Taves Management

Stormwater Management Plan
SE ¼ 29-40-22 W4

TAGISH ENGINEERING LTD

Issued for Approval

TAV01

April, 2019

Revisions:

Date	Description
March 2019	Issued for Review
April 2019	Issued for Approval

Corporate Authorization:

Prepared by Chad Carmichael, P.Tech. (Eng.)

Reviewed by Greg Smith P. Eng.

PERMIT TO PRACTICE
TAGISH ENGINEERING LTD.
Signature
Date April 11, 2019
PERMIT NUMBER: P 3686
The Association of Professional Engineers, Geologists and Geophysicists of Alberta

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Contents

Images:

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1.0 Location

The property in question is the SE ¼ 29-40-22 W4 (referred to from here on as SE29) directly west of the Village of Mirror.

2.0 Background

The detailed design of this site is currently underway. The purpose of the Storm Water Management Plan is to identify the following:

A. Pre-Development release rate
B. Post-Development release rate
C. Pond volumes
D. Existing and proposed outlets
E. Wetlands
F. BMP's for water quality

3.0 Drainage Patterns

This report outlines the existing and proposed drainage patterns for north SE 29. The existing contours are based on LIDAR data and Drone survey. The proposed grades are based on preliminary design grades, which would closely match the existing contours when possible. To acquire Alberta Environment approval for the Storm Water Management Plan, it is necessary that the post development runoff be controlled to an acceptable rate so that there will be negligible impact downstream due to the proposed development.

3.1 Stormwater Master Drainage Plan

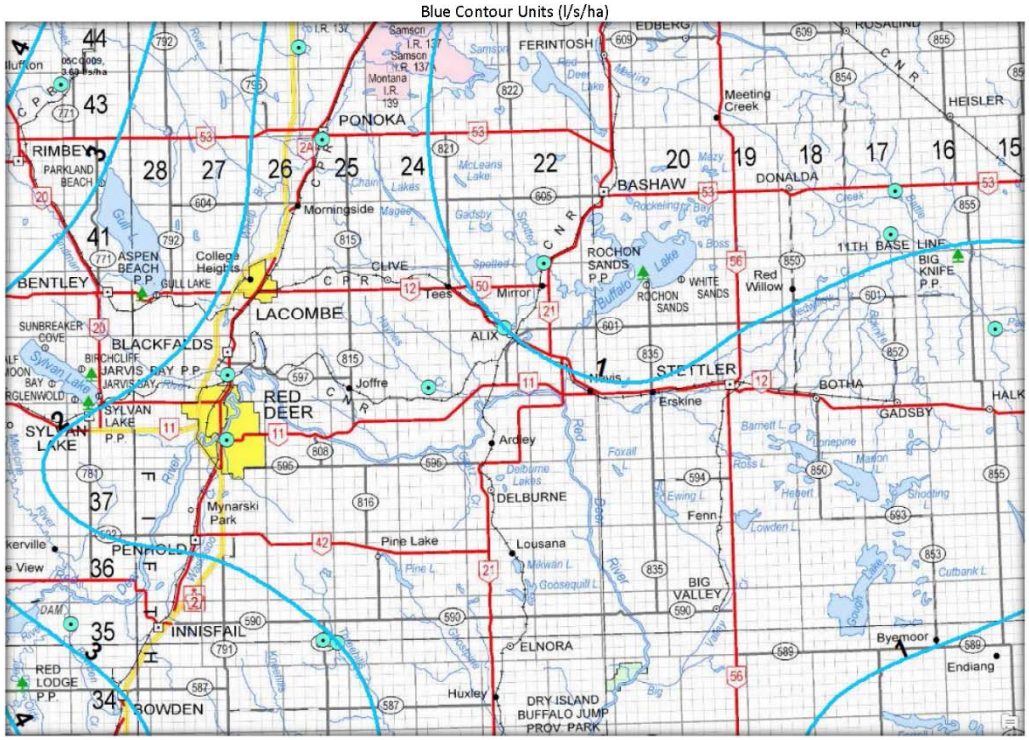
Alberta Environment has completed some preliminary stream flow analysis in this area and are recommending that it be used as a guideline and not be taken as absolute. The following image "Image A" presents the results from the regional analysis supplied by Alberta Environment. The contour intervals are in L/s/ha and represent approximate pre-development rates for these areas.

The stream flow analysis results show a pre-development flow rate of approximately 1 l/s/ha. The Stormwater Management Plan being proposed for Taves Development will keep this in mind while calculating the pre/post development models.

Image A *– Alberta Environment Regional Analysis Mapping*

Alberta Environment and Parks Red Deer North Sask Region Red Deer, Alberta	Terry Chamulak, Regional Hydrologist Recommended 1:100 year design predevelopment runoff rate map Feb 28, 2019

Map Location East-Central Alberta
Blue Contour Units (l/s/ha)



3.2 Existing Site

3.2.1 Existing Basin Analysis

The site is currently open fields with minimal development; one acreage, one oil lease and an existing railway spur. To the north is undeveloped land with the exception of one residential development. Directly East is a large rail yard then the Village of Mirror. To the West is an undeveloped site except for a fish pond and to the South is farm land. A reconnaissance survey of the property was completed and there appears to be no culverts entering or leaving the property under any of the adjacent roadways or railways. *(See Figure 2 Pre-Development Basins, Attached in Appendix A).*

Running from south to north on the west side of the SE29 is an open channel which is part of the Parlby Creek – Buffalo Lake Water Management Project. This channel/creek transports water from The Red Deer River to Buffalo Lake.

Aerial photography and existing ground contours were used to analyze the ground cover and site drainage. The basin boundaries are delineated as well as the time of concentration for each basin. The pre-development flows have been calculated based on what the site may have been like prior to any development. Where man has interfered to a point where water pools or is diverted it is recognized that this will impact drainage and has been modeled accordingly.

3.2.2 Basin Outlets

The following describes the outlets from each basin and reference *Figure 3, Basin Outlets, Attached in Appendix A.*

- Sub-basin# A1 drains to the existing Parlby Creek
- Sub-basin# A2 drains to the existing Parlby Creek
- Sub-basin# A3 drains to the existing Parlby Creek
- Sub-basin# A4 drains to the existing Parlby Creek
- Sub-basin# A5 will retain water then spill over into Sub Basin A2
- Sub-basin# A6 will retain water then spill over into Sub Basin A5
- Sub-basin# A7 drains towards and joins up with A8 then to Sub-Basin A2
- Sub-basin# A8 will retain water then spill over into Sub Basin A2

3.2.3 Wetland Assessment

Tagish has completed some preliminary steps toward completing the wetland assessment. First, we viewed the area using Alberta Environments Wetland Assessment Tool. No wetlands were identified using this tool. Secondly, we reviewed aerial photographs and there appears to be multiple low area that potentially could be wetlands. (see the following Image B).

A Qualified Aquatic Environmental Specialist (QAES) will determine the class of wetland and make recommendations on how to proceed regarding wetlands if required. The recommendation from the QAES could then be submitted separately from the stormwater management plan.

Image B – Potential Wetland

3.3 Proposed Site

3.3.1 Proposed Site Design Overview

The proposed site consists of a 64.3 ha industrial lot that will be used for the purpose of train routing. The lot will be serviced by rural roads utilizing a ditch and culvert system to convey stormwater to the proposed storm pond. (*See Figure 4 Post-Development Basins, Attached in Appendix A).* Approximately 75% of the proposed site will remain unchanged from the existing pasture land ground cover. Sub Basin B1 will remain completely undeveloped in its pre-development state and drain directly to the creek without storage or treatment. The remaining three basins will be routed to the proposed pond.

3.3.2 Proposed Basin Analysis

- Sub-basin# B1 will drain directly to Parlby Creek
- Sub-basin# B2 will be routed through a culvert into the proposed pond in Sub Basin B4
- Sub-basin# B3 will be routed through a culvert into the Sub Basin B2
- Sub-basin# B4 will drain directly to the proposed pond.

4.0 Storm Analysis

4.1 Data Analysis

An analysis was completed utilizing the following data:

- Environment Canada IDF curve for the City of Lacombe to determine 1:100-year (10 mm) - 24-hour storm.
- SCS Type II curve was used.
- The Times of Concentration were calculated using the TR55 Method

4.2 Data Input

The following Tables present the data that was input into the model.

- Table 1 – Pre-Development
- Table 2 – Post-Development

Table 1 Pre-Development Basin Input

Sub-basin	Areas (hectares)	Weighted CN	Description	Soil Type	Time (min.)
A1	21.9	60	Pasture/Bush	B	167.6
A2	23.76	61	Pasture/Bush	B	140.7
A3	7.3	61	Pasture	B	57.9
A4	2.22	61	Pasture/Bush	B	50.7
A5	3.94	59	Pasture/Bush	B	43.9
A6	1.74	61	Pasture	B	42.5
A7	2.62	59	Pasture/Bush	B	62.5
A8	0.82	61	Pasture/Bush	B	29
Totals	**64.3**	**60.5**			

Table 2 Post-Development Basins Input

Sub-basin	Areas (hectares)	Weighted CN	Description	Soil Type	Time (min.)
B1	18	68	Industrial/Pasture	B	196.9
B2	27.9	70	Industrial/Pasture	B	166.3
B3	2.3	66	Industrial/Pasture	B	206.7
B4	16.1	73	Industrial/Pasture	B	29.7
Totals	**64.3**	**70**	Industrial/Pasture	B	

4.3 Results

The following Tables, (Table 3 & Table 4) presents the results from the routing model.

Table 3 Summary of Pre-Development

No.	Calculated Pre-development			Regional Analysis Pre-development	
	Area (ha.)	Peak Flow (l/s)	Flow Rate (l/s/ha)	Flow Rate (l/s/ha)	Target Peak Flow (l/s)
A1	21.9	219.9	10.04	1	21.9
A2	23.76	297.5	12.52	1	23.76
A3	7.3	173.9	23.82	1	7.3
A4	2.22	58.1	26.17	1	2.22
A5	3.94	94	23.86	1	3.94
A6	1.74	61.6	35.40	1	1.74
A7	2.62	48.4	18.47	1	2.62
A8	0.82	32.3	39.39	1	0.82
Totals	**64.3**	**985.7**	**15.33**	**1**	**64.3**

Table 4 Summary of Pre-Development Summary

No.	Calculated Post-Development			Calculated Post-development using storage (Full Build Out)				
	Peak Flow (l/s)	Area (ha.)	Flow Rate (l/s/ha)	Cumulative Area (ha.)	Storage (m^3)	Peak Flow (l/s)	Flow Rate (l/s/ha)	Orifice Diameter (mm)
B1	318	18	17.6667	18	0	318	17.67	N/A
B2	455	27.9	16.3082	27.9	13,900	46.3	1.00	226
B3	81	2.3	35.2174	30.2				
B4	372	16.1	23.1056	46.3				
Totals	**1226**	**64.3**	**19.0669**	**46.3**	**13,900**	**46.3**	**1.00**	

5.0 Water Quality

A dry pond with a forebay is being recommended for this site to achieve the desired water quality. A wet pond was considered for this site, although area of the ponds footprint is less than that recommended for wet ponds.

Extended Release Time

It is recommended that the pond utilize an outlet structure that incorporates a weir and orifice system which can regulate the more frequent storms as well as the less frequent storms thus enhancing water quality further.

Due to these factors, we are confident that the removal of sediment of particle size 75 µm and greater will be removed at a percentage of 85% or higher.

The proposed pond is to be designed to hold the 1:100-year storm event while releasing at 1/s/ha. The pond will hold 13,900 m^3 and outlet through a 226-mm orifice to Parlsby Creek that is then routed to Buffalo Lake.

The proposed dry pond will follow the Alberta Environment Guidelines.

6.0 Conclusion

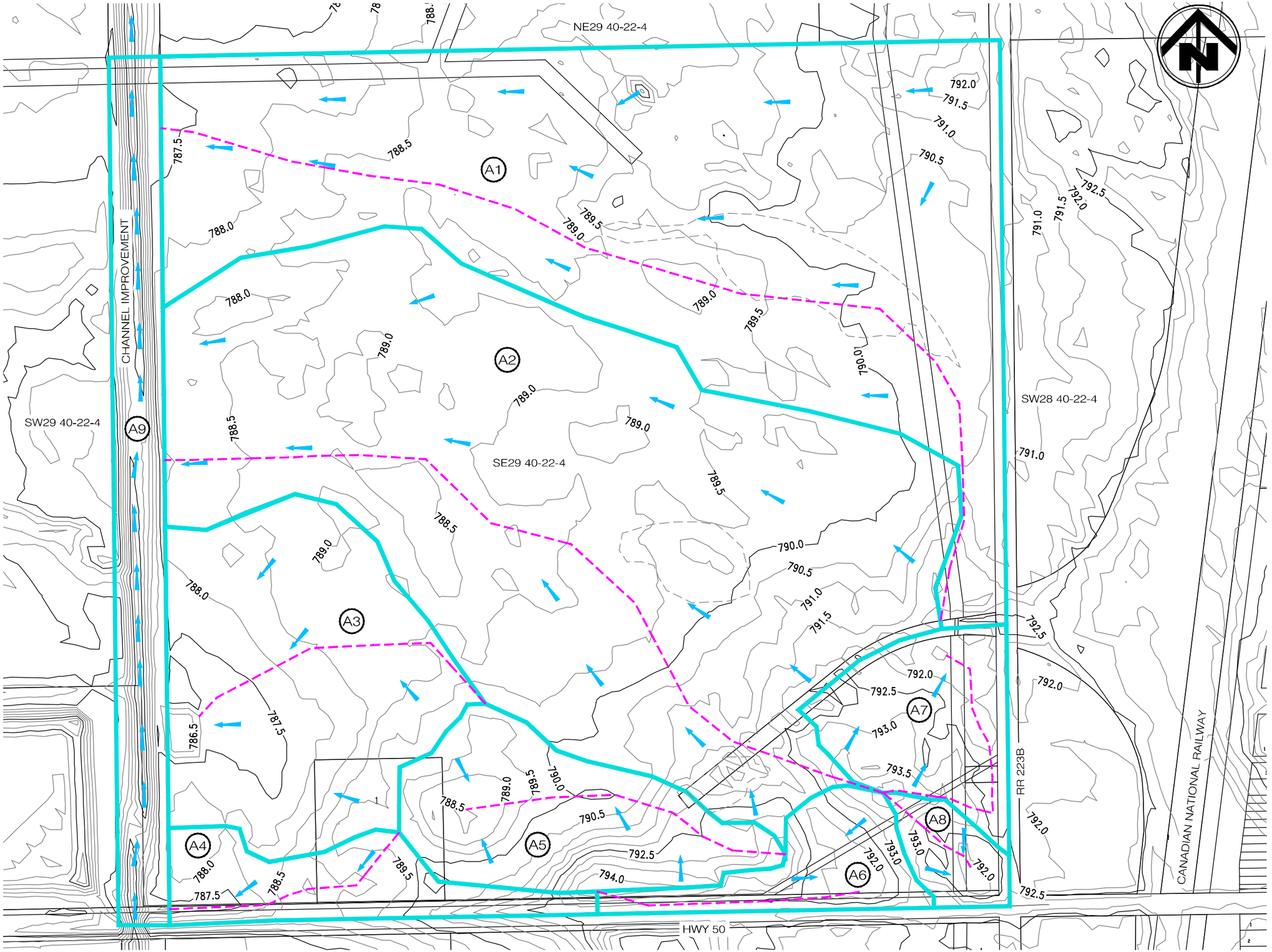
This Stormwater Management Plan lowers the Post-development flow, to that of the recommended regional flow and outlets directly to an adequate outlet.

- Sub Basin B1 will remain undeveloped and continue to drain as it does now in its existing state to Parlby Creek without treatment or flow retention.
- The required storage volume in the Pond for Sub Basins B2 - B4 is 13,900 m^3 with a 226 mm orifice.
- The pond outlets directly into Parlby Creek which has been designed to route water from the Red Deer River to Buffalo Lake.

The release rate has been set to 1 l/s/ha which closely matches Alberta Environments stream flow analysis. The pond will not empty completely within 24 hours (1 day) of the storm as per Alberta Environment guidelines; the pond will require 160 hours (6.7 days) to empty completely during the 1:100-year event. Although approximately 90% of the pond will drain within the first 72 hours (3 days).

Tagish Engineering believes that the design complies with Alberta Environment standards and guidelines. Please contact the office of Tagish Engineering if you have any questions or require any further information.

APPENDIX A



Client
TAVES MANAGEMENT

Project
STORMWATER MANAGEMENT PLAN

Consultant
TAGISH ENGINEERING LTD
Consulting Engineers
G4, 5550 - 45 Street, RED DEER, AB T4N 1L1
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E-mail admin@tagish-engineering.com

LEGEND

MAJOR ELEVATION CONTOURS	800
MINOR ELEVATION CONTOURS	800
STORM BASIN BOUNDARY	
TIME OF CONCENTRATION PATHWAY	
EXISTING OVERLAND FLOW	

BASIN #	AREA (ha)
A1	21.9
A2	23.8
A3	7.3
A4	2.2
A5	3.9
A6	1.7
A7	2.6
A8	0.8
A9	3.9

No.	Date	By	Eng.	Revisions
G				
F				
E				
D				
C				
B				
A				

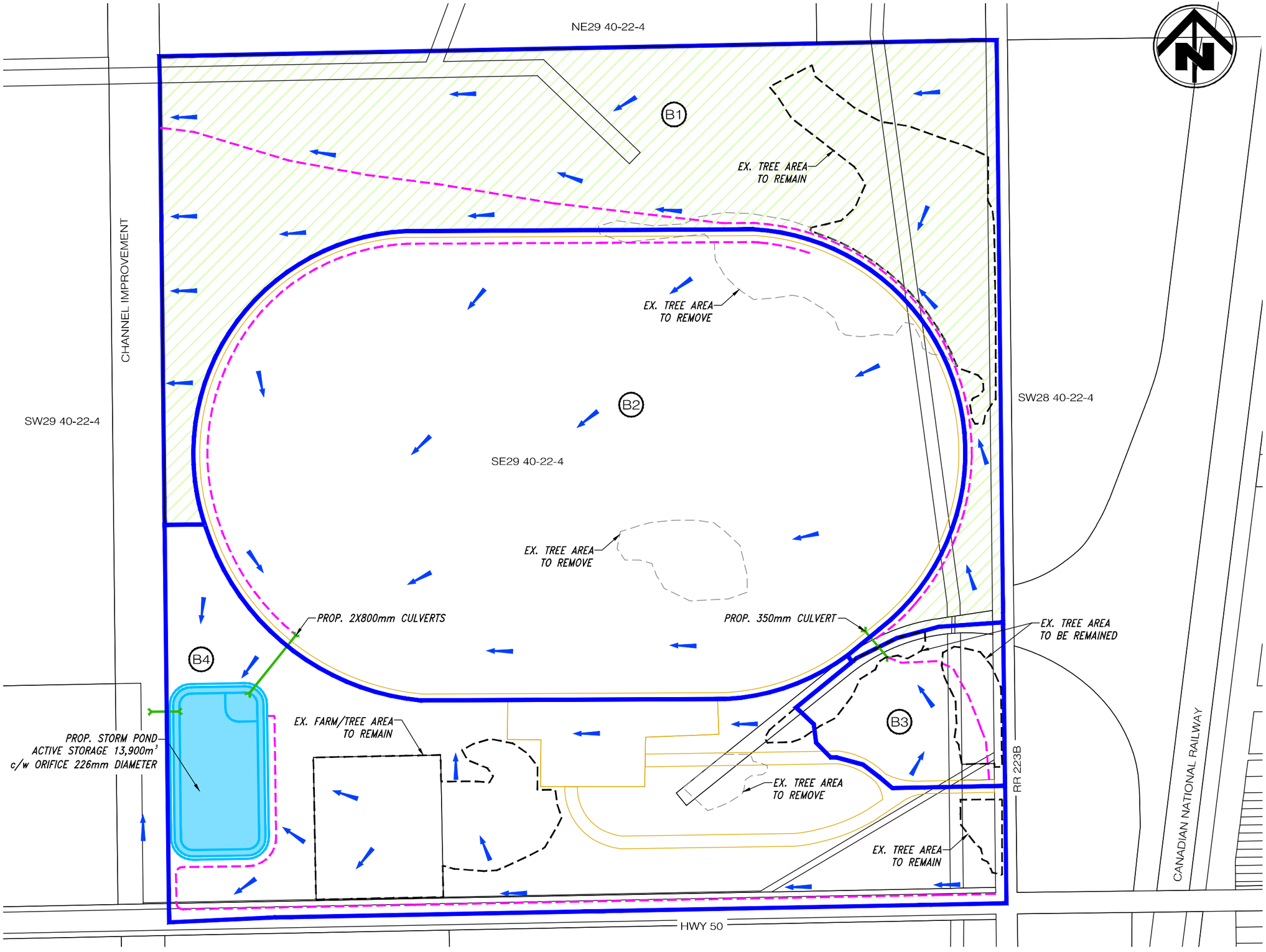
NOT FOR CONSTRUCTION

Scale	1 : 3,500
Date	MAR 01, 2019
Dwg. File	TAV01_DGN03_08APR2019
Drawn	AW
Designed	CC
Checked	CC
Approved	GS

Title
PRE-DEVELOPMENT CONDITIONS

Project No.
TAV01

Drawing No.
FIG. 1



Client
TAVES MANAGEMENT

Project
STORMWATER
MANAGEMENT PLAN

Consultant
TAGISH ENGINEERING LTD
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LEGEND

- STORM BASIN BOUNDARY
- TIME OF CONCENTRATION PATHWAY
- PROPOSED CULVERT
- PROPOSED STORM POND
- PROPOSED OVERLAND FLOW
- UNDISTURBED AREA

BASIN #	AREA (ha)
B1	18.0
B2	27.9
B3	2.3
B4	16.1

No.	Date	By	Eng.	Revisions
G				
F				
E				
D				
C				
B				
A				

NOT FOR CONSTRUCTION

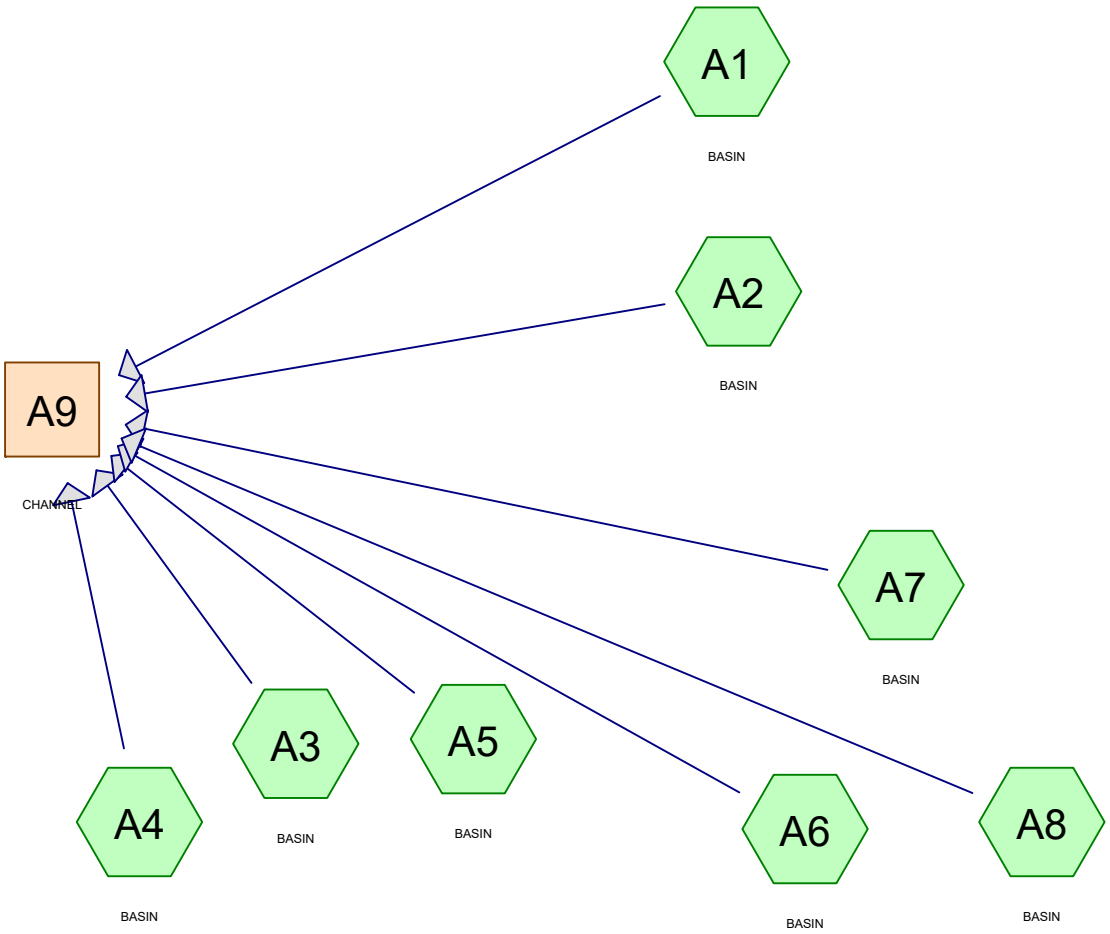
Scale	1 : 3,500
Date	APR 03, 2019
Dwg. File	TAV01_DGN03_08APR2019
Drawn	AW
Designed	CC
Checked	CC
Approved	GS

Title
POST-DEVELOPMENT
CONDITIONS

Project No.
TAV01

Drawing No.
FIG. 2

APPENDIX B



Subcat Reach Pond Link

Routing Diagram for TAV01_PRE_Rev1
Prepared by {enter your company name here}, Printed 3/15/2019

Area Listing (all nodes)

Area (hectares)	CN	Description (subcatchment-numbers)
7.6500	56	Brush, Fair, HSG B (A1, A2, A4, A5, A7, A8)
56.5300	61	Pasture/grassland/range, Good, HSG B (A1, A2, A3, A4, A5, A6, A7, A8)
0.1200	89	Paved roads w/open ditches, 50% imp, HSG B (A6)
64.3000	**60**	**TOTAL AREA**

Soil Listing (all nodes)

Area (hectares)	Soil Group	Subcatchment Numbers
0.0000	HSG A	
64.3000	HSG B	A1, A2, A3, A4, A5, A6, A7, A8
0.0000	HSG C	
0.0000	HSG D	
0.0000	Other	
64.3000		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (hectares)	HSG-B (hectares)	HSG-C (hectares)	HSG-D (hectares)	Other (hectares)	Total (hectares)	Ground Cover	Su Nu
0.0000	7.6500	0.0000	0.0000	0.0000	7.6500	Brush, Fair	
0.0000	56.5300	0.0000	0.0000	0.0000	56.5300	Pasture/grassland/range, Good	
0.0000	0.1200	0.0000	0.0000	0.0000	0.1200	Paved roads w/open ditches, 50% imp	
0.0000	**64.3000**	**0.0000**	**0.0000**	**0.0000**	**64.3000**	**TOTAL AREA**	

Time span=1.00-75.00 hrs, dt=0.01 hrs, 7401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment A1: BASIN Runoff Area=21.9000 ha 0.00% Impervious Runoff Depth=19 mm
Flow Length=1,029.0 m Tc=167.6 min CN=60 Runoff=0.2199 m³/s 4.174 Ml

Subcatchment A2: BASIN Runoff Area=23.7600 ha 0.00% Impervious Runoff Depth=20 mm
Flow Length=804.0 m Tc=140.7 min CN=61 Runoff=0.2975 m³/s 4.831 Ml

Subcatchment A3: BASIN Runoff Area=7.3000 ha 0.00% Impervious Runoff Depth=20 mm
Flow Length=315.0 m Tc=57.9 min CN=61 Runoff=0.1739 m³/s 1.484 Ml

Subcatchment A4: BASIN Runoff Area=2.2200 ha 0.00% Impervious Runoff Depth=20 mm
Flow Length=243.0 m Tc=50.7 min CN=61 Runoff=0.0581 m³/s 0.451 Ml

Subcatchment A5: BASIN Runoff Area=3.9400 ha 0.00% Impervious Runoff Depth=18 mm
Flow Length=315.0 m Tc=43.9 min CN=59 Runoff=0.0940 m³/s 0.702 Ml

Subcatchment A6: BASIN Runoff Area=1.7400 ha 3.45% Impervious Runoff Depth=23 mm
Flow Length=250.0 m Tc=42.5 min CN=63 Runoff=0.0616 m³/s 0.400 Ml

Subcatchment A7: BASIN Runoff Area=2.6200 ha 0.00% Impervious Runoff Depth=18 mm
Flow Length=273.0 m Tc=62.5 min CN=59 Runoff=0.0484 m³/s 0.467 Ml

Subcatchment A8: BASIN Runoff Area=0.8200 ha 0.00% Impervious Runoff Depth=20 mm
Flow Length=110.0 m Tc=29.0 min CN=61 Runoff=0.0323 m³/s 0.167 Ml

Reach A9: CHANNEL Inflow=0.6343 m³/s 12.676 Ml
Outflow=0.6343 m³/s 12.676 Ml

Total Runoff Area = 64.3000 ha Runoff Volume = 12.676 Ml Average Runoff Depth = 20 mm
99.91% Pervious = 64.2400 ha 0.09% Impervious = 0.0600 ha

Summary for Subcatchment A1: BASIN

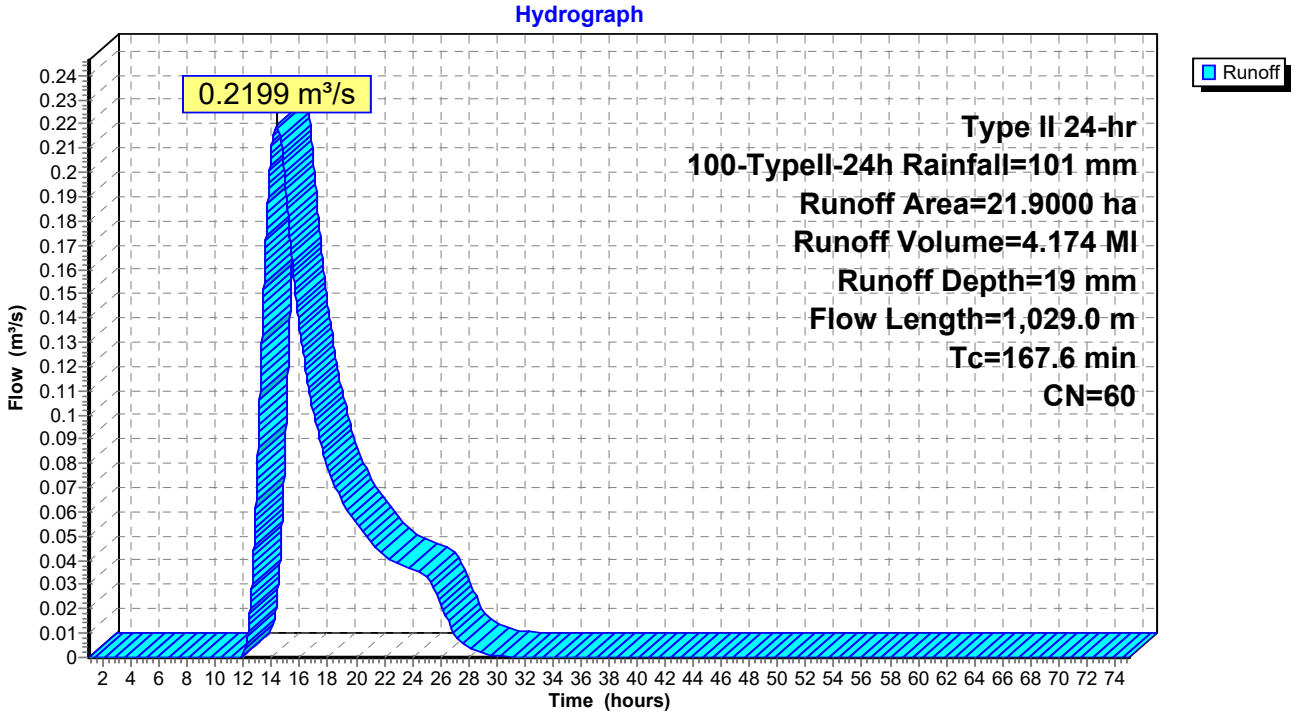
Runoff = 0.2199 m³/s @ 14.34 hrs, Volume= 4.174 Ml, Depth= 19 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-75.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-TypeII-24h Rainfall=101 mm

Area (ha)	CN	Description
17.6300	61	Pasture/grassland/range, Good, HSG B
4.2700	56	Brush, Fair, HSG B
21.9000	60	Weighted Average
21.9000		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
43.2	100.0	0.0096	0.04		**Sheet Flow,** Range n= 0.130 P2= 40 mm
3.3	49.0	0.0137	0.25		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
106.5	720.0	0.0028	0.11		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
14.6	160.0	0.0074	0.18		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
167.6	1,029.0	Total			

Subcatchment A1: BASIN



Summary for Subcatchment A2: BASIN

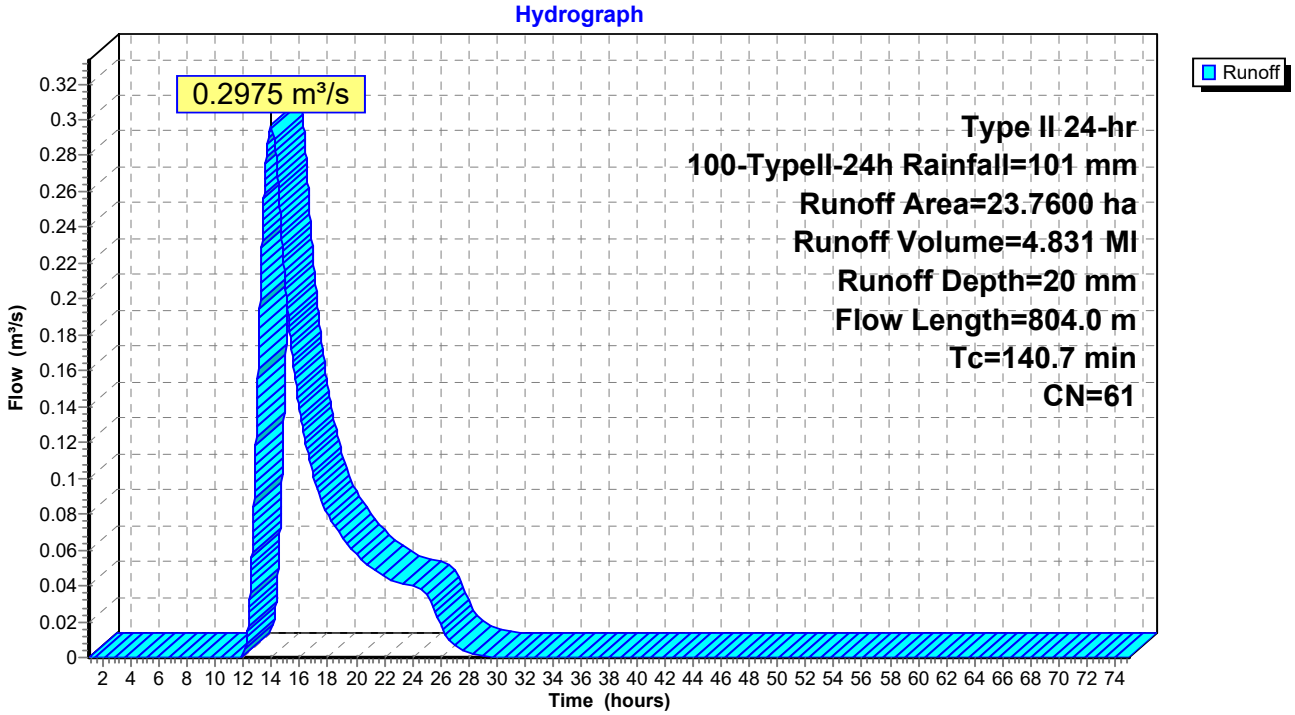
Runoff = 0.2975 m³/s @ 13.92 hrs, Volume= 4.831 Ml, Depth= 20 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-75.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-TypeII-24h Rainfall=101 mm

Area (ha)	CN	Description
22.7700	61	Pasture/grassland/range, Good, HSG B
0.9900	56	Brush, Fair, HSG B
23.7600	61	Weighted Average
23.7600		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
42.5	100.0	0.0100	0.04		**Sheet Flow,** Range n= 0.130 P2= 40 mm
10.4	177.0	0.0176	0.28		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
14.8	121.0	0.0041	0.14		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
65.5	324.0	0.0015	0.08		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
7.5	82.0	0.0073	0.18		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
140.7	804.0	Total			

Subcatchment A2: BASIN



Summary for Subcatchment A3: BASIN

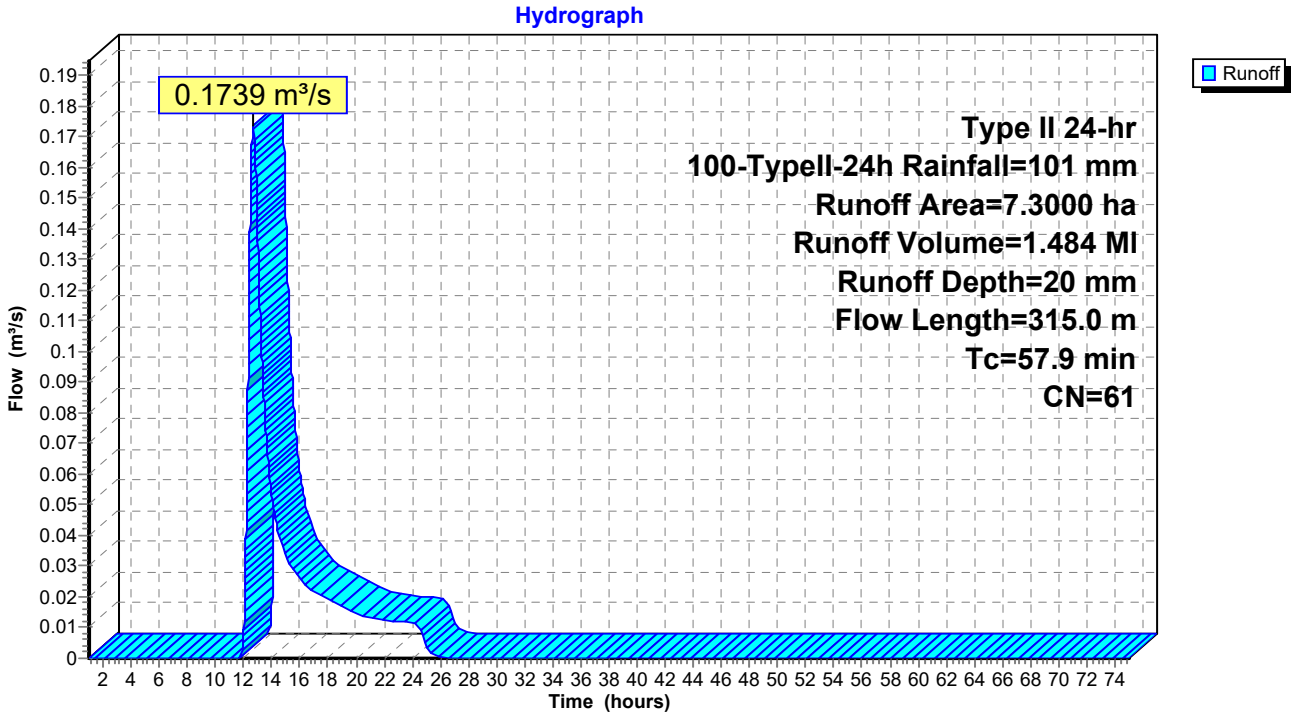
Runoff = 0.1739 m³/s @ 12.68 hrs, Volume= 1.484 Ml, Depth= 20 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-75.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-TypeII-24h Rainfall=101 mm

Area (ha)	CN	Description
7.3000	61	Pasture/grassland/range, Good, HSG B
7.3000		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
39.0	100.0	0.0124	0.04		**Sheet Flow,** Range n= 0.130 P2= 40 mm
18.9	215.0	0.0079	0.19		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
57.9	315.0	Total			

Subcatchment A3: BASIN



Summary for Subcatchment A4: BASIN

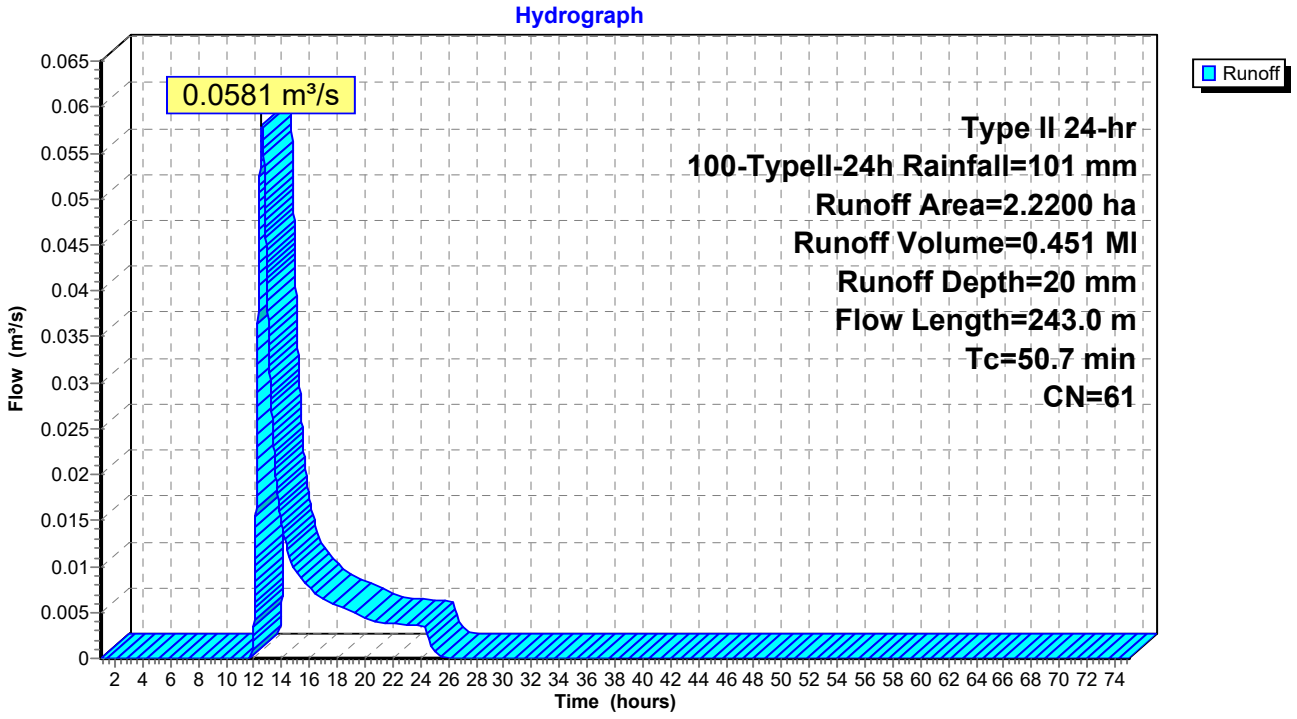
Runoff = 0.0581 m³/s @ 12.57 hrs, Volume= 0.451 Ml, Depth= 20 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-75.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-TypeII-24h Rainfall=101 mm

Area (ha)	CN	Description
2.1600	61	Pasture/grassland/range, Good, HSG B
0.0600	56	Brush, Fair, HSG B
2.2200	61	Weighted Average
2.2200		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
39.8	100.0	0.0118	0.04		**Sheet Flow,** Range n= 0.130 P2= 40 mm
10.9	143.0	0.0106	0.22		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
50.7	243.0	Total			

Subcatchment A4: BASIN



Summary for Subcatchment A5: BASIN

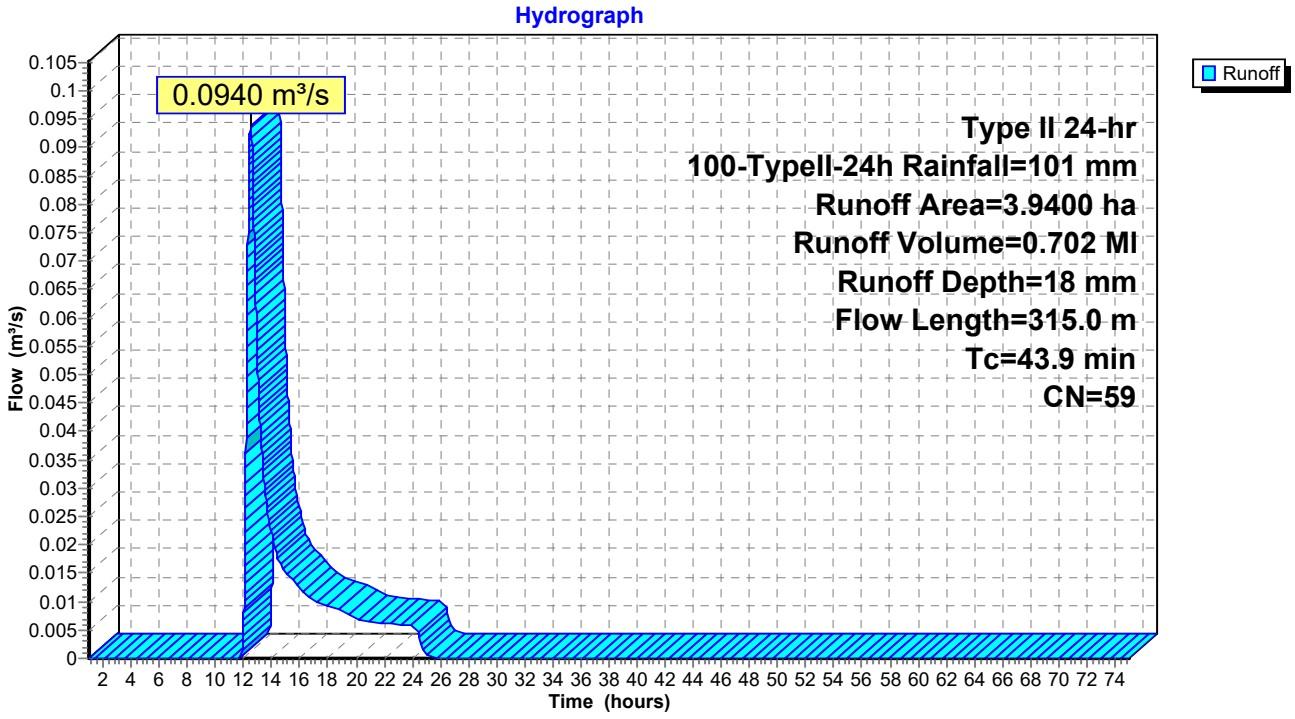
Runoff = 0.0940 m³/s @ 12.53 hrs, Volume= 0.702 Ml, Depth= 18 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-75.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-TypeII-24h Rainfall=101 mm

Area (ha)	CN	Description
2.6100	61	Pasture/grassland/range, Good, HSG B
1.3300	56	Brush, Fair, HSG B
3.9400	59	Weighted Average
3.9400		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
30.8	100.0	0.0224	0.05		**Sheet Flow,** Range n= 0.130 P2= 40 mm
13.1	215.0	0.0165	0.27		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
43.9	315.0	Total			

Subcatchment A5: BASIN



Summary for Subcatchment A6: BASIN

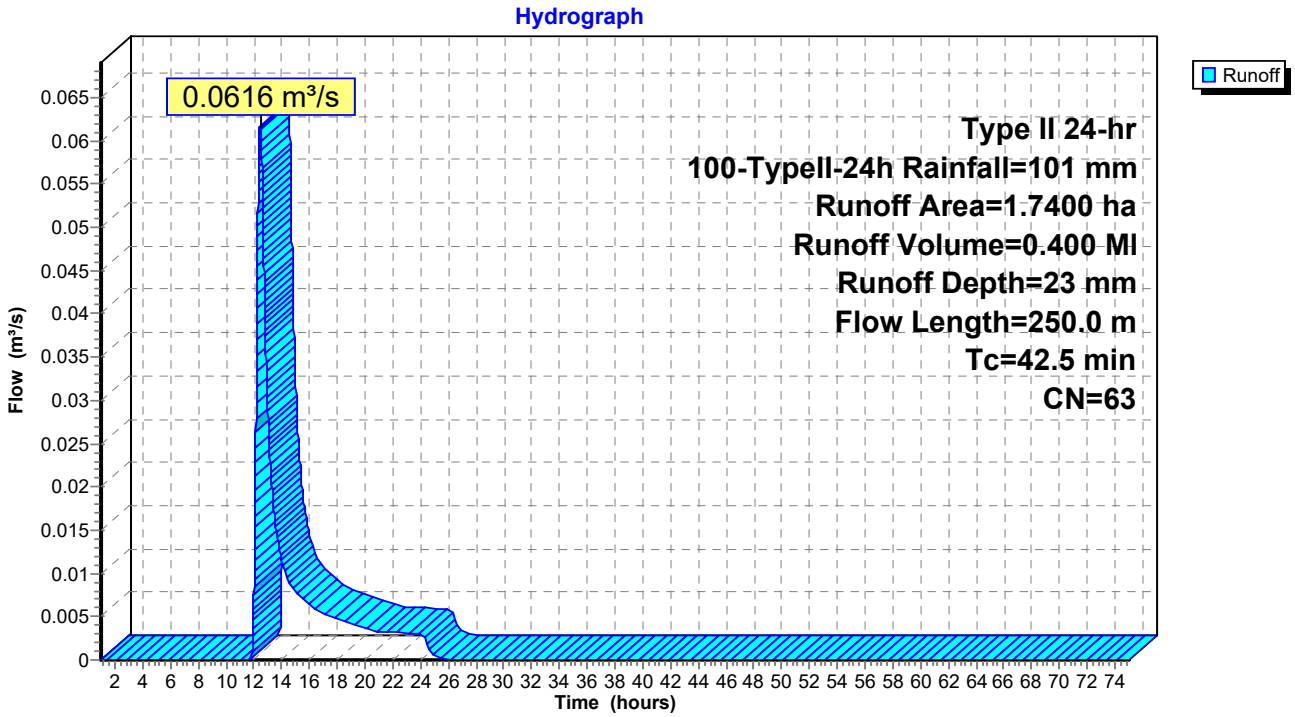
Runoff = 0.0616 m³/s @ 12.46 hrs, Volume= 0.400 Ml, Depth= 23 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-75.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-TypeII-24h Rainfall=101 mm

Area (ha)	CN	Description
1.6200	61	Pasture/grassland/range, Good, HSG B
0.1200	89	Paved roads w/open ditches, 50% imp, HSG B
1.7400	63	Weighted Average
1.6800		96.55% Pervious Area
0.0600		3.45% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
26.6	100.0	0.0322	0.06		**Sheet Flow,** Range n= 0.130 P2= 40 mm
7.9	60.0	0.0035	0.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
8.0	90.0	0.0078	0.19		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
42.5	250.0	Total			

Subcatchment A6: BASIN



Summary for Subcatchment A7: BASIN

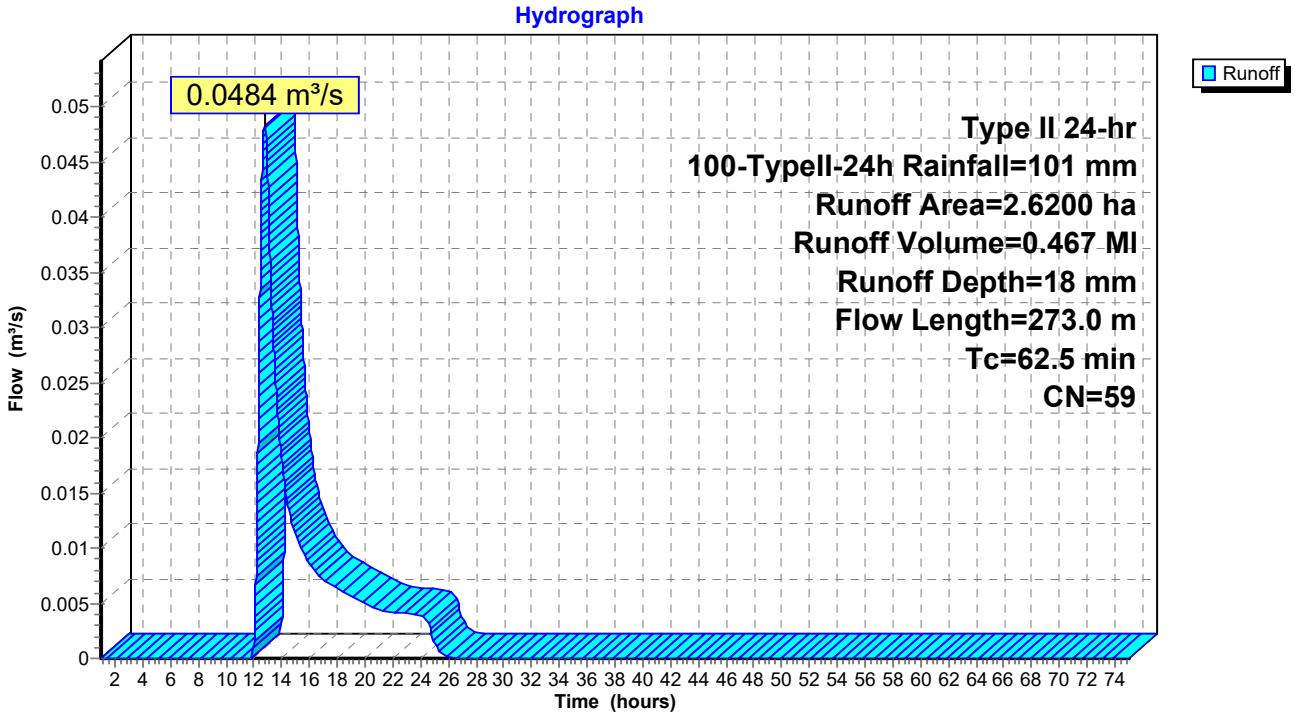
Runoff = 0.0484 m³/s @ 12.78 hrs, Volume= 0.467 Ml, Depth= 18 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-75.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-TypeII-24h Rainfall=101 mm

Area (ha)	CN	Description
1.7000	61	Pasture/grassland/range, Good, HSG B
0.9200	56	Brush, Fair, HSG B
2.6200	59	Weighted Average
2.6200		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
44.7	100.0	0.0088	0.04		**Sheet Flow,** Range n= 0.130 P2= 40 mm
17.8	173.0	0.0058	0.16		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
62.5	273.0	Total			

Subcatchment A7: BASIN



Summary for Subcatchment A8: BASIN

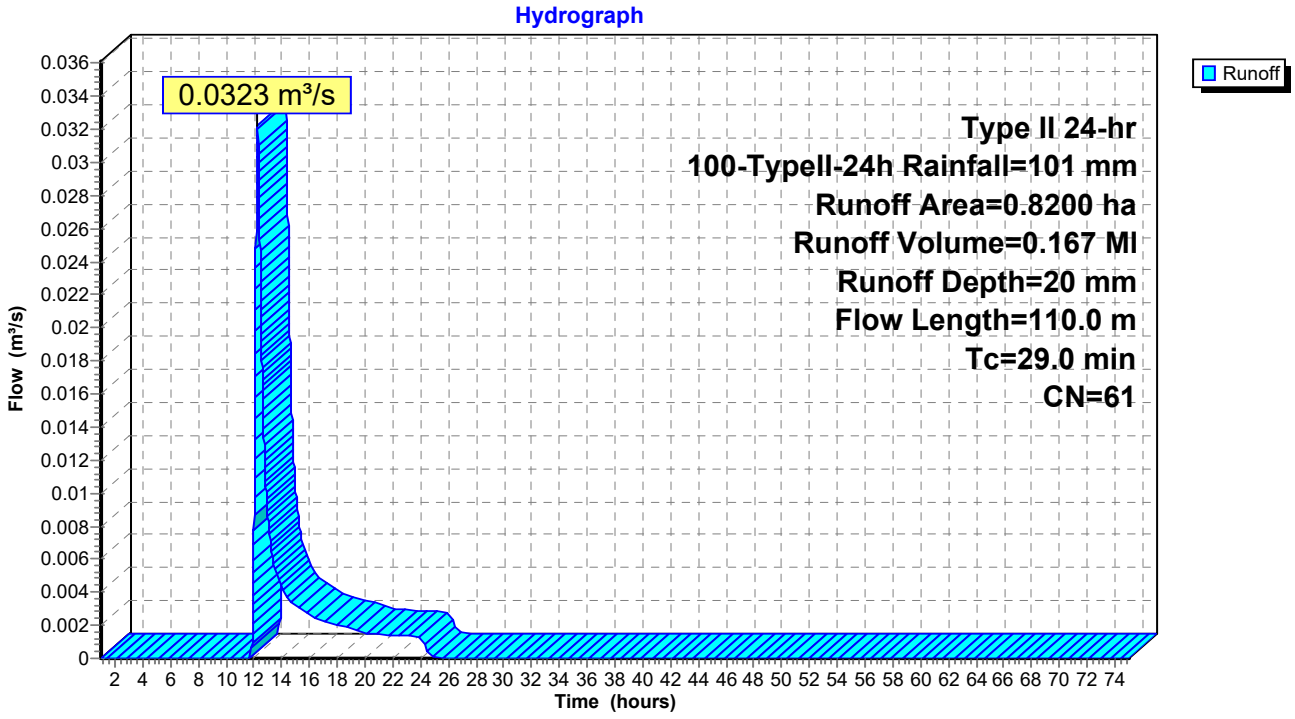
Runoff = 0.0323 m³/s @ 12.28 hrs, Volume= 0.167 Ml, Depth= 20 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-75.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-TypeII-24h Rainfall=101 mm

Area (ha)	CN	Description
0.7400	61	Pasture/grassland/range, Good, HSG B
0.0800	56	Brush, Fair, HSG B
0.8200	61	Weighted Average
0.8200		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
28.3	100.0	0.0276	0.06		**Sheet Flow,** Range n= 0.130 P2= 40 mm
0.7	10.0	0.0137	0.25		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
29.0	110.0	Total			

Subcatchment A8: BASIN



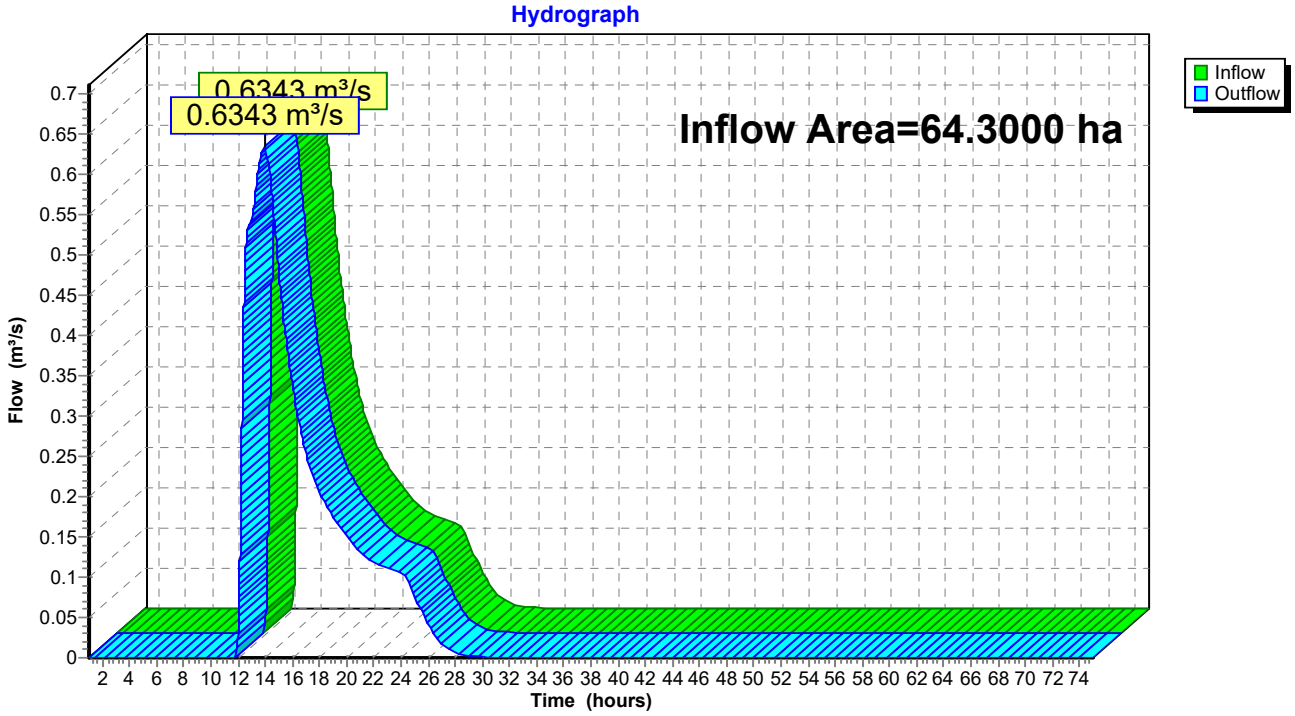
Summary for Reach A9: CHANNEL

[40] Hint: Not Described (Outflow=Inflow)

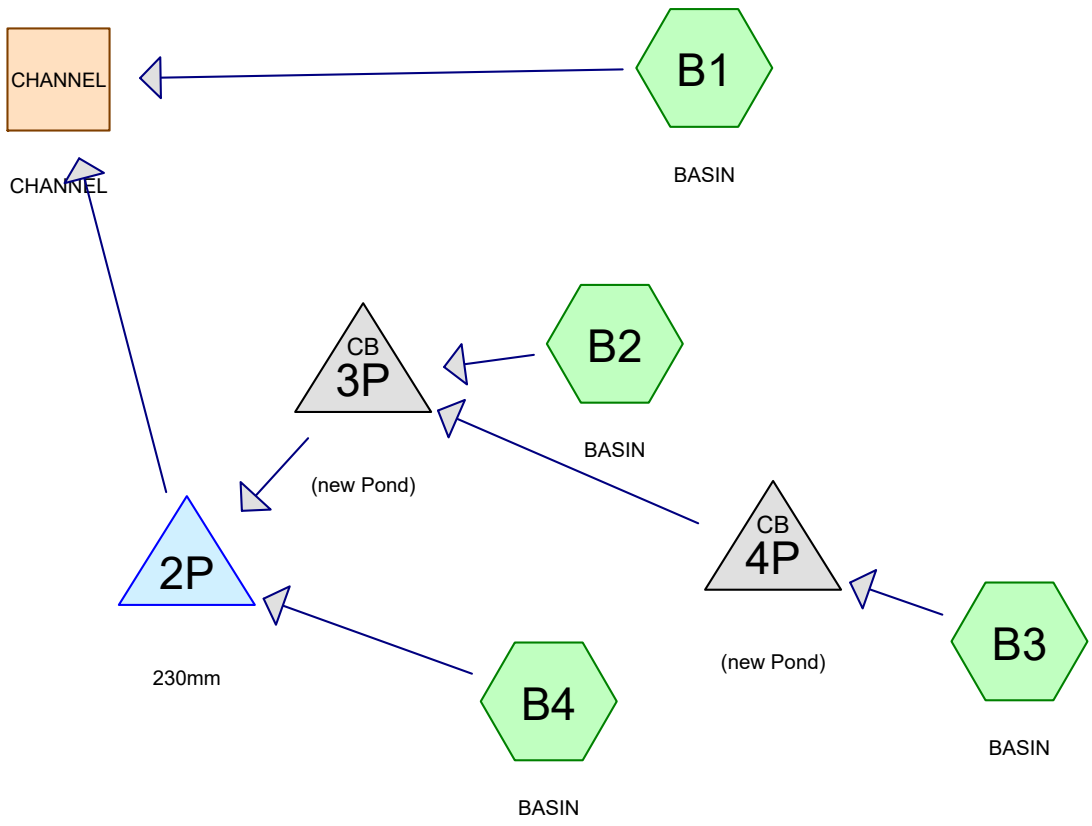
Inflow Area = 64.3000 ha, 0.09% Impervious, Inflow Depth = 20 mm for 100-TypeII-24h event
Inflow = 0.6343 m³/s @ 13.92 hrs, Volume= 12.676 Ml
Outflow = 0.6343 m³/s @ 13.92 hrs, Volume= 12.676 Ml, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-75.00 hrs, dt= 0.01 hrs

Reach A9: CHANNEL



APPENDIX C



Subcat Reach Pond Link

Routing Diagram for TAV01_PROP_Option 4
Prepared by {enter your company name here}, Printed 4/10/2019

Area Listing (all nodes)

Area (hectares)	CN	Description (subcatchment-numbers)
0.5400	68	1 acre lots, 20% imp, HSG B (B4)
5.1900	56	Brush, Fair, HSG B (B1, B3, B4)
4.9900	85	Gravel roads, HSG B (B1, B2, B3, B4)
51.8000	69	Pasture/grassland/range, Fair, HSG B (B1, B2, B3, B4)
0.3400	89	Paved roads w/open ditches, 50% imp, HSG B (B4)
0.0500	98	Roofs, HSG B (B3)
1.3900	98	Water Surface, HSG B (B4)
64.3000	**70**	**TOTAL AREA**

Soil Listing (all nodes)

Area (hectares)	Soil Group	Subcatchment Numbers
0.0000	HSG A	
64.3000	HSG B	B1, B2, B3, B4
0.0000	HSG C	
0.0000	HSG D	
0.0000	Other	
64.3000		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (hectares)	HSG-B (hectares)	HSG-C (hectares)	HSG-D (hectares)	Other (hectares)	Total (hectares)	Ground Cover	Su Nu
0.0000	0.5400	0.0000	0.0000	0.0000	0.5400	1 acre lots, 20% imp	
0.0000	5.1900	0.0000	0.0000	0.0000	5.1900	Brush, Fair	
0.0000	4.9900	0.0000	0.0000	0.0000	4.9900	Gravel roads	
0.0000	51.8000	0.0000	0.0000	0.0000	51.8000	Pasture/grassland/range, Fair	
0.0000	0.3400	0.0000	0.0000	0.0000	0.3400	Paved roads w/open ditches, 50% imp	
0.0000	0.0500	0.0000	0.0000	0.0000	0.0500	Roofs	
0.0000	1.3900	0.0000	0.0000	0.0000	1.3900	Water Surface	
0.0000	**64.3000**	**0.0000**	**0.0000**	**0.0000**	**64.3000**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (meters)	Out-Invert (meters)	Length (meters)	Slope (m/m)	n	Diam/Width (mm)	Height (mm)	Inside-Fill (mm)
1	2P	786.200	785.900	30.00	0.0100	0.025	226	0	0
2	3P	787.800	787.400	10.00	0.0400	0.025	800	0	0
3	4P	888.000	887.500	12.00	0.0417	0.025	350	0	0

Time span=1.00-200.00 hrs, dt=0.01 hrs, 19901 points x 2
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment B1: BASIN Runoff Area=18.0000 ha 0.00% Impervious Runoff Depth=30 mm
Flow Length=1,100.0 m Tc=177.3 min CN=68 Runoff=0.3180 m³/s 5.441 Ml

Subcatchment B2: BASIN Runoff Area=27.9000 ha 0.00% Impervious Runoff Depth=33 mm
Flow Length=885.0 m Tc=231.0 min CN=70 Runoff=0.4547 m³/s 9.311 Ml

Subcatchment B3: BASIN Runoff Area=2.3000 ha 2.17% Impervious Runoff Depth=27 mm
Flow Length=180.0 m Tc=58.9 min CN=66 Runoff=0.0807 m³/s 0.626 Ml

Subcatchment B4: BASIN Runoff Area=16.1000 ha 10.36% Impervious Runoff Depth=38 mm
Flow Length=970.0 m Tc=182.6 min CN=73 Runoff=0.3715 m³/s 6.177 Ml

Reach CHANNEL: CHANNEL Inflow=0.3447 m³/s 20.971 Ml
Outflow=0.3447 m³/s 20.971 Ml

Pond 2P: 230mm Peak Elev=787.393 m Storage=13.896 Ml Inflow=0.8071 m³/s 16.115 Ml
226 mm Round Culvert n=0.025 L=30.00 m S=0.0100 m/m Outflow=0.0463 m³/s 15.530 Ml

Pond 3P: (new Pond) Peak Elev=788.198 m Inflow=0.4671 m³/s 9.938 Ml
800 mm Round Culvert x 2.00 n=0.025 L=10.00 m S=0.0400 m/m Outflow=0.4671 m³/s 9.938 Ml

Pond 4P: (new Pond) Peak Elev=888.332 m Inflow=0.0807 m³/s 0.626 Ml
350 mm Round Culvert n=0.025 L=12.00 m S=0.0417 m/m Outflow=0.0807 m³/s 0.626 Ml

Total Runoff Area = 64.3000 ha Runoff Volume = 21.556 Ml Average Runoff Depth = 34 mm
97.33% Pervious = 62.5820 ha 2.67% Impervious = 1.7180 ha

Summary for Subcatchment B1: BASIN

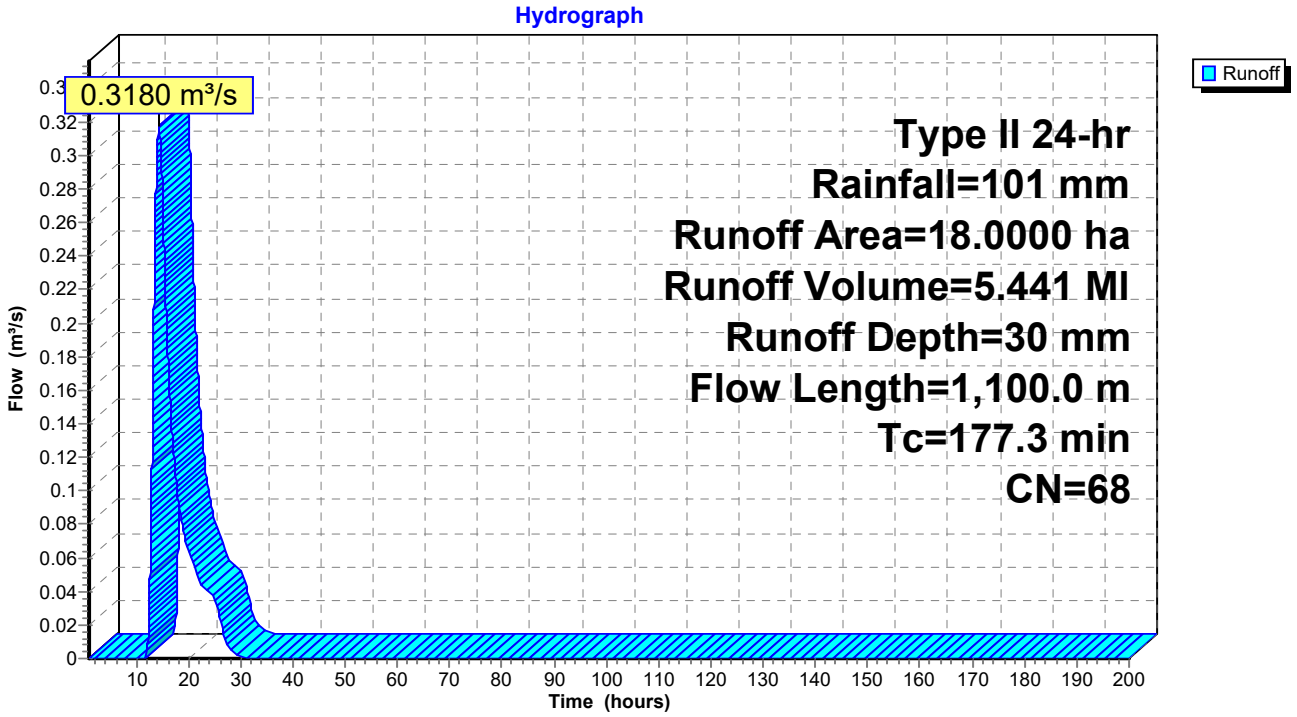
Runoff = 0.3180 m³/s @ 14.38 hrs, Volume= 5.441 Ml, Depth= 30 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-200.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=101 mm

Area (ha)	CN	Description
0.9000	85	Gravel roads, HSG B
14.3700	69	Pasture/grassland/range, Fair, HSG B
2.7300	56	Brush, Fair, HSG B
18.0000	68	Weighted Average
18.0000		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
25.0	50.0	0.0094	0.03		**Sheet Flow,** Range n= 0.130 P2= 40 mm
13.6	150.0	0.0074	0.18		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
75.3	360.0	0.0014	0.08		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
15.8	160.0	0.0063	0.17		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
47.6	380.0	0.0039	0.13		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
177.3	1,100.0	Total			

Subcatchment B1: BASIN



Summary for Subcatchment B2: BASIN

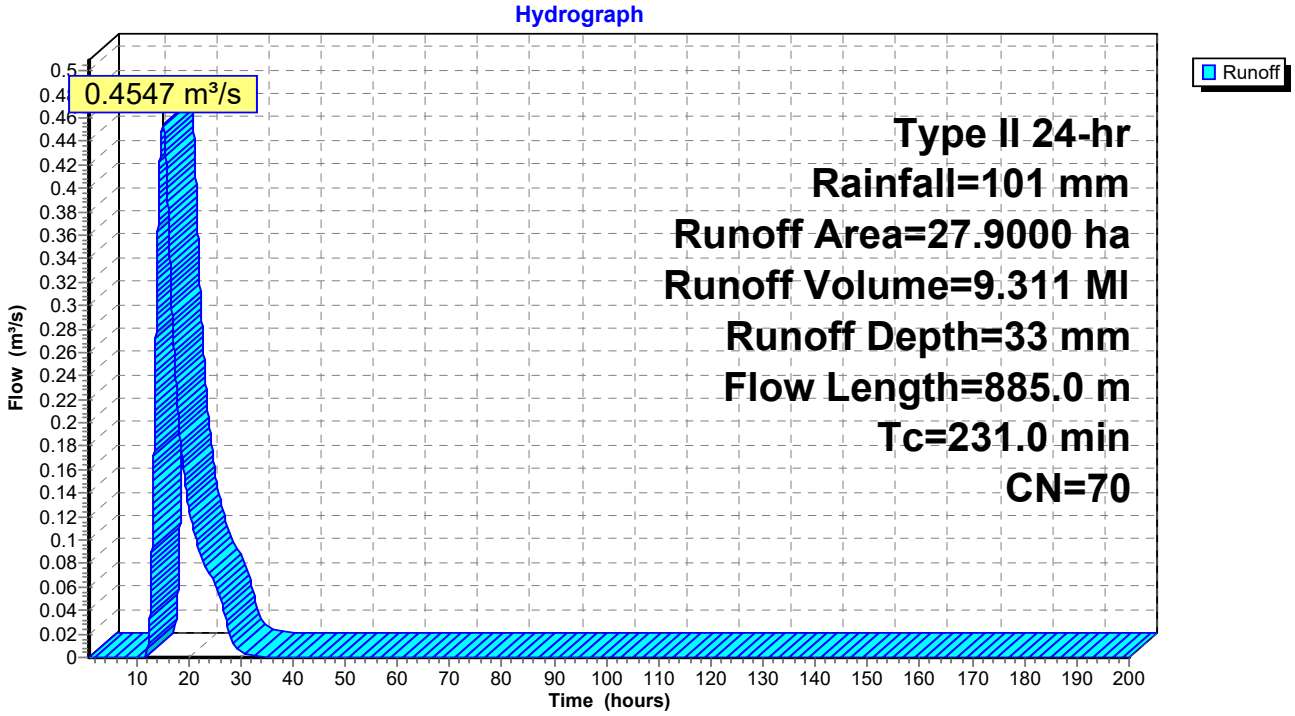
Runoff = 0.4547 m³/s @ 15.14 hrs, Volume= 9.311 Ml, Depth= 33 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-200.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=101 mm

Area (ha)	CN	Description
26.0900	69	Pasture/grassland/range, Fair, HSG B
1.8100	85	Gravel roads, HSG B
27.9000	70	Weighted Average
27.9000		100.00% Pervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
24.4	50.0	0.0100	0.03		**Sheet Flow,** Range n= 0.130 P2= 40 mm
17.1	150.0	0.0047	0.15		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
189.5	685.0	0.0008	0.06		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
231.0	885.0	Total			

Subcatchment B2: BASIN



Summary for Subcatchment B3: BASIN

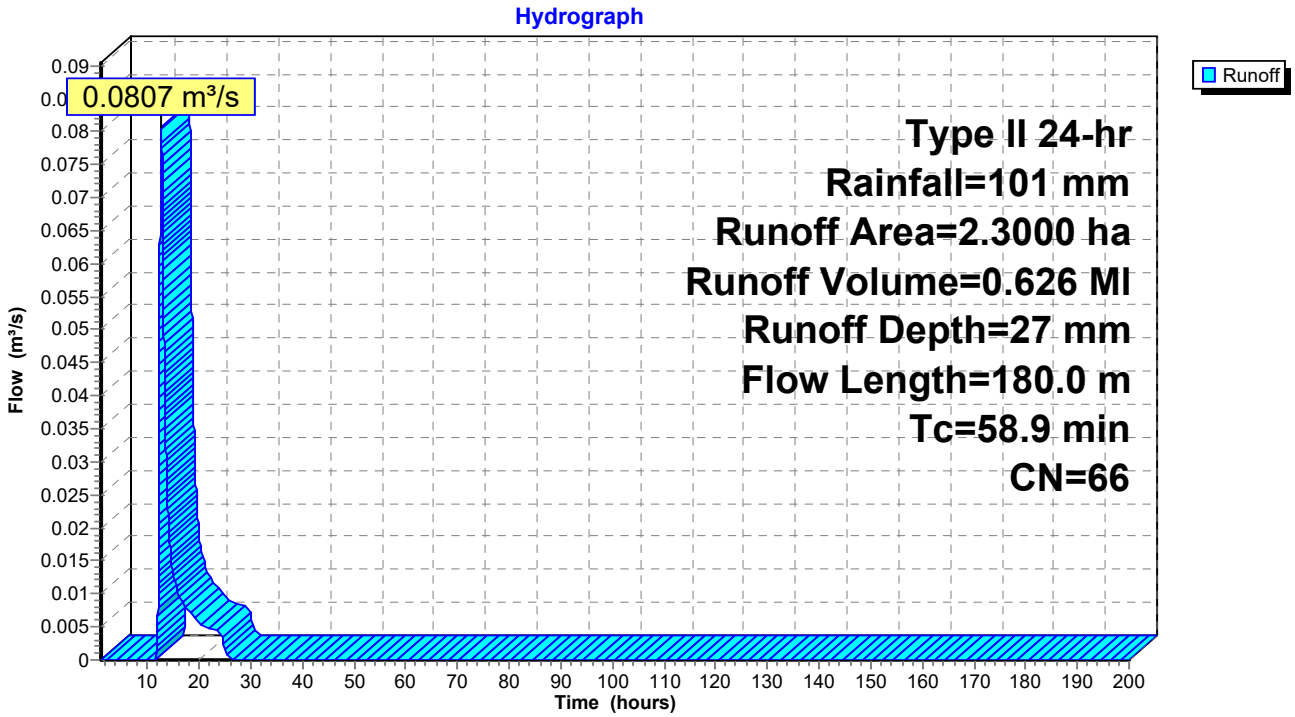
Runoff = 0.0807 m³/s @ 12.64 hrs, Volume= 0.626 Ml, Depth= 27 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-200.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=101 mm

Area (ha)	CN	Description
0.1600	85	Gravel roads, HSG B
1.2400	69	Pasture/grassland/range, Fair, HSG B
0.8500	56	Brush, Fair, HSG B
0.0500	98	Roofs, HSG B
2.3000	66	Weighted Average
2.2500		97.83% Pervious Area
0.0500		2.17% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
26.7	50.0	0.0080	0.03		**Sheet Flow,** Range n= 0.130 P2= 40 mm
32.2	130.0	0.0010	0.07		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
58.9	180.0	Total			

Subcatchment B3: BASIN



Summary for Subcatchment B4: BASIN

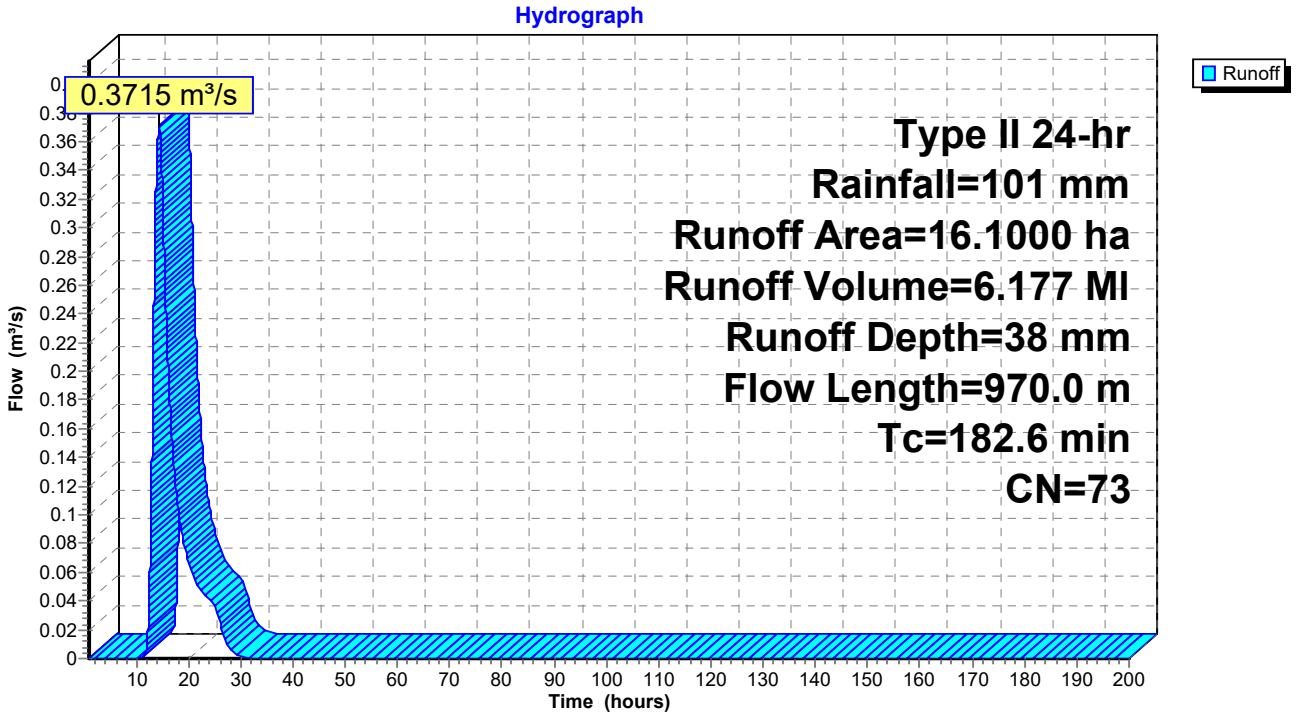
Runoff = 0.3715 m³/s @ 14.40 hrs, Volume= 6.177 Ml, Depth= 38 mm

Runoff by SCS TR-20 method, UH=SCS, Time Span= 1.00-200.00 hrs, dt= 0.01 hrs
Type II 24-hr Rainfall=101 mm

Area (ha)	CN	Description
2.1200	85	Gravel roads, HSG B
10.1000	69	Pasture/grassland/range, Fair, HSG B
1.6100	56	Brush, Fair, HSG B
0.5400	68	1 acre lots, 20% imp, HSG B
0.3400	89	Paved roads w/open ditches, 50% imp, HSG B
1.3900	98	Water Surface, HSG B
16.1000	73	Weighted Average
14.4320		89.64% Pervious Area
1.6680		10.36% Impervious Area

Tc (min)	Length (meters)	Slope (m/m)	Velocity (m/sec)	Capacity (m³/s)	Description
61.3	50.0	0.0010	0.01		**Sheet Flow,** Range n= 0.130 P2= 40 mm
55.9	500.0	0.0049	0.15		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
15.9	220.0	0.0117	0.23		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
49.5	200.0	0.0010	0.07		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 2.13 m/s
182.6	970.0	Total			

Subcatchment B4: BASIN



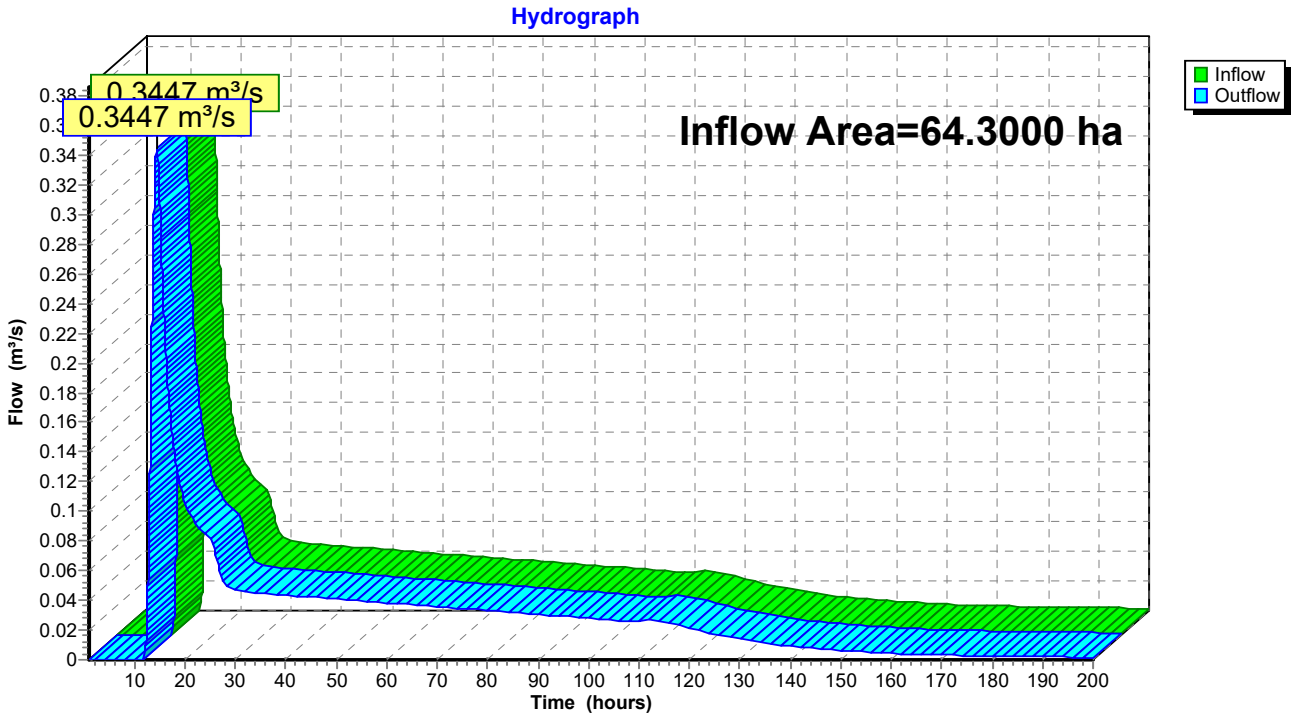
Summary for Reach CHANNEL: CHANNEL

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 64.3000 ha, 2.67% Impervious, Inflow Depth > 33 mm
Inflow = 0.3447 m³/s @ 14.38 hrs, Volume= 20.971 Ml
Outflow = 0.3447 m³/s @ 14.38 hrs, Volume= 20.971 Ml, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-200.00 hrs, dt= 0.01 hrs / 2

Reach CHANNEL: CHANNEL



Summary for Pond 2P: 230mm

Inflow Area = 46.3000 ha, 3.71% Impervious, Inflow Depth = 35 mm
Inflow = 0.8071 m³/s @ 14.64 hrs, Volume= 16.115 Ml
Outflow = 0.0463 m³/s @ 27.10 hrs, Volume= 15.530 Ml, Atten= 94%, Lag= 747.7 min
Primary = 0.0463 m³/s @ 27.10 hrs, Volume= 15.530 Ml

Routing by Dyn-Stor-Ind method, Time Span= 1.00-200.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 787.393 m @ 27.10 hrs Surf.Area= 1.2293 ha Storage= 13.896 Ml
Flood Elev= 787.800 m Surf.Area= 1.2300 ha Storage= 13.980 Ml

Plug-Flow detention time= 3,265.6 min calculated for 15.529 Ml (96% of inflow)
Center-of-Mass det. time= 3,243.6 min (4,284.9 - 1,041.3)

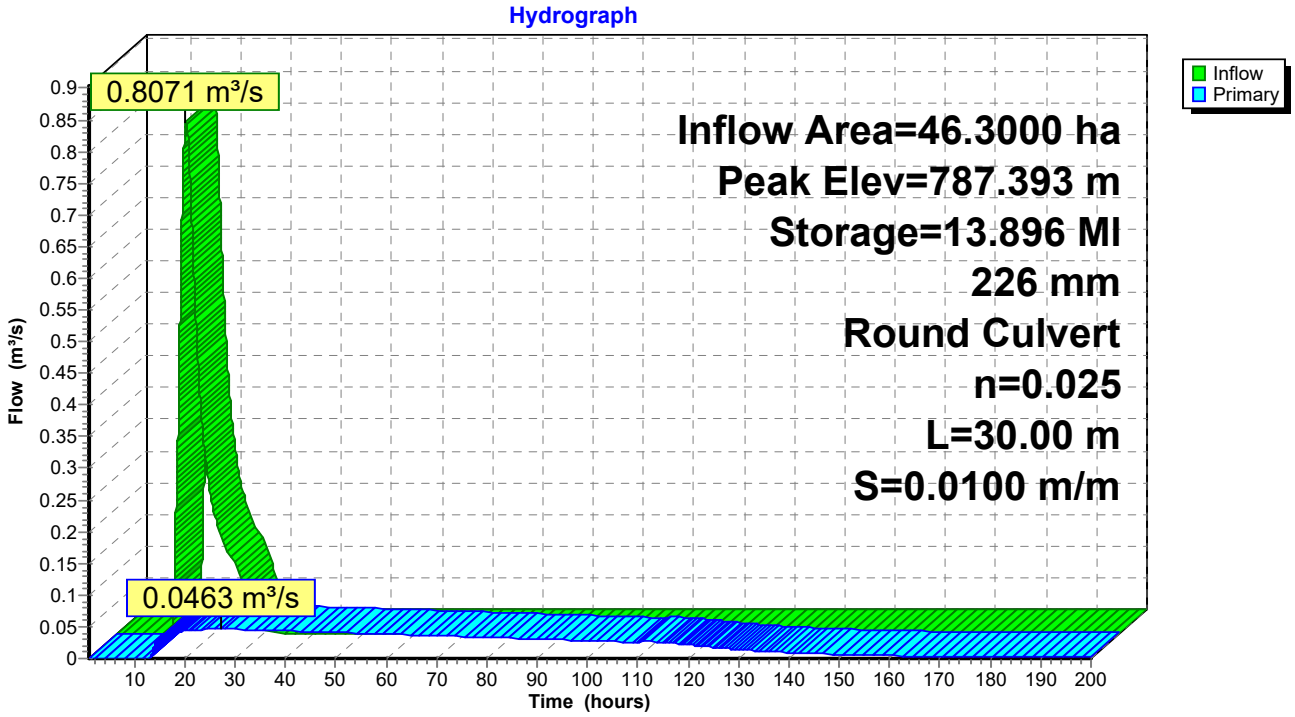
Volume	Invert	Avail.Storage	Storage Description
#1	786.200 m	13.980 Ml	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (meters)	Surf.Area (hectares)	Inc.Store (Mega-liters)	Cum.Store (Mega-liters)
786.200	1.1000	0.000	0.000
787.400	1.2300	13.980	13.980

Device	Routing	Invert	Outlet Devices
#1	Primary	786.200 m	**226 mm Round Culvert** L= 30.00 m CMP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 786.200 m / 785.900 m S= 0.0100 m/m Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 0.040 m²

Primary OutFlow Max=0.0463 m³/s @ 27.10 hrs HW=787.393 m TW=0.000 m (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 0.0463 m³/s @ 1.15 m/s)

Pond 2P: 230mm



Summary for Pond 3P: (new Pond)

[57] Hint: Peaked at 788.198 m (Flood elevation advised)

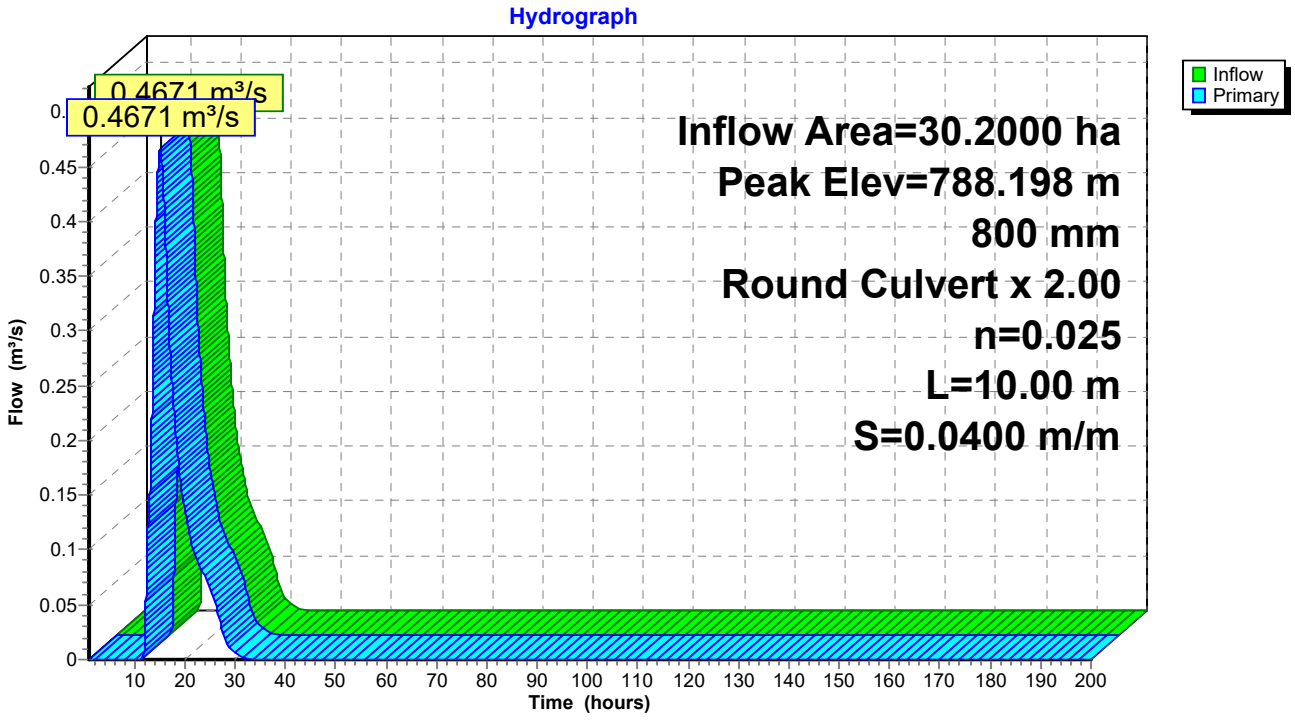
Inflow Area = 30.2000 ha, 0.17% Impervious, Inflow Depth = 33 mm
Inflow = 0.4671 m³/s @ 15.14 hrs, Volume= 9.938 Ml
Outflow = 0.4671 m³/s @ 15.14 hrs, Volume= 9.938 Ml, Atten= 0%, Lag= 0.0 min
Primary = 0.4671 m³/s @ 15.14 hrs, Volume= 9.938 Ml

Routing by Dyn-Stor-Ind method, Time Span= 1.00-200.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 788.198 m @ 15.14 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	787.800 m	**800 mm Round Culvert X 2.00** L= 10.00 m CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 787.800 m / 787.400 m S= 0.0400 m/m Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 0.503 m²

Primary OutFlow Max=0.4671 m³/s @ 15.14 hrs HW=788.198 m TW=786.670 m (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 0.4671 m³/s @ 0.94 m/s)

Pond 3P: (new Pond)



Summary for Pond 4P: (new Pond)

[57] Hint: Peaked at 888.332 m (Flood elevation advised)

Inflow Area = 2.3000 ha, 2.17% Impervious, Inflow Depth = 27 mm
Inflow = 0.0807 m³/s @ 12.64 hrs, Volume= 0.626 Ml
Outflow = 0.0807 m³/s @ 12.64 hrs, Volume= 0.626 Ml, Atten= 0%, Lag= 0.0 min
Primary = 0.0807 m³/s @ 12.64 hrs, Volume= 0.626 Ml

Routing by Dyn-Stor-Ind method, Time Span= 1.00-200.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 888.332 m @ 12.64 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	888.000 m	**350 mm Round Culvert** L= 12.00 m CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 888.000 m / 887.500 m S= 0.0417 m/m Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 0.096 m²

Primary OutFlow Max=0.0807 m³/s @ 12.64 hrs HW=888.332 m TW=787.986 m (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.0807 m³/s @ 0.86 m/s)

Pond 4P: (new Pond)