2 -1.07ha

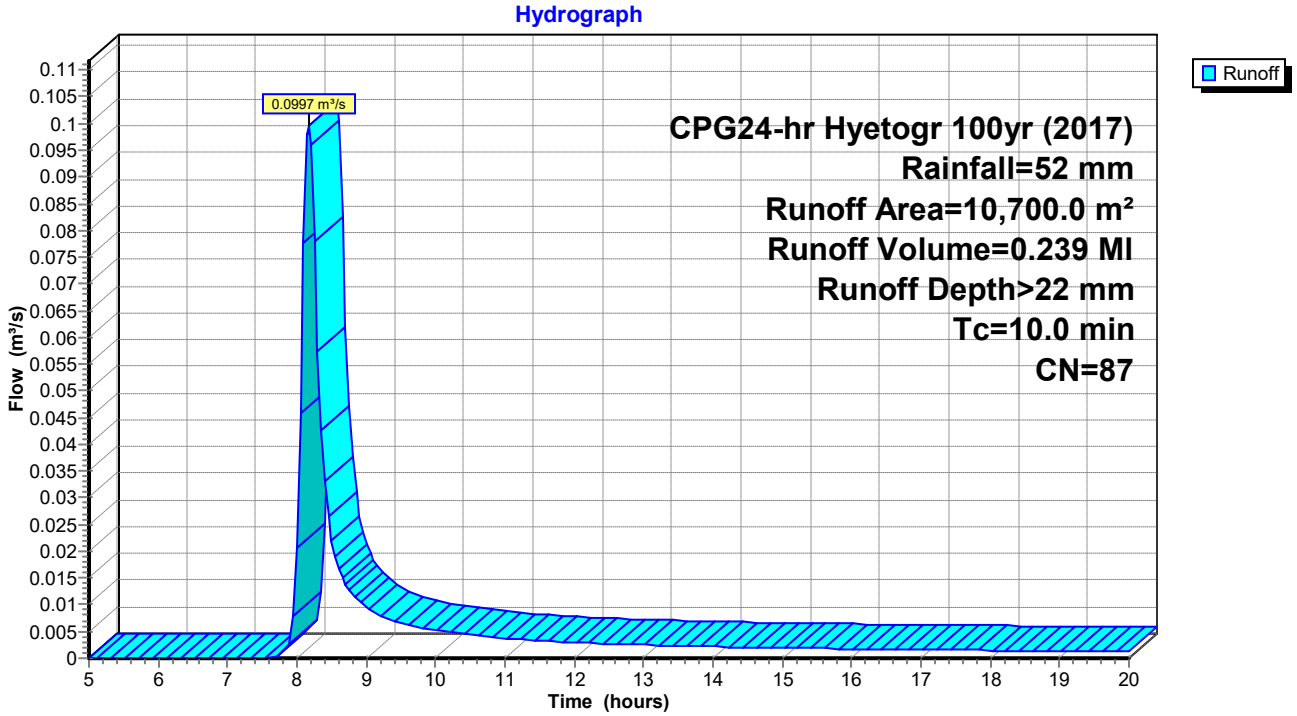
Runoff = 0.0997 m³/s @ 8.17 hrs, Volume= 0.239 Ml, Depth> 22 mm

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
CPG24-hr Hyetogr 100yr (2017) Rainfall=52 mm

Area (m²)	CN	Description
10,700.0	87	1/4 acre lots, 38% imp, HSG D
6,634.0		62.00% Pervious Area
4,066.0		38.00% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
10.0					**Direct Entry,**

Subcatchment 38S: Proposed Zoning RS2 -1.07ha



APPENDIX E

OSPIKA SOUTH NEIGHBOURHOOD
STORM WATER MANAGEMENT PLAN

CENTURY GROUP

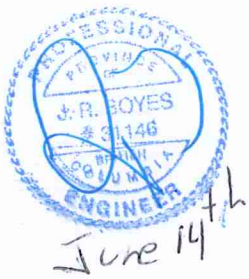
GLEN LYON RESIDENTIAL DEVELOPMENT

OSPIKA SOUTH NEIGHBOURHOOD

STORM WATER MANAGEMENT PLAN

Prepared by:
L&M Engineering Limited

File: 1106-11-02
March 2013



June 14th 2013

ENGINEERING LIMITED

Contents

1.0 Introduction

Century Group has engaged L&M Engineering Limited to provide consulting engineering services in the development of a storm water management plan for the subject lands known as the Ospika South Neighbourhood. The Ospika South Neighbourhood is part of the Gladstone watershed, and the catchment areas for the undeveloped lands area shown on catchment plan CP. The catchment boundary is limited to the natural terrain and current drainage patterns as it relates to the residential zoned lands in this area.

As background information, Associated Engineering (AE), on behalf of the City of Prince George, previously completed a Watershed Drainage Plan for the Gladstone Catchment and surrounding area. This watershed plan has been utilized to addresses the drainage of approximately 149 hectares of land within this boundary.

The following report provides a summary of the methodology used, assumptions made, and the recommended storm water management principles to be applied to this development.

2.0 Overview

The development of the catchment area within the Gladstone catchment will require the construction of three storm detention ponds. These ponds will service all catchments labelled on drawing CP. The purpose of these ponds is to regulate the peak flows within the catchment area as well as provide relief to the downstream storm water system to avoid surcharging during a storm event. For ease of reference the catchment areas have been labeled from A to F and the proposed detention ponds are labeled 1, 2, & 3. The proposed detention ponds are also discussed with particular emphasis on Pond 1 which is planned for construction with the development of Glen Lyon Phase II. The storm sewer collection system for the proposed subdivision will be designed in accordance with the City of Prince George Draft Design Guidelines, City of Prince George Subdivision and Development Servicing Bylaw 7652, 2004, as well as the 'Land Development Guidelines' as published by the Department of Fisheries and Oceans.

The approximate storm detention pond locations are shown on the enclosed catchment plan. Detention ponds 1 & 2 will be located in natural drainage channels which will be retained as green belt. Retaining this riparian corridor provides opportunities for a trail network and environmental protection.

During high flows the earth filled structure will detain the water in the natural drainage channel and release it slowly through a flow control structure.

3.0 Catchment Area

The entire drainage catchment area is shown on drawing CP and is limited to the natural topography.

The overall catchment areas contributing to detention Pond 1 are Areas A, B, C, D, and F (123.1 ha).

Pond 2 will be constructed once plans to develop the land within Area F commences. Detention Pond 2 will capture flow from drainage Area F (42.1 ha) in the future and release the water at a controlled rate into Pond 1. Drainage Area D (20.4 ha) will also contribute to Pond 1, but only when the land is developed due to existing topography. The 10-year flows from this catchment will be routed to Pond 1 through a storm main, and the remaining storm water will drain overland to Pond 3. Area E (26.0 ha) will drain to detention Pond 3.

The ponds will be designed to restrict the flows up to 100-year post- development storm events and release them from the ponds at pre-development rates.

4.0 Regulatory Process

This SWM plan has been prepared and submitted to the City of Prince George in support of current land use and development applications. Subsequent approvals would be sought from the provincial Ministry of Environment (MoE) as required at the time of detailed design.

5.0 Performance Targets

The Fisheries Act provides the legislative basis for DFO's Policy for the Management of Fish Habitat (DFO 1986) and the principle of no net loss of the productive capacity (i.e. the maximum natural capacity) of fish habitat. Each land development is therefore subject to the following guideline objectives:

Guideline	Comment
Provision and protection of leave strips adjacent to watercourses	Applicable
Control of soil erosion and sediment in runoff water	Applicable
Control rates of storm water runoff to minimize impacts on watercourses	Applicable
Control of instream work, construction and diversions on watercourses	Applicable
Maintenance of fish passage in watercourses for all salmonid life stages	Not Applicable as no fish bearing waters are present on subject lands
Prevention of the discharge of deleterious substances to watercourses	Applicable

6.0 Methodology and Analysis

The purpose of this analysis is to determine storm water management principles for the development of the catchment area and to determine the effects of development on the downstream receiving storm sewer system. This section provides a summary of the following key elements incorporated in the storm water management plan for the catchment area in order to complete the analysis:

- Model Selection
- Rainfall Information
- Model Input Parameters
- Existing Storm water Network

6.1 Model Selection

Storm water modelling and drainage design techniques can be divided into two basic groups. The first being steady state (constant flow) methods such as the Rational method as used to design storm drainage networks and the second being the Hydrograph method designed to simulate the time varying nature of actual storm water runoff. The City of Prince George Draft Design Guidelines recommends the hydrograph method for sizing of all storage facilities as well as for sizing the minor and major conveyance systems for developments exceeding 20 hectares.

The post-development drainage conditions for the subject area have been analyzed using the Soil Conservation Service TR-20 Unit Hydrograph procedure, which is considered a reliable method for modelling urban watersheds. The SCS-UH hydrologic model was developed using HydroCAD (v. 8.0) software. The pre-development flows were taken from the AE report in order to ensure that the City guidelines constraining the flow rates are met. This report shows that the model's 2, 5, 10, and 100-year post-development design flows meet the pre-development flow rates for the corresponding years.

6.2 Rainfall Information

The City of Prince George's Draft Design Guidelines Table 5.3.2 rainfall distribution patterns (hyetographs) for the 24 hr storm duration have been utilized for the 2, 5, 10, and 100-year return periods in order to assess the minor and major system flows respectively.

6.3 Model Input Parameters

This section provides a summary of the following key model input parameters used for the modelling of the storm water system:

- Runoff Curve Numbers (CN)
- Times of Concentration
- Model Parameters
- Storage Concept (Pond 1)

6.3.1 Runoff Curve Numbers (CN)

Runoff Curve numbers (CN) are used in the SCS Velocity Method to represent the percentage of rainfall runoff from a surface. A lower CN indicates a greater retention and infiltration capability of a surface. For post- development, an overall CN of 87 was applied to the areas. The description for the CN of 87 used is for an average lot area of 1/4 acre, 38% impermeable, Hydrologic Soil Group (HSG) class "D", and Antecedent Moisture Condition of 2 which represents an average moisture condition. This CN is based on the existing silt and clay soil conditions in the area and we believe this to be a conservative assumption. HSG class "D" soils typically have low permeability rates in the range of 0 to 1.3 mm/hr. It should be noted that the area does have limited till and

gravel soils in some areas which will provide more permeability throughout the catchment areas providing less runoff into the detention ponds.

6.3.2 Times of Concentration

The times of concentrations for the pre-development conditions were calculated using the SCS Velocity Method and the Lag/CN method. The individual inlet times of concentrations for the post- development conditions in the developed areas were calculated and range between 5 and 22 minutes. These inlet times are calculated based on estimated house, driveway, road, storm and drainage channel lengths, and the corresponding grades, surface properties, and overland flow velocities.

6.3.3 Model Parameters

The storm sewer system, piping system, and road networks will be designed to facilitate both the 10 year and 100- year overland flows. The hydrograph method was modelled based on the following:

- The storm sewer system shall be designed to satisfy the 10 year design storm level-of-service requirement.
- The storm sewer and road system shall be designed to accommodate the 100-year post- development overland flow to protect against surface flooding and property damage.
- Rainfall intensity duration frequency information for the 10 year and 100- year return periods from the "City of Prince George Design Guidelines (Draft 2001)"
- A Manning's 'n' value of 0.013 for PVC pipe and 0.024 for CSP culvert.

6.3.4 Storage Concept (Pond 1)

As shown on the overall catchment plan (CP) three storm water detention ponds are proposed and are labeled Pond 1, 2, and 3 respectively. The Pond locations have been selected to work with site and road grading and in an effort to mimic the pre-development hydrology of the lands. The pond locations were also chosen to minimize the aesthetic impact and to minimize land use and earth disturbance. This report will address Pond 1 as it will be the first pond to be constructed. During each storm event the pond will detain storm flows to pre-defined levels which will allow for sediments to displace and prevent the downstream storm sewer from becoming overloaded.

6.4 Existing Storm Water Network

The majority of the Gladstone watershed catchment area currently drains to the existing storm sewer system at the end of Southridge Avenue via a 300mm diameter storm inlet. Future development conditions were modelled using the existing downstream storm sewer network, and many pipes became surcharged under the 2 and 5-year events by the runoff from the Gladstone catchment. These results demonstrated the need for best management practices (BMPs) to be put into place. The BMPs that will be used to limit the flows from this catchment are by the way of detention ponds. These ponds will limit the flows leaving the Gladstone catchment and will allow the distribution of the 2, 5, 10, & 100-year floods into the existing storm system at the pre-development flow rate. This 300mm diameter main was installed after the City of Prince George Watershed Drainage Plan (December 2002) was assessed, and the size of pipe was selected to ensure the flows leaving the pond are restricted to the post development flow rates.

The recommended upgrades drawing from the AE report shows one area that is in need of upgrading downstream. This upgrade consists of replacing two reaches of pipe along Domano Blvd. These reaches of pipe overflow during a 10-year storm event. They have a capacity of 0.54m^3/s and 0.51m^3/s, but after development upgrades they must convey future peak flows of 0.75m^3/s and 0.71m^3/s respectively, and become surcharged. These reaches of pipe must be increased in size and replaced. The other upgrade outlined in the AE report is at the end of St. Patrick Way and states that the existing pipes are undersized for the 2-year return period under existing development conditions. These reaches of pipe are collecting flow from residences outside our scope of development. The future design will bypass this system with new storm sewers which will transport flow from Pond 3 down to Domano Blvd. along the Glen Lyon Way right-of-way. These pipes will be of sufficient size and capacity and will tie into the existing 750mm dia. main in Domano Blvd.

The proposed detention ponds within the Ospika Neighbourhood South Neighbourhood Storm Water Management Plan are designed to release the storm water into the existing network at a rate that is as good as or better than before development providing a high level of service to the residents within the area.

7.0 Storage Facility Design

Based on the topography, preliminary lot layout, rainfall data, and preliminary design calculations, Pond 1 is capable of storing the 2, 5, 10, and 100-year post-development runoff from catchment Areas A, B, and C, D, and the pre-development flow from Area F. The results of this Pond 1 model are shown below:

Pond 1 Model 1 Flows and Storage Volumes – Areas A, B, C, D Full Build Out & F Pre-Development					
Storm Event	Pre-Development Flow (m^3/s)	Post Development Flow without Pond (m^3/s)	Post Development Flow with Pond (m^3/s)	Required Pond Storage (m^3)	Storage Depth (m)
2 yr	0.12	0.59	0.12	1788	0.64
5 yr	0.18	1.35	0.18	3044	1.43
10 yr	0.24	2.04	0.22	4819	2.09
100 yr	1.22	4.40	0.84	11494	4.20

Detention Pond 1 was calculated in this way to mimic the first stage of development. In the future, Area F will be required to have detention Pond 2 constructed before it is developed, at which point Area F will release a controlled flow into Pond 1. Pond 1 will be able to store this flow. When Area D is developed, a storm main shall be designed to drain the 10-year post-development flows from this area into Pond 1. Pond 3 will be designed to handle the excess overland flow running from Area D during a 100-year post-development storm event, as well as the 100-year post-development flows from Area E. The results of this Pond 1 model are shown below:

Pond 1 Model 2 Flows and Storage Volumes – Areas A, B, C, D, & F Full Build Out					
Storm Event	Pre-Development Flow (m^3/s)	Post Development Flow without Pond (m^3/s)	Post Development Flow with Pond (m^3/s)	Required Pond Storage (m^3)	Storage Depth (m)
2 yr	0.12	0.59	0.12	1862	0.93
5 yr	0.19	1.35	0.18	3766	1.70
10 yr	0.25	2.04	0.21	5453	2.30
100 yr	1.22	4.40	0.28	11015	3.93

Pond 1 must be able to store 11,015m^3 of water, and it is designed to hold 11,500m^3. The required post-development storage volume for Pond 2 during a 100-year storm event is 7487m^3 and for Pond 3 the storage required is 4751m^3.

Shown below is a summary of the previously designed AE pond storage volumes. The AE ponds are compared to the L&M ponds. AE's seven ponds have been consolidated into three new ponds in order to promote safety, ease of maintenance, and aesthetics throughout the catchment areas. The three new detention ponds will have a larger capacity than those outlined in the AE report, and this will ensure sufficient storage and release of storm water into the existing downstream system.

POND STORAGE VOLUMES				
Associated Engineering Pond #	AE Storage Volume (m^3)	L&M Pond # (AE Pond #)	L&M Storage Volume (m^3)	AE Storage Volume (m^3)
Glad P3	3,400	1 (P3, P6, P5-2, P5-1)	11,500	10,821
Glad P6	1,900	2 (P2)	7,487	4,720
Glad P1-1	4,520	3 (P1-1, P1-2)	4,751	6,890
Glad P1-2	2,370			
Glad P5-2	2,608			
Glad P2	4,720			
Glad P5-1	2,913			
Total	**22,431**		**23,738**	**22,431**

7.1 Pond 1 Overflow Analysis

Analysis has been completed addressing the issue concerning the possibility of the primary outlet structure in Pond 1 becoming fully blocked. If this problem should occur during a 100-year storm event, the weir at the top of the pond will direct the overflow onto Southridge Avenue below. In the analysis based on no outflow from the primary outlet and all water being released through the overflow weir, Southridge Avenue will receive a flow of 0.54m^3/s. Pond 1 will store a total volume of 11,500m^3 of water and release a total volume of 12,835m^3 of water onto the street over the duration of the 100-year storm period. The street channel below was modeled as a trapezoidal channel having a width of 13.0m and a curb height of 0.09m. The capacity of the street channel is 1.04m^3/s and will therefore accommodate the 100-year storm event within the road and direct the overland flow safely downstream without flooding the adjacent residences.

8.0 Pond Development Timeline

Construction of Pond 1 will be constructed in conjunction with Glen Lyon Phase 2 in 2013. Areas A, B, C, & D will utilize Pond 1. As development continues and services are brought up through Area D, Pond 2 will be constructed to service Area F. This will allow for a controlled release of overland flow downstream into Pond 1 as Area F is developed. Pond 3 will be constructed when Area E is developed, when Glen Lyon Way connects with Southridge Ave., or Southridge Ave. connects to Malaspina Ave.

Prepared By:
L&M ENGINEERING LIMITED

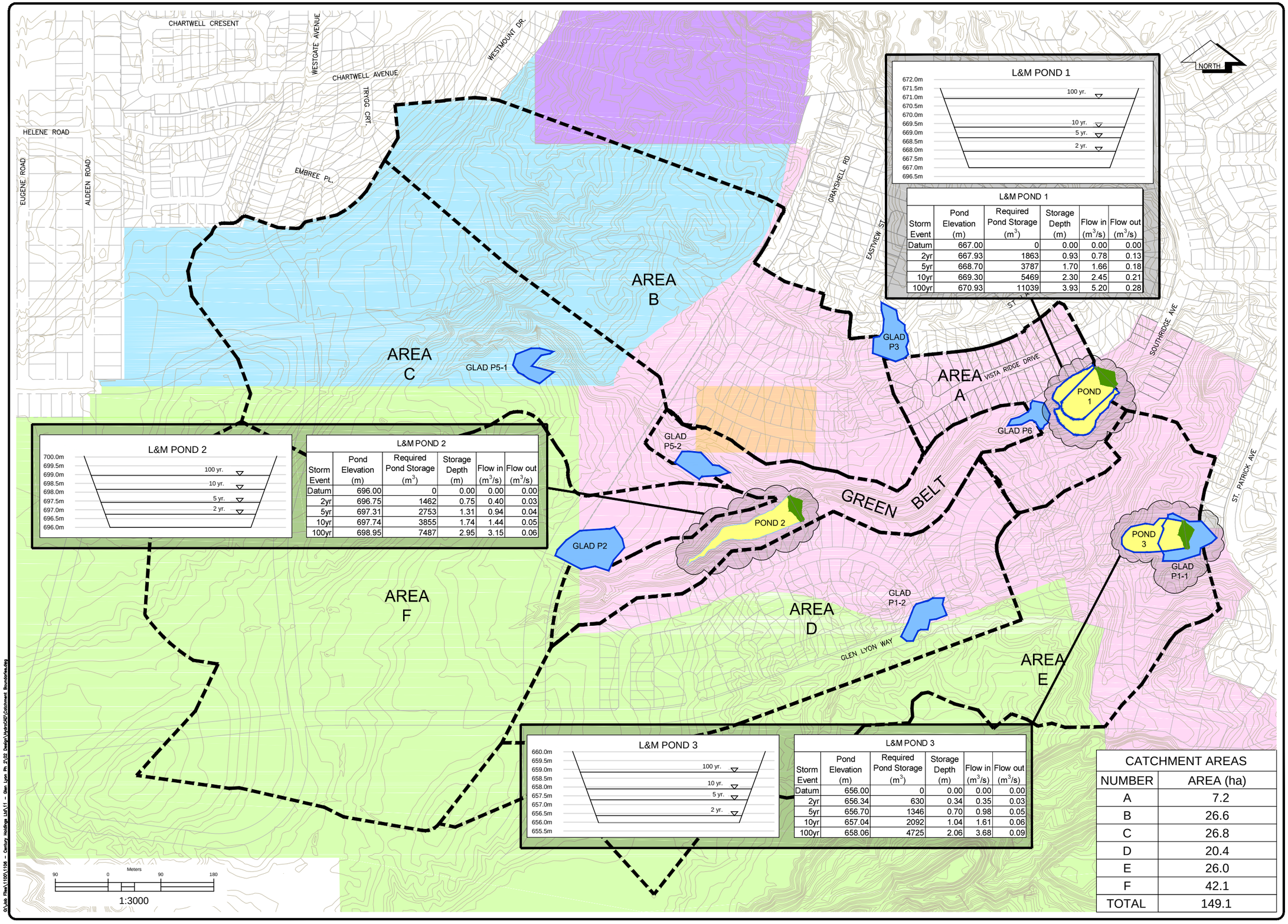
Completed by Kyle Teschke, EIT
Project Engineer

Reviewed by Jason Boyes, P.ENG
Associate

Appendix A

Overall Catchment Plan – CP

HydroCAD Modelling Results for 100- year design storm event



L&M POND 1

Storm Event	Pond Elevation (m)	Required Pond Storage (m^3)	Storage Depth (m)	Flow in (m^3/s)	Flow out (m^3/s)
Datum	667.00	0	0.00	0.00	0.00
2yr	667.93	1863	0.93	0.78	0.13
5yr	668.70	3787	1.70	1.66	0.18
10yr	669.30	5469	2.30	2.45	0.21
100yr	670.93	11039	3.93	5.20	0.28

L&M POND 2

Storm Event	Pond Elevation (m)	Required Pond Storage (m^3)	Storage Depth (m)	Flow in (m^3/s)	Flow out (m^3/s)
Datum	696.00	0	0.00	0.00	0.00
2yr	696.75	1462	0.75	0.40	0.03
5yr	697.31	2753	1.31	0.94	0.04
10yr	697.74	3855	1.74	1.44	0.05
100yr	698.95	7487	2.95	3.15	0.06

L&M POND 3

Storm Event	Pond Elevation (m)	Required Pond Storage (m^3)	Storage Depth (m)	Flow in (m^3/s)	Flow out (m^3/s)
Datum	656.00	0	0.00	0.00	0.00
2yr	656.34	630	0.34	0.35	0.03
5yr	656.70	1346	0.70	0.98	0.05
10yr	657.04	2092	1.04	1.61	0.06
100yr	658.06	4725	2.06	3.68	0.09

CATCHMENT AREAS

NUMBER	AREA (ha)
A	7.2
B	26.6
C	26.8
D	20.4
E	26.0
F	42.1
TOTAL	149.1

LEGEND

- CATCHMENT BOUNDARY
- PROPOSED DEVELOPMENT
- EXISTING DEVELOPMENT
- PROPOSED L&M DETENTION POND
- PROPOSED ASSOCIATED ENGINEERING DETENTION POND AS PER 2002 WDP

LAND OWNERSHIP

- CENTURY HOLDINGS
- BELCO
- RCEC
- PRIVATE
- KODE'S PIT

NO.	DATE	REVISION	DR.

L&M ENGINEERING LIMITED
1210 FOURTH AVENUE
PRINCE GEORGE, B.C.
V2L 3J4
TEL. (250) 562-1977
FAX (250) 562-1967

DRAWN:	KJT
CHECKED:	JRB
ENGINEER:	JRB
SURVEY FILE:	
DRAWING FILE:	Catchment Boundaries.dwg
CORRESPONDENCE:	CPG
GRID:	
DATE:	MARCH 2013
SCALES:	HORZ. 1:3000

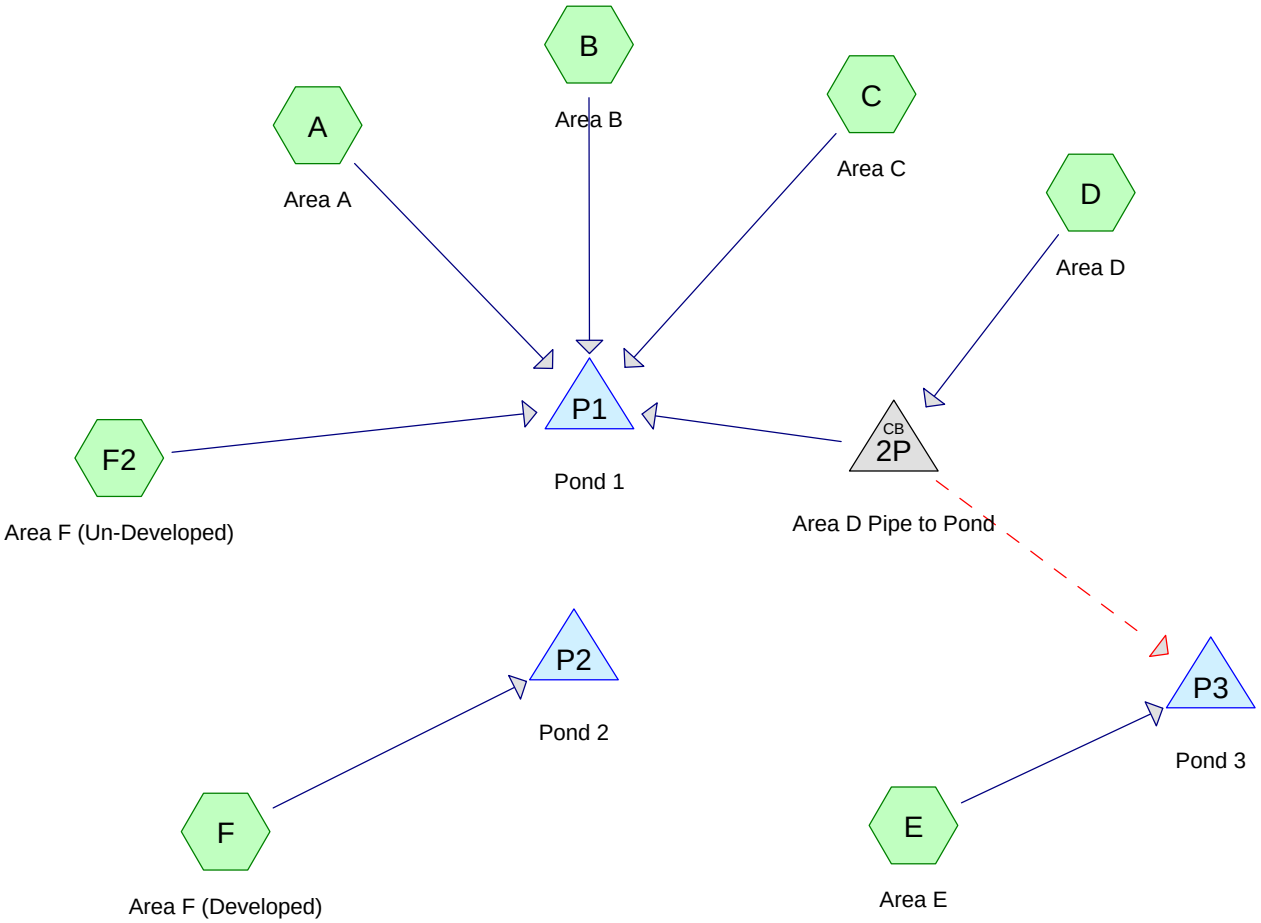
CENTURY HOLDINGS LTD.
GLADSTONE WATERSHED
STORM WATER MANAGEMENT

CATCHMENT PLAN

CONSULTANTS PROJECT No.
1106-11-02
DRAWING No.
CP

SHEET No. 1 OF 1
REV. No.

G:\Job Files\1100\1106 - Century Holdings Ltd\11 - Glen Lyon Ph 2\02 Design\Hydro\DAV\Catchment Boundaries.dwg



Subcat Reach Pond Link

Drainage Diagram for Southridge Pond Post-Devo
Prepared by L&M Engineering Ltd. 12/21/2012

100 YEAR DESIGN DRAINAGE MODEL (POND 1 DEVELOPMENT ONLY)

Area Listing (all nodes)

Area (hectares)	CN	Description (subcats)
42.1000	77	Woods, Good, HSG D (F2)
149.1000	87	1/4 acre lots, 38% imp, HSG D (A,B,C,D,E,F)
191.2000		

Time span=1.00-30.00 hrs, dt=0.02 hrs, 1451 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment A: Area A Runoff Area=7.2000 ha Runoff Depth=26 mm
Flow Length=517.0 m Tc=5.3 min CN=87 Runoff=0.8524 m³/s 1.838 Ml

Subcatchment B: Area B Runoff Area=26.6000 ha Runoff Depth=26 mm
Flow Length=1,060.0 m Slope=0.0300 m/m Tc=13.7 min CN=87 Runoff=2.3677 m³/s 6.791 Ml

Subcatchment C: Area C Runoff Area=26.8000 ha Runoff Depth=26 mm
Flow Length=1,470.0 m Tc=21.2 min CN=87 Runoff=1.8924 m³/s 6.842 Ml

Subcatchment D: Area D Runoff Area=20.4000 ha Runoff Depth=26 mm
Flow Length=967.0 m Tc=13.0 min CN=87 Runoff=1.8603 m³/s 5.208 Ml

Subcatchment E: Area E Runoff Area=26.0000 ha Runoff Depth=26 mm
Flow Length=967.0 m Tc=8.0 min CN=87 Runoff=2.8138 m³/s 6.638 Ml

Subcatchment F: Area F (Developed) Runoff Area=42.1000 ha Runoff Depth=26 mm
Flow Length=1,367.0 m Tc=19.2 min CN=87 Runoff=3.1493 m³/s 10.748 Ml

Subcatchment F2: Area F (Un-Developed) Runoff Area=42.1000 ha Runoff Depth=13 mm
Flow Length=1,010.0 m Slope=0.0300 m/m Tc=31.8 min CN=77 Runoff=0.8386 m³/s 5.533 Ml

Pond 2P: Area D Pipe to Pond Peak Elev=803.744 m Inflow=1.8603 m³/s 5.208 Ml
Primary=0.8456 m³/s 4.066 Ml Secondary=1.0147 m³/s 1.142 Ml Outflow=1.8603 m³/s 5.208 Ml

Pond P1: Pond 1 Peak Elev=671.206 m Storage=11,493.9 m³ Inflow=5.4212 m³/s 25.070 Ml
Primary=0.2859 m³/s 19.795 Ml Secondary=0.5521 m³/s 2.066 Ml Outflow=0.8381 m³/s 21.861 Ml

Pond P2: Pond 2 Peak Elev=679.949 m Storage=7,486.9 m³ Inflow=3.1493 m³/s 10.748 Ml
150 mm x 10.00 m Culvert Outflow=0.0629 m³/s 4.770 Ml

Pond P3: Pond 3 Peak Elev=679.064 m Storage=4,751.0 m³ Inflow=3.6844 m³/s 7.780 Ml
200 mm x 10.00 m Culvert Outflow=0.0924 m³/s 6.291 Ml

Total Runoff Area = 191.2000 ha Runoff Volume = 43.599 Ml Average Runoff Depth = 23 mm
70.37% Pervious Area = 134.5420 ha 29.63% Impervious Area = 56.6580 ha

Subcatchment A: Area A

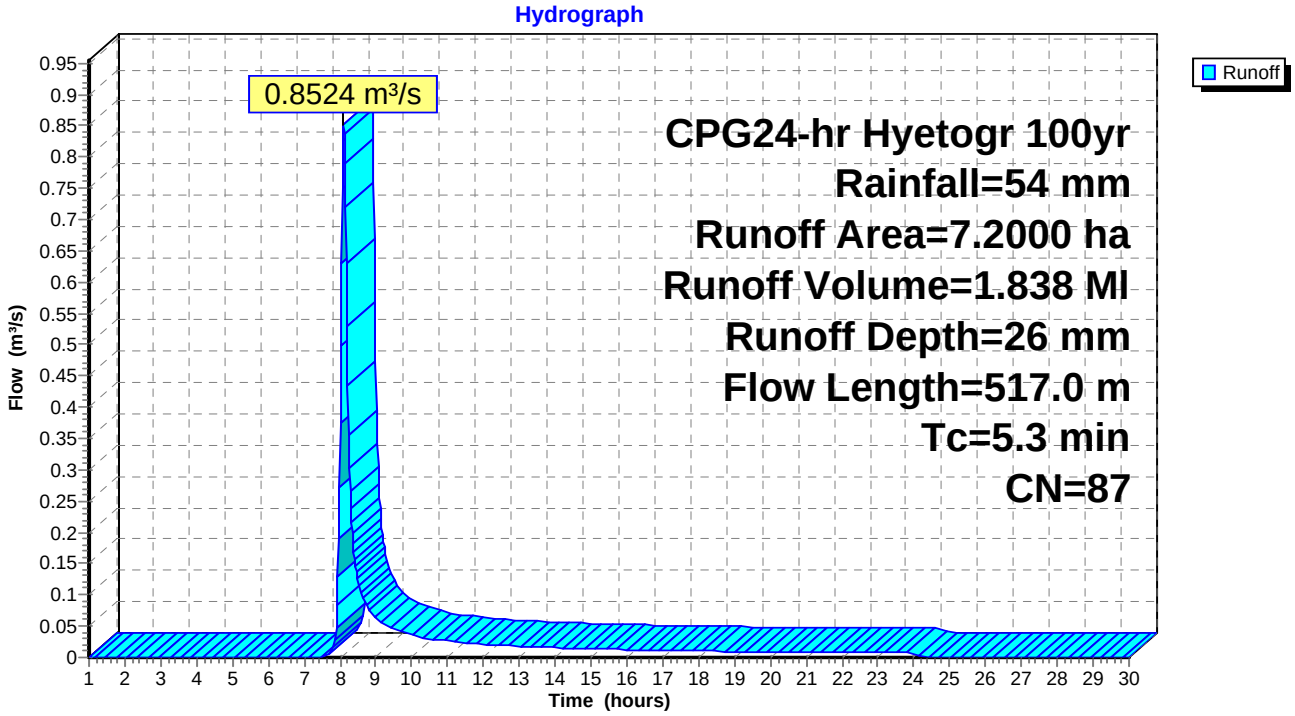
Runoff = 0.8524 m³/s @ 8.10 hrs, Volume= 1.838 Ml, Depth= 26 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
CPG24-hr Hyetogr 100yr Rainfall=54 mm

Area (ha)	CN	Description
7.2000	87	1/4 acre lots, 38% imp, HSG D
4.4640		Pervious Area
2.7360		Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
0.2	7.0	0.3000	0.54		**Sheet Flow, roof** Smooth surfaces n= 0.011 P2= 28 mm
0.7	10.0	0.0300	0.23		**Sheet Flow, driveway** Smooth surfaces n= 0.011 P2= 28 mm
1.6	100.0	0.0300	1.07		**Shallow Concentrated Flow, curb** Paved Kv= 6.19 m/s
2.8	400.0	0.0400	2.42	0.1189	**Circular Channel (pipe), pipe** Diam= 250 mm Area= 0.05 m² Perim= 0.79 m r= 0.06 m n= 0.01
5.3	517.0	Total			

Subcatchment A: Area A



Subcatchment B: Area B

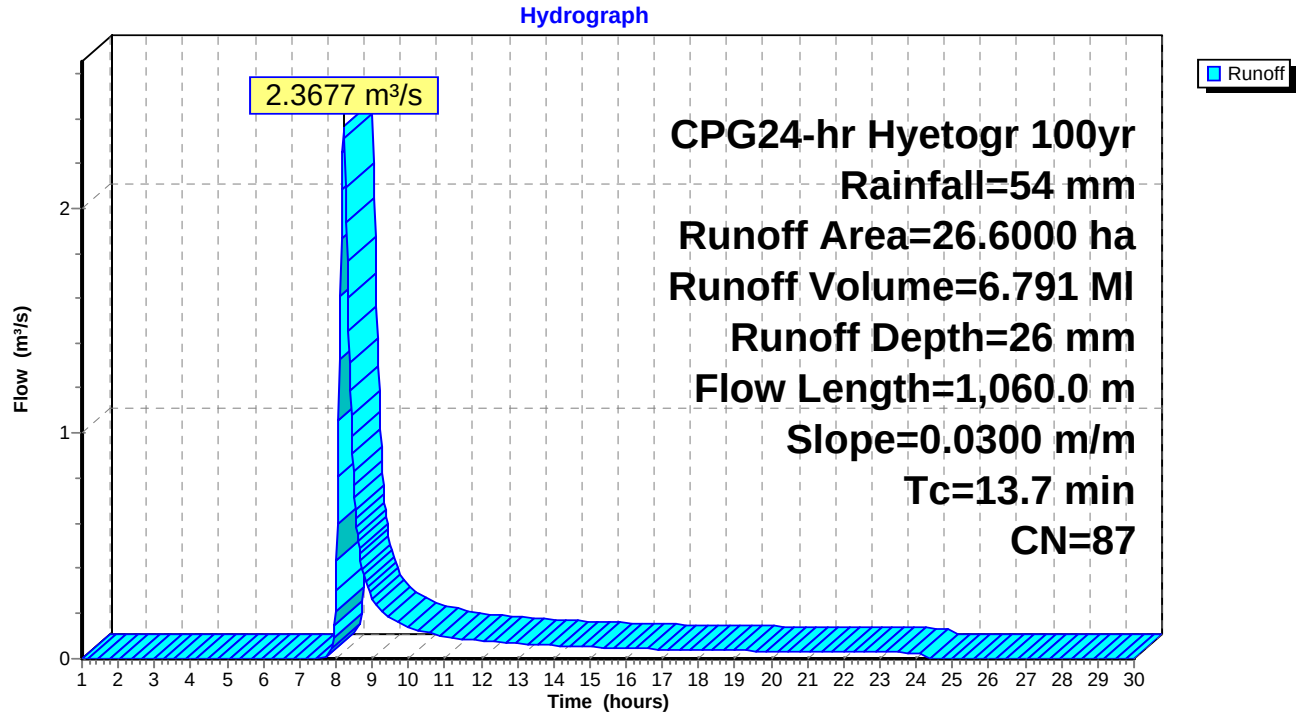
Runoff = 2.3677 m³/s @ 8.22 hrs, Volume= 6.791 Ml, Depth= 26 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
CPG24-hr Hyetogr 100yr Rainfall=54 mm

Area (ha)	CN	Description
26.6000	87	1/4 acre lots, 38% imp, HSG D
16.4920		Pervious Area
10.1080		Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
0.7	10.0	0.0300	0.23		**Sheet Flow, Driveway** Smooth surfaces n= 0.011 P2= 28 mm
0.8	50.0	0.0300	1.07		**Shallow Concentrated Flow, Gutter** Paved Kv= 6.19 m/s
2.7	500.0	0.0300	3.10	0.4938	**Circular Channel (pipe), Pipe** Diam= 450 mm Area= 0.16 m² Perim= 1.41 m r= 0.11 m n= 0.01
9.5	500.0	0.0300	0.88	0.2888	**Trap/Vee/Rect Channel Flow, Natural Drainage Ravine** Bot.W=3.00 m D=0.10 m Z= 3.0 m/m Top.W=3.60 m n= 0.040 Mountain streams
13.7	1,060.0	Total			

Subcatchment B: Area B



Subcatchment C: Area C

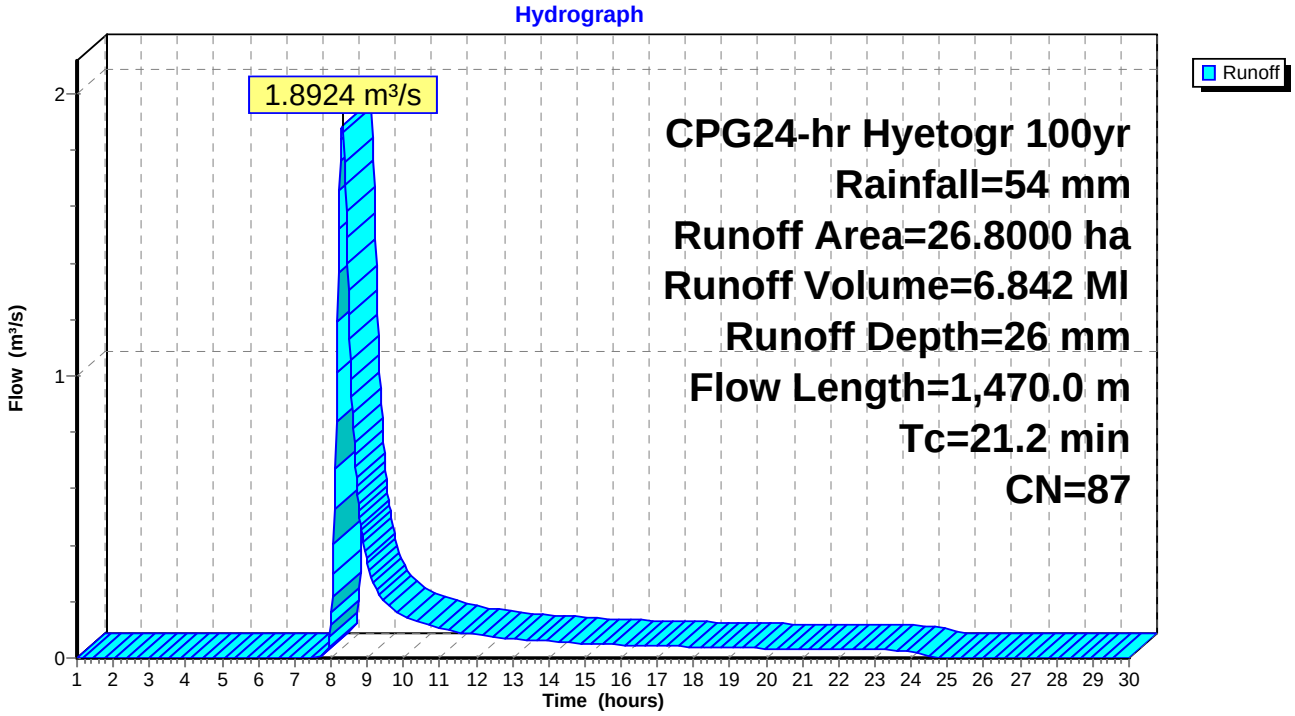
Runoff = 1.8924 m³/s @ 8.32 hrs, Volume= 6.842 Ml, Depth= 26 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
CPG24-hr Hyetogr 100yr Rainfall=54 mm

Area (ha)	CN	Description
26.8000	87	1/4 acre lots, 38% imp, HSG D
16.6160		Pervious Area
10.1840		Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
0.3	10.0	0.3000	0.58		**Sheet Flow, Roof** Smooth surfaces n= 0.011 P2= 28 mm
0.7	10.0	0.0300	0.23		**Sheet Flow, Driveway** Smooth surfaces n= 0.011 P2= 28 mm
0.8	50.0	0.0300	1.07		**Shallow Concentrated Flow, Gutter** Paved Kv= 6.19 m/s
4.2	600.0	0.0300	2.37	0.1675	**Circular Channel (pipe), Pipe** Diam= 300 mm Area= 0.07 m² Perim= 0.94 m r= 0.07 m n= 0.01
15.2	800.0	0.0300	0.88	0.2888	**Trap/Vee/Rect Channel Flow, Natural Drainage Ravine** Bot.W=3.00 m D=0.10 m Z= 3.0 m/m Top.W=3.60 m n= 0.040 Mountain streams
21.2	1,470.0	Total			

Subcatchment C: Area C



Subcatchment D: Area D

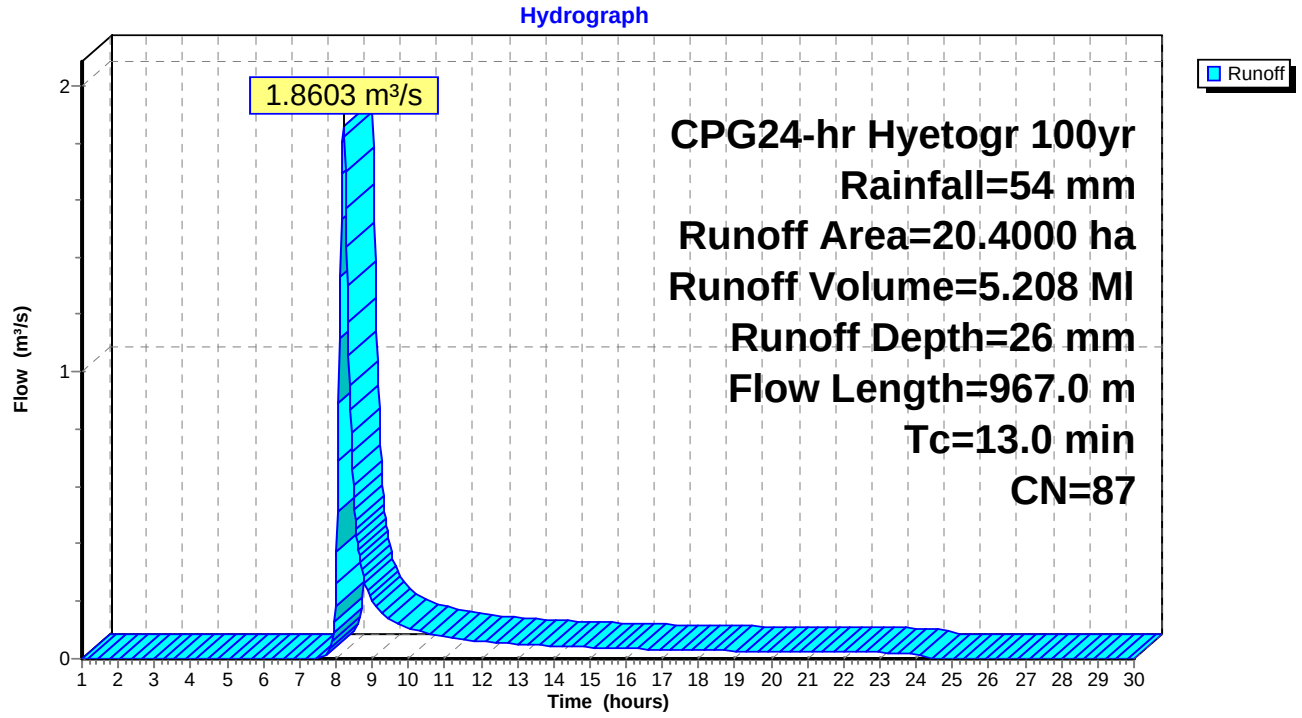
Runoff = 1.8603 m³/s @ 8.21 hrs, Volume= 5.208 Ml, Depth= 26 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
CPG24-hr Hyetogr 100yr Rainfall=54 mm

Area (ha)	CN	Description
20.4000	87	1/4 acre lots, 38% imp, HSG D
12.6480		Pervious Area
7.7520		Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
5.0					**Direct Entry,**
0.2	7.0	0.3000	0.54		**Sheet Flow, Roof** Smooth surfaces n= 0.011 P2= 28 mm
0.7	10.0	0.0300	0.23		**Sheet Flow, Driveway** Smooth surfaces n= 0.011 P2= 28 mm
0.8	50.0	0.0300	1.07		**Shallow Concentrated Flow, Gutter** Paved Kv= 6.19 m/s
6.3	900.0	0.0300	2.37	0.1675	**Circular Channel (pipe), Pipe** Diam= 300 mm Area= 0.07 m² Perim= 0.94 m r= 0.07 m n= 0.01
13.0	967.0	Total			

Subcatchment D: Area D



Subcatchment E: Area E

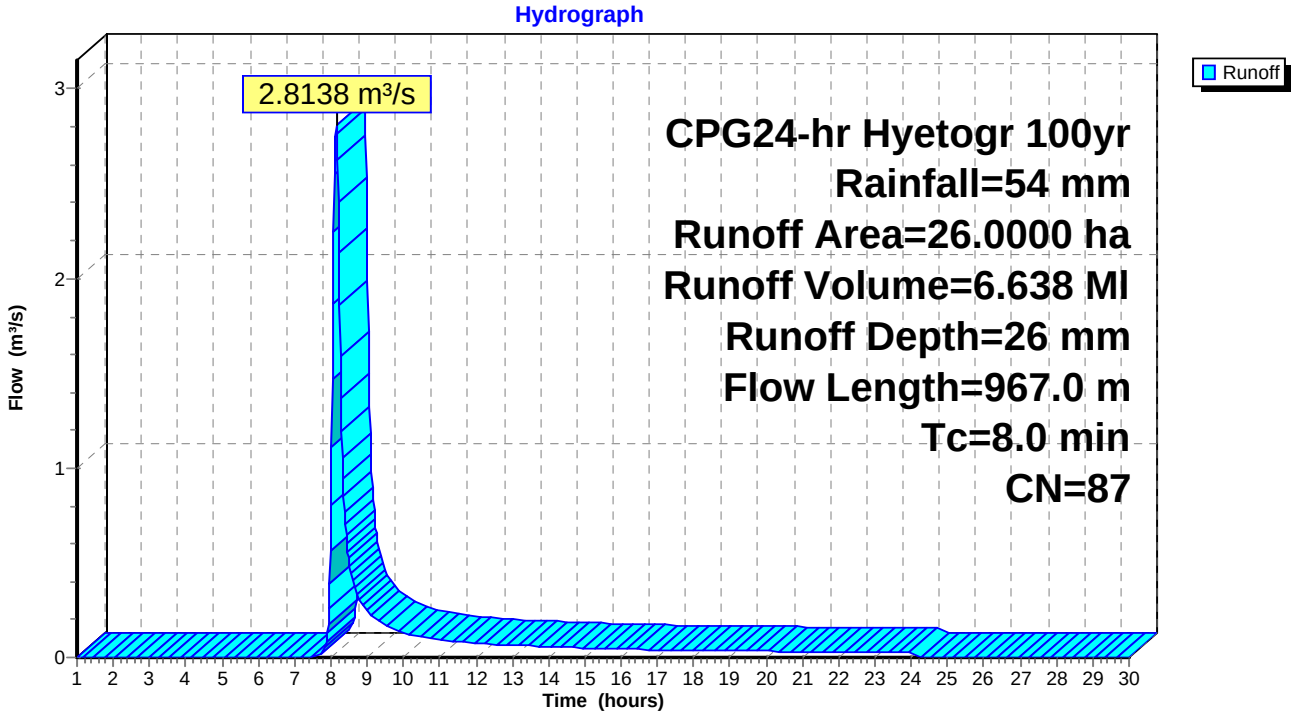
Runoff = 2.8138 m³/s @ 8.14 hrs, Volume= 6.638 Ml, Depth= 26 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
CPG24-hr Hyetogr 100yr Rainfall=54 mm

Area (ha)	CN	Description
26.0000	87	1/4 acre lots, 38% imp, HSG D
16.1200		Pervious Area
9.8800		Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
0.2	7.0	0.3000	0.54		**Sheet Flow, Roof** Smooth surfaces n= 0.011 P2= 28 mm
0.7	10.0	0.0300	0.23		**Sheet Flow, Driveway** Smooth surfaces n= 0.011 P2= 28 mm
0.8	50.0	0.0300	1.07		**Shallow Concentrated Flow, Gutter** Paved Kv= 6.19 m/s
6.3	900.0	0.0300	2.37	0.1675	**Circular Channel (pipe), Pipe** Diam= 300 mm Area= 0.07 m² Perim= 0.94 m r= 0.07 m n= 0.01
8.0	967.0	Total			

Subcatchment E: Area E



Subcatchment F: Area F (Developed)

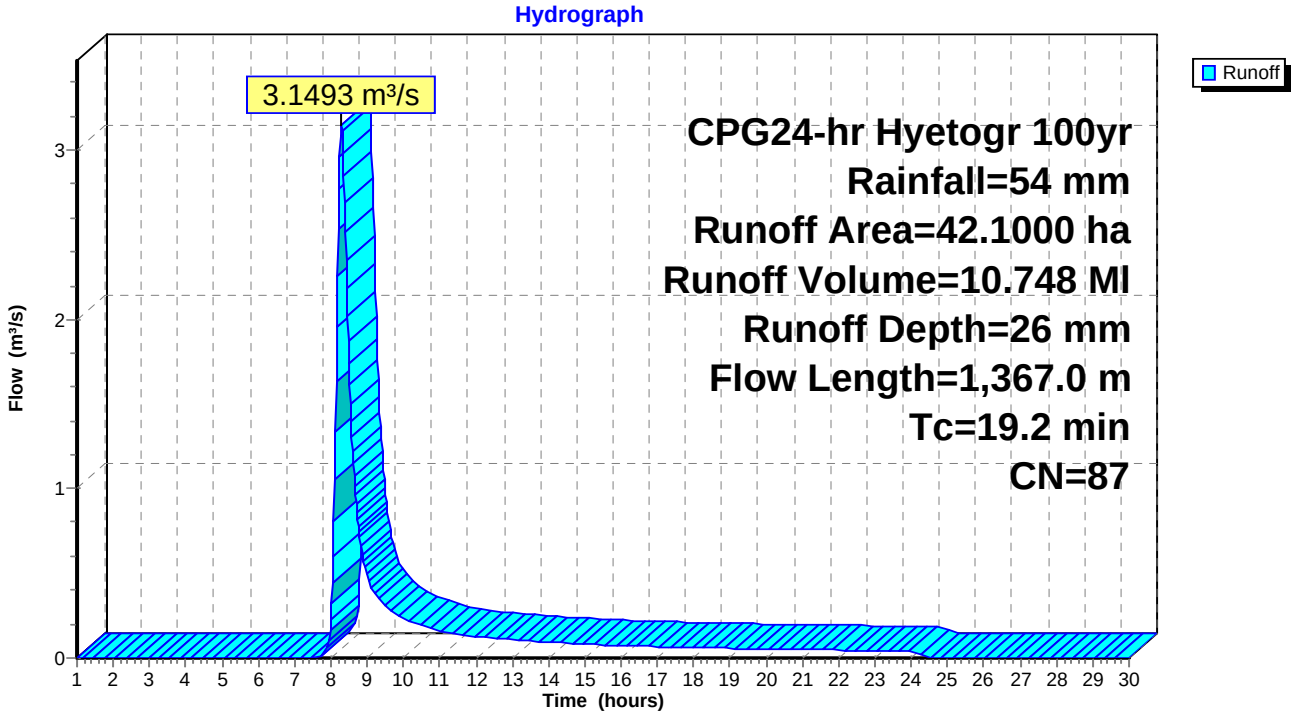
Runoff = 3.1493 m³/s @ 8.29 hrs, Volume= 10.748 Ml, Depth= 26 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
CPG24-hr Hyetogr 100yr Rainfall=54 mm

Area (ha)	CN	Description
42.1000	87	1/4 acre lots, 38% imp, HSG D
26.1020		Pervious Area
15.9980		Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
0.2	7.0	0.3000	0.54		**Sheet Flow, Roof** Smooth surfaces n= 0.011 P2= 28 mm
0.7	10.0	0.0300	0.23		**Sheet Flow, Driveway** Smooth surfaces n= 0.011 P2= 28 mm
0.8	50.0	0.0300	1.07		**Shallow Concentrated Flow, Gutter** Paved Kv= 6.19 m/s
4.2	600.0	0.0300	2.37	0.1675	**Circular Channel (pipe), Pipe** Diam= 300 mm Area= 0.07 m² Perim= 0.94 m r= 0.07 m n= 0.01
13.3	700.0	0.0300	0.88	0.2888	**Trap/Vee/Rect Channel Flow, Natural Drainage Ravine** Bot.W=3.00 m D=0.10 m Z= 3.0 m/m Top.W=3.60 m n= 0.040 Mountain streams
19.2	1,367.0	Total			

Subcatchment F: Area F (Developed)



Subcatchment F2: Area F (Un-Developed)

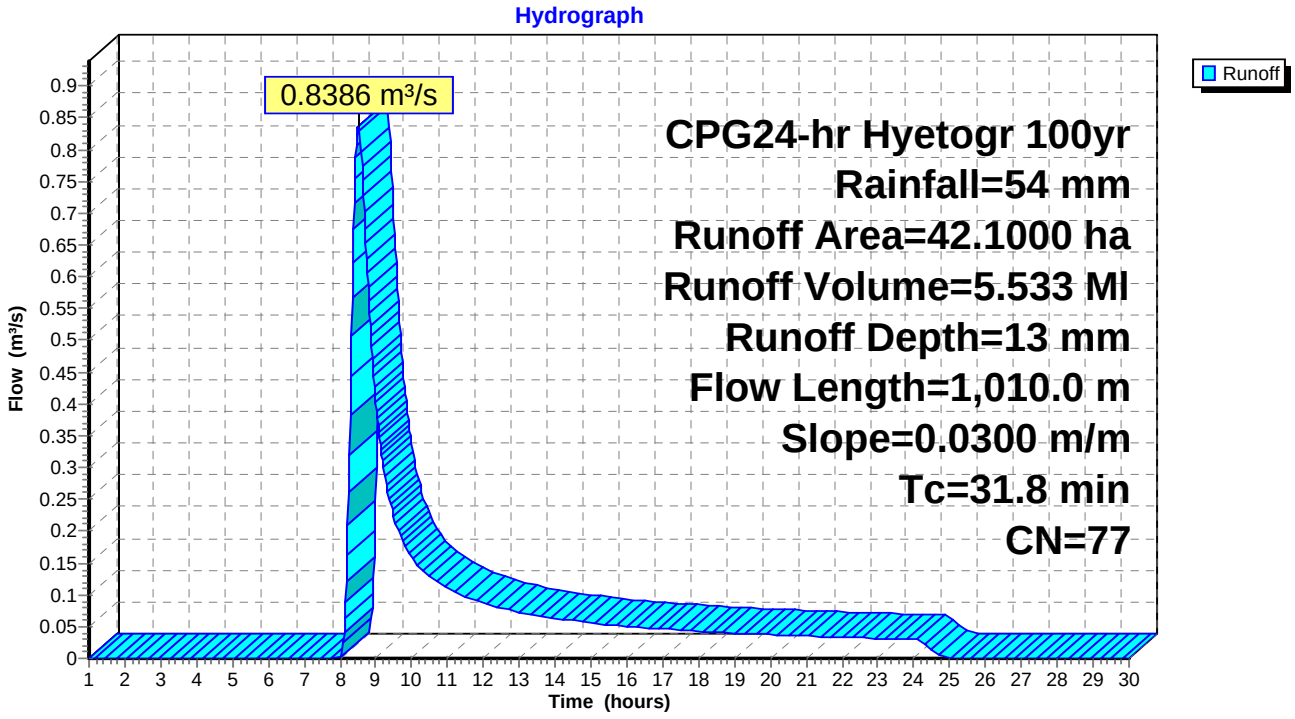
Runoff = 0.8386 m³/s @ 8.52 hrs, Volume= 5.533 Ml, Depth= 13 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
CPG24-hr Hyetogr 100yr Rainfall=54 mm

Area (ha)	CN	Description
42.1000	77	Woods, Good, HSG D
42.1000		Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
12.8	10.0	0.0300	0.01		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 28 mm
19.0	1,000.0	0.0300	0.88	0.2888	**Trap/Vee/Rect Channel Flow,** Bot.W=3.00 m D=0.10 m Z= 3.0 m/m Top.W=3.60 m n= 0.040 Mountain streams
31.8	1,010.0	Total			

Subcatchment F2: Area F (Un-Developed)



Pond 2P: Area D Pipe to Pond

Inflow Area = 20.4000 ha, Inflow Depth = 26 mm
Inflow = 1.8603 m³/s @ 8.21 hrs, Volume= 5.208 Ml
Outflow = 1.8603 m³/s @ 8.21 hrs, Volume= 5.208 Ml, Atten= 0%, Lag= 0.0 min
Primary = 0.8456 m³/s @ 8.21 hrs, Volume= 4.066 Ml
Secondary = 1.0147 m³/s @ 8.21 hrs, Volume= 1.142 Ml

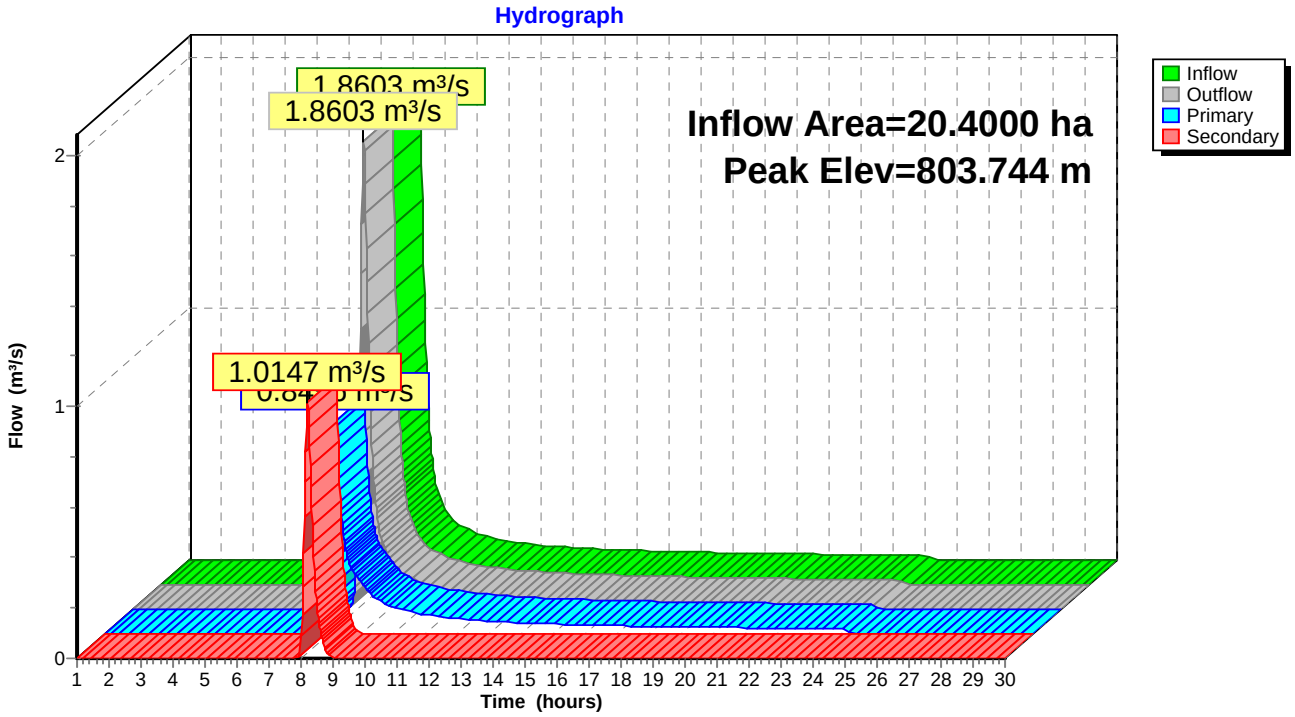
Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
Peak Elev= 803.744 m @ 8.21 hrs
Flood Elev= 900.000 m

Device	Routing	Invert	Outlet Devices
#1	Primary	800.000 m	**525 mm x 100.00 m long Culvert** Ke= 0.900 Outlet Invert= 797.000 m S= 0.0300 m/m Cc= 0.900 n= 0.013
#2	Secondary	800.500 m	**600 mm x 10.00 m long Culvert** Ke= 0.900 Outlet Invert= 800.000 m S= 0.0500 m/m Cc= 0.900 n= 0.013

Primary OutFlow Max=0.8447 m³/s @ 8.21 hrs HW=803.721 m (Free Discharge)
└**1=Culvert** (Inlet Controls 0.8447 m³/s @ 3.90 m/s)

Secondary OutFlow Max=1.0139 m³/s @ 8.21 hrs HW=803.721 m (Free Discharge)
└**2=Culvert** (Inlet Controls 1.0139 m³/s @ 3.59 m/s)

Pond 2P: Area D Pipe to Pond



Pond P1: Pond 1

Inflow Area = 123.1000 ha, Inflow Depth = 20 mm
Inflow = 5.4212 m³/s @ 8.24 hrs, Volume= 25.070 Ml
Outflow = 0.8381 m³/s @ 9.42 hrs, Volume= 21.861 Ml, Atten= 85%, Lag= 70.6 min
Primary = 0.2859 m³/s @ 9.42 hrs, Volume= 19.795 Ml
Secondary = 0.5521 m³/s @ 9.42 hrs, Volume= 2.066 Ml

Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs / 3
Peak Elev= 671.206 m @ 9.42 hrs Surf.Area= 0.0 m² Storage= 11,493.9 m³

Plug-Flow detention time= 447.7 min calculated for 21.861 Ml (87% of inflow)
Center-of-Mass det. time= 366.6 min (1,058.1 - 691.5)

Volume	Invert	Avail.Storage	Storage Description
#1	667.000 m	11,500.0 m³	**Custom Stage Data** Listed below

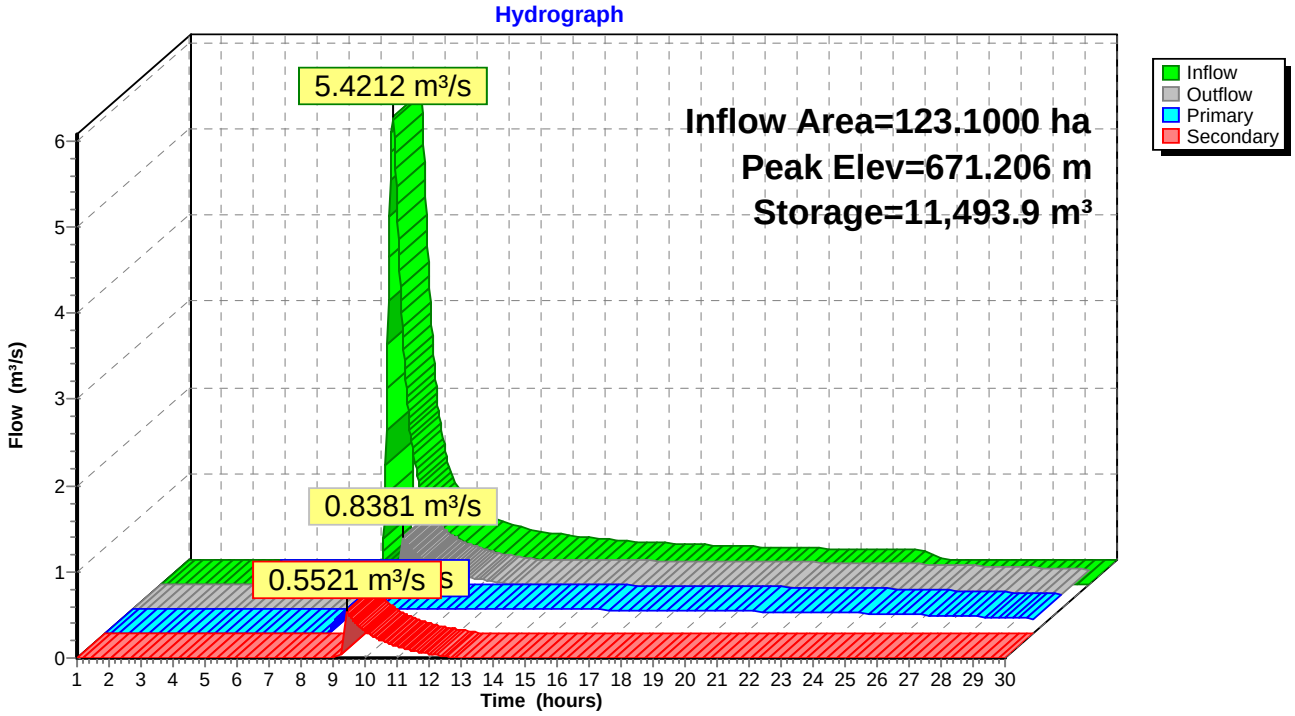
Elevation (meters)	Cum.Store (cubic-meters)
667.000	0.0
667.500	924.0
668.000	2,007.0
668.500	3,219.0
669.000	4,561.0
669.500	6,038.0
670.000	7,650.0
670.500	9,400.0
671.050	11,489.0
671.400	11,500.0

Device	Routing	Invert	Outlet Devices
#1	Primary	667.000 m	**300 mm x 30.00 m long Culvert** Ke= 0.900 Outlet Invert= 666.700 m S= 0.0100 m/m Cc= 0.900 n= 0.013
#2	Secondary	671.050 m	**45.0 deg x 5.00 m long x 0.60 m rise Sharp-Crested Vee/Trap Weir** C= 1.41

Primary OutFlow Max=0.2860 m³/s @ 9.42 hrs HW=671.206 m (Free Discharge)
↑—**1=Culvert** (Barrel Controls 0.2860 m³/s @ 4.05 m/s)

Secondary OutFlow Max=0.5474 m³/s @ 9.42 hrs HW=671.206 m (Free Discharge)
↑—**2=Sharp-Crested Vee/Trap Weir** (Weir Controls 0.5474 m³/s @ 0.69 m/s)

Pond P1: Pond 1



Pond P2: Pond 2

Inflow Area = 42.1000 ha, Inflow Depth = 26 mm
Inflow = 3.1493 m³/s @ 8.29 hrs, Volume= 10.748 Ml
Outflow = 0.0629 m³/s @ 17.66 hrs, Volume= 4.770 Ml, Atten= 98%, Lag= 562.1 min
Primary = 0.0629 m³/s @ 17.66 hrs, Volume= 4.770 Ml

Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
Peak Elev= 679.949 m @ 17.66 hrs Surf.Area= 0.0 m² Storage= 7,486.9 m³

Plug-Flow detention time= 648.1 min calculated for 4.767 Ml (44% of inflow)
Center-of-Mass det. time= 477.6 min (1,149.6 - 672.0)

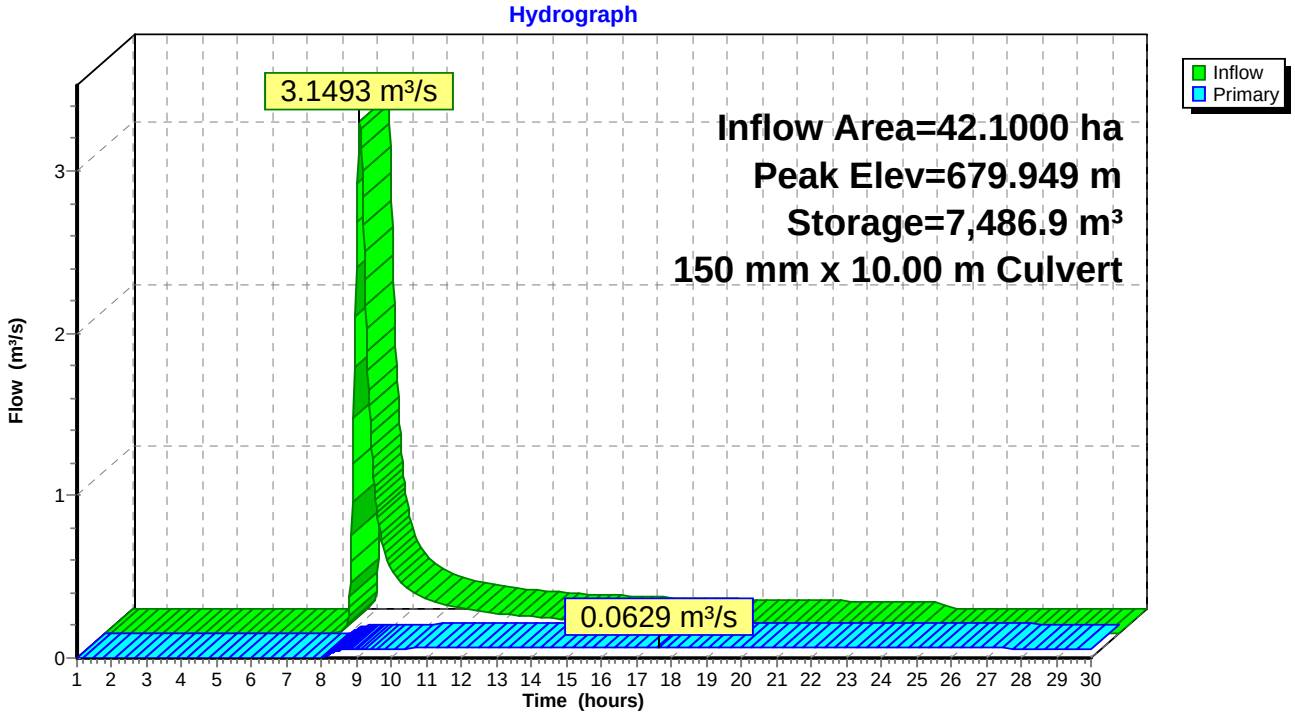
Volume	Invert	Avail.Storage	Storage Description
#1	677.000 m	11,489.0 m³	**Custom Stage Data** Listed below

Elevation (meters)	Cum.Store (cubic-meters)
677.000	0.0
677.500	924.0
678.000	2,007.0
678.500	3,219.0
679.000	4,561.0
679.500	6,038.0
680.000	7,650.0
680.500	9,400.0
681.050	11,489.0

Device	Routing	Invert	Outlet Devices
#1	Primary	677.000 m	**150 mm x 10.00 m long Culvert** Ke= 0.900 Outlet Invert= 676.600 m S= 0.0400 m/m Cc= 0.900 n= 0.013

Primary OutFlow Max=0.0629 m³/s @ 17.66 hrs HW=679.949 m (Free Discharge)
↑—**1=Culvert** (Inlet Controls 0.0629 m³/s @ 3.56 m/s)

Pond P2: Pond 2



Pond P3: Pond 3

Inflow Area = 26.0000 ha, Inflow Depth = 30 mm
Inflow = 3.6844 m³/s @ 8.16 hrs, Volume= 7.780 Ml
Outflow = 0.0924 m³/s @ 11.13 hrs, Volume= 6.291 Ml, Atten= 97%, Lag= 178.6 min
Primary = 0.0924 m³/s @ 11.13 hrs, Volume= 6.291 Ml

Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
Peak Elev= 679.064 m @ 11.13 hrs Surf.Area= 0.0 m² Storage= 4,751.0 m³

Plug-Flow detention time= 560.1 min calculated for 6.291 Ml (81% of inflow)
Center-of-Mass det. time= 456.7 min (1,094.1 - 637.4)

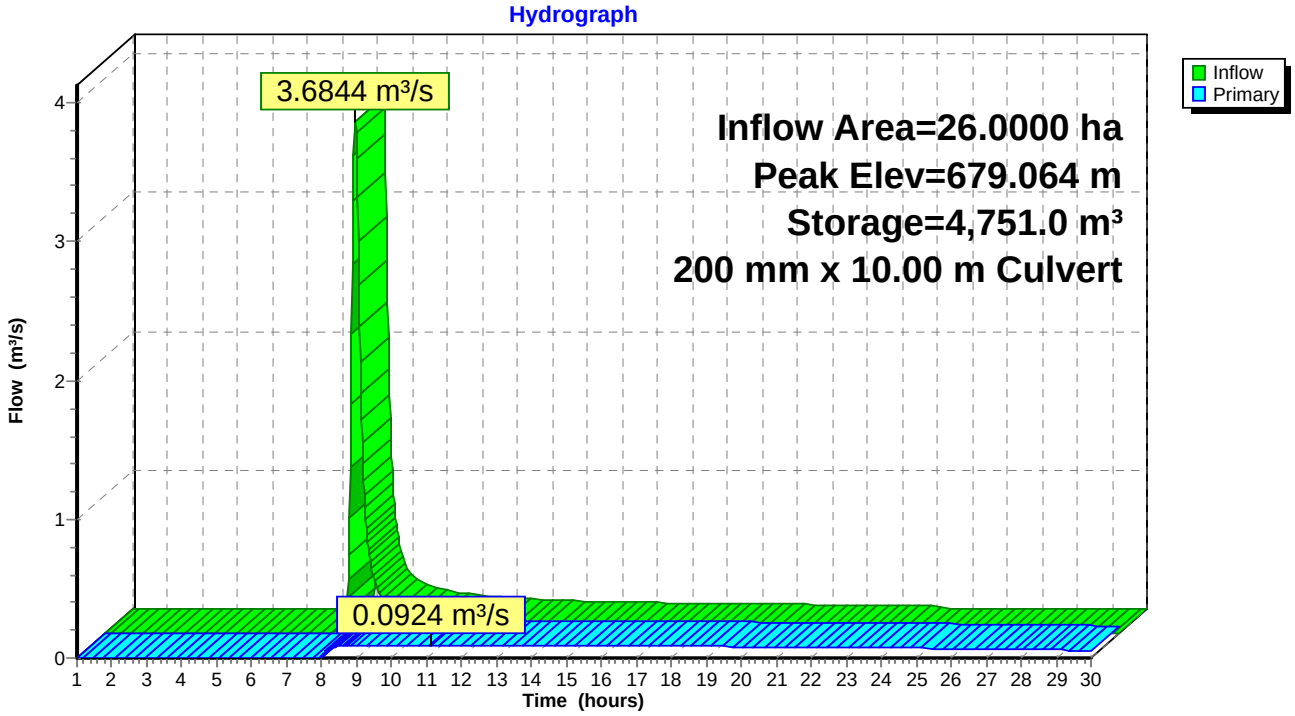
Volume	Invert	Avail.Storage	Storage Description
#1	677.000 m	11,489.0 m³	**Custom Stage Data** Listed below

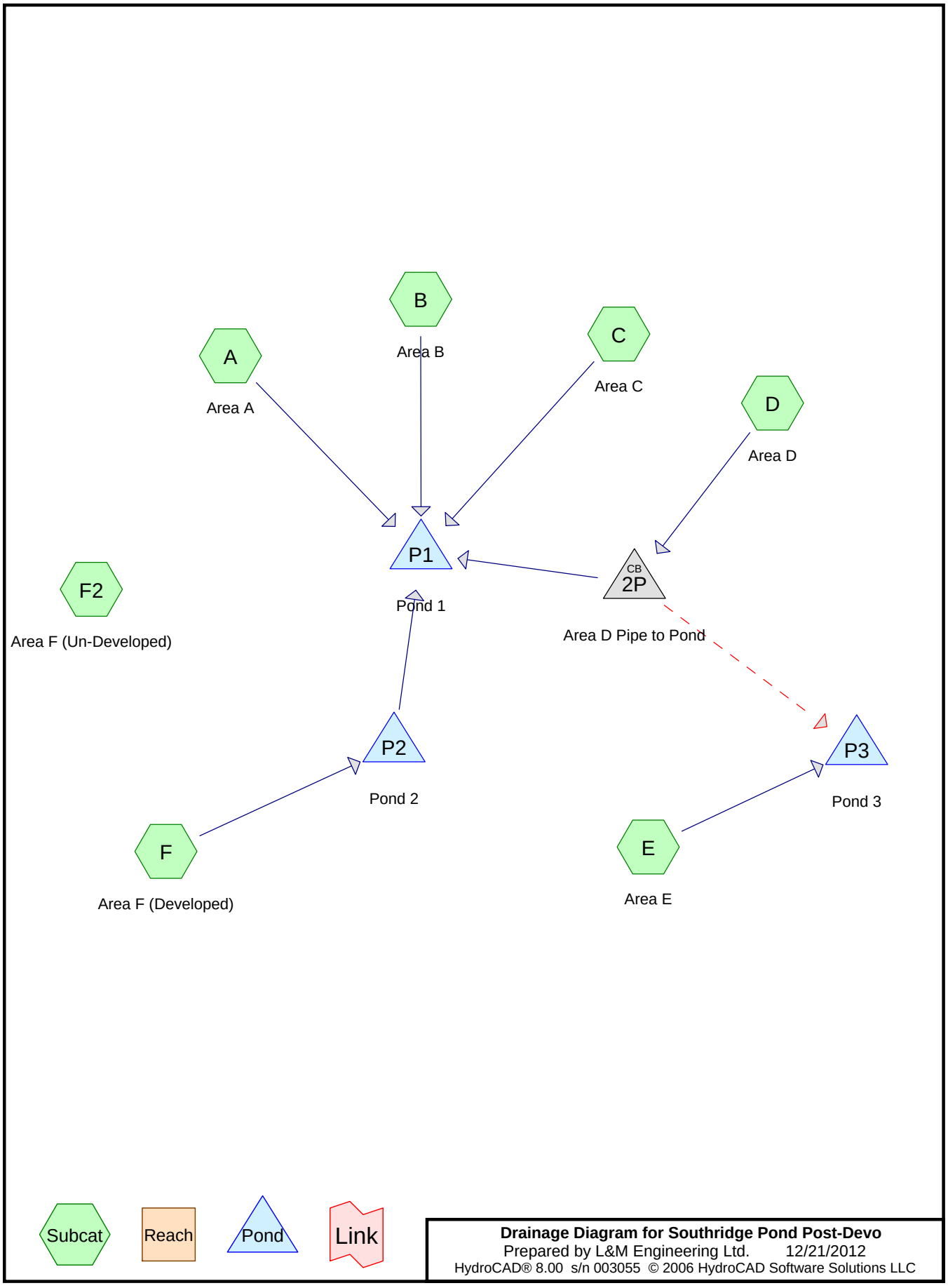
Elevation (meters)	Cum.Store (cubic-meters)
677.000	0.0
677.500	924.0
678.000	2,007.0
678.500	3,219.0
679.000	4,561.0
679.500	6,038.0
680.000	7,650.0
680.500	9,400.0
681.050	11,489.0

Device	Routing	Invert	Outlet Devices
#1	Primary	677.000 m	**200 mm x 10.00 m long Culvert** Ke= 0.900 Outlet Invert= 676.600 m S= 0.0400 m/m Cc= 0.900 n= 0.013

Primary OutFlow Max=0.0924 m³/s @ 11.13 hrs HW=679.064 m (Free Discharge)
↑—**1=Culvert** (Inlet Controls 0.0924 m³/s @ 2.94 m/s)

Pond P3: Pond 3





Drainage Diagram for Southridge Pond Post-Devo
Prepared by L&M Engineering Ltd. 12/21/2012

100 YEAR DRAINAGE MODEL 2 (FULL DEVELOPMENT ALL PONDS)

Area Listing (all nodes)

Area (hectares)	CN	Description (subcats)
42.1000	77	Woods, Good, HSG D (F2)
149.1000	87	1/4 acre lots, 38% imp, HSG D (A,B,C,D,E,F)
191.2000		

Time span=1.00-30.00 hrs, dt=0.02 hrs, 1451 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment A: Area A Runoff Area=7.2000 ha Runoff Depth=26 mm
Flow Length=517.0 m Tc=5.3 min CN=87 Runoff=0.8524 m³/s 1.838 Ml

Subcatchment B: Area B Runoff Area=26.6000 ha Runoff Depth=26 mm
Flow Length=1,060.0 m Slope=0.0300 m/m Tc=13.7 min CN=87 Runoff=2.3677 m³/s 6.791 Ml

Subcatchment C: Area C Runoff Area=26.8000 ha Runoff Depth=26 mm
Flow Length=1,470.0 m Tc=21.2 min CN=87 Runoff=1.8924 m³/s 6.842 Ml

Subcatchment D: Area D Runoff Area=20.4000 ha Runoff Depth=26 mm
Flow Length=967.0 m Tc=13.0 min CN=87 Runoff=1.8603 m³/s 5.208 Ml

Subcatchment E: Area E Runoff Area=26.0000 ha Runoff Depth=26 mm
Flow Length=967.0 m Tc=8.0 min CN=87 Runoff=2.8138 m³/s 6.638 Ml

Subcatchment F: Area F (Developed) Runoff Area=42.1000 ha Runoff Depth=26 mm
Flow Length=1,367.0 m Tc=19.2 min CN=87 Runoff=3.1493 m³/s 10.748 Ml

Subcatchment F2: Area F (Un-Developed) Runoff Area=42.1000 ha Runoff Depth=13 mm
Flow Length=1,010.0 m Slope=0.0300 m/m Tc=31.8 min CN=77 Runoff=0.8386 m³/s 5.533 Ml

Pond 2P: Area D Pipe to Pond Peak Elev=803.744 m Inflow=1.8603 m³/s 5.208 Ml
Primary=0.8456 m³/s 4.066 Ml Secondary=1.0147 m³/s 1.142 Ml Outflow=1.8603 m³/s 5.208 Ml

Pond P1: Pond 1 Peak Elev=670.925 m Storage=11,015.0 m³ Inflow=5.2018 m³/s 24.307 Ml
Primary=0.2762 m³/s 19.838 Ml Secondary=0.0000 m³/s 0.000 Ml Outflow=0.2762 m³/s 19.838 Ml

Pond P2: Pond 2 Peak Elev=679.949 m Storage=7,486.9 m³ Inflow=3.1493 m³/s 10.748 Ml
150 mm x 10.00 m Culvert Outflow=0.0629 m³/s 4.770 Ml

Pond P3: Pond 3 Peak Elev=679.064 m Storage=4,751.0 m³ Inflow=3.6844 m³/s 7.780 Ml
200 mm x 10.00 m Culvert Outflow=0.0924 m³/s 6.291 Ml

Total Runoff Area = 191.2000 ha Runoff Volume = 43.599 Ml Average Runoff Depth = 23 mm
70.37% Pervious Area = 134.5420 ha 29.63% Impervious Area = 56.6580 ha

Subcatchment A: Area A

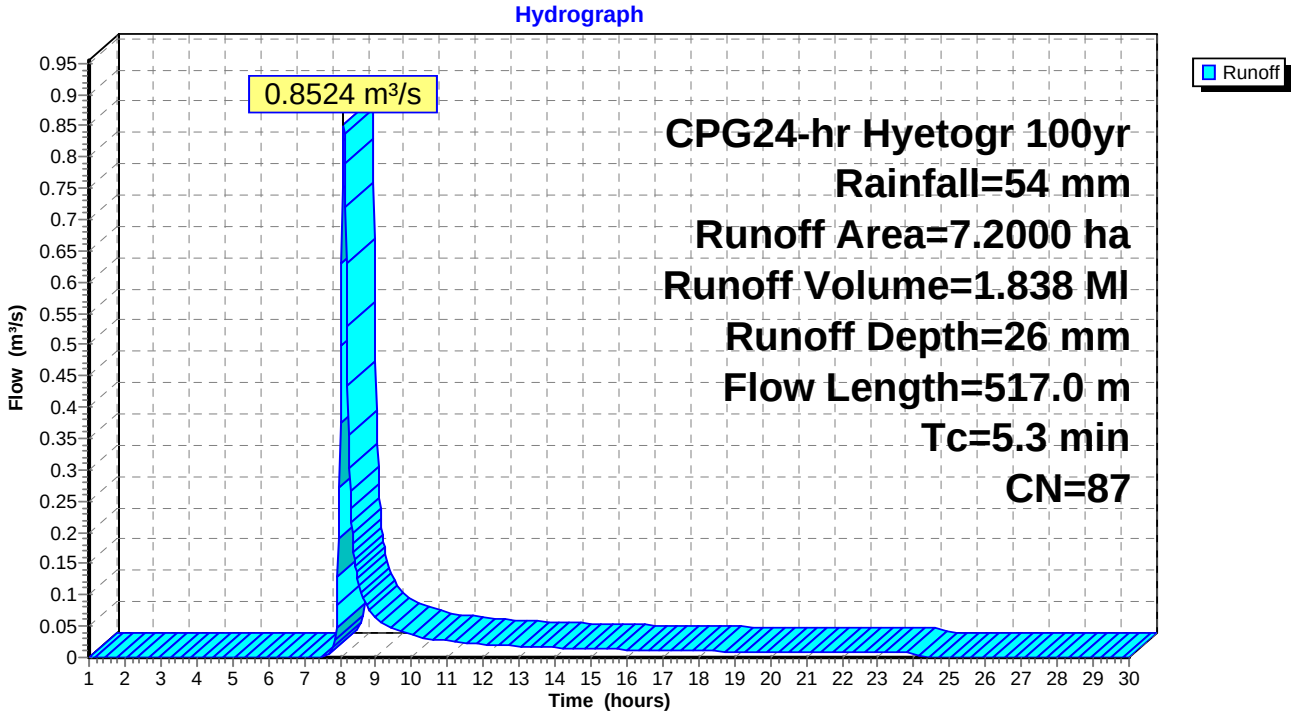
Runoff = 0.8524 m³/s @ 8.10 hrs, Volume= 1.838 Ml, Depth= 26 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
CPG24-hr Hyetogr 100yr Rainfall=54 mm

Area (ha)	CN	Description
7.2000	87	1/4 acre lots, 38% imp, HSG D
4.4640		Pervious Area
2.7360		Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
0.2	7.0	0.3000	0.54		**Sheet Flow, roof** Smooth surfaces n= 0.011 P2= 28 mm
0.7	10.0	0.0300	0.23		**Sheet Flow, driveway** Smooth surfaces n= 0.011 P2= 28 mm
1.6	100.0	0.0300	1.07		**Shallow Concentrated Flow, curb** Paved Kv= 6.19 m/s
2.8	400.0	0.0400	2.42	0.1189	**Circular Channel (pipe), pipe** Diam= 250 mm Area= 0.05 m² Perim= 0.79 m r= 0.06 m n= 0.01
5.3	517.0	Total			

Subcatchment A: Area A



Subcatchment B: Area B

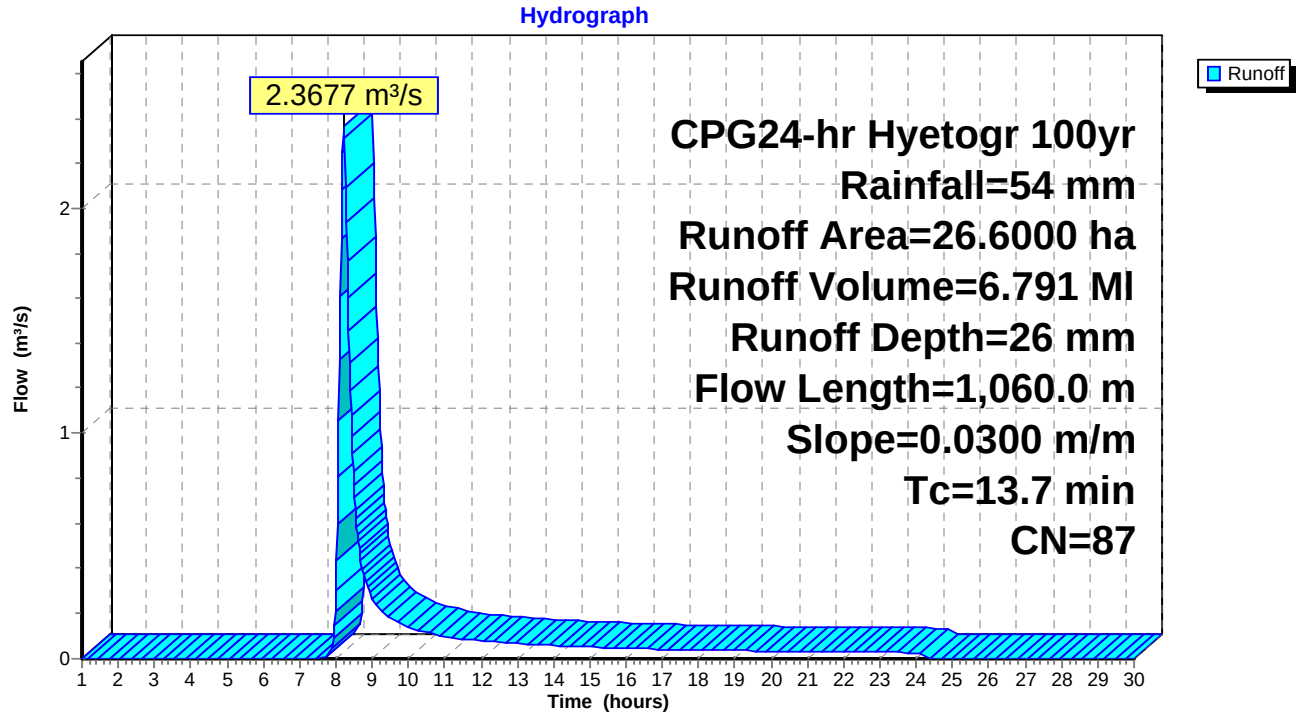
Runoff = 2.3677 m³/s @ 8.22 hrs, Volume= 6.791 Ml, Depth= 26 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
CPG24-hr Hyetogr 100yr Rainfall=54 mm

Area (ha)	CN	Description
26.6000	87	1/4 acre lots, 38% imp, HSG D
16.4920		Pervious Area
10.1080		Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
0.7	10.0	0.0300	0.23		**Sheet Flow, Driveway** Smooth surfaces n= 0.011 P2= 28 mm
0.8	50.0	0.0300	1.07		**Shallow Concentrated Flow, Gutter** Paved Kv= 6.19 m/s
2.7	500.0	0.0300	3.10	0.4938	**Circular Channel (pipe), Pipe** Diam= 450 mm Area= 0.16 m² Perim= 1.41 m r= 0.11 m n= 0.01
9.5	500.0	0.0300	0.88	0.2888	**Trap/Vee/Rect Channel Flow, Natural Drainage Ravine** Bot.W=3.00 m D=0.10 m Z= 3.0 m/m Top.W=3.60 m n= 0.040 Mountain streams
13.7	1,060.0	Total			

Subcatchment B: Area B



Subcatchment C: Area C

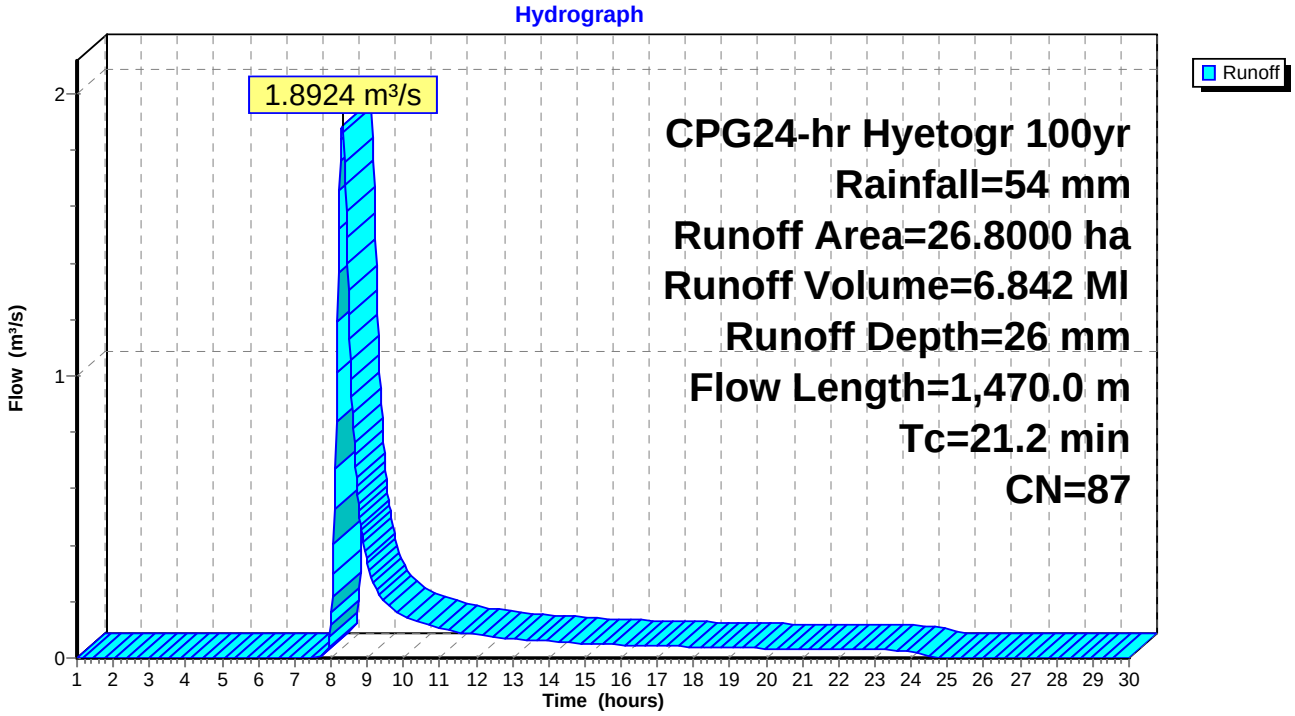
Runoff = 1.8924 m³/s @ 8.32 hrs, Volume= 6.842 Ml, Depth= 26 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
CPG24-hr Hyetogr 100yr Rainfall=54 mm

Area (ha)	CN	Description
26.8000	87	1/4 acre lots, 38% imp, HSG D
16.6160		Pervious Area
10.1840		Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
0.3	10.0	0.3000	0.58		**Sheet Flow, Roof** Smooth surfaces n= 0.011 P2= 28 mm
0.7	10.0	0.0300	0.23		**Sheet Flow, Driveway** Smooth surfaces n= 0.011 P2= 28 mm
0.8	50.0	0.0300	1.07		**Shallow Concentrated Flow, Gutter** Paved Kv= 6.19 m/s
4.2	600.0	0.0300	2.37	0.1675	**Circular Channel (pipe), Pipe** Diam= 300 mm Area= 0.07 m² Perim= 0.94 m r= 0.07 m n= 0.01
15.2	800.0	0.0300	0.88	0.2888	**Trap/Vee/Rect Channel Flow, Natural Drainage Ravine** Bot.W=3.00 m D=0.10 m Z= 3.0 m/m Top.W=3.60 m n= 0.040 Mountain streams
21.2	1,470.0	Total			

Subcatchment C: Area C



Subcatchment D: Area D

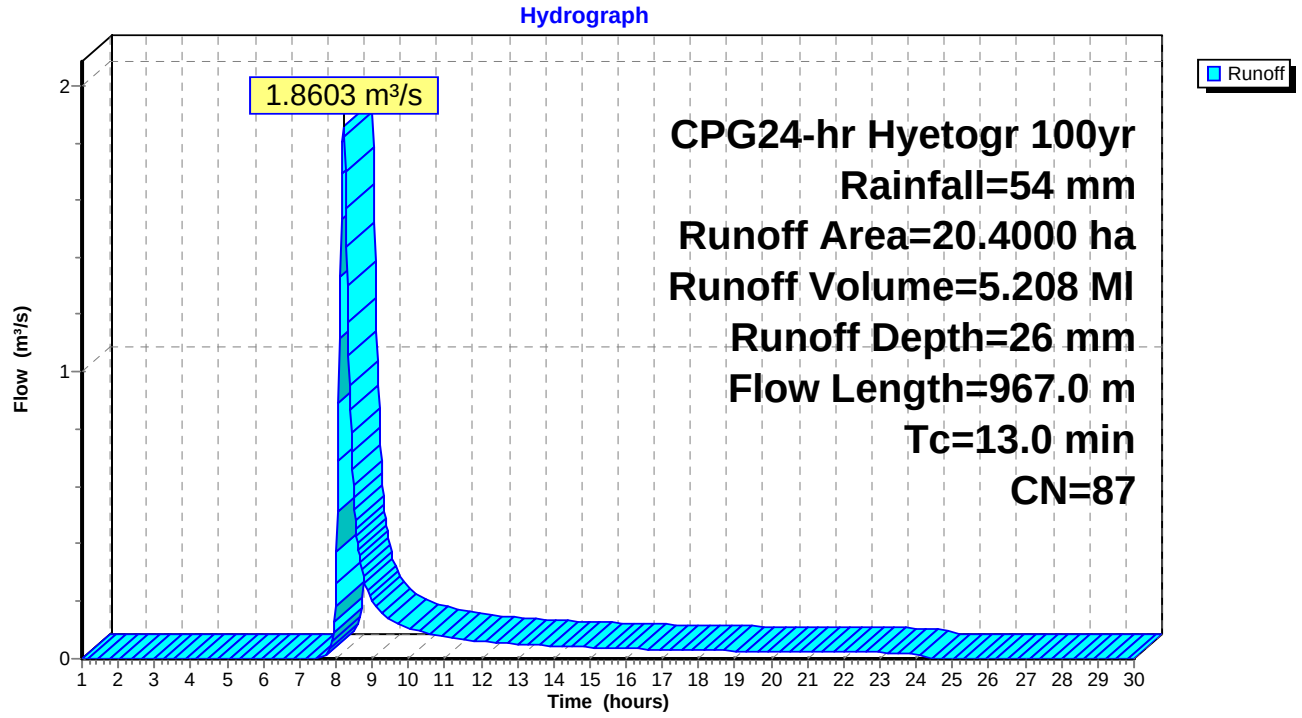
Runoff = 1.8603 m³/s @ 8.21 hrs, Volume= 5.208 Ml, Depth= 26 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
CPG24-hr Hyetogr 100yr Rainfall=54 mm

Area (ha)	CN	Description
20.4000	87	1/4 acre lots, 38% imp, HSG D
12.6480		Pervious Area
7.7520		Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
5.0					**Direct Entry,**
0.2	7.0	0.3000	0.54		**Sheet Flow, Roof** Smooth surfaces n= 0.011 P2= 28 mm
0.7	10.0	0.0300	0.23		**Sheet Flow, Driveway** Smooth surfaces n= 0.011 P2= 28 mm
0.8	50.0	0.0300	1.07		**Shallow Concentrated Flow, Gutter** Paved Kv= 6.19 m/s
6.3	900.0	0.0300	2.37	0.1675	**Circular Channel (pipe), Pipe** Diam= 300 mm Area= 0.07 m² Perim= 0.94 m r= 0.07 m n= 0.01
13.0	967.0	Total			

Subcatchment D: Area D



Subcatchment E: Area E

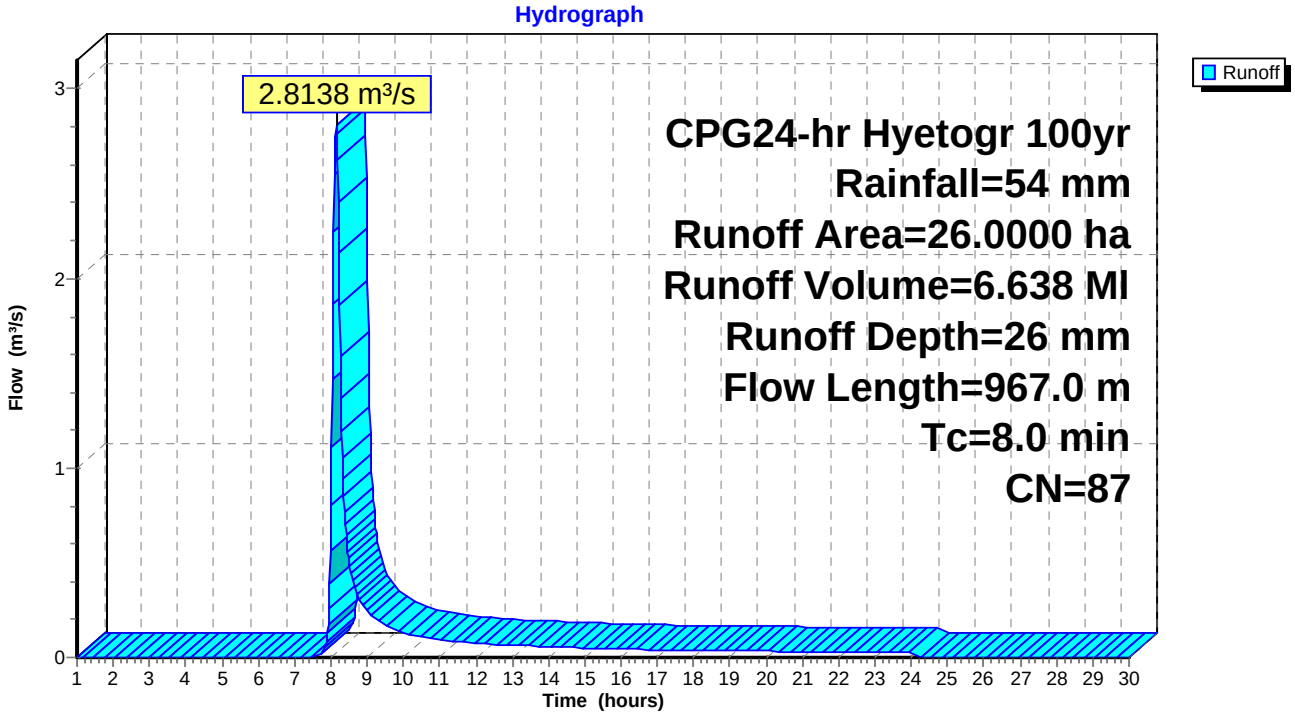
Runoff = 2.8138 m³/s @ 8.14 hrs, Volume= 6.638 Ml, Depth= 26 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
CPG24-hr Hyetogr 100yr Rainfall=54 mm

Area (ha)	CN	Description
26.0000	87	1/4 acre lots, 38% imp, HSG D
16.1200		Pervious Area
9.8800		Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
0.2	7.0	0.3000	0.54		**Sheet Flow, Roof** Smooth surfaces n= 0.011 P2= 28 mm
0.7	10.0	0.0300	0.23		**Sheet Flow, Driveway** Smooth surfaces n= 0.011 P2= 28 mm
0.8	50.0	0.0300	1.07		**Shallow Concentrated Flow, Gutter** Paved Kv= 6.19 m/s
6.3	900.0	0.0300	2.37	0.1675	**Circular Channel (pipe), Pipe** Diam= 300 mm Area= 0.07 m² Perim= 0.94 m r= 0.07 m n= 0.01
8.0	967.0	Total			

Subcatchment E: Area E



Subcatchment F: Area F (Developed)

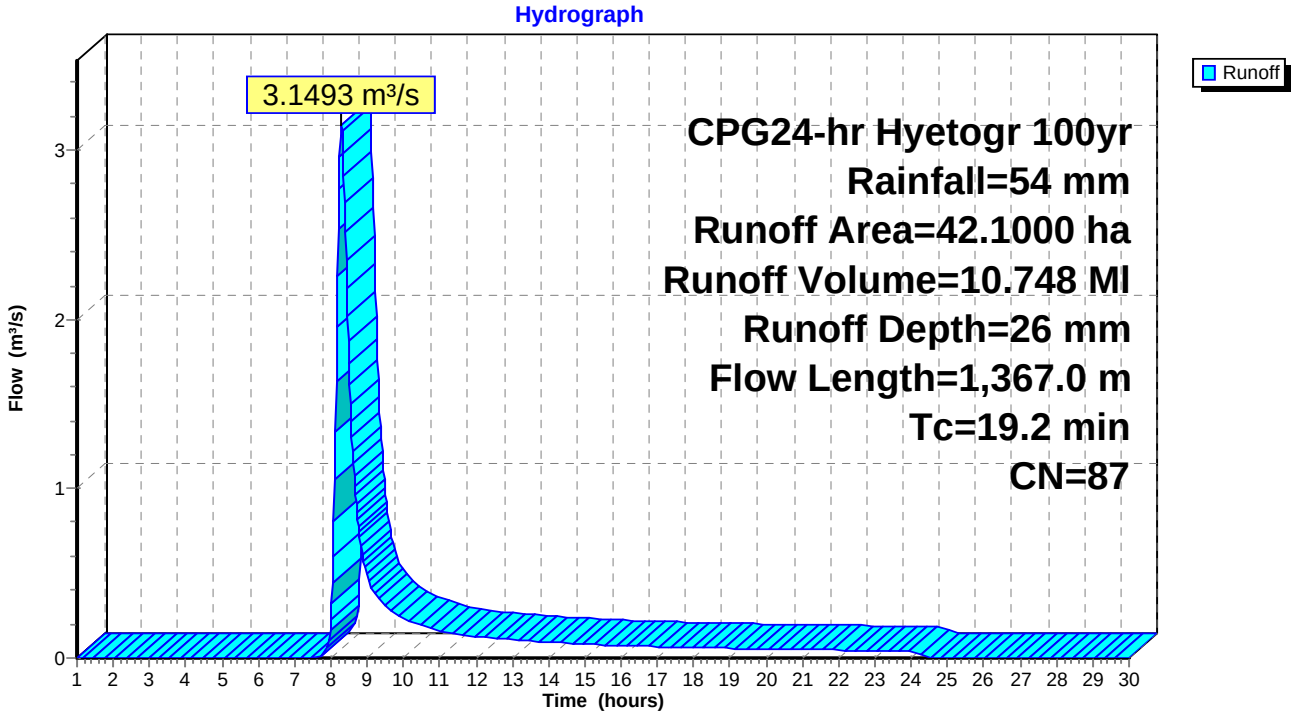
Runoff = 3.1493 m³/s @ 8.29 hrs, Volume= 10.748 Ml, Depth= 26 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
CPG24-hr Hyetogr 100yr Rainfall=54 mm

Area (ha)	CN	Description
42.1000	87	1/4 acre lots, 38% imp, HSG D
26.1020		Pervious Area
15.9980		Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
0.2	7.0	0.3000	0.54		**Sheet Flow, Roof** Smooth surfaces n= 0.011 P2= 28 mm
0.7	10.0	0.0300	0.23		**Sheet Flow, Driveway** Smooth surfaces n= 0.011 P2= 28 mm
0.8	50.0	0.0300	1.07		**Shallow Concentrated Flow, Gutter** Paved Kv= 6.19 m/s
4.2	600.0	0.0300	2.37	0.1675	**Circular Channel (pipe), Pipe** Diam= 300 mm Area= 0.07 m² Perim= 0.94 m r= 0.07 m n= 0.01
13.3	700.0	0.0300	0.88	0.2888	**Trap/Vee/Rect Channel Flow, Natural Drainage Ravine** Bot.W=3.00 m D=0.10 m Z= 3.0 m/m Top.W=3.60 m n= 0.040 Mountain streams
19.2	1,367.0	Total			

Subcatchment F: Area F (Developed)



Subcatchment F2: Area F (Un-Developed)

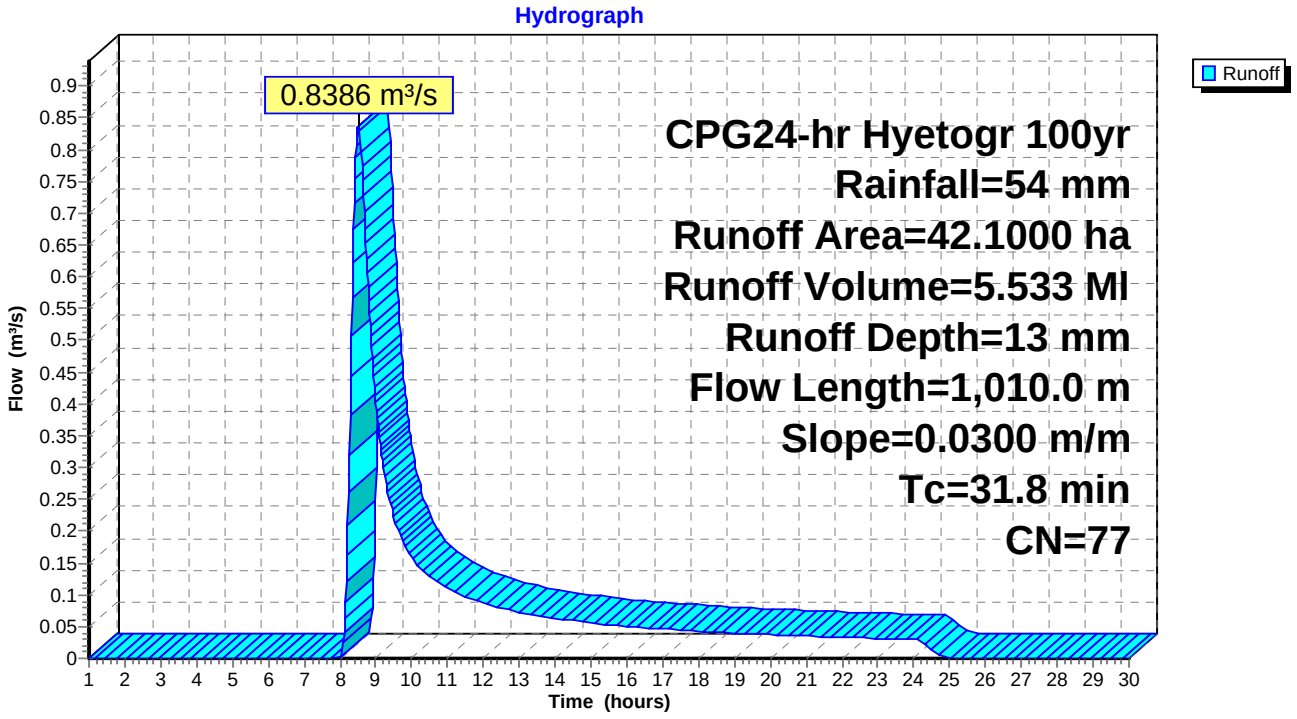
Runoff = 0.8386 m³/s @ 8.52 hrs, Volume= 5.533 Ml, Depth= 13 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
CPG24-hr Hyetogr 100yr Rainfall=54 mm

Area (ha)	CN	Description
42.1000	77	Woods, Good, HSG D
42.1000		Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
12.8	10.0	0.0300	0.01		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 28 mm
19.0	1,000.0	0.0300	0.88	0.2888	**Trap/Vee/Rect Channel Flow,** Bot.W=3.00 m D=0.10 m Z= 3.0 m/m Top.W=3.60 m n= 0.040 Mountain streams
31.8	1,010.0	Total			

Subcatchment F2: Area F (Un-Developed)



Pond 2P: Area D Pipe to Pond

Inflow Area = 20.4000 ha, Inflow Depth = 26 mm
Inflow = 1.8603 m³/s @ 8.21 hrs, Volume= 5.208 Ml
Outflow = 1.8603 m³/s @ 8.21 hrs, Volume= 5.208 Ml, Atten= 0%, Lag= 0.0 min
Primary = 0.8456 m³/s @ 8.21 hrs, Volume= 4.066 Ml
Secondary = 1.0147 m³/s @ 8.21 hrs, Volume= 1.142 Ml

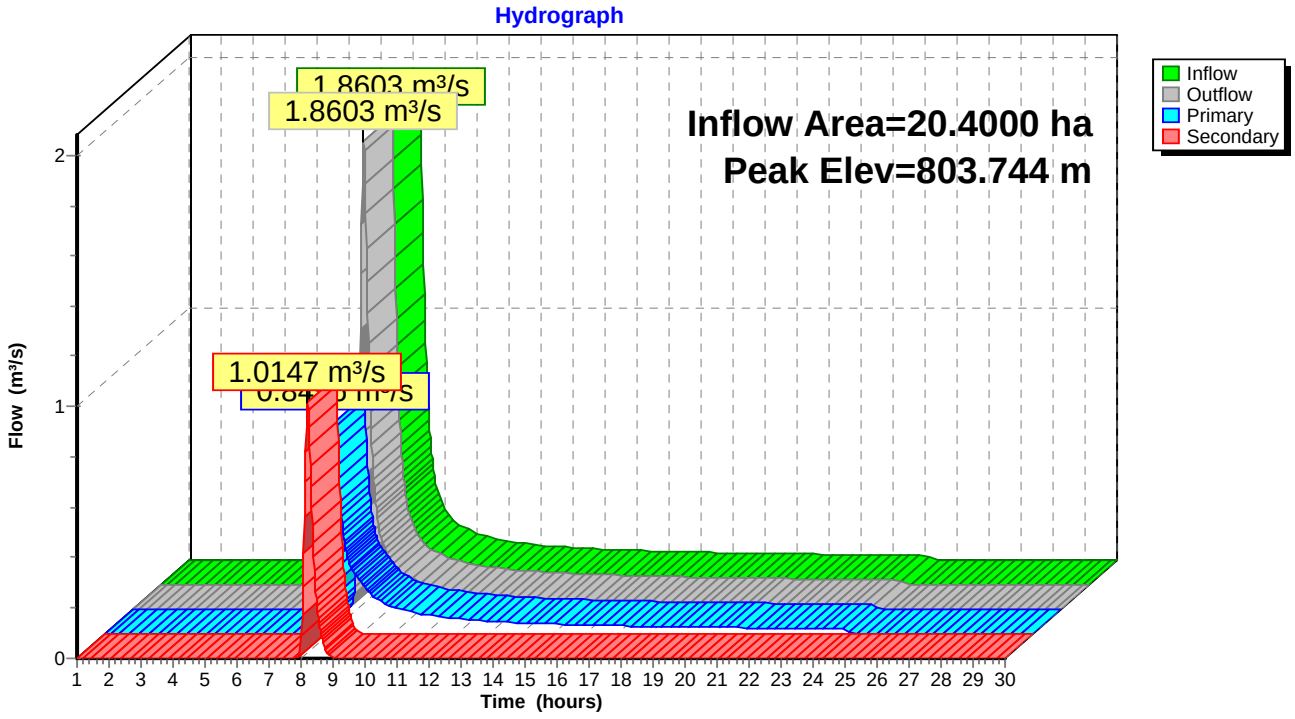
Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
Peak Elev= 803.744 m @ 8.21 hrs
Flood Elev= 900.000 m

Device	Routing	Invert	Outlet Devices
#1	Primary	800.000 m	**525 mm x 100.00 m long Culvert** Ke= 0.900 Outlet Invert= 797.000 m S= 0.0300 m/m Cc= 0.900 n= 0.013
#2	Secondary	800.500 m	**600 mm x 10.00 m long Culvert** Ke= 0.900 Outlet Invert= 800.000 m S= 0.0500 m/m Cc= 0.900 n= 0.013

Primary OutFlow Max=0.8447 m³/s @ 8.21 hrs HW=803.721 m (Free Discharge)
└**1=Culvert** (Inlet Controls 0.8447 m³/s @ 3.90 m/s)

Secondary OutFlow Max=1.0139 m³/s @ 8.21 hrs HW=803.721 m (Free Discharge)
└**2=Culvert** (Inlet Controls 1.0139 m³/s @ 3.59 m/s)

Pond 2P: Area D Pipe to Pond



Pond P1: Pond 1

Inflow Area = 123.1000 ha, Inflow Depth > 20 mm
Inflow = 5.2018 m³/s @ 8.23 hrs, Volume= 24.307 Ml
Outflow = 0.2762 m³/s @ 12.70 hrs, Volume= 19.838 Ml, Atten= 95%, Lag= 268.2 min
Primary = 0.2762 m³/s @ 12.70 hrs, Volume= 19.838 Ml
Secondary = 0.0000 m³/s @ 1.00 hrs, Volume= 0.000 Ml

Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs / 3
Peak Elev= 670.925 m @ 12.70 hrs Surf.Area= 0.0 m² Storage= 11,015.0 m³

Plug-Flow detention time= 482.4 min calculated for 19.838 Ml (82% of inflow)
Center-of-Mass det. time= 346.6 min (1,117.4 - 770.8)

Volume	Invert	Avail.Storage	Storage Description
#1	667.000 m	11,500.0 m³	**Custom Stage Data** Listed below

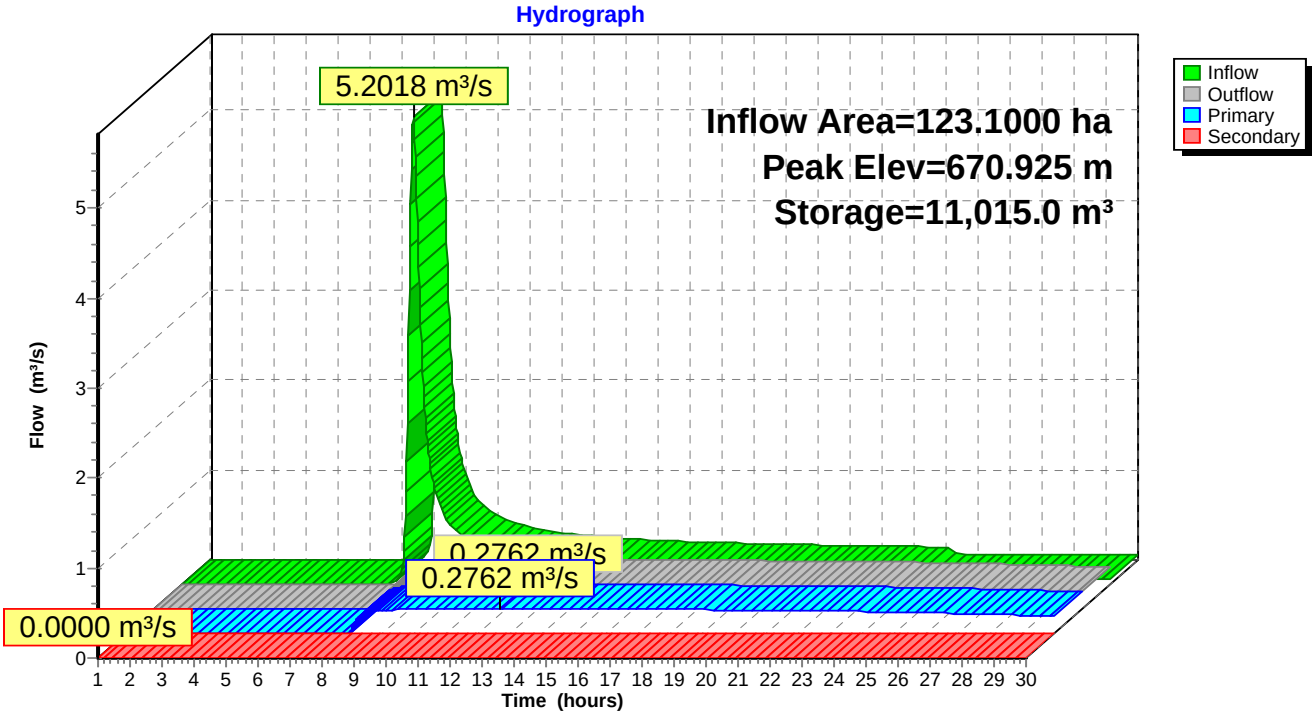
Elevation (meters)	Cum.Store (cubic-meters)
667.000	0.0
667.500	924.0
668.000	2,007.0
668.500	3,219.0
669.000	4,561.0
669.500	6,038.0
670.000	7,650.0
670.500	9,400.0
671.050	11,489.0
671.400	11,500.0

Device	Routing	Invert	Outlet Devices
#1	Primary	667.000 m	**300 mm x 30.00 m long Culvert** Ke= 0.900 Outlet Invert= 666.700 m S= 0.0100 m/m Cc= 0.900 n= 0.013
#2	Secondary	671.050 m	**45.0 deg x 5.00 m long x 0.60 m rise Sharp-Crested Vee/Trap Weir** C= 1.41

Primary OutFlow Max=0.2762 m³/s @ 12.70 hrs HW=670.925 m (Free Discharge)
↑—**1=Culvert** (Barrel Controls 0.2762 m³/s @ 3.91 m/s)

Secondary OutFlow Max=0.0000 m³/s @ 1.00 hrs HW=667.000 m (Free Discharge)
↑—**2=Sharp-Crested Vee/Trap Weir** (Controls 0.0000 m³/s)

Pond P1: Pond 1



Pond P2: Pond 2

Inflow Area = 42.1000 ha, Inflow Depth = 26 mm
Inflow = 3.1493 m³/s @ 8.29 hrs, Volume= 10.748 Ml
Outflow = 0.0629 m³/s @ 17.66 hrs, Volume= 4.770 Ml, Atten= 98%, Lag= 562.1 min
Primary = 0.0629 m³/s @ 17.66 hrs, Volume= 4.770 Ml

Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
Peak Elev= 679.949 m @ 17.66 hrs Surf.Area= 0.0 m² Storage= 7,486.9 m³

Plug-Flow detention time= 648.1 min calculated for 4.767 Ml (44% of inflow)
Center-of-Mass det. time= 477.6 min (1,149.6 - 672.0)

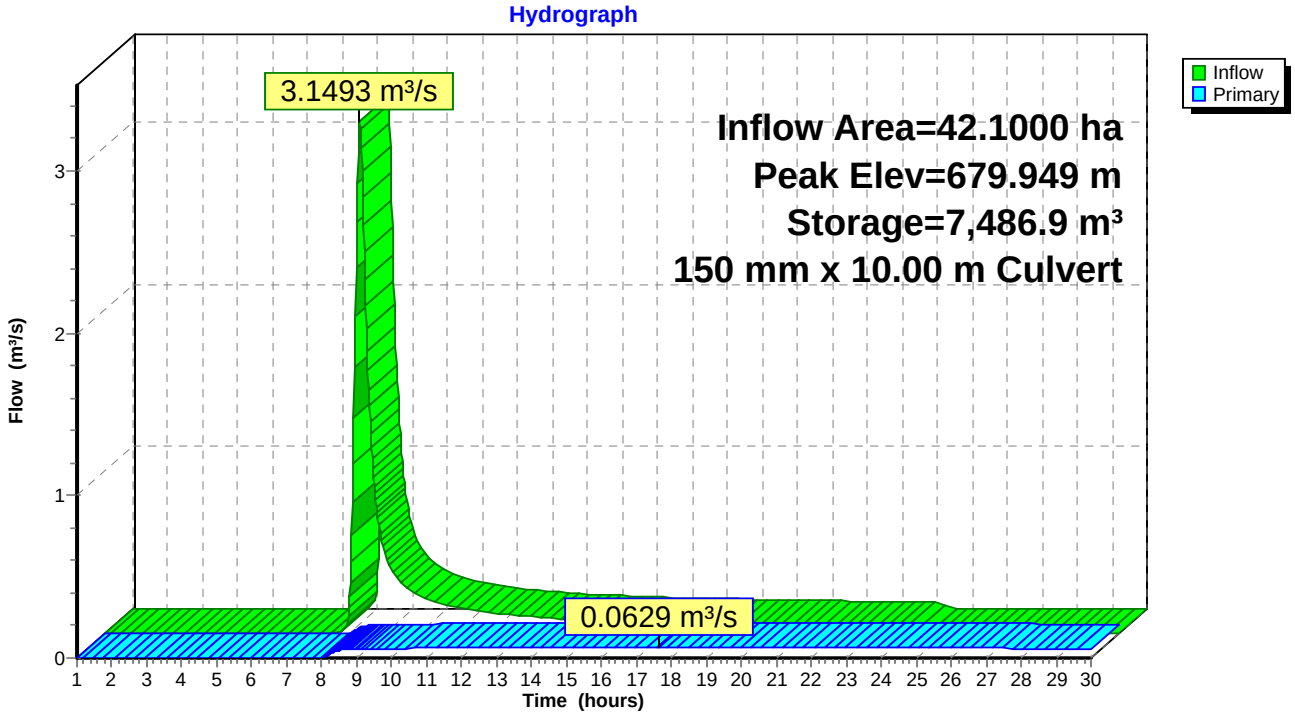
Volume	Invert	Avail.Storage	Storage Description
#1	677.000 m	11,489.0 m³	**Custom Stage Data** Listed below

Elevation (meters)	Cum.Store (cubic-meters)
677.000	0.0
677.500	924.0
678.000	2,007.0
678.500	3,219.0
679.000	4,561.0
679.500	6,038.0
680.000	7,650.0
680.500	9,400.0
681.050	11,489.0

Device	Routing	Invert	Outlet Devices
#1	Primary	677.000 m	**150 mm x 10.00 m long Culvert** Ke= 0.900 Outlet Invert= 676.600 m S= 0.0400 m/m Cc= 0.900 n= 0.013

Primary OutFlow Max=0.0629 m³/s @ 17.66 hrs HW=679.949 m (Free Discharge)
↑—**1=Culvert** (Inlet Controls 0.0629 m³/s @ 3.56 m/s)

Pond P2: Pond 2



Pond P3: Pond 3

Inflow Area = 26.0000 ha, Inflow Depth = 30 mm
Inflow = 3.6844 m³/s @ 8.16 hrs, Volume= 7.780 Ml
Outflow = 0.0924 m³/s @ 11.13 hrs, Volume= 6.291 Ml, Atten= 97%, Lag= 178.6 min
Primary = 0.0924 m³/s @ 11.13 hrs, Volume= 6.291 Ml

Routing by Stor-Ind method, Time Span= 1.00-30.00 hrs, dt= 0.02 hrs
Peak Elev= 679.064 m @ 11.13 hrs Surf.Area= 0.0 m² Storage= 4,751.0 m³

Plug-Flow detention time= 560.1 min calculated for 6.291 Ml (81% of inflow)
Center-of-Mass det. time= 456.7 min (1,094.1 - 637.4)

Volume	Invert	Avail.Storage	Storage Description
#1	677.000 m	11,489.0 m³	**Custom Stage Data** Listed below

Elevation (meters)	Cum.Store (cubic-meters)
677.000	0.0
677.500	924.0
678.000	2,007.0
678.500	3,219.0
679.000	4,561.0
679.500	6,038.0
680.000	7,650.0
680.500	9,400.0
681.050	11,489.0

Device	Routing	Invert	Outlet Devices
#1	Primary	677.000 m	**200 mm x 10.00 m long Culvert** Ke= 0.900 Outlet Invert= 676.600 m S= 0.0400 m/m Cc= 0.900 n= 0.013

Primary OutFlow Max=0.0924 m³/s @ 11.13 hrs HW=679.064 m (Free Discharge)
↑—**1=Culvert** (Inlet Controls 0.0924 m³/s @ 2.94 m/s)

Pond P3: Pond 3