Northeast Civil Solutions

Northeast Civil Solutions
INCORPORATED

www. northeastcivilsolutions.com

153 U.S. Route 1

Scarborough

Maine 04074

tel

207.883.1000

800.882.2227

fax

207.883.1001

May 1, 2013

Ms. Barbara Barhydt, Development Review Services Manager
Development Review Program, City of Portland
Fourth Floor, City Hall, 389 Congress Street
Portland, ME 04101

RE: 760 Ocean Avenue Stormwater Management – Barrantes & Staub Property

Dear Barbara,

A stormwater analysis was completed for the development of a single family residence at 760 Ocean Avenue. The analysis was completed for the existing (pre-development) and proposed (post-development) drainage condition. The SCS TR-20 (HydroCAD) method was used to calculate runoff for the existing and proposed condition.

EXISTING CONDITIONS

The site is analyzed as one drainage area for the existing condition. The drainage area collects runoff from the ridge near the rear of the site and drains to a wetland at the front of the site. There is an existing culvert that drains the wetland, easterly, under Ocean Avenue, to another wooded low spot. A study point (SP-1) was located at the culvert to measure flows leaving the site into the Ocean Avenue right of way.

POST DEVELOPMENT CONDITIONS

The existing drainage area is to be broken down into three smaller subcatchments based on the proposed grading and stormwater infrastructure. The largest of these subcatchments (S1) includes runoff from the proposed house, garage, and some of the driveway as well as the runoff from the ridge to the rear of the site. This subcatchment is directed to a proposed Gravelpave2 System (GP2) in the driveway. The GP2 acts as a detention pond with void space in the gravel to store runoff and allow it to infiltrate into the ground below. During the 2-year storm event, all runoff collected in the GP2 is infiltrated. During the 10 and 25-year events, there is some overflow out of the GP2 that flows along the ditch on the north side of the proposed driveway down to the existing wetland. S2 drains along the south side of the proposed driveway and eventually into the ditch along Ocean Avenue. S3 drains along the ditch on the northern side of the proposed driveway to the wetland without passing through the GP2. All of the runoff from the three subcatchments is tributary to the study point (SP-1) which is used to compare the pre development and post development peak runoff flows.

CONCLUSION

By inspection of the pre and post development drainage, no increase in runoff is realized by the development of this project. See pre and post development drainage summaries below. Please refer to the attached drainage calculations for detailed information for the 2, 10 and 25-year storm events.

Table 1- Pre-Development Drainage Summary

	Q2 (cfs)	Q10 (cfs)	Q25 (cfs)
SP-1	1.4	3.4	4.5

Table 2- Post Development Drainage Summary

	Q2 (cfs)	Q10 (cfs)	Q25 (cfs)
SP-1	1.1	3.1	4.3

Table 3- Comparison of Pre- and Post-Development Discharges for Study Point #1

Return Period (Yrs)	SP-1 Pre Flows (cfs)	SP-1 Post Flows (cfs)	Diff. (cfs)
2	1.4	1.1	-0.3
10	3.4	3.1	-0.3
25	4.5	4.3	-0.2

MAINTENANCE

Ditches and Swales

Open swales and ditches need to be inspected on a monthly basis or after a major rainfall event to ensure that debris or sediments do not reduce the effectiveness of the system. All debris needs to be removed. Any sign of erosion or blockage shall be immediately repaired to promote a vigorous growth of vegetation. Vegetated ditches should be mowed at least monthly during the growing season. Larger brush or trees must be prevented from becoming established in the channel. Any areas where the vegetation fails will be subject to erosion and should be repaired and re-vegetated.

Gravelpave2 System

Potholes will only appear if the base course has not been compacted properly before laying the rings or if the base material is allowed to mix into clay soils below (use nonwoven fabric to keep separate). Should this occur, remove a section by vacuuming the gravel from the rings, unfasten the snap fit fastener, bring the base course to the proper grade and compaction, put the Gravelpave2 square back in place, anchor, and fill to the top of the rings. Seasonally check the rings in high-traffic areas and entrance lanes for lower levels of fill and replace by sweeping gravel from other areas to bring it level again. Leaves should be raked or vacuumed and not allowed to decay. Organic matter will stimulate weed growth and reduce porosity. To attack any occasional weeds that may locate within the Gravelpave2 installation, simply spray them with a weed killer and remove when dead.

Educate your snow removal crew to take care not to have the plow blade make contact with the Gravelpave2 system. Experienced snowplow drivers can leave a thin layer of snow on the systems or they can attach skids (3/4 inch—2 cm) to the bottom of the blades.

Remove and replace segments of Gravelpave2 units where three or more adjacent rings are broken or damaged, reinstalling as specified.

Sincerely,
Northeast Civil Solutions, Inc.

Jacob Sparkowich, E.I.T.
Project Engineer

S1
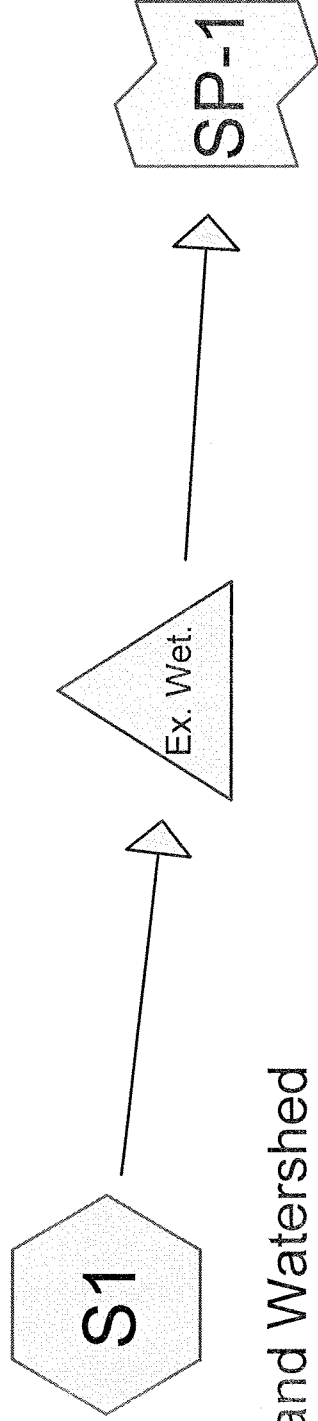
Wetland Watershed

Ex. Wet.
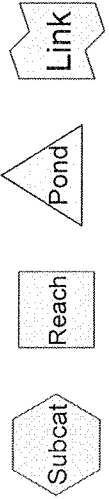
Existing Wetland

SP-1

Study Point 1

Subcat   Reach   Pond   Link

Routing Diagram for Pre-Development Conditions
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Pre-Development Conditions
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Type III 24-hr 2-Year Rainfall=3.00"
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Page 1

Time span=0.00-40.00 hrs, dt=0.01 hrs, 4001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment S1: Wetland Watershed   Runoff Area=125,582 sf 8.02% Impervious Runoff Depth=0.91"
Flow Length=845' Tc=40.7 min CN=74 Runoff=1.40 cfs 0.218 af

Pond Ex. Wet.: Existing Wetland   Peak Elev=86.95' Storage=38 cf Inflow=1.40 cfs 0.218 af
24.0" Round Culvert n=0.025 L=80.8' S=0.0021 '/' Outflow=1.40 cfs 0.218 af

Link SP-1: Study Point 1   Inflow=1.40 cfs 0.218 af
Primary=1.40 cfs 0.218 af

Total Runoff Area = 2.883 ac   Runoff Volume = 0.218 af   Average Runoff Depth = 0.91"
91.98% Pervious = 2.652 ac   8.02% Impervious = 0.231 ac

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Type III 24-hr 2-Year Rainfall=3.00"
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Summary for Subcatchment S1: Wetland Watershed

Runoff   =   1.40 cfs @ 12.62 hrs, Volume=   0.218 af, Depth= 0.91"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.00"

	Area (sf)	CN	Description
	5,386	98	Paved parking, HSG C
	33,021	71	Meadow, non-grazed, HSG C
	61,162	70	Woods, Good, HSG C
	21,331	78	Meadow, non-grazed, HSG D
*	4,682	98	Ledge Outcrop, HSG D
	125,582	74	Weighted Average
	115,514		91.98% Pervious Area
	10,068		8.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.7	100	0.0680	0.07		**Sheet Flow, A-B**
					Woods: Dense underbrush n= 0.800 P2= 3.00"
1.2	85	0.2188	1.17		**Shallow Concentrated Flow, B-C**
					Forest w/Heavy Litter Kv= 2.5 fps
12.8	502	0.0679	0.65		**Shallow Concentrated Flow, C-D**
					Forest w/Heavy Litter Kv= 2.5 fps
3.0	158	0.0310	0.88		**Shallow Concentrated Flow, D-E**
					Woodland Kv= 5.0 fps
40.7	845	Total			

Pre-Development Conditions
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Type III 24-hr 2-Year Rainfall=3.00"
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Summary for Pond Ex. Wet.: Existing Wetland

Inflow Area =	2.883 ac,	8.02% Impervious, Inflow Depth = 0.91" for 2-Year event
Inflow =	1.40 cfs @ 12.62 hrs, Volume=	0.218 af
Outflow =	1.40 cfs @ 12.62 hrs, Volume=	0.218 af, Atten= 0%, Lag= 0.3 min
Primary =	1.40 cfs @ 12.62 hrs, Volume=	0.218 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Peak Elev= 86.95' @ 12.62 hrs   Surf.Area= 81 sf   Storage= 38 cf

Plug-Flow detention time= 0.7 min calculated for 0.218 af (100% of inflow)
Center-of-Mass det. time= 0.7 min (899.1 - 898.4)

Volume	Invert	Avail.Storage	Storage Description
#1	86.00'	6,072 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
86.00	0	0	0
87.00	85	43	43
88.00	1,964	1,025	1,067
89.00	8,046	5,005	6,072

Device	Routing	Invert	Outlet Devices
#1	Primary	86.14'	**24.0" Round Culvert**
			L= 80.8' CMP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 86.14' / 85.97' S= 0.0021 '/' Cc= 0.900
			n= 0.025 Corrugated metal, Flow Area= 3.14 sf

Primary OutFlow Max=1.40 cfs @ 12.62 hrs HW=86.95' TW=0.00' (Dynamic Tailwater)
└─1=Culvert (Barrel Controls 1.40 cfs @ 1.73 fps)

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Type III 24-hr 2-Year Rainfall=3.00"
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Summary for Link SP-1: Study Point 1

Inflow Area =   2.883 ac,   8.02% Impervious, Inflow Depth = 0.91"   for 2-Year event
Inflow   =   1.40 cfs @   12.62 hrs, Volume=   0.218 af
Primary   =   1.40 cfs @   12.62 hrs, Volume=   0.218 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

Pre-Development Conditions
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Type III 24-hr 10-Year Rainfall=4.70"
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Time span=0.00-40.00 hrs, dt=0.01 hrs, 4001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment S1: Wetland Watershed Runoff Area=125,582 sf 8.02% Impervious Runoff Depth=2.13"
Flow Length=845' Tc=40.7 min CN=74 Runoff=3.47 cfs 0.511 af

Pond Ex. Wet.: Existing Wetland Peak Elev=87.41' Storage=236 cf Inflow=3.47 cfs 0.511 af
24.0" Round Culvert n=0.025 L=80.8' S=0.0021 '/' Outflow=3.44 cfs 0.511 af

Link SP-1: Study Point 1 Inflow=3.44 cfs 0.511 af
Primary=3.44 cfs 0.511 af

Total Runoff Area = 2.883 ac Runoff Volume = 0.511 af Average Runoff Depth = 2.13"
91.98% Pervious = 2.652 ac   8.02% Impervious = 0.231 ac

Summary for Subcatchment S1: Wetland Watershed

Runoff   =   3.47 cfs @ 12.57 hrs, Volume=   0.511 af, Depth= 2.13"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
	5,386	98	Paved parking, HSG C
	33,021	71	Meadow, non-grazed, HSG C
	61,162	70	Woods, Good, HSG C
	21,331	78	Meadow, non-grazed, HSG D
*	4,682	98	Ledge Outcrop, HSG D
	125,582	74	Weighted Average
	115,514		91.98% Pervious Area
	10,068		8.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.7	100	0.0680	0.07		**Sheet Flow, A-B**
					Woods: Dense underbrush n= 0.800 P2= 3.00"
1.2	85	0.2188	1.17		**Shallow Concentrated Flow, B-C**
					Forest w/Heavy Litter Kv= 2.5 fps
12.8	502	0.0679	0.65		**Shallow Concentrated Flow, C-D**
					Forest w/Heavy Litter Kv= 2.5 fps
3.0	158	0.0310	0.88		**Shallow Concentrated Flow, D-E**
					Woodland Kv= 5.0 fps
40.7	845	Total			

Pre-Development Conditions
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Type III 24-hr 10-Year Rainfall=4.70"
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Summary for Pond Ex. Wet.: Existing Wetland

Inflow Area = 2.883 ac, 8.02% Impervious, Inflow Depth = 2.13" for 10-Year event
Inflow   = 3.47 cfs @ 12.57 hrs, Volume=   0.511 af
Outflow   = 3.44 cfs @ 12.63 hrs, Volume=   0.511 af, Atten= 1%, Lag= 3.1 min
Primary   = 3.44 cfs @ 12.63 hrs, Volume=   0.511 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Peak Elev= 87.41' @ 12.63 hrs Surf.Area= 857 sf Storage= 236 cf

Plug-Flow detention time= 0.9 min calculated for 0.511 af (100% of inflow)
Center-of-Mass det. time= 0.7 min (873.4 - 872.7)

Volume	Invert	Avail.Storage	Storage Description
#1	86.00'	6,072 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
86.00	0	0	0
87.00	85	43	43
88.00	1,964	1,025	1,067
89.00	8,046	5,005	6,072

Device	Routing	Invert	Outlet Devices
#1	Primary	86.14'	**24.0" Round Culvert** L= 80.8' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 86.14' / 85.97' S= 0.0021 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 3.14 sf

Primary OutFlow Max=3.44 cfs @ 12.63 hrs HW=87.41' TW=0.00' (Dynamic Tailwater)
└─1=Culvert (Barrel Controls 3.44 cfs @ 2.33 fps)

Summary for Link SP-1: Study Point 1

Inflow Area =   2.883 ac,   8.02% Impervious, Inflow Depth = 2.13"   for 10-Year event
Inflow   =   3.44 cfs @   12.63 hrs, Volume=   0.511 af
Primary   =   3.44 cfs @   12.63 hrs, Volume=   0.511 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

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Type III 24-hr 25-Year Rainfall=5.50"
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Time span=0.00-40.00 hrs, dt=0.01 hrs, 4001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment S1: Wetland Watershed   Runoff Area=125,582 sf 8.02% Impervious Runoff Depth=2.77"
Flow Length=845' Tc=40.7 min CN=74 Runoff=4.55 cfs 0.665 af

Pond Ex. Wet.: Existing Wetland   Peak Elev=87.60' Storage=437 cf Inflow=4.55 cfs 0.665 af
24.0" Round Culvert n=0.025 L=80.8' S=0.0021 '/' Outflow=4.49 cfs 0.665 af

Link SP-1: Study Point 1   Inflow=4.49 cfs 0.665 af
Primary=4.49 cfs 0.665 af

Total Runoff Area = 2.883 ac   Runoff Volume = 0.665 af   Average Runoff Depth = 2.77"
91.98% Pervious = 2.652 ac   8.02% Impervious = 0.231 ac

Pre-Development Conditions
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Type III 24-hr 25-Year Rainfall=5.50"
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Summary for Subcatchment S1: Wetland Watershed

Runoff   =   4.55 cfs @ 12.57 hrs, Volume=   0.665 af, Depth= 2.77"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=5.50"

Area (sf)	CN	Description
5,386	98	Paved parking, HSG C
33,021	71	Meadow, non-grazed, HSG C
61,162	70	Woods, Good, HSG C
21,331	78	Meadow, non-grazed, HSG D
* 4,682	98	Ledge Outcrop, HSG D
125,582	74	Weighted Average
115,514		91.98% Pervious Area
10,068		8.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.7	100	0.0680	0.07		**Sheet Flow, A-B**
					Woods: Dense underbrush n= 0.800 P2= 3.00"
1.2	85	0.2188	1.17		**Shallow Concentrated Flow, B-C**
					Forest w/Heavy Litter Kv= 2.5 fps
12.8	502	0.0679	0.65		**Shallow Concentrated Flow, C-D**
					Forest w/Heavy Litter Kv= 2.5 fps
3.0	158	0.0310	0.88		**Shallow Concentrated Flow, D-E**
					Woodland Kv= 5.0 fps
40.7	845	Total			

Summary for Pond Ex. Wet.: Existing Wetland

Inflow Area =	2.883 ac,	8.02% Impervious,	Inflow Depth =	2.77"	for 25-Year event
Inflow =	4.55 cfs @	12.57 hrs,	Volume=	0.665 af	
Outflow =	4.49 cfs @	12.63 hrs,	Volume=	0.665 af,	Atten= 1%, Lag= 3.6 min
Primary =	4.49 cfs @	12.63 hrs,	Volume=	0.665 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Peak Elev= 87.60' @ 12.63 hrs   Surf.Area= 1,221 sf   Storage= 437 cf

Plug-Flow detention time= 0.9 min calculated for 0.665 af (100% of inflow)
Center-of-Mass det. time= 0.9 min (865.9 - 865.0)

Volume	Invert	Avail.Storage	Storage Description
#1	86.00'	6,072 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
86.00	0	0	0
87.00	85	43	43
88.00	1,964	1,025	1,067
89.00	8,046	5,005	6,072

Device	Routing	Invert	Outlet Devices
#1	Primary	86.14'	**24.0" Round Culvert**
			L= 80.8' CMP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 86.14' / 85.97' S= 0.0021 '/' Cc= 0.900
			n= 0.025 Corrugated metal, Flow Area= 3.14 sf

Primary OutFlow Max=4.49 cfs @ 12.63 hrs HW=87.60' TW=0.00' (Dynamic Tailwater)
└─1=Culvert (Barrel Controls 4.49 cfs @ 2.54 fps)

Summary for Link SP-1: Study Point 1

Inflow Area =   2.883 ac,   8.02% Impervious, Inflow Depth = 2.77"   for 25-Year event
Inflow   =   4.49 cfs @   12.63 hrs, Volume=   0.665 af
Primary   =   4.49 cfs @   12.63 hrs, Volume=   0.665 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

S1

Subcatchment 1

GP2

Gravelpave2 System

Ditch

Ditch

OF1

Overland Flow 1

S3

Subcatchment 3

OF2

Overland Flow 2

Ex. Wet.

Existing Wetland

SP-1

Study Point 1

S2

Subcatchment 2

Subcat   Reach   Pond   Link

Time span=0.00-40.00 hrs, dt=0.01 hrs, 4001 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 S1: Subcatchment 1   Runoff Area=68,868 sf   5.76% Impervious   Runoff Depth=0.81"
Flow Length=421'   Tc=30.5 min   CN=72   Runoff=0.76 cfs 0.106 af

Subcatchment S2: Subcatchment 2   Runoff Area=24,600 sf   5.40% Impervious   Runoff Depth=0.96"
Flow Length=385'   Tc=11.8 min   UI Adjusted CN=75   Runoff=0.49 cfs 0.045 af

Subcatchment S3: Subcatchment 3   Runoff Area=33,477 sf   21.41% Impervious   Runoff Depth=1.31"
Flow Length=623'   Tc=25.6 min   CN=81   Runoff=0.71 cfs 0.084 af

Reach Ditch: Ditch   Avg. Flow Depth=0.00'   Max Vel=0.00 fps   Inflow=0.00 cfs 0.000 af
n=0.022   L=93.0'   S=0.0774 '/'   Capacity=34.29 cfs   Outflow=0.00 cfs 0.000 af

Reach OF1: Overland Flow 1   Avg. Flow Depth=0.00'   Max Vel=0.00 fps   Inflow=0.00 cfs 0.000 af
n=0.030   L=137.0'   S=0.1161 '/'   Capacity=3.70 cfs   Outflow=0.00 cfs 0.000 af

Reach OF2: Overland Flow 2   Avg. Flow Depth=0.00'   Max Vel=0.00 fps   Inflow=0.00 cfs 0.000 af
n=0.030   L=170.0'   S=0.0345 '/'   Capacity=25.16 cfs   Outflow=0.00 cfs 0.000 af

Pond Ex. Wet.: Existing Wetland   Peak Elev=86.73'   Storage=22 cf   Inflow=0.71 cfs 0.084 af
24.0" Round Culvert   n=0.025   L=80.8'   S=0.0021 '/'   Outflow=0.71 cfs 0.084 af

Pond GP2: Gravelpave2 System   Peak Elev=117.75'   Storage=671 cf   Inflow=0.76 cfs 0.106 af
Discarded=0.35 cfs 0.106 af   Primary=0.00 cfs 0.000 af   Outflow=0.35 cfs 0.106 af

Link SP-1: Study Point 1   Inflow=1.05 cfs 0.129 af
Primary=1.05 cfs 0.129 af

Total Runoff Area = 2.914 ac   Runoff Volume = 0.236 af   Average Runoff Depth = 0.97"
90.19% Pervious = 2.628 ac   9.81% Impervious = 0.286 ac

Post-Development Conditions
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Type III 24-hr 2-Year Rainfall=3.00"
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Summary for Subcatchment S1: Subcatchment 1

Runoff   =   0.76 cfs @ 12.47 hrs, Volume=   0.106 af, Depth= 0.81"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.00"

	Area (sf)	CN	Description
	56,267	70	Woods, Good, HSG C
	6,121	74	>75% Grass cover, Good, HSG C
*	1,349	98	Ledge Outcrop, HSG D
	2,310	98	Unconnected roofs, HSG A
	306	98	Paved parking, HSG A
*	2,515	74	Gravel Pave System
	68,868	72	Weighted Average
	64,903		94.24% Pervious Area
	3,965		5.76% Impervious Area
	2,310		58.26% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.7	100	0.0680	0.07		**Sheet Flow, A-B**
					Woods: Dense underbrush n= 0.800 P2= 3.00"
1.2	85	0.2188	1.17		**Shallow Concentrated Flow, B-C**
					Forest w/Heavy Litter Kv= 2.5 fps
4.8	189	0.0679	0.65		**Shallow Concentrated Flow, C-D**
					Forest w/Heavy Litter Kv= 2.5 fps
0.8	47	0.0212	1.02		**Shallow Concentrated Flow, D-E**
					Short Grass Pasture Kv= 7.0 fps
30.5	421	Total			

Post-Development Conditions
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Type III 24-hr 2-Year Rainfall=3.00"
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Summary for Subcatchment S2: Subcatchment 2

Runoff   =   0.49 cfs @ 12.18 hrs, Volume=   0.045 af, Depth= 0.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.00"

Area (sf)	CN	Description
7,191	70	Woods, Good, HSG C
7,984	74	>75% Grass cover, Good, HSG C
8,097	80	>75% Grass cover, Good, HSG D
1,328	98	Unconnected roofs, HSG A
24,600	76	Weighted Average, UI Adjusted CN = 75
23,272		94.60% Pervious Area
1,328		5.40% Impervious Area
1,328		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	43	0.3300	0.29		**Sheet Flow, A-B**
					Grass: Dense n= 0.240 P2= 3.00"
4.5	21	0.1905	0.08		**Sheet Flow, B-C**
					Woods: Dense underbrush n= 0.800 P2= 3.00"
2.3	62	0.0322	0.45		**Shallow Concentrated Flow, C-D**
					Forest w/Heavy Litter Kv= 2.5 fps
0.7	96	0.0938	2.14		**Shallow Concentrated Flow, D-E**
					Short Grass Pasture Kv= 7.0 fps
1.5	84	0.0179	0.94		**Shallow Concentrated Flow, E-F**
					Short Grass Pasture Kv= 7.0 fps
0.4	79	0.0063	3.58	14.33	**Trap/Vee/Rect Channel Flow, F-G**
					Bot.W=1.00' D=1.00' Z= 3.0 '/' Top.W=7.00'
					n= 0.022 Earth, clean & straight
11.8	385	Total			

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Type III 24-hr 2-Year Rainfall=3.00"
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Summary for Subcatchment S3: Subcatchment 3

Runoff   =   0.71 cfs @ 12.37 hrs, Volume=   0.084 af, Depth= 1.31"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.00"

Area (sf)	CN	Description
4,092	70	Woods, Good, HSG C
11,217	74	>75% Grass cover, Good, HSG C
11,002	80	>75% Grass cover, Good, HSG D
7,166	98	Paved parking, HSG A
33,477	81	Weighted Average
26,311		78.59% Pervious Area
7,166		21.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.1	129	0.1511	0.10		**Sheet Flow, A-B**
					Woods: Dense underbrush n= 0.800 P2= 3.00"
0.9	94	0.0638	1.77		**Shallow Concentrated Flow, B-C**
					Short Grass Pasture Kv= 7.0 fps
0.1	93	0.0752	11.27	33.80	**Trap/Vee/Rect Channel Flow, C-D**
					Bot.W=0.00' D=1.00' Z= 3.0 '/' Top.W=6.00'
					n= 0.022
1.3	137	0.1168	1.71		**Shallow Concentrated Flow, D-E**
					Woodland Kv= 5.0 fps
2.2	170	0.0353	1.32		**Shallow Concentrated Flow, E-F**
					Short Grass Pasture Kv= 7.0 fps
25.6	623	Total			

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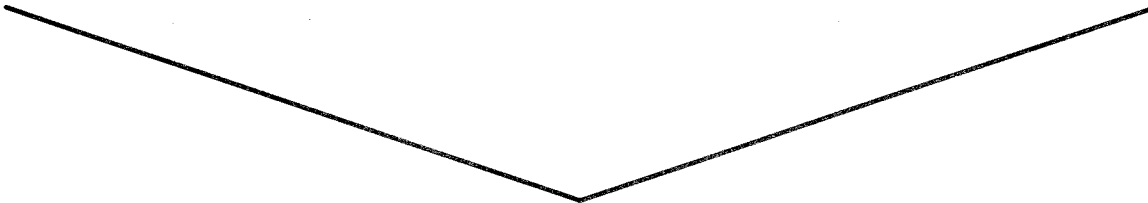Page 5

Summary for Reach Ditch: Ditch

Inflow Area =   1.581 ac,   5.76% Impervious, Inflow Depth = 0.00"   for 2-Year event
Inflow   =   0.00 cfs @   0.00 hrs, Volume=   0.000 af
Outflow   =   0.00 cfs @   0.00 hrs, Volume=   0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.00' Flow Area= 3.0 sf, Capacity= 34.29 cfs

0.00' x 1.00' deep channel, n= 0.022
Side Slope Z-value= 3.0 '/'   Top Width= 6.00'
Length= 93.0'   Slope= 0.0774 '/'
Inlet Invert= 115.10', Outlet Invert= 107.90'
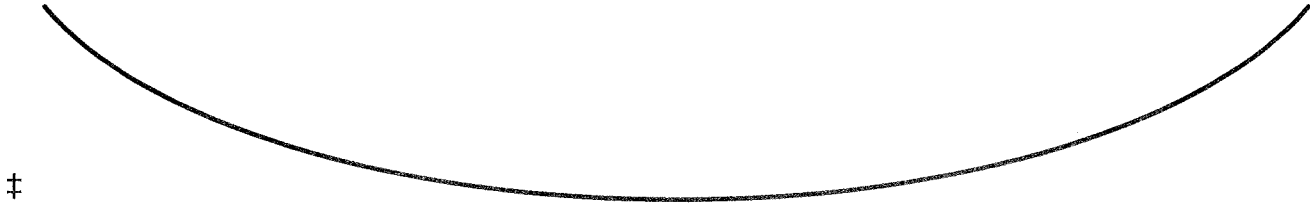
Summary for Reach OF1: Overland Flow 1

Inflow Area =   1.581 ac,   5.76% Impervious, Inflow Depth = 0.00"   for 2-Year event
Inflow   =   0.00 cfs @   0.00 hrs, Volume=   0.000 af
Outflow   =   0.00 cfs @   0.00 hrs, Volume=   0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 0.10' Flow Area= 1.3 sf, Capacity= 3.70 cfs

20.00' x 0.10' deep Parabolic Channel, n= 0.030 Earth, grassed & winding
Length= 137.0' Slope= 0.1161 '/'
Inlet Invert= 107.90', Outlet Invert= 92.00'

‡

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Type III 24-hr 2-Year Rainfall=3.00"
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Summary for Reach OF2: Overland Flow 2

Inflow Area =   1.581 ac,   5.76% Impervious, Inflow Depth = 0.00"   for 2-Year event
Inflow   =   0.00 cfs @   0.00 hrs, Volume=   0.000 af
Outflow   =   0.00 cfs @   0.00 hrs, Volume=   0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 0.30' Flow Area= 8.0 sf, Capacity= 25.16 cfs

40.00' x 0.30' deep Parabolic Channel, n= 0.030
Length= 170.0' Slope= 0.0345 '/'
Inlet Invert= 92.00', Outlet Invert= 86.14'

‡

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Type III 24-hr 2-Year Rainfall=3.00"
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Summary for Pond Ex. Wet.: Existing Wetland

[62] Hint: Exceeded Reach OF2 OUTLET depth by 0.59' @ 12.38 hrs

Inflow Area =	2.350 ac, 10.88% Impervious, Inflow Depth = 0.43" for 2-Year event	
Inflow =	0.71 cfs @ 12.37 hrs, Volume=	0.084 af
Outflow =	0.71 cfs @ 12.38 hrs, Volume=	0.084 af, Atten= 0%, Lag= 0.4 min
Primary =	0.71 cfs @ 12.38 hrs, Volume=	0.084 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 86.73' @ 12.38 hrs Surf.Area= 62 sf Storage= 22 cf

Plug-Flow detention time= 1.1 min calculated for 0.084 af (100% of inflow)
Center-of-Mass det. time= 0.9 min (861.9 - 861.0)

Volume	Invert	Avail.Storage	Storage Description
#1	86.00'	6,072 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
86.00	0	0	0
87.00	85	43	43
88.00	1,964	1,025	1,067
89.00	8,046	5,005	6,072

Device	Routing	Invert	Outlet Devices
#1	Primary	86.14'	**24.0" Round Culvert** L= 80.8' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 86.14' / 85.97' S= 0.0021 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 3.14 sf

Primary OutFlow Max=0.71 cfs @ 12.38 hrs HW=86.73' TW=0.00' (Dynamic Tailwater)
└─1=Culvert (Barrel Controls 0.71 cfs @ 1.38 fps)

Summary for Pond GP2: Gravelpave2 System

[87] Warning: Oscillations may require Finer Routing or smaller dt

Inflow Area =   1.581 ac,   5.76% Impervious, Inflow Depth = 0.81"   for 2-Year event
Inflow   =   0.76 cfs @ 12.47 hrs, Volume=   0.106 af
Outflow   =   0.35 cfs @ 12.98 hrs, Volume=   0.106 af, Atten= 54%, Lag= 30.0 min
Discarded =   0.35 cfs @ 12.98 hrs, Volume=   0.106 af
Primary   =   0.00 cfs @   0.00 hrs, Volume=   0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 117.75' @ 12.98 hrs   Surf.Area= 2,515 sf   Storage= 671 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 10.1 min (906.2 - 896.0)

Volume	Invert	Avail.Storage	Storage Description
#1	117.92'	70 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 201 cf Overall x 35.0% Voids
#2	116.42'	755 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 3,773 cf Overall x 20.0% Voids
		825 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
117.92	2,515	0	0
118.00	2,515	201	201

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
116.42	2,515	0	0
117.92	2,515	3,773	3,773

Device	Routing	Invert	Outlet Devices
#1	Device 2	116.42'	**7.370 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Discarded	116.42'	**6.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#3	Primary	118.00'	**2.0" x 120.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.35 cfs @ 12.98 hrs HW=117.75' (Free Discharge)
└─**2=Exfiltration** (Controls 0.35 cfs)
  └─**1=Exfiltration** (Passes 0.35 cfs of 0.43 cfs potential flow)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=116.42' TW=115.10' (Dynamic Tailwater)
└─**3=Orifice/Grate** (Controls 0.00 cfs)

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Summary for Link SP-1: Study Point 1

Inflow Area =   2.914 ac,   9.81% Impervious, Inflow Depth = 0.53"   for 2-Year event
Inflow   =   1.05 cfs @   12.31 hrs, Volume=   0.129 af
Primary   =   1.05 cfs @   12.31 hrs, Volume=   0.129 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

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Time span=0.00-40.00 hrs, dt=0.01 hrs, 4001 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 S1: Subcatchment 1   Runoff Area=68,868 sf 5.76% Impervious Runoff Depth=1.97"
Flow Length=421' Tc=30.5 min CN=72 Runoff=2.02 cfs 0.259 af

Subcatchment S2: Subcatchment 2   Runoff Area=24,600 sf 5.40% Impervious Runoff Depth=2.21"
Flow Length=385' Tc=11.8 min UI Adjusted CN=75 Runoff=1.20 cfs 0.104 af

Subcatchment S3: Subcatchment 3   Runoff Area=33,477 sf 21.41% Impervious Runoff Depth=2.72"
Flow Length=623' Tc=25.6 min CN=81 Runoff=1.49 cfs 0.174 af

Reach Ditch: Ditch   Avg. Flow Depth=0.29' Max Vel=5.05 fps Inflow=1.35 cfs 0.045 af
n=0.022 L=93.0' S=0.0774 '/' Capacity=34.29 cfs Outflow=1.31 cfs 0.045 af

Reach OF1: Overland Flow 1   Avg. Flow Depth=0.06' Max Vel=2.01 fps Inflow=1.31 cfs 0.045 af
n=0.030 L=137.0' S=0.1161 '/' Capacity=3.70 cfs Outflow=1.31 cfs 0.045 af

Reach OF2: Overland Flow 2   Avg. Flow Depth=0.08' Max Vel=1.26 fps Inflow=1.31 cfs 0.045 af
n=0.030 L=170.0' S=0.0345 '/' Capacity=25.16 cfs Outflow=1.29 cfs 0.045 af

Pond Ex. Wet.: Existing Wetland   Peak Elev=87.23' Storage=114 cf Inflow=2.62 cfs 0.220 af
24.0" Round Culvert n=0.025 L=80.8' S=0.0021 '/' Outflow=2.57 cfs 0.220 af

Pond GP2: Gravelpave2 System   Peak Elev=118.07' Storage=825 cf Inflow=2.02 cfs 0.259 af
Discarded=0.70 cfs 0.214 af Primary=1.35 cfs 0.045 af Outflow=2.05 cfs 0.259 af

Link SP-1: Study Point 1   Inflow=3.10 cfs 0.323 af
Primary=3.10 cfs 0.323 af

Total Runoff Area = 2.914 ac   Runoff Volume = 0.538 af   Average Runoff Depth = 2.21"
90.19% Pervious = 2.628 ac   9.81% Impervious = 0.286 ac

Summary for Subcatchment S1: Subcatchment 1

Runoff   =   2.02 cfs @ 12.44 hrs, Volume=   0.259 af, Depth= 1.97"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

	Area (sf)	CN	Description
	56,267	70	Woods, Good, HSG C
	6,121	74	>75% Grass cover, Good, HSG C
*	1,349	98	Ledge Outcrop, HSG D
	2,310	98	Unconnected roofs, HSG A
	306	98	Paved parking, HSG A
*	2,515	74	Gravel Pave System
	68,868	72	Weighted Average
	64,903		94.24% Pervious Area
	3,965		5.76% Impervious Area
	2,310		58.26% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.7	100	0.0680	0.07		**Sheet Flow, A-B**
					Woods: Dense underbrush n= 0.800 P2= 3.00"
1.2	85	0.2188	1.17		**Shallow Concentrated Flow, B-C**
					Forest w/Heavy Litter Kv= 2.5 fps
4.8	189	0.0679	0.65		**Shallow Concentrated Flow, C-D**
					Forest w/Heavy Litter Kv= 2.5 fps
0.8	47	0.0212	1.02		**Shallow Concentrated Flow, D-E**
					Short Grass Pasture Kv= 7.0 fps
30.5	421	Total			

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Summary for Subcatchment S2: Subcatchment 2

Runoff   =   1.20 cfs @ 12.17 hrs, Volume=   0.104 af, Depth= 2.21"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
7,191	70	Woods, Good, HSG C
7,984	74	>75% Grass cover, Good, HSG C
8,097	80	>75% Grass cover, Good, HSG D
1,328	98	Unconnected roofs, HSG A
24,600	76	Weighted Average, UI Adjusted CN = 75
23,272		94.60% Pervious Area
1,328		5.40% Impervious Area
1,328		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	43	0.3300	0.29		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.00"
4.5	21	0.1905	0.08		**Sheet Flow, B-C** Woods: Dense underbrush n= 0.800 P2= 3.00"
2.3	62	0.0322	0.45		**Shallow Concentrated Flow, C-D** Forest w/Heavy Litter Kv= 2.5 fps
0.7	96	0.0938	2.14		**Shallow Concentrated Flow, D-E** Short Grass Pasture Kv= 7.0 fps
1.5	84	0.0179	0.94		**Shallow Concentrated Flow, E-F** Short Grass Pasture Kv= 7.0 fps
0.4	79	0.0063	3.58	14.33	**Trap/Vee/Rect Channel Flow, F-G** Bot.W=1.00' D=1.00' Z= 3.0 '/' Top.W=7.00' n= 0.022 Earth, clean & straight
11.8	385				Total

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Summary for Subcatchment S3: Subcatchment 3

Runoff   =   1.49 cfs @ 12.36 hrs, Volume=   0.174 af, Depth= 2.72"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.70"

Area (sf)	CN	Description
4,092	70	Woods, Good, HSG C
11,217	74	>75% Grass cover, Good, HSG C
11,002	80	>75% Grass cover, Good, HSG D
7,166	98	Paved parking, HSG A
33,477	81	Weighted Average
26,311		78.59% Pervious Area
7,166		21.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.1	129	0.1511	0.10		**Sheet Flow, A-B**
					Woods: Dense underbrush n= 0.800 P2= 3.00"
0.9	94	0.0638	1.77		**Shallow Concentrated Flow, B-C**
					Short Grass Pasture Kv= 7.0 fps
0.1	93	0.0752	11.27	33.80	**Trap/Vee/Rect Channel Flow, C-D**
					Bot.W=0.00' D=1.00' Z= 3.0 '/' Top.W=6.00'
					n= 0.022
1.3	137	0.1168	1.71		**Shallow Concentrated Flow, D-E**
					Woodland Kv= 5.0 fps
2.2	170	0.0353	1.32		**Shallow Concentrated Flow, E-F**
					Short Grass Pasture Kv= 7.0 fps
25.6	623	Total			

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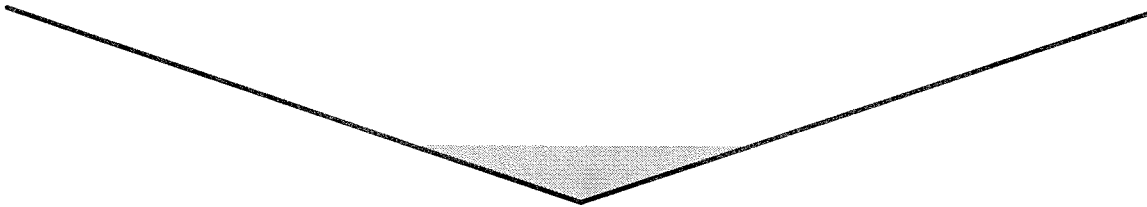Page 15

Summary for Reach Ditch: Ditch

Inflow Area =   1.581 ac,   5.76% Impervious, Inflow Depth =   0.34"   for 10-Year event
Inflow   =   1.35 cfs @   12.45 hrs, Volume=   0.045 af
Outflow   =   1.31 cfs @   12.44 hrs, Volume=   0.045 af, Atten= 3%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 5.05 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 3.58 fps, Avg. Travel Time= 0.4 min

Peak Storage= 24 cf @ 12.44 hrs
Average Depth at Peak Storage= 0.29'
Bank-Full Depth= 1.00' Flow Area= 3.0 sf, Capacity= 34.29 cfs

0.00' x 1.00' deep channel, n= 0.022
Side Slope Z-value= 3.0 '/' Top Width= 6.00'
Length= 93.0' Slope= 0.0774 '/'
Inlet Invert= 115.10', Outlet Invert= 107.90'

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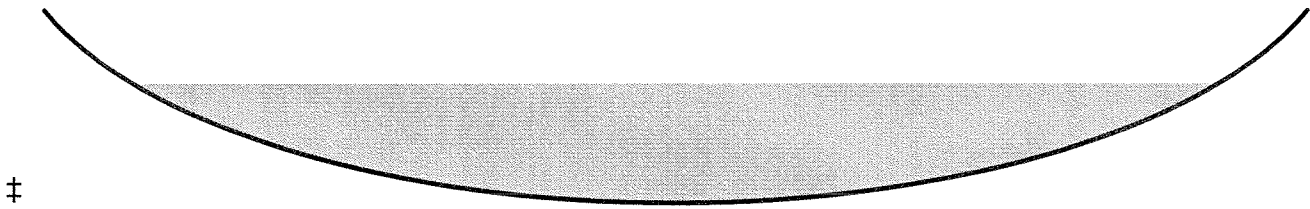
Summary for Reach OF1: Overland Flow 1

[61] Hint: Exceeded Reach Ditch outlet invert by 0.06' @ 12.46 hrs

Inflow Area =	1.581 ac, 5.76% Impervious, Inflow Depth = 0.34" for 10-Year event	
Inflow =	1.31 cfs @ 12.44 hrs, Volume=	0.045 af
Outflow =	1.31 cfs @ 12.46 hrs, Volume=	0.045 af, Atten= 0%, Lag= 0.9 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 2.01 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 0.70 fps, Avg. Travel Time= 3.3 min

Peak Storage= 89 cf @ 12.46 hrs
Average Depth at Peak Storage= 0.06'
Bank-Full Depth= 0.10' Flow Area= 1.3 sf, Capacity= 3.70 cfs

20.00' x 0.10' deep Parabolic Channel, n= 0.030 Earth, grassed & winding
Length= 137.0'   Slope= 0.1161 '/'
Inlet Invert= 107.90', Outlet Invert= 92.00'

‡

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Summary for Reach OF2: Overland Flow 2
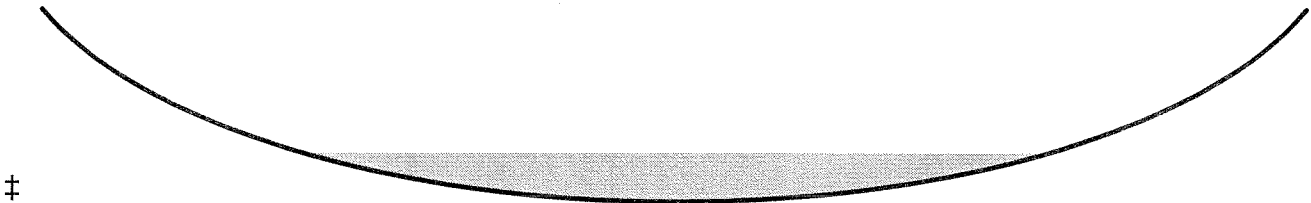
[62] Hint: Exceeded Reach OF1 OUTLET depth by 0.02' @ 12.60 hrs

Inflow Area =   1.581 ac,   5.76% Impervious, Inflow Depth = 0.34"   for 10-Year event
Inflow   =   1.31 cfs @   12.46 hrs, Volume=   0.045 af
Outflow   =   1.29 cfs @   12.50 hrs, Volume=   0.045 af, Atten= 2%, Lag= 2.5 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 1.26 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.40 fps, Avg. Travel Time= 7.2 min

Peak Storage= 174 cf @ 12.50 hrs
Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 0.30' Flow Area= 8.0 sf, Capacity= 25.16 cfs

40.00' x 0.30' deep Parabolic Channel, n= 0.030
Length= 170.0'   Slope= 0.0345 '/'
Inlet Invert= 92.00', Outlet Invert= 86.14'

‡

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Summary for Pond Ex. Wet.: Existing Wetland

[62] Hint: Exceeded Reach OF2 OUTLET depth by 1.02' @ 12.50 hrs

Inflow Area =	2.350 ac, 10.88% Impervious, Inflow Depth = 1.12" for 10-Year event	
Inflow =	2.62 cfs @ 12.46 hrs, Volume=	0.220 af
Outflow =	2.57 cfs @ 12.50 hrs, Volume=	0.220 af, Atten= 2%, Lag= 2.1 min
Primary =	2.57 cfs @ 12.50 hrs, Volume=	0.220 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 87.23' @ 12.50 hrs   Surf.Area= 526 sf   Storage= 114 cf

Plug-Flow detention time= 0.8 min calculated for 0.219 af (100% of inflow)
Center-of-Mass det. time= 0.7 min (823.8 - 823.1)

Volume	Invert	Avail.Storage	Storage Description
#1	86.00'	6,072 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
86.00	0	0	0
87.00	85	43	43
88.00	1,964	1,025	1,067
89.00	8,046	5,005	6,072

Device	Routing	Invert	Outlet Devices
#1	Primary	86.14'	**24.0" Round Culvert** L= 80.8' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 86.14' / 85.97' S= 0.0021 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 3.14 sf

Primary OutFlow Max=2.57 cfs @ 12.50 hrs HW=87.23' TW=0.00' (Dynamic Tailwater)
└─1=Culvert (Barrel Controls 2.57 cfs @ 2.12 fps)

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Type III 24-hr 10-Year Rainfall=4.70"
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Summary for Pond GP2: Gravelpave2 System

[93] Warning: Storage range exceeded by 0.07'
[90] Warning: Qout>Qin may require Finer Routing or smaller dt
[87] Warning: Oscillations may require Finer Routing or smaller dt

Inflow Area =   1.581 ac,   5.76% Impervious, Inflow Depth = 1.97"   for 10-Year event
Inflow   =   2.02 cfs @ 12.44 hrs, Volume=   0.259 af
Outflow   =   2.05 cfs @ 12.45 hrs, Volume=   0.259 af, Atten= 0%, Lag= 0.6 min
Discarded =   0.70 cfs @ 12.45 hrs, Volume=   0.214 af
Primary   =   1.35 cfs @ 12.45 hrs, Volume=   0.045 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 118.07' @ 12.45 hrs   Surf.Area= 5,030 sf   Storage= 825 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 11.4 min (879.8 - 868.5)

Volume	Invert	Avail.Storage	Storage Description
#1	117.92'	70 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 201 cf Overall x 35.0% Voids
#2	116.42'	755 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 3,773 cf Overall x 20.0% Voids
		825 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
117.92	2,515	0	0
118.00	2,515	201	201

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
116.42	2,515	0	0
117.92	2,515	3,773	3,773

Device	Routing	Invert	Outlet Devices
#1	Device 2	116.42'	**7.370 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Discarded	116.42'	**6.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#3	Primary	118.00'	**2.0" x 120.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.70 cfs @ 12.45 hrs HW=118.07'   (Free Discharge)
└─**2=Exfiltration** (Controls 0.70 cfs)
  └─**1=Exfiltration** (Passes 0.70 cfs of 0.86 cfs potential flow)

Primary OutFlow Max=1.35 cfs @ 12.45 hrs HW=118.07' TW=115.39'   (Dynamic Tailwater)
└─**3=Orifice/Grate** (Weir Controls 1.35 cfs @ 0.89 fps)

Summary for Link SP-1: Study Point 1

Inflow Area =   2.914 ac,   9.81% Impervious, Inflow Depth = 1.33"   for 10-Year event
Inflow   =   3.10 cfs @   12.48 hrs, Volume=   0.323 af
Primary   =   3.10 cfs @   12.48 hrs, Volume=   0.323 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs

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Time span=0.00-40.00 hrs, dt=0.01 hrs, 4001 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 S1: Subcatchment 1   Runoff Area=68,868 sf 5.76% Impervious Runoff Depth=2.59"
Flow Length=421' Tc=30.5 min CN=72 Runoff=2.68 cfs 0.341 af

Subcatchment S2: Subcatchment 2   Runoff Area=24,600 sf 5.40% Impervious Runoff Depth=2.86"
Flow Length=385' Tc=11.8 min UI Adjusted CN=75 Runoff=1.56 cfs 0.135 af

Subcatchment S3: Subcatchment 3   Runoff Area=33,477 sf 21.41% Impervious Runoff Depth=3.43"
Flow Length=623' Tc=25.6 min CN=81 Runoff=1.87 cfs 0.220 af

Reach Ditch: Ditch   Avg. Flow Depth=0.34' Max Vel=5.60 fps Inflow=2.38 cfs 0.084 af
n=0.022 L=93.0' S=0.0774 '/' Capacity=34.29 cfs Outflow=1.97 cfs 0.084 af

Reach OF1: Overland Flow 1   Avg. Flow Depth=0.07' Max Vel=2.29 fps Inflow=1.97 cfs 0.084 af
n=0.030 L=137.0' S=0.1161 '/' Capacity=3.70 cfs Outflow=1.97 cfs 0.084 af

Reach OF2: Overland Flow 2   Avg. Flow Depth=0.09' Max Vel=1.43 fps Inflow=1.97 cfs 0.084 af
n=0.030 L=170.0' S=0.0345 '/' Capacity=25.16 cfs Outflow=1.96 cfs 0.084 af

Pond Ex. Wet.: Existing Wetland   Peak Elev=87.44' Storage=266 cf Inflow=3.70 cfs 0.304 af
24.0" Round Culvert n=0.025 L=80.8' S=0.0021 '/' Outflow=3.62 cfs 0.304 af

Pond GP2: Gravelpave2 System   Peak Elev=118.11' Storage=825 cf Inflow=2.68 cfs 0.341 af
Discarded=0.70 cfs 0.257 af Primary=2.38 cfs 0.084 af Outflow=3.08 cfs 0.341 af

Link SP-1: Study Point 1   Inflow=4.33 cfs 0.438 af
Primary=4.33 cfs 0.438 af

Total Runoff Area = 2.914 ac   Runoff Volume = 0.696 af   Average Runoff Depth = 2.86"
90.19% Pervious = 2.628 ac   9.81% Impervious = 0.286 ac

Summary for Subcatchment S1: Subcatchment 1

Runoff   =   2.68 cfs @ 12.44 hrs, Volume=   0.341 af, Depth= 2.59"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=5.50"

	Area (sf)	CN	Description
	56,267	70	Woods, Good, HSG C
	6,121	74	>75% Grass cover, Good, HSG C
*	1,349	98	Ledge Outcrop, HSG D
	2,310	98	Unconnected roofs, HSG A
	306	98	Paved parking, HSG A
*	2,515	74	Gravel Pave System
	68,868	72	Weighted Average
	64,903		94.24% Pervious Area
	3,965		5.76% Impervious Area
	2,310		58.26% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
23.7	100	0.0680	0.07		**Sheet Flow, A-B**
					Woods: Dense underbrush n= 0.800 P2= 3.00"
1.2	85	0.2188	1.17		**Shallow Concentrated Flow, B-C**
					Forest w/Heavy Litter Kv= 2.5 fps
4.8	189	0.0679	0.65		**Shallow Concentrated Flow, C-D**
					Forest w/Heavy Litter Kv= 2.5 fps
0.8	47	0.0212	1.02		**Shallow Concentrated Flow, D-E**
					Short Grass Pasture Kv= 7.0 fps
30.5	421	Total			

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Summary for Subcatchment S2: Subcatchment 2

Runoff   =   1.56 cfs @ 12.16 hrs, Volume=   0.135 af, Depth= 2.86"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=5.50"

Area (sf)	CN	Description
7,191	70	Woods, Good, HSG C
7,984	74	>75% Grass cover, Good, HSG C
8,097	80	>75% Grass cover, Good, HSG D
1,328	98	Unconnected roofs, HSG A
24,600	76	Weighted Average, UI Adjusted CN = 75
23,272		94.60% Pervious Area
1,328		5.40% Impervious Area
1,328		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	43	0.3300	0.29		**Sheet Flow, A-B** Grass: Dense n= 0.240 P2= 3.00"
4.5	21	0.1905	0.08		**Sheet Flow, B-C** Woods: Dense underbrush n= 0.800 P2= 3.00"
2.3	62	0.0322	0.45		**Shallow Concentrated Flow, C-D** Forest w/Heavy Litter Kv= 2.5 fps
0.7	96	0.0938	2.14		**Shallow Concentrated Flow, D-E** Short Grass Pasture Kv= 7.0 fps
1.5	84	0.0179	0.94		**Shallow Concentrated Flow, E-F** Short Grass Pasture Kv= 7.0 fps
0.4	79	0.0063	3.58	14.33	**Trap/Vee/Rect Channel Flow, F-G** Bot.W=1.00' D=1.00' Z= 3.0 '/' Top.W=7.00' n= 0.022 Earth, clean & straight
11.8	385				Total

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Summary for Subcatchment S3: Subcatchment 3

Runoff   =   1.87 cfs @ 12.35 hrs, Volume=   0.220 af, Depth= 3.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=5.50"

Area (sf)	CN	Description
4,092	70	Woods, Good, HSG C
11,217	74	>75% Grass cover, Good, HSG C
11,002	80	>75% Grass cover, Good, HSG D
7,166	98	Paved parking, HSG A
33,477	81	Weighted Average
26,311		78.59% Pervious Area
7,166		21.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
21.1	129	0.1511	0.10		**Sheet Flow, A-B**
					Woods: Dense underbrush n= 0.800 P2= 3.00"
0.9	94	0.0638	1.77		**Shallow Concentrated Flow, B-C**
					Short Grass Pasture Kv= 7.0 fps
0.1	93	0.0752	11.27	33.80	**Trap/Vee/Rect Channel Flow, C-D**
					Bot.W=0.00' D=1.00' Z= 3.0 '/' Top.W=6.00'
					n= 0.022
1.3	137	0.1168	1.71		**Shallow Concentrated Flow, D-E**
					Woodland Kv= 5.0 fps
2.2	170	0.0353	1.32		**Shallow Concentrated Flow, E-F**
					Short Grass Pasture Kv= 7.0 fps
25.6	623	Total			

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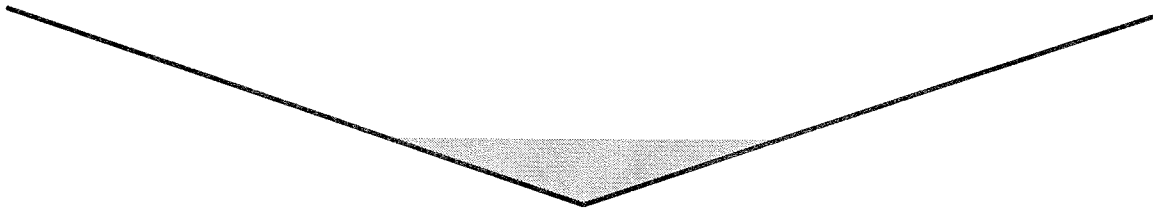
Summary for Reach Ditch: Ditch

Inflow Area =   1.581 ac,   5.76% Impervious, Inflow Depth = 0.64"   for 25-Year event
Inflow   =   2.38 cfs @ 12.43 hrs, Volume=   0.084 af
Outflow   =   1.97 cfs @ 12.44 hrs, Volume=   0.084 af, Atten= 17%, Lag= 0.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 5.60 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 4.00 fps, Avg. Travel Time= 0.4 min

Peak Storage= 33 cf @ 12.44 hrs
Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 1.00' Flow Area= 3.0 sf, Capacity= 34.29 cfs

0.00' x 1.00' deep channel, n= 0.022
Side Slope Z-value= 3.0 '/'   Top Width= 6.00'
Length= 93.0'   Slope= 0.0774 '/'
Inlet Invert= 115.10', Outlet Invert= 107.90'

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Summary for Reach OF1: Overland Flow 1

[61] Hint: Exceeded Reach Ditch outlet invert by 0.07' @ 12.45 hrs

Inflow Area =	1.581 ac,	5.76% Impervious, Inflow Depth = 0.64" for 25-Year event	
Inflow =	1.97 cfs @ 12.44 hrs,	Volume=	0.084 af
Outflow =	1.97 cfs @ 12.45 hrs,	Volume=	0.084 af, Atten= 0%, Lag= 0.6 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 2.29 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 0.86 fps, Avg. Travel Time= 2.7 min
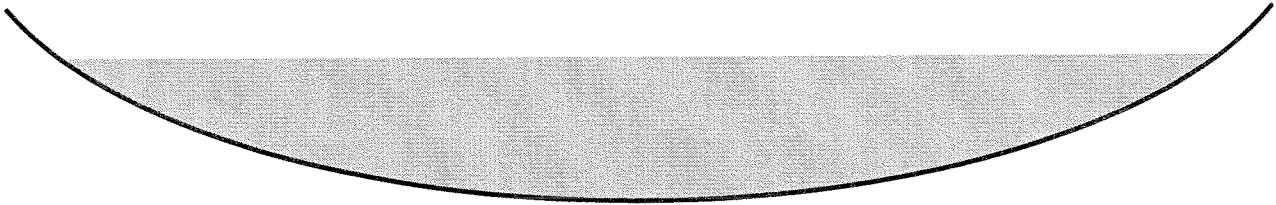
Peak Storage= 118 cf @ 12.45 hrs
Average Depth at Peak Storage= 0.07'
Bank-Full Depth= 0.10' Flow Area= 1.3 sf, Capacity= 3.70 cfs

20.00' x 0.10' deep Parabolic Channel, n= 0.030 Earth, grassed & winding
Length= 137.0'   Slope= 0.1161 '/'
Inlet Invert= 107.90', Outlet Invert= 92.00'

‡

Summary for Reach OF2: Overland Flow 2

[62] Hint: Exceeded Reach OF1 OUTLET depth by 0.02' @ 12.56 hrs

Inflow Area =   1.581 ac,   5.76% Impervious, Inflow Depth = 0.64"   for 25-Year event
Inflow   =   1.97 cfs @   12.45 hrs, Volume=   0.084 af
Outflow   =   1.96 cfs @   12.47 hrs, Volume=   0.084 af, Atten= 1%, Lag= 1.4 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Max. Velocity= 1.43 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.47 fps, Avg. Travel Time= 6.0 min

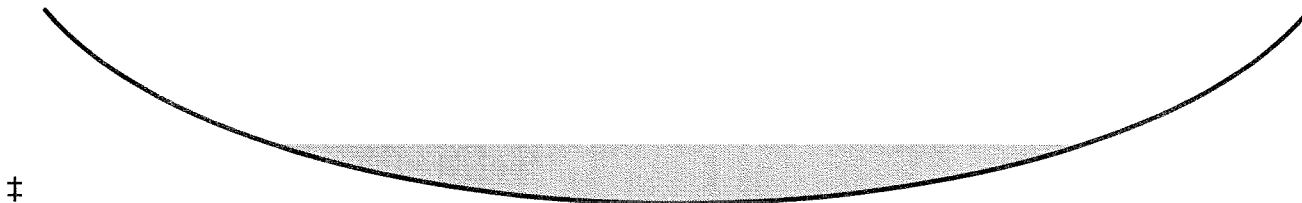Peak Storage= 232 cf @ 12.47 hrs
Average Depth at Peak Storage= 0.09'
Bank-Full Depth= 0.30' Flow Area= 8.0 sf, Capacity= 25.16 cfs

40.00' x 0.30' deep Parabolic Channel, n= 0.030
Length= 170.0' Slope= 0.0345 '/'
Inlet Invert= 92.00', Outlet Invert= 86.14'

‡

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Summary for Pond Ex. Wet.: Existing Wetland

[62] Hint: Exceeded Reach OF2 OUTLET depth by 1.21' @ 12.48 hrs

Inflow Area =	2.350 ac, 10.88% Impervious, Inflow Depth = 1.55" for 25-Year event	
Inflow =	3.70 cfs @ 12.43 hrs, Volume=	0.304 af
Outflow =	3.62 cfs @ 12.48 hrs, Volume=	0.304 af, Atten= 2%, Lag= 3.1 min
Primary =	3.62 cfs @ 12.48 hrs, Volume=	0.304 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 87.44' @ 12.48 hrs   Surf.Area= 919 sf   Storage= 266 cf

Plug-Flow detention time= 0.9 min calculated for 0.304 af (100% of inflow)
Center-of-Mass det. time= 0.9 min (813.1 - 812.2)

Volume	Invert	Avail.Storage	Storage Description
#1	86.00'	6,072 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
86.00	0	0	0
87.00	85	43	43
88.00	1,964	1,025	1,067
89.00	8,046	5,005	6,072

Device	Routing	Invert	Outlet Devices
#1	Primary	86.14'	**24.0" Round Culvert** L= 80.8' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 86.14' / 85.97' S= 0.0021 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 3.14 sf

Primary OutFlow Max=3.62 cfs @ 12.48 hrs HW=87.44' TW=0.00' (Dynamic Tailwater)
└─1=Culvert (Barrel Controls 3.62 cfs @ 2.37 fps)

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Summary for Pond GP2: Gravelpave2 System

[93] Warning: Storage range exceeded by 0.11'
[90] Warning: Qout>Qin may require Finer Routing or smaller dt
[87] Warning: Oscillations may require Finer Routing or smaller dt

Inflow Area =	1.581 ac,	5.76% Impervious,	Inflow Depth = 2.59" for 25-Year event	
Inflow =	2.68 cfs @	12.44 hrs,	Volume=	0.341 af
Outflow =	3.08 cfs @	12.43 hrs,	Volume=	0.341 af, Atten= 0%, Lag= 0.0 min
Discarded =	0.70 cfs @	12.43 hrs,	Volume=	0.257 af
Primary =	2.38 cfs @	12.43 hrs,	Volume=	0.084 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs / 2
Peak Elev= 118.11' @ 12.43 hrs Surf.Area= 5,030 sf Storage= 825 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 11.1 min (871.6 - 860.5)

Volume	Invert	Avail.Storage	Storage Description
#1	117.92'	70 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 201 cf Overall x 35.0% Voids
#2	116.42'	755 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 3,773 cf Overall x 20.0% Voids
		825 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
117.92	2,515	0	0
118.00	2,515	201	201

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
116.42	2,515	0	0
117.92	2,515	3,773	3,773

Device	Routing	Invert	Outlet Devices
#1	Device 2	116.42'	**7.370 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#2	Discarded	116.42'	**6.000 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 0.00'
#3	Primary	118.00'	**2.0" x 120.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.70 cfs @ 12.43 hrs HW=118.11' (Free Discharge)
└─2=Exfiltration (Controls 0.70 cfs)
  └─1=Exfiltration (Passes 0.70 cfs of 0.87 cfs potential flow)

Primary OutFlow Max=2.37 cfs @ 12.43 hrs HW=118.11' TW=115.44' (Dynamic Tailwater)
└─3=Orifice/Grate (Weir Controls 2.37 cfs @ 1.08 fps)

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Summary for Link SP-1: Study Point 1

Inflow Area =   2.914 ac,   9.81% Impervious, Inflow Depth = 1.81"   for 25-Year event
Inflow   =   4.33 cfs @ 12.45 hrs, Volume=   0.438 af
Primary   =   4.33 cfs @ 12.45 hrs, Volume=   0.438 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-40.00 hrs, dt= 0.01 hrs