# DRAINAGE COMPUTATIONS FOR PROPOSED BOX CULVERT

Prepared for

# SINGLE-FAMILY DEVELOPMENT 350 BREAKNECK HILL ROAD KILLINGLY, CT

November 2023 Revised to January 2024

Prepared for

Gavin Sheehan

Prepared by

Killingly Engineering Associates Civil Engineering & Surveying

> Normand Thibeault Jr., P.E. CT License #22834

#### Introduction

Gavin Sheehan. has submitted a proposal to the Town of Killingly to develop a 20-acre parcel of land with access from Breakneck Hill Road. The portion of the property to be developed is currently wooded and undeveloped and drainage from the site sheet flows down gradient to a linear wetland system and perennial stream. The project proposes to utilize and existing gravel drive that crosses the wetlands. The design calls for installation of a  $5\alpha 20$  open bottomed box culvert to preserve the stream bed bottom and reduce the overall wetland impact footprint.

#### Summary

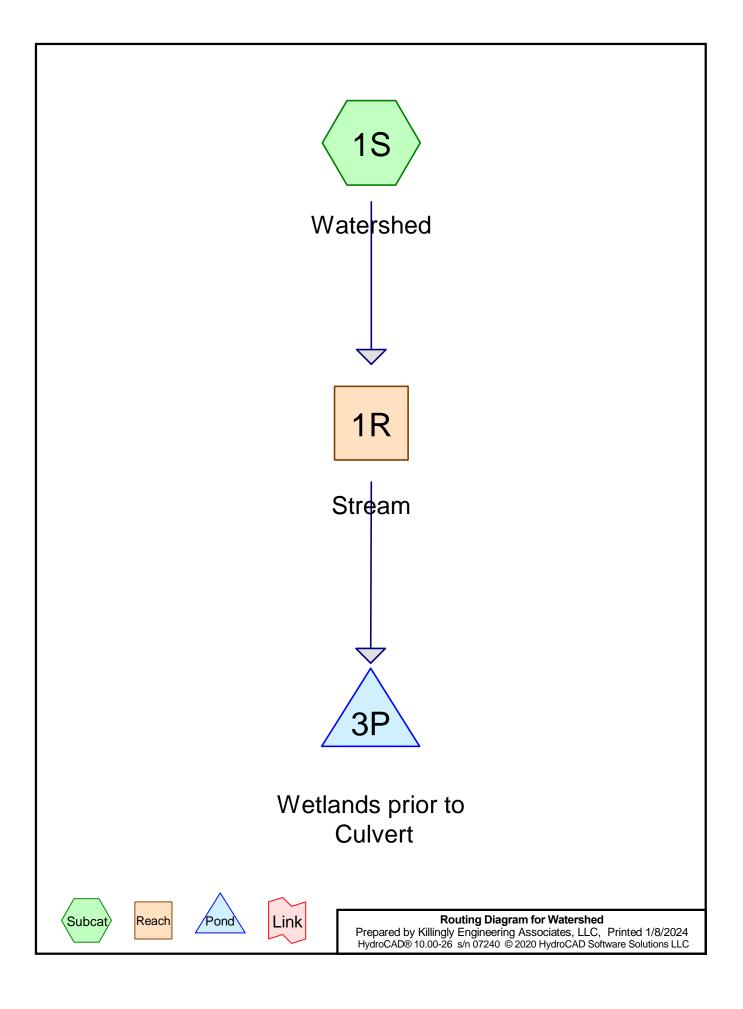
According to the USDA-SCS Soil Survey, approximately 30% of the soils in the watershed consist of excessively drained Hinckley sands and gravels which are associated with hydrologic soil group õAö. The reminder of the site consists of Sudbury and Canton/Charlton fine sandy loams and wetlands soils which we have defined as õB/Cö. The bulk of the 89-acre watershed that drains to the proposed crossing point is undeveloped.

The calculations utilized HydroCAD® Stormwater Modeling System, a computer model, to analyze pre-and post-development drainage conditions, and to aid in the design of the stormwater detention system. The model used the Soil Conservation Service TR-20 method with a Type III 24-hour rainfall to calculate the runoff. The 2 through 100-year frequency storms were analyzed to evaluate peak runoff to the proposed culvert. Our computations demonstrate that the proposed 50 wide x 20 deep open bottomed box culvert will convey flow from a 100-year storm.

Design Storm	Depth (in)	Peak Runoff Rate
2-Year	3.37	2.15 CFS
5-Year	4.28	7.80 CFS
10-Year	5.04	15.34 CFS
25-Year	6.09	29.19 CFS
50-Year	6.87	41.50 CFS
100-Year	7.70	56.26 CFS

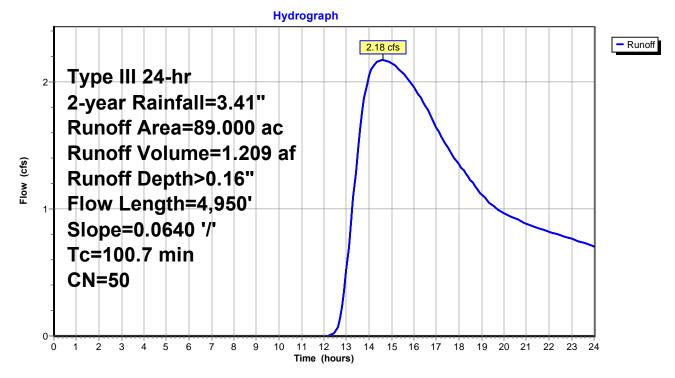
#### Table 1. Existing & Proposed Peak Flows from Watershed

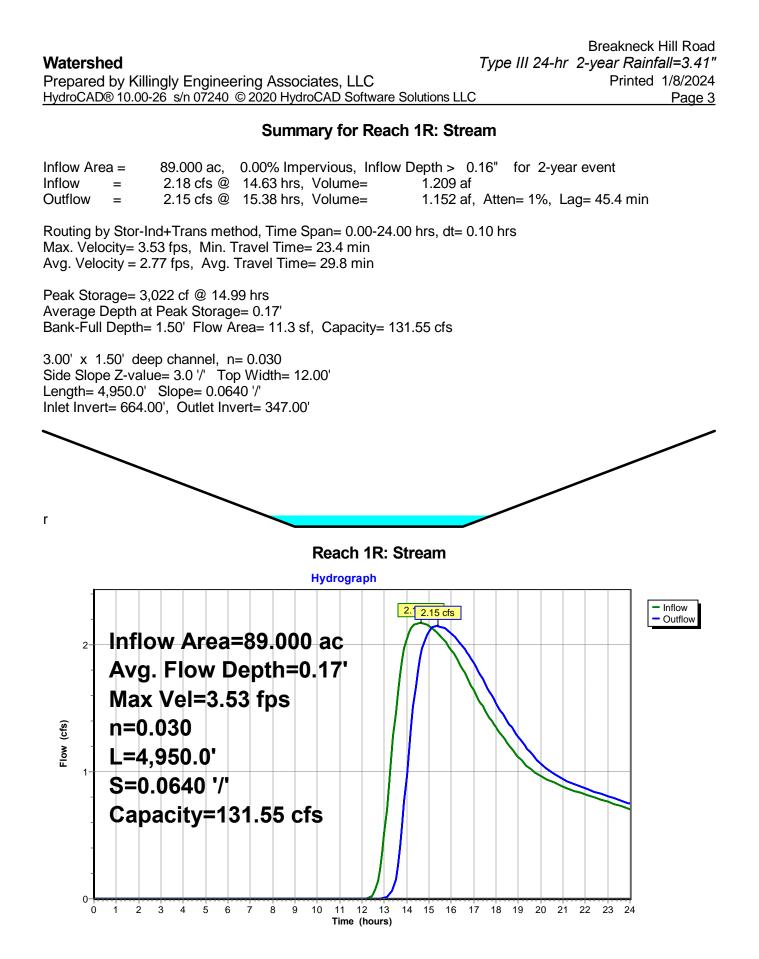
# HYDROCAD COMPUTATIONS



	Killing	Breakneck Hill Road <i>Type III 24-hr 2-year Rainfall=3.41"</i> y Engineering Associates, LLC Printed 1/8/2024 s/n 07240 © 2020 HydroCAD Software Solutions LLC Page 2					
Summary for Subcatchment 1S: Watershed							
Runoff =	2	.18 cfs @ 14.63 hrs, Volume= 1.209 af, Depth> 0.16"					
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Type III 24-hr 2-year Rainfall=3.41"							
Area (ac)	CN	Description					
31.000	30	Woods, Good, HSG A					
* 20.000	58	Brush/Grass, Good, HSG B/C					
* 38.000	61	Woods, Good, HSG B/C					

		000 t 000		Weighted Average 100.00% Pervious Area			
	Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description	
-	100.7	4,950	0.0640	0.82		Lag/CN Method, Tc-1	





WatershedTypePrepared by Killingly Engineering Associates, LLCHydroCAD® 10.00-26 s/n 07240 © 2020 HydroCAD Software Solutions LLC

#### Summary for Pond 3P: Wetlands prior to Culvert

Inflow Area =	89.000 ac,	0.00% Impervious, Inflow D	Depth > 0.16" for 2-year event
Inflow =	2.15 cfs @	15.38 hrs, Volume=	1.152 af
Outflow =	2.16 cfs @	15.32 hrs, Volume=	1.150 af, Atten= 0%, Lag= 0.0 min
Primary =	2.16 cfs @	15.32 hrs, Volume=	1.150 af
Secondary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af

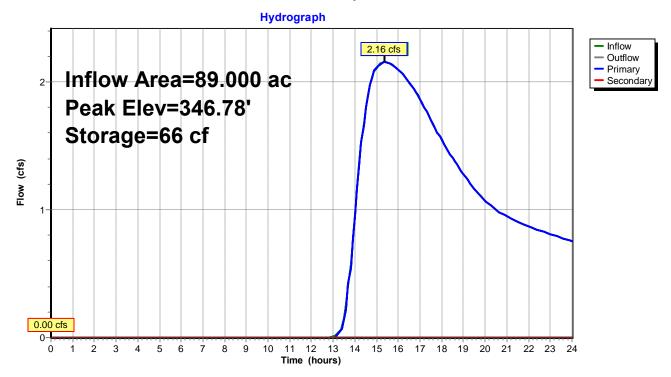
Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Peak Elev= 346.78' @ 15.32 hrs Surf.Area= 109 sf Storage= 66 cf

Plug-Flow detention time= 0.7 min calculated for 1.146 af (99% of inflow) Center-of-Mass det. time= 0.4 min (1,080.7 - 1,080.4)

Volume	Invert	Avail.Stor	rage Storage D	escription	
#1	346.00'	4,86	60 cf Custom S	tage Data (Prismatic) Listed b	elow (Recalc)
Elevatio (fee		urf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	
346.0	0	58	0	0	
348.0	0	188	246	246	
350.0	0	2,650	2,838	3,084	
350.6	0	3,270	1,776	4,860	
Device	Routing	Invert	Outlet Devices		
#1	Primary	346.50'	60.0" W x 30.0	' H Box Culvert	
#2	Secondary	350.40'	Inlet / Outlet In n= 0.030, Flow <b>16.0' long x 60</b> Head (feet) 0.2	0° wingwalls, square crown ed vert= 346.50' / 346.00' S= 0.0 v Area= 12.50 sf <b>0.0' breadth Broad-Crested Re</b> 20 0.40 0.60 0.80 1.00 1.20 2.68 2.70 2.70 2.64 2.63 2	167 '/' Cc= 0.900 ectangular Weir 1.40 1.60

Primary OutFlow Max=2.15 cfs @ 15.32 hrs HW=346.78' (Free Discharge) ←1=Culvert (Inlet Controls 2.15 cfs @ 1.51 fps)

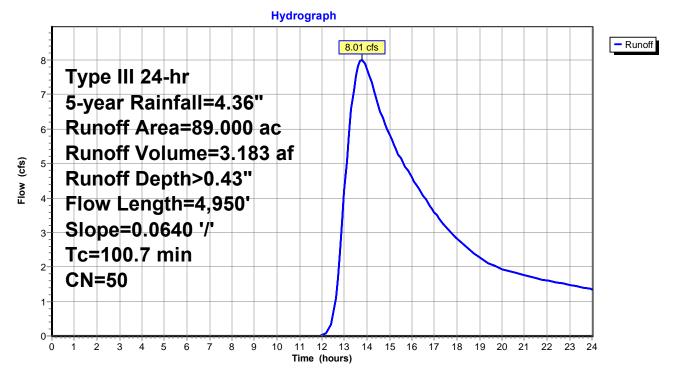
Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=346.00' (Free Discharge) 2=Broad-Crested Rectangular Weir (Controls 0.00 cfs) Breakneck Hill Road



<b>Watersh</b> Prepared	d by Kill					
HydroCAE	D® 10.00	-26 s/n 07240	© 2020 HydroCAD Softwa	are Solutions LLC Page 6		
Summary for Subcatchment 1S: Watershed						
Runoff	=	8.01 cfs @	13.78 hrs, Volume=	3.183 af, Depth> 0.43"		

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Type III 24-hr 5-year Rainfall=4.36"

	Area	(ac)	CN	Desc	cription		
	31.	000	30	Woo	ds, Good,	HSG A	
*	20.	000	58	Brus	h/Grass, G	Good, HSG	B/C
*	38.	000	61	Woo	ds, Good,	HSG B/C	
	89.	000	50	Weig	ghted Aver	age	
	89.	000		100.0	00% Pervi	ous Area	
	Tc (min)	Lengt (fee		Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
	100.7	4,95	60 C	0.0640	0.82		Lag/CN Method, Tc-1



Breakneck Hill Road Watershed Type III 24-hr 5-year Rainfall=4.36" Prepared by Killingly Engineering Associates, LLC Printed 1/8/2024 HydroCAD® 10.00-26 s/n 07240 © 2020 HydroCAD Software Solutions LLC Page 7 Summary for Reach 1R: Stream Inflow Area = 89.000 ac. 0.00% Impervious, Inflow Depth > 0.43" for 5-year event 8.01 cfs @ 13.78 hrs, Volume= Inflow 3.183 af = 3.101 af, Atten= 3%, Lag= 28.0 min Outflow 7.79 cfs @ 14.25 hrs, Volume= = Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Max. Velocity= 5.33 fps, Min. Travel Time= 15.5 min Avg. Velocity = 3.76 fps, Avg. Travel Time= 22.0 min Peak Storage= 7,241 cf @ 13.99 hrs Average Depth at Peak Storage= 0.36' Bank-Full Depth= 1.50' Flow Area= 11.3 sf, Capacity= 131.55 cfs 3.00' x 1.50' deep channel, n= 0.030 Side Slope Z-value= 3.0 '/' Top Width= 12.00' Length= 4,950.0' Slope= 0.0640 '/' Inlet Invert= 664.00', Outlet Invert= 347.00' r **Reach 1R: Stream** Hydrograph - Inflow 8 01 of 7.79 cfs Outflow 8-Inflow Area=89,000 ac 7 Avg. Flow Depth=0.36' 6 Max Vel=5.33 fps n=0.030 5-Flow (cfs) L=4,950.0' 4-S=0.0640 '/' 3-Capacity=131.55 cfs 2 1-

11 12 13

Time (hours)

14 15 16 17 18 19 20 21 22 23 24

0

2 3 4 5 6 7 8 9 10

WatershedTyPrepared by Killingly Engineering Associates, LLCHydroCAD® 10.00-26 s/n 07240 © 2020 HydroCAD Software Solutions LLC

#### Summary for Pond 3P: Wetlands prior to Culvert

Inflow Area =	89.000 ac,	0.00% Impervious, Inflow D	epth > 0.42" for 5-year event
Inflow =	7.79 cfs @	14.25 hrs, Volume=	3.101 af
Outflow =	7.80 cfs @	14.27 hrs, Volume=	3.100 af, Atten= 0%, Lag= 1.4 min
Primary =	7.80 cfs @	14.27 hrs, Volume=	3.100 af
Secondary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af

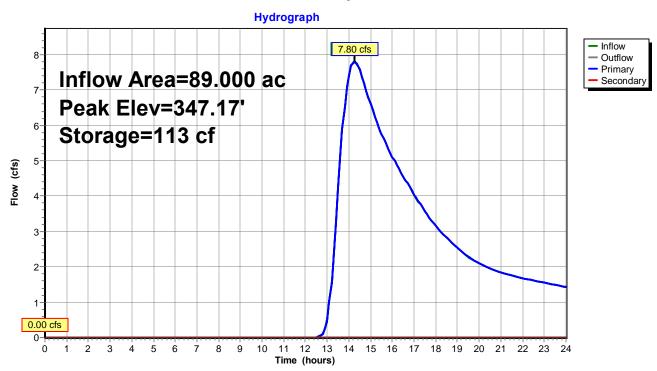
Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Peak Elev= 347.17' @ 14.27 hrs Surf.Area= 134 sf Storage= 113 cf

Plug-Flow detention time= 0.4 min calculated for 3.100 af (100% of inflow) Center-of-Mass det. time= 0.2 min (1,022.9 - 1,022.7)

Volume	Invert	Avail.Stor	age Storage E	Description	
#1	346.00'	4,86	60 cf Custom S	Stage Data (Pris	matic) Listed below (Recalc)
Elevatio (fee		ırf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	
346.0	0	58	0	0	
348.0	0	188	246	246	
350.0	0	2,650	2,838	3,084	
350.6	0	3,270	1,776	4,860	
Device	Routing	Invert	Outlet Devices	i	
#1	Primary	346.50'	60.0" W x 30.0	" H Box Culver	t
#2	Secondary	350.40'	Inlet / Outlet In n= 0.030, Flow <b>16.0' long x 60</b> Head (feet) 0.2	vert= 346.50 <sup>°</sup> /3 v Area= 12.50 si <b>0.0' breadth Bro</b> 20 0.40 0.60 0	quare crown edge, Ke= 0.700 346.00' S= 0.0167 '/' Cc= 0.900 f <b>pad-Crested Rectangular Weir</b> 0.80 1.00 1.20 1.40 1.60 70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=7.78 cfs @ 14.27 hrs HW=347.17' (Free Discharge) ←1=Culvert (Inlet Controls 7.78 cfs @ 2.32 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=346.00' (Free Discharge) 2=Broad-Crested Rectangular Weir (Controls 0.00 cfs) Breakneck Hill Road



		Breakneck Hill Road
Watershed	Type III 24-hr	10-year Rainfall=5.14"
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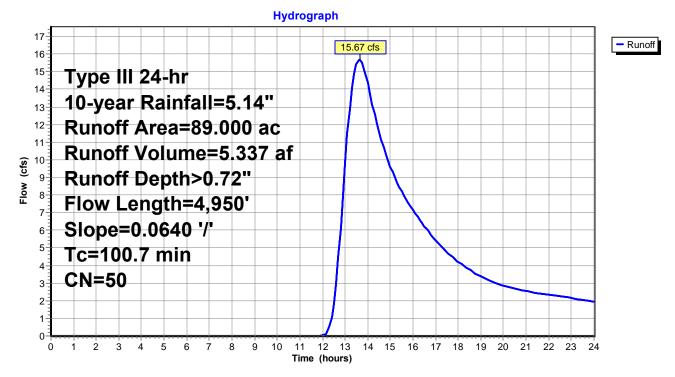
### Summary for Subcatchment 1S: Watershed

Ru	noff =	15	5.67 cfs @ 13	3.64 hrs, `	Volume=	5.337 af, Depth> 0.72"		
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Type III 24-hr 10-year Rainfall=5.14"								
	Area (ac)	CN	Description					
	31.000	30	Woods, Goo	od, HSG A	4			
*	20.000	58	Brush/Grass, Good, HSG B/C					
*	38.000	61	Woods, Goo	od, HSG E	3/C			
	89.000	50	Weighted A					

	Tc (min)	Length (feet)	•	Velocity (ft/sec)	Capacity (cfs)	Description
-	100.7	4,950	0.0640	0.82		Lag/CN Method, Tc-1

100.00% Pervious Area

89.000



Breakneck Hill Road Watershed Type III 24-hr 10-year Rainfall=5.14" Prepared by Killingly Engineering Associates, LLC Printed 1/8/2024 HydroCAD® 10.00-26 s/n 07240 © 2020 HydroCAD Software Solutions LLC Page 11 Summary for Reach 1R: Stream 0.00% Impervious, Inflow Depth > 0.72" for 10-year event Inflow Area = 89.000 ac. 15.67 cfs @ 13.64 hrs, Volume= Inflow 5.337 af = Outflow 15.34 cfs @ 14.02 hrs, Volume= 5.235 af, Atten= 2%, Lag= 22.6 min = Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Max. Velocity= 6.52 fps, Min. Travel Time= 12.6 min Avg. Velocity = 4.40 fps, Avg. Travel Time= 18.8 min Peak Storage= 11,652 cf @ 13.81 hrs Average Depth at Peak Storage= 0.52' Bank-Full Depth= 1.50' Flow Area= 11.3 sf, Capacity= 131.55 cfs 3.00' x 1.50' deep channel, n= 0.030 Side Slope Z-value= 3.0 '/' Top Width= 12.00' Length= 4,950.0' Slope= 0.0640 '/' Inlet Invert= 664.00', Outlet Invert= 347.00' r **Reach 1R: Stream** Hydrograph 17 - Inflow 15.34 cfs 16 Outflow 15 Inflow Area=89.000 ac 14 Avg. Flow Depth=0.52' 13 12 Max Vel=6.52 fps 11 10 n=0.030 (cfs) 9 Flow L=4.950.0' 8 7 S=0.0640 '/' 6 5 Capacity=131.55 cfs 4 3-2 1-

Time (hours)

11 12 13 14 15 16 17 18 19 20 21 22 23 24

0

0

2 3

5

6 7 8 9 10

4

Watershed Prepared by Killingly Engineering Associates, LLC HydroCAD® 10.00-26 s/n 07240 © 2020 HydroCAD Software Solutions LLC

#### Summary for Pond 3P: Wetlands prior to Culvert

Inflow Area =	89.000 ac,	0.00% Impervious, Inflow D	epth > 0.71" for 10-year event
Inflow =	15.34 cfs @	14.02 hrs, Volume=	5.235 af
Outflow =	15.34 cfs @	14.02 hrs, Volume=	5.234 af, Atten= 0%, Lag= 0.1 min
Primary =	15.34 cfs @	14.02 hrs, Volume=	5.234 af
Secondary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Peak Elev= 347.55' @ 14.02 hrs Surf.Area= 159 sf Storage= 169 cf

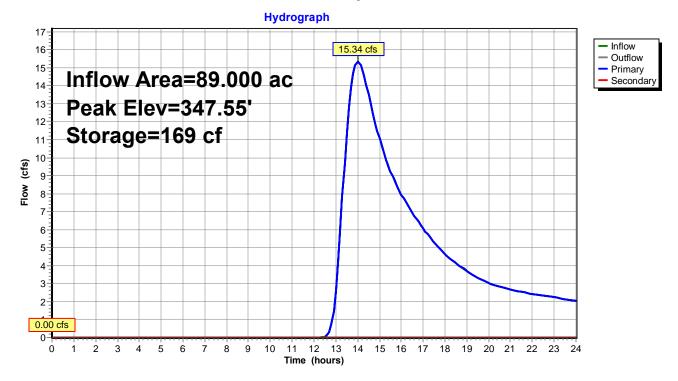
Plug-Flow detention time= 0.3 min calculated for 5.212 af (100% of inflow) Center-of-Mass det. time= 0.2 min (998.2 - 998.1)

Volume	Invert	Avail.Sto	rage Storage	Description	
#1	346.00'	4,86	60 cf Custom	Stage Data (Prism	atic) Listed below (Recalc)
Elevatic (fee		urf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	
346.0	0	58	0	0	
348.0	0	188	246	246	
350.0	0	2,650	2,838	3,084	
350.6	60	3,270	1,776	4,860	
Device	Routing	Invert	Outlet Device:	6	
#1	Primary	346.50'	60.0" W x 30.0	)" H Box Culvert	
#2	Secondary	y 350.40'	Inlet / Outlet In n= 0.030, Flo <b>16.0' long x 6</b> Head (feet) 0	wert= 346.50' / 346 w Area= 12.50 sf <b>i0.0' breadth Broad</b> .20 0.40 0.60 0.8	are crown edge, Ke= 0.700 5.00' S= 0.0167 '/' Cc= 0.900 <b>d-Crested Rectangular Weir</b> 0 1.00 1.20 1.40 1.60 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=15.32 cfs @ 14.02 hrs HW=347.55' (Free Discharge) **1=Culvert** (Inlet Controls 15.32 cfs @ 2.91 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=346.00' (Free Discharge) 2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

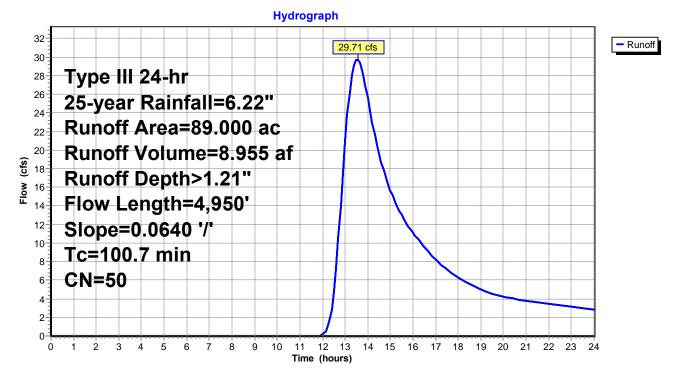
Breakneck Hill Road



		Breakneck Hill Road
Watershed	Type III 24-hr	25-year Rainfall=6.22"
Prepared by Killingly Engineering Associates, LLC		Printed 1/8/2024
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# Summary for Subcatchment 1S: Watershed

Runoff	=	29.71 cfs	s@ 13.5	5 hrs, Volu	me= 8.955 af, Depth> 1.21"		
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Type III 24-hr 25-year Rainfall=6.22"							
Area	(ac) C	N Dese	cription				
* 20	.000	58 Brus	ods, Good, sh/Grass, C ods, Good,	Good, HSG	B/C		
	.000 .000 Length		ghted Aver 00% Pervi Velocity	0	Description		
(min)	(feet)	(ft/ft)	(ft/sec)	(cfs)			
100.7	4,950	0.0640	0.82		Lag/CN Method, Tc-1		



Breakneck Hill Road Watershed Type III 24-hr 25-year Rainfall=6.22" Prepared by Killingly Engineering Associates, LLC Printed 1/8/2024 HydroCAD® 10.00-26 s/n 07240 © 2020 HydroCAD Software Solutions LLC Page 15 Summary for Reach 1R: Stream Inflow Area = 89.000 ac. 0.00% Impervious, Inflow Depth > 1.21" for 25-year event 29.71 cfs @ 13.55 hrs, Volume= Inflow 8.955 af = Outflow 29.19 cfs @ 13.86 hrs, Volume= 8.828 af, Atten= 2%, Lag= 19.0 min = Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Max. Velocity= 7.83 fps, Min. Travel Time= 10.5 min Avg. Velocity = 5.05 fps, Avg. Travel Time= 16.3 min Peak Storage= 18,492 cf @ 13.69 hrs Average Depth at Peak Storage= 0.72' Bank-Full Depth= 1.50' Flow Area= 11.3 sf, Capacity= 131.55 cfs 3.00' x 1.50' deep channel, n= 0.030 Side Slope Z-value= 3.0 '/' Top Width= 12.00' Length= 4,950.0' Slope= 0.0640 '/' Inlet Invert= 664.00', Outlet Invert= 347.00' r **Reach 1R: Stream** Hydrograph 32-- Inflow 29.19 cfs Outflow 30-Inflow Area=89.000 ac 28-26-Avg. Flow Depth=0.72' 24 22 Max Vel=7.83 fps 20 n=0.030 (S) 18-Flow 16 L=4.950.0' 14 S=0.0640 '/' 12-10-Capacity=131.55 cfs 8 6 4-2 0-

11 12 13 14 15 16 17 18 19 20 21 22

Time (hours)

23 24

2

3 4 5 6 7 8 9 10

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Watershed Type III 24-hr 25-year Rainfall=6.22" Prepared by Killingly Engineering Associates, LLC HydroCAD® 10.00-26 s/n 07240 © 2020 HydroCAD Software Solutions LLC

### Summary for Pond 3P: Wetlands prior to Culvert

Breakneck Hill Road

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Inflow Area =	89.000 ac,	0.00% Impervious, Inflow D	Depth > 1.19" for 25-year event
Inflow =	29.19 cfs @	13.86 hrs, Volume=	8.828 af
Outflow =	29.18 cfs @	13.86 hrs, Volume=	8.826 af, Atten= 0%, Lag= 0.1 min
Primary =	29.18 cfs @	13.86 hrs, Volume=	8.826 af
Secondary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Peak Elev= 348.17' @ 13.86 hrs Surf.Area= 393 sf Storage= 294 cf

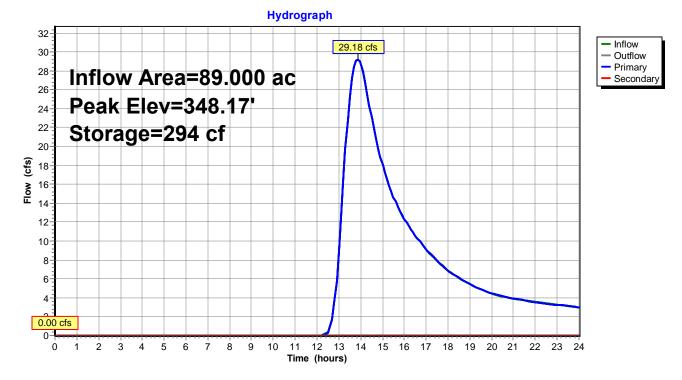
Plug-Flow detention time= 0.2 min calculated for 8.790 af (100% of inflow) Center-of-Mass det. time= 0.1 min (977.1 - 977.0)

Volume	Invert	Avail.Stor	age Storage	Description	
#1	346.00'	4,86	60 cf Custom	Stage Data (Pri	smatic) Listed below (Recalc)
Elevatio (fee		urf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	
346.0	0	58	0	0	
348.0	0	188	246	246	
350.0	0	2,650	2,838	3,084	
350.6	0	3,270	1,776	4,860	
Device	Routing	Invert	Outlet Devices	6	
#1	Primary	346.50'	60.0" W x 30.0	" H Box Culve	rt
#2	Secondary	350.40'	Inlet / Outlet In n= 0.030, Flow <b>16.0' long x 6</b> Head (feet) 0.	vert= 346.50' / w Area= 12.50 s <b>0.0' breadth Br</b> .20 0.40 0.60	square crown edge, Ke= 0.700 346.00' S= 0.0167 '/' Cc= 0.900 sf <b>oad-Crested Rectangular Weir</b> 0.80 1.00 1.20 1.40 1.60 70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=29.13 cfs @ 13.86 hrs HW=348.16' (Free Discharge) **1=Culvert** (Barrel Controls 29.13 cfs @ 4.67 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=346.00' (Free Discharge) 2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

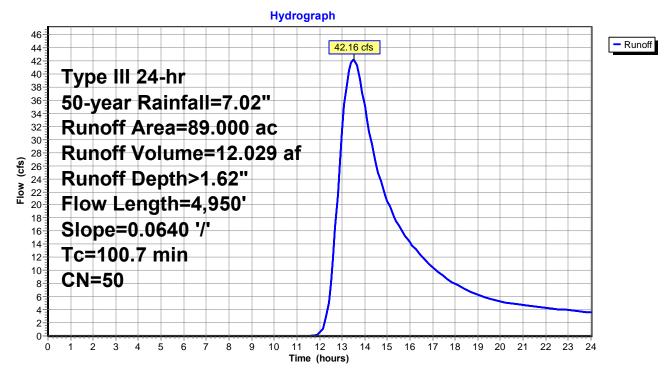
Breakneck Hill Road



		Breakneck Hill Road
Watershed	Type III 24-hr	50-year Rainfall=7.02"
Prepared by Killingly Engineering Associates, LLC		Printed 1/8/2024
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# Summary for Subcatchment 1S: Watershed

Runoff	=	4	2.16 cfs	s@ 13.5	1 hrs, Volu	ume= 12.029 af, Depth> 1.62"	
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Type III 24-hr 50-year Rainfall=7.02"							
Area	(ac)	CN	Desc	ription			
* 20	.000 .000 .000	30 58 61	Brus		HSG A Good, HSG HSG B/C		
	.000 .000 Leng (fee			hted Aver 00% Pervi Velocity (ft/sec)	0	1	
100.7	4,95	,	0.0640	0.82	(015)	Lag/CN Method, Tc-1	



Breakneck Hill Road Watershed Type III 24-hr 50-year Rainfall=7.02" Prepared by Killingly Engineering Associates, LLC Printed 1/8/2024 HydroCAD® 10.00-26 s/n 07240 © 2020 HydroCAD Software Solutions LLC Page 19 Summary for Reach 1R: Stream Inflow Area = 0.00% Impervious, Inflow Depth > 1.62" for 50-year event 89.000 ac. 42.16 cfs @ 13.51 hrs, Volume= Inflow 12.029 af = Outflow 41.51 cfs @ 13.79 hrs, Volume= 11.883 af, Atten= 2%, Lag= 17.2 min = Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Max. Velocity= 8.62 fps, Min. Travel Time= 9.6 min Avg. Velocity = 5.42 fps, Avg. Travel Time= 15.2 min Peak Storage= 23,887 cf @ 13.63 hrs Average Depth at Peak Storage= 0.86' Bank-Full Depth= 1.50' Flow Area= 11.3 sf, Capacity= 131.55 cfs 3.00' x 1.50' deep channel, n= 0.030 Side Slope Z-value= 3.0 '/' Top Width= 12.00' Length= 4,950.0' Slope= 0.0640 '/' Inlet Invert= 664.00', Outlet Invert= 347.00' r Reach 1R: Stream Hydrograph 46 Inflow 44 41.51 cfs Outflow 42 40-Inflow Area=89.000 ac 38 36 Avg. Flow Depth=0.86' 34 32-Max Vel=8.62 fps 30 28 n=0.030 (cfs) 26 24 Flow L=4.950.0' 22-20 18-S=0.0640 '/' 16 14 Capacity=131.55 cfs

11 12 13 14 15 16 17 18 19 20 21 22

Time (hours)

23 24

2 3 4 5 6 7 8 9 10

Watershed Type III 24-hr 50-year Rainfall=7.02" Prepared by Killingly Engineering Associates, LLC HydroCAD® 10.00-26 s/n 07240 © 2020 HydroCAD Software Solutions LLC

### Summary for Pond 3P: Wetlands prior to Culvert

Breakneck Hill Road

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Inflow Area =	89.000 ac,	0.00% Impervious, Inflow	Depth > 1.60" for 50-year ev	rent
Inflow =	41.51 cfs @	13.79 hrs, Volume=	11.883 af	
Outflow =	41.51 cfs @	13.80 hrs, Volume=	11.881 af, Atten= 0%, Lag= 0	.6 min
Primary =	41.51 cfs @	13.80 hrs, Volume=	11.881 af	
Secondary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af	

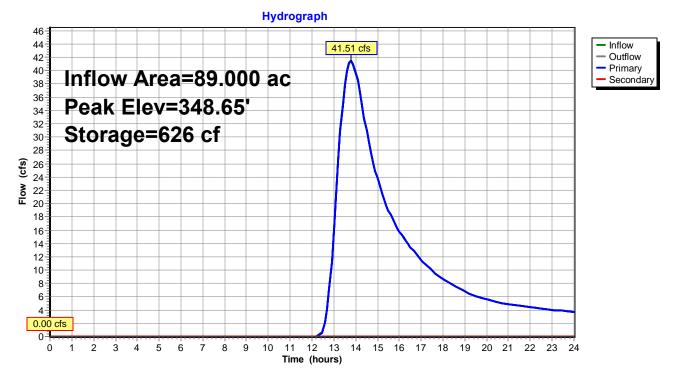
Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Peak Elev= 348.65' @ 13.80 hrs Surf.Area= 985 sf Storage= 626 cf

Plug-Flow detention time= 0.2 min calculated for 11.832 af (100% of inflow) Center-of-Mass det. time= 0.1 min (966.4 - 966.3)

Volume	Invert	Avail.Stor	age Storage	Description	
#1	346.00'	4,86	0 cf Custom	Stage Data (Pri	ismatic) Listed below (Recalc)
Elevatio (fee		ırf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	
346.0	0	58	0	0	
348.0	0	188	246	246	
350.0	0	2,650	2,838	3,084	
350.6	0	3,270	1,776	4,860	
Device	Routing	Invert	Outlet Devices	6	
#1	Primary	346.50'	60.0" W x 30.0	" H Box Culve	rt
#2	Secondary	350.40'	Inlet / Outlet In n= 0.030, Flow <b>16.0' long x 6</b> Head (feet) 0.	nvert= 346.50' / w Area= 12.50 <b>0.0' breadth Br</b> .20 0.40 0.60	square crown edge, Ke= 0.700 346.00' S= 0.0167 '/' Cc= 0.900 sf <b>road-Crested Rectangular Weir</b> 0.80 1.00 1.20 1.40 1.60 70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=41.51 cfs @ 13.80 hrs HW=348.65' (Free Discharge) **1=Culvert** (Barrel Controls 41.51 cfs @ 5.15 fps)

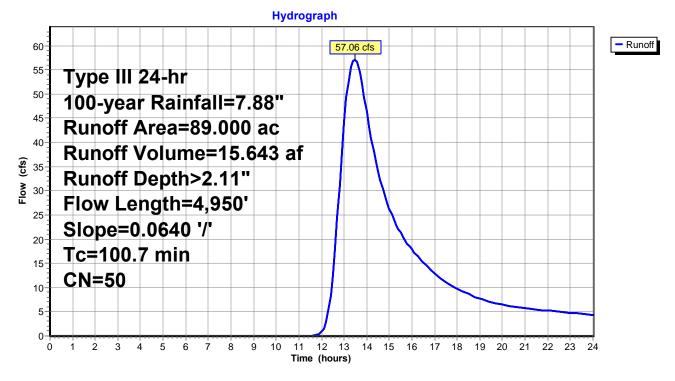
Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=346.00' (Free Discharge) 2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)



		Breakneck Hill Road
Watershed	Type III 24-hr	100-year Rainfall=7.88"
Prepared by Killingly Engineering Associates, LLC		Printed 1/8/2024
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# Summary for Subcatchment 1S: Watershed

Runoff	=	5	7.06 cfs	。@ 13.4	7 hrs, Volu	me= 15	.643 af, Depth> 2.11"
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Type III 24-hr 100-year Rainfall=7.88"							
Area	(ac)	CN	Desc	ription			
* 20.	.000 .000 .000	30 58 61	Brus	,	HSG A Good, HSG HSG B/C	B/C	
	.000 .000 Leng (fee			hted Ave 00% Perv Velocity (ft/sec)	rage ious Area Capacity (cfs)	Description	
100.7	4,95	/	0.0640	0.82	(0.0)	Lag/CN Meth	od, Tc-1



Breakneck Hill Road Watershed Type III 24-hr 100-year Rainfall=7.88" Prepared by Killingly Engineering Associates, LLC Printed 1/8/2024 HydroCAD® 10.00-26 s/n 07240 © 2020 HydroCAD Software Solutions LLC Page 23 Summary for Reach 1R: Stream Inflow Area = 89.000 ac. 0.00% Impervious, Inflow Depth > 2.11" for 100-year event 57.06 cfs @ 13.47 hrs, Volume= Inflow 15.643 af = 15.477 af, Atten= 1%, Lag= 15.7 min Outflow 56.30 cfs @ 13.73 hrs, Volume= = Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Max. Velocity= 9.36 fps, Min. Travel Time= 8.8 min Avg. Velocity = 5.72 fps, Avg. Travel Time= 14.4 min Peak Storage= 29,840 cf @ 13.59 hrs Average Depth at Peak Storage= 1.00' Bank-Full Depth= 1.50' Flow Area= 11.3 sf, Capacity= 131.55 cfs 3.00' x 1.50' deep channel, n= 0.030 Side Slope Z-value= 3.0 '/' Top Width= 12.00' Length= 4,950.0' Slope= 0.0640 '/' Inlet Invert= 664.00', Outlet Invert= 347.00' r **Reach 1R: Stream** Hydrograph - Inflow 60 56.30 cfs Outflow 55-Inflow Area=89.000 ac 50 Avg. Flow Depth=1.00' 45 Max Vel=9.36 fps 40 n=0.030 (sj) 35 8 30-L=4.950.0' 25 S=0.0640 '/' 20 Capacity=131.55 cfs 15-10-5 0

11 12 13 14 15 16 17 18 19 20 21 22

Time (hours)

23 24

3

2

Ó

5

6 7 8 9 10

4

WatershedType III 24-hr100-year Rainfall=7.88"Prepared by Killingly Engineering Associates, LLCPrinted1/8/2024HydroCAD® 10.00-26 s/n 07240 © 2020 HydroCAD Software Solutions LLCPage 24

### Summary for Pond 3P: Wetlands prior to Culvert

Inflow Area =	89.000 ac,	0.00% Impervious, Inflow	Depth > 2.09" for 100-year event
Inflow =	56.30 cfs @	13.73 hrs, Volume=	15.477 af
Outflow =	56.29 cfs @	13.75 hrs, Volume=	15.475 af, Atten= 0%, Lag= 0.9 min
Primary =	56.29 cfs @	13.75 hrs, Volume=	15.475 af
Secondary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs Peak Elev= 349.17' @ 13.75 hrs Surf.Area= 1,632 sf Storage= 1,313 cf

Plug-Flow detention time= 0.3 min calculated for 15.475 af (100% of inflow) Center-of-Mass det. time= 0.2 min (957.5 - 957.3)

Volume	Invert	Avail.Stor	age Storage D	Description	
#1	346.00'	4,86	0 cf Custom S	Stage Data (Pri	smatic) Listed below (Recalc)
Elevatio (fee		rf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	
346.0	0	58	0	0	
348.0	0	188	246	246	
350.0	0	2,650	2,838	3,084	
350.6	0	3,270	1,776	4,860	
Device	Routing	Invert	Outlet Devices		
#1	Primary	346.50'	60.0" W x 30.0	" H Box Culve	rt
#2	Secondary	350.40'	L= 30.0' Box, 0° wingwalls, square crown edge, Ke= 0.700 Inlet / Outlet Invert= 346.50' / 346.00' S= 0.0167 '/' Cc= 0.900 n= 0.030, Flow Area= 12.50 sf <b>16.0' long x 60.0' breadth Broad-Crested Rectangular Weir</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63		

Primary OutFlow Max=56.16 cfs @ 13.75 hrs HW=349.17' (Free Discharge) ←1=Culvert (Barrel Controls 56.16 cfs @ 5.61 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=346.00' (Free Discharge) 2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

