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PUBLIC SERVICES AND PROCUREMENT CANADA

CATTLE AND GOAT BARN PROJECT

JOYCEVILLE, ONTARIO

JANUARY 10, 2022

COPY

CATTLE AND GOAT BARN PROJECT

JOYCEVILLE, ONTARIO

PUBLIC SERVICES AND PROCUREMENT CANADA

STORMWATER MANAGEMENT MEMORANDUM (REVISION 00)
COPY

PROJECT NO.: OUR REF. NO. 191-08574-02
CLIENT REF:R.100644.001
DATE: OCTOBER 15, 2021

WSP
201-1224 GARDINERS ROAD
KINGSTON, ON
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SIGNATURES

PREPARED BY

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1 INTRODUCTION

WSP Canada Inc. (WSP) was retained by Public Services and Procurement Canada (PSPC) to complete a Stormwater Management report for two (2) new livestock barns, one (1) for cattle and one (1) for goats at Joyceville Minimum Institution. The purpose of this report is to summarize the stormwater management measures required for the design and construction of the two (2) new livestock barns.

2 EXISTING LAND USE

The proposed site for the new Joyceville Institution Cattle and Goat Barns consists of seven (7) existing buildings and is located approximately 20 kilometers north-east of Kingston, Ontario. The usage of the existing buildings are an Implement Shed, Heavy Equipment Shed, Dairy Cattle Barn, Storage Shed, Farm Manager's House, Old Farm Building, and a Hay Storage Structure. The proposed site for the construction of the two (2) barns is considered a brownfield site (land available for reuse).

The proposed facilities will be designed as industrial occupancy and farm building occupancy. It is bordered by CSC – Joyceville Institution to the north, an existing quarry to the east, open greenspace to the south and Highway 15 to the west.

Access to the site is currently provided by an existing entrance on Provincial Highway 15. The site is located in the Countryside District and does not contain any municipal services (i.e. sanitary sewers or watermains).

3 PROPOSED DEVELOPMENT

The proposed development includes the construction of two (2) new livestock barns. The proposed barns are configured to have office spaces, holding areas, parlours, nurseries, and other ancillary spaces. One (1) barn will be a Goat Barn with an area requirement of 6,099 m^2. The Goat Barn's intended five (5) year occupancy is to maintain a milking goat herd of roughly 1,500 goats. The second barn will be a Cattle Barn with an area requirement of 3,089m^2. The Cattle Barn will be designed to accommodate approximately 70 Cattle as a milking herd. The Cattle Barn will also incorporate a milking parlour in the barn to allow for the future expansion to the herd.

3.1 STORMWATER MANAGEMENT & SITE GRADING

With the construction of two (2) new structures there will be an increase in impervious area for the site post-development. To ensure that post-development flows are equal to or less than pre-development flows, on-site stormwater storage will be included in the development. The overall grading of the site will generally match existing conditions. Localized grading adjacent to new structures will ensure all stormwater is directed away from the finished floor elevations. Swales and road-side ditches will be incorporated to capture and convey stormwater to a dry stormwater management retention area complete with an oil/grit separator. The oil/grit separator operations and maintenance should be as per the supplier's recommendations. The stormwater will ultimately outlet to the existing northeast bound roadside ditch along Highway 15.

HydroCAD 10.00 Stormwater Modelling software was used to calculate the pre and post-development flow conditions for the 5-year (minor) and 100-year (major) return period design storm events. The software uses the Modified Rationale Method and has the ability to solve for critical storm durations taking into consideration peak flow from catchments with differing time of concentrations, as well as retention areas outlet hydraulics.

The following Tables 3-1 and 3-2 detail the pre- and post-development areas and flows for the site. Pre-development time of concentration for the site was calculated to be 91 minutes. Post-development time of concentration was calculated using an initial 15 minutes for runoff to enter the ditching system, followed by an additional 12.2 minutes

of time for the water to route to the stormwater retention area through the ditching network. Refer to Appendix A for detailed calculations.

Table 3-1 Land Use and Runoff Coefficients

	Pre-Development		Post-Development	
Lane Use	**Runoff Coefficient**	**Area (m2)**	**Runoff Coefficient**	**Area (m2)**
Granular	0.80	9,275	0.80	26,264
Asphalt/Concrete	0.90	6,852	0.90	8,197
Manure Tank*	0.00	0	0.00	1,513
Structures	0.90	4,098	0.90	14,237
Grassed	0.25	172,570	0.25	142,656
Weighted Coefficient and Total Area	0.31	192,867	0.40	192,867

*The manure tanks have been assigned a runoff coefficient of "0" as rainfall which falls within the tanks stays within manure handling process and not directed to the on-site storm system.

Table 3-2 Pre- and Post-Development Peak Stormwater Flows

	Pre-Development		Post-Development (Uncontrolled)	
Design Storm	**1:5 Year**	**1:100 Year**	**1:5 Year**	**1:100 Year**
Weighted Coefficient	0.31	0.39	0.40	0.50
Peak Flow	342 L/s	718 L/s	1,025 L/s	2,141 L/s

The dry stormwater management retention area has been designed with an outlet structure comprised of a 450mm HDPE outlet pipe and a 5.0m wide clay weir lined with Rip-Rap. The release of post-development flows from the retention area have been restricted to the capacity of the new private outlet ditch, as it was found to be the governing factor for the site's allowable stormwater release (less than 100-year pre-development flow rate). Refer to Table 3-3 for comparison of receiving ditch capacities and proposed controlled peak site release rates. Refer to Appendix A for detailed stormwater calculations and Appendix B for HydroCAD model outputs.

Table 3-3 Ditch Capacity vs. Post-Development Peak Runoff (Controlled)

Ditch Capacity		Post-Development Peak Runoff (Controlled)		SWM Facility - Peak Ponding	
Private Outlet Ditch	**Highway 15 Ditch**	**1:5 Year***	**1:100 Year****	**1:5 Year*****	**1:100 Year******
565 L/s	5,213 L/s	193 L/s	471 L/s	123.48m	123.73m

* Relative to the outlet's critical storm duration of 93 mins.
** Relative to the outlet's critical storm duration of 132 mins.
*** Relative to the pond's critical storm duration of 114 mins.
** ** Relative to the pond's critical storm duration of 123 mins.

Ditches throughout the development were designed to convey major flows. Culverts throughout the site were designed such that overtopping of the embankment (i.e. laneways) will occur under major events. Spill elevation for

the embankments have been graded such that desired flow routing is maintained and ponding elevations do not encroach up to building envelops. Refer to Appendix A for detailed ditching calculations and HY-8 model outputs.

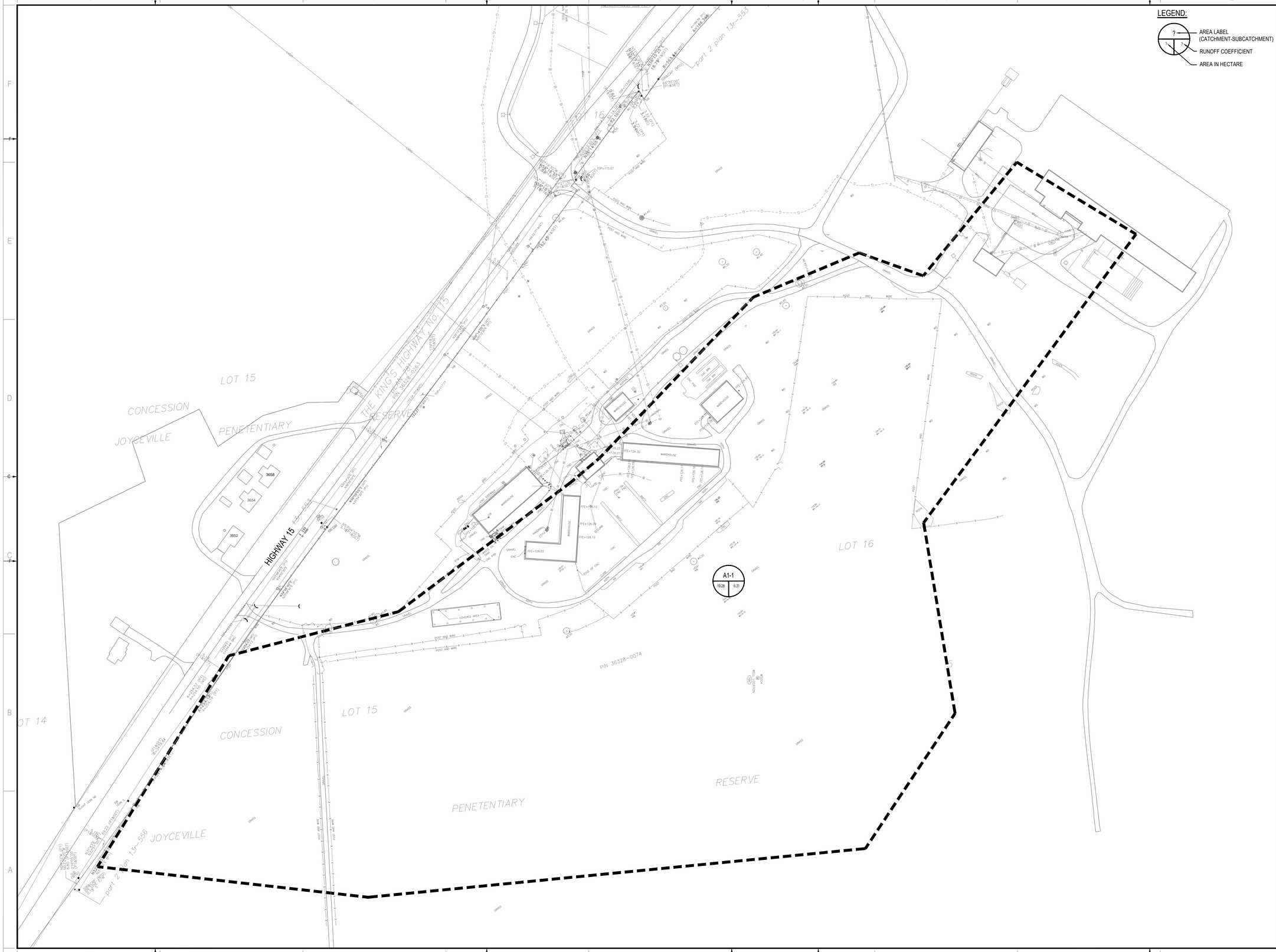
The dry stormwater management retention area has been designed to ensure best management practices for quality control. An oil/grit separator device is proposed to provide quality treatment to stormwater released from the retention facility. The device shall be size to provide normal-level protection (70% TSS Removal) in accordance with the Ministry of the Environment, Conservation, and Parks' (MECP) Stormwater Management Guidelines. The device shall also be sized based on Fine Distribution for particle size distribution. As the site is designed with shallow slope ditches, additional water quality will be obtained prior to the quality unit.

4 SUMMARY

We trust that this Stormwater Management Memorandum is suitable to support the proposed development of Joyceville Cattle and Goat Barns.

If you require any additional information or have any comments or concerns please do not hesitate to contact our office.

A STORMWATER CALCULATIONS AND FIGURES



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CONSULTANT:

SEAL:

NORTH

CLIENT:

JOYCEVILLE INSTITUTION

CLIENT REF. #: 20162022

PROJECT:

CSC CATTLE AND GOAT BARNS

KEY PLAN:

DISCLAIMER:

ISSUED FOR - REVISION:

IS	RE	DATE	DESCRIPTION
1		2021/10/15	ISSUED FOR SWM REPORT

PROJECT NO: 191-08574-00

DATE: OCT 2021

ORIGINAL SCALE: 1:1250

IF THIS BAR IS NOT 25mm LONG, ADJUST YOUR PLOTTING SCALE.

25mm

DESIGNED BY: DS

DRAWN BY: JD

CHECKED BY: KC

DISCIPLINE: CIVIL

TITLE:

PRE - DEVELOPMENT CATCHMENT FIGURE

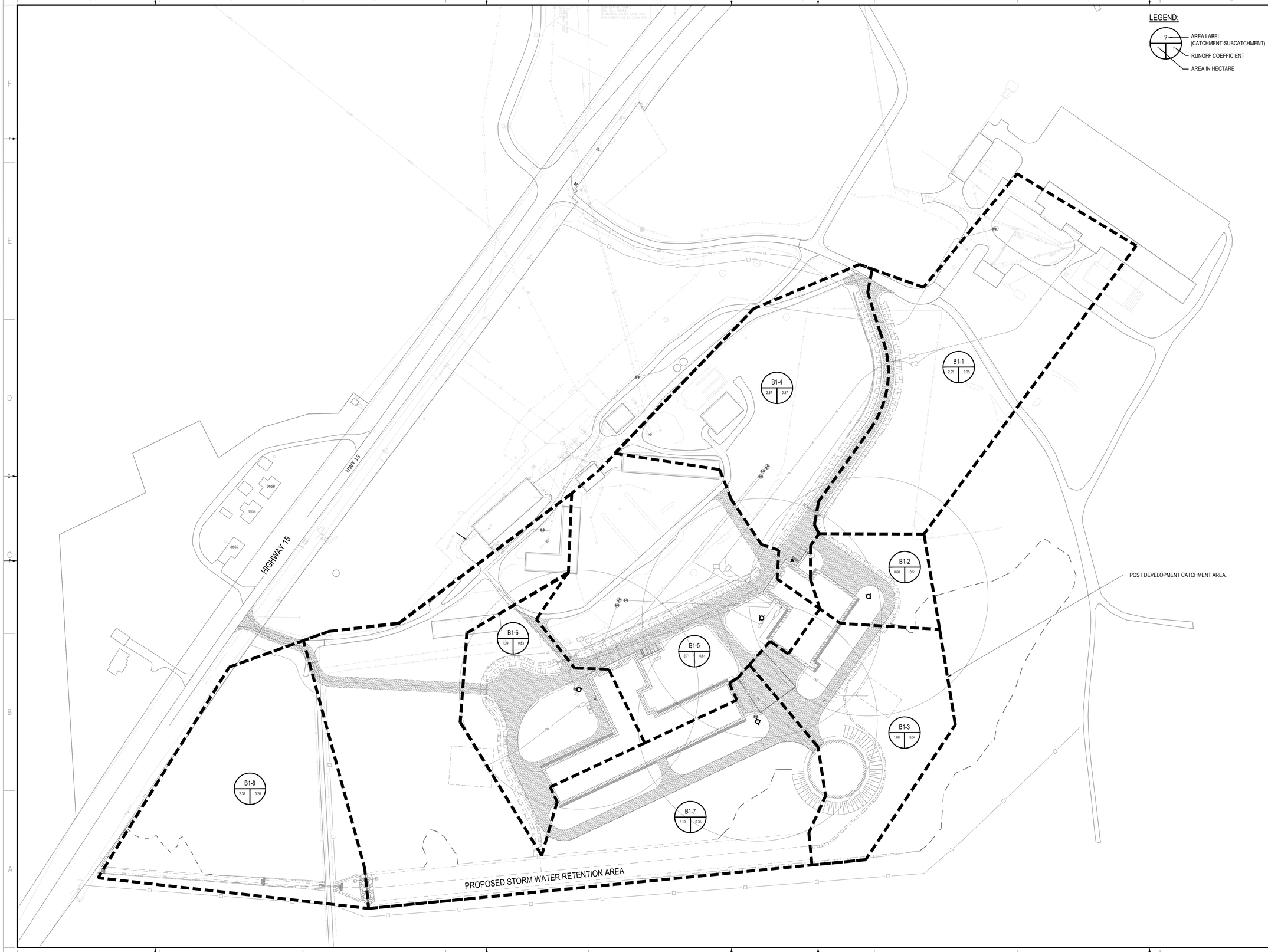
SHEET NUMBER: SK1.1

SHEET #: 1 OF 2

ISSUE: ISSUED FOR SWM REPORT

DATE OF: 2021/10/15

REV #: 0



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PROJECT NO: 191-08574-00
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IF THIS BAR IS NOT 25mm LONG, ADJUST YOUR PLOTTING SCALE.
25mm
DESIGNED BY: DS
DRAWN BY: JD
CHECKED BY: KC

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TITLE:

POST - DEVELOPMENT CATCHMENT FIGURE

SHEET NUMBER: SK1.2

SHEET #: 2 OF 2

ISSUE: ISSUED FOR SWM REPORT

DATE OF: 2021/10/15

REV #: 0

Table A1 - Land Use

PRE-DEVELOPMENT (ENTIRE SITE)

AREA No.	AREA (m^2)	RUNOFF COEFFICIENT	LAND USE
	9275	0.80	Gravel
	6852	0.90	Asphalt, Concrete
	4098	0.90	Roof Areas
	172642	0.25	Grassed Area
A1-1	**192867**	**0.31**	**Total**

POST-DEVELOPMENT (ENTIRE SITE)

AREA No.	AREA (m^2)	RUNOFF COEFFICIENT	LAND USE
	26264	0.80	Gravel
	8197	0.90	Asphalt, Concrete
	1513	0.00	Manure Tank
	14237	0.90	Roof Areas
	142656	0.25	Grassed Area
B	**192867**	**0.40**	**Total**

Pre-Development Time of Concentration (Tc)

1 - AIRPORT FORMULA
(WHERE "C" IS LESS THAN 0.4)

$$\frac{3.26 \times (1.1 - c) \times L^{0.5}}{Sw^{0.33}}$$

c = 0.31
L = 792 m
Sw= 0.5 %
Pre-Development T_c = 90.9 mins

POST-DEVELOPMENT (SUBCATCHMENT BREAKDOWN)

POST-DEVELOPMENT (B1-1)

AREA No.	AREA (m^2)	COEFFICIENT	LAND USE
	5181	0.80	Gravel
	0	0.90	Asphalt, Concrete
	0	0.00	Manure Tank
	1539	0.90	Roof Areas
	22819	0.25	Grassed Area
B1-1	**29540**	**0.38**	**Total**

POST-DEVELOPMENT (B1-2)

AREA No.	AREA (m^2)	COEFFICIENT	LAND USE
	1347	0.80	Gravel
	46	0.90	Asphalt, Concrete
	0	0.00	Manure Tank
	1175	0.90	Roof Areas
	3446	0.25	Grassed Area
B1-2	**6014**	**0.51**	**Total**

POST-DEVELOPMENT (B1-3)

AREA No.	AREA (m^2)	COEFFICIENT	LAND USE
	2254	0.80	Gravel
	70	0.90	Asphalt, Concrete
	1239	0.00	Manure Tank
	809	0.90	Roof Areas
	12577	0.25	Grassed Area
B1-3	**16948**	**0.34**	**Total**

POST-DEVELOPMENT (B1-4)

AREA No.	AREA (m^2)	COEFFICIENT	LAND USE
	3290	0.80	Gravel
	268	0.90	Asphalt, Concrete
	0	0.00	Manure Tank
	1249	0.90	Roof Areas
	18874	0.25	Grassed Area
B1-4	**23680**	**0.37**	**Total**

POST-DEVELOPMENT (B1-5)

AREA No.	AREA (m^2)	COEFFICIENT	LAND USE
	3775	0.80	Gravel
	7307	0.90	Asphalt, Concrete
	0	0.00	Manure Tank
	4356	0.90	Roof Areas
	11650	0.25	Grassed Area
B1-5	**27088**	**0.61**	**Total**

POST-DEVELOPMENT (B1-6)

AREA No.	AREA (m^2)	COEFFICIENT	LAND USE
	4917	0.80	Gravel
	289	0.90	Asphalt, Concrete
	0	0.00	Manure Tank
	1561	0.90	Roof Areas
	7099	0.25	Grassed Area
B1-6	**13865**	**0.53**	**Total**

POST-DEVELOPMENT (B1-7)

AREA No.	AREA (m^2)	COEFFICIENT	LAND USE
	4987	0.80	Gravel
	217	0.90	Asphalt, Concrete
	274	0.00	Manure Tank
	3550	0.90	Roof Areas
	42891	0.25	Grassed Area
B1-7	**51919**	**0.35**	**Total**

POST-DEVELOPMENT (B1-8)

AREA No.	AREA (m^2)	COEFFICIENT	LAND USE
	513	0.80	Gravel
	0	0.90	Asphalt, Concrete
	0	0.00	Manure Tank
	0	0.90	Roof Areas
	23300	0.25	Grassed Area
B1-7	**23813**	**0.26**	**Total**

STORM DITCH DESIGN SHEET (5-YEAR)

Q - 2.78(ACI) peak flow in litres per second (L/s)
A - area in hectares (ha)
I - rainfall intensity in millimetres per hour (mm/hr)
C - runoff coefficient

$i = 27.7(Tc/60)^{-0.699}$
Peak Flow = 2.78 AC *i
Capacity = $(1/n)*A*R^{2/3}*S^{1/1}$
V = $(1/n)*R^{2/3}*S^{1/2}$
Time of Flow = (L/V)/60

LOCATION	AREAS	FROM	TO	AREA (ha)	RUNOFF COEFFICIENT	INDIV. EQUIV. AREA 2.78*(AC)	ACCUM. EQUIV. AREA 2.78*(AC)	TIME OF CONC. (min)	RAINFALL INTENSITY (mm/hr)	PEAK FLOW (l/s)	DITCH DATA														
											BOTTOM WIDTH (m)	SIDE SLOPES RIGHT	SIDE SLOPES LEFT	SIDE SLOPES LENGTHS RIGHT (m)	SIDE SLOPES LENGTHS LEFT (m)	FLOW DEPTH (m)	WETTED PERIMETER (m)	FLOW AREA (m^2)	R (FA/WP)	SLOPE (%)	LENGTH (m)	CAPACITY (l/s) n= 0.035	VELOCITY (m/s)	TIME OF FLOW (min)
Ditching	**B1-1**			2.954	0.380	3.123	3.123	15.00	72.999	**228.00**	0.00	3	3	2.34	2.34	0.740	4.68	1.64	0.35	0.75	166.00	**2022.69**	1.2312	2.25
Ditching	**B1-4**			2.368	0.368	2.423	2.423	15.00	72.999	**176.86**	2.00	3	3	0.95	0.95	0.300	3.90	0.87	0.22	0.22	64.00	**429.04**	0.493	2.16
Ditching	**B1-2**			0.601	0.505	0.845	6.391	17.25	66.213	**423.14**	0.00	3	3	2.75	2.75	0.870	5.50	2.27	0.41	0.16	178.00	**1438.44**	0.6335	4.68
Ditching	**B1-3**			1.695	0.339	1.595	7.986	21.93	55.978	**447.04**	0.00	3	3	2.75	2.75	0.870	5.50	2.27	0.41	0.16	200.00	**1438.44**	0.6335	5.26
Ditching	**B1-5**			2.709	0.607	4.567	4.567	15.00	72.999	**333.41**	2.00	3	3	1.52	1.52	0.480	5.04	1.65	0.33	0.20	157.00	**1003.23**	0.608	4.31
Ditching	**B1-6**			1.387	0.532	2.050	6.617	19.31	61.192	**404.90**	2.00	3	3	1.83	1.83	0.580	5.67	2.17	0.38	0.20	192.50	**1460.99**	0.674	4.76
Pond	**B1-7**	POND	POND	5.192	0.349	5.033	19.635	27.19	48.165	**945.74**														
Private Outlet Ditch*	**B1-8**	POND	OUTLET	2.381	0.262	REFER TO HYDROCAD OUTPUT				**193.00**	2.50	3	3	1.11	1.11	0.350	4.71	1.24	0.26	0.15	67.00	**565.25**	0.45	2.45
HWY 15 Ditch**										**193.00**	0.00	3	3	3.16	3.16	1.000	6.32	3.00	0.47	1.00		**5213.32**	1.74	

*TOTAL PEAK FLOW RELATIVE TO COMBINATION OF POND OUTLET AND B1-8 RUNOFF @ SITE OUTLET'S 5-YEAR CRITICAL DURATION (93 mins)
**CAPACITY CHECK OF EXISTING RECEIVING DITCH RELATIVE TO PEAK SITE RELEASE

Joyceville Institution
CSC Cattle and Goat Barns

STORM DITCH DESIGN SHEET (100-YEAR)

Q - 2.78(ACI) peak flow in litres per second (L/s)
A - area in hectares (ha)
I - rainfall intensity in millimetres per hour (mm/hr)
C - runoff coefficient

$i = 46.1(Tc/60)^{-0.699}$
Peak Flow = 2.78 AC *I*(1.25)
Capacity = $(1/n)*A*R^{2/3}*S^{1\backslash1}$
V = $(1/n)*R^{2/3}*S^{1\backslash2}$
Time of Flow = (L/V)/60

Additional 25% allocated for the 100-year only.

LOCATION	AREAS	FROM	TO	AREA (ha)	RUNOFF COEFFICIENT	INDIV. EQUIV. AREA 2.78*(AC)	ACCUM. EQUIV. AREA 2.78*(AC)	TIME OF CONC. (min)	RAINFALL INTENSITY (mm/hr)	PEAK FLOW (l/s)	DITCH DATA														
											BOTTOM WIDTH (m)	SIDE SLOPES		SIDE SLOPES LENGTHS		FLOW DEPTH (m)	WETTED PERIMETER (m)	FLOW AREA (m^2)	R (FA/WP)	SLOPE (%)	LENGTH (m)	CAPACITY (l/s) n= 0.035	VELOCITY (m/s)	TIME OF FLOW (min)
												RIGHT	LEFT	RIGHT (m)	LEFT (m)										
Ditching	**B1-1**			2.954	0.380	3.123	3.123	15.00	121.490	**474.31**	0.00	3	3	2.34	2.34	0.740	4.68	1.64	0.35	0.75	166.00	**2022.69**	1.2312	2.25
Ditching	**B1-4**			2.368	0.368	2.423	2.423	15.00	121.490	**367.93**	2.00	3	3	0.95	0.95	0.300	3.90	0.87	0.22	0.22	64.00	**429.04**	0.493	2.16
Ditching	**B1-2**			0.601	0.505	0.845	6.391	17.25	110.196	**880.27**	0.00	3	3	2.75	2.75	0.870	5.50	2.27	0.41	0.16	178.00	**1438.44**	0.6335	4.68
Ditching	**B1-3**			1.695	0.339	1.595	7.986	21.93	93.162	**929.98**	0.00	3	3	2.75	2.75	0.870	5.50	2.27	0.41	0.16	200.00	**1438.44**	0.6335	5.26
Ditching	**B1-5**			2.709	0.607	4.567	4.567	15.00	121.490	**693.60**	2.00	3	3	1.52	1.52	0.480	5.04	1.65	0.33	0.20	157.00	**1003.23**	0.608	4.31
Ditching	**B1-6**			1.387	0.532	2.050	6.617	19.31	101.840	**842.33**	2.00	3	3	1.83	1.83	0.580	5.67	2.17	0.38	0.20	192.50	**1460.99**	0.674	4.76
Pond	**B1-7**	POND	POND	5.192	0.349	5.033	19.635	27.19	80.159	**1967.44**														
Private Outlet Ditch*	**B1-8**	POND	OUTLET	2.381	0.262	REFER TO HYDROCAD OUTPUT				**474.00**	2.50	3	3	1.11	1.11	0.350	4.71	1.24	0.26	0.15	67.00	**565.25**	0.45	2.45
HWY 15 Ditch**										**474.00**	0.00	3	3	3.16	3.16	1.000	6.32	3.00	0.47	1.00		**5213.32**	1.74	

*TOTAL PEAK FLOW RELATIVE TO COMBINATION OF POND OUTLET AND B1-8 RUNOFF @ SITE OUTLET'S 100-YEAR CRITICAL DURATION (132 mins)
**CAPACITY CHECK OF EXISTING RECEIVING DITCH RELATIVE TO PEAK SITE RELEASE

HY-8 Culvert Analysis Report

Project Notes

Project Title:CSC Cattle & Goat Barns - New Facilities (191-08574-00)

Designer:Daniel Searle, P.Eng.

Project Date:Wednesday, October 13, 2021

Notes:

Project Units: SI Units (Metric)

Crossing Discharge Data

Discharge Selection Method: Recurrence

CULVERT B1-4 (OUTLET)

Table 1 - Summary of Culvert Flows at Crossing: B1-4 (Outlet)

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	2 x 450 Discharge (cms)	Roadway Discharge (cms)	Iterations
124.41	5 year	0.18	0.18	0.00	1
124.62	100 year	0.37	0.37	0.00	1
124.76	Overtopping	0.47	0.47	0.00	Overtopping

Rating Curve Plot for Crossing: B1-4 (Outlet)

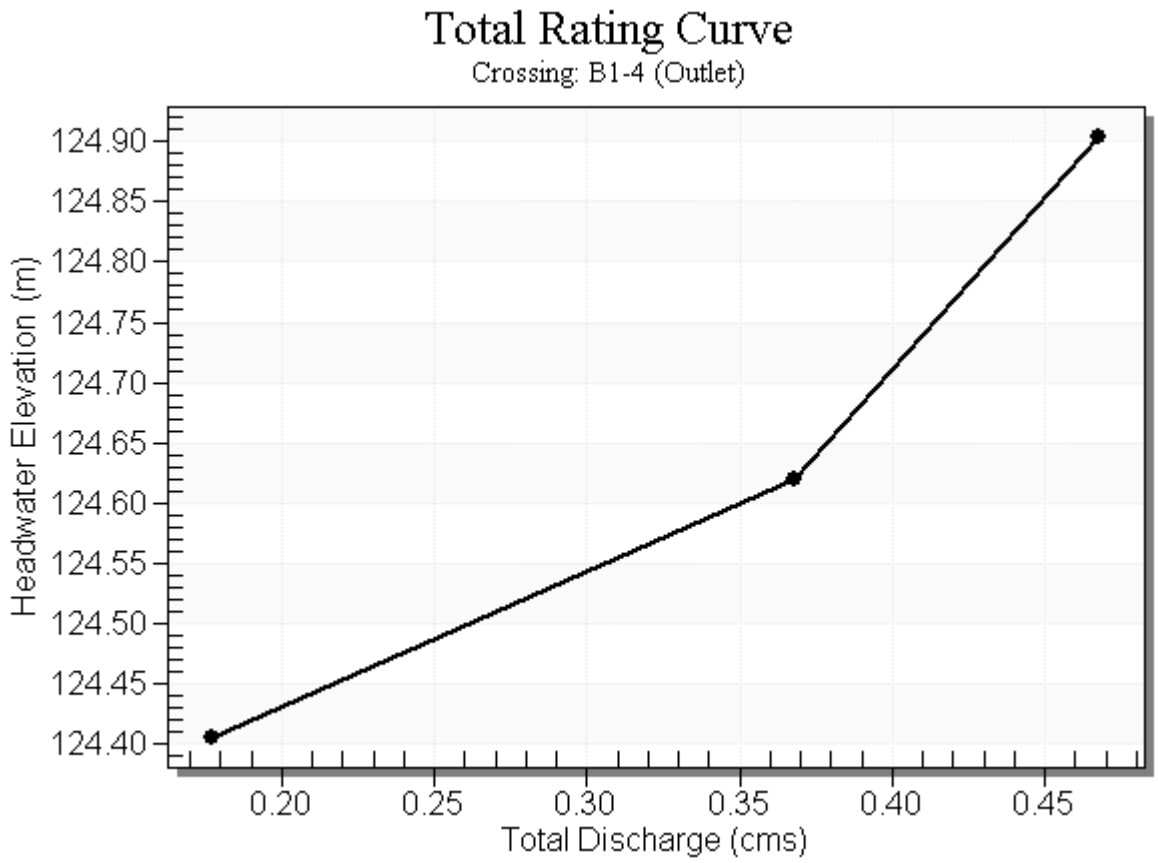


Table 2 - Culvert Summary Table: 2 x 450

Discharge Names	Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)
5 year	0.18	0.18	124.41	0.316	0.229	1-S2n	0.165	0.206	0.165	0.354	1.626
100 year	0.37	0.37	124.62	0.530	0.491	5-JS1f	0.251	0.301	0.450	0.466	1.157

****

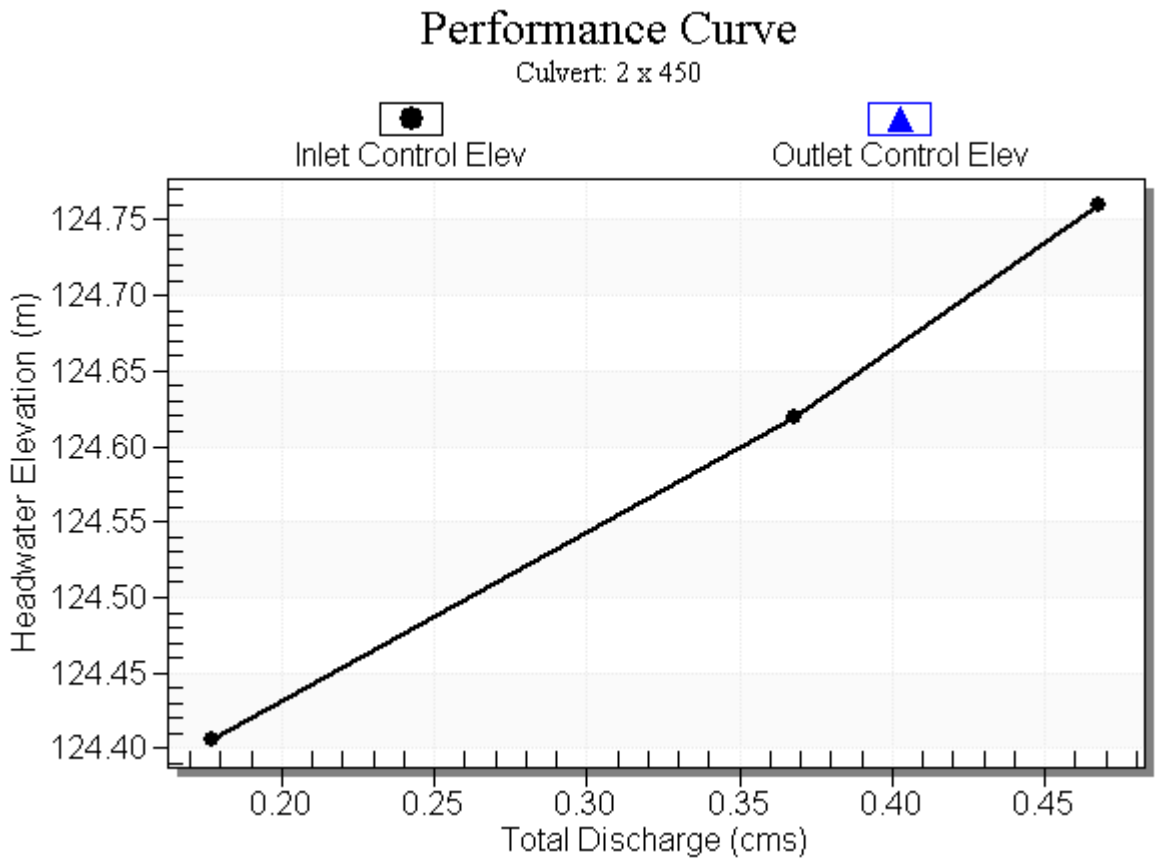
Straight Culvert

Inlet Elevation (invert): 124.09 m, Outlet Elevation (invert): 123.92 m

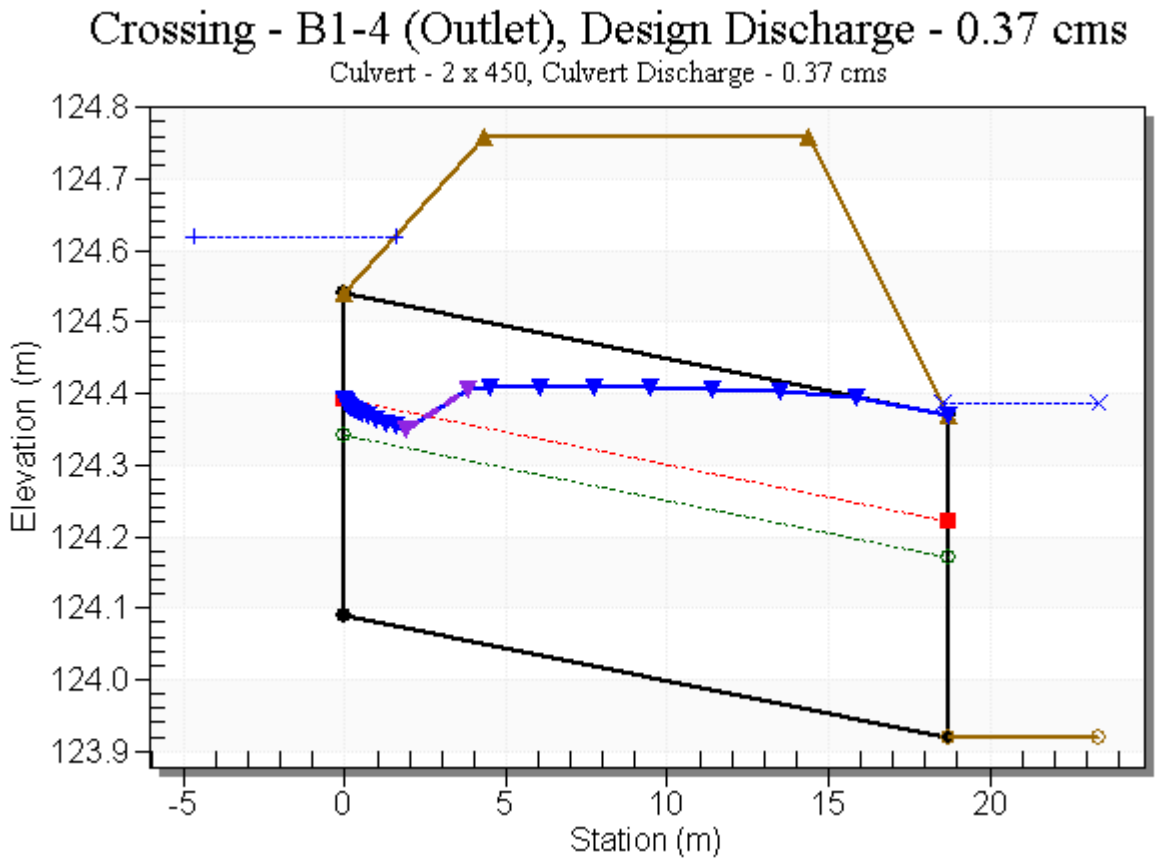
Culvert Length: 18.70 m, Culvert Slope: 0.0091

****

Culvert Performance Curve Plot: 2 x 450



Water Surface Profile Plot for Culvert: 2 x 450



Site Data - 2 x 450

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 124.09 m

Outlet Station: 18.70 m

Outlet Elevation: 123.92 m

Number of Barrels: 2

Culvert Data Summary - 2 x 450

Barrel Shape: Circular

Barrel Diameter: 450.00 mm

Barrel Material: Smooth HDPE

Embedment: 0.00 mm

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

Table 3 - Downstream Channel Rating Curve (Crossing: B1-4 (Outlet))

Flow (cms)	Water Surface Elev (m)	Depth (m)	Velocity (m/s)	Shear (Pa)	Froude Number
0.18	124.27	0.35	0.47	5.20	0.36
0.37	124.39	0.47	0.57	6.84	0.37

Tailwater Channel Data - B1-4 (Outlet)

Tailwater Channel Option: Triangular Channel

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0015

Channel Manning's n: 0.0250

Channel Invert Elevation: 123.92 m

Roadway Data for Crossing: B1-4 (Outlet)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 124.76 m

Roadway Surface: Gravel

Roadway Top Width: 10.00 m

CULVERT B1-5 (OUTLET)

Crossing Discharge Data

Discharge Selection Method: Recurrence

Table 4 - Summary of Culvert Flows at Crossing: B1-5 (Outlet)

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	2 x 450 Discharge (cms)	Roadway Discharge (cms)	Iterations
124.18	5 year	0.33	0.33	0.00	1
124.71	100 year	0.69	0.60	0.10	11
124.67	Overtopping	0.58	0.58	0.00	Overtopping

Rating Curve Plot for Crossing: B1-5 (Outlet)

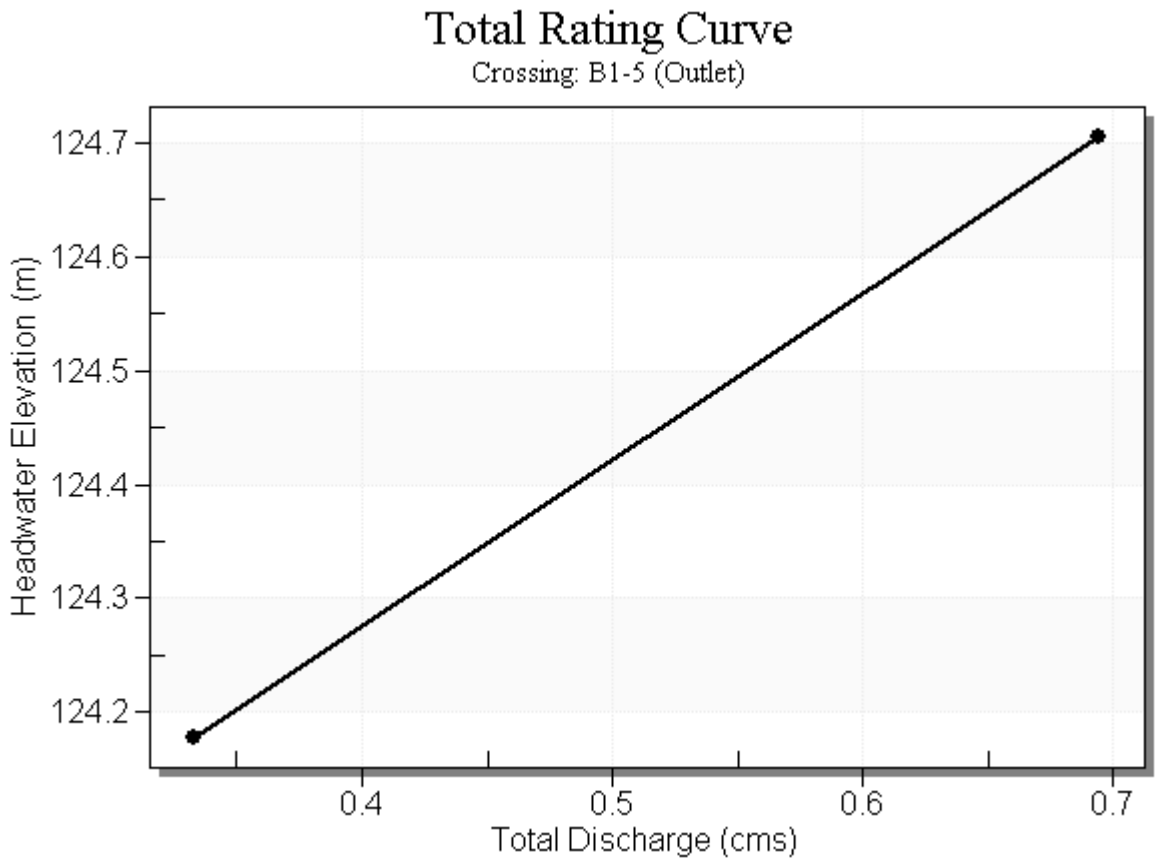


Table 5 - Culvert Summary Table: 2 x 450

Discharge Names	Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)
5 year	0.33	0.33	124.18	0.521	0.529	7-M2c	0.425	0.291	0.291	0.223	1.611
100 year	0.69	0.60	124.71	1.056	1.008	7-M2c	0.425	0.380	0.380	0.332	2.237

****

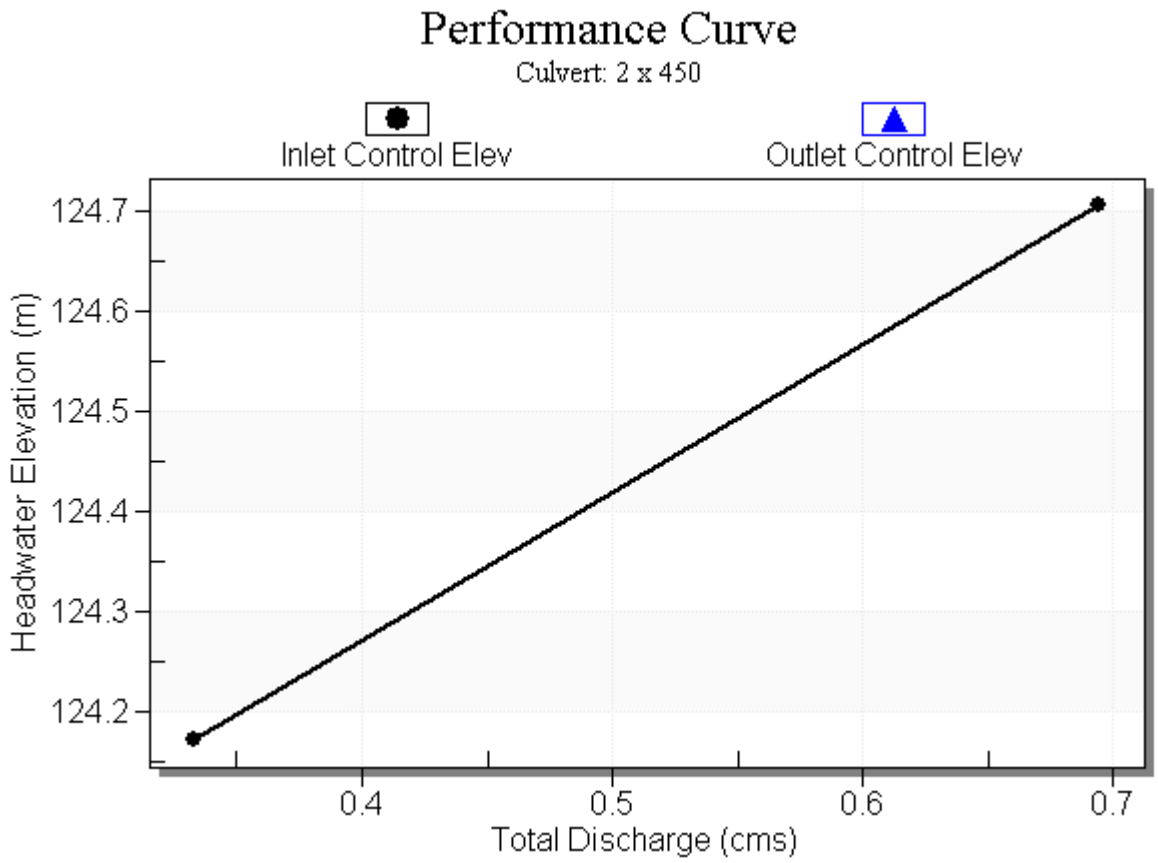
Straight Culvert

Inlet Elevation (invert): 123.65 m, Outlet Elevation (invert): 123.62 m

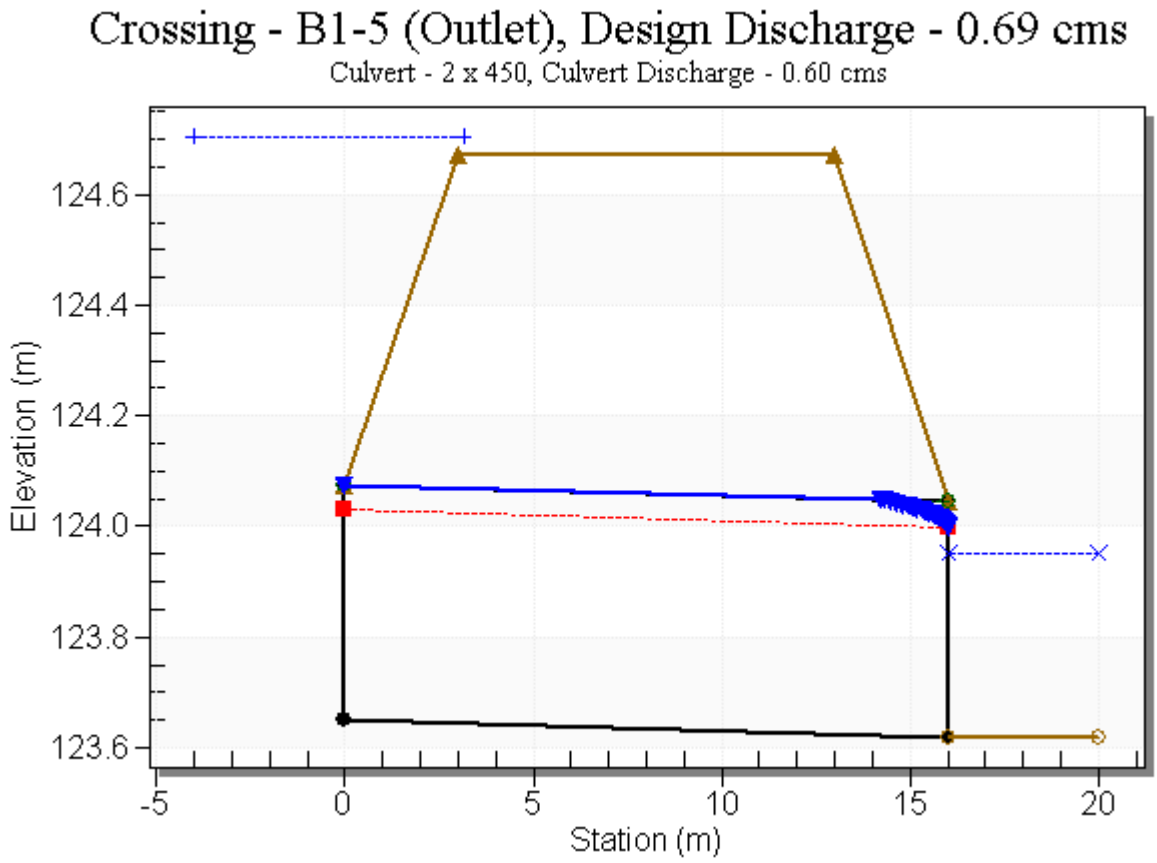
Culvert Length: 16.00 m, Culvert Slope: 0.0019

****

Culvert Performance Curve Plot: 2 x 450



Water Surface Profile Plot for Culvert: 2 x 450



Site Data - 2 x 450

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 123.65 m

Outlet Station: 16.00 m

Outlet Elevation: 123.62 m

Number of Barrels: 2

Culvert Data Summary - 2 x 450

Barrel Shape: Circular

Barrel Diameter: 425.00 mm

Barrel Material: Smooth HDPE

Embedment: 0.00 mm

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

Table 6 - Downstream Channel Rating Curve (Crossing: B1-5 (Outlet))

Flow (cms)	Water Surface Elev (m)	Depth (m)	Velocity (m/s)	Shear (Pa)	Froude Number
0.33	123.84	0.22	0.56	4.38	0.42
0.69	123.95	0.33	0.70	6.52	0.45

Tailwater Channel Data - B1-5 (Outlet)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 m

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0020

Channel Manning's n: 0.0250

Channel Invert Elevation: 123.62 m

Roadway Data for Crossing: B1-5 (Outlet)

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 10.00 m

Crest Elevation: 124.67 m

Roadway Surface: Gravel

Roadway Top Width: 10.00 m

CULVERT B1-6 (MIDPOINT)

Crossing Discharge Data

Discharge Selection Method: Recurrence

Table 7 - Summary of Culvert Flows at Crossing: B1-6 (MidPoint)

Headwater Elevation (m)	Discharge Names	Total Discharge (cms)	2 X 450 Discharge (cms)	Roadway Discharge (cms)	Iterations
124.08	5 year	0.40	0.40	0.00	1
124.29	100 year	0.84	0.54	0.31	6
124.21	Overtopping	0.49	0.49	0.00	Overtopping

Rating Curve Plot for Crossing: B1-6 (MidPoint)

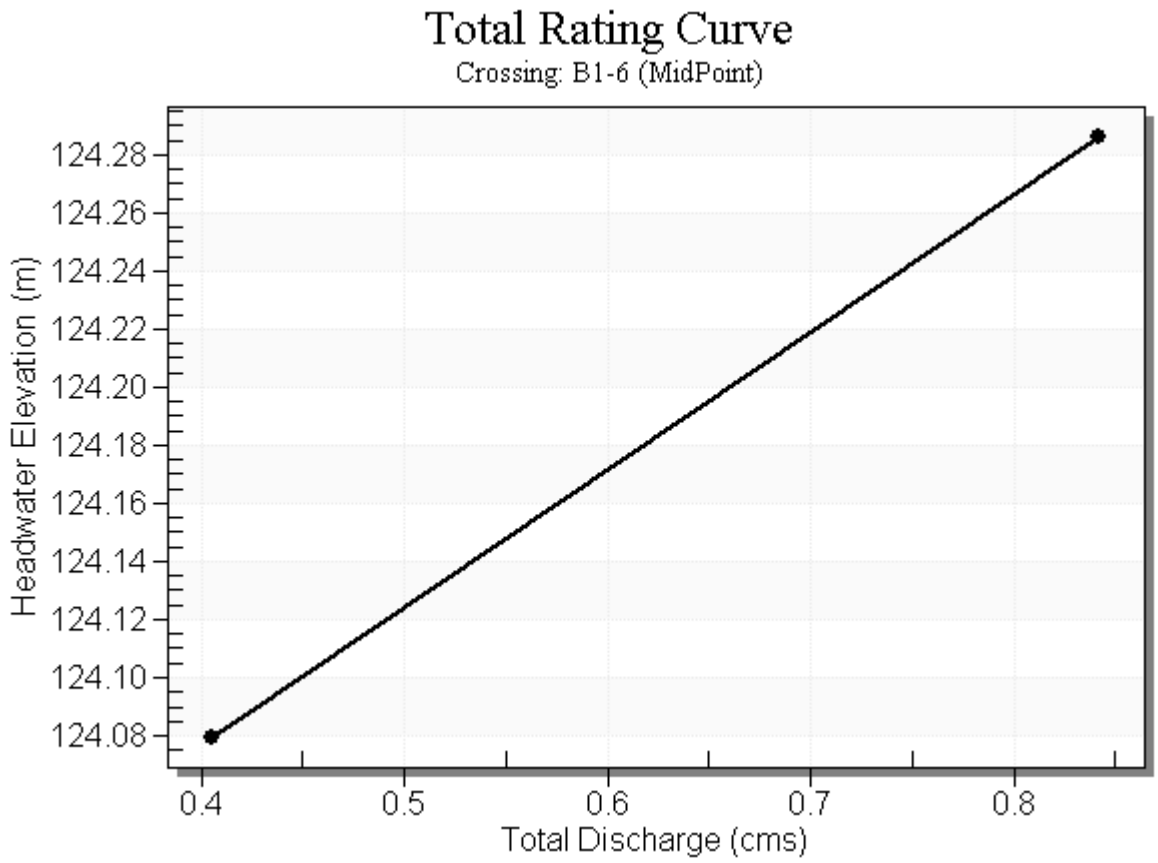


Table 8 - Culvert Summary Table: 2 X 450

Discharge Names	Total Discharge (cms)	Culvert Discharge (cms)	Headwater Elevation (m)	Inlet Control Depth (m)	Outlet Control Depth (m)	Flow Type	Normal Depth (m)	Critical Depth (m)	Outlet Depth (m)	Tailwater Depth (m)	Outlet Velocity (m/s)
5 year	0.40	0.40	124.08	0.580	0.579	7-M2c	0.450	0.316	0.316	0.298	1.697
100 year	0.84	0.54	124.29	0.786	0.794	7-M2t	0.450	0.363	0.439	0.439	1.696

****

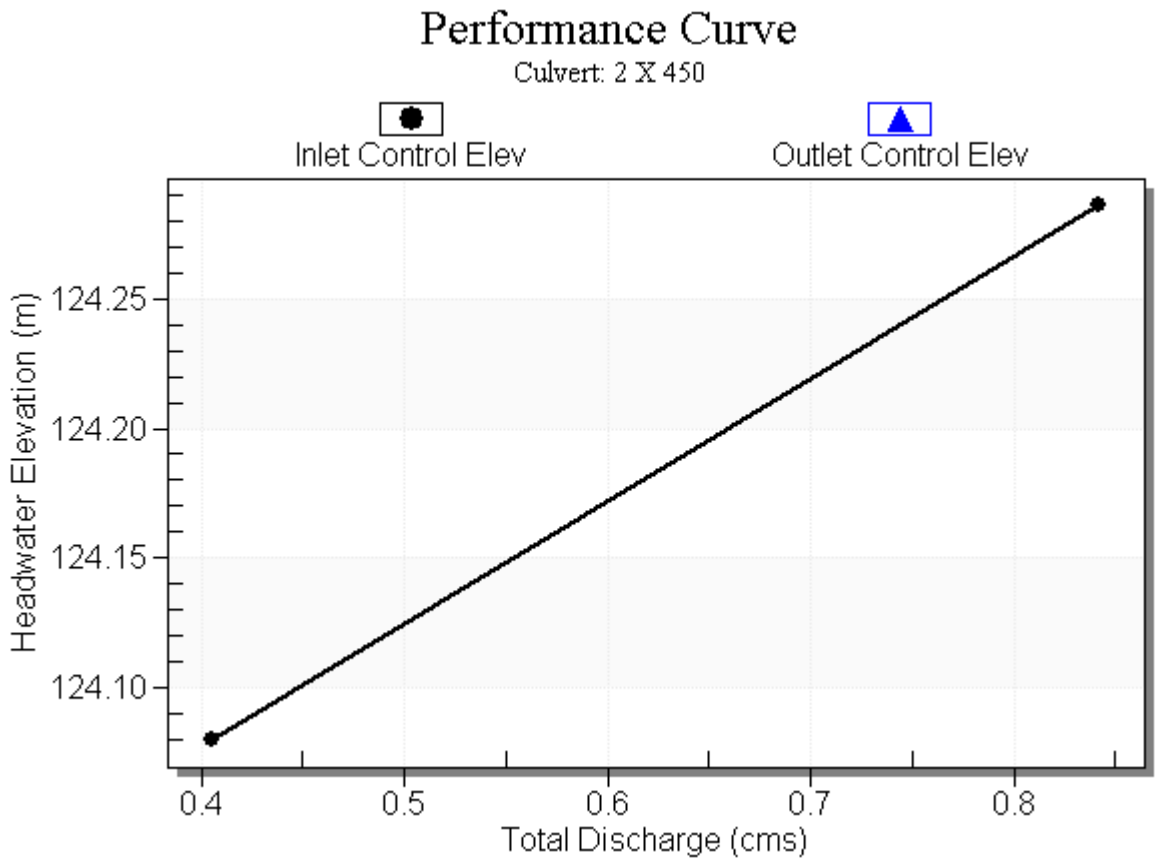
Straight Culvert

Inlet Elevation (invert): 123.50 m, Outlet Elevation (invert): 123.47 m

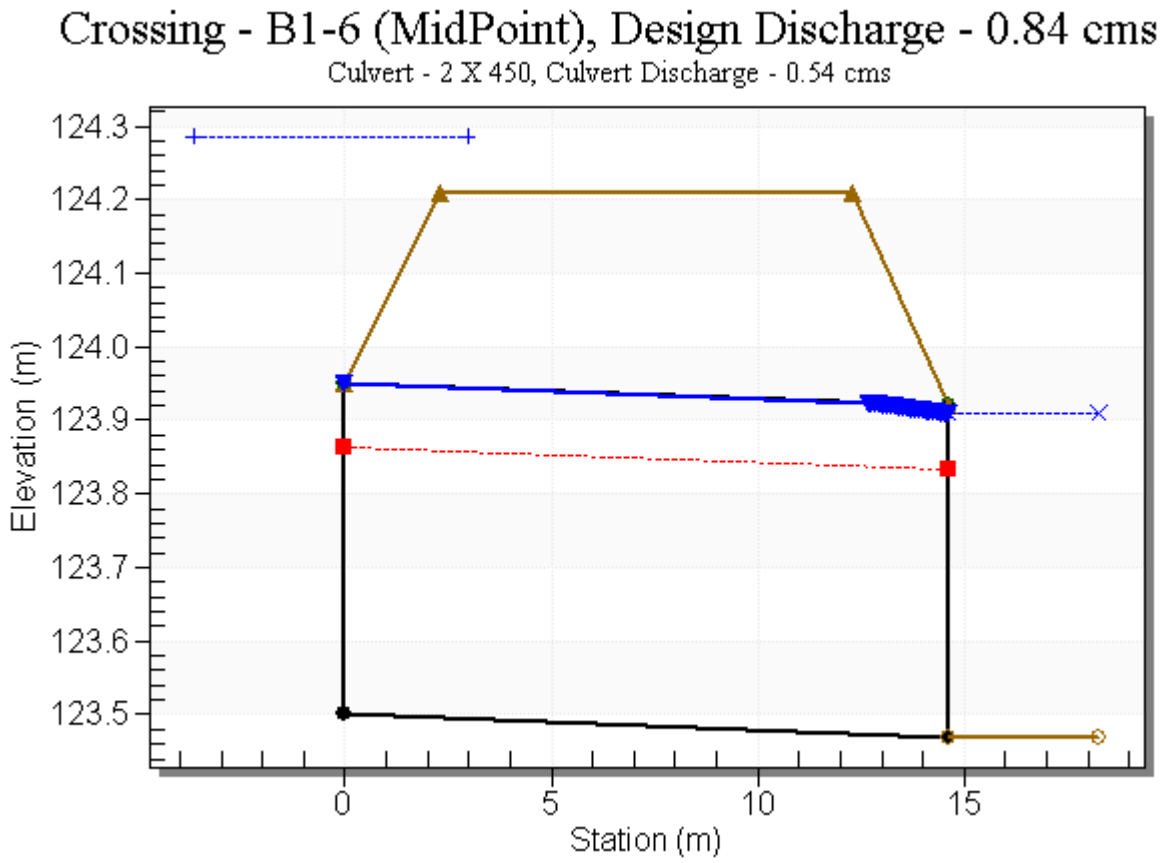
Culvert Length: 14.60 m, Culvert Slope: 0.0021

****

Culvert Performance Curve Plot: 2 X 450



Water Surface Profile Plot for Culvert: 2 X 450



Site Data - 2 X 450

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 m

Inlet Elevation: 123.50 m

Outlet Station: 14.60 m

Outlet Elevation: 123.47 m

Number of Barrels: 2

Culvert Data Summary - 2 X 450

Barrel Shape: Circular

Barrel Diameter: 450.00 mm

Barrel Material: Smooth HDPE

Embedment: 0.00 mm

Barrel Manning's n: 0.0120

Culvert Type: Straight

Inlet Configuration: Thin Edge Projecting

Inlet Depression: None

Table 9 - Downstream Channel Rating Curve (Crossing: B1-6 (MidPoint))

Flow (cms)	Water Surface Elev (m)	Depth (m)	Velocity (m/s)	Shear (Pa)	Froude Number
0.40	123.77	0.30	0.47	5.85	0.31
0.84	123.91	0.44	0.58	8.60	0.33

Tailwater Channel Data - B1-6 (MidPoint)

Tailwater Channel Option: Trapezoidal Channel

Bottom Width: 2.00 m

Side Slope (H:V): 3.00 (_:1)

Channel Slope: 0.0020

Channel Manning's n: 0.0350

Channel Invert Elevation: 123.47 m

Roadway Data for Crossing: B1-6 (MidPoint)

Roadway Profile Shape: Constant Roadway Elevation

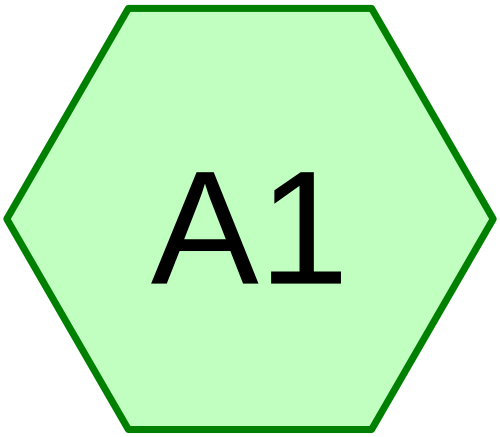
Crest Length: 10.00 m

Crest Elevation: 124.21 m

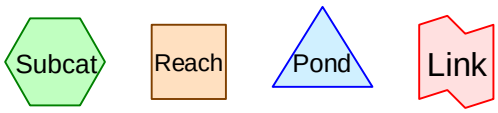
Roadway Surface: Gravel

Roadway Top Width: 10.00 m

B HYDROCAD MODEL OUTPUTS



Pre-Dev (Site)



Routing Diagram for 191-08574-02 - PreDev
Prepared by WSP Canada Inc., Printed 10/13/2021

Area Listing (all nodes)

Area (hectares)	C	Description (subcatchment-numbers)
0.6852	0.90	Asphalt / Concrete (A1)
0.4098	0.90	Building (A1)
17.2570	0.25	Grass (A1)
0.9275	0.80	Gravel (A1)
19.2795	**0.31**	**TOTAL AREA**

Summary for Subcatchment A1: Pre-Dev (Site)

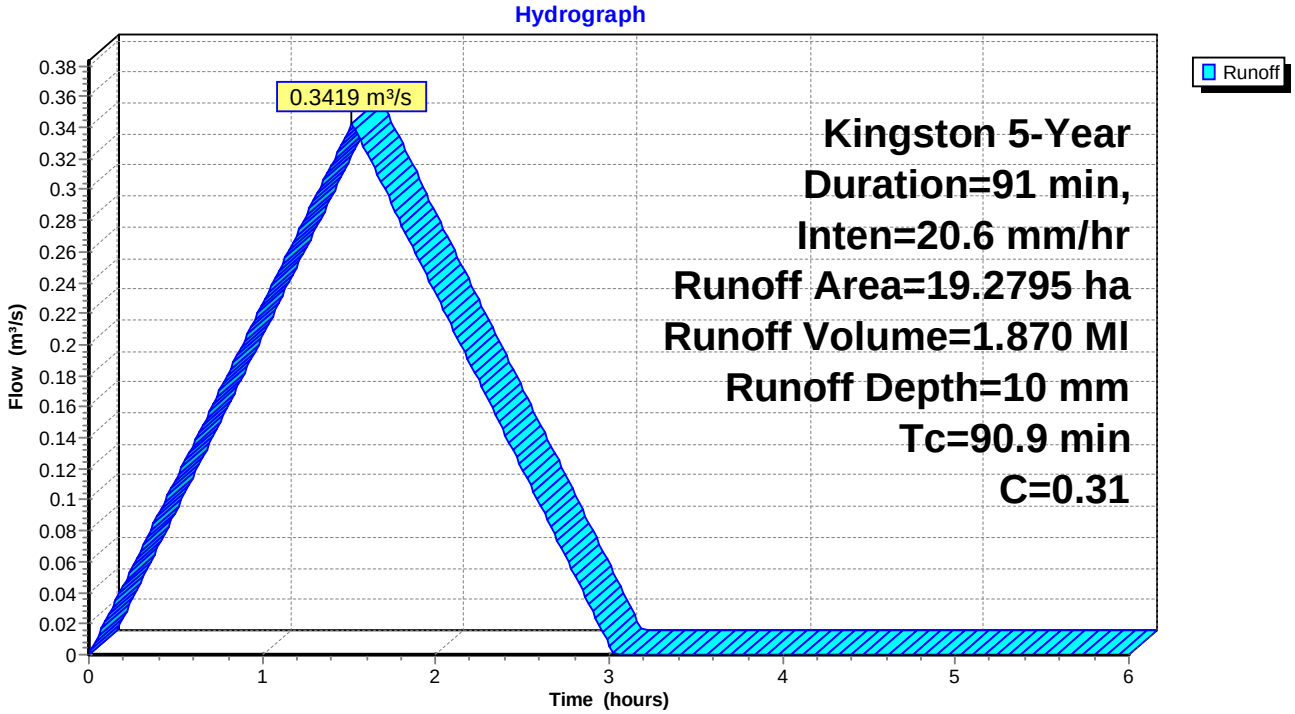
Runoff = 0.3419 m³/s @ 1.52 hrs, Volume= 1.870 Ml, Depth= 10 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=91 min, Inten=20.6 mm/hr

Area (ha)	C	Description
0.9275	0.80	Gravel
0.6852	0.90	Asphalt / Concrete
0.4098	0.90	Building
17.2570	0.25	Grass
19.2795	0.31	Weighted Average
19.2795		100.00% Pervious Area

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

Subcatchment A1: Pre-Dev (Site)



Summary for Subcatchment A1: Pre-Dev (Site)

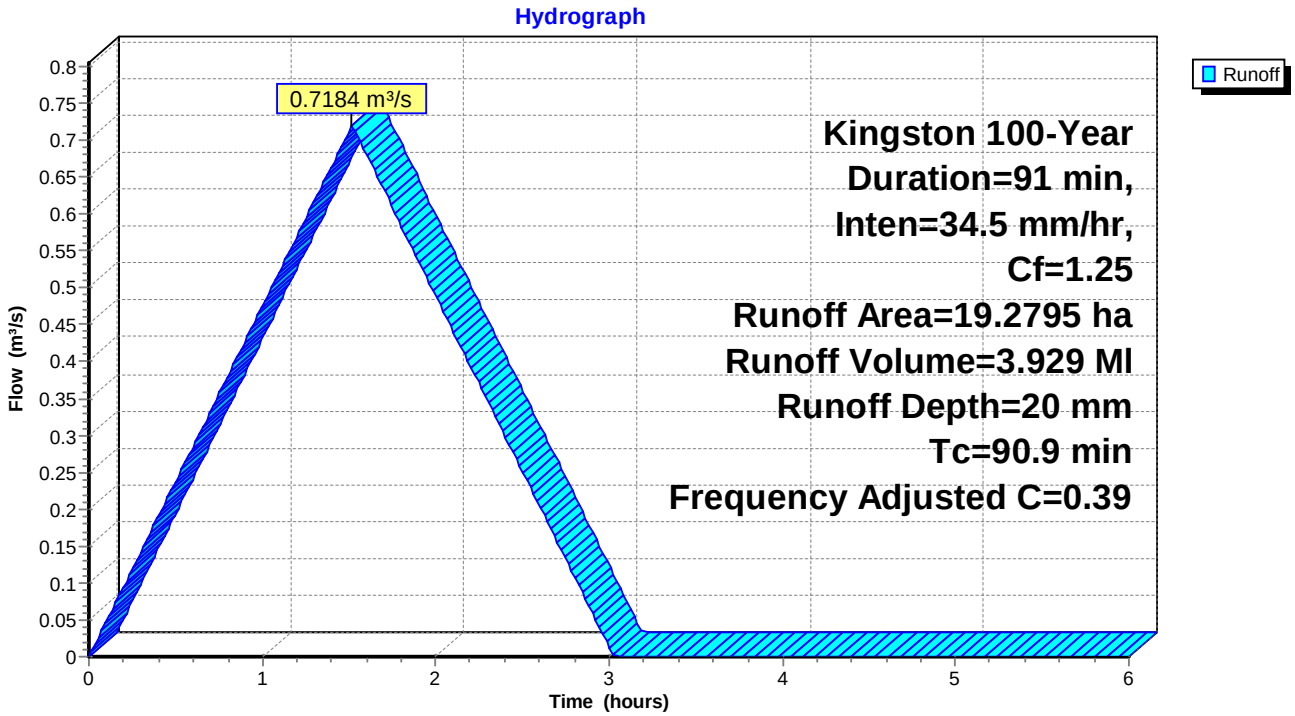
Runoff = 0.7184 m³/s @ 1.52 hrs, Volume= 3.929 Ml, Depth= 20 mm

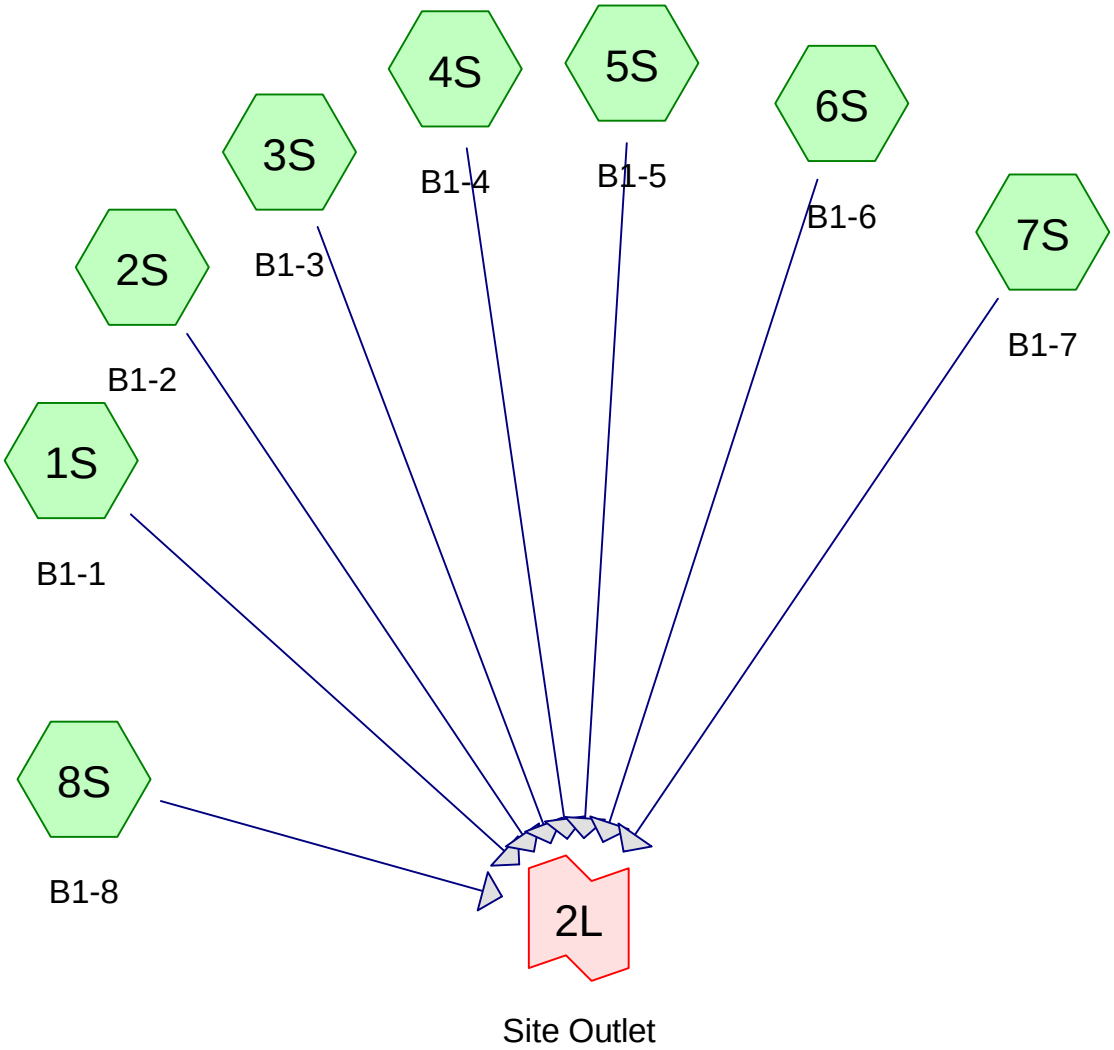
Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=91 min, Inten=34.5 mm/hr, Cf=1.25

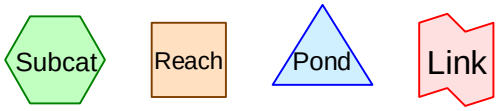
Area (ha)	C	Adj	Description
0.9275	0.80		Gravel
0.6852	0.90		Asphalt / Concrete
0.4098	0.90		Building
17.2570	0.25		Grass
19.2795	0.31	0.39	Weighted Average, Frequency Adjusted
19.2795			100.00% Pervious Area

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

Subcatchment A1: Pre-Dev (Site)







Routing Diagram for 191-08574-02 - PostDev_UNCTLD_v3
Prepared by WSP Canada Inc., Printed 10/13/2021
HydroCAD® 10.00-24 s/n 10698 © 2018 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (hectares)	C	Description (subcatchment-numbers)
0.8197	0.90	Asphalt / Concrete (2S, 3S, 4S, 5S, 6S, 7S)
14.2656	0.25	Grass (1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S)
2.6264	0.80	Gravel (1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S)
0.1513	0.01	Manure Tank (3S, 7S)
1.4239	0.90	Roof (1S, 2S, 3S, 4S, 5S, 6S, 7S)
19.2869	**0.40**	**TOTAL AREA**

Summary for Subcatchment 1S: B1-1

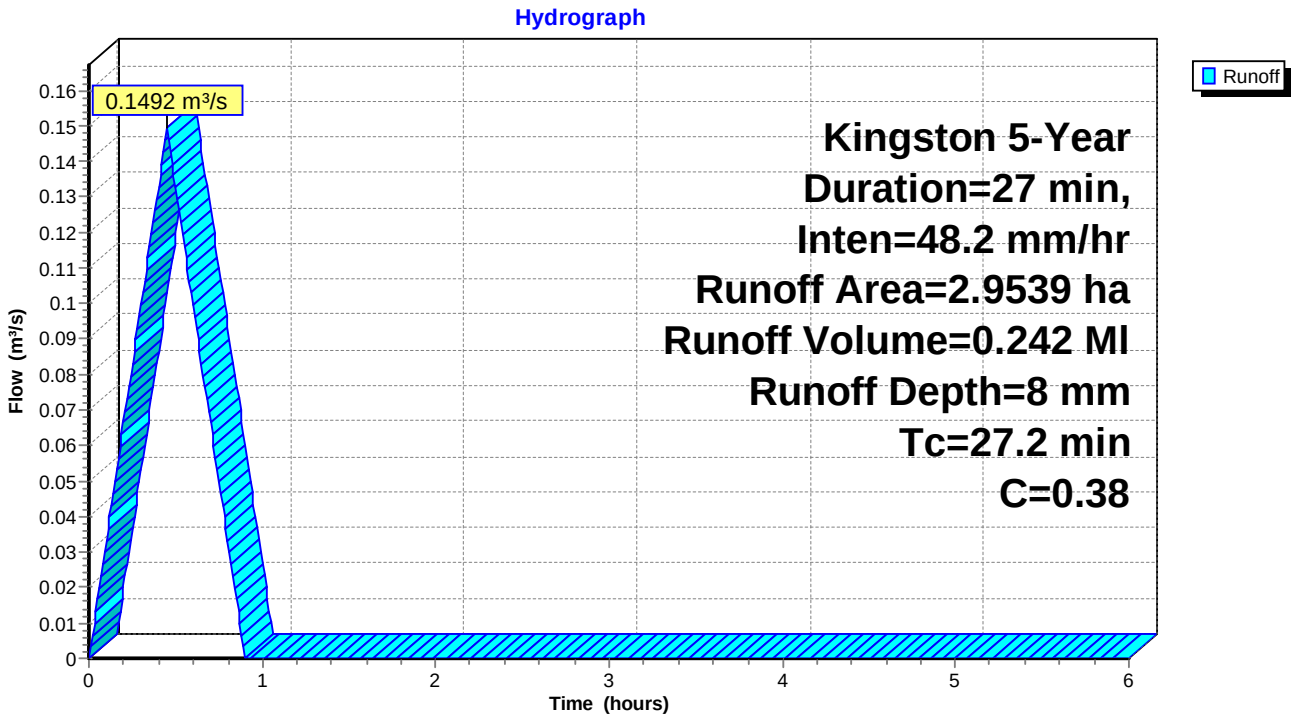
Runoff = 0.1492 m³/s @ 0.45 hrs, Volume= 0.242 Ml, Depth= 8 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=27 min, Inten=48.2 mm/hr

Area (ha)	C	Description
0.5181	0.80	Gravel
0.0000	0.90	Asphalt / Concrete
0.0000	0.01	Manure Tank
0.1539	0.90	Roof
2.2819	0.25	Grass
2.9539	0.38	Weighted Average
2.9539		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Per Ditch Design Sheet**

Subcatchment 1S: B1-1



Summary for Subcatchment 2S: B1-2

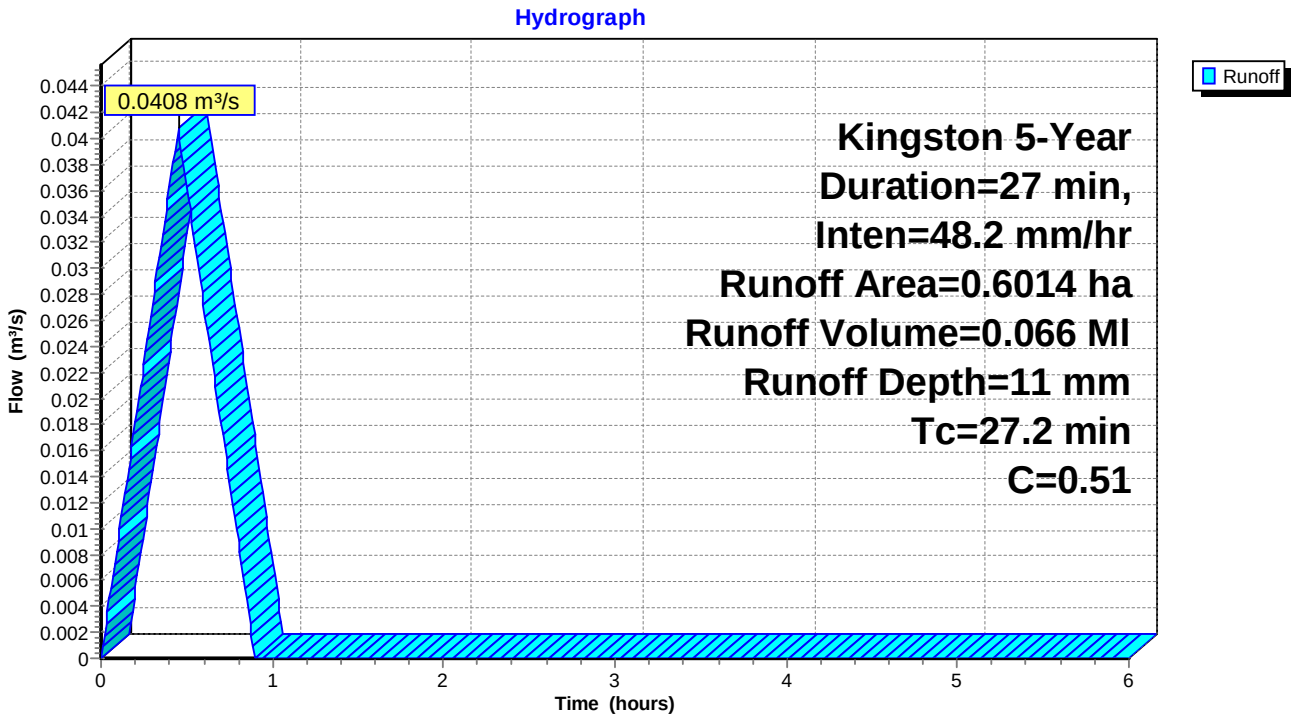
Runoff = 0.0408 m³/s @ 0.45 hrs, Volume= 0.066 Ml, Depth= 11 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=27 min, Inten=48.2 mm/hr

Area (ha)	C	Description
0.1347	0.80	Gravel
0.0046	0.90	Asphalt / Concrete
0.0000	0.01	Manure Tank
0.1175	0.90	Roof
0.3446	0.25	Grass
0.6014	0.51	Weighted Average
0.6014		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 2S: B1-2



Summary for Subcatchment 3S: B1-3

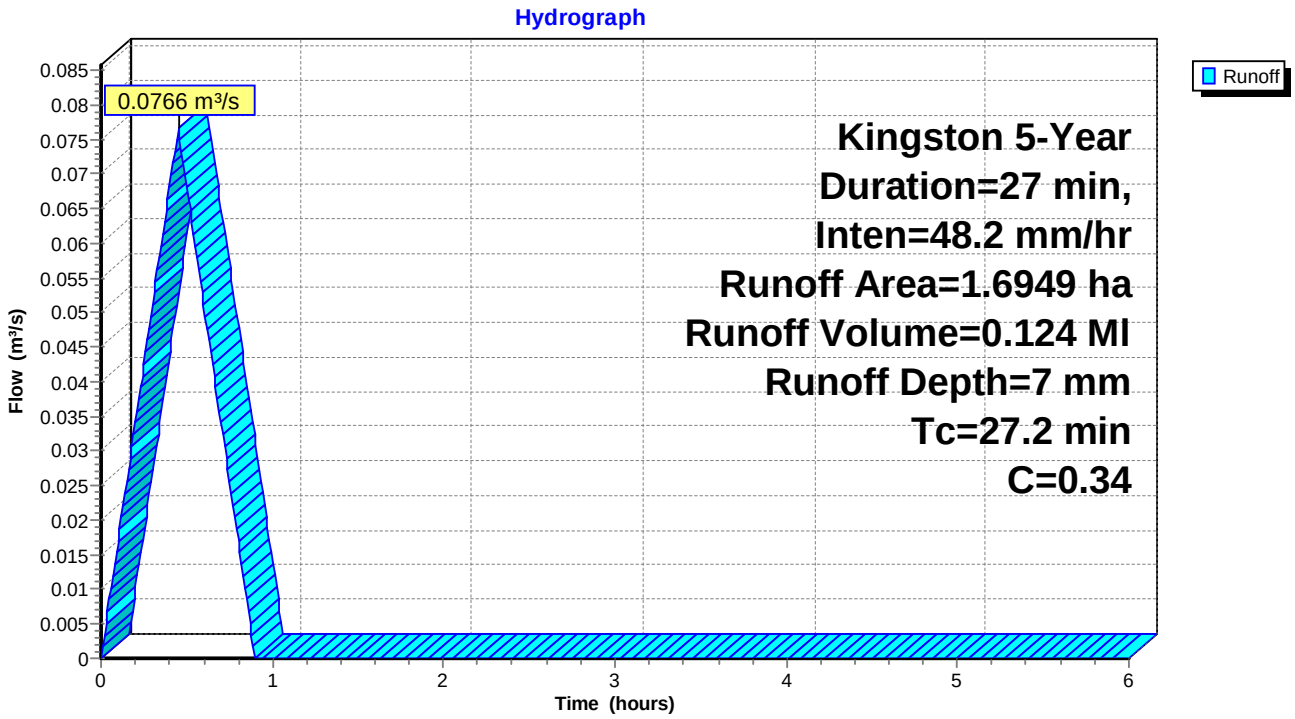
Runoff = 0.0766 m³/s @ 0.45 hrs, Volume= 0.124 Ml, Depth= 7 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=27 min, Inten=48.2 mm/hr

Area (ha)	C	Description
0.2254	0.80	Gravel
0.0070	0.90	Asphalt / Concrete
0.1239	0.01	Manure Tank
0.0809	0.90	Roof
1.2577	0.25	Grass
1.6949	0.34	Weighted Average
1.6949		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 3S: B1-3



Summary for Subcatchment 4S: B1-4

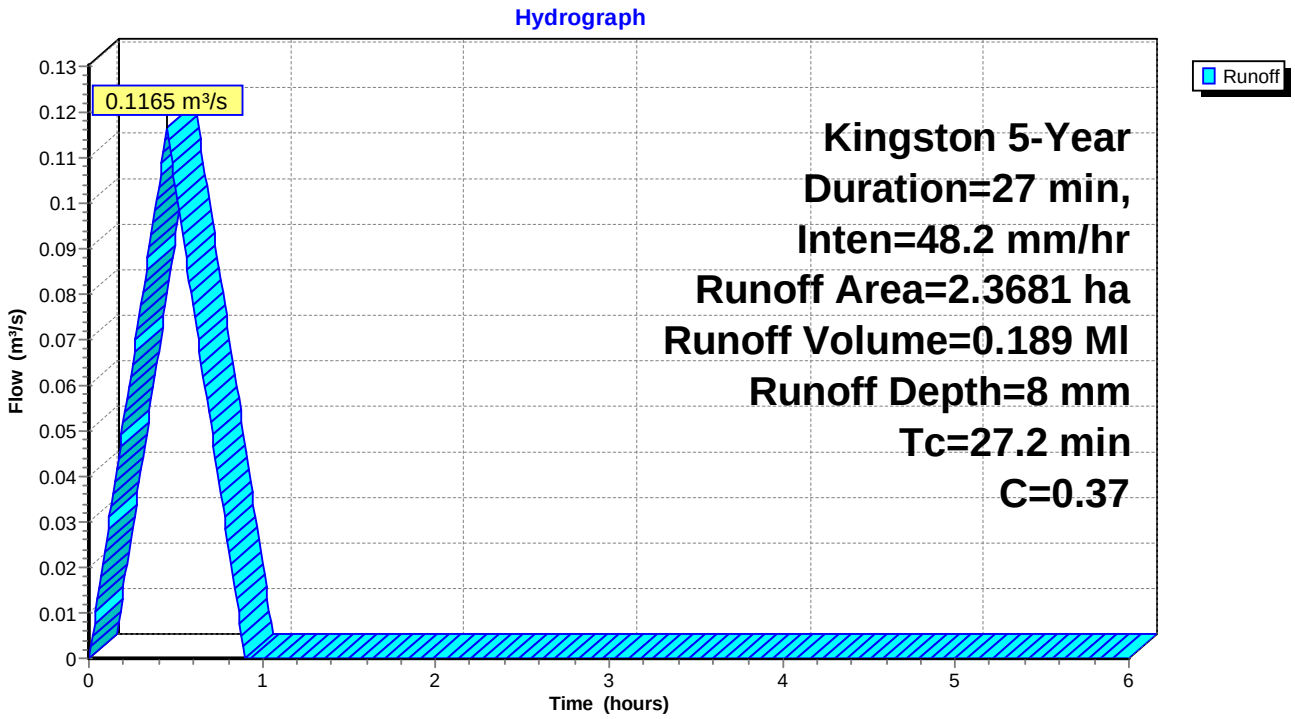
Runoff = 0.1165 m³/s @ 0.45 hrs, Volume= 0.189 Ml, Depth= 8 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=27 min, Inten=48.2 mm/hr

Area (ha)	C	Description
0.3290	0.80	Gravel
0.0268	0.90	Asphalt / Concrete
0.0000	0.01	Manure Tank
0.1249	0.90	Roof
1.8874	0.25	Grass
2.3681	0.37	Weighted Average
2.3681		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 4S: B1-4



Summary for Subcatchment 5S: B1-5

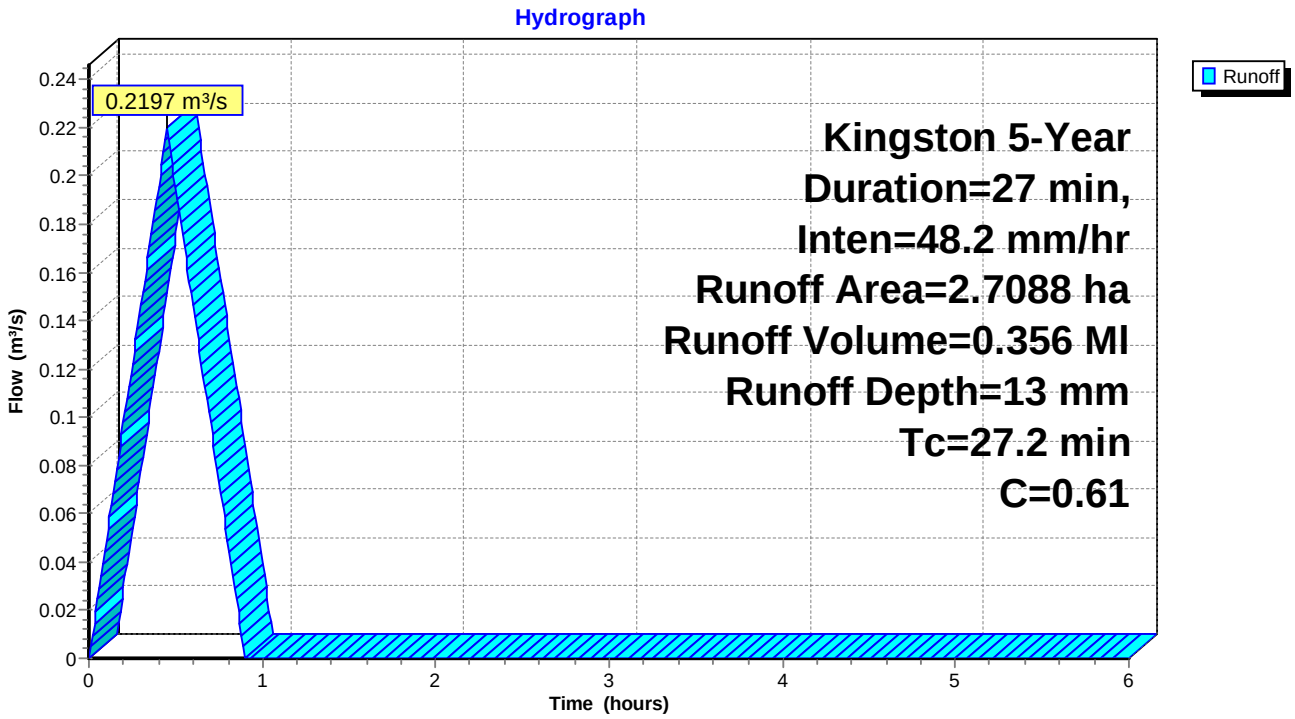
Runoff = 0.2197 m³/s @ 0.45 hrs, Volume= 0.356 Ml, Depth= 13 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=27 min, Inten=48.2 mm/hr

Area (ha)	C	Description
0.3775	0.80	Gravel
0.7307	0.90	Asphalt / Concrete
0.0000	0.01	Manure Tank
0.4356	0.90	Roof
1.1650	0.25	Grass
2.7088	0.61	Weighted Average
2.7088		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 5S: B1-5



Summary for Subcatchment 6S: B1-6

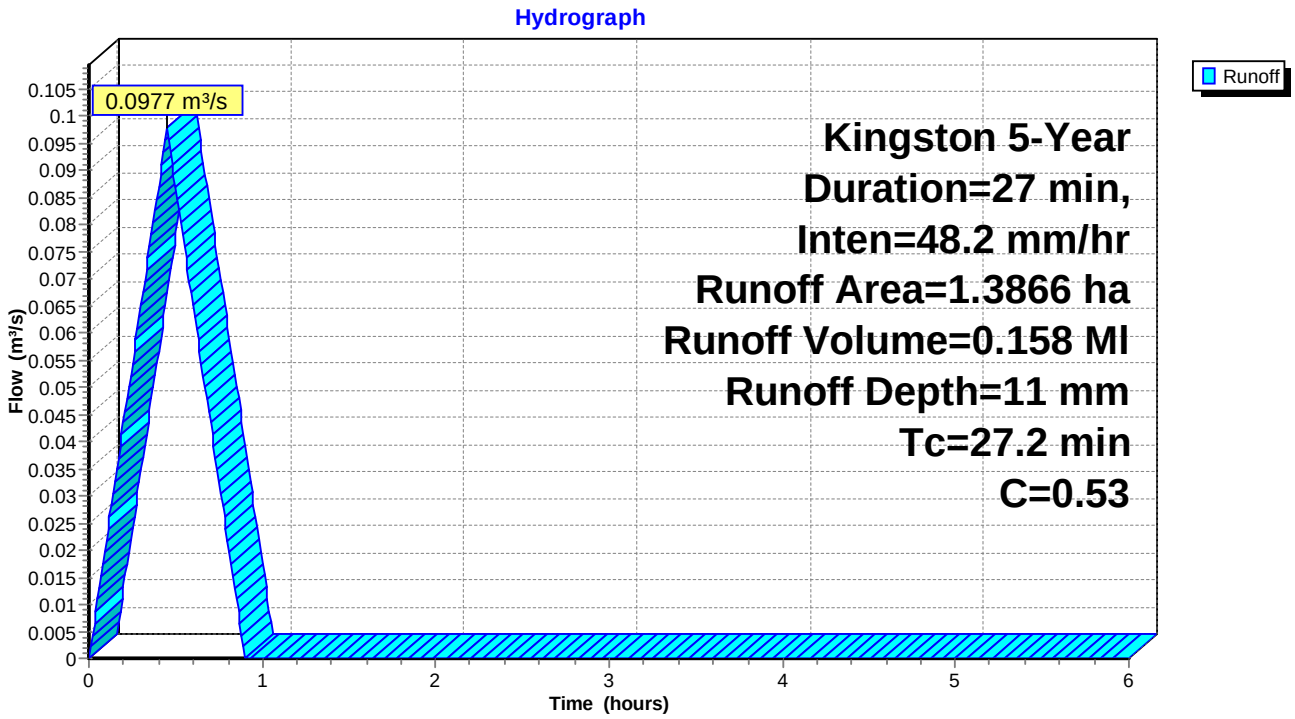
Runoff = 0.0977 m³/s @ 0.45 hrs, Volume= 0.158 Ml, Depth= 11 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=27 min, Inten=48.2 mm/hr

Area (ha)	C	Description
0.4917	0.80	Gravel
0.0289	0.90	Asphalt / Concrete
0.0000	0.01	Manure Tank
0.1561	0.90	Roof
0.7099	0.25	Grass
1.3866	0.53	Weighted Average
1.3866		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 6S: B1-6



Summary for Subcatchment 7S: B1-7

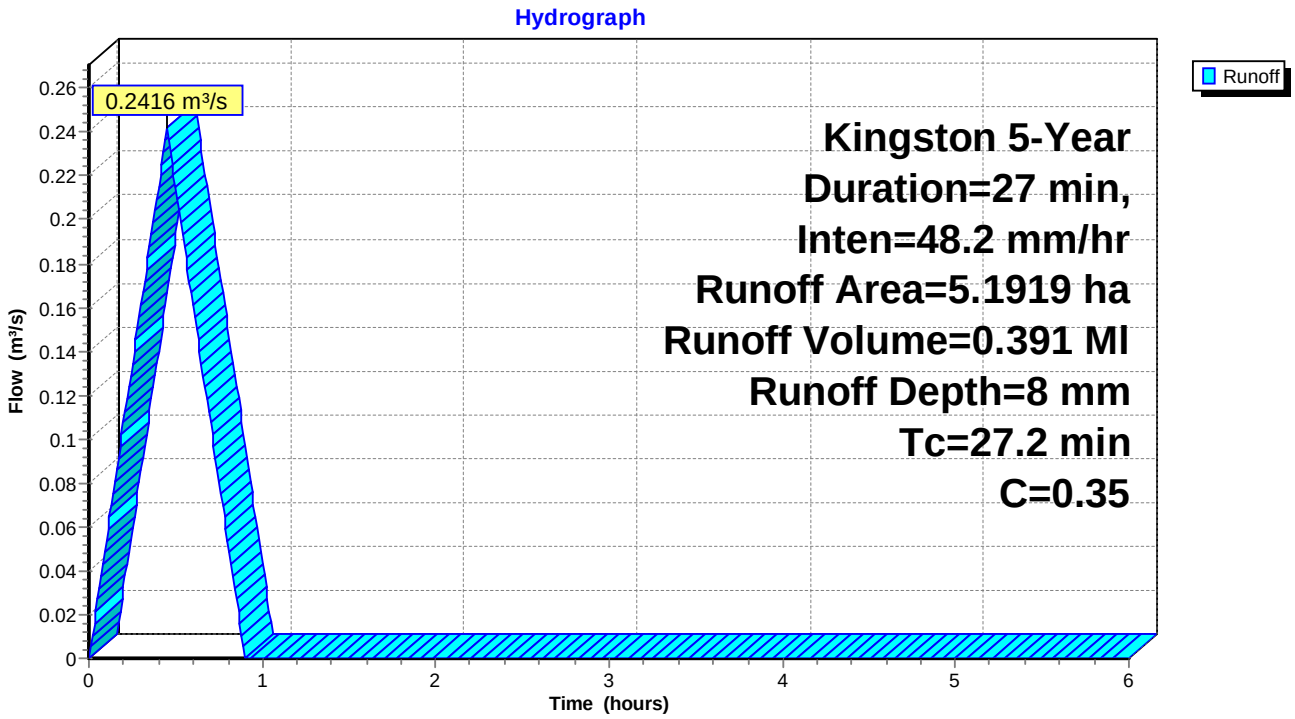
Runoff = 0.2416 m³/s @ 0.45 hrs, Volume= 0.391 Ml, Depth= 8 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=27 min, Inten=48.2 mm/hr

Area (ha)	C	Description
0.4987	0.80	Gravel
0.0217	0.90	Asphalt / Concrete
0.0274	0.01	Manure Tank
0.3550	0.90	Roof
4.2891	0.25	Grass
5.1919	0.35	Weighted Average
5.1919		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 7S: B1-7



Summary for Subcatchment 8S: B1-8

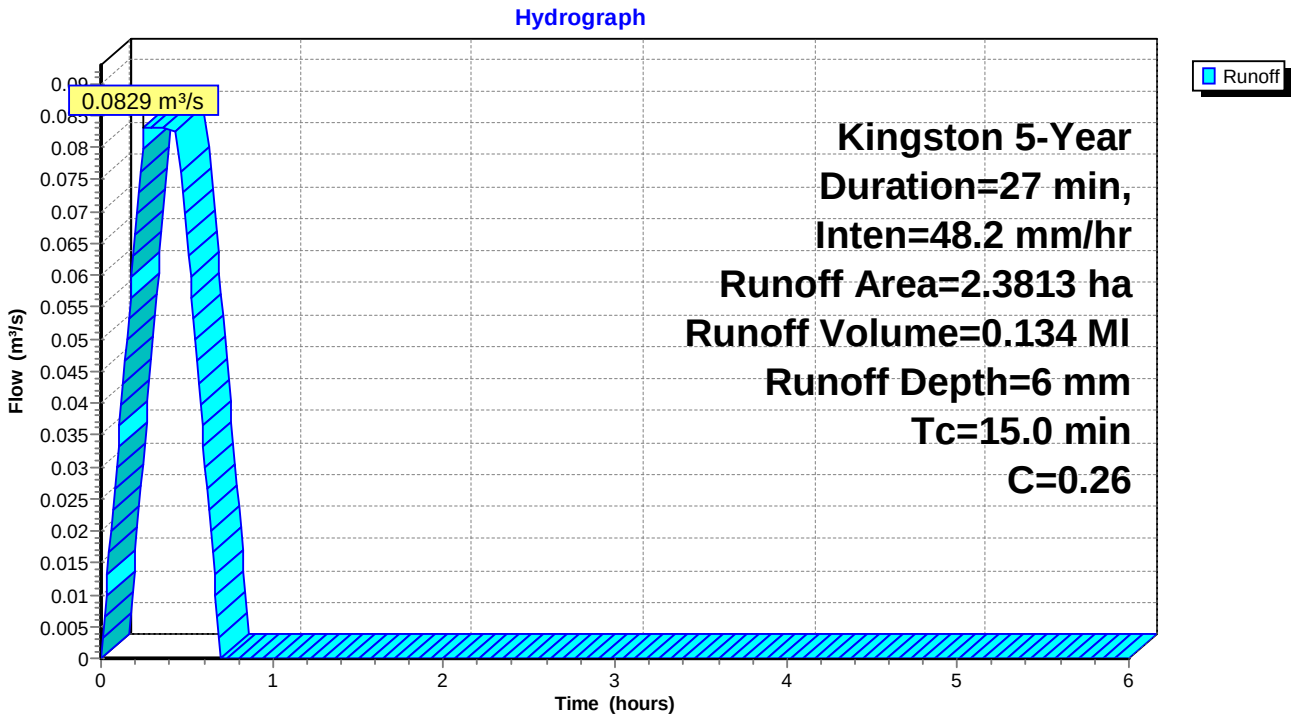
Runoff = 0.0829 m³/s @ 0.25 hrs, Volume= 0.134 Ml, Depth= 6 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=27 min, Inten=48.2 mm/hr

Area (ha)	C	Description
0.0513	0.80	Gravel
0.0000	0.90	Asphalt/Concrete
0.0000	0.01	Manure Tank
0.0000	0.90	Roof
2.3300	0.25	Grass
2.3813	0.26	Weighted Average
2.3813		100.00% Pervious Area

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

Subcatchment 8S: B1-8

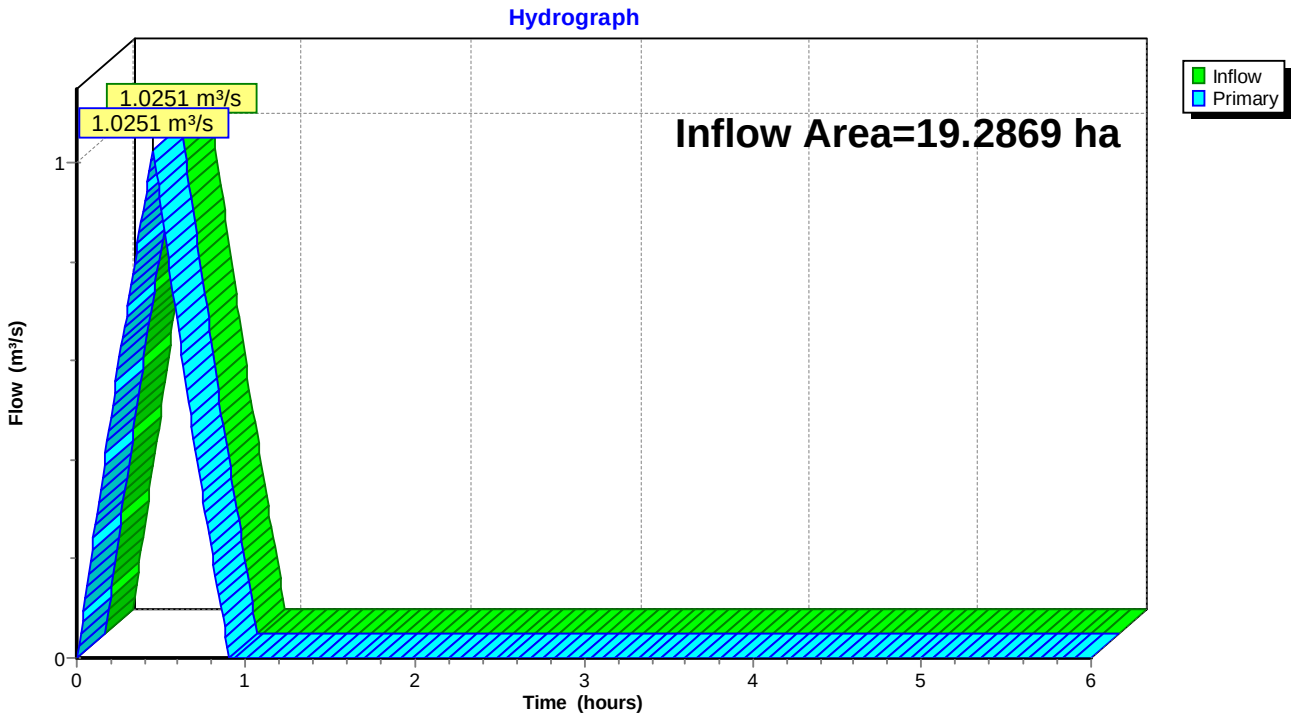


Summary for Link 2L: Site Outlet

Inflow Area = 19.2869 ha, 0.00% Impervious, Inflow Depth = 9 mm for 5-Year event
Inflow = 1.0251 m³/s @ 0.45 hrs, Volume= 1.661 Ml
Primary = 1.0251 m³/s @ 0.45 hrs, Volume= 1.661 Ml, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs

Link 2L: Site Outlet



Summary for Subcatchment 1S: B1-1

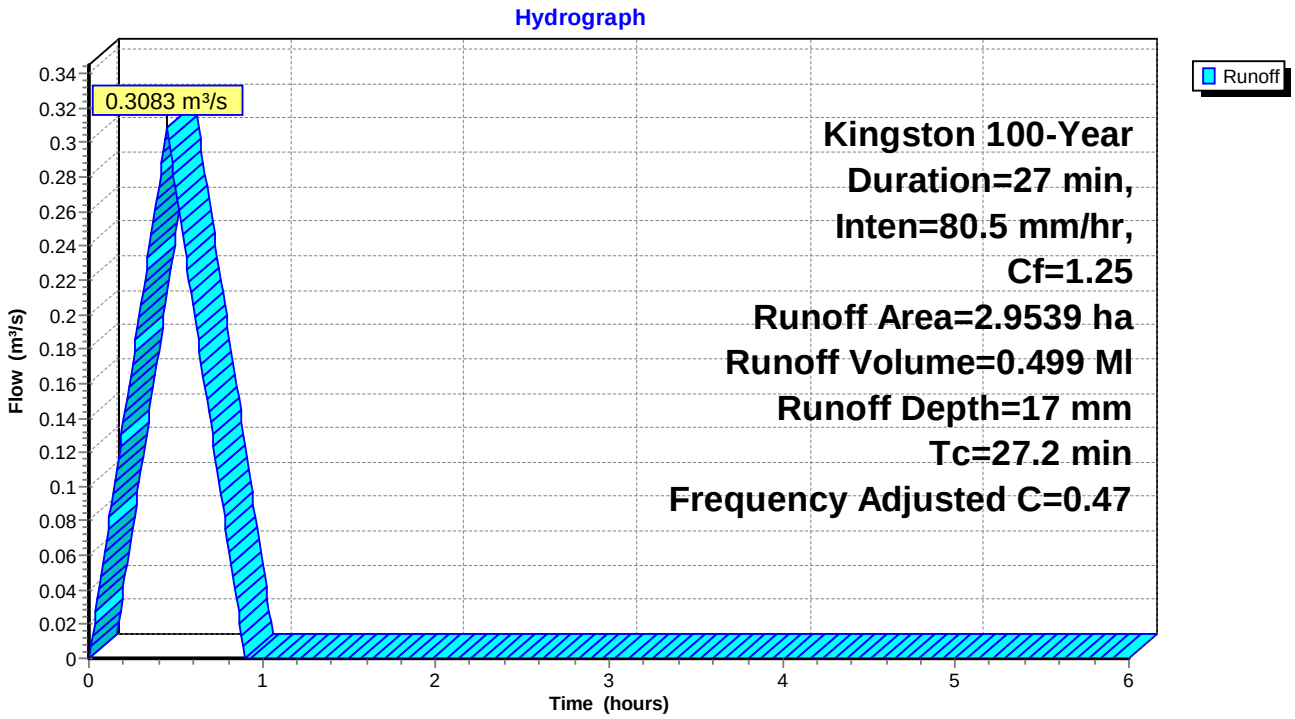
Runoff = 0.3083 m³/s @ 0.45 hrs, Volume= 0.499 Ml, Depth= 17 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=27 min, Inten=80.5 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.5181	0.80		Gravel
0.0000	0.90		Asphalt / Concrete
0.0000	0.01		Manure Tank
0.1539	0.90		Roof
2.2819	0.25		Grass
2.9539	0.38	0.47	Weighted Average, Frequency Adjusted
2.9539			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Per Ditch Design Sheet**

Subcatchment 1S: B1-1



Summary for Subcatchment 2S: B1-2

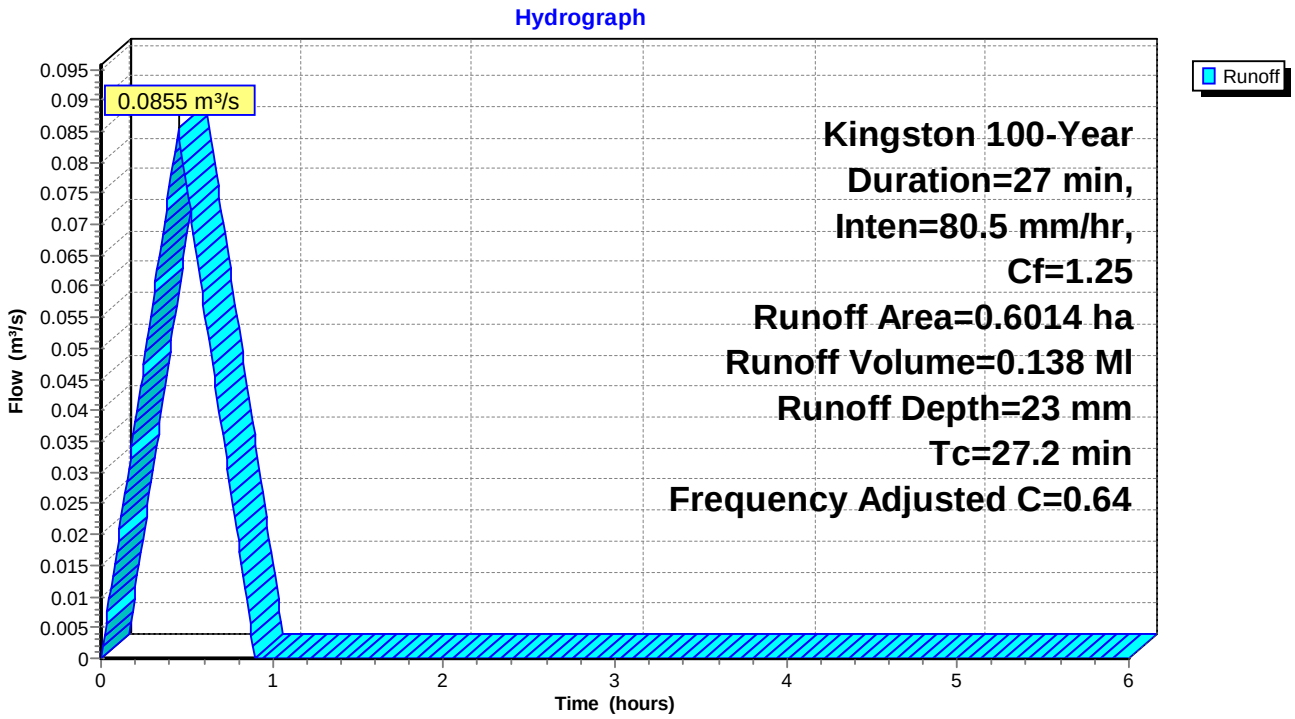
Runoff = 0.0855 m³/s @ 0.45 hrs, Volume= 0.138 Ml, Depth= 23 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=27 min, Inten=80.5 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.1347	0.80		Gravel
0.0046	0.90		Asphalt / Concrete
0.0000	0.01		Manure Tank
0.1175	0.90		Roof
0.3446	0.25		Grass
0.6014	0.51	0.64	Weighted Average, Frequency Adjusted
0.6014			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 2S: B1-2



Summary for Subcatchment 3S: B1-3

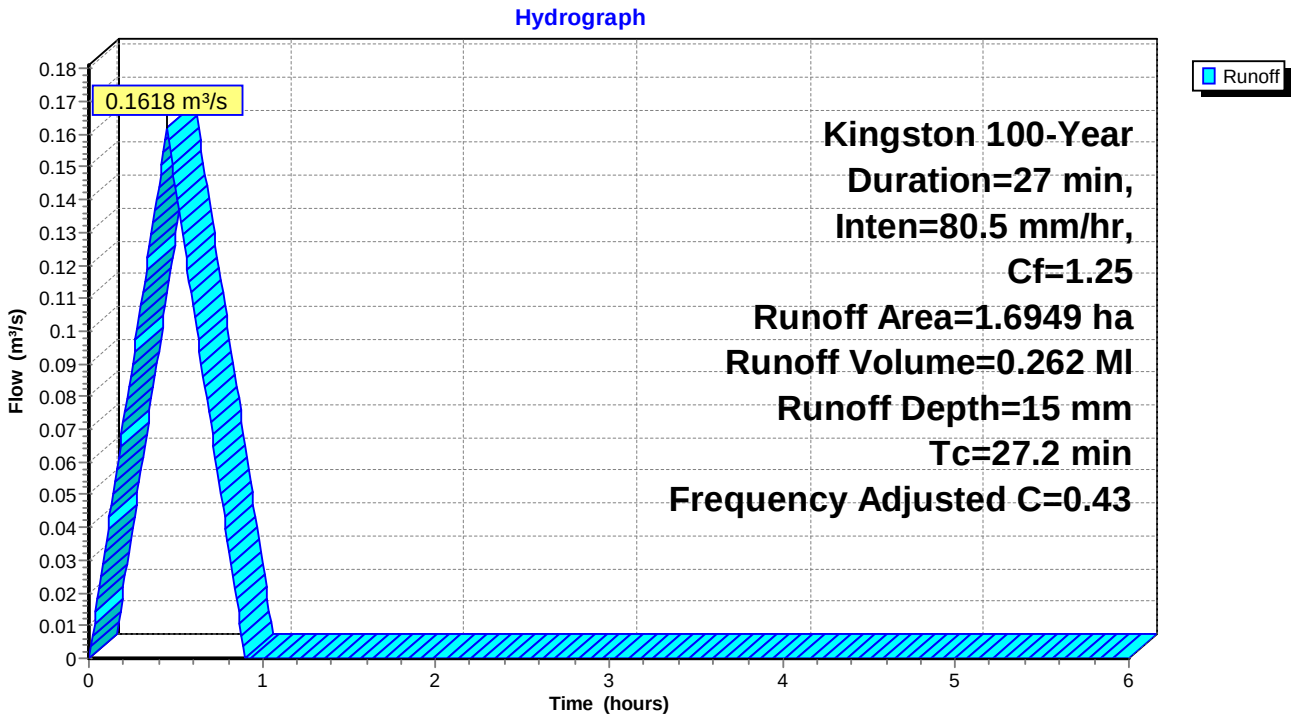
Runoff = 0.1618 m³/s @ 0.45 hrs, Volume= 0.262 Ml, Depth= 15 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=27 min, Inten=80.5 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.2254	0.80		Gravel
0.0070	0.90		Asphalt / Concrete
0.1239	0.01		Manure Tank
0.0809	0.90		Roof
1.2577	0.25		Grass
1.6949	0.34	0.43	Weighted Average, Frequency Adjusted
1.6949			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 3S: B1-3



Summary for Subcatchment 4S: B1-4

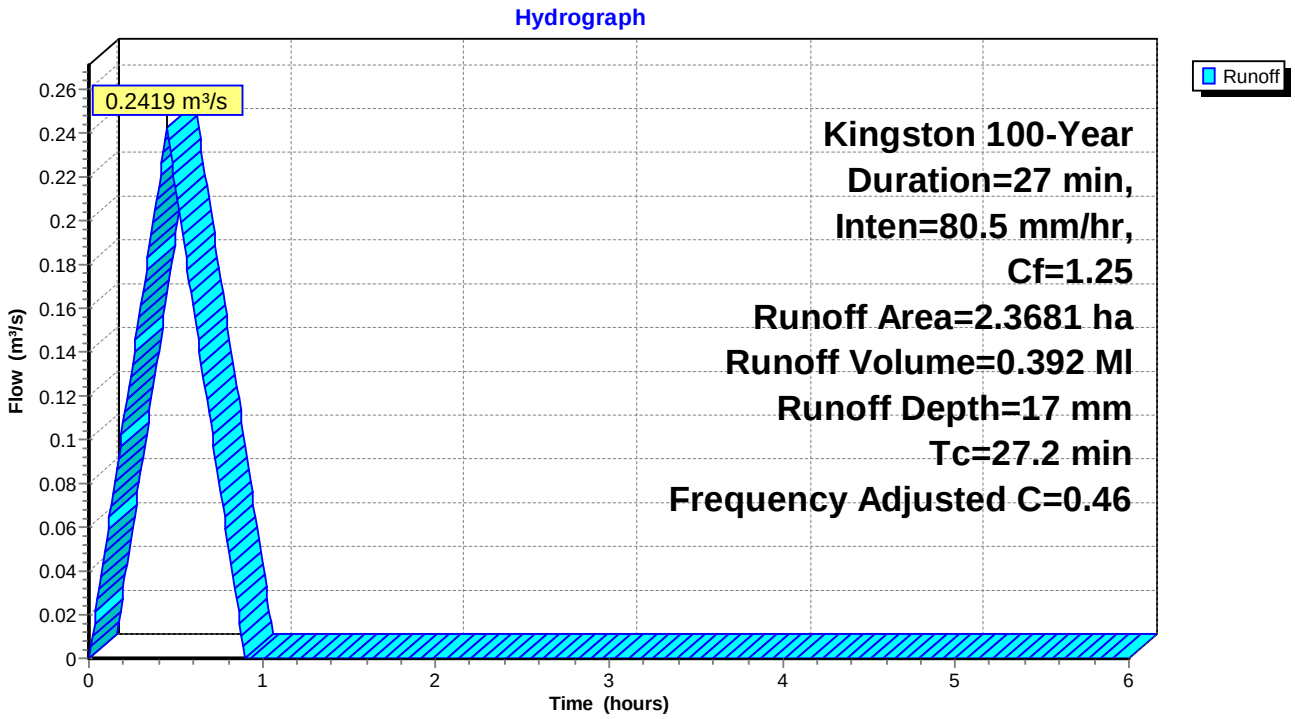
Runoff = 0.2419 m³/s @ 0.45 hrs, Volume= 0.392 Ml, Depth= 17 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=27 min, Inten=80.5 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.3290	0.80		Gravel
0.0268	0.90		Asphalt / Concrete
0.0000	0.01		Manure Tank
0.1249	0.90		Roof
1.8874	0.25		Grass
2.3681	0.37	0.46	Weighted Average, Frequency Adjusted
2.3681			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 4S: B1-4



Summary for Subcatchment 5S: B1-5

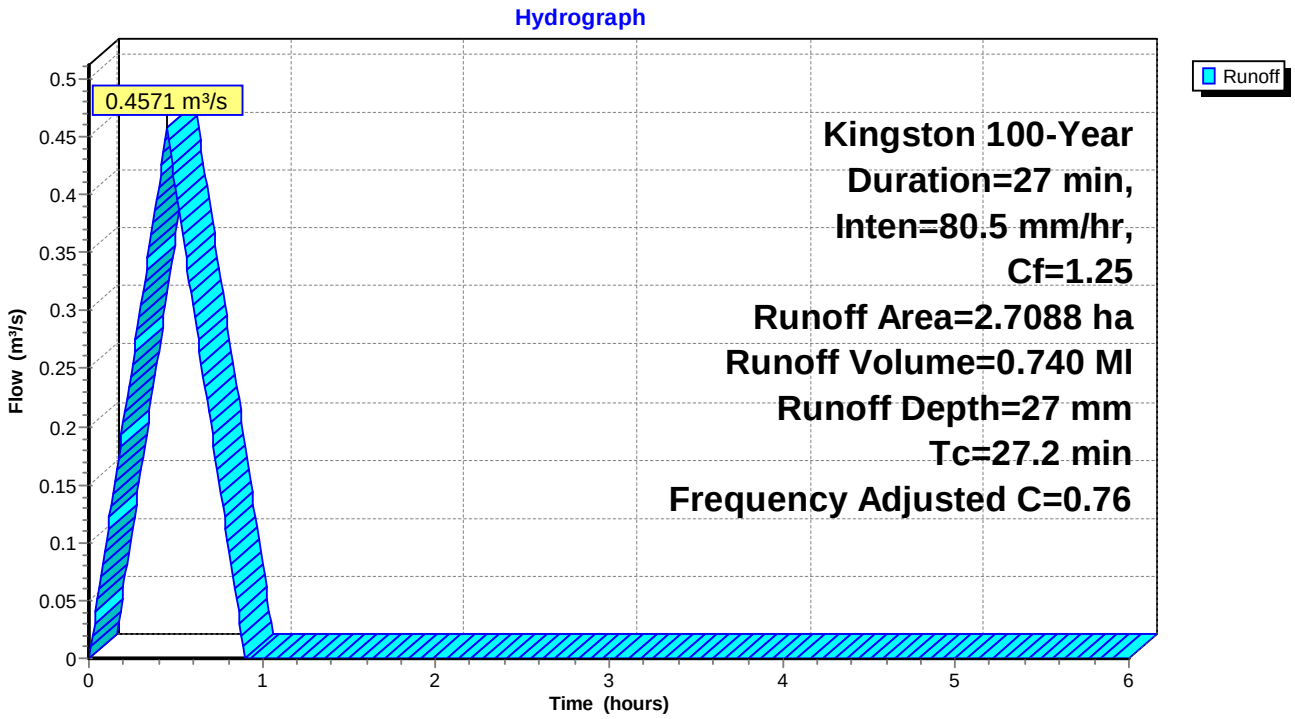
Runoff = 0.4571 m³/s @ 0.45 hrs, Volume= 0.740 Ml, Depth= 27 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=27 min, Inten=80.5 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.3775	0.80		Gravel
0.7307	0.90		Asphalt / Concrete
0.0000	0.01		Manure Tank
0.4356	0.90		Roof
1.1650	0.25		Grass
2.7088	0.61	0.76	Weighted Average, Frequency Adjusted
2.7088			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 5S: B1-5



Summary for Subcatchment 6S: B1-6

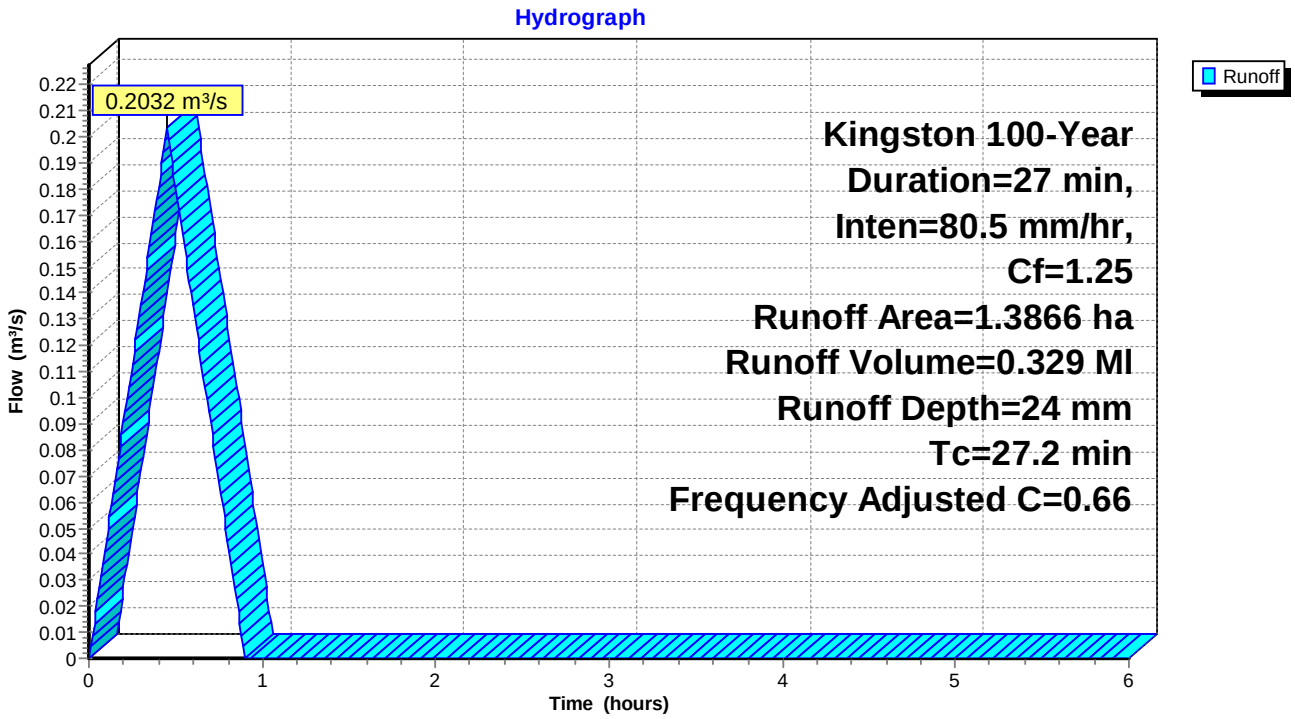
Runoff = 0.2032 m³/s @ 0.45 hrs, Volume= 0.329 Ml, Depth= 24 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=27 min, Inten=80.5 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.4917	0.80		Gravel
0.0289	0.90		Asphalt / Concrete
0.0000	0.01		Manure Tank
0.1561	0.90		Roof
0.7099	0.25		Grass
1.3866	0.53	0.66	Weighted Average, Frequency Adjusted
1.3866			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 6S: B1-6



Summary for Subcatchment 7S: B1-7

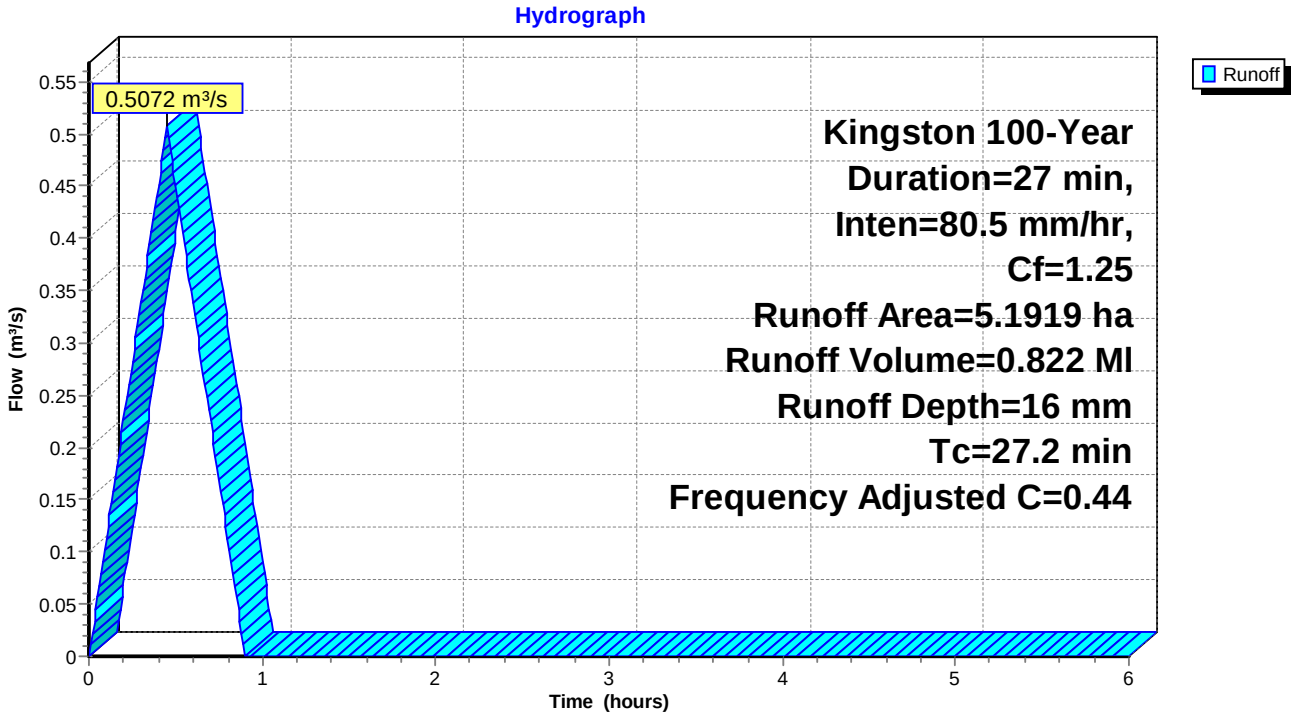
Runoff = 0.5072 m³/s @ 0.45 hrs, Volume= 0.822 Ml, Depth= 16 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=27 min, Inten=80.5 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.4987	0.80		Gravel
0.0217	0.90		Asphalt / Concrete
0.0274	0.01		Manure Tank
0.3550	0.90		Roof
4.2891	0.25		Grass
5.1919	0.35	0.44	Weighted Average, Frequency Adjusted
5.1919			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 7S: B1-7



Summary for Subcatchment 8S: B1-8

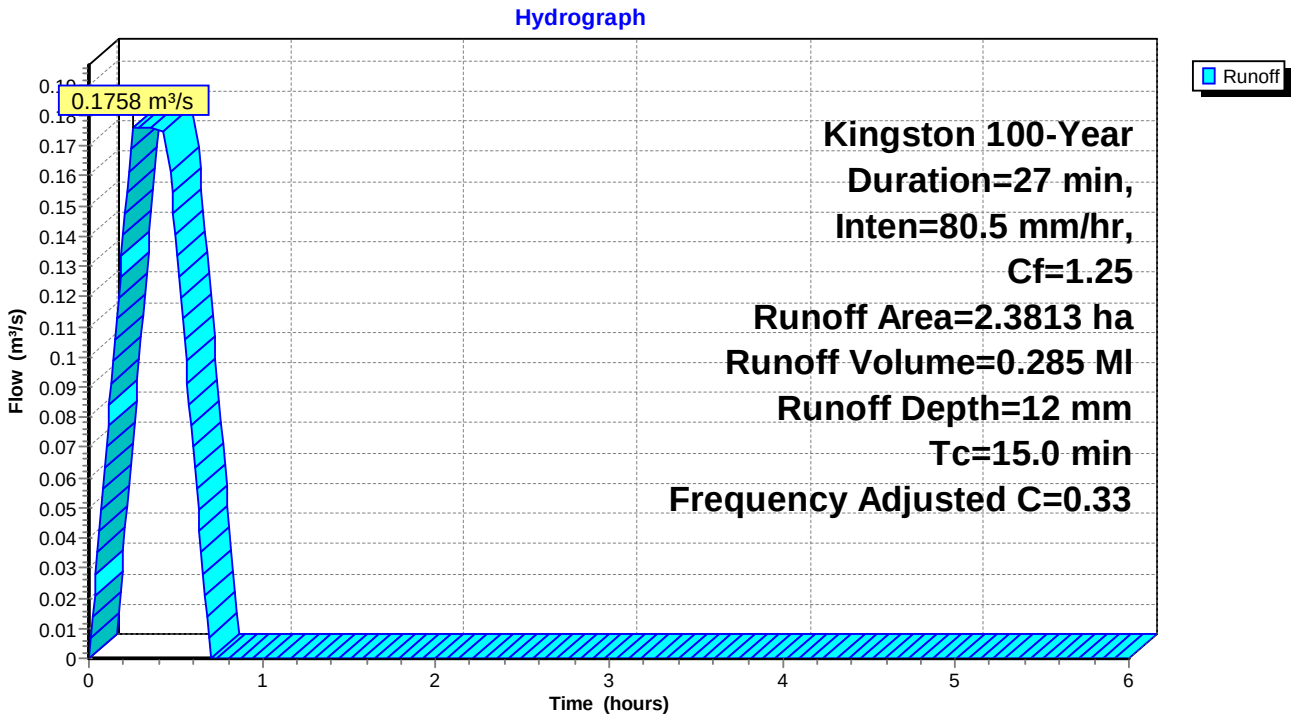
Runoff = 0.1758 m³/s @ 0.25 hrs, Volume= 0.285 Ml, Depth= 12 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=27 min, Inten=80.5 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.0513	0.80		Gravel
0.0000	0.90		Asphalt/Concrete
0.0000	0.01		Manure Tank
0.0000	0.90		Roof
2.3300	0.25		Grass
2.3813	0.26	0.33	Weighted Average, Frequency Adjusted
2.3813			100.00% Pervious Area

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

Subcatchment 8S: B1-8

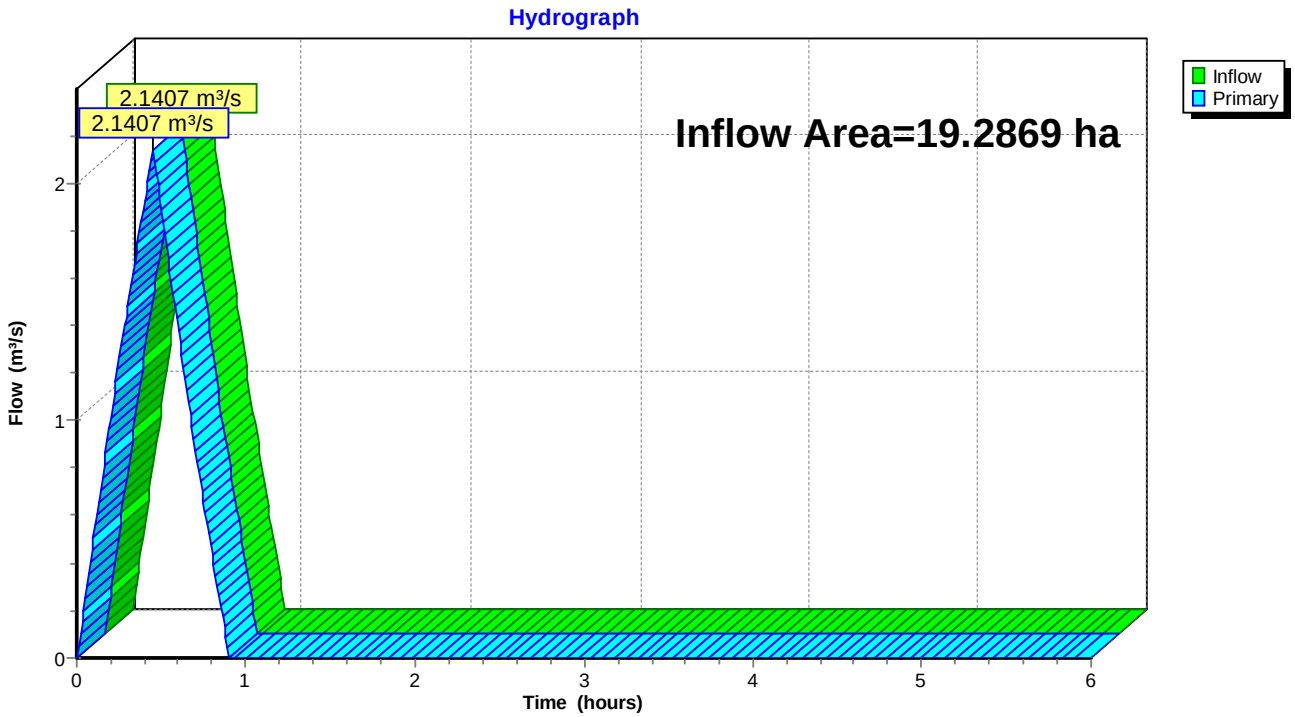


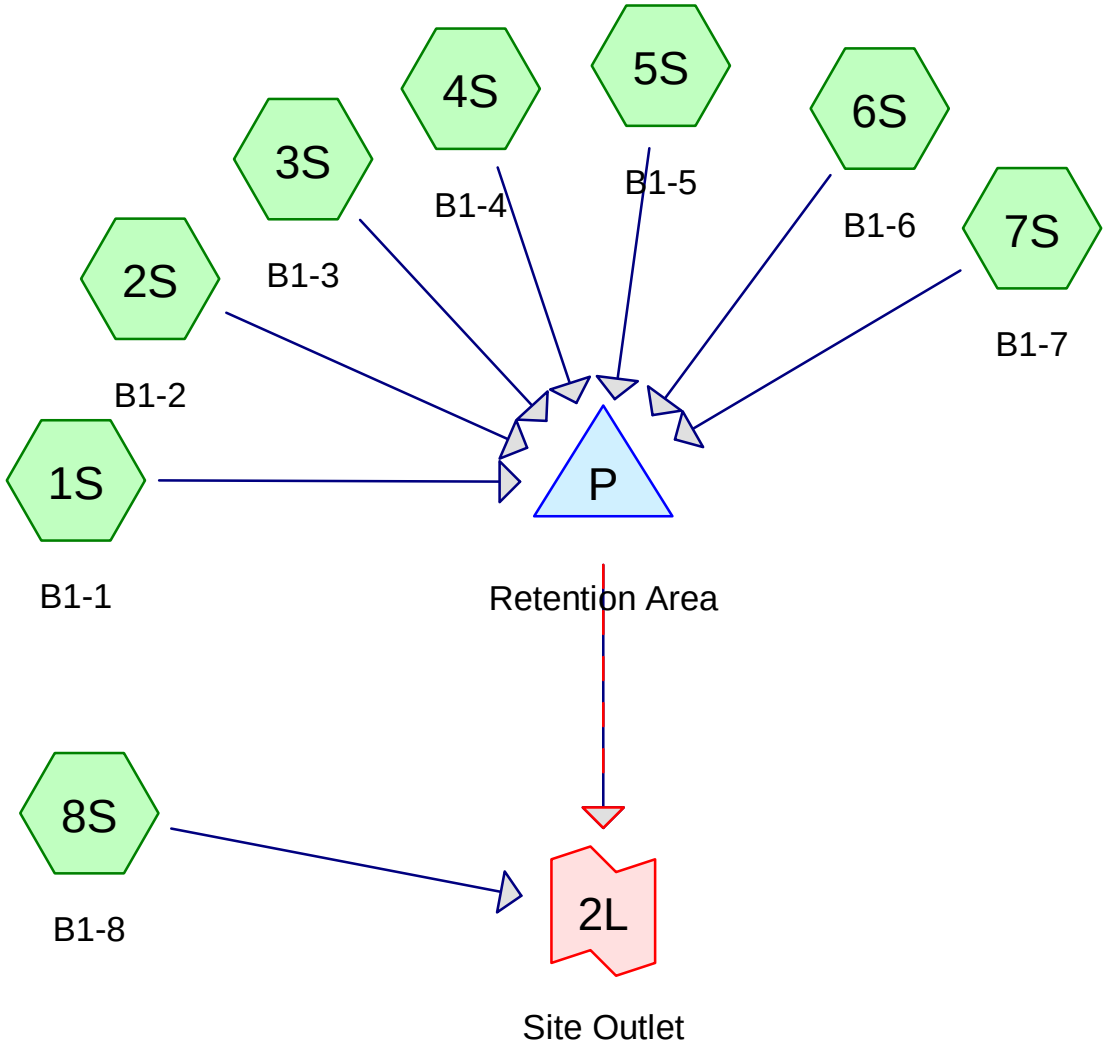
Summary for Link 2L: Site Outlet

Inflow Area = 19.2869 ha, 0.00% Impervious, Inflow Depth = 18 mm for 100-Year event
Inflow = 2.1407 m³/s @ 0.45 hrs, Volume= 3.468 Ml
Primary = 2.1407 m³/s @ 0.45 hrs, Volume= 3.468 Ml, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs

Link 2L: Site Outlet





Subcat Reach Pond Link

Routing Diagram for 191-08574-02 - PostDev_CTLD_v3
Prepared by WSP Canada Inc., Printed 10/13/2021
HydroCAD® 10.00-24 s/n 10698 © 2018 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (hectares)	C	Description (subcatchment-numbers)
0.8197	0.90	Asphalt / Concrete (2S, 3S, 4S, 5S, 6S, 7S)
14.2656	0.25	Grass (1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S)
2.6264	0.80	Gravel (1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S)
0.1513	0.01	Manure Tank (3S, 7S)
1.4239	0.90	Roof (1S, 2S, 3S, 4S, 5S, 6S, 7S)
19.2869	**0.40**	**TOTAL AREA**

Summary for Subcatchment 1S: B1-1

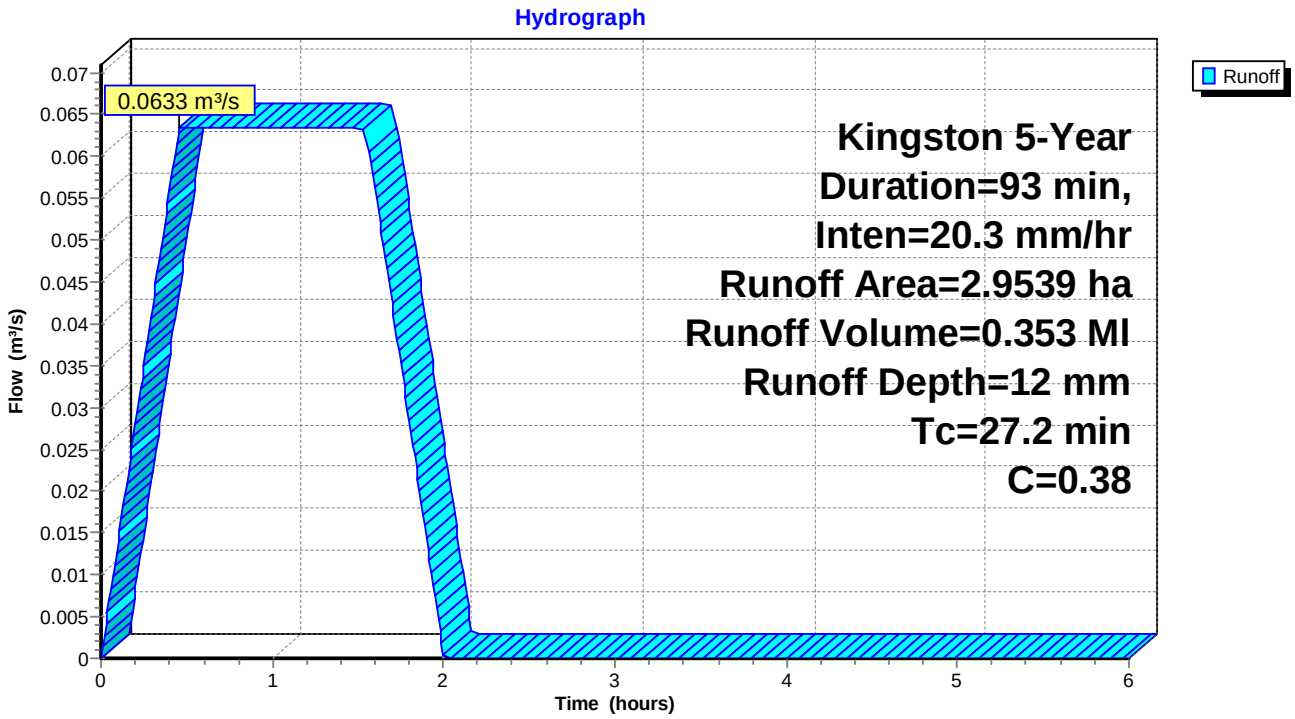
Runoff = 0.0633 m³/s @ 0.46 hrs, Volume= 0.353 Ml, Depth= 12 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=93 min, Inten=20.3 mm/hr

Area (ha)	C	Description
0.5181	0.80	Gravel
0.0000	0.90	Asphalt / Concrete
0.0000	0.01	Manure Tank
0.1539	0.90	Roof
2.2819	0.25	Grass
2.9539	0.38	Weighted Average
2.9539		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Per Ditch Design Sheet**

Subcatchment 1S: B1-1



Summary for Subcatchment 2S: B1-2

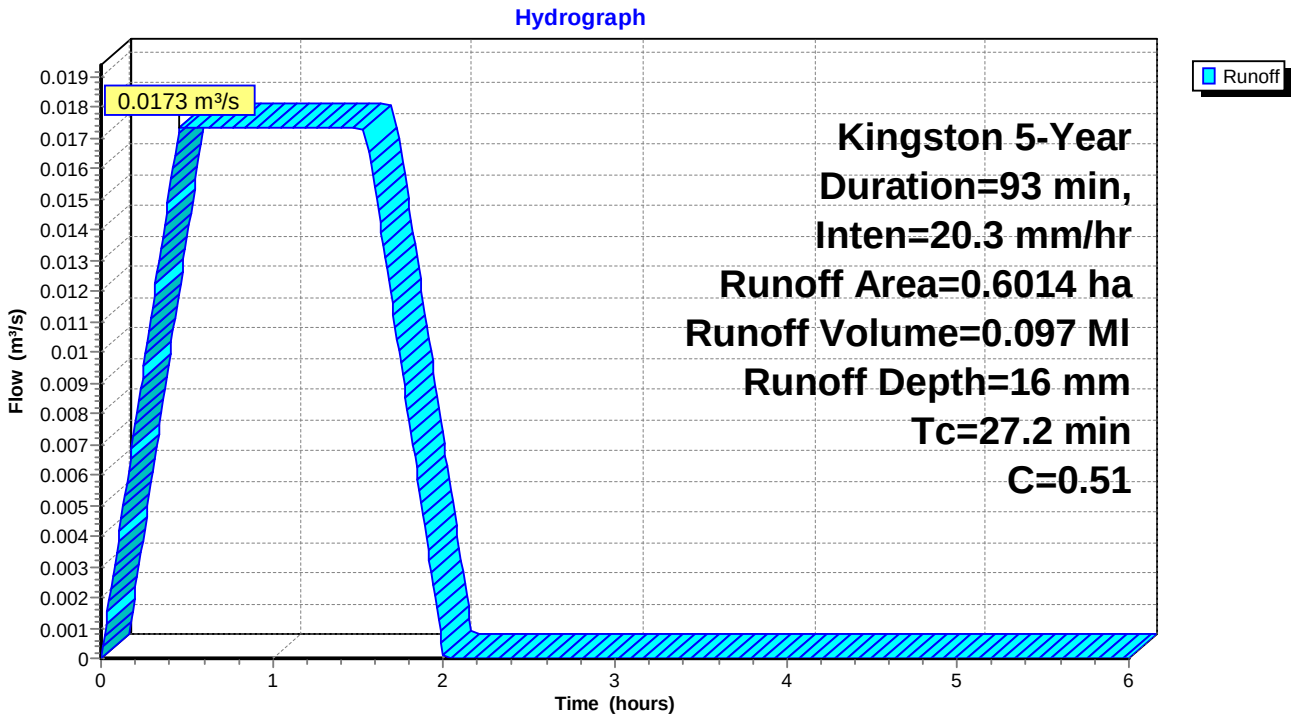
Runoff = 0.0173 m³/s @ 0.46 hrs, Volume= 0.097 Ml, Depth= 16 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=93 min, Inten=20.3 mm/hr

Area (ha)	C	Description
0.1347	0.80	Gravel
0.0046	0.90	Asphalt / Concrete
0.0000	0.01	Manure Tank
0.1175	0.90	Roof
0.3446	0.25	Grass
0.6014	0.51	Weighted Average
0.6014		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 2S: B1-2



Summary for Subcatchment 3S: B1-3

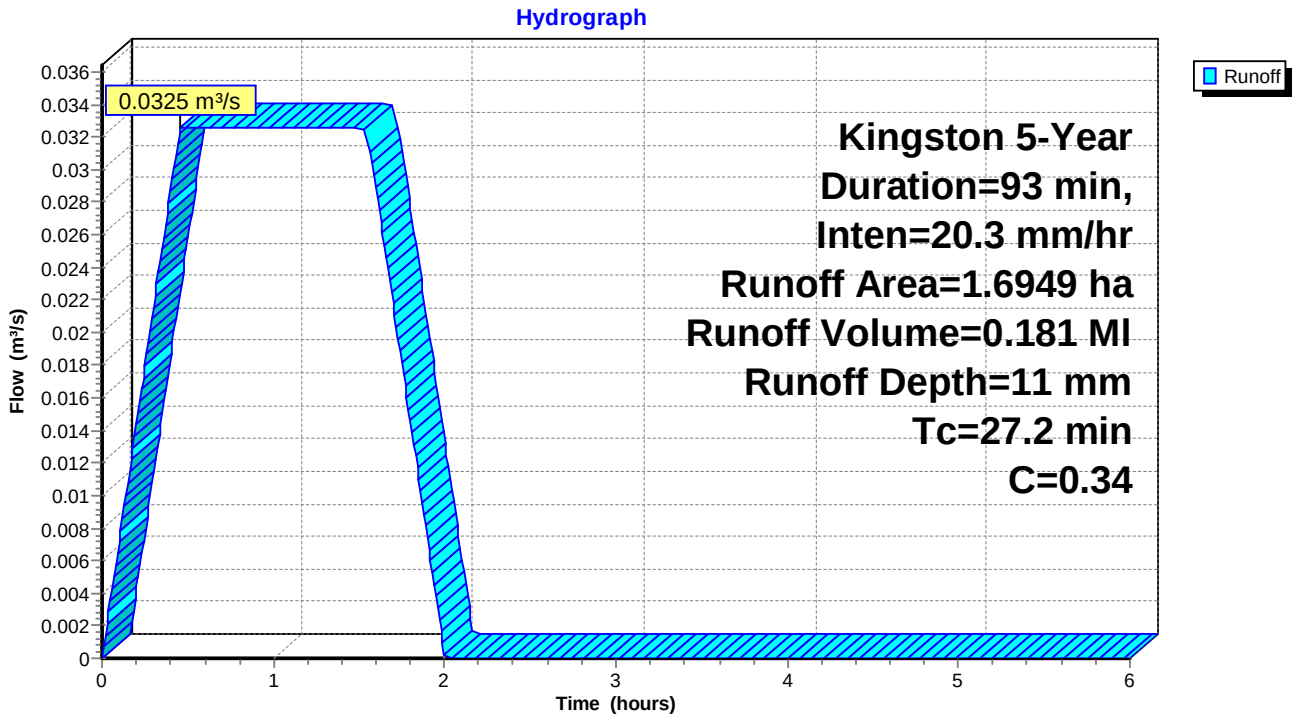
Runoff = 0.0325 m³/s @ 0.46 hrs, Volume= 0.181 Ml, Depth= 11 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=93 min, Inten=20.3 mm/hr

Area (ha)	C	Description
0.2254	0.80	Gravel
0.0070	0.90	Asphalt / Concrete
0.1239	0.01	Manure Tank
0.0809	0.90	Roof
1.2577	0.25	Grass
1.6949	0.34	Weighted Average
1.6949		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 3S: B1-3



Summary for Subcatchment 4S: B1-4

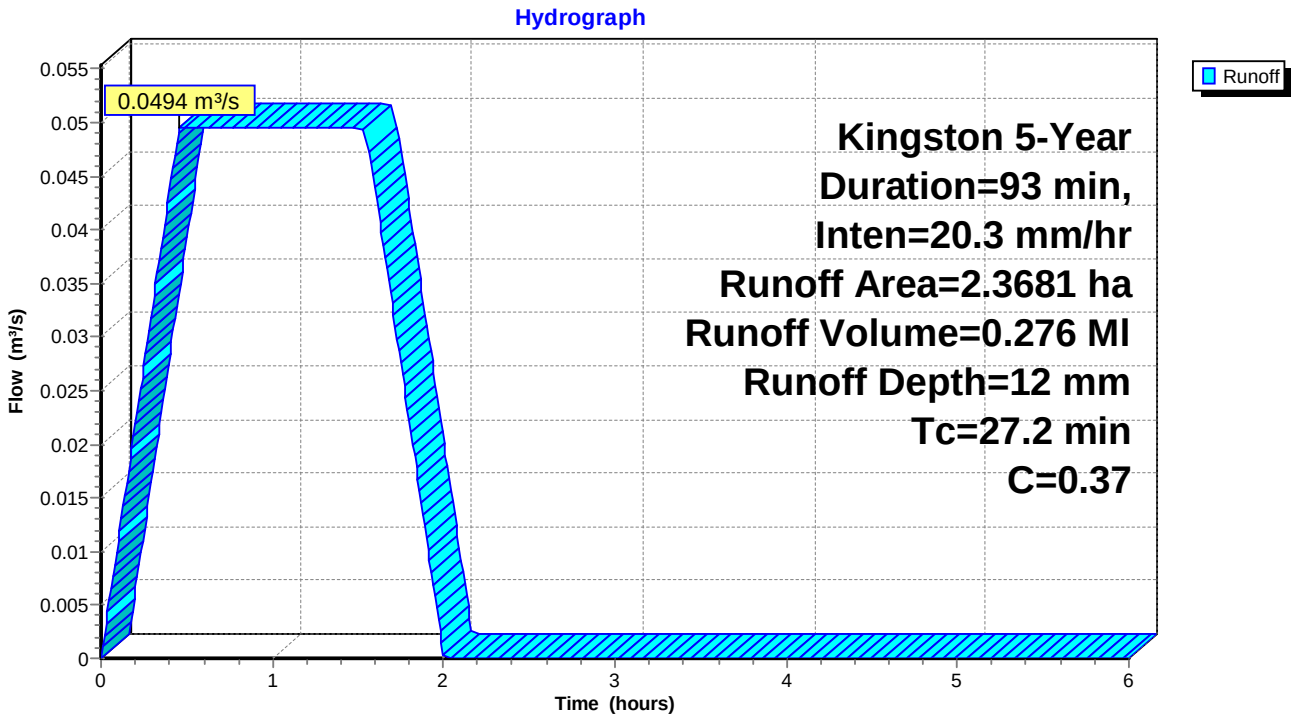
Runoff = 0.0494 m³/s @ 0.46 hrs, Volume= 0.276 Ml, Depth= 12 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=93 min, Inten=20.3 mm/hr

Area (ha)	C	Description
0.3290	0.80	Gravel
0.0268	0.90	Asphalt / Concrete
0.0000	0.01	Manure Tank
0.1249	0.90	Roof
1.8874	0.25	Grass
2.3681	0.37	Weighted Average
2.3681		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 4S: B1-4



Summary for Subcatchment 5S: B1-5

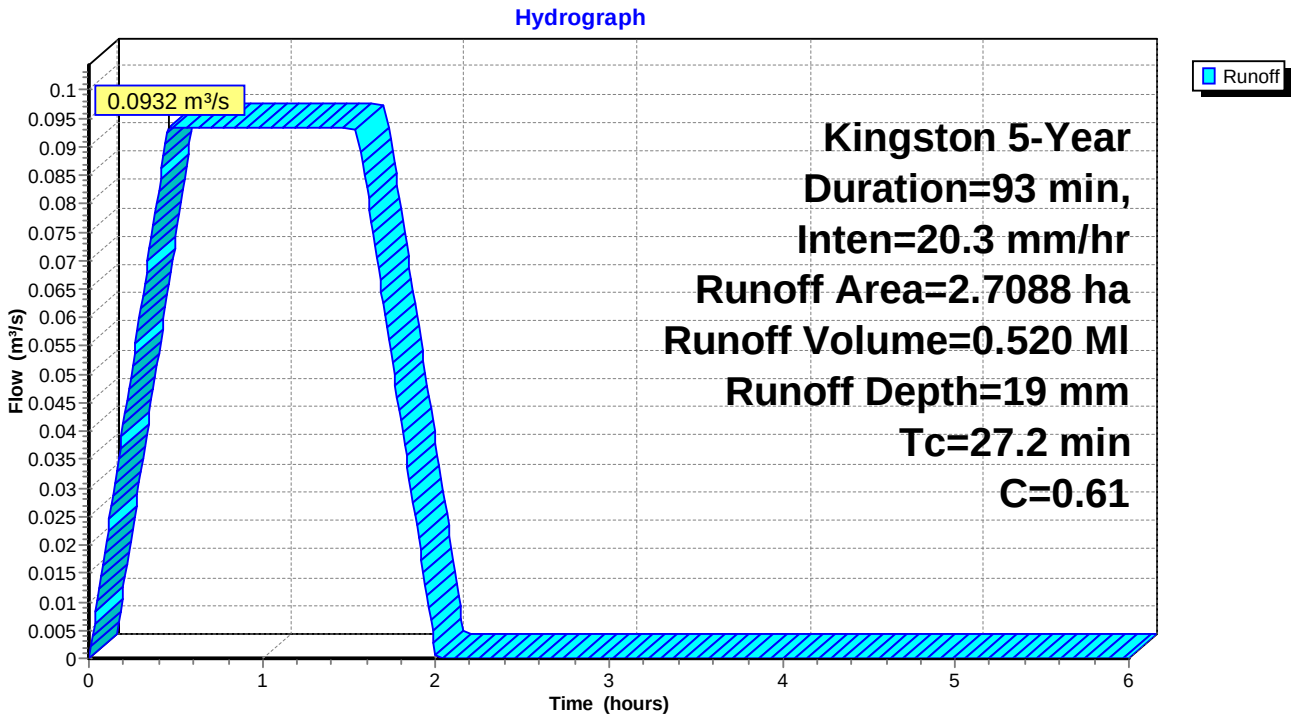
Runoff = 0.0932 m³/s @ 0.46 hrs, Volume= 0.520 Ml, Depth= 19 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=93 min, Inten=20.3 mm/hr

Area (ha)	C	Description
0.3775	0.80	Gravel
0.7307	0.90	Asphalt / Concrete
0.0000	0.01	Manure Tank
0.4356	0.90	Roof
1.1650	0.25	Grass
2.7088	0.61	Weighted Average
2.7088		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 5S: B1-5



Summary for Subcatchment 6S: B1-6

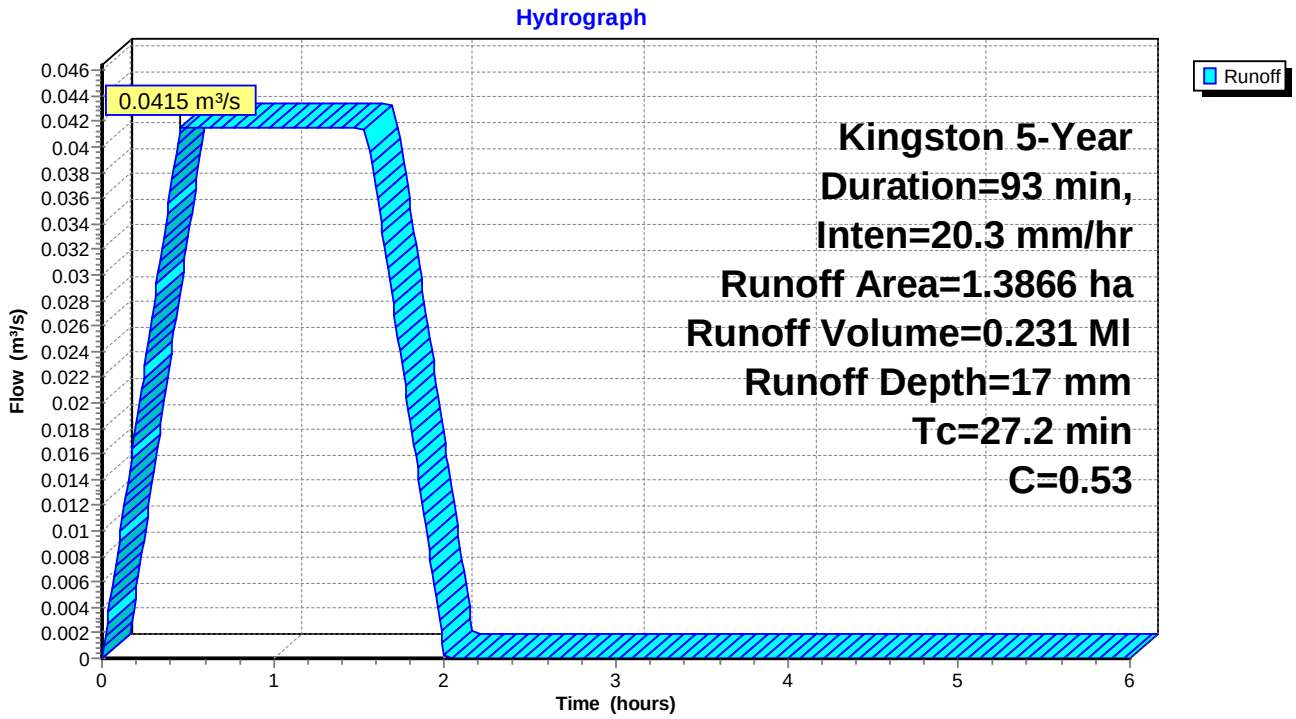
Runoff = 0.0415 m³/s @ 0.46 hrs, Volume= 0.231 Ml, Depth= 17 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=93 min, Inten=20.3 mm/hr

Area (ha)	C	Description
0.4917	0.80	Gravel
0.0289	0.90	Asphalt / Concrete
0.0000	0.01	Manure Tank
0.1561	0.90	Roof
0.7099	0.25	Grass
1.3866	0.53	Weighted Average
1.3866		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 6S: B1-6



Summary for Subcatchment 7S: B1-7

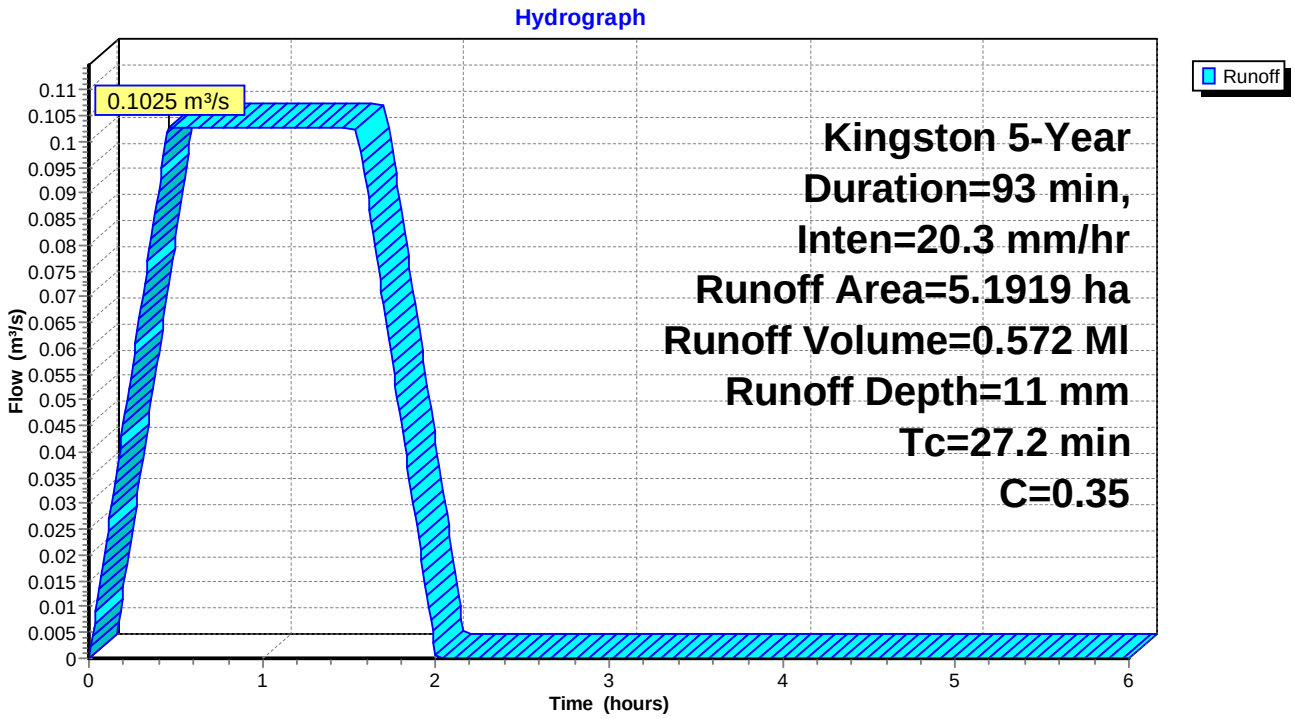
Runoff = 0.1025 m³/s @ 0.46 hrs, Volume= 0.572 Ml, Depth= 11 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=93 min, Inten=20.3 mm/hr

Area (ha)	C	Description
0.4987	0.80	Gravel
0.0217	0.90	Asphalt / Concrete
0.0274	0.01	Manure Tank
0.3550	0.90	Roof
4.2891	0.25	Grass
5.1919	0.35	Weighted Average
5.1919		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 7S: B1-7



Summary for Subcatchment 8S: B1-8

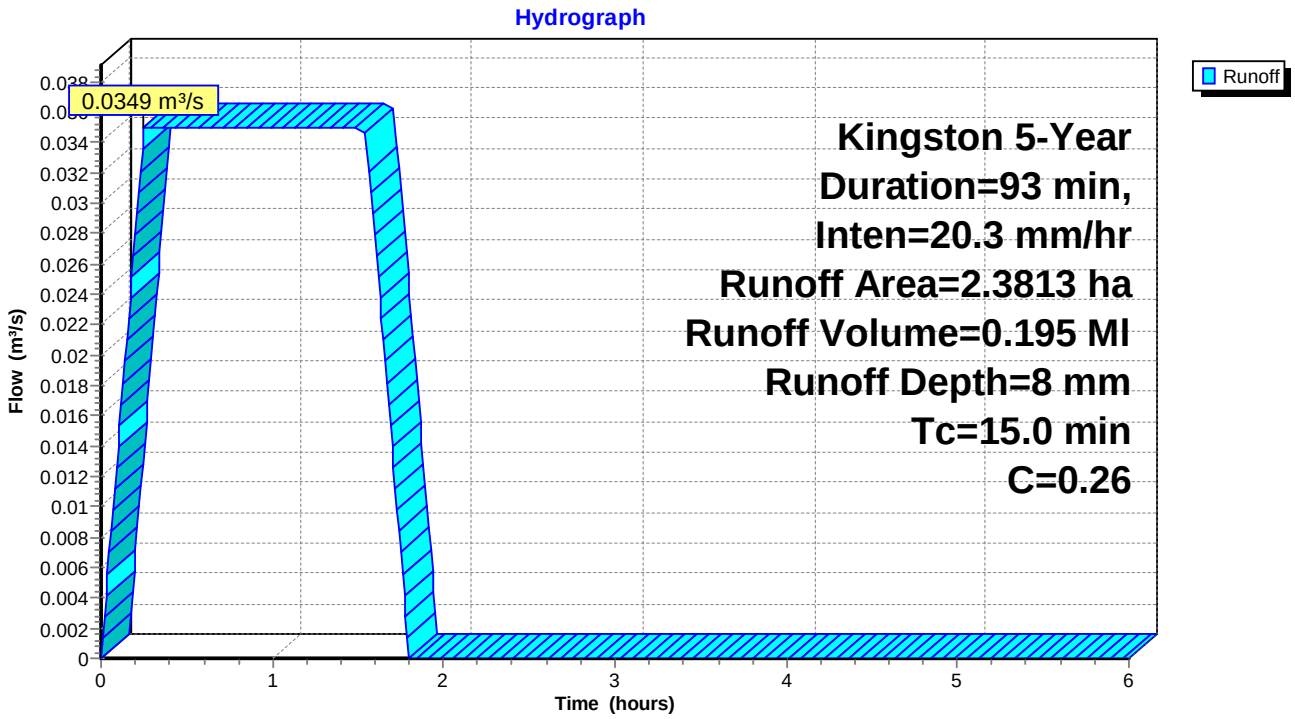
Runoff = 0.0349 m³/s @ 0.25 hrs, Volume= 0.195 Ml, Depth= 8 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=93 min, Inten=20.3 mm/hr

Area (ha)	C	Description
0.0513	0.80	Gravel
0.0000	0.90	Asphalt/Concrete
0.0000	0.01	Manure Tank
0.0000	0.90	Roof
2.3300	0.25	Grass
2.3813	0.26	Weighted Average
2.3813		100.00% Pervious Area

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

Subcatchment 8S: B1-8



Summary for Pond P: Retention Area

Inflow Area = 16.9056 ha, 0.00% Impervious, Inflow Depth = 13 mm for 5-Year event
Inflow = 0.3999 m³/s @ 0.46 hrs, Volume= 2.231 Ml
Outflow = 0.1675 m³/s @ 1.81 hrs, Volume= 1.944 Ml, Atten= 58%, Lag= 81.2 min
Primary = 0.1675 m³/s @ 1.81 hrs, Volume= 1.944 Ml
Secondary = 0.0000 m³/s @ 0.00 hrs, Volume= 0.000 Ml

Routing by Stor-Ind method, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Peak Elev= 123.483 m @ 1.81 hrs Surf.Area= 0.0 m² Storage= 1,586.2 m³

Plug-Flow detention time= 109.6 min calculated for 1.940 Ml (87% of inflow)
Center-of-Mass det. time= 103.5 min (163.6 - 60.1)

Volume	Invert	Avail.Storage	Storage Description
#1	123.100 m	3,743.6 m³	**Custom Stage Data** Listed below

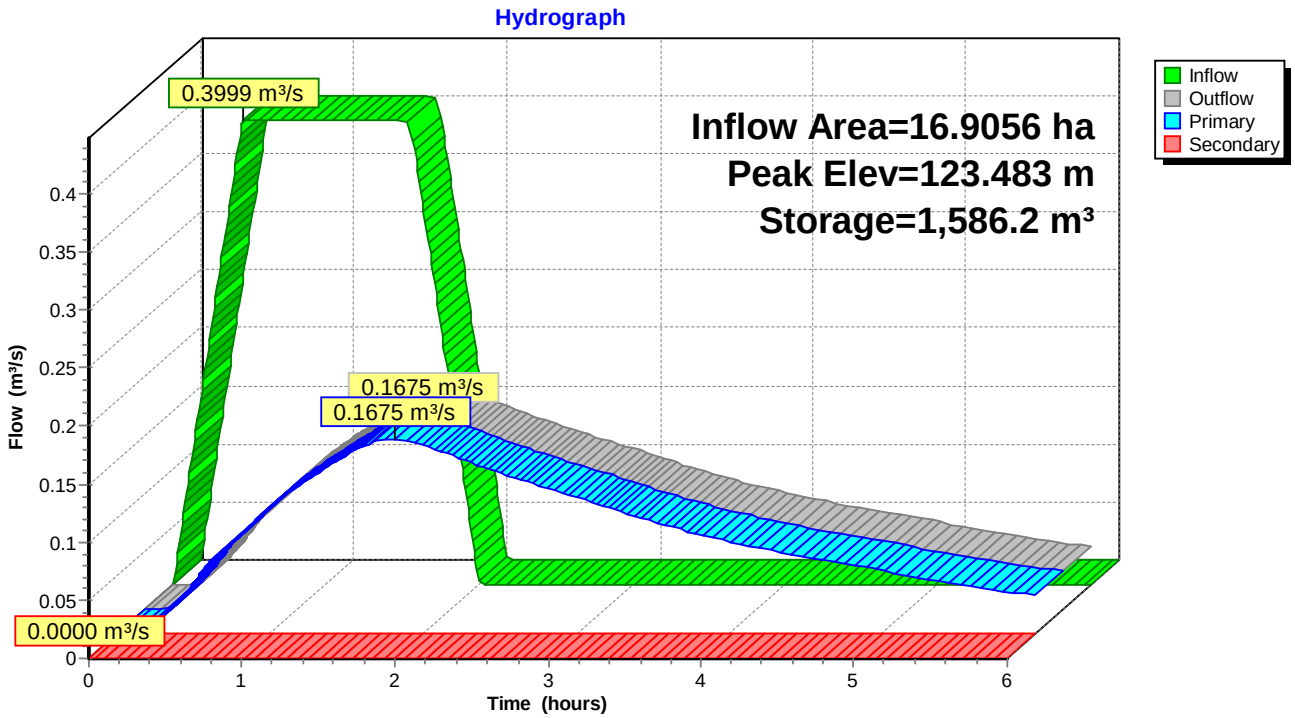
Elevation (meters)	Cum.Store (cubic-meters)
123.100	0.0
123.200	126.7
123.300	461.6
123.400	1,010.1
123.500	1,708.2
123.600	2,421.7
123.700	3,166.9
123.775	3,743.6

Device	Routing	Invert	Outlet Devices
#1	Primary	123.100 m	**450 mm Vert. Orifice/Grate** C= 0.600
#2	Secondary	123.660 m	**Custom Weir/Orifice, Cv= 1.45 (C= 1.81)**
			Head (meters) 0.000 0.500
			Width (meters) 5.00 8.00

Primary OutFlow Max=0.1675 m³/s @ 1.81 hrs HW=123.483 m (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 0.1675 m³/s @ 1.16 m/s)

Secondary OutFlow Max=0.0000 m³/s @ 0.00 hrs HW=123.100 m (Free Discharge)
└**2=Custom Weir/Orifice** (Controls 0.0000 m³/s)

Pond P: Retention Area

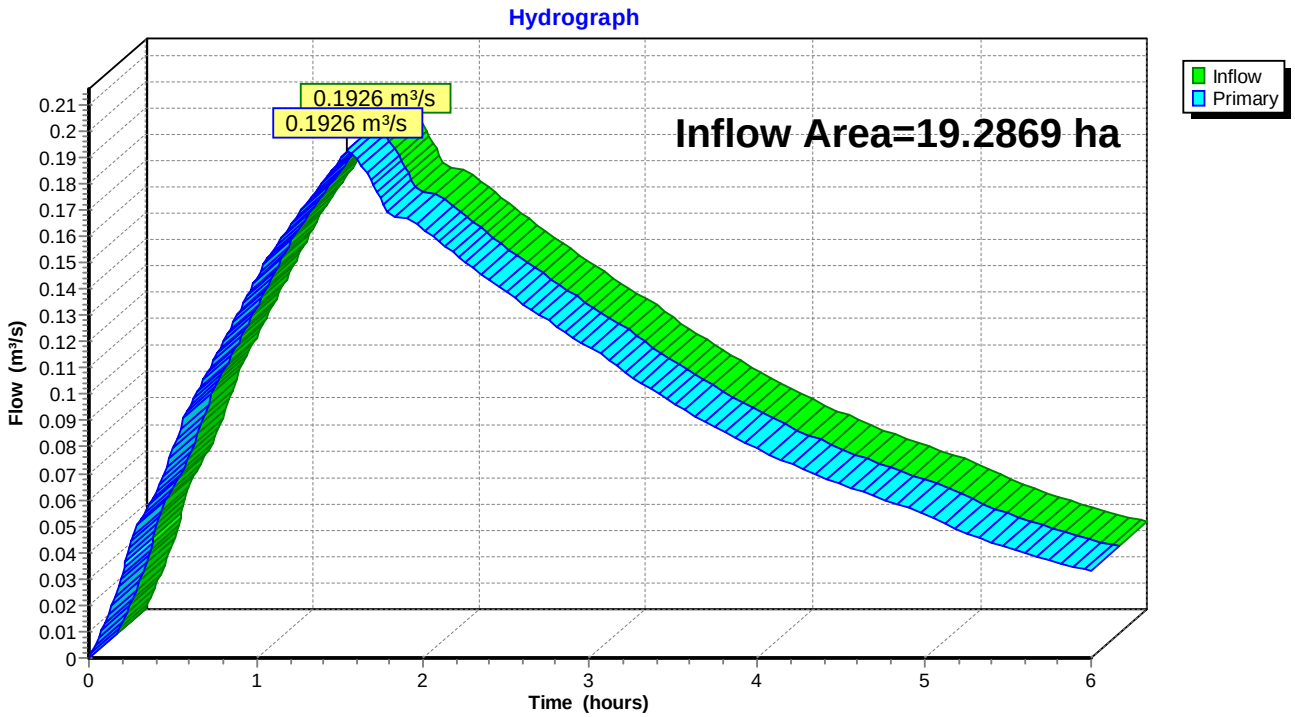


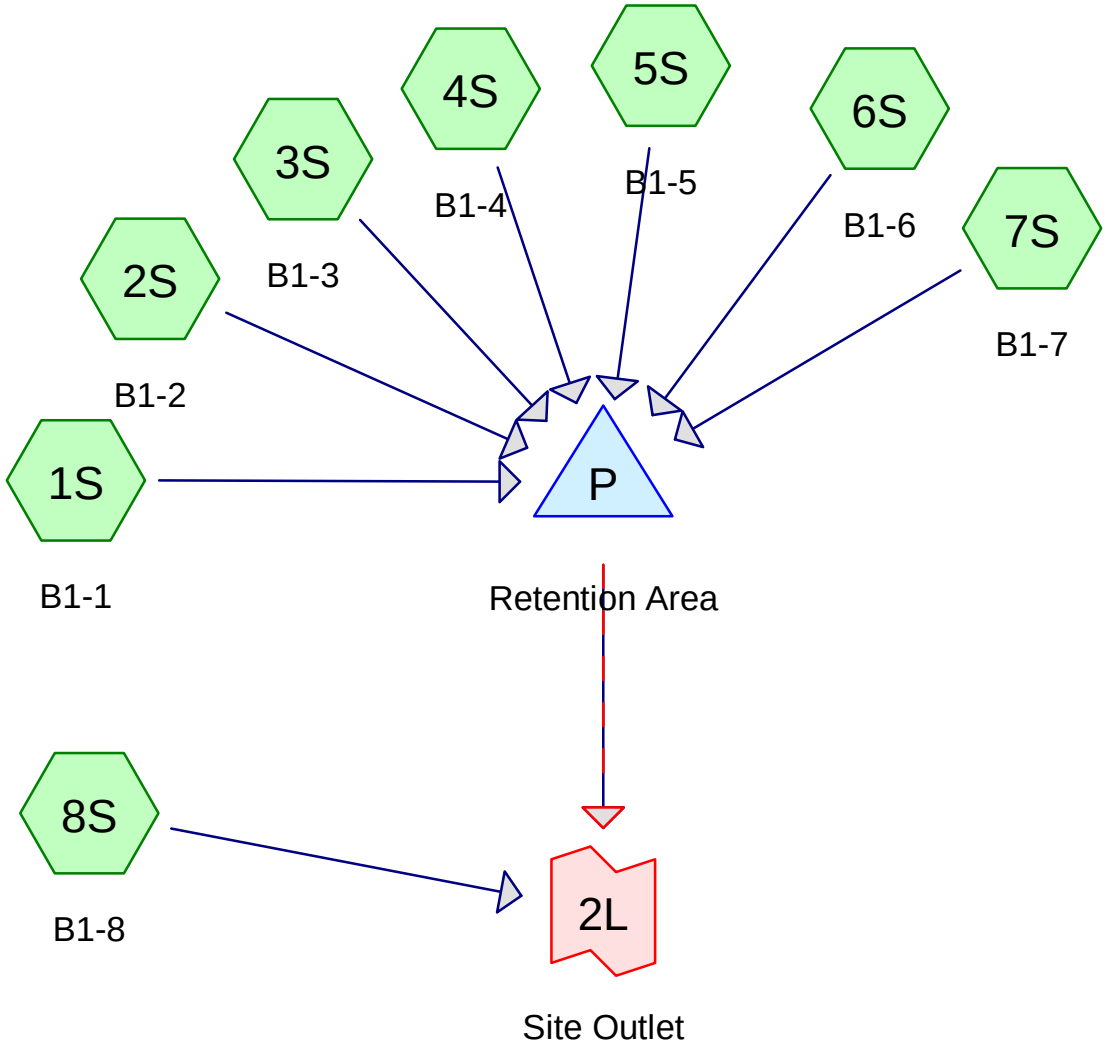
Summary for Link 2L: Site Outlet

Inflow Area = 19.2869 ha, 0.00% Impervious, Inflow Depth > 11 mm for 5-Year event
Inflow = 0.1926 m³/s @ 1.55 hrs, Volume= 2.138 Ml
Primary = 0.1926 m³/s @ 1.55 hrs, Volume= 2.138 Ml, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs

Link 2L: Site Outlet





Subcat Reach Pond Link

Routing Diagram for 191-08574-02 - PostDev_CTLD_v3
Prepared by WSP Canada Inc., Printed 10/13/2021
HydroCAD® 10.00-24 s/n 10698 © 2018 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (hectares)	C	Description (subcatchment-numbers)
0.8197	0.90	Asphalt / Concrete (2S, 3S, 4S, 5S, 6S, 7S)
14.2656	0.25	Grass (1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S)
2.6264	0.80	Gravel (1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S)
0.1513	0.01	Manure Tank (3S, 7S)
1.4239	0.90	Roof (1S, 2S, 3S, 4S, 5S, 6S, 7S)
19.2869	**0.40**	**TOTAL AREA**

Summary for Subcatchment 1S: B1-1

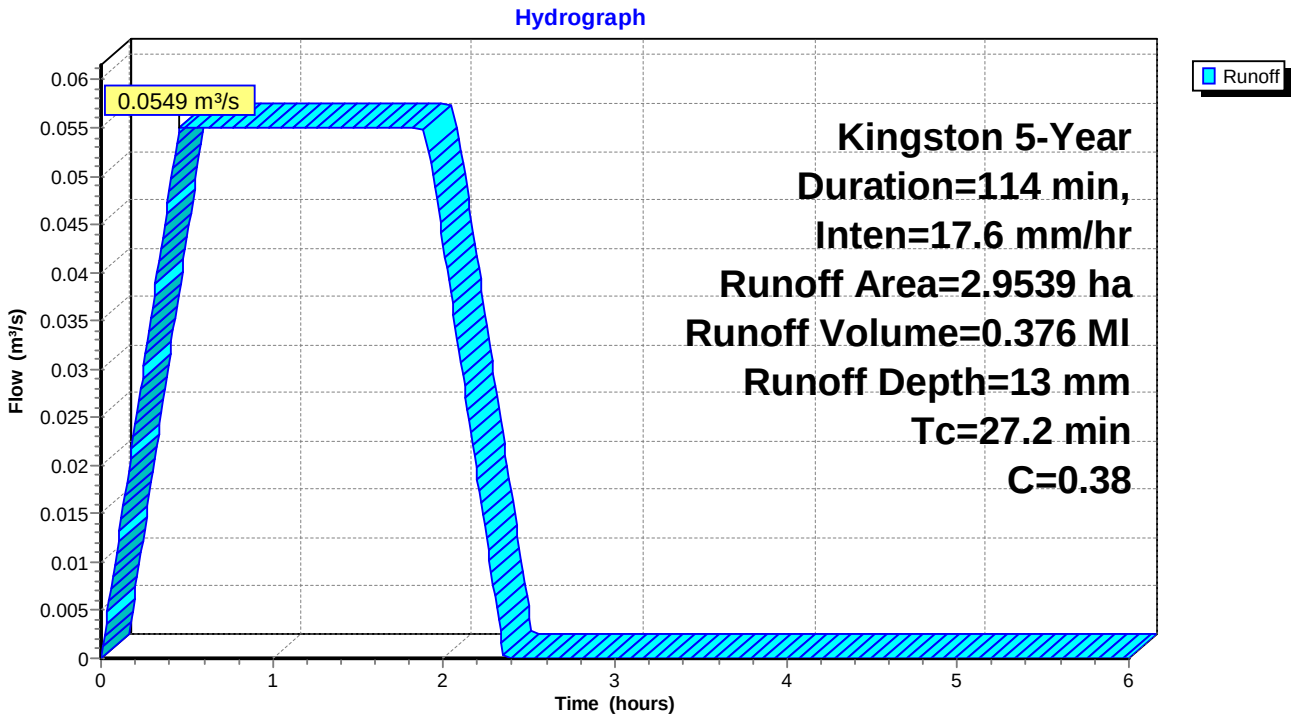
Runoff = 0.0549 m³/s @ 0.46 hrs, Volume= 0.376 Ml, Depth= 13 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=114 min, Inten=17.6 mm/hr

Area (ha)	C	Description
0.5181	0.80	Gravel
0.0000	0.90	Asphalt / Concrete
0.0000	0.01	Manure Tank
0.1539	0.90	Roof
2.2819	0.25	Grass
2.9539	0.38	Weighted Average
2.9539		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Per Ditch Design Sheet**

Subcatchment 1S: B1-1



Summary for Subcatchment 2S: B1-2

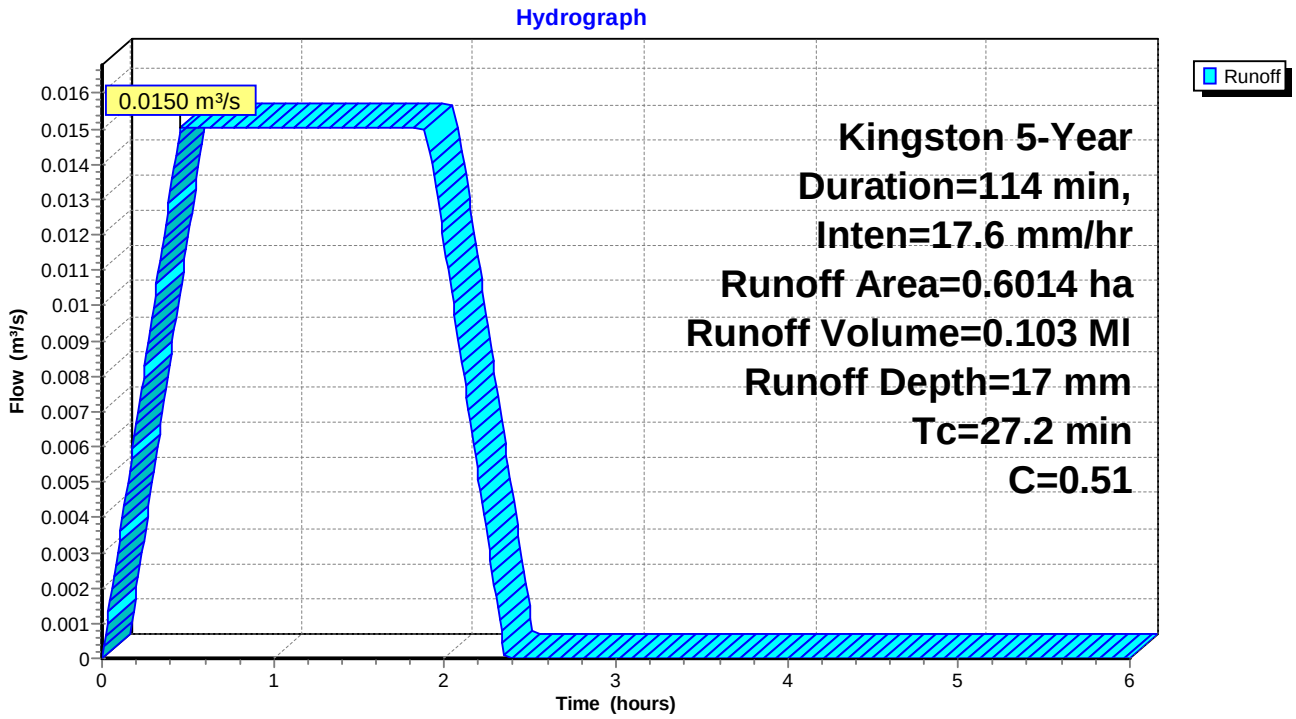
Runoff = 0.0150 m³/s @ 0.46 hrs, Volume= 0.103 Ml, Depth= 17 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=114 min, Inten=17.6 mm/hr

Area (ha)	C	Description
0.1347	0.80	Gravel
0.0046	0.90	Asphalt / Concrete
0.0000	0.01	Manure Tank
0.1175	0.90	Roof
0.3446	0.25	Grass
0.6014	0.51	Weighted Average
0.6014		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 2S: B1-2



Summary for Subcatchment 3S: B1-3

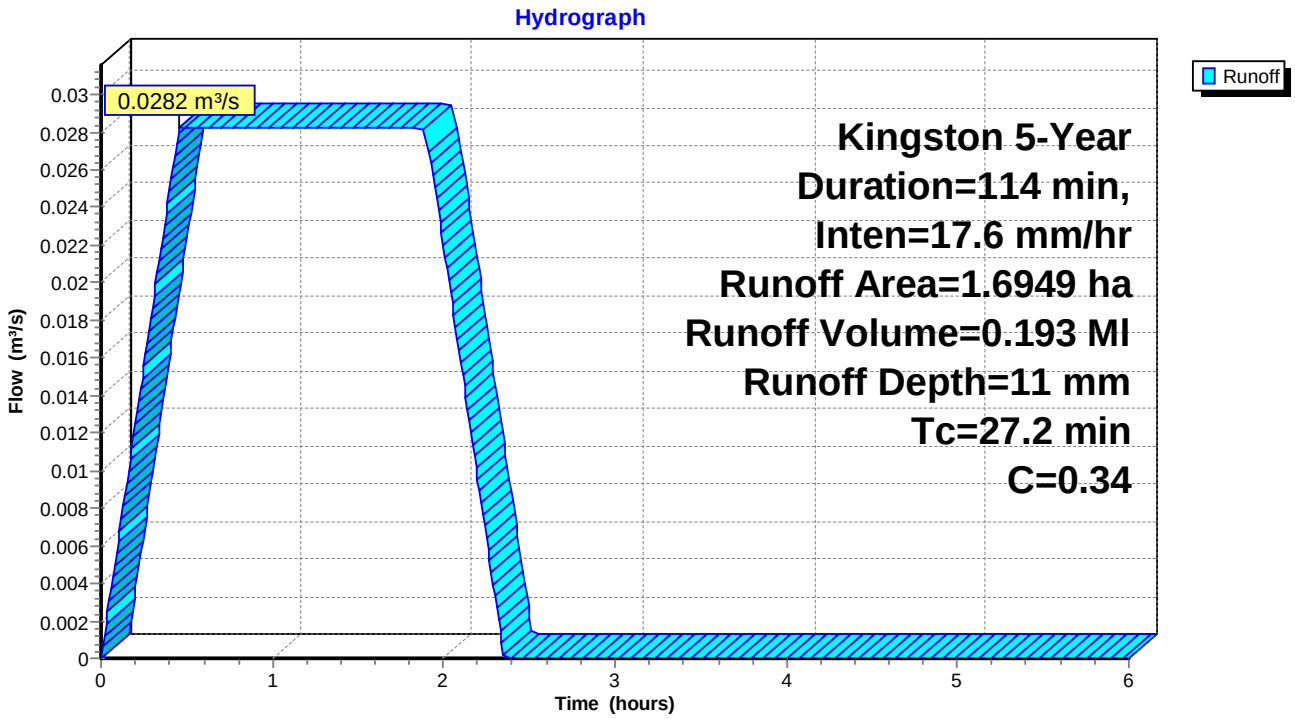
Runoff = 0.0282 m³/s @ 0.46 hrs, Volume= 0.193 Ml, Depth= 11 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=114 min, Inten=17.6 mm/hr

Area (ha)	C	Description
0.2254	0.80	Gravel
0.0070	0.90	Asphalt / Concrete
0.1239	0.01	Manure Tank
0.0809	0.90	Roof
1.2577	0.25	Grass
1.6949	0.34	Weighted Average
1.6949		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 3S: B1-3



Summary for Subcatchment 4S: B1-4

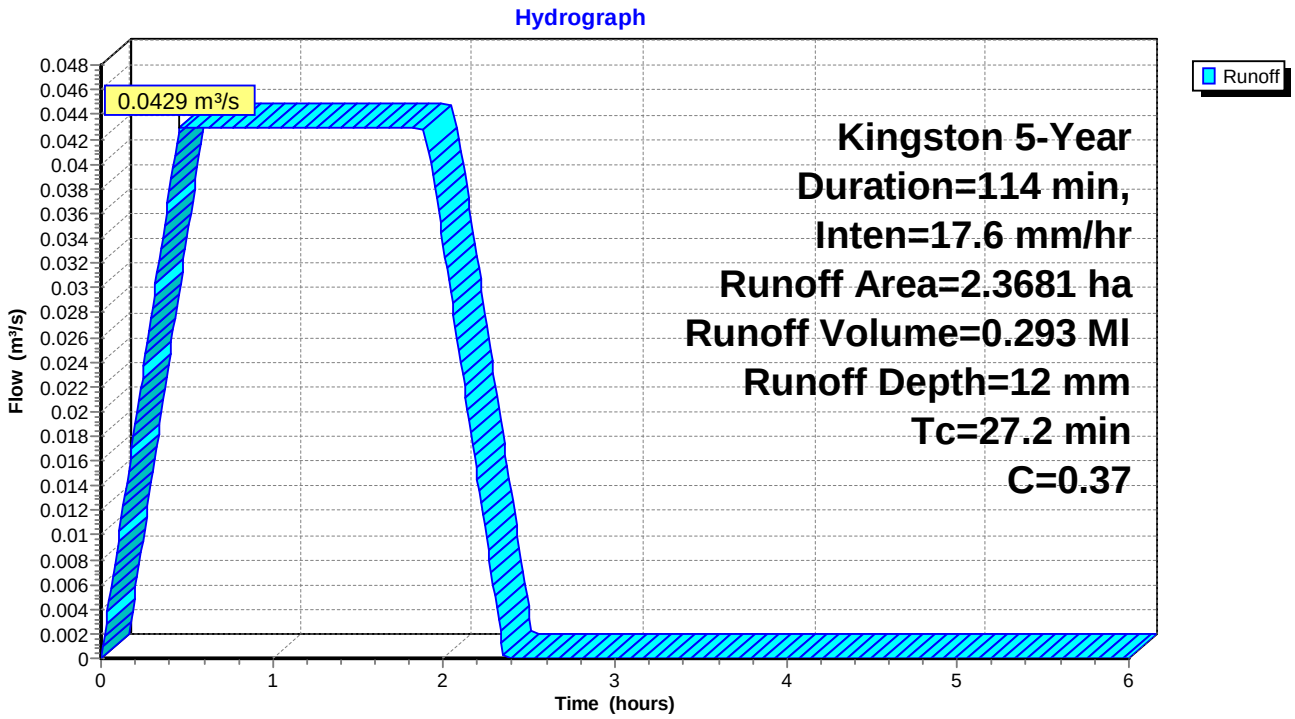
Runoff = 0.0429 m³/s @ 0.46 hrs, Volume= 0.293 Ml, Depth= 12 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=114 min, Inten=17.6 mm/hr

Area (ha)	C	Description
0.3290	0.80	Gravel
0.0268	0.90	Asphalt / Concrete
0.0000	0.01	Manure Tank
0.1249	0.90	Roof
1.8874	0.25	Grass
2.3681	0.37	Weighted Average
2.3681		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 4S: B1-4



Summary for Subcatchment 5S: B1-5

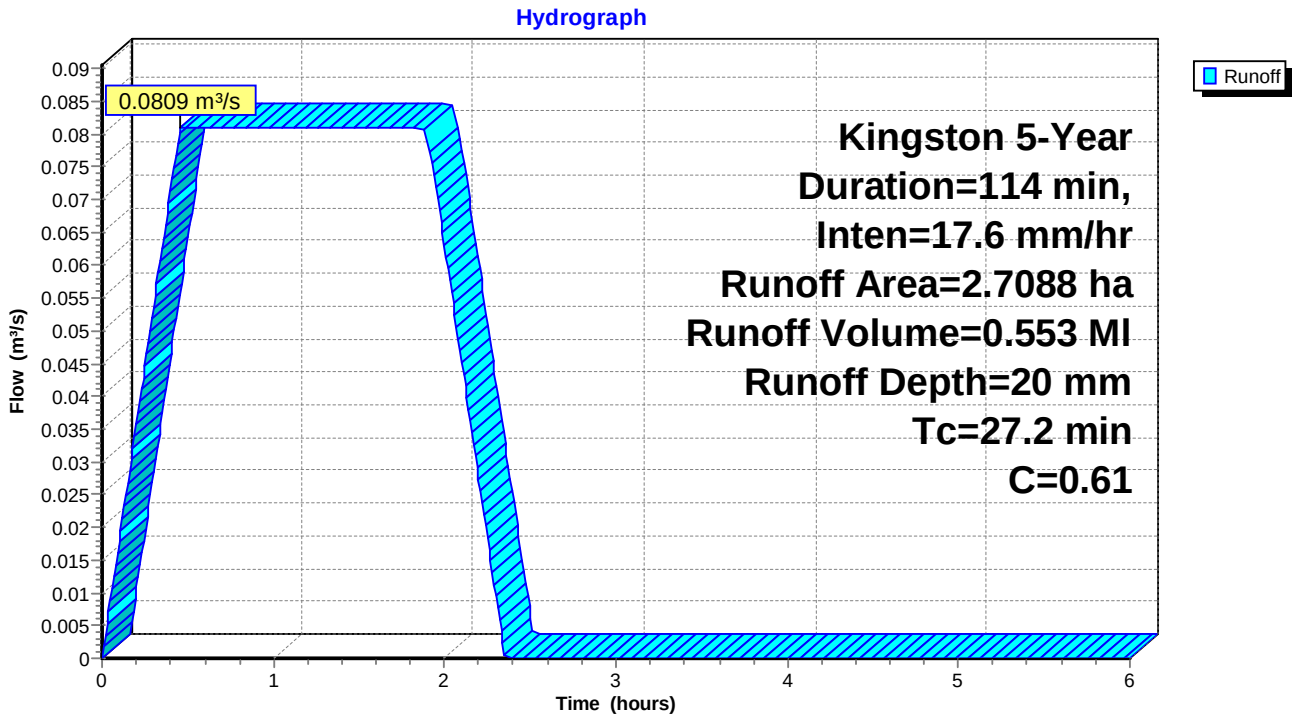
Runoff = 0.0809 m³/s @ 0.46 hrs, Volume= 0.553 Ml, Depth= 20 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=114 min, Inten=17.6 mm/hr

Area (ha)	C	Description
0.3775	0.80	Gravel
0.7307	0.90	Asphalt / Concrete
0.0000	0.01	Manure Tank
0.4356	0.90	Roof
1.1650	0.25	Grass
2.7088	0.61	Weighted Average
2.7088		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 5S: B1-5



Summary for Subcatchment 6S: B1-6

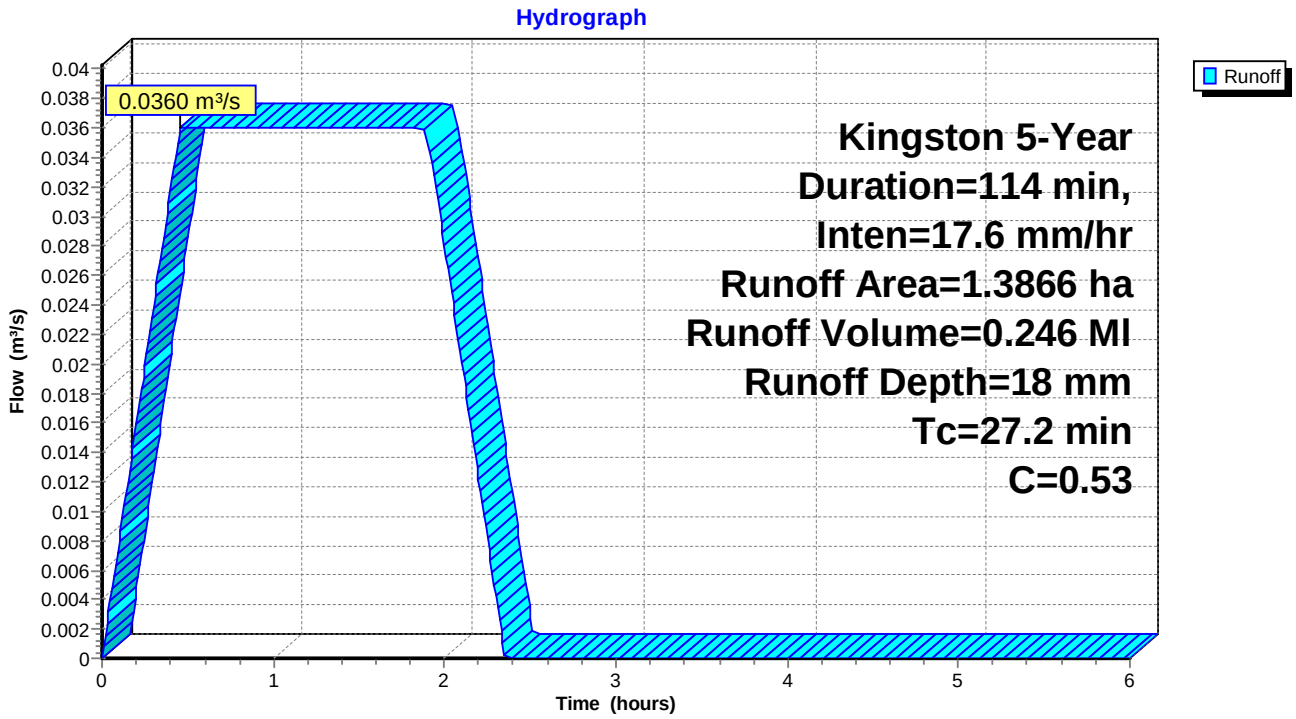
Runoff = 0.0360 m³/s @ 0.46 hrs, Volume= 0.246 Ml, Depth= 18 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=114 min, Inten=17.6 mm/hr

Area (ha)	C	Description
0.4917	0.80	Gravel
0.0289	0.90	Asphalt / Concrete
0.0000	0.01	Manure Tank
0.1561	0.90	Roof
0.7099	0.25	Grass
1.3866	0.53	Weighted Average
1.3866		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 6S: B1-6



Summary for Subcatchment 7S: B1-7

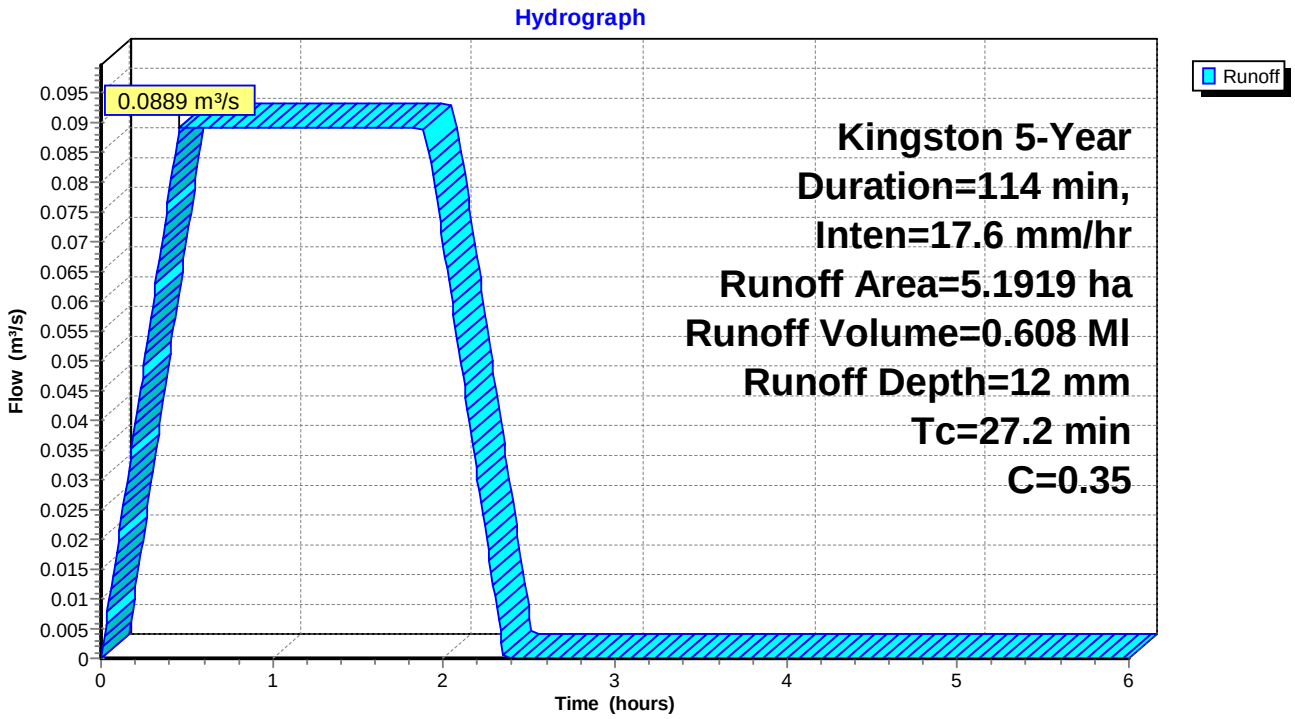
Runoff = 0.0889 m³/s @ 0.46 hrs, Volume= 0.608 Ml, Depth= 12 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=114 min, Inten=17.6 mm/hr

Area (ha)	C	Description
0.4987	0.80	Gravel
0.0217	0.90	Asphalt / Concrete
0.0274	0.01	Manure Tank
0.3550	0.90	Roof
4.2891	0.25	Grass
5.1919	0.35	Weighted Average
5.1919		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 7S: B1-7



Summary for Subcatchment 8S: B1-8

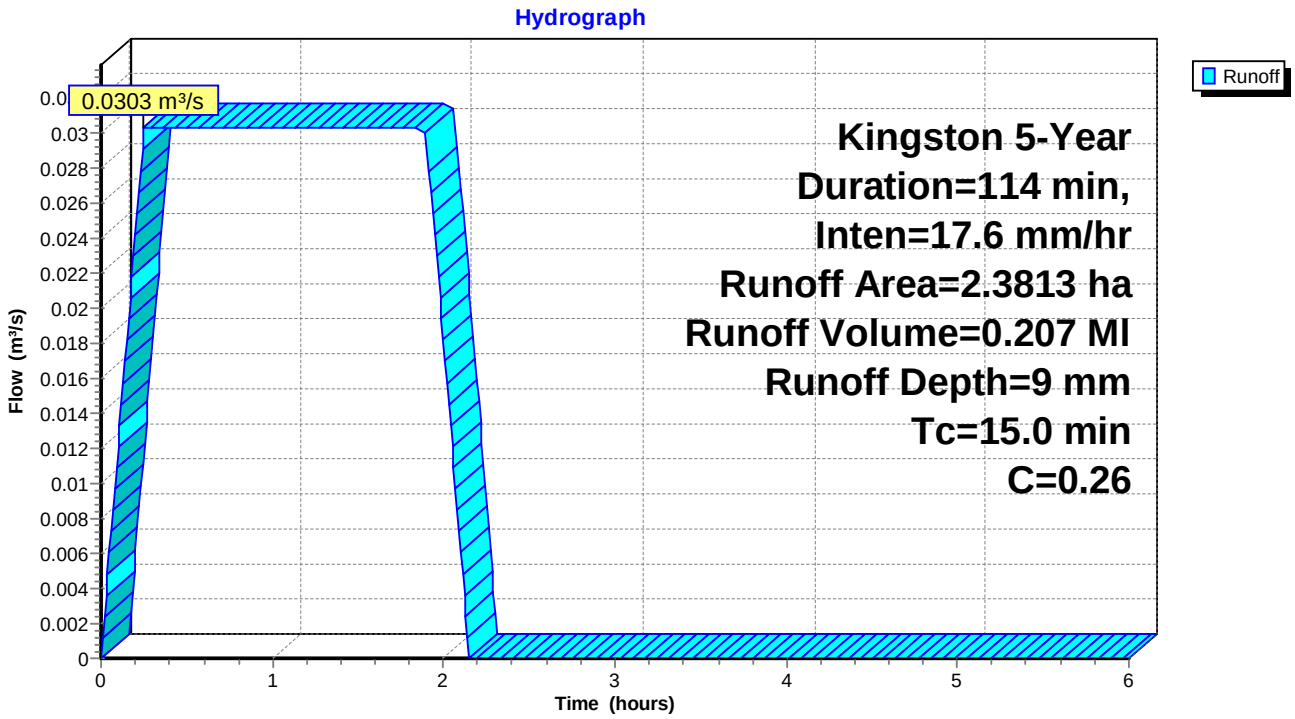
Runoff = 0.0303 m³/s @ 0.25 hrs, Volume= 0.207 Ml, Depth= 9 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 5-Year Duration=114 min, Inten=17.6 mm/hr

Area (ha)	C	Description
0.0513	0.80	Gravel
0.0000	0.90	Asphalt/Concrete
0.0000	0.01	Manure Tank
0.0000	0.90	Roof
2.3300	0.25	Grass
2.3813	0.26	Weighted Average
2.3813		100.00% Pervious Area

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

Subcatchment 8S: B1-8



Summary for Pond P: Retention Area

Inflow Area = 16.9056 ha, 0.00% Impervious, Inflow Depth = 14 mm for 5-Year event
Inflow = 0.3468 m³/s @ 0.46 hrs, Volume= 2.372 Ml
Outflow = 0.1683 m³/s @ 2.13 hrs, Volume= 2.039 Ml, Atten= 51%, Lag= 100.4 min
Primary = 0.1683 m³/s @ 2.13 hrs, Volume= 2.039 Ml
Secondary = 0.0000 m³/s @ 0.00 hrs, Volume= 0.000 Ml

Routing by Stor-Ind method, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Peak Elev= 123.484 m @ 2.13 hrs Surf.Area= 0.0 m² Storage= 1,595.9 m³

Plug-Flow detention time= 109.3 min calculated for 2.039 Ml (86% of inflow)
Center-of-Mass det. time= 101.0 min (171.6 - 70.6)

Volume	Invert	Avail.Storage	Storage Description
#1	123.100 m	3,743.6 m³	**Custom Stage Data** Listed below

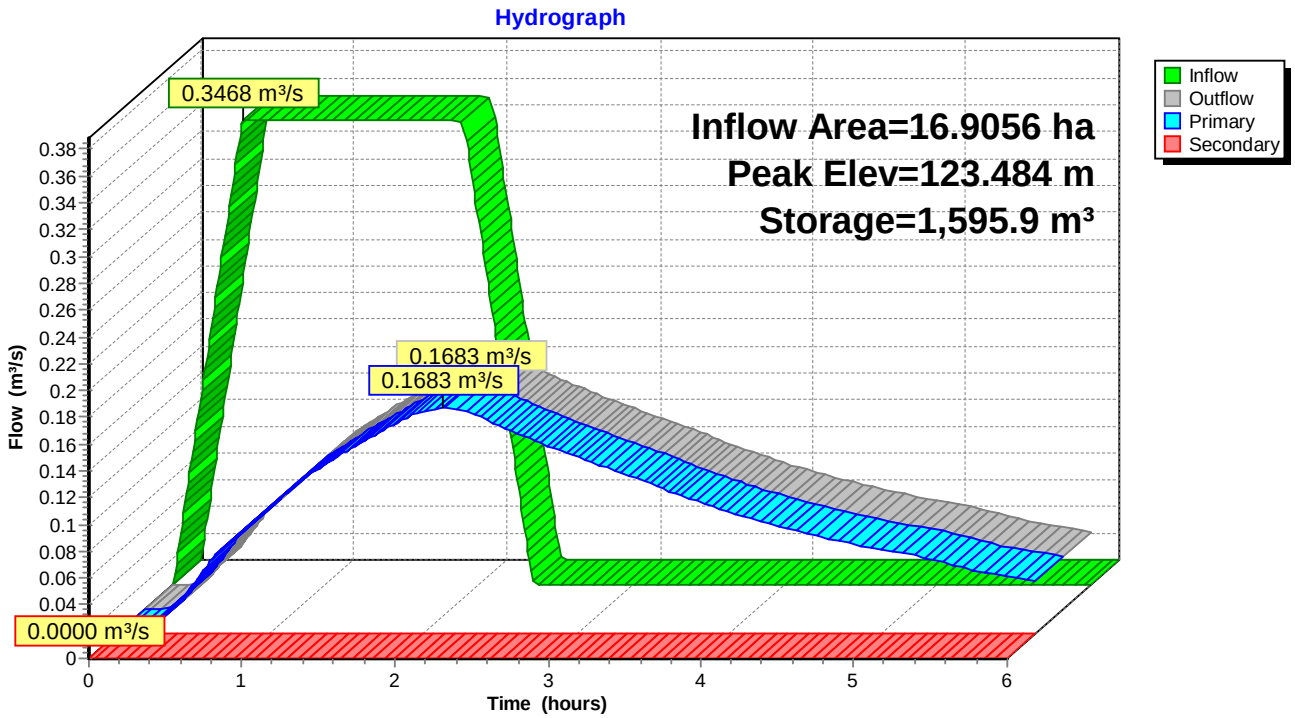
Elevation (meters)	Cum.Store (cubic-meters)
123.100	0.0
123.200	126.7
123.300	461.6
123.400	1,010.1
123.500	1,708.2
123.600	2,421.7
123.700	3,166.9
123.775	3,743.6

Device	Routing	Invert	Outlet Devices
#1	Primary	123.100 m	**450 mm Vert. Orifice/Grate** C= 0.600
#2	Secondary	123.660 m	**Custom Weir/Orifice, Cv= 1.45 (C= 1.81)**
			Head (meters) 0.000 0.500
			Width (meters) 5.00 8.00

Primary OutFlow Max=0.1683 m³/s @ 2.13 hrs HW=123.484 m (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 0.1683 m³/s @ 1.16 m/s)

Secondary OutFlow Max=0.0000 m³/s @ 0.00 hrs HW=123.100 m (Free Discharge)
└**2=Custom Weir/Orifice** (Controls 0.0000 m³/s)

Pond P: Retention Area

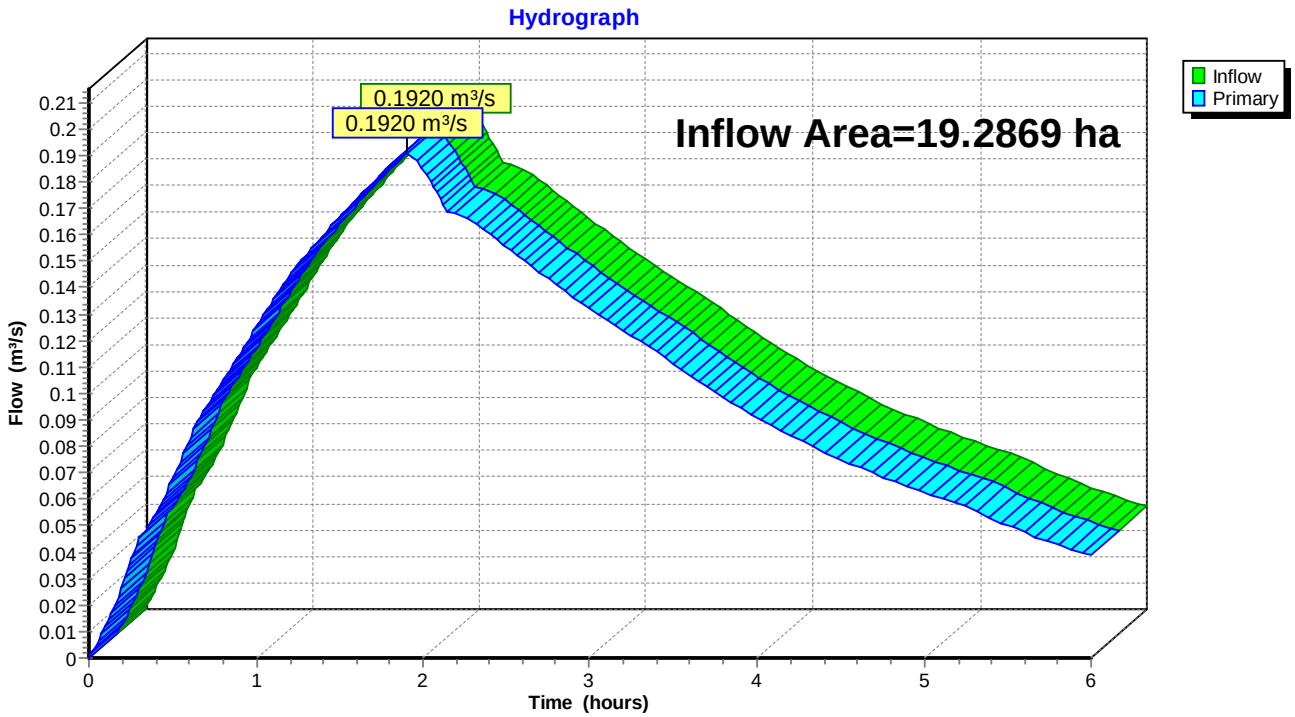


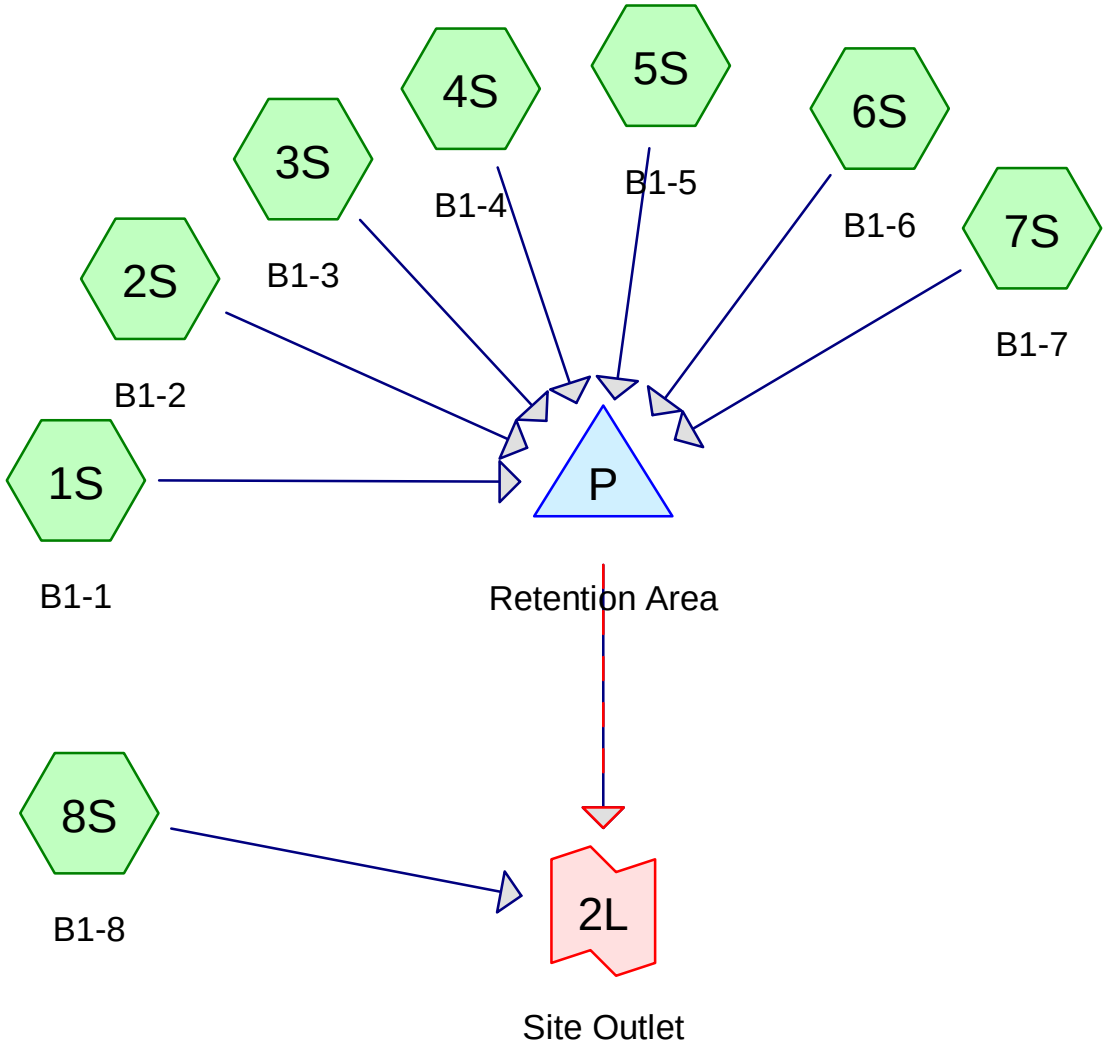
Summary for Link 2L: Site Outlet

Inflow Area = 19.2869 ha, 0.00% Impervious, Inflow Depth > 12 mm for 5-Year event
Inflow = 0.1920 m³/s @ 1.90 hrs, Volume= 2.246 Ml
Primary = 0.1920 m³/s @ 1.90 hrs, Volume= 2.246 Ml, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs

Link 2L: Site Outlet





Subcat Reach Pond Link

Routing Diagram for 191-08574-02 - PostDev_CTLD_v3
Prepared by WSP Canada Inc., Printed 10/13/2021
HydroCAD® 10.00-24 s/n 10698 © 2018 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (hectares)	C	Description (subcatchment-numbers)
0.8197	0.90	Asphalt / Concrete (2S, 3S, 4S, 5S, 6S, 7S)
14.2656	0.25	Grass (1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S)
2.6264	0.80	Gravel (1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S)
0.1513	0.01	Manure Tank (3S, 7S)
1.4239	0.90	Roof (1S, 2S, 3S, 4S, 5S, 6S, 7S)
19.2869	**0.40**	**TOTAL AREA**

Summary for Subcatchment 1S: B1-1

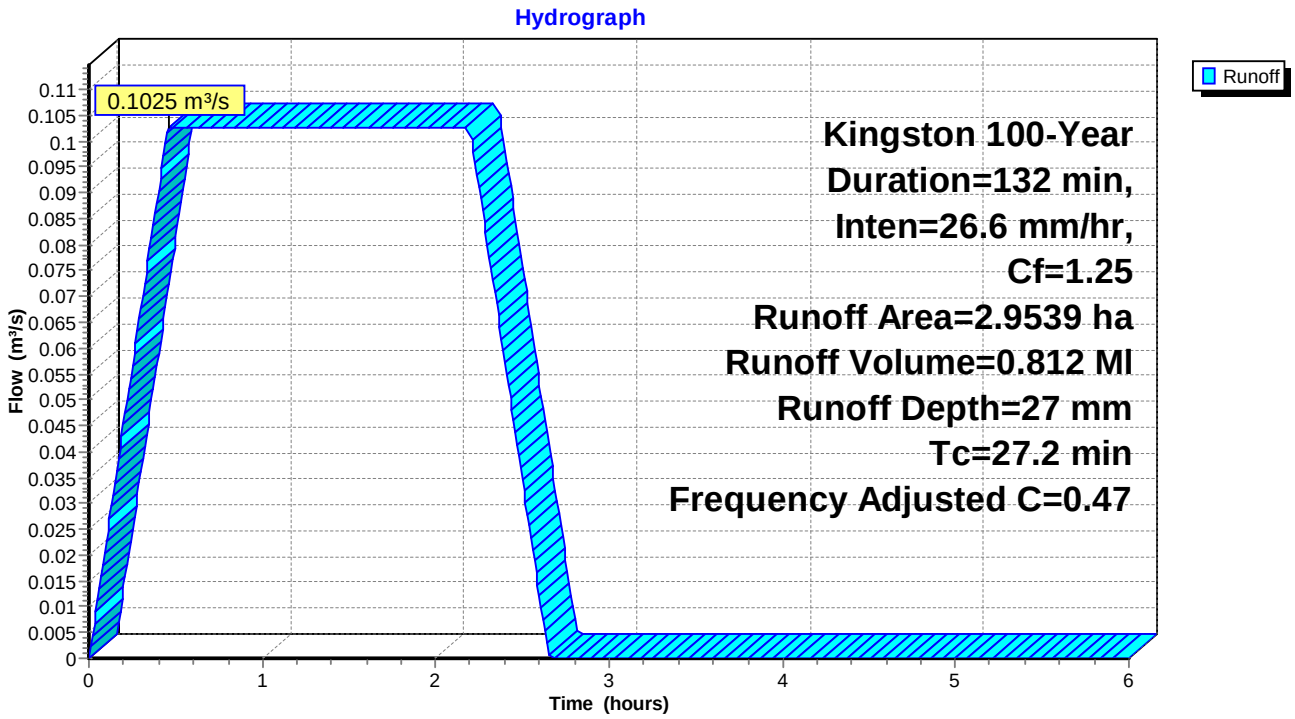
Runoff = 0.1025 m³/s @ 0.46 hrs, Volume= 0.812 Ml, Depth= 27 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=132 min, Inten=26.6 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.5181	0.80		Gravel
0.0000	0.90		Asphalt / Concrete
0.0000	0.01		Manure Tank
0.1539	0.90		Roof
2.2819	0.25		Grass
2.9539	0.38	0.47	Weighted Average, Frequency Adjusted
2.9539			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Per Ditch Design Sheet**

Subcatchment 1S: B1-1



Summary for Subcatchment 2S: B1-2

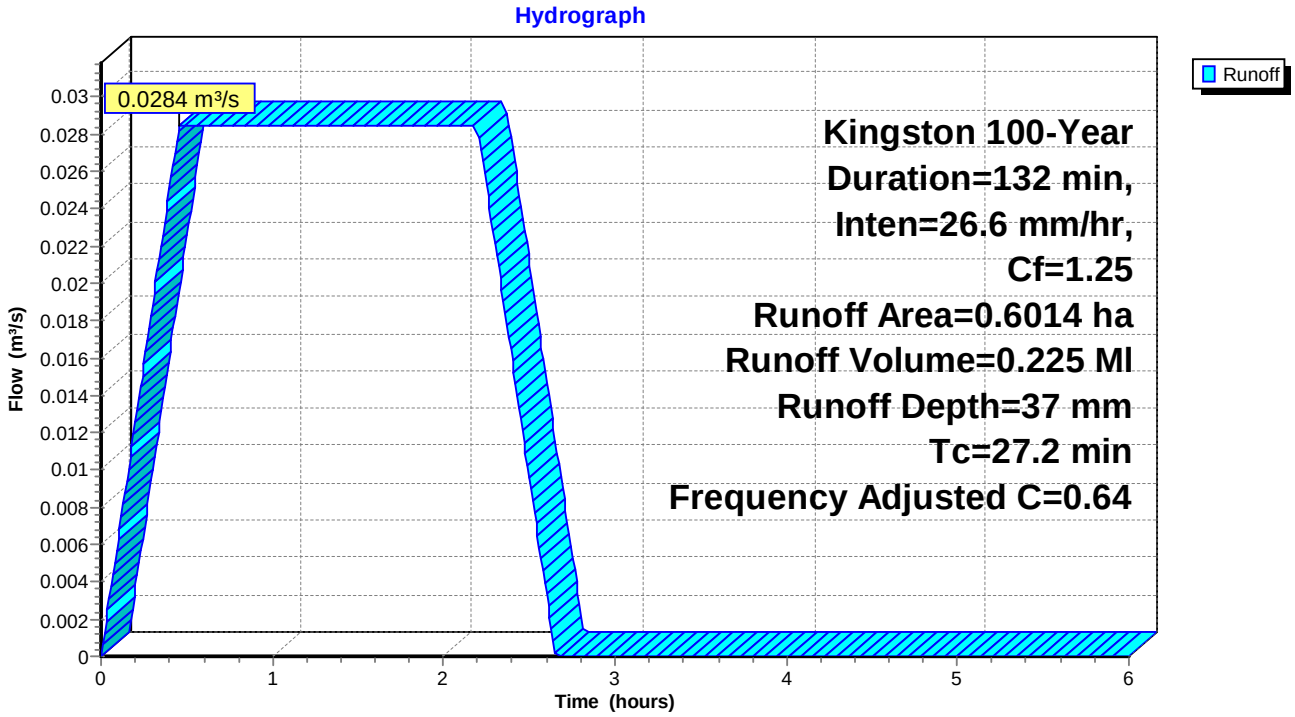
Runoff = 0.0284 m³/s @ 0.46 hrs, Volume= 0.225 Ml, Depth= 37 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=132 min, Inten=26.6 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.1347	0.80		Gravel
0.0046	0.90		Asphalt / Concrete
0.0000	0.01		Manure Tank
0.1175	0.90		Roof
0.3446	0.25		Grass
0.6014	0.51	0.64	Weighted Average, Frequency Adjusted
0.6014			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 2S: B1-2



Summary for Subcatchment 3S: B1-3

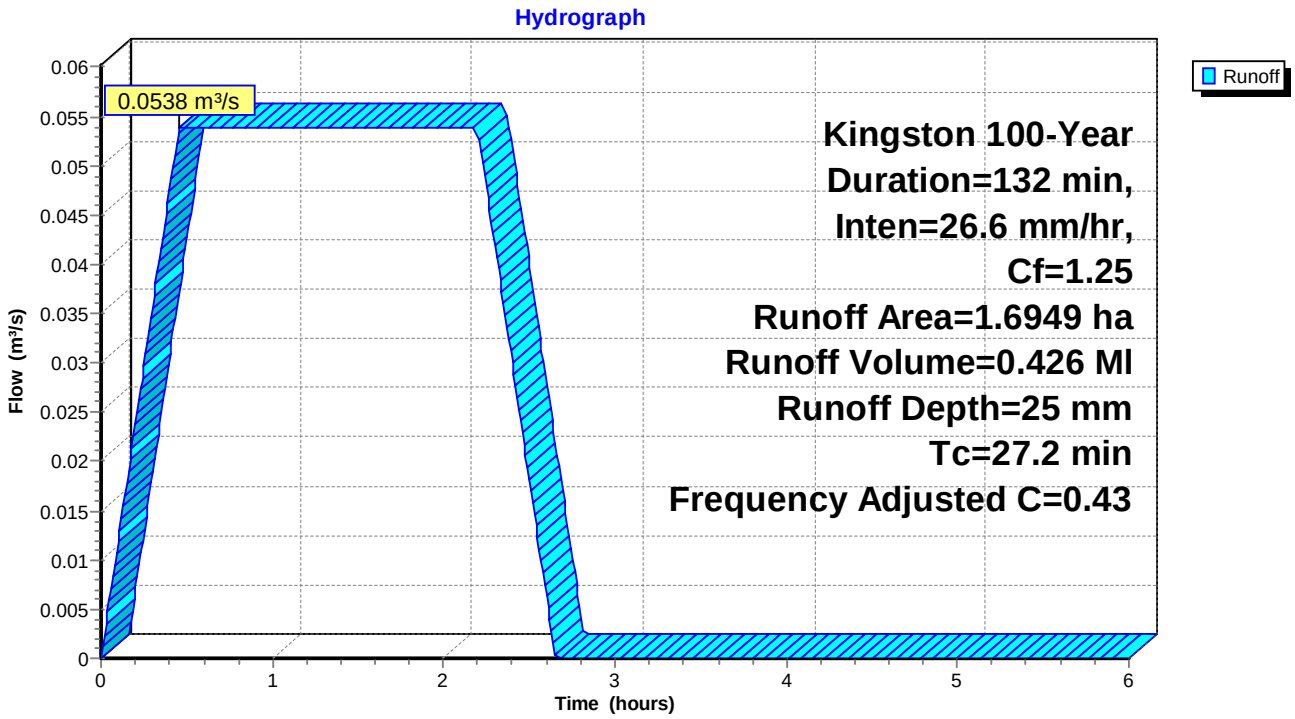
Runoff = 0.0538 m³/s @ 0.46 hrs, Volume= 0.426 Ml, Depth= 25 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=132 min, Inten=26.6 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.2254	0.80		Gravel
0.0070	0.90		Asphalt / Concrete
0.1239	0.01		Manure Tank
0.0809	0.90		Roof
1.2577	0.25		Grass
1.6949	0.34	0.43	Weighted Average, Frequency Adjusted
1.6949			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 3S: B1-3



Summary for Subcatchment 4S: B1-4

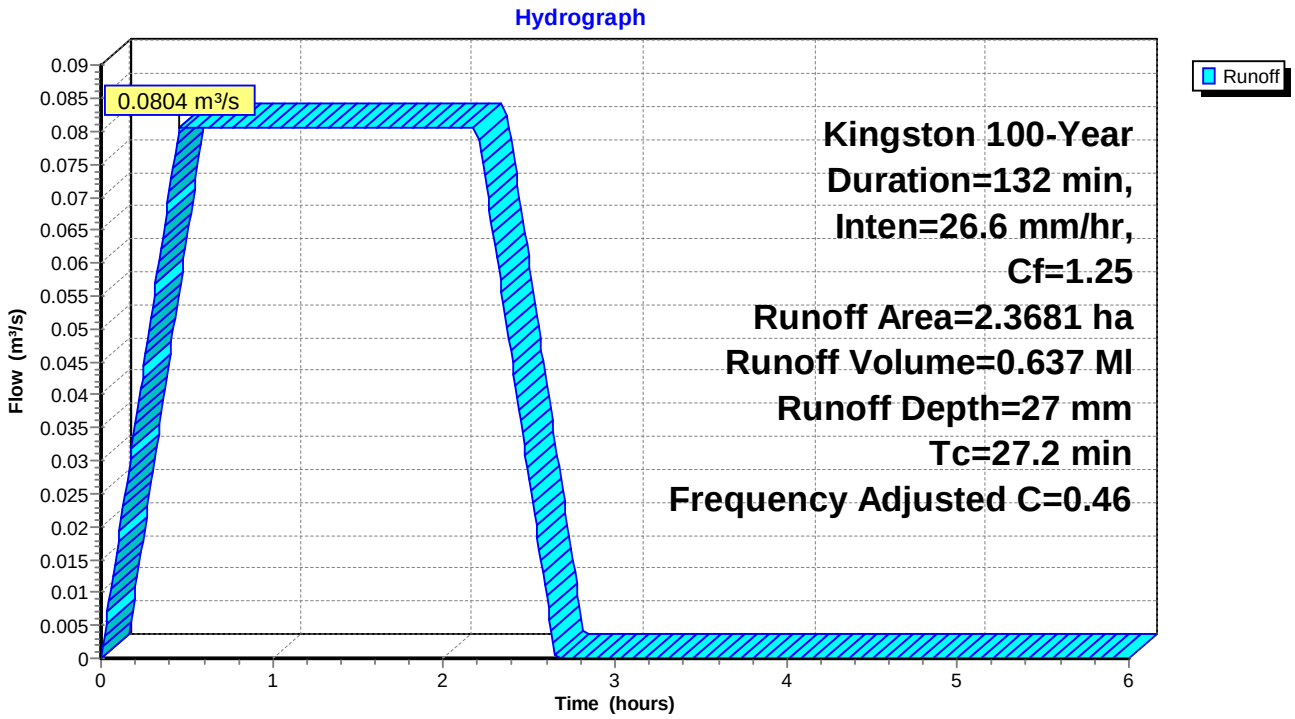
Runoff = 0.0804 m³/s @ 0.46 hrs, Volume= 0.637 Ml, Depth= 27 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=132 min, Inten=26.6 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.3290	0.80		Gravel
0.0268	0.90		Asphalt / Concrete
0.0000	0.01		Manure Tank
0.1249	0.90		Roof
1.8874	0.25		Grass
2.3681	0.37	0.46	Weighted Average, Frequency Adjusted
2.3681			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 4S: B1-4



Summary for Subcatchment 5S: B1-5

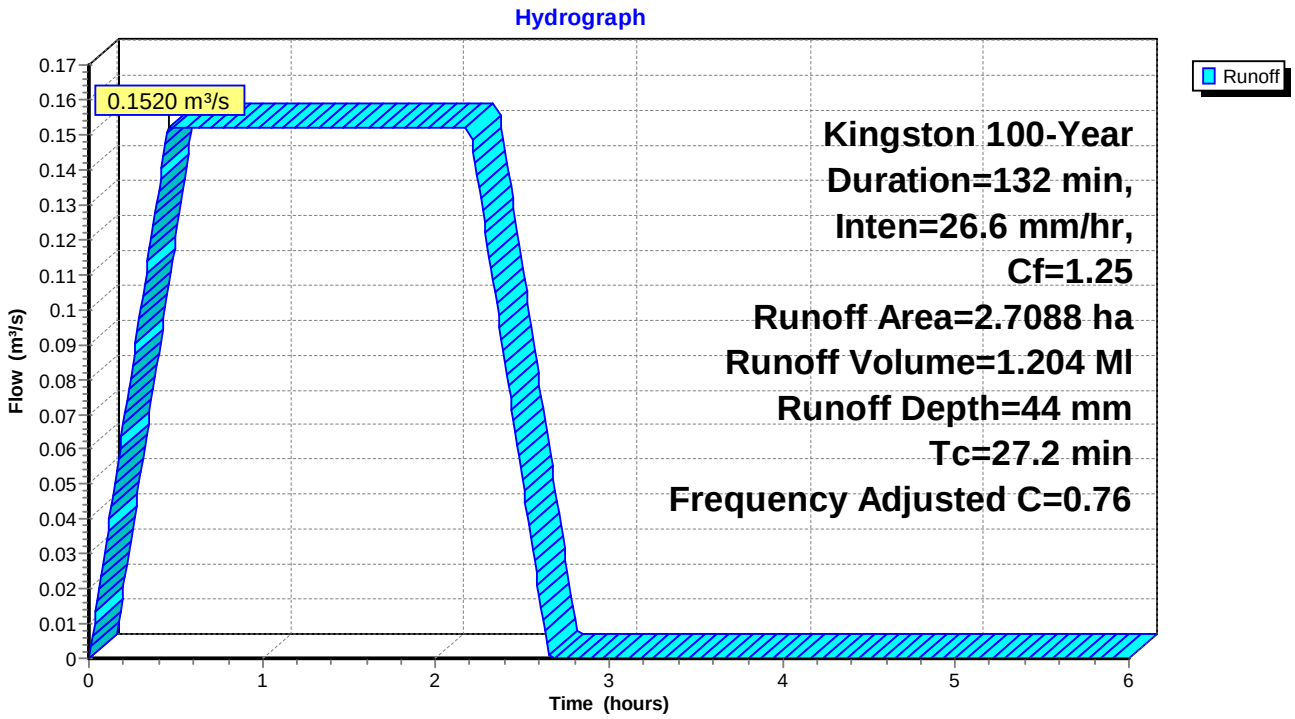
Runoff = 0.1520 m³/s @ 0.46 hrs, Volume= 1.204 Ml, Depth= 44 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=132 min, Inten=26.6 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.3775	0.80		Gravel
0.7307	0.90		Asphalt / Concrete
0.0000	0.01		Manure Tank
0.4356	0.90		Roof
1.1650	0.25		Grass
2.7088	0.61	0.76	Weighted Average, Frequency Adjusted
2.7088			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 5S: B1-5



Summary for Subcatchment 6S: B1-6

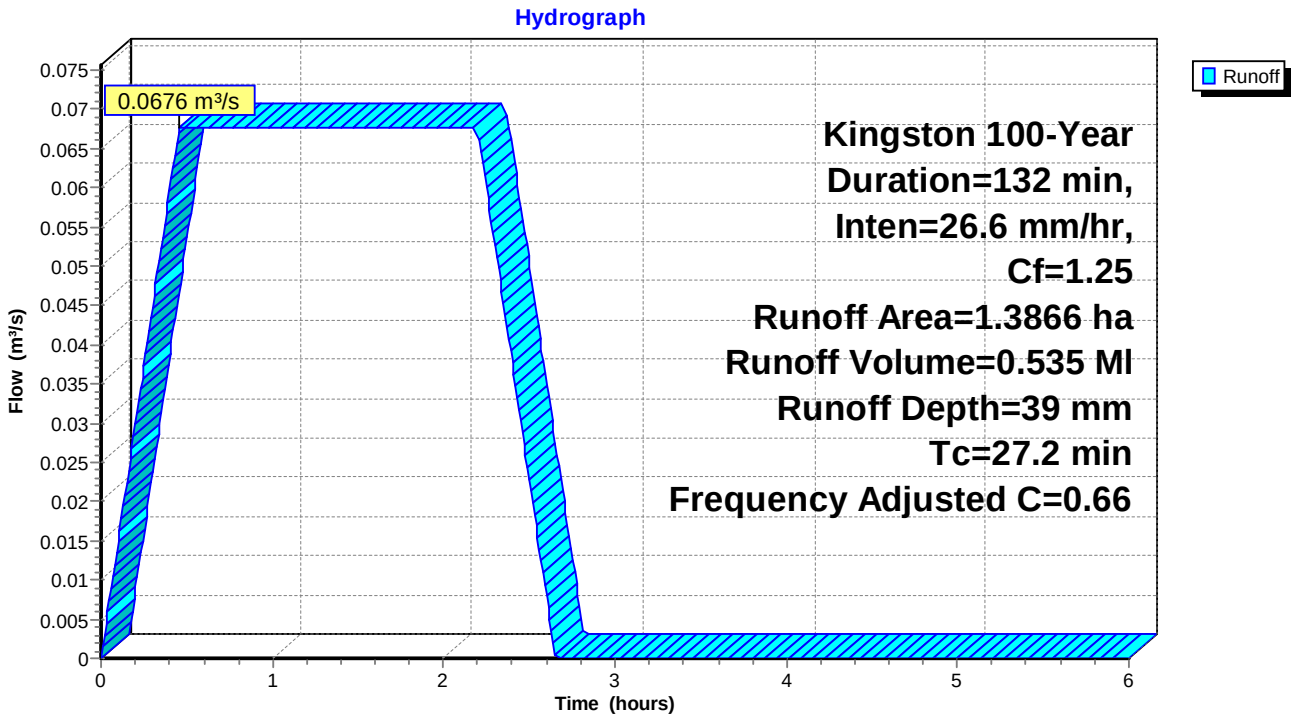
Runoff = 0.0676 m³/s @ 0.46 hrs, Volume= 0.535 Ml, Depth= 39 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=132 min, Inten=26.6 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.4917	0.80		Gravel
0.0289	0.90		Asphalt / Concrete
0.0000	0.01		Manure Tank
0.1561	0.90		Roof
0.7099	0.25		Grass
1.3866	0.53	0.66	Weighted Average, Frequency Adjusted
1.3866			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 6S: B1-6



Summary for Subcatchment 7S: B1-7

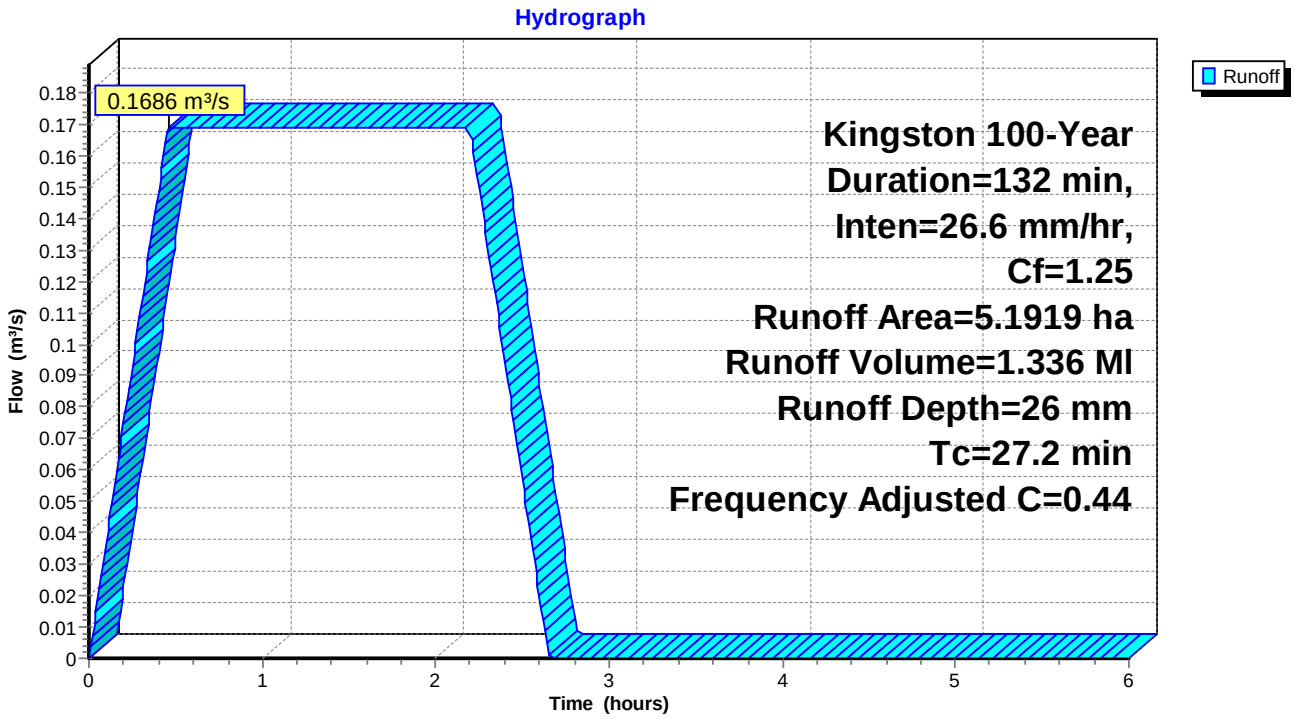
Runoff = 0.1686 m³/s @ 0.46 hrs, Volume= 1.336 Ml, Depth= 26 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=132 min, Inten=26.6 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.4987	0.80		Gravel
0.0217	0.90		Asphalt / Concrete
0.0274	0.01		Manure Tank
0.3550	0.90		Roof
4.2891	0.25		Grass
5.1919	0.35	0.44	Weighted Average, Frequency Adjusted
5.1919			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 7S: B1-7



Summary for Subcatchment 8S: B1-8

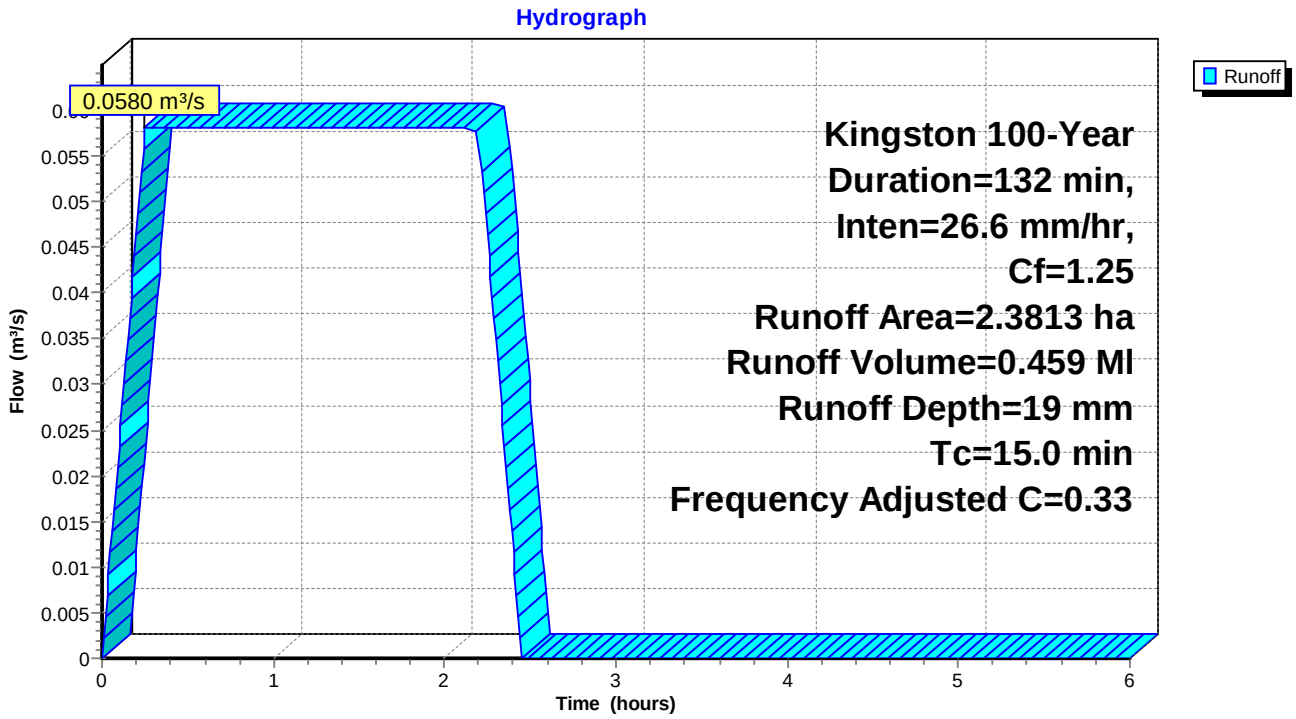
Runoff = 0.0580 m³/s @ 0.25 hrs, Volume= 0.459 Ml, Depth= 19 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=132 min, Inten=26.6 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.0513	0.80		Gravel
0.0000	0.90		Asphalt/Concrete
0.0000	0.01		Manure Tank
0.0000	0.90		Roof
2.3300	0.25		Grass
2.3813	0.26	0.33	Weighted Average, Frequency Adjusted
2.3813			100.00% Pervious Area

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

Subcatchment 8S: B1-8



Summary for Pond P: Retention Area

Inflow Area = 16.9056 ha, 0.00% Impervious, Inflow Depth = 31 mm for 100-Year event
Inflow = 0.6532 m³/s @ 0.46 hrs, Volume= 5.174 Ml
Outflow = 0.4381 m³/s @ 2.35 hrs, Volume= 4.235 Ml, Atten= 33%, Lag= 113.4 min
Primary = 0.2686 m³/s @ 2.35 hrs, Volume= 3.879 Ml
Secondary = 0.1695 m³/s @ 2.35 hrs, Volume= 0.356 Ml

Routing by Stor-Ind method, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Peak Elev= 123.729 m @ 2.35 hrs Surf.Area= 0.0 m² Storage= 3,388.7 m³

Plug-Flow detention time= 113.2 min calculated for 4.235 Ml (82% of inflow)
Center-of-Mass det. time= 101.0 min (180.6 - 79.6)

Volume	Invert	Avail.Storage	Storage Description
#1	123.100 m	3,743.6 m³	**Custom Stage Data** Listed below

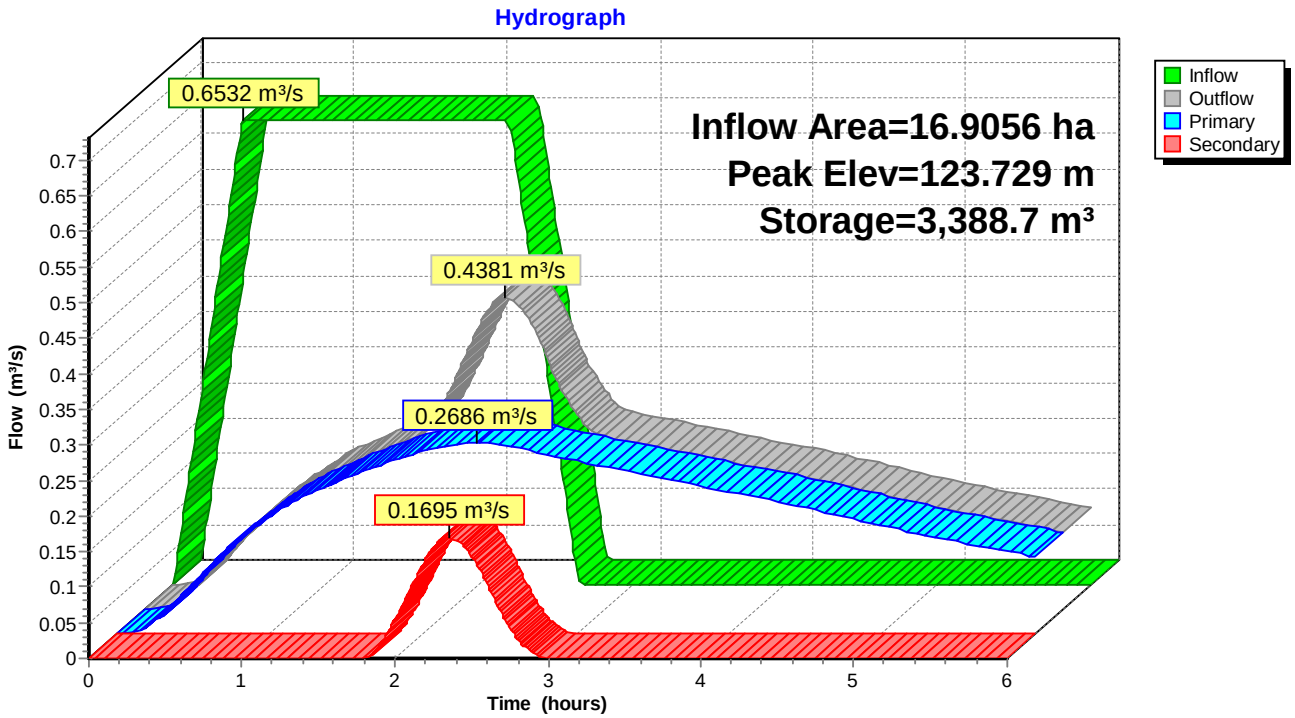
Elevation (meters)	Cum.Store (cubic-meters)
123.100	0.0
123.200	126.7
123.300	461.6
123.400	1,010.1
123.500	1,708.2
123.600	2,421.7
123.700	3,166.9
123.775	3,743.6

Device	Routing	Invert	Outlet Devices
#1	Primary	123.100 m	**450 mm Vert. Orifice/Grate** C= 0.600
#2	Secondary	123.660 m	**Custom Weir/Orifice, Cv= 1.45 (C= 1.81)**
			Head (meters) 0.000 0.500
			Width (meters) 5.00 8.00

Primary OutFlow Max=0.2686 m³/s @ 2.35 hrs HW=123.729 m (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 0.2686 m³/s @ 1.69 m/s)

Secondary OutFlow Max=0.1691 m³/s @ 2.35 hrs HW=123.729 m (Free Discharge)
└**2=Custom Weir/Orifice** (Weir Controls 0.1691 m³/s @ 0.47 m/s)

Pond P: Retention Area

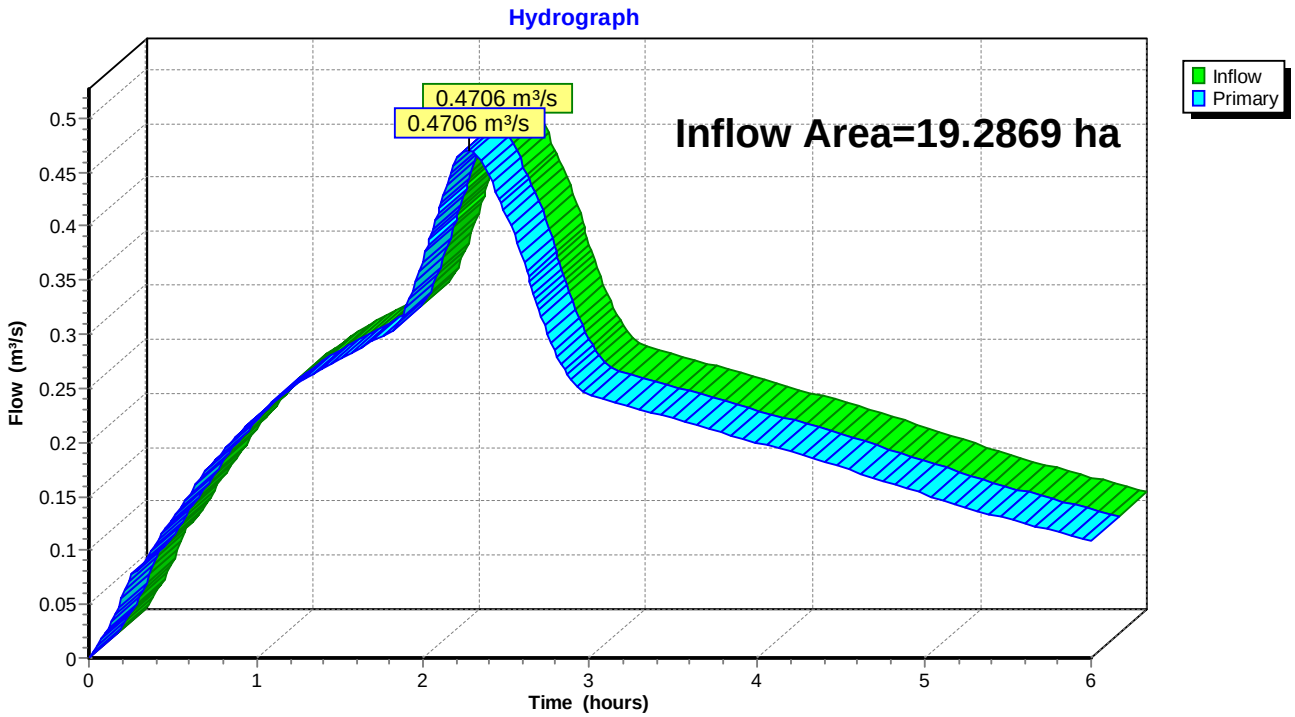


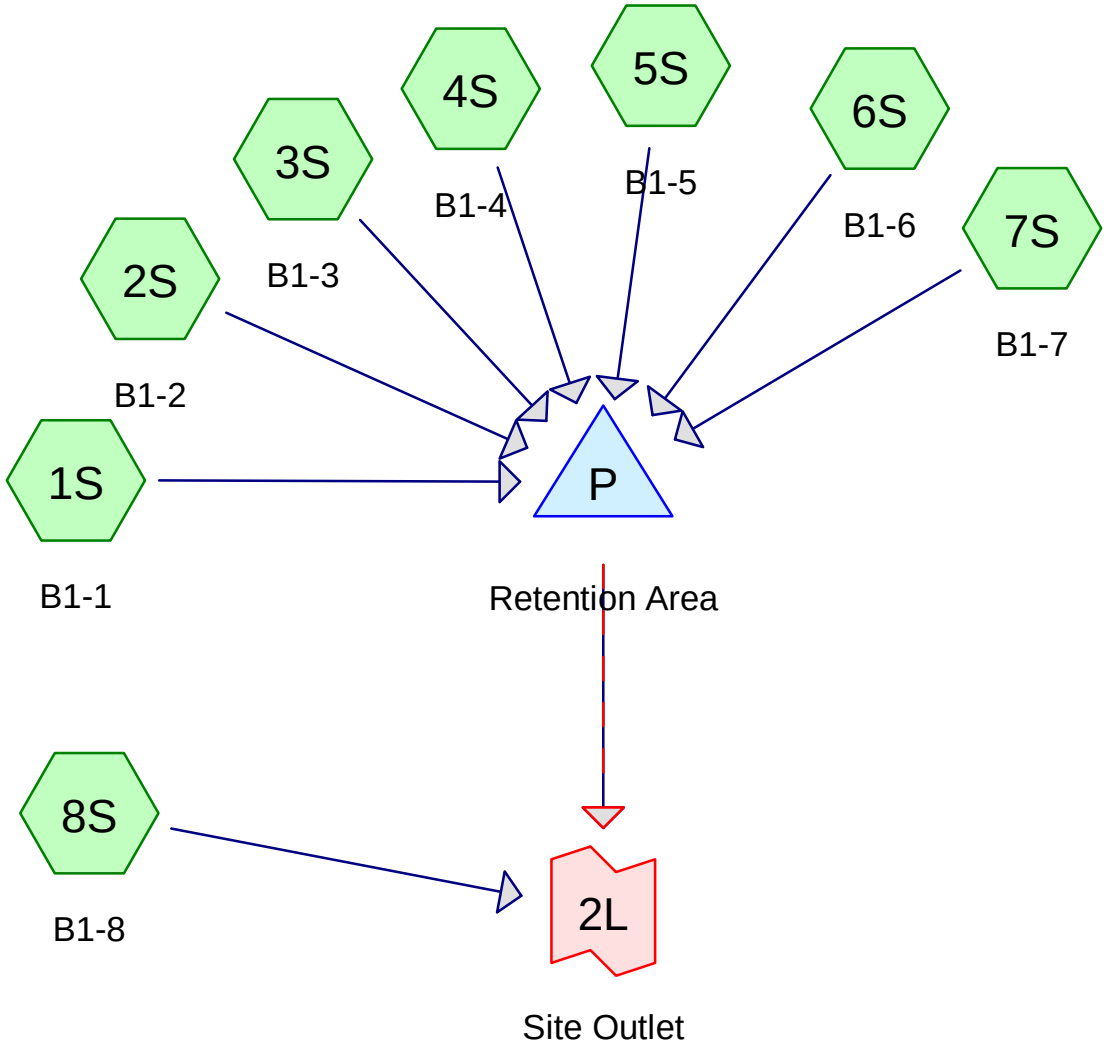
Summary for Link 2L: Site Outlet

Inflow Area = 19.2869 ha, 0.00% Impervious, Inflow Depth > 24 mm for 100-Year event
Inflow = 0.4706 m³/s @ 2.27 hrs, Volume= 4.694 Ml
Primary = 0.4706 m³/s @ 2.27 hrs, Volume= 4.694 Ml, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs

Link 2L: Site Outlet





Subcat Reach Pond Link

Routing Diagram for 191-08574-02 - PostDev_CTLD_v3
Prepared by WSP Canada Inc., Printed 10/13/2021
HydroCAD® 10.00-24 s/n 10698 © 2018 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (hectares)	C	Description (subcatchment-numbers)
0.8197	0.90	Asphalt / Concrete (2S, 3S, 4S, 5S, 6S, 7S)
14.2656	0.25	Grass (1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S)
2.6264	0.80	Gravel (1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S)
0.1513	0.01	Manure Tank (3S, 7S)
1.4239	0.90	Roof (1S, 2S, 3S, 4S, 5S, 6S, 7S)
19.2869	**0.40**	**TOTAL AREA**

Summary for Subcatchment 1S: B1-1

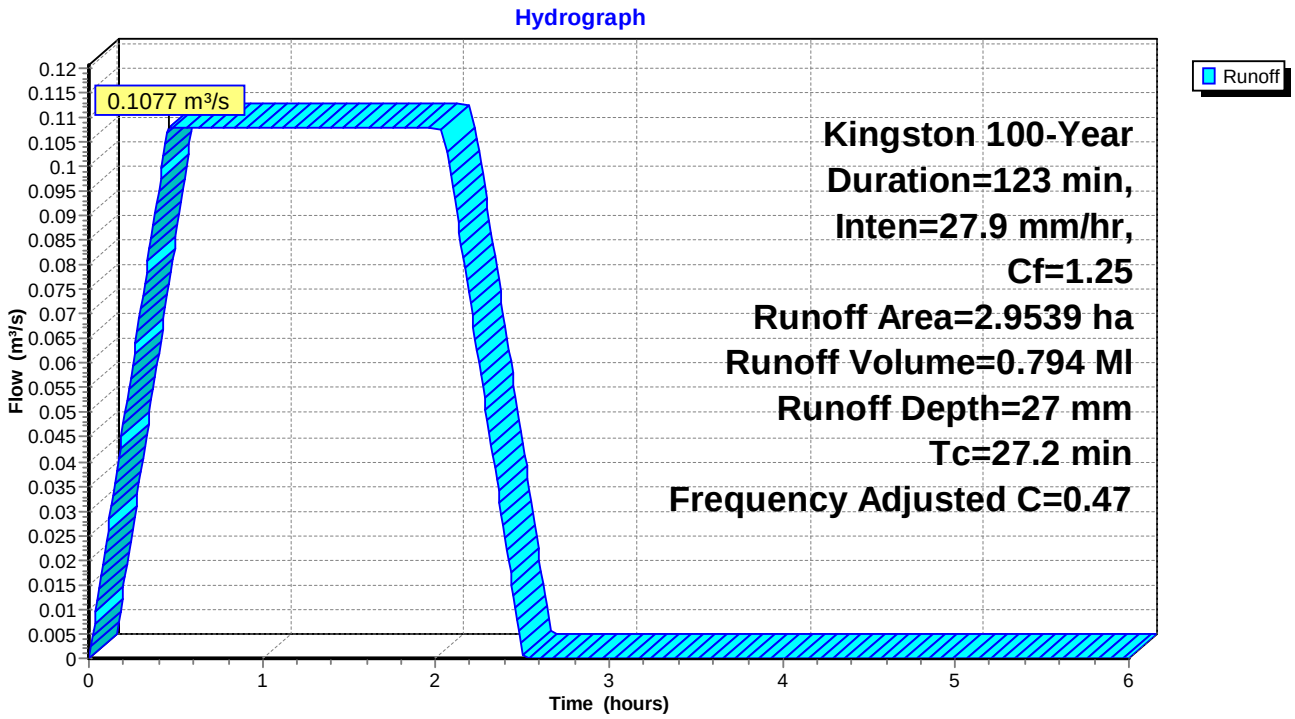
Runoff = 0.1077 m³/s @ 0.46 hrs, Volume= 0.794 Ml, Depth= 27 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=123 min, Inten=27.9 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.5181	0.80		Gravel
0.0000	0.90		Asphalt / Concrete
0.0000	0.01		Manure Tank
0.1539	0.90		Roof
2.2819	0.25		Grass
2.9539	0.38	0.47	Weighted Average, Frequency Adjusted
2.9539			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Per Ditch Design Sheet**

Subcatchment 1S: B1-1



Summary for Subcatchment 2S: B1-2

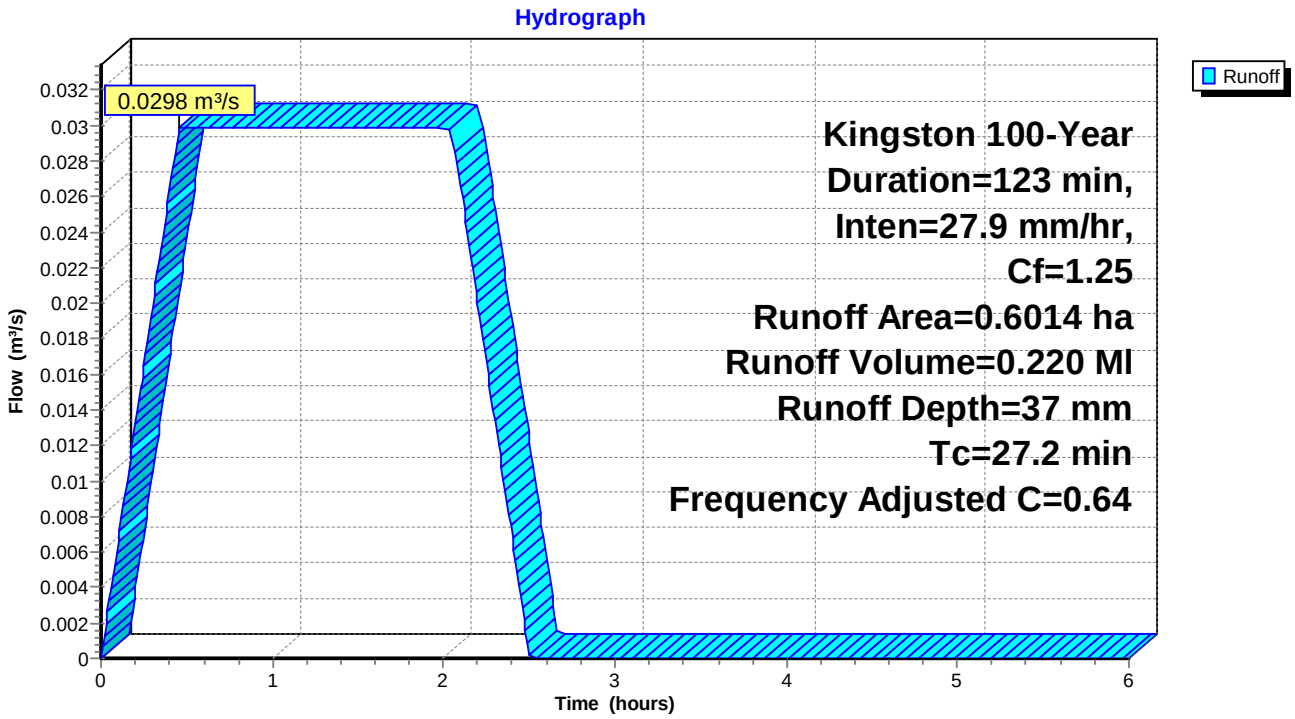
Runoff = 0.0298 m³/s @ 0.46 hrs, Volume= 0.220 Ml, Depth= 37 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=123 min, Inten=27.9 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.1347	0.80		Gravel
0.0046	0.90		Asphalt / Concrete
0.0000	0.01		Manure Tank
0.1175	0.90		Roof
0.3446	0.25		Grass
0.6014	0.51	0.64	Weighted Average, Frequency Adjusted
0.6014			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 2S: B1-2



Summary for Subcatchment 3S: B1-3

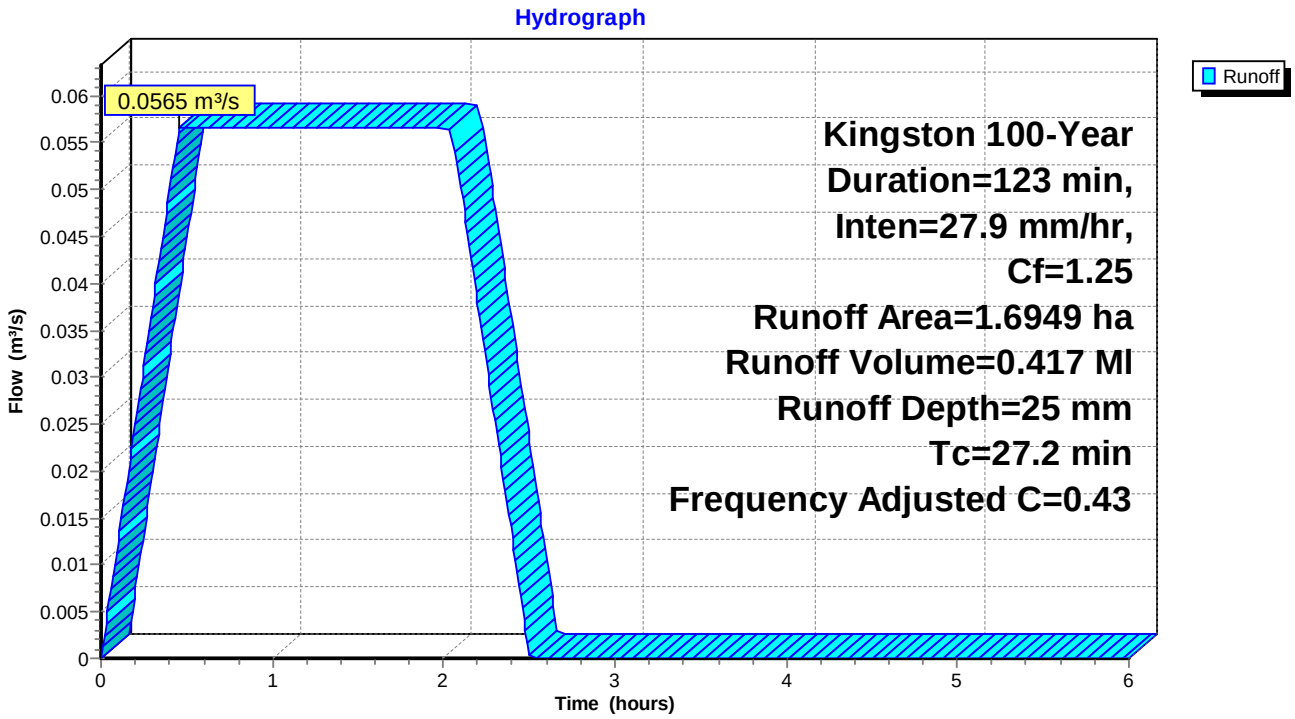
Runoff = 0.0565 m³/s @ 0.46 hrs, Volume= 0.417 Ml, Depth= 25 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=123 min, Inten=27.9 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.2254	0.80		Gravel
0.0070	0.90		Asphalt / Concrete
0.1239	0.01		Manure Tank
0.0809	0.90		Roof
1.2577	0.25		Grass
1.6949	0.34	0.43	Weighted Average, Frequency Adjusted
1.6949			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 3S: B1-3



Summary for Subcatchment 4S: B1-4

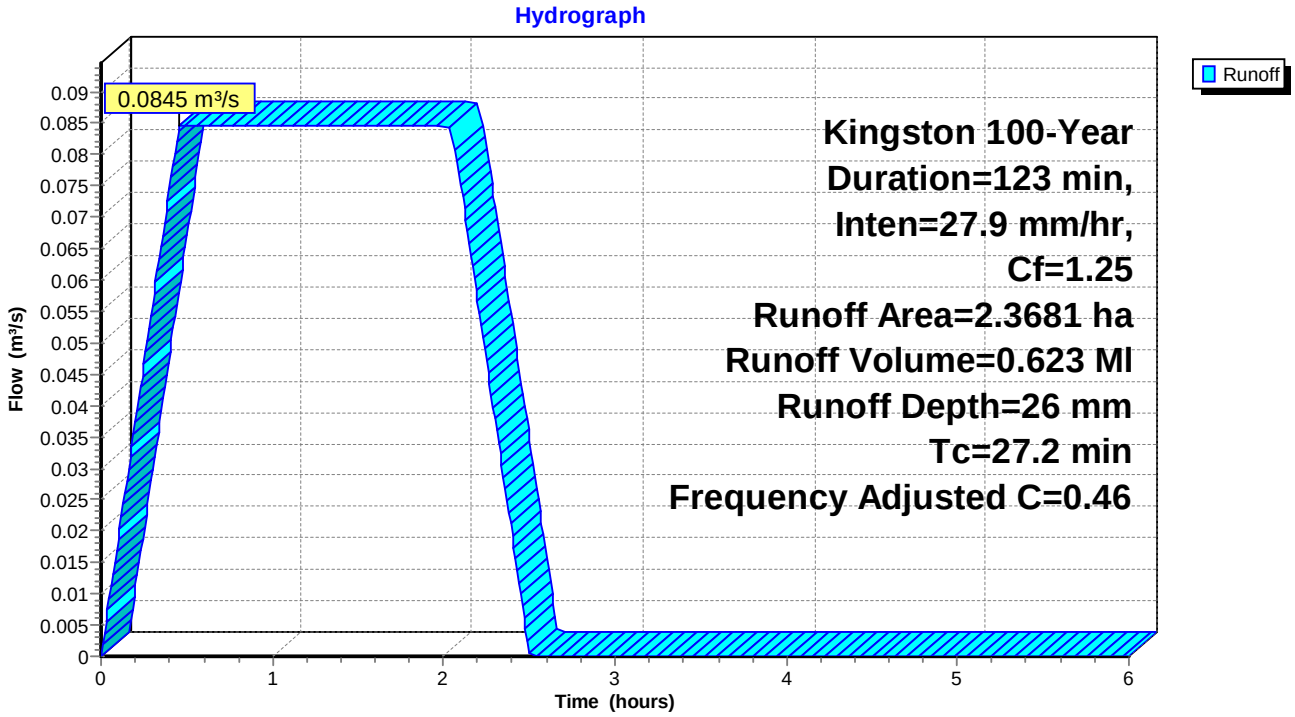
Runoff = 0.0845 m³/s @ 0.46 hrs, Volume= 0.623 Ml, Depth= 26 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=123 min, Inten=27.9 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.3290	0.80		Gravel
0.0268	0.90		Asphalt / Concrete
0.0000	0.01		Manure Tank
0.1249	0.90		Roof
1.8874	0.25		Grass
2.3681	0.37	0.46	Weighted Average, Frequency Adjusted
2.3681			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 4S: B1-4



Summary for Subcatchment 5S: B1-5

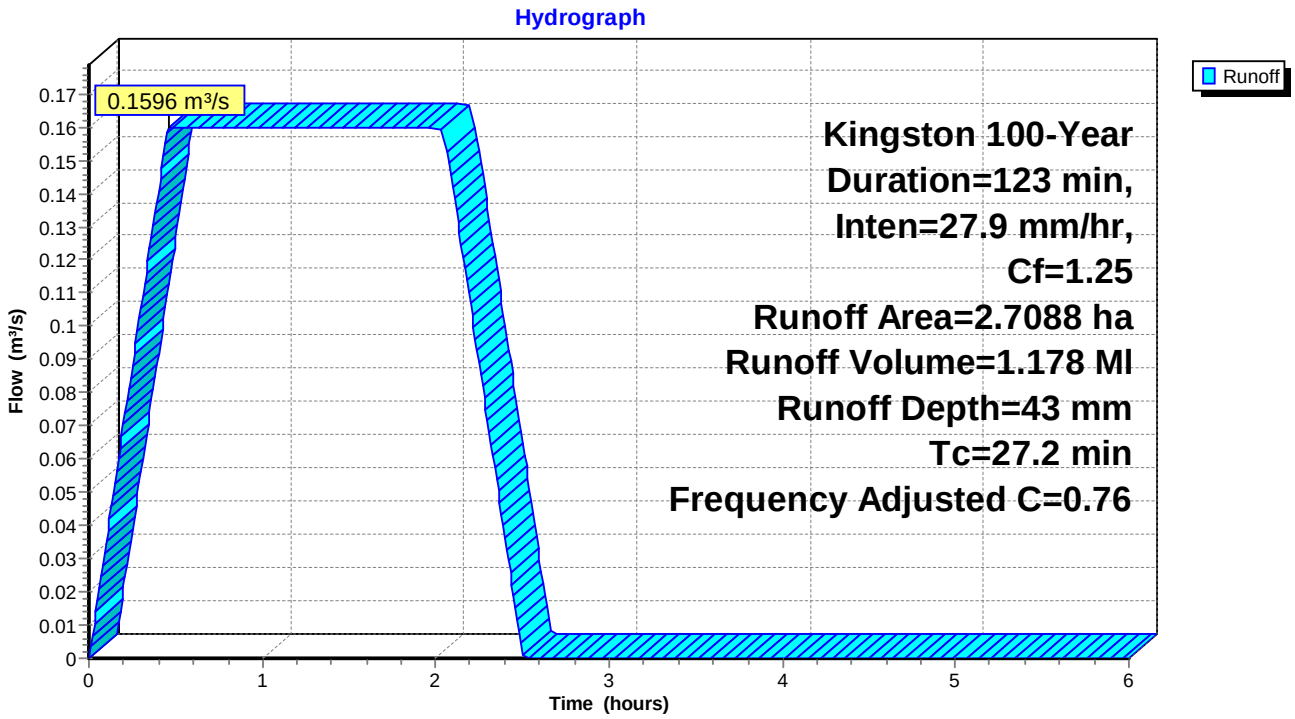
Runoff = 0.1596 m³/s @ 0.46 hrs, Volume= 1.178 Ml, Depth= 43 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=123 min, Inten=27.9 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.3775	0.80		Gravel
0.7307	0.90		Asphalt / Concrete
0.0000	0.01		Manure Tank
0.4356	0.90		Roof
1.1650	0.25		Grass
2.7088	0.61	0.76	Weighted Average, Frequency Adjusted
2.7088			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 5S: B1-5



Summary for Subcatchment 6S: B1-6

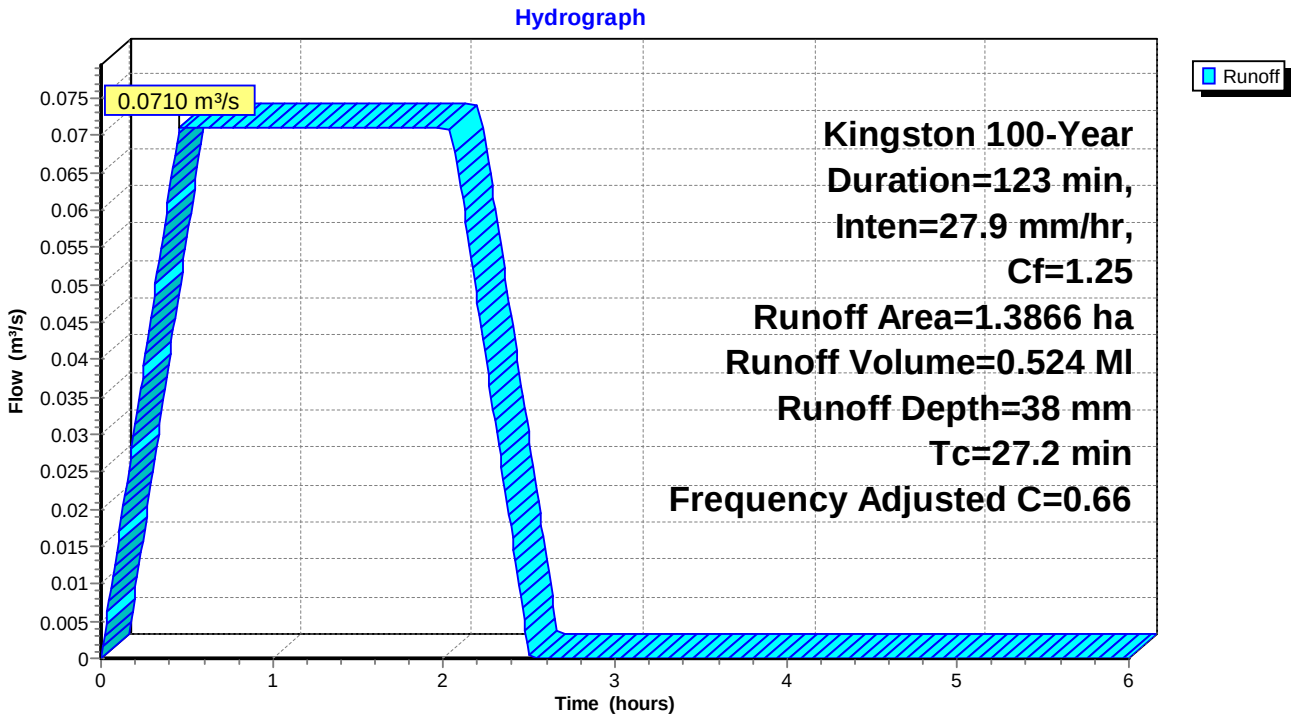
Runoff = 0.0710 m³/s @ 0.46 hrs, Volume= 0.524 Ml, Depth= 38 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=123 min, Inten=27.9 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.4917	0.80		Gravel
0.0289	0.90		Asphalt / Concrete
0.0000	0.01		Manure Tank
0.1561	0.90		Roof
0.7099	0.25		Grass
1.3866	0.53	0.66	Weighted Average, Frequency Adjusted
1.3866			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 6S: B1-6



Summary for Subcatchment 7S: B1-7

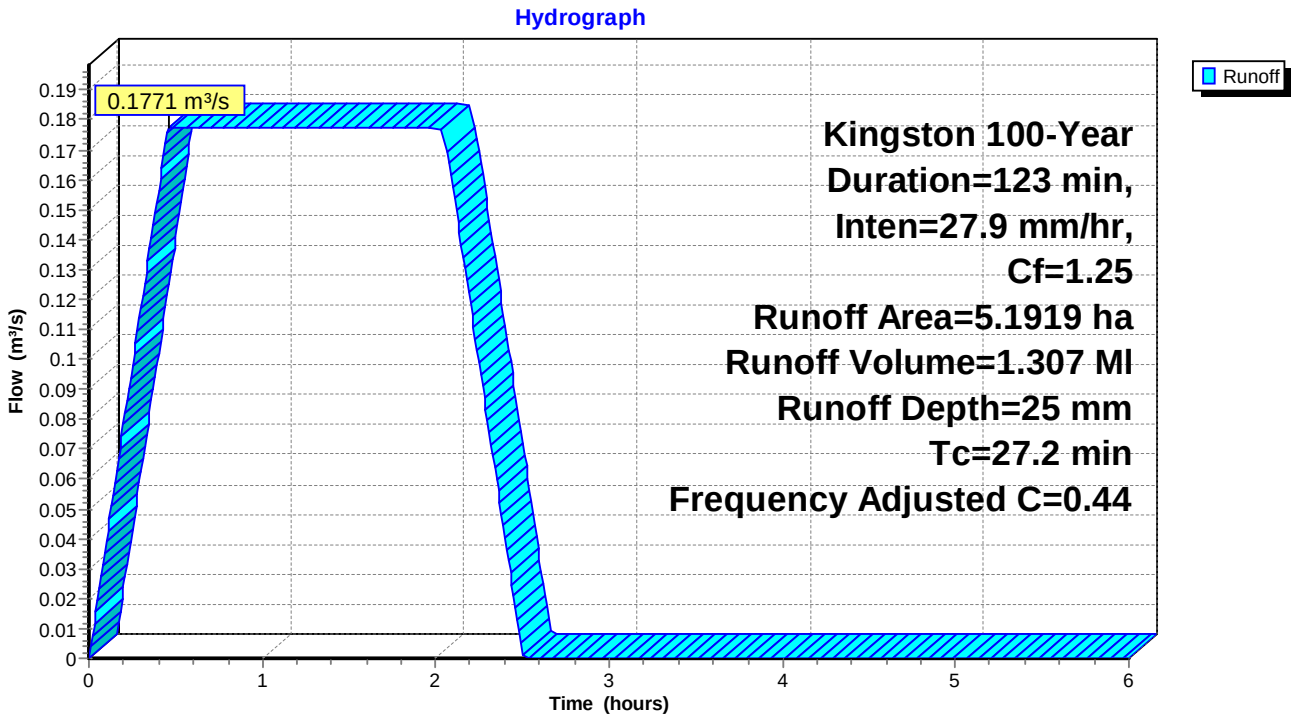
Runoff = 0.1771 m³/s @ 0.46 hrs, Volume= 1.307 Ml, Depth= 25 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=123 min, Inten=27.9 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.4987	0.80		Gravel
0.0217	0.90		Asphalt / Concrete
0.0274	0.01		Manure Tank
0.3550	0.90		Roof
4.2891	0.25		Grass
5.1919	0.35	0.44	Weighted Average, Frequency Adjusted
5.1919			100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
27.2					**Direct Entry, Pert Ditch Design Sheet**

Subcatchment 7S: B1-7



Summary for Subcatchment 8S: B1-8

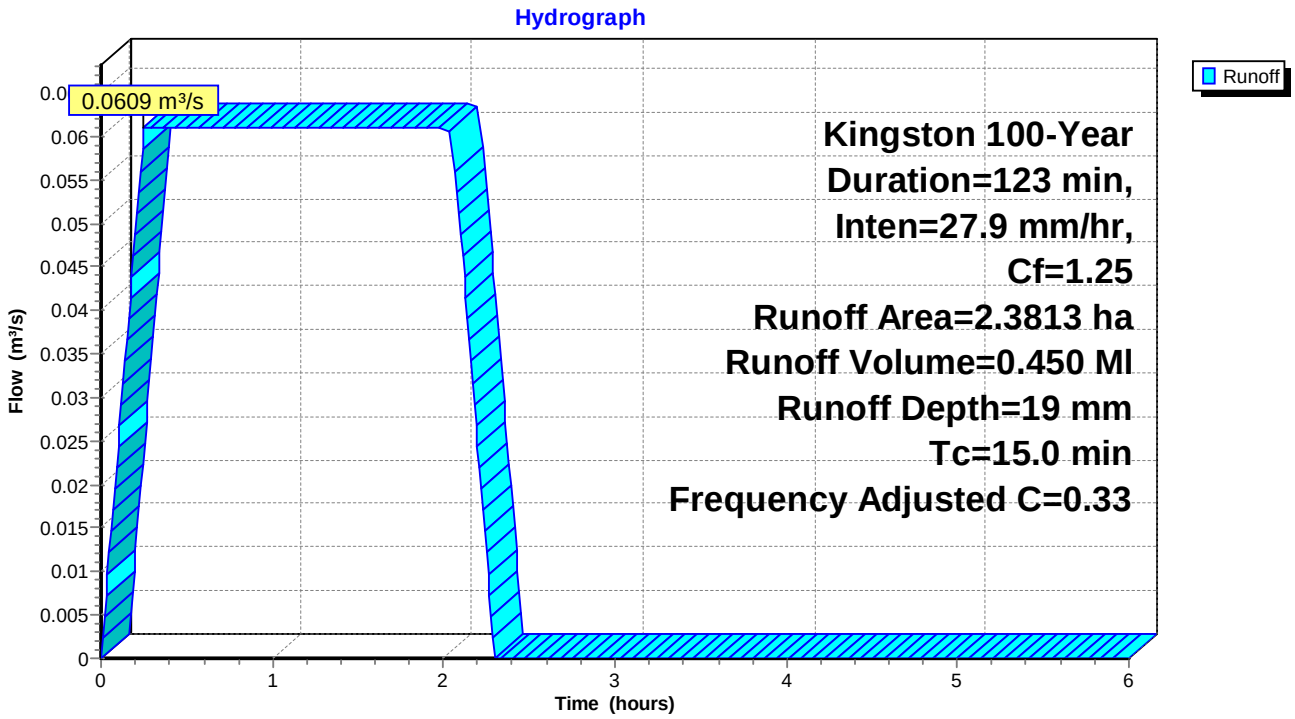
Runoff = 0.0609 m³/s @ 0.25 hrs, Volume= 0.450 Ml, Depth= 19 mm

Runoff by Rational method, Rise/Fall=1.0/1.0 xTc, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Kingston 100-Year Duration=123 min, Inten=27.9 mm/hr, Cf=1.25

Area (ha)	C	Adj	Description
0.0513	0.80		Gravel
0.0000	0.90		Asphalt/Concrete
0.0000	0.01		Manure Tank
0.0000	0.90		Roof
2.3300	0.25		Grass
2.3813	0.26	0.33	Weighted Average, Frequency Adjusted
2.3813			100.00% Pervious Area

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

Subcatchment 8S: B1-8



Summary for Pond P: Retention Area

Inflow Area = 16.9056 ha, 0.00% Impervious, Inflow Depth = 30 mm for 100-Year event
Inflow = 0.6862 m³/s @ 0.46 hrs, Volume= 5.064 Ml
Outflow = 0.4388 m³/s @ 2.21 hrs, Volume= 4.179 Ml, Atten= 36%, Lag= 105.2 min
Primary = 0.2687 m³/s @ 2.21 hrs, Volume= 3.836 Ml
Secondary = 0.1702 m³/s @ 2.21 hrs, Volume= 0.344 Ml

Routing by Stor-Ind method, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs
Peak Elev= 123.729 m @ 2.21 hrs Surf.Area= 0.0 m² Storage= 3,390.0 m³

Plug-Flow detention time= 113.6 min calculated for 4.179 Ml (83% of inflow)
Center-of-Mass det. time= 102.6 min (177.7 - 75.1)

Volume	Invert	Avail.Storage	Storage Description
#1	123.100 m	3,743.6 m³	**Custom Stage Data** Listed below

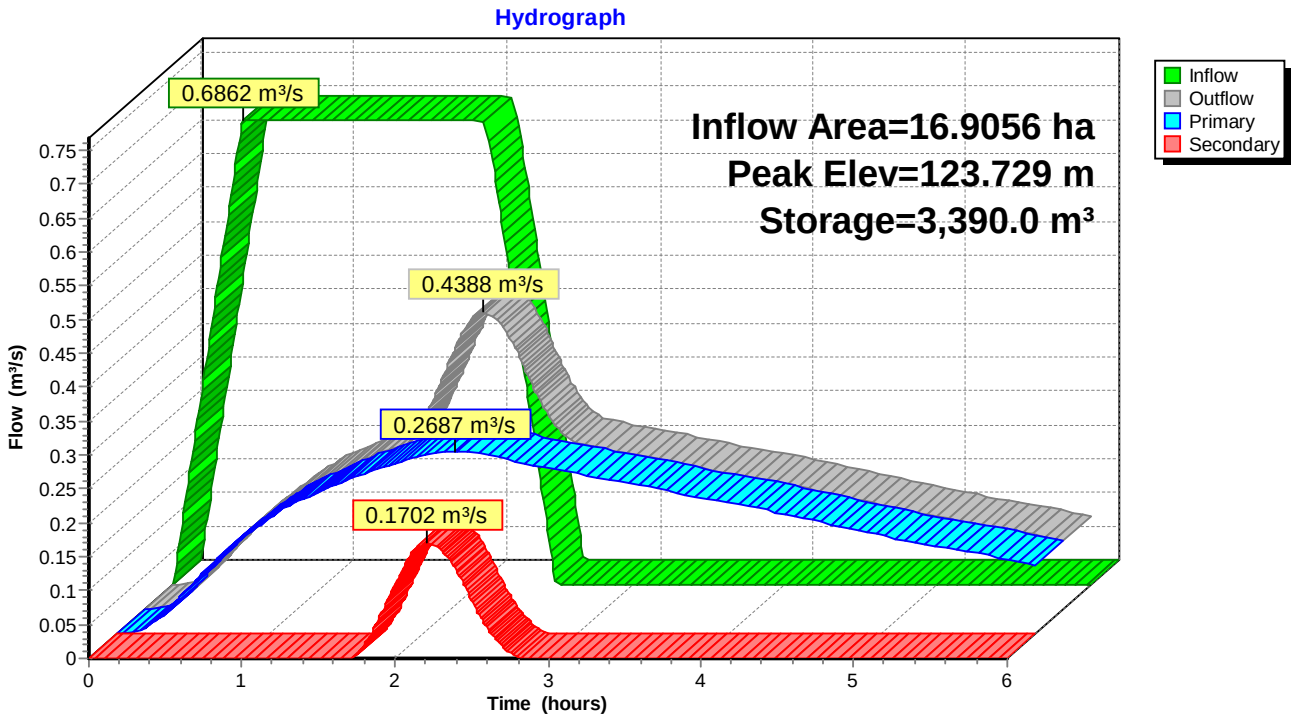
Elevation (meters)	Cum.Store (cubic-meters)
123.100	0.0
123.200	126.7
123.300	461.6
123.400	1,010.1
123.500	1,708.2
123.600	2,421.7
123.700	3,166.9
123.775	3,743.6

Device	Routing	Invert	Outlet Devices
#1	Primary	123.100 m	**450 mm Vert. Orifice/Grate** C= 0.600
#2	Secondary	123.660 m	**Custom Weir/Orifice, Cv= 1.45 (C= 1.81)**
			Head (meters) 0.000 0.500
			Width (meters) 5.00 8.00

Primary OutFlow Max=0.2687 m³/s @ 2.21 hrs HW=123.729 m (Free Discharge)
└**1=Orifice/Grate** (Orifice Controls 0.2687 m³/s @ 1.69 m/s)

Secondary OutFlow Max=0.1697 m³/s @ 2.21 hrs HW=123.729 m (Free Discharge)
└**2=Custom Weir/Orifice** (Weir Controls 0.1697 m³/s @ 0.47 m/s)

Pond P: Retention Area



Summary for Link 2L: Site Outlet

Inflow Area = 19.2869 ha, 0.00% Impervious, Inflow Depth > 24 mm for 100-Year event
Inflow = 0.4695 m³/s @ 2.14 hrs, Volume= 4.629 Ml
Primary = 0.4695 m³/s @ 2.14 hrs, Volume= 4.629 Ml, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-6.00 hrs, dt= 0.01 hrs

Link 2L: Site Outlet