

POST CONSTRUCTION STORMWATER MANAGEMENT REPORT

PROPOSED MID-COUNTY SHOPPING CENTER

LANGFORD RUN ROAD
MARPLE TOWNSHIP
DELAWARE COUNTY, PENNSYLVANIA

PREPARED FOR:

MARPLE ASSOCIATES, LP

1604 WALNUT STREET, 4TH FLOOR
PHILADELPHIA, PENNSYLVANIA 19103

PREPARED BY:



LANDCORE ENGINEERING CONSULTANTS, P.C.

8614 MONTGOMERY AVENUE
WYNDMOOR, PENNSYLVANIA 19038

RYAN T. WHITMORE, P.E.
PA LICENSE # PE076556

DECEMBER 22, 2017

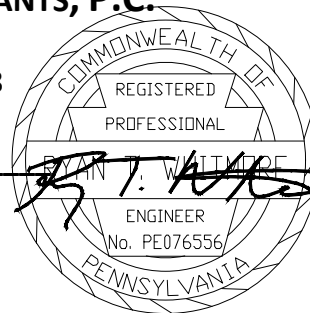


TABLE OF CONTENTS	PAGE
1.0 PROJECT DESCRIPTION.....	5
2.0 SITE CHARACTERISTICS.....	5
2.1 EXISTING SITE FEATURES.....	5
2.2 TOPOGRAPHIC FEATURES.....	5
2.3 RECEIVING WATERS.....	5
2.4 PROJECT AREA SOILS.....	6
2.5 VEGETATION.....	8
2.6 HYDROLOGY.....	8
2.7 FLOODPLAINS.....	8
2.8 PAST, PRESENT AND PROPOSED LAND USE.....	8
2.9 GEOLOGICAL FORMATIONS / SOIL CONDITIONS.....	8
2.10 WETLANDS.....	9
3.0 DESIGN CRITERIA.....	9
4.0 METHODOLOGY.....	11
4.1 RUNOFF CURVE NUMBER (CN).....	11
4.2 TIME OF CONCENTRATION (TOC).....	12
4.3 DESIGN STORM RAINFALL.....	12
4.4 RUNOFF HYDROGRAPHS.....	12
5.0 ANALYSIS.....	12
5.1 PRE-DEVELOPMENT DRAINAGE AREAS.....	12
5.2 POST-DEVELOPMENT DRAINAGE AREAS.....	13
5.3 EROSION AND SEDIMENT CONTROL DURING REGULATED EARTH DISTURBANCE ACTIVITIES.....	14
5.4 VOLUME CONTROL (MARPLE TOWNSHIP AND NPDES).....	14
5.5 WATER QUALITY (NPDES).....	14
5.6 WATER QUALITY (MARPLE TOWNSHIP).....	15
5.7 PEAK RATE CONTROL (NPDES).....	15
5.8 PEAK RATE CONTROL (MARPLE TOWNSHIP).....	15
5.9 STREAM BANK EROSION (MARPLE TOWNSHIP).....	16
5.10 Storm Sewer Conveyance Design.....	17
5.11 DOWNSTREAM IMPACTS AND EROSION POTENTIAL (NPDES).....	17
6.0 POST CONSTRUCTION STORMWATER MANAGEMENT.....	17

6.1	PRESERVE THE INTEGRITY OF STREAM CHANNELS AND MAINTAIN AND PROTECT THE PHYSICAL, BIOLOGICAL AND CHEMICAL QUALITIES OF THE RECEIVING STREAM	17
6.2	PREVENT AN INCREASE IN THE RATE OF STORMWATER RUNOFF	18
6.3	MINIMIZE ANY INCREASE IN STORMWATER RUNOFF VOLUME	18
6.4	MINIMIZE IMPERVIOUS AREAS	18
6.5	MAXIMIZE THE PROTECTION OF EXISTING DRAINAGE FEATURES AND EXISTING VEGETATION	18
6.6	MINIMIZE LAND CLEARING AND GRADING	18
6.7	MINIMIZE SOIL COMPACTION	19
6.8	UTILIZE OTHER STRUCTURAL OR NONSTRUCTURAL BMPs THAT PREVENT OR MINIMIZE CHANGE IN STORMWATER RUNOFF	19
6.9	THERMAL IMPACTS	19
6.10	PERMANENT STABILIZATION AND SEED MIX NOTES	19
6.11	ADDITIONAL STABILIZATION NOTES	22
6.12	BMP OPERATION AND MAINTENANCE SCHEDULE	23
6.13	Critical Stages of Implementation of the PCSM Plan for which a Licensed Professional or Designee shall be present on Site	26
6.14	Recycling and Disposal of Wastes	26
6.15	LIST OF PROPOSED PCSM BMPs	26
6.16	BMP 5.4.1 Protect Sensitive and Special Value Features and Outfall Structures Impacts	26
7.0	CONCLUSION	27
8.0	REFERENCES	27

TABLES		PAGE
CHART 1	— SOILS LIMITATION	7
TABLE 1	— VOLUME CONTROL SUMMARY FOR POI#1	14
TABLE 2	— WORKSHEET 10 WQ BMPs FOR POI#1 (NPDES)	15
TABLE 3	— PEAK DISCHARGE AT POI#1 (NPDES)	15
TABLE 4	— DARBY-COBBS WATERSHED DISTRICT B-2 RELEASE RATES	15
TABLE 5	— PEAK DISCHARGE AT POI#1 (MARPLE TWSP)	16
TABLE 6	— STREAM BANK EROSION (MARPLE TWSP)	16

APPENDICES	PAGE
APPENDIX A – PROJECT LOCATION MAP	28
APPENDIX B – SOILS MAP	30
APPENDIX C – FEMA FLOOD INSURANCE RATE MAP	35
APPENDIX D – DARBY – COBBS WATERSHED DISTRICT MAP	38
APPENDIX E – NOAA PRECIPITATION FREQUENCY DATA	40
APPENDIX F – STORM PEAK RATE CONTROL ANALYSIS	47
CN WORKSHEETS	48
TIME OF CONCENTRATION WORKSHEETS	56
PRE AND POST HYDROGRAPHS AND BASIN ROUTINGS	57
BASIN DEWATERING	192
APPENDIX G – NPDES BMP MANUAL WORKSHEETS	203
WORKSHEET 5B	210
INFILTRATION BASINS VOLUME CALCULATIONS	211
REVEGETATE AND REFOREST RECHARGE VOLUME CALCULATIONS	216
APPENDIX H – LOADING RATIO RISK ASSESSMENT	217
APPENDIX I – DOWNSTREAM STABILITY ANALYSIS	221
APPENDIX J – CONVEYANCE DESIGN	223
APPENDIX K – PLAN PREPARER EXPERIENCE AND TRAINING	245
APPENDIX L – INFILTRATION TESTING REPORT	247
APPENDIX M – DECLARATION OF RESTRICTIVE COVENANTS FOR CONSERVATION EASEMENT	312
APPENDIX N – DRAINAGE MAPS (ATTACHED TO REPORT)	321

POST CONSTRUCTION STORMWATER MANAGEMENT REPORT

1.0 PROJECT DESCRIPTION

Marple Associates, LP is proposing to develop the property located along the southerly side of Langford Run Road (between West Chester Pike and Langford Road), in Marple Township, Delaware County, PA. The improvements are for the proposed “Mid-County Shopping Center” with a total of 200,669 sf retail and office building area, including two (2) outparcels. Other improvements associated with the proposed development are parking areas, loading docks, stormwater management facilities and underground utilities.

The property in question is further identified as Assessment Map 25-20, Parcel 40, per Deed Book 403, page 1654. A Project Location Map can be found in Appendix A.

Tract area = 24.443 acres (24.108 acres excluding Langford Road ROW).

Limit of disturbance = 15.78 acres

NPDES Boundary = 25.43 acres

2.0 SITE CHARACTERISTICS

2.1 EXISTING SITE FEATURES

Under existing conditions, aside from an existing dwelling at the northerly most corner of the site, the property is vacant and previously graded as part of the Langford Run Road construction. Temporary BMPs were also constructed on site during the road construction, including a sediment basin and swale, which still remain today. Along the south and westerly property line, a creek (Langford Run and unnamed tributary respectively) flow in an easterly direction towards a culvert in Langford Run Road. The areas immediately adjacent to the creek are heavily wooded and almost entirely included in an existing conservation easement. Several stockpiles are also present on site as part of the previous roadway construction.

2.2 TOPOGRAPHIC FEATURES

Site topography varies drastically due to the former regrading of the site and stockpile areas due to the road construction. Generally, the site is flatter along the north (3-5%) with drastically steeper slopes heading south due to the soil stockpiles and existing grades along the creek.

2.3 RECEIVING WATERS

As mentioned above, along the south and westerly property line, Langford Run and an unnamed tributary flow in an easterly direction towards a culvert in Langford Run Road. Langford Run is a tributary to Darby Creek. Langford Run and its tributary collects runoff

from the entire site. The point of interest is identified as POI#1 and is located at the Langford Run Road culvert.

Per Pennsylvania's Water Plan, the project site is located within the Darby-Crum Creeks, which is part of the Lower Delaware River sub-basin, within the Delaware River basin.

Langford Run has a Designated Use of Warm Water Fish – Migratory Fish (WWF-MF) streams as determined by the Pennsylvania Department of Environmental Protection (PADEP), Chapter 93. Also per the Pennsylvania Department of Environmental Protection (PADEP), Chapter 303(d), Langford Run is impaired waters.

2.4 PROJECT AREA SOILS

The Soil Survey for Delaware County, Pennsylvania details the soils type underlying the area to be developed as follows:

"Chewacla Silt Loam" (Ch); Hyd Group B/D

"Glenelg Channery silt Loam, 8-15% slopes" (GeC2); Hyd Group B

"Glenelg Channery silt Loam, 15-25% slopes" (GeD); Hyd Group B

"Glenelg Channery silt Loam, 15-25% slopes, Moderately Eroded" (GeD2); Hyd Group B

"Manor Loam, 15-25% slopes" (MgD); Hyd Group B

"Made Land, Schist and Gneiss Materials" (Me); Hyd Group B / D

"Melvin Silt Loam" (Mn); Hyd Group B / D

"Wehadkee Silt Loam" (We); Hyd Group B / D

The Soil Boundary Map in Appendix B details the distribution of the soils throughout the project area. Due to the similarity of the soils distribution throughout the site as shown in the Geotechnical Report and Stormwater infiltration Testing Report, for the purpose of the hydrological study, all soils type will be considered belong to Hydrologic Group "B". See the Appendix in this report for detailed soils information.

Grading for construction of the proposed facilities will be conducted to minimize earth disturbance. Proper scheduling of the construction activities will:

1. Reduce exposed disturbed soil area.
2. Control erosion at the source.
3. Eliminate upslope water from flowing across the work area.
4. Stabilize disturbed areas by seeding and mulching as soon as possible to reduce the erosion and sedimentation impacts of the soil types that have a higher risk of erosion and surface water runoff.

See next page for Soils Limitation Chart.

MAP SYMBOL & SOIL NAME	CUTBANKS CAVE	CORROSIVE CONCRETE/STEEL	DROUGHTY	EASILY ERODIBLE	FLOODING	DEPTH TO SATURATED ZONE / SEASONAL HIGH WATER TABLE	HYDRIC/HYDRIC INCLUSION	LOW STRENGTH / LANDSLIDE PRONE	SLOW PERCOLATION	PIPING	POOR SOURCE OF TOPSOIL	FROST ACTION	SHRINK - SWELL	POTENTIAL SINKHOLE	PONDING	WETNESS
CHEWACLA SILT LOAM																
Ch	X	C/S			X	X	X	X	X	X		X				X
GLENELG CHANNERY SILT LOAM																
GeC2, GeD, GeD2	X	C		X			X	X	X	X	X	X				X
MANOR LOAM																
MgD	X	C		X				X	X	X	X	X				
MADE LAND, SCHIST AND GNEISS MATERIALS																
Me	NO DATA AVAILABLE															
MELVIN SILT LOAM																
Mn	X	S		X	X	X	X	X	X	X	X	X	X	X	X	X
WEHADKEE SILT LOAM																
We	X	C/S			X	X		X	X	X		X				X
LIMITATIONS																
CUTBANKS / CAVE	IT IS IMPERATIVE THAT APPROPRIATE PRECAUTIONS BE TAKEN TO SAFEGUARD WORKERS DURING ALL TRENCHING AND EXCAVATION OPERATIONS. ALL APPLICABLE OSHA STANDARDS AND REGULATIONS MUST BE IMPLEMENTED AT ALL TIMES.															
CORROSIVE TO CONCRETE /STEEL	ADDITIONAL SOILS TESTING TO EVALUATE THE CORROSIVE PROPERTIES OF THE SOILS SHALL BE COMPLETED PRIOR TO CONSTRUCTION AND MATERIAL ADJUSTMENTS WILL BE MADE ACCORDINGLY.															
EASILY ERODIBLE	CONSTRUCTION TIMING WILL BE COORDINATED TO AVOID EARTH MOVEMENT OPERATIONS AND MAJOR TRENCHING WORK DURING THE RAINY SEASON TO MINIMIZE EROSION. SEDIMENT BARRIERS WILL BE PLACED DOWNSTREAM OF CONSTRUCTION AREAS TO CAPTURE SEDIMENTS IN RUNOFF. DISTURBED AREAS WILL BE TEMPORARILY /PERMANENTLY STABILIZED AT THE COMPLETION OF EACH CONSTRUCTION STAGE.															
FLOODING	ALL IMPROVEMENTS WILL OCCUR IN AREAS ABOVE THE 100-YEAR FLOODPLAIN.															
DEPTH TO SATURATED ZONE / SHWT	THE PROPOSED IMPROVEMENTS AND BMPs HAVE BEEN DESIGNED TO ACCOUNT FOR GROUNDWATER AND ANY OTHER LIMITING ZONE.															
HYDRIC /HYDRIC INCLUSIONS	ALL IMPROVEMENTS WILL OCCUR IN AREAS ABOVE THE 100-YEAR FLOODPLAIN. PLANT SPECIES HAVE BEEN SELECTED TO ACCOUNT FOR HYDRIC SOIL CONDITIONS.															
LOW STRENGTH / LANDSLIDE PRONE	PRECAUTIONS SHOULD BE TAKEN TO PREVENT SLOPE FAILURES DUE TO IMPROPER CONSTRUCTION PRACTICES SUCH AS OVER-S STEEPENING AND OVERLOADING OF SLOPES. REMOVAL OF LATERAL SUPPORT, AND FAILURE TO PREVENT SATURATION OF SLOPES. SETBACKS SHOULD COMPLY WITH THE STANDARDS CONTAINED IN CHAPTER 16 UNLESS IT CAN BE SHOWN THAT PROPOSED CUTS AND FILLS DO NOT POSE A HAZARD TO PUBLIC SAFETY OR TO SURFACE WATERS. ALSO, ROAD FILL MATERIAL WILL LIKELY NEED TO BE IMPORTED IN AREAS WHERE SOILS HAVE LOW STRENGTH. ADDITIONAL SOIL TESTING WILL BE DONE BY A PROFESSIONAL GEOTECHNICAL ENGINEER PRIOR TO CONSTRUCTION AND RECOMMENDATION PROVIDED.															
SLOW PERCOLATION	RECHARGE BMPs HAVE BEEN DESIGNED IN AREAS WITH POSITIVE PERMEABILITY RATES AS DETERMINED BY FIELD TESTING.															
PIPING	CALCULATIONS FOR ANTI-SEEP COLLARS HAVE BEEN PROVIDED, AND ADDED WHERE REQUIRED.															
POOR SOURCE OF TOPSOIL	ANY TOPSOIL ENCOUNTERED ON-SITE WILL BE STOCKPILED AND RETULITIZED ON SITE IN LANDSCAPED/LAWN AREAS. ADDITIONAL TOPSOIL REQUIRED WILL BE IMPORTED.															
FROST ACTION	CONSTRUCTION TIMING WILL BE COORDINATED TO AVOID PLACING FROST SENSITIVE MATERIALS, SUCH AS POURED CONCRETE, FOUNDATIONS, ETC. DURING FROST POTENTIAL MONTHS.															
SHRINK SWELL	CONSTRUCTION TIMING WILL BE COORDINATED TO AVOID EARTH MOVEMENT OPERATIONS AND MAJOR TRENCHING WORK DURING THE RAINY SEASON TO MINIMIZE GROUNDWATER IMPACTS. ALSO, SUMP PUMPS EQUIPPED WITH FILTERING BAGS WILL BE UTILITZED DURING CONSTRUCTION.															
POTENTIAL SINKHOLE	PER PA EMAP AND GEOTECHNICAL INVESTIGATION, THE SITE IS NOT LOCATED IN AN AREA KNOWN FOR NATURALLY OCCURRING GEOLOGICAL FORMATIONS OR SOIL CONDITIONS THAT MAY HAVE THE POTENTIAL TO CAUSE POLLUTION OR POTENTIAL SINK HOLES DURING EARTH DISTURBANCE ACTIVITIES. IN THE EVENT ANY GEOLOGICAL FORMATION OR SOIL CONDITIONS ARE DISCOVERED DURING CONSTRUCTION, THE PERMITTEE SHALL NOTIFY THE ENGINEER OF RECORD AND COUNTY CONSERVATION DISTRICT FOR ACTIONS TO BE TAKEN.															
PONDING	ALL IMPROVEMENTS WILL OCCUR IN AREAS NOT SUBJECT TO PONDING.															
WETNESS	CONSTRUCTION TIMING WILL BE COORDINATED TO AVOID EARTH MOVEMENT OPERATIONS AND MAJOR TRENCHING WORK DURING THE RAINY SEASON. ADDITIONAL SOIL TESTING WILL BE DONE BY A PROFESSIONAL GEOTECHNICAL ENGINEER PRIOR TO CONSTRUCTION AND RECOMMENDATION PROVIDED.															

2.5 VEGETATION

As mentioned above, the site is vacant and previously graded as part of the Langford Run Road construction. The area proposed to be developed is primarily meadow conditions while the undisturbed areas immediately adjacent to the creek are heavily wooded and almost entirely included in an existing conservation easement.

2.6 HYDROLOGY

The site generally slopes in a southerly direction towards Langford Run forming one point of interest at the Langford Run Road culvert. The point of interest will be known as POI#1.

2.7 FLOODPLAINS

FEMA's Flood Insurance Rate Map for Delaware County, Pa, map numbers "42045C0102F" and "42045C0101F", dated 11-18-2009, designates the area to be developed as "Zone X" or "Areas determined to be outside the 0.2% annual chance floodplain". The area along Langford Run is designated as "Zone A" or "Special Flood Hazard Area subject to inundation by the 1% annual chance flood – no base flood elevations determined (see Map in Appendix D). The floodplain shown on the accompanying plans is based on the Floodplain Management Analysis for Marple Associates, prepared by Chester Valley Engineers, Inc. dated February 2, 2009, last revised March 3, 2009.

2.8 PAST, PRESENT AND PROPOSED LAND USE

Past land uses (for past 50 years) per Penn Pilot Historical Aerial Photographs:

Historical aerials from 1937 to 1971 shows the property in question being an undeveloped and wooded site. Sometime during the 70ies/early 80ies, the I-476 interchange at S.R. 3 was built and the site may have been used as a staging area for the construction, as a substantial wooded area was cleared.

Present land uses (for last 5 years):

Sometime in the past 5 years, Langford Run Road was constructed, which included the construction of the Langford Run culvert. Finally, the site was regraded within the past year, which is the current conditions today.

Proposed alteration/land uses shown on a plan map:

The site will be developed to construct a shopping center.

2.9 GEOLOGICAL FORMATIONS / SOIL CONDITIONS

The site is not located in an area known for naturally occurring geological formations or soil conditions that may have the potential to cause pollution during earth disturbance activities. In the event any geological formation or soil conditions are discovered during construction, the permittee shall notify the engineer of record and county conservation district for actions to be taken.

2.10 Wetlands

On the southerly and easterly boundary lines, along Langford Run and the unnamed tributary, wetlands are present as depicted on the accompanying plans. These wetland features have been identified on-site by Conestoga-Rovers and Associates, Exton PA in April 2003 and field located by Chester Valley Engineers, Inc in May 2003.

A conservation easement has been established by the Army Corps of Engineers to protect these features and the stream.

The proposed improvements will not disturb the wetlands or the conservation easement. An existing stormwater outfall located in an existing "Outfall Maintenance Area" will be reutilized for the proposed development's outfall.

3.0 DESIGN CRITERIA

The stormwater design standards for the development are set forth by Marple Township Stormwater Management Chapter 257 ordinance, PADEP's NPDES 25 Pa. Code "§§102.8 PCSM Requirements" and PADEP's Erosion and Sediment Pollution Control Program regulations. Specific design standards and project site conditions are as follows:

Marple Township SWM Ordinance:

- **Section 257-14: Infiltration Volume Requirements:**

The size of the infiltration facility and Rev shall be based upon the following volume criteria: Modified Control Guideline One (MCG-1) of the Pennsylvania Stormwater Best Management Practices (PA BMP) Manual. The retention (infiltration) volume (Rev) to be captured and infiltrated shall be the net two-year twenty-four-hour volume.

The net volume is the difference between the post-development runoff volume and the pre-development runoff volume. The post-development total runoff volume for all storms equal to or less than the two-year twenty-four-hour duration precipitation shall not be increased.

For modeling purposes, existing (pre-development) non-forested pervious areas must be considered meadow in good condition or its equivalent, and 20% of existing impervious area, when present, shall be considered meadow in good condition.

- **257-15. Water quality requirements:**

The applicant shall comply with the following water quality requirements of this article. To control post-construction stormwater impacts from regulated activities and conform to state water quality requirements, BMPs which replicate pre-development stormwater infiltration and runoff conditions must be provided in the site design such

that post-construction stormwater discharges do not degrade the physical, chemical, or biological characteristics of the receiving waters. This may be achieved by the following:

- I. Infiltration: replication of preconstruction stormwater infiltration conditions;
- II. Treatment: use of water quality treatment BMPs to provide filtering of chemical and physical pollutants from the stormwater runoff;
- III. Stream bank and stream bed protection: management of volume and rate of postconstruction stormwater discharges to prevent physical degradation of receiving waters (e.g., from scouring).

From Control Guideline (CG-1) in the PA BMP Manual, the water quality volume shall be the net two-year twenty-four-hour volume. The net volume is the difference between the post-development runoff volume and the pre-development runoff volume. The post-development total runoff volume for all storms equal to or less than the two-year twenty-four-hour duration precipitation shall not be increased. For modeling purposes, existing (pre-development) non-forested pervious areas must be considered meadow in good condition or its equivalent, and 20% of existing impervious area, when present, shall be considered meadow in good condition.

257-16. Stream bank erosion requirements.

In addition to controlling the water quality volume (in order to minimize the impact of stormwater runoff on downstream stream bank erosion), the primary requirement to control stream bank erosion is to design a BMP to detain the proposed conditions two-year, twenty-four-hour design storm to the existing conditions one-year flow using the SCS Type II distribution. Additionally, provisions shall be made (such as adding a small orifice at the bottom of the outlet structure) to release the proposed conditions one-year storm for a minimum of 24 hours from a point in time when the maximum volume of water from the one-year storm is stored in a proposed BMP (i.e., the maximum water surface elevation is achieved in the facility). Release of water can begin at the start of the storm (i.e., the invert of the water quality orifice is at the invert of the facility).

257-17. Stormwater peak rate control.

The Site is located in the Darby-Cobbs Watershed District "B2" with the following release rates:

<u>Post</u>	<u>Reduce to</u>	<u>Pre</u>
2-yr		1-yr
5-yr		2-yr
25-yr		5-yr
50-yr		10-yr
100-yr		100-yr

25 Pa. Code §§102.8 PCSM requirements are as follows:

1. §§102.8(g)(2): Analysis demonstrating that the PCSM BMPs will meet the volume reduction and water quality requirements specified in an applicable Department approved and current Act 167 stormwater management watershed plan; or manage the net change for storms up to and including the 2year / 24hour storm event when compared to preconstruction runoff volume and water quality. The analysis for the 2-year/24hour storm event shall be conducted using the following minimum criteria:

§102.8(g)(2)(i) Existing predevelopment non-forested pervious areas must be considered meadow in good condition or its equivalent except for repair, reconstruction or restoration of roadways or rail lines, or construction, repair, reconstruction or restoration of utility infrastructure when the site will be returned to existing condition.

§102.8(g)(2)(ii) When the existing project site contains impervious area, 20% of the existing impervious area to be disturbed must be considered meadow in good condition or better, except for repair, reconstruction or restoration of roadways or rail lines, or construction, repair, reconstruction, or restoration of utility infrastructure when the site will be returned to existing condition.

2. §§102.8(g)(3): Analysis demonstrating that the PCSM BMPs will meet the rate requirements specified in an applicable Department approved and current Act 167 stormwater management watershed plan; or manage the net change in peak rate for the 2, 10, 50, and 100-year/24hour storm events in a manner not to exceed preconstruction rates.

4.0 METHODOLOGY

The SCS Method was utilized to analyze the pre-development and post-development stormwater flows. The computer program “Hydrocad” Ver. 10 by “Hydrocad Software Solutions LLC” was used to calculate and plot the runoff hydrographs. The SCS Method incorporates the time of concentration, CN values, 24-hour rainfall and associated drainage area to calculate the runoff rates. Input values were obtained from: existing and proposed site conditions, PennDOT Design Manual No. 2, PADEP Erosion and Sediment Pollution Control Program Manual, PA DEP BMP Manual and the Stormwater Management requirements of Marple Township.

4.1 RUNOFF CURVE NUMBER (CN)

To determine the existing and proposed conditions weighted runoff curve numbers, the drainage areas were broken down into the various land cover types for each hydrological soils group as obtained by the Delaware County Soils map. CN values for pre-development and post development conditions were taken from the USDA Urban

Hydrology for Small Watersheds (TR55) manual. See the Runoff Calculations CN Worksheet in the Appendix of this report.

As mentioned above, due to the similarity of the soils distribution throughout the site as shown in the Geotechnical Report and Stormwater infiltration Testing Report, for the purpose of the hydrological study, all soils type will be considered belong to Hydrologic Group “B”.

4.2 TIME OF CONCENTRATION (TOC)

Time of concentrations were determined based on the methodology specified in the USDA Urban Hydrology for Small Watersheds (TR55) manual. A minimum time of concentration of 5 minutes has been utilized.

4.3 DESIGN STORM RAINFALL

Design storm rainfall values were taken from NOAA Atlas 14, Volume 2, Version 3. See Appendix for NOAA rainfall report.

Rainfall depths are as follows:

<u>24-hour storm</u>	<u>Rainfall (inches)</u>
1-yr	2.71
2-yr	3.26
5-yr	4.11
10-yr	4.81
25-yr	5.84
50-yr	6.70
100-yr	7.64

4.4 RUNOFF HYDROGRAPH

Hydrographs for the 1-yr through the 100-yr storms were computed with the SCS TR-55 Method utilizing Hydrocad version 10.0 software and the weighted CN’s and time of concentration values computed as mentioned above. See the runoff hydrograph in the Appendix of this report for details.

5.0 ANALYSIS

5.1 PRE-DEVELOPMENT DRAINAGE AREAS

The site topography forms one (1) drainage area tributary to Langford Run with the point of interest (POI#1) at the Langford Run Road culvert. Pre-development drainage area described as follows:

- Drainage area E-1 of 15.86 acres encompasses the entire tract.

The point of interest and drainage area for pre-development conditions are designated in the PCSM Pre-Development Drainage Area Map, sheet “EDAM”, included with this

report and with the PCSM Plans. Pre-development calculation data can be found in Appendixes of this report.

5.2 POST-DEVELOPMENT DRAINAGE AREAS

Under post-development conditions, the drainage patterns have been maintained and one (1) point of interest will be considered. The post-development drainage areas are described as follows:

- Drainage area P-1 of 3.23 acres encompasses the proposed paved areas along the rear of the center. The runoff is collected by a series of catch basins and conveyed to the proposed subsurface infiltration basin P-1. The discharge from basin P-1 will drain to the existing outfall within the outfall maintenance area. The point of interest will be known as POI#1.
- Drainage area P-2 of 2.74 acres encompasses portion of the proposed building and front parking lot. The runoff is collected by a series of roof drains and catch basins and conveyed to the proposed subsurface infiltration basin P-2. The discharge from basin P-2 will also drain to the existing outfall within the outfall maintenance area. The point of interest will also be POI#1
- Drainage area P-3 of 3.71 acres encompasses portion of the proposed building and front parking lot. The runoff is collected by a series of roof drains and catch basins and conveyed to the proposed subsurface infiltration basin P-3. The discharge from basin P-3 will also drain to the existing outfall within the outfall maintenance area. The point of interest will also be POI#1
- Drainage area P-4 of 2.10 acres encompasses portion of the proposed building and front parking lot. The runoff is collected by a series of roof drains and catch basins and conveyed to the proposed subsurface infiltration basin P-4. The discharge from basin P-4 will also drain to the existing outfall within the outfall maintenance area. The point of interest will also be POI#1
- Drainage area P-5 of 1.47 acres encompasses portion of the proposed building and front parking lot. The runoff is collected by a series of roof drains and catch basins and conveyed to the proposed subsurface infiltration basin P-5. The discharge from basin P-5 will also drain to the existing outfall within the outfall maintenance area. The point of interest will also be POI#1
- Drainage area P-6 of 1.79 acres encompasses portion of the proposed building and front parking lot. The runoff is collected by a series of roof drains and catch basins and conveyed to the proposed subsurface extended detention basin P-6. The discharge from basin P-6 will also drain to the existing outfall within the outfall maintenance area. The point of interest will also be POI#1
- Drainage area P-7 of 0.82 acres encompasses un-detained perimeter bypass areas that flow directly to Langford Run.

The point of interest and drainage areas for post-development conditions are designated in the PCSM Post-Development Drainage Area Map, sheet “PDAM”, included

with this report and with the PCSM Plans. Post-development calculation data can be found in Appendixes of this report.

5.3 EROSION AND SEDIMENT CONTROL DURING REGULATED EARTH DISTURBANCE ACTIVITIES

An Erosion and Sediment Control Plan (E&S) has been developed in accordance with the Erosion and Sediment Control requirements of Pennsylvania. In addition, the site has been designed to meet PADEP NPDES requirements. The Berks County Conservation District will review the plans for compliance with both E&S and NPDES requirements.

5.4 Volume Control (Marple Township & NPDES):

Volume control as required by Marple Township and PADEP 25 Pa. Code §§102.8 has been met as follows:

Table 1: Volume Control Summary for POI#1

Pre Development Runoff Volume:	29,215 cf
Post Development Runoff Volume w/o BMPs:	<u>157,194 cf</u>
Increase in Runoff Volume:	127,979 cf
Structural Volume Provided:	134,554 cf
Net increase in Runoff Volume:	-6,575 cf

To meet the Volume Control requirements for POI#1, the following BMPs are proposed:

<u>BMP Type</u>	<u>Recharge Volume (cf)</u>
Five (5) Subsurface Infiltration Basins:	133,524
Re-Vegetate / Re-Forest Disturbed Areas:	<u>1,030</u>
Total:	134,554

See the “NPDES BMP Manual Worksheets” in the Appendix of this report.

5.5 Water Quality (NPDES):

According to the PADEP Stormwater BMP Manual Chapter 3, Section 3.5, the recommended control guideline for total water quality control is as follows:

achieve an 85 percent reduction in post-development particulate associated pollutant load (as represented by Total Suspended Solids), an 85 percent reduction in post-development total phosphorus loads, and a 50 percent reduction in post-development solute loads (as represented by NO₃-N), all based on post-development land use.

Water quality compliance can be assumed if the DEP guidance, as documented in the BMP Manual Chapter 8 “Flow Chart D”, is followed.

Per “Flow Chart D”, since the volume requirements are satisfied, water quality compliance can be assumed if BMP Worksheets 10 guidance is followed. BMP Manual Worksheet 10 Water Quality Compliance for Nitrate is achieved as follows:

Table 2: Worksheet 10 Water Quality BMPs for POI#1 (NPDES)

- NS BMP 5.4.2 - Protect / Conserve / Enhance Riparian Buffers
- NS BMP 5.6.3 - Re-Vegetate / Re-Forest Disturbed Areas (Native Species)
- NS BMP 5.9.1 - Street Sweeping / Vacuuming

See the BMP Manual Worksheets in the Appendix for details

5.6 Water Quality (Marple Township):

Water Quality as required by Marple Township has been met as follows:

- Infiltration: Per Table 1 above, the site has been designed to meet the PA BMP Manual CG-1 volume requirements.
- Treatment: Per Table 2 above, the site has been designed to meet the PA BMP Manual Chapter 3 recommended control guideline.
- Stream Bank and Stream Bed Protection: Per Table 6 below, the site has been designed to meet the Stream Bank Erosion requirements, which will minimize the impact of stormwater runoff on downstream stream bank erosion. In addition, a conservation easement along Langford Run has been established which will further protect stream.

5.7 PEAK RATE CONTROL (NPDES)

The site has been designed with five (5) subsurface infiltration basins, one (1) subsurface extended detention basin. All these basins will be equipped with outlet structures designed to infiltrate and/or extend the dewatering time of the 2-yr / 24-hour storm, while attenuating the peak flows of the higher storms (5 – 100 year) to meet the rate requirements. Table 3 below demonstrate that the post development rates will be equal to or less than the allowable pre-development flows. See routings in the Appendix of this report for details.

TABLE 3: PEAK DISCHARGE AT POI#1 (NPDES)

Pre-Development		Allowable		Post-Development		Net Change (cfs)
Storm Event	Peak Discharge (cfs)	Percent of Pre-Development	Peak Discharge (cfs)	Storm Event	Peak Discharge (cfs)	
2-yr	5.65	100%	5.65	2-yr	1.47	-4.18
10-yr	22.55	100%	22.55	10-yr	5.56	-16.99
50-yr	49.69	100%	49.69	50-yr	19.45	-30.24
100-yr	64.79	100%	64.79	100-yr	28.92	-35.87

5.8 PEAK RATE CONTROL (MARPLE TOWNSHIP)

The Site is located in the Darby-Cobbs Watershed District “B-2” with the following required release rates:

Table 4: Darby-Cobbs Watershed

District B-2 Release Rates

<u>Post</u>	<u>Reduce to</u>	<u>Pre</u>
2-yr		1-yr
5-yr		2-yr
25-yr		5-yr
50-yr		10-yr
100-yr		100-yr

The site has been designed with five (5) subsurface infiltration basins, one (1) subsurface extended detention basin. All these basins will be equipped with outlet structures designed to infiltrate and/or extend the dewatering time of the 2-yr / 24-hour storm, while attenuating the peak flows of the higher storms (5 – 100 year) to meet the rate requirements. Table 5 below demonstrate that the post development rates will be equal to or less than the allowable pre-development flows. See routings in the Appendix of this report for details.

TABLE 5: PEAK DISCHARGE AT POI#1 (MARPLE)

Pre-Development		Allowable		Post-Development		Net Change (cfs)
Storm Event	Peak Discharge (cfs)	Percent of Pre-Development	Peak Discharge (cfs)	Storm Event	Peak Discharge (cfs)	
1-yr	1.85	100%	1.85	2-yr	1.47	-0.38
2-yr	5.65	100%	5.65	5-yr	2.26	-3.39
5-yr	14.09	100%	14.09	25-yr	13.03	-1.06
10-yr	22.55	100%	22.55	50-yr	19.45	-3.10
100-yr	64.79	100%	64.79	100-yr	28.92	-35.87

5.9 STREAM BANK EROSION (MARPLE TOWNSHIP)

As shown in Table 6 below, the site stormwater management system has been designed to ensure the proposed conditions 2-year, 24-hour design storm does not exceed the existing 1-year, 24-hour peak flow.

Table 6: STREAM BANK EROSION (MARPLE TOWNSHIP)

Pre-Development		Allowable	Post-Development		Decrease
Storm Event	Peak Discharge (cfs)	Peak Discharge (cfs)	Storm Event	Peak Discharge (cfs)	(cfs)
1-yr	1.85	1.85	2-yr	1.47	0.38

In addition, while the infiltration basins have been designed to infiltrate the entire 2-yr, 24-hour volume, the extended detention basin has been equipped with a 3" orifice to extend the dewatering time of the 2-yr storm.

5.10 STORM SEWER CONVEYANCE DESIGN

Storm sewers have been designed for the 100-yr storm. The Rational Method was utilized to analyze the stormwater flows. The rainfall intensities are taken from NOAA Atlas 14, Volume 2, Version 3. The “Hydraflow Storm Sewers” design data is located in the Appendix of the report.

The computer program “Hydraflow Storm Sewers Extension for Autocad Civil 3D” Ver. 2014 by Autodesk is utilized to design the proposed storm sewer conveyance system. This program calculates a hydraulic grade line utilizing the standard step method. Bernoulli’s energy equation is solved between downstream and upstream ends using Manning’s equation to calculate head loss. This iterative methodology allows a solution to be found regardless of flow regime. Junction Loss Coefficients (JLC) are calculated by the program based on structure type and junction angle.

5.11 DOWNSTREAM IMPACTS AND EROSION POTENTIAL (NPDES)

As shown in Tables 3 and 6 of this report, the peak runoff rates for the 1-year thru 100-year storms have been significantly reduced when compared to pre-development runoff rates. The proposed reduction to the peak runoff rates will decrease the potential for long term stability degradation of the receiving waters during post-development conditions. Also per Table 1 of this report, Control Guideline 1 (CG-1) has been satisfied and exceeded by incorporating five (5) subsurface infiltration basins, which will further reduce the runoff volume to the receiving channel and the potential for long term stability degradation of the receiving waters during post-development conditions.

Downstream Stability Analysis calculations have been provided for the existing “upgraded” outfall location. Based on the calculations, the proposed velocities do not exceed the allowable velocity of the existing channel – see Appendix H of this report for the Stability Calculations. In addition, the existing “upgraded” outfall has been designed with the proper PADEP E&S Manual recommended Outlet Protection, which will further prevent erosion at the point of discharge, which occurs just upgradient of the existing channel.

6.0 POST CONSTRUCTION STORMWATER MANAGEMENT

6.1 Preserve the integrity of stream channels and maintain and protect the physical, biological and chemical qualities of the receiving stream.

To preserve the integrity of the stream channels and maintain and protect the physical, biological and chemical qualities of the receiving stream, Control Guideline No. 1 (CG1) will be met by providing structural BMPs to enhance water quality, meet volume requirements and reduce peak rates. In addition, a conservation easement has been established along the of the stream, which will be protected during construction and post development.

The following BMPs are proposed to meet water quality, recharge and peak rates:

- Five (5) subsurface infiltration basins (volume control, water quality and peak rates)
- One (1) subsurface extended detention basin (water quality and peak rates)
- NS BMP 5.4.2: Protect / Conserve / Enhance Riparian Buffers (water quality)
- NS BMP 5.6.3: Revegetate and Reforest (volume control and water quality)

6.2 Prevent an Increase in the Rate of Stormwater Runoff

Post-development peak rates have been significantly reduced when compared to pre-development rates (see Table 3) by utilizing the following BMPs:

- Five (5) subsurface infiltration basins
- One (1) subsurface extended detention basin

6.3 Minimize Any Increase in Stormwater Runoff Volume

To minimize the increase in stormwater runoff volume, Control guideline No. 1 has been met by utilizing several structural BMPs as follows:

- Five (5) subsurface infiltration basins
- One (1) subsurface extended detention basin
- Re-vegetate and Re-Forest disturbed areas

6.4 Minimize Impervious Areas

To the maximum extent possible, the site has been designed to minimize the amount of impervious coverage, by efficiently designing the parking and drive aisles, while maintaining sufficient parking to satisfy the facility requirements. Also, per the sequence of construction, disturbed areas will be stabilized as soon as practical, to keep non pervious areas to a minimum. See the sequence of construction in the Erosion and Sediment Control Narrative.

6.5 Maximize the Protection of Existing Drainage Features and Existing Vegetation

Existing drainage features and vegetation will be protected after construction by ensuring the site remains stabilized as depicted on the Landscaping Plan Sheet "LA" and Post Construction Stormwater Management Plan sheet "PCS". Also, a conservation easement exists along Langford Run, which will be protected during construction and post development.

6.6 Minimize Land Clearing and Grading

To the maximum extent possible, the site has been designed to minimize land grading, by efficiently designing the parking and drive aisles, while maintaining sufficient parking

to satisfy the facility requirements. With respect to clearing, the portion of the site to be developed is already cleared. The wooded areas along the stream will be protected during construction.

6.7 MINIMIZE SOIL COMPACTION

Soil compaction will be minimized after construction by ensuring that heavy equipment is not allowed over open space areas and within the limits of infiltration BMPs.

6.8 UTILIZE OTHER STRUCTURAL OR NONSTRUCTURAL BMPs THAT PREVENT OR MINIMIZE CHANGE IN STORMWATER RUNOFF

By ensuring that all BMPs are operational through regular scheduled inspections and maintenance, and ensuring repairs are instituted in a timely fashion in accordance with the Post Construction Stormwater Management Plan, the development should not generate an increase in stormwater runoff.

6.9 Thermal Impacts

To aid in reducing thermal impacts, a series of subsurface BMPs are proposed to meet the volume requirements of Control Guideline No. 1, which in essence will remove runoff volume from the 2-yr storm. In addition, a subsurface extended detention basin is proposed which will extend dewatering time allowing the runoff to cool down. Finally shade trees are also proposed throughout the site which will further allow the runoff to cool down.

6.10 Permanent Stabilization and Seed Mix Notes

- A. Standard for seeding and soil treatment for permanent vegetative cover:
 - a. Site preparation:
 - i. Grade as needed and feasible to permit the use of conventional equipment for seedbed preparation, seeding, mulch application, anchoring and maintenance.
 - ii. Subsoil should be tested by a reputable laboratory for the lime requirement; and limestone, if needed, should be applied to bring soil ph to 6.5 and incorporated into the soil as nearly as practical to a depth of four (4) inches.
 - iii. Immediately prior to topsoil distribution, the surface should be scarified to provide a good bond with the topsoil.
 - b. Applying topsoil:

Areas which are to be top-soiled shall be scarified to a minimum depth of 3 to 5 inches (6 to 12 inches on compacted soils) prior to placement of topsoil. Areas to be vegetated shall have a minimum 4 inches of topsoil in place prior to seeding and mulching, i.e. yards.

- i. Topsoil should be handled only when it is dry enough to work without damaging soil structure.
- ii. A uniform application to a depth of five (5) inches (unsettled) is recommended. Soils with a ph of 4.0 or less, or containing iron sulfide, shall be covered with a minimum depth of twelve (12) inches of soil having a ph of 6.0 or more.

c. Seed bed preparation:

- i. Perform all cultural operations at right angles to the slope.
- ii. Apply 10-20-20 or equivalent rated fertilizer at a rate of 500 lbs./acre or 11 lbs./1,000 s.f
- iii. Apply 300 lbs. of 38-0-0 per acre or equivalent of slow release nitrogen.
- iv. Apply pulverized dolomitic limestone at a rate of 4.0 ton/acre or 184 lbs./1,000 s.f.
- v. Work lime and fertilizer into the soil as nearly as practical to a depth of four (4) inches. Continue tillage until a reasonably uniform fine seedbed is prepared.
- vi. Remove from the surface all stones two (2) inches or larger in any dimension. Remove all other debris such as wire, cable, tree roots, pieces of concrete, clods, lumps or other unsuitable material.
- vii. Inspect seedbed just before seeding. If traffic has left the soil compacted, the area must be re-tilled and firmed as above.

d. General seeding rates:

Perennial ryegrass	1/2 lb./1,000 s.f.
Kentucky bluegrass	1.0 lb./1,000 s.f.
Red fescue	1-1/2 lbs./1,000 s.f.
Spreading fescue	1-1/2 lbs./1,000 s.f.
Fertilizer (20-10-10)	14 lbs./1,000 s.f.
Hay or straw mulch	138 lbs./1,000 s.f. (or 3 tons/acre)

e. Ernst 5311 Conservation Mix (ERNMX-114) seeding rates:

Festuca rubra, pennalawn
 Poa pratensis, alene
 Poa pratensis, cache
 Lolium multiflorum
 Lolium perenne
 Pennlawn creeping red fescue
 Alene kentucky bluegrass
 Cache kentucky bluegrass

Annual ryegrass	
Turf type perennial ryegrass	4 lb./1,000 s.f.
Fertilizer (20-10-10)	14 lbs./1,000 s.f.
Hay or straw mulch	138 lbs./1,000 s.f. (or 3 tons/acre)

f. Irrigation - (where feasible):

g. Water a minimum of 1/4" twice a day until vegetation is well established, especially when seeding is performed in abnormally dry or hot weather or on droughty sites.

B. Standard for Permanent Stabilization with Sod:

a. Methods and Materials:

- i. Cultivated sod is preferred over native or pasture sod. Specify "certified sod", or other high-quality cultivated sod.
- ii. Sod should be free of weeds and undesirable coarse weedy grasses.
- iii. Sod should be of uniform thickness, approximately 5/8 inch, plus or minus 1/4 inch, at the time of cutting (excludes top growth).
- iv. Sod should be vigorous and dense and be able to retain its own shape and weight when suspended vertically with a firm grasp from the upper 10% of the strip. Broken pads or torn and uneven ends will not be acceptable.
- v. For drought/dry sites, a sod of Kentucky 31 tall fescue and bluegrass is preferred over a straight bluegrass sod.
- vi. Only moist, fresh, un-heated sod should be used. Sod should be harvested, delivered and installed within a period of 36 hours, otherwise it shall be rejected.

b. Site Preparation:

- i. See Standard for Land Grading.

c. Soil Preparation:

- i. See Specification for Seeding and Soil Treatment for Permanent Vegetative Cover.

d. Sod Placement:

- i. Sod strips should be laid on the contour, never up and down the slope, starting at the bottom of the slope and working up. On steep slopes, the use of ladders will facilitate the work and prevent damage to the sod. During periods of high temperature, lightly irrigate the soil immediately prior to applying the sod.
- ii. Place sod strips with snug even joints that are staggered. Open spaces will result in erosion and sediment pollution.

- iii. Roll or tamp sod immediately following placement to ensure solid contact of root mat and soil surface. Do not overlap sod. All joints should be butted tightly in order to prevent voids, which would cause drying of the roots.
- iv. On slopes greater than 3:1, secure sod to surface soil with wood pegs, wire staples, or split shingles (8 to 10 inches long by 3/4 inch wide).
- v. Surface water cannot always be diverted from flowing over the face of the slope, but a capping strip of heavy jute or plastic netting, properly secured, along the crown of the slope and edges will provide extra protection against lifting and undercutting of sod. The same technique can be used to anchor sod in water-carrying channels and other critical areas. Wire staples must be used to anchor netting in channel work.
- vi. Penetrate the soil layer beneath the sod to a depth of 4 inches. Maintain optimum moisture for at least two (2) weeks.
- e. Topdressing:
 - i. If slow release nitrogen (300 lbs. of 38-0-0 per acre or equivalent) is used in addition to suggested fertilizer, then a follow-up of topdressing is not mandatory.
 - ii. Spring installation of sod will require an application of fertilizer such as 10-20-10 or equivalent at 400 lbs./acre or 10 lbs./1,000 S.F. between March 15 and May 1.
 - iii. Fall Installation of sod will require the above between September 1 and October 15.

6.11 Additional Stabilization Notes

1. Permanent stabilization is defined as a minimum uniform 70% perennial vegetative cover or other permanent non-vegetative cover with a density sufficient to resist accelerated surface erosion and subsurface characteristics sufficient to resist sliding and other movements.
2. Immediately after earth disturbance activities cease, the operator shall stabilize the disturbed areas. During non-germinating periods, mulch must be applied at the specified rates. Disturbed areas which are not at finished grade and which will be re-disturbed within 1 year must be stabilized in accordance with the temporary vegetative stabilization specifications. Disturbed areas which are at final grade or which will not be re-disturbed within 1 year must be stabilized in accordance with the permanent vegetative stabilization specifications.

3. An erosion control blanket will be installed on all disturbed slopes steeper than 3:1, all areas of concentrated flows, and disturbed areas within 50' of Waters of the Commonwealth.

6.12 BMP Operation and Maintenance Schedule

Permanent Stormwater Management BMPs:

Maintenance of the permanent stormwater control BMPs shall be the responsibility of applicant of the subject project site at the time that the applicable maintenance is required. The applicant of the initial NPDES permit is:

National Developers, Inc.
4605 West Chester Pike
Newtown Square, Pa 19073
Attn: Ed Pereira
Phone: 610-325-2198
Fax: 610-325-2186
Cell: 484-571-7008
Email: EDP@ndidelco.com

Maintenance requirements for the permanent stormwater BMPs can be found in the Approved Post-Construction Stormwater Management Plan (PCSM) as required by the NPDES permit for stormwater discharges associated with construction activities. (A copy of the approved NPDES permit and PCSM Plan should be kept on-site at all times both during the construction process and after construction has been completed.)

1. Re-forestation and landscape plantings: plantings need deep regular watering during the first growing season, either natural watering via rainfall, or planned watering via caretaker. Planting in the fall increases the likelihood of sufficient rain during planting establishment. Mulch will assist in moisture retention in the root zone of plantings, moderate soil temperature, provide some weed suppression and retard evaporation. Use coarse organic mulch that is slow to decompose in order to minimize repeat application. Apply 2-4 inch layer, leaving air space around tree trunk to prevent fungus growth. Use a combination of woodchips, leaves, and twigs that are stockpiled for six months to a year. Weed competition limits growth and survival, therefore the weeds should be controlled by either herbicides, mowing or weed mats. Herbicides are a short-term maintenance technique (2-3 years) that is generally considered less expensive and more flexible than mowing, and will result in a quicker establishment of the plantings. Herbicide use is regulated by the pa department of agriculture. Proper care should be taken to ensure that proximity to water features is considered.

- Any bare, dead or damaged lawn areas shall be re-seeded in accordance with the original procedures as outlined in the erosion and sediment

control plans using the same mix and seeding rates. Stabilization of bare or damaged areas shall be done in a timely fashion so as to avoid exposing the soil to erosion. If season prevents the re-establishment of turf cover, exposed areas should be stabilized with straw or mulch as described in the erosion and sediment control plans until permanent seeding can be done.

- If a tree or shrub is severely damaged or experiences more than 2/3 die back, it should be replaced in either the spring or fall planting season, whichever comes first. The only exception to this is if the replacement tree has a fall transplanting hazard. Replacement trees should be planted at the same size and condition as specified on the landscape plans. Any tree or shrub maintenance, tree pruning or plant material substitution of species or size shall be subject to the approval of the project landscape architect.
2. Catch basins and storm sewer conveyance system: all catch basins and associated conveyance system should be inspected for clogging and excessive debris and sediment accumulation at least four (4) times per year, as well as after every storm greater than 1 inch. Sediment laden water created during inlet and storm sewer cleaning must be captured before it enters the underground infiltration facilities. Sediment should be disposed of properly. If signs of failure are noted, an engineer or other qualified professional should be contacted to initiate the repair process.
 3. Subsurface infiltration basin:
 - Catch basins and inlets (upgradient of subsurface infiltration basin) should be inspected and cleaned at least two times per year and after runoff events. Structures include basin bottoms, trash racks, outlet structures, riprap or gabion structures, and inlets.
 - Inspect the basin after runoff events and make sure that runoff drains down within 72 hours. Mosquito's should not be a problem if the water drains in 72 hours. Mosquitoes require a considerably long breeding period with relatively static water levels.
 - Also inspect for accumulation of sediment, damage to outlet control structures, erosion control measures, and signs of water contamination/spills.
 - Remove accumulated sediment from basin as required. Properly dispose of sediment.

If signs of failure are noted, an engineer or other qualified professional should be contacted to initiate the repair process.

4. Extended detention basin: all basin structures expected to receive and/or trap debris and sediment should be inspected for clogging and excessive debris and sediment

accumulation at least four times per year, as well as after each storm greater than 1 inch.

- Structures include basin bottoms, trash racks, outlet structures, riprap or gabion structures, and inlets.
- Receiving structures should be inspected more frequently in the fall season for leaf debris.

Sediment removal should be conducted when the basin is completely dry. Sediment should be disposed of properly and once sediment is removed, disturbed areas need to be immediately stabilized and revegetated mowing and/or trimming of vegetation should be performed as necessary to sustain the system, but all detritus should be removed from the basin.

- Vegetated areas should be inspected annually for erosion.
- Vegetated areas should be inspected annually for unwanted growth of exotic/invasive species.
 - Vegetative cover should be maintained at a minimum of 95 percent. If vegetative cover has been reduced by 10%, vegetation should be reestablished.

If signs of failure are noted, an engineer or other qualified professional should be contacted to initiate the repair process.

5. Ground cover: all disturbed areas are to be prepared and seeded, or other permanent ground cover provided, following final grading. Ground cover should be maintained and/or replaced until permanent stabilization has occurred.
6. Roof drains: gutters, gutter leaf guards and downspout should be inspected for clogging and excessive debris and sediment accumulation at least four (4) times per year, as well as after every storm greater than 1 inch. Sediment should be disposed of properly.
7. Street sweeping: sweep all paved areas, including entrances from street / highway. Parking lot sweeping shall occur weekly. Use regenerative air, vacuum-assisted sweepers like Tymco or equal. Sweeping shall occur after hours or during off-peak hours.
8. Other maintenance:
 - Blow off all sidewalks and corners using power blowers. (Service to be provided on days when lot cannot be swept, i.e.: heavy rains, snow). Frequency: weekly.
 - Empty all trash receptacles and replace liners. Frequency: seven (7) times per week.
 - Hand-pick entire lot front, rear, and sides, including all trash enclosures of visible trash. Include catch basins. Frequency: weekly.
 - Hand-pick all landscaped areas. Frequency: weekly.

9. A written report documenting each inspection and all bmp repair and maintenance activities must be maintained and made available for review by the county conservation district and township upon request. Maintenance records must be retained for at least 10 years.

6.13 Critical Stages of Implementation of the PCSM Plan for which a Licensed Professional or Designee shall be present on site

The overall installation of the following structural PCSM BMPs are subject to construction engineering oversight.

- Construct subsurface infiltration basins “P1”, “P2”, “P3”, “P4” and “P5” and subsurface extended detention basin “p6”, including outfall pipes. Do not connect to upstream conveyance system at this time.
- Connect subsurface basins “P2”, “P3”, “P4”, “P5” and “P6” to upstream conveyance system. Cap all temporary bypass pipes with water tight seals.
- Connect subsurface basin “P1” to upstream conveyance system. Cap all temporary bypass pipes with water tight seals.

6.14 Recycling and Disposal of Wastes

1. All wastes from post construction bmps, such as silt, trash, grass clippings, etc., shall be removed from the site and recycled or disposed of in accordance with the department's solid waste management regulations at 25 PA. Code 260.1 et seq., 271.1., and 287.1 et seq. No building materials or wastes or unused building materials shall be burned, buried, dumped, or discharged at the site.
2. In the event of a sinkhole formation, under the supervision of a professional geologist or a licensed geotechnical engineer, material deemed unsuitable for backfill must be removed from the site and recycled or disposed of in accordance with the Pennsylvania Department of Environmental Protection's (PADEP) solid waste management regulations.

6.15 List of proposed PCSM BMPs

The following is a list of all proposed PCSM BMP utilized in the design:

- Five (5) subsurface infiltration basins
- One (1) subsurface extended detention basins
- Protect / Conserve / Enhance Riparian Buffers (water quality)
- Revegetation and Reforest Disturbed Areas

6.16 NS BMP 5.4.2: Protect / Conserve / Enhance Riparian Buffers

During the approval process for the construction of Langford Run Road and the extension of Langford Run's culvert, the reviewing agency (ACOE) required the establishment of a conservation easement along the embankments of Langford Run, which is currently in place today, as depicted on the PCSM Plans. Since the average

width of this conservation is approximately 100 feet, it also meets the required width for a voluntary riparian buffer. The area in this conservation easement is heavily wooded and undisturbed, and will not require further enhancement.

7.0 CONCLUSION

The stormwater management facility design detailed within this Stormwater Management Report meets or exceeds the standards set forth by Marple Township Stormwater Management Ordinance and the PADEP's NPDES 25 Pa. Code "§§102.8 PCSM Requirements. It will also meet the requirements as set forth in the PADEP Erosion and Sedimentation Control Regulations.

8.0 REFERENCES

Marple Township Chapter 257 Stormwater Management ordinance

Marple Township Chapter 265 Subdivision and Land Development Ordinance.

PADEP's NPDES 25 Pa. Code "§§102.8 PCSM Requirements.

PA Stormwater BMP Manual. December 2006.

"Erosion and Sediment Pollution Control Program Manual". Commonwealth of Pennsylvania, Department of Environmental Protection, Office of Water Management. March 2012.

"Specifications: Publication 408/2000". Commonwealth of Pennsylvania, Pennsylvania Department of Transportation, Bureau of Design.

"Design Manual, Part 2 Highway Design: Publication 13M, July 2002 Edition". Commonwealth of Pennsylvania, Pennsylvania Department of Transportation, Bureau of Design.

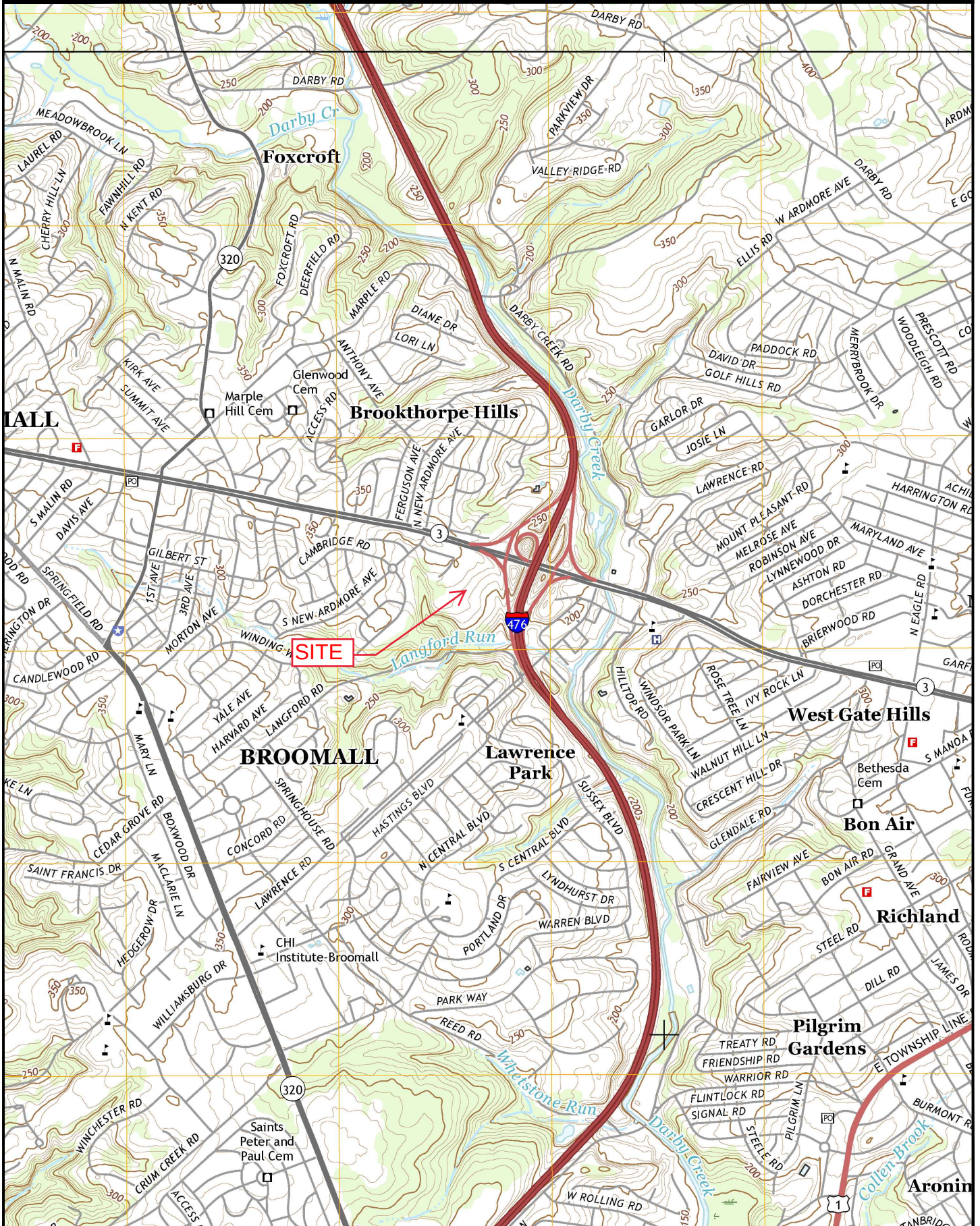
"USDA Urban Hydrology for Small Watersheds Technical Release 55 (TR55)"

Appendix A

Project Location Map

U.S.G.S. MAP

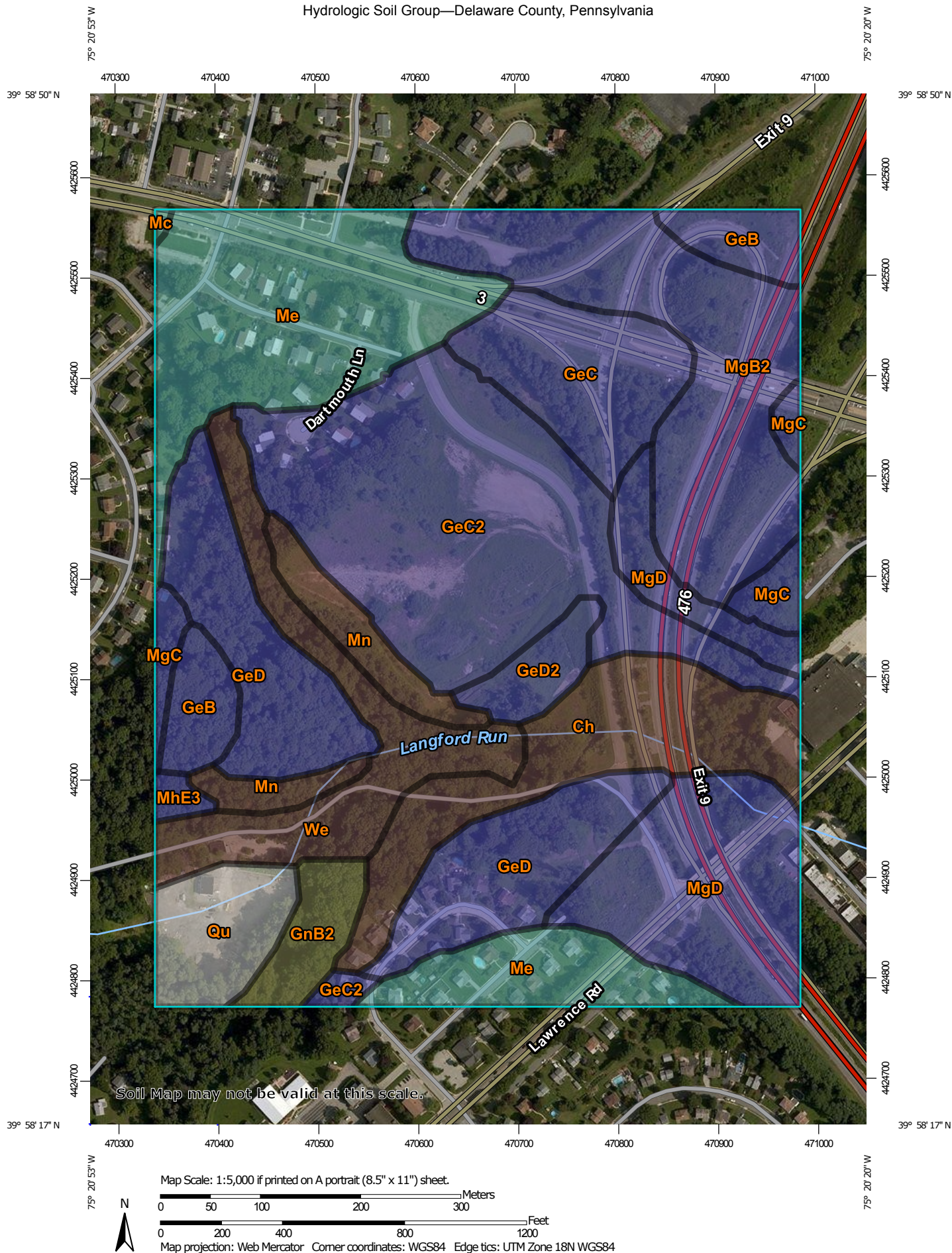
1" = 2,000'



Appendix B

Soils Maps

Hydrologic Soil Group—Delaware County, Pennsylvania



MAP LEGEND**Area of Interest (AOI)**
 Area of Interest (AOI)
Soils**Soil Rating Polygons**

-  A
-  A/D
-  B
-  B/D
-  C
-  C/D
-  D
-  Not rated or not available

Soil Rating Lines

-  A
-  A/D
-  B
-  B/D
-  C
-  C/D
-  D
-  Not rated or not available

Soil Rating Points

-  A
-  A/D
-  B
-  B/D

-  C
-  C/D
-  D
-  Not rated or not available

Water Features
 Streams and Canals
Transportation

-  Rails
-  Interstate Highways
-  US Routes
-  Major Roads
-  Local Roads

Background
 Aerial Photography
MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Delaware County, Pennsylvania
Survey Area Data: Version 14, Nov 27, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jul 25, 2014—Sep 22, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
Ch	Chewacla silt loam	B/D	10.0	7.9%
GeB	Glenelg channery loam, 3 to 8 percent slopes	B	4.0	3.2%
GeC	Glenelg channery silt loam, 8 to 15 percent slopes	B	6.8	5.3%
GeC2	Glenelg channery silt loam, 8 to 15 percent slopes, moderately eroded	B	22.2	17.4%
GeD	Glenelg channery silt loam, 15 to 25 percent slopes	B	13.7	10.8%
GeD2	Glenelg channery silt loam, 15 to 25 percent slopes, moderately eroded	B	2.1	1.6%
GnB2	Glenville silt loam, 3 to 8 percent slopes, moderately eroded	C/D	2.5	2.0%
Mc	Made land, silt and clay materials	C	0.1	0.1%
Me	Made land, schist and gneiss materials	C	19.1	15.0%
MgB2	Manor loam, 3 to 8 percent slopes, moderately eroded	B	15.2	12.0%
MgC	Manor loam, 8 to 15 percent slopes	B	2.3	1.8%
MgD	Manor loam, 15 to 25 percent slopes	B	12.4	9.7%
MhE3	Manor loam and channery loam, 25 to 35 percent slopes, severely eroded	B	0.5	0.4%
Mn	Melvin silt loam	B/D	3.8	3.0%
Qu	Quarries		4.1	3.2%
We	Wehadkee silt loam	B/D	8.5	6.6%
Totals for Area of Interest			127.3	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix C

FEMA Flood Insurance Rate Map

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) Zone 18. **Horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov/> or contact the National Geodetic Survey at the following address:

Spatial Reference System Division
National Geodetic Survey, NOAA
Silver Spring Metro Center
1315 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3191

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at <http://www.ngs.noaa.gov/>.

BASE MAP SOURCE: Base map files were obtained in digital spatial data format from the Delaware Valley Regional Planning Commission and Delaware County. Road centerlines, streamlines, and township/borough boundaries were provided by Delaware County. The county boundary was downloaded from the 2006 TIGER/Line files. 2002 and 2005 digital orthophotographs were provided by the Delaware Valley Regional Planning Commission. Adjustments were made to specific base map features to align them to 1"=200' scale orthophotos.

Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unvisited streams may differ from what is shown on previous maps.

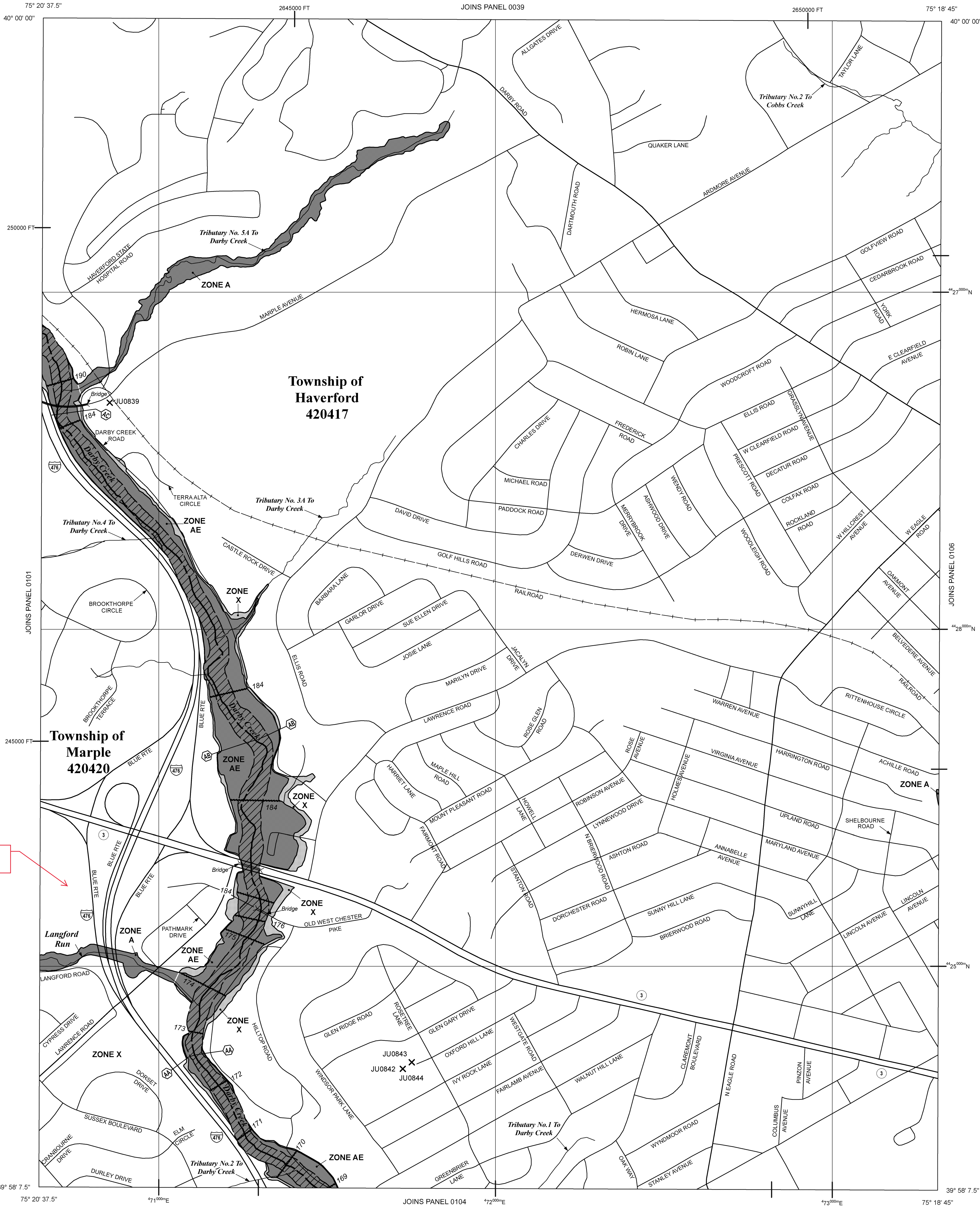
Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map repository addresses, and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at <http://msc.fema.gov/>.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov/business/nfp>.

Stillwater elevations may be shown to the nearest tenth of a foot. Users should refer to the Flood Insurance Study (FIS) for detailed flood elevation information.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile; and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAS)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
Base Flood Elevation line and value; elevation in feet*
Base Flood Elevation value where uniform within zone; elevation in feet*

* Referenced to the North American Vertical Datum of 1988

87°07'45", 32°22'30"
4276 000 M
600000 FT
DX5510 x
M1.5

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
SEPTEMBER 30, 1993

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
NOVEMBER 18, 2009 - to change Special Flood Hazard Areas, to delete Special Flood Hazard Areas, to reflect updated topographic information, and to incorporate previously issued Letters of Map Revision.
For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.
To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'
250 0 500 1000
150 0 150 300
FEET
METERS

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0102F

FIRM
FLOOD INSURANCE RATE MAP

DELAWARE COUNTY, PENNSYLVANIA (ALL JURISDICTIONS)

PANEL 102 OF 250
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
HAVERFORD, TWP OF	420417	0102	F
MARPLE, TWP OF	420420	0102	F

Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
42045C0102F
MAP REVISED
NOVEMBER 18, 2009

Federal Emergency Management Agency

36

NOTES TO USERS

This map is for use in administering the National Flood Insurance Program. It does not necessarily identify all areas subject to flooding, particularly from local drainage sources of small size. The **community map repository** should be consulted for possible updated or additional flood hazard information.

To obtain more detailed information in areas where **Base Flood Elevations** (BFEs) and/or **floodways** have been determined, users are encouraged to consult the Flood Profiles and Floodway Data and/or Summary of Stillwater Elevations tables contained within the Flood Insurance Study (FIS) report that accompanies this FIRM. Users should be aware that BFEs shown on the FIRM represent rounded whole-foot elevations. These BFEs are intended for flood insurance rating purposes only and should not be used as the sole source of flood elevation information. Accordingly, flood elevation data presented in the FIS report should be utilized in conjunction with the FIRM for purposes of construction and/or floodplain management.

Boundaries of the **floodways** were computed at cross sections and interpolated between cross sections. The floodways were based on hydraulic considerations with regard to requirements of the National Flood Insurance Program. Floodway widths and other pertinent floodway data are provided in the Flood Insurance Study report for this jurisdiction.

Certain areas not in Special Flood Hazard Areas may be protected by **flood control structures**. Refer to Section 2.4 "Flood Protection Measures" of the Flood Insurance Study report for information on flood control structures for this jurisdiction.

The **projection** used in the preparation of this map was Universal Transverse Mercator (UTM) Zone 18. **Horizontal datum** was NAD 83, GRS80 spheroid. Differences in datum, spheroid, projection or UTM zones used in the production of FIRMs for adjacent jurisdictions may result in slight positional differences in map features across jurisdiction boundaries. These differences do not affect the accuracy of this FIRM.

Flood elevations on this map are referenced to the North American Vertical Datum of 1988. These flood elevations must be compared to structure and ground elevations referenced to the same **vertical datum**. For information regarding conversion between the National Geodetic Vertical Datum of 1929 and the North American Vertical Datum of 1988, visit the National Geodetic Survey website at <http://www.ngs.noaa.gov/> or contact the National Geodetic Survey at the following address:

Spatial Reference System Division
National Geodetic Survey, NOAA
Silver Spring Metro Center
1315 East-West Highway
Silver Spring, Maryland 20910
(301) 713-3191

To obtain current elevation, description, and/or location information for **bench marks** shown on this map, please contact the Information Services Branch of the National Geodetic Survey at (301) 713-3242, or visit its website at <http://www.ngs.noaa.gov/>.

BASE MAP SOURCE: Base map files were obtained in digital spatial data format from the Delaware Valley Regional Planning Commission and Delaware County. Road centerlines, streamlines, and township/borough boundaries were provided by Delaware County. The county boundary was downloaded from the 2006 TIGER/Line files. 2002 and 2005 digital orthophotographs were provided by the Delaware Valley Regional Planning Commission. Adjustments were made to specific base map features to align them to 1"=200' scale orthophotos.

Based on updated topographic information, this map reflects more detailed and up-to-date **stream channel configurations and floodplain delineations** than those shown on the previous FIRM for this jurisdiction. As a result, the Flood Profiles and Floodway Data tables may reflect stream channel distances that differ from what is shown on the map. Also, the road to floodplain relationships for unreviewed streams may differ from what is shown on previous maps.

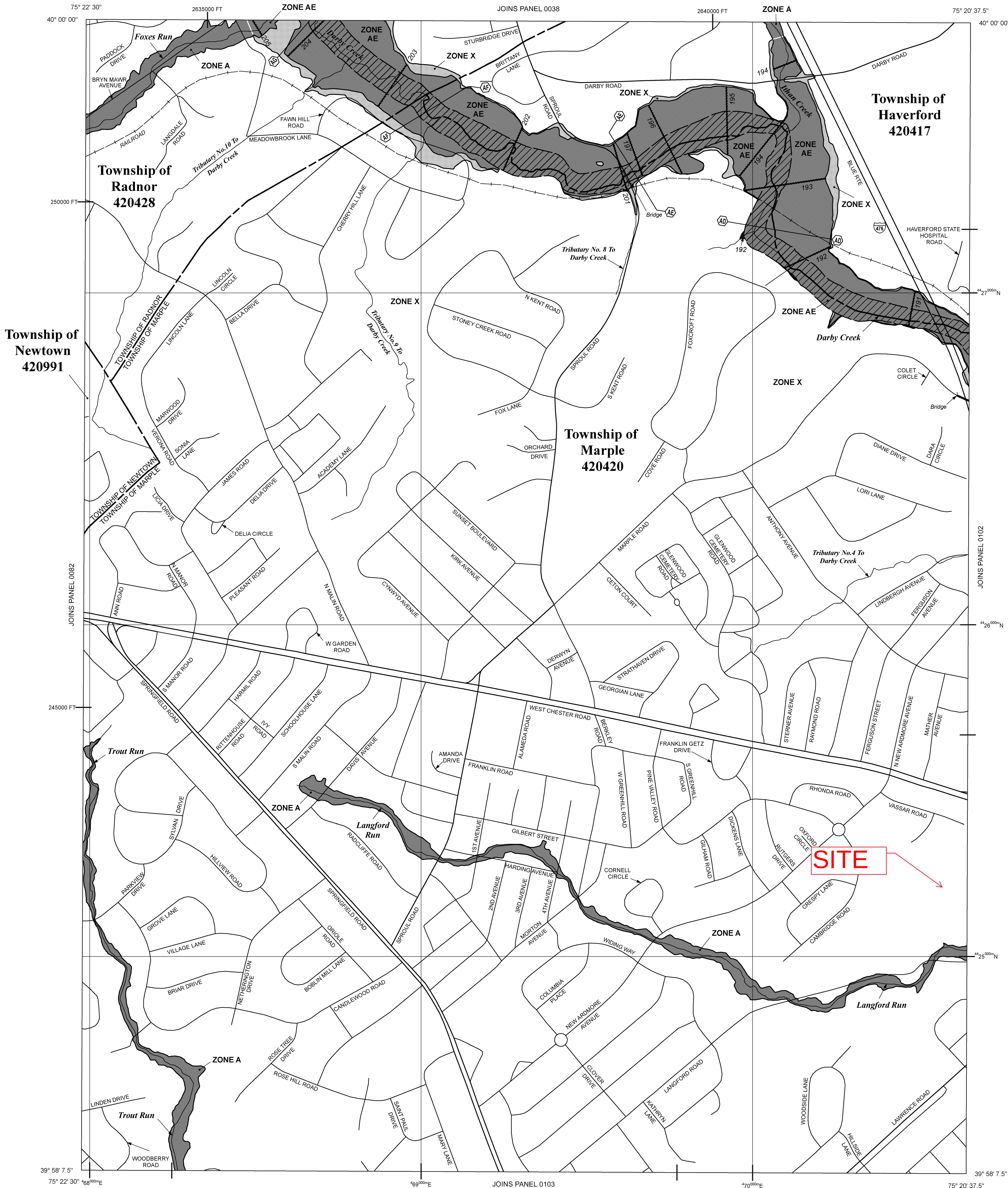
Corporate limits shown on this map are based on the best data available at the time of publication. Because changes due to annexations or de-annexations may have occurred after this map was published, map users should contact appropriate community officials to verify current corporate limit locations.

Please refer to the separately printed **Map Index** for an overview map of the county showing the layout of map panels, community map repository addresses, and a Listing of Communities table containing National Flood Insurance Program dates for each community as well as a listing of the panels on which each community is located.

Contact the **FEMA Map Service Center** at 1-800-358-9616 for information on available products associated with this FIRM. Available products may include previously issued Letters of Map Change, a Flood Insurance Study report, and/or digital versions of this map. The FEMA Map Service Center may also be reached by Fax at 1-800-358-9620 and its website at <http://msc.fema.gov/>.

If you have **questions about this map** or questions concerning the National Flood Insurance Program in general, please call **1-877-FEMA MAP** (1-877-336-2627) or visit the FEMA website at <http://www.fema.gov/business/nfp>.

Stillwater elevations may be shown to the nearest tenth of a foot. Users should refer to the Flood Insurance Study (FIS) for detailed flood elevation information.



LEGEND

SPECIAL FLOOD HAZARD AREAS (SFHAs) SUBJECT TO INUNDATION BY THE 1% ANNUAL CHANCE FLOOD

The 1% annual chance flood (100-year flood), also known as the base flood, is the flood that has a 1% chance of being equaled or exceeded in any given year. The Special Flood Hazard Area is the area subject to flooding by the 1% annual chance flood. Areas of Special Flood Hazard include Zones A, AE, AH, AO, AR, A99, V, and VE. The Base Flood Elevation is the water-surface elevation of the 1% annual chance flood.

ZONE A No Base Flood Elevations determined.

ZONE AE Base Flood Elevations determined.

ZONE AH Flood depths of 1 to 3 feet (usually areas of ponding); Base Flood Elevations determined.

ZONE AO Flood depths of 1 to 3 feet (usually sheet flow on sloping terrain); average depths determined. For areas of alluvial fan flooding, velocities also determined.

ZONE AR Special Flood Hazard Area formerly protected from the 1% annual chance flood by a flood control system that was subsequently decertified. Zone AR indicates that the former flood control system is being restored to provide protection from the 1% annual chance or greater flood.

ZONE A99 Area to be protected from 1% annual chance flood by a Federal flood protection system under construction; no Base Flood Elevations determined.

ZONE V Coastal flood zone with velocity hazard (wave action); no Base Flood Elevations determined.

ZONE VE Coastal flood zone with velocity hazard (wave action); Base Flood Elevations determined.

FLOODWAY AREAS IN ZONE AE

The floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance flood can be carried without substantial increases in flood heights.

OTHER FLOOD AREAS

ZONE X Areas of 0.2% annual chance flood; areas of 1% annual chance flood with average depths of less than 1 foot or with drainage areas less than 1 square mile, and areas protected by levees from 1% annual chance flood.

OTHER AREAS

ZONE X Areas determined to be outside the 0.2% annual chance floodplain.

ZONE D Areas in which flood hazards are undetermined, but possible.

COASTAL BARRIER RESOURCES SYSTEM (CBRS) AREAS

OTHERWISE PROTECTED AREAS (OPAS)

CBRS areas and OPAs are normally located within or adjacent to Special Flood Hazard Areas.

1% annual chance floodplain boundary
0.2% annual chance floodplain boundary
Floodway boundary
Zone D boundary
CBRS and OPA boundary
Boundary dividing Special Flood Hazard Areas of different Base Flood Elevations, flood depths or flood velocities.
Base Flood Elevation line and value; elevation in feet*
Base Flood Elevation value where uniform within zone; elevation in feet*
(EL. 987)

* Referenced to the North American Vertical Datum of 1988

87°07'45", 32°22'30"
4276 000 M
600000 FT
DX5510 x
M1.5

Cross section line
Transect line
Geographic coordinates referenced to the North American Datum of 1983 (NAD 83)
1000-meter Universal Transverse Mercator grid values, zone 18
5000-foot grid ticks: Pennsylvania State Plane coordinate system (FIPSZONE 3702), Lambert Conformal Conic projection
Bench mark (see explanation in Notes to Users section of this FIRM panel)
River Mile

MAP REPOSITORY
Refer to listing of Map Repositories on Map Index

EFFECTIVE DATE OF COUNTYWIDE FLOOD INSURANCE RATE MAP
SEPTEMBER 30, 1993

EFFECTIVE DATE(S) OF REVISION(S) TO THIS PANEL
MAY 2, 1995

NOVEMBER 18, 2009 - to change Special Flood Hazard Areas, to delete Special Flood Hazard Areas, to reflect updated topographic information, and to incorporate previously issued Letters of Map Revision.
For community map revision history prior to countywide mapping, refer to the Community Map History table located in the Flood Insurance Study report for this jurisdiction.
To determine if flood insurance is available in this community, contact your insurance agent or call the National Flood Insurance Program at 1-800-638-6620.

MAP SCALE 1" = 500'
250 0 500 1000
150 0 150 300
FEET
METERS

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0101F

FIRM
FLOOD INSURANCE RATE MAP

DELAWARE COUNTY, PENNSYLVANIA (ALL JURISDICTIONS)

PANEL 101 OF 250
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
HAVERTFORD, TWP OF	420417	0101	F
MARPLE, TWP OF	420420	0101	F
NEWTOWN, TWP OF	420991	0101	F
RADNOR, TWP OF	420428	0101	F

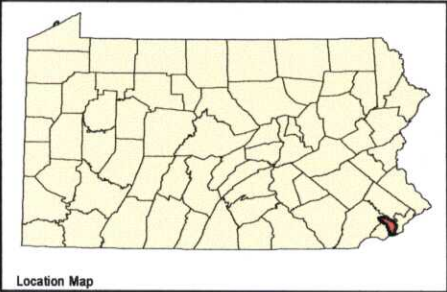
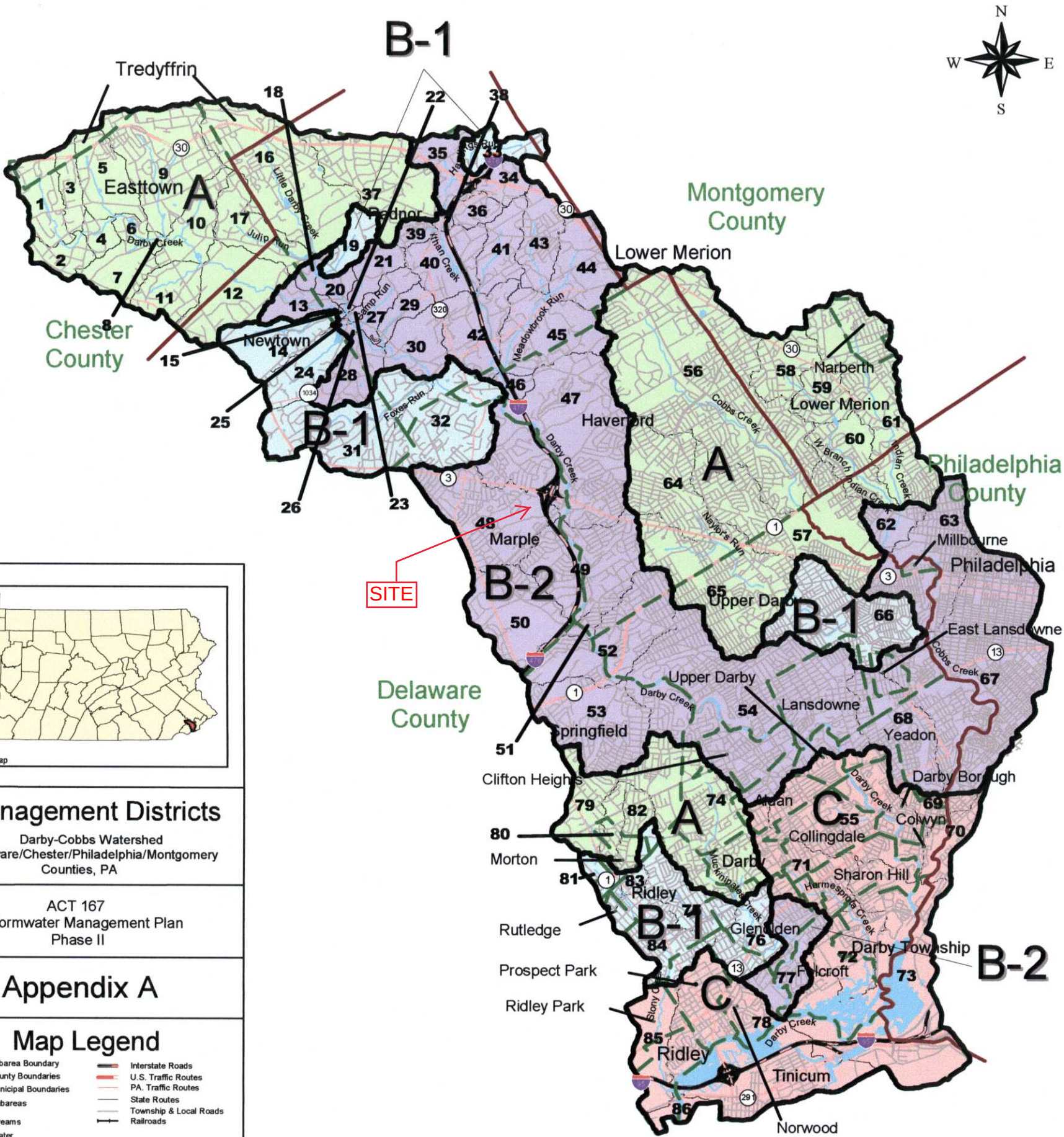
Notice to User: The Map Number shown below should be used when placing map orders; the Community Number shown above should be used on insurance applications for the subject community.

MAP NUMBER
42045C0101F
MAP REVISED
NOVEMBER 18, 2009

Federal Emergency Management Agency

Appendix D

Darby-Cobbs Watershed Map



Management Districts
Darby-Cobbs Watershed
Delaware/Chester/Philadelphia/Montgomery
Counties, PA

ACT 167
Stormwater Management Plan
Phase II

Appendix A

Map Legend

Subarea Boundary	Interstate Roads
County Boundaries	U.S. Traffic Routes
Municipal Boundaries	PA. Traffic Routes
Subareas	State Routes
Streams	Township & Local Roads
Water	Railroads

Prepared For:
Delaware County Planning Department
Court House/Government Center
201 West Front Street
Media, PA 19063
610-891-5200

Note:
Portions of these maps were generated from existing data sources as listed below. This existing data was utilized for base mapping purposes and is shown on the maps for spatial reference only. This data did not enter into any computations or affect the reliability of the hydrologic analysis. Borton-Lawson Engineering has found some inaccuracies in some of this data and has corrected the data in locations where these discrepancies were obvious, however, it was not a part of this ACT 167 Plan to correct all of the base data.

Data Sources:
DRGs - USGS
Subareas - BLE



**Borton
Lawson
ENGINEERING**

613 Baltimore Drive
Suite 300
Wilkes-Barre, PA 18702-7903
610-821-1999 Fax 610-821-1990
World Wide Web : <http://www.borton-lawson.com>

6814 Christoph Drive
Suite 200
Bath, PA 18014
610-837-5916 Fax 610-837-5918

Prepared By: CGF Check By: *[Signature]*
Project Number: 99613.01 Date of Plot: December 2003

Management Districts Legend		
	Design Storm Proposed Conditions	Design Storm Existing Conditions
A	2 - Year 5 - Year 10 - Year 25 - Year 100 - Year	1 - Year 5 - Year 10 - Year 25 - Year 100 - Year
B-1	2 - Year 10 - Year 25 - Year 50 - Year 100 - Year	1 - Year 5 - Year 10 - Year 25 - Year 100 - Year
B-2	2 - Year 5 - Year 25 - Year 50 - Year 100 - Year	1 - Year 2 - Year 5 - Year 10 - Year 100 - Year
C*	Provisional Discharge District (see notes below *)	

* If storms greater than the 2 - year storm cannot be conveyed to a stream or watercourse in a safe manner, then District A requirements shall apply. (See model ACT 167 Stormwater Management Ordinance, Article III Section 308 for details.)

In addition to the Management District Criteria above, the groundwater recharge (Section 305), water quality (Section 306), and streambank erosion (Section 307) requirements shall also apply to all Management Districts within the Darby-Cobbs Watershed.



Appendix E

NOAA Precipitation Frequency Data



NOAA Atlas 14, Volume 2, Version 3
Location name: Broomall, Pennsylvania, USA*
Latitude: 39.9765°, Longitude: -75.3442°
Elevation: 272.29 ft**
 * source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps & aerals](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.349 (0.321-0.379)	0.415 (0.382-0.452)	0.487 (0.447-0.529)	0.537 (0.492-0.585)	0.598 (0.544-0.650)	0.638 (0.578-0.695)	0.679 (0.612-0.741)	0.713 (0.639-0.781)	0.753 (0.668-0.829)	0.783 (0.689-0.866)
10-min	0.557 (0.513-0.606)	0.664 (0.611-0.722)	0.780 (0.716-0.848)	0.859 (0.787-0.935)	0.952 (0.867-1.04)	1.02 (0.921-1.11)	1.08 (0.972-1.18)	1.13 (1.01-1.24)	1.19 (1.06-1.31)	1.23 (1.09-1.36)
15-min	0.696 (0.641-0.758)	0.834 (0.768-0.908)	0.987 (0.905-1.07)	1.09 (0.995-1.18)	1.21 (1.10-1.31)	1.29 (1.17-1.40)	1.36 (1.23-1.49)	1.43 (1.28-1.56)	1.50 (1.33-1.65)	1.55 (1.36-1.71)
30-min	0.954 (0.879-1.04)	1.15 (1.06-1.25)	1.40 (1.29-1.52)	1.57 (1.44-1.71)	1.79 (1.63-1.94)	1.94 (1.76-2.11)	2.09 (1.88-2.28)	2.22 (1.99-2.43)	2.39 (2.12-2.63)	2.51 (2.21-2.77)
60-min	1.19 (1.10-1.30)	1.45 (1.33-1.57)	1.80 (1.65-1.95)	2.05 (1.88-2.23)	2.38 (2.17-2.59)	2.63 (2.38-2.86)	2.88 (2.59-3.14)	3.11 (2.79-3.41)	3.42 (3.04-3.77)	3.66 (3.22-4.05)
2-hr	1.43 (1.30-1.56)	1.73 (1.59-1.90)	2.16 (1.97-2.37)	2.49 (2.27-2.72)	2.92 (2.64-3.19)	3.26 (2.92-3.56)	3.59 (3.21-3.94)	3.93 (3.48-4.32)	4.38 (3.84-4.84)	4.72 (4.09-5.24)
3-hr	1.56 (1.43-1.71)	1.89 (1.73-2.07)	2.37 (2.16-2.59)	2.73 (2.48-2.99)	3.21 (2.90-3.51)	3.59 (3.23-3.93)	3.98 (3.55-4.37)	4.38 (3.86-4.81)	4.90 (4.27-5.42)	5.31 (4.58-5.89)
6-hr	1.94 (1.78-2.13)	2.34 (2.15-2.58)	2.92 (2.67-3.21)	3.38 (3.08-3.71)	4.03 (3.64-4.42)	4.56 (4.08-5.00)	5.11 (4.53-5.61)	5.69 (4.98-6.26)	6.50 (5.59-7.20)	7.15 (6.06-7.96)
12-hr	2.35 (2.16-2.60)	2.84 (2.60-3.14)	3.56 (3.25-3.93)	4.16 (3.78-4.59)	5.04 (4.52-5.54)	5.77 (5.13-6.35)	6.57 (5.76-7.24)	7.42 (6.43-8.22)	8.67 (7.34-9.65)	9.72 (8.07-10.9)
24-hr	2.71 (2.49-2.95)	3.26 (3.00-3.56)	4.11 (3.78-4.48)	4.81 (4.41-5.25)	5.84 (5.32-6.34)	6.70 (6.08-7.27)	7.64 (6.88-8.28)	8.65 (7.74-9.36)	10.1 (8.97-11.0)	11.4 (9.97-12.3)
2-day	3.12 (2.86-3.41)	3.77 (3.46-4.11)	4.75 (4.35-5.18)	5.55 (5.08-6.05)	6.70 (6.10-7.29)	7.66 (6.94-8.32)	8.67 (7.82-9.42)	9.76 (8.75-10.6)	11.3 (10.1-12.3)	12.6 (11.1-13.7)
3-day	3.29 (3.03-3.60)	3.97 (3.65-4.34)	4.99 (4.58-5.45)	5.82 (5.33-6.34)	7.01 (6.39-7.63)	8.00 (7.26-8.69)	9.04 (8.17-9.83)	10.2 (9.13-11.0)	11.8 (10.5-12.8)	13.1 (11.6-14.2)
4-day	3.47 (3.19-3.79)	4.18 (3.85-4.56)	5.23 (4.81-5.71)	6.09 (5.59-6.64)	7.32 (6.68-7.96)	8.34 (7.59-9.06)	9.41 (8.52-10.2)	10.6 (9.51-11.5)	12.2 (10.9-13.3)	13.6 (12.0-14.8)
7-day	4.03 (3.74-4.38)	4.83 (4.48-5.25)	5.99 (5.55-6.51)	6.94 (6.41-7.53)	8.30 (7.64-9.00)	9.43 (8.63-10.2)	10.6 (9.68-11.5)	11.9 (10.8-12.9)	13.7 (12.3-14.9)	15.2 (13.5-16.5)
10-day	4.57 (4.26-4.93)	5.46 (5.09-5.89)	6.67 (6.20-7.19)	7.65 (7.10-8.24)	9.01 (8.33-9.70)	10.1 (9.32-10.9)	11.3 (10.3-12.1)	12.4 (11.4-13.4)	14.1 (12.8-15.2)	15.5 (14.0-16.8)
20-day	6.17 (5.80-6.59)	7.33 (6.88-7.83)	8.75 (8.21-9.34)	9.87 (9.26-10.5)	11.4 (10.6-12.1)	12.6 (11.7-13.4)	13.8 (12.8-14.7)	15.0 (13.9-16.0)	16.6 (15.3-17.8)	17.9 (16.4-19.2)
30-day	7.69 (7.27-8.13)	9.07 (8.57-9.59)	10.6 (10.0-11.2)	11.8 (11.1-12.4)	13.3 (12.5-14.1)	14.5 (13.6-15.3)	15.7 (14.7-16.6)	16.8 (15.7-17.8)	18.3 (17.1-19.4)	19.5 (18.0-20.7)
45-day	9.77 (9.27-10.3)	11.5 (10.9-12.1)	13.2 (12.5-13.9)	14.5 (13.8-15.3)	16.2 (15.3-17.0)	17.4 (16.5-18.3)	18.6 (17.5-19.6)	19.7 (18.5-20.8)	21.1 (19.8-22.2)	22.1 (20.7-23.3)
60-day	11.7 (11.1-12.3)	13.7 (13.0-14.4)	15.6 (14.9-16.5)	17.1 (16.2-18.0)	18.9 (17.9-19.9)	20.2 (19.2-21.3)	21.5 (20.3-22.6)	22.6 (21.4-23.8)	24.0 (22.7-25.3)	25.0 (23.6-26.4)

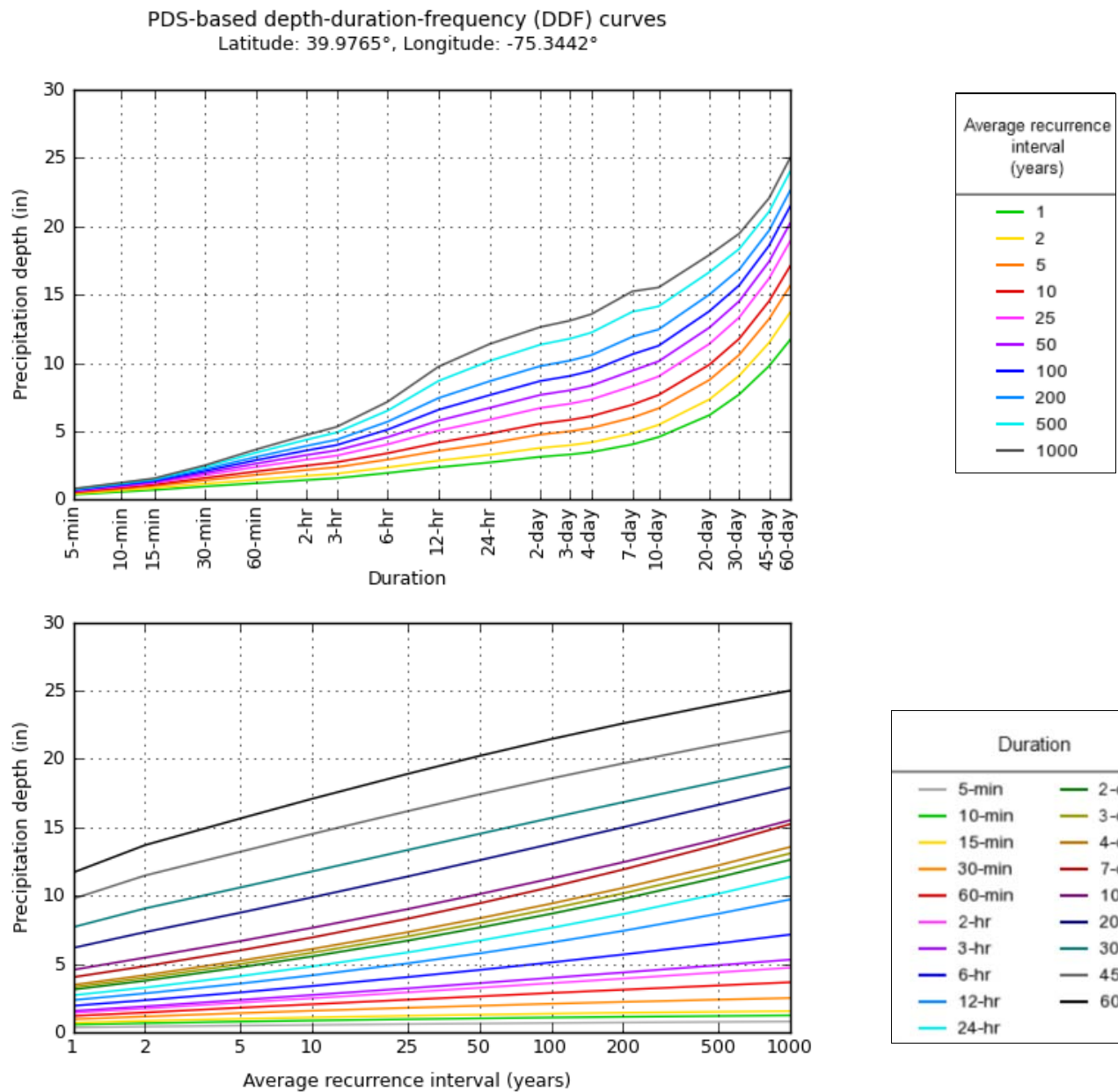
¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

PF graphical



NOAA Atlas 14, Volume 2, Version 3

Created (GMT): Fri Sep 22 13:28:55 2017

[Back to Top](#)

Maps & aerials

Small scale terrain



NOAA Atlas 14, Volume 2, Version 3
Location name: Broomall, Pennsylvania, USA*
Latitude: 39.9765°, Longitude: -75.3442°
Elevation: 272.29 ft**
 * source: ESRI Maps
 ** source: USGS



POINT PRECIPITATION FREQUENCY ESTIMATES

G.M. Bonnin, D. Martin, B. Lin, T. Parzybok, M.Yekta, and D. Riley

NOAA, National Weather Service, Silver Spring, Maryland

[PF_tabular](#) | [PF_graphical](#) | [Maps & aeriels](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches/hour)¹										
Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	4.19 (3.85-4.55)	4.98 (4.58-5.42)	5.84 (5.36-6.35)	6.44 (5.90-7.02)	7.18 (6.53-7.80)	7.66 (6.94-8.34)	8.15 (7.34-8.89)	8.56 (7.67-9.37)	9.04 (8.02-9.95)	9.40 (8.27-10.4)
10-min	3.34 (3.08-3.64)	3.98 (3.67-4.33)	4.68 (4.30-5.09)	5.15 (4.72-5.61)	5.71 (5.20-6.22)	6.10 (5.53-6.64)	6.47 (5.83-7.06)	6.78 (6.08-7.42)	7.15 (6.34-7.87)	7.40 (6.51-8.18)
15-min	2.78 (2.56-3.03)	3.34 (3.07-3.63)	3.95 (3.62-4.29)	4.35 (3.98-4.73)	4.83 (4.40-5.25)	5.15 (4.66-5.60)	5.45 (4.92-5.95)	5.70 (5.11-6.24)	6.00 (5.32-6.60)	6.19 (5.45-6.84)
30-min	1.91 (1.76-2.08)	2.30 (2.12-2.51)	2.80 (2.57-3.05)	3.15 (2.88-3.43)	3.58 (3.26-3.89)	3.88 (3.51-4.22)	4.17 (3.77-4.56)	4.44 (3.98-4.86)	4.77 (4.23-5.25)	5.01 (4.41-5.54)
60-min	1.19 (1.10-1.30)	1.45 (1.33-1.57)	1.80 (1.65-1.95)	2.05 (1.88-2.23)	2.38 (2.17-2.59)	2.63 (2.38-2.86)	2.88 (2.59-3.14)	3.11 (2.79-3.41)	3.42 (3.04-3.77)	3.66 (3.22-4.05)
2-hr	0.714 (0.652-0.781)	0.867 (0.793-0.948)	1.08 (0.987-1.18)	1.24 (1.13-1.36)	1.46 (1.32-1.60)	1.63 (1.46-1.78)	1.80 (1.60-1.97)	1.96 (1.74-2.16)	2.19 (1.92-2.42)	2.36 (2.05-2.62)
3-hr	0.519 (0.476-0.569)	0.629 (0.577-0.690)	0.788 (0.719-0.862)	0.908 (0.827-0.994)	1.07 (0.967-1.17)	1.20 (1.08-1.31)	1.33 (1.18-1.45)	1.46 (1.29-1.60)	1.63 (1.42-1.80)	1.77 (1.53-1.96)
6-hr	0.324 (0.296-0.356)	0.391 (0.358-0.430)	0.487 (0.445-0.535)	0.565 (0.514-0.620)	0.674 (0.608-0.738)	0.761 (0.681-0.834)	0.854 (0.757-0.937)	0.950 (0.832-1.05)	1.09 (0.934-1.20)	1.19 (1.01-1.33)
12-hr	0.195 (0.179-0.216)	0.236 (0.216-0.261)	0.296 (0.270-0.326)	0.346 (0.314-0.381)	0.418 (0.375-0.460)	0.479 (0.426-0.527)	0.545 (0.478-0.601)	0.616 (0.533-0.682)	0.720 (0.609-0.801)	0.807 (0.670-0.901)
24-hr	0.113 (0.104-0.123)	0.136 (0.125-0.149)	0.171 (0.157-0.187)	0.201 (0.184-0.219)	0.243 (0.222-0.264)	0.279 (0.253-0.303)	0.318 (0.287-0.345)	0.360 (0.323-0.390)	0.422 (0.374-0.457)	0.474 (0.415-0.512)
2-day	0.065 (0.060-0.071)	0.079 (0.072-0.086)	0.099 (0.091-0.108)	0.116 (0.106-0.126)	0.140 (0.127-0.152)	0.159 (0.145-0.173)	0.181 (0.163-0.196)	0.203 (0.182-0.221)	0.236 (0.210-0.256)	0.263 (0.232-0.286)
3-day	0.046 (0.042-0.050)	0.055 (0.051-0.060)	0.069 (0.064-0.076)	0.081 (0.074-0.088)	0.097 (0.089-0.106)	0.111 (0.101-0.121)	0.126 (0.113-0.136)	0.141 (0.127-0.153)	0.164 (0.145-0.178)	0.182 (0.160-0.198)
4-day	0.036 (0.033-0.039)	0.043 (0.040-0.048)	0.054 (0.050-0.059)	0.063 (0.058-0.069)	0.076 (0.070-0.083)	0.087 (0.079-0.094)	0.098 (0.089-0.107)	0.110 (0.099-0.120)	0.127 (0.113-0.138)	0.141 (0.125-0.154)
7-day	0.024 (0.022-0.026)	0.029 (0.027-0.031)	0.036 (0.033-0.039)	0.041 (0.038-0.045)	0.049 (0.045-0.054)	0.056 (0.051-0.061)	0.063 (0.058-0.069)	0.071 (0.064-0.077)	0.082 (0.073-0.089)	0.091 (0.081-0.098)
10-day	0.019 (0.018-0.021)	0.023 (0.021-0.025)	0.028 (0.026-0.030)	0.032 (0.030-0.034)	0.038 (0.035-0.040)	0.042 (0.039-0.045)	0.047 (0.043-0.050)	0.052 (0.047-0.056)	0.059 (0.053-0.063)	0.065 (0.058-0.070)
20-day	0.013 (0.012-0.014)	0.015 (0.014-0.016)	0.018 (0.017-0.019)	0.021 (0.019-0.022)	0.024 (0.022-0.025)	0.026 (0.024-0.028)	0.029 (0.027-0.031)	0.031 (0.029-0.033)	0.035 (0.032-0.037)	0.037 (0.034-0.040)
30-day	0.011 (0.010-0.011)	0.013 (0.012-0.013)	0.015 (0.014-0.016)	0.016 (0.015-0.017)	0.019 (0.017-0.020)	0.020 (0.019-0.021)	0.022 (0.020-0.023)	0.023 (0.022-0.025)	0.025 (0.024-0.027)	0.027 (0.025-0.029)
45-day	0.009 (0.009-0.010)	0.011 (0.010-0.011)	0.012 (0.012-0.013)	0.013 (0.013-0.014)	0.015 (0.014-0.016)	0.016 (0.015-0.017)	0.017 (0.016-0.018)	0.018 (0.017-0.019)	0.020 (0.018-0.021)	0.020 (0.019-0.022)
60-day	0.008 (0.008-0.009)	0.010 (0.009-0.010)	0.011 (0.010-0.011)	0.012 (0.011-0.012)	0.013 (0.012-0.014)	0.014 (0.013-0.015)	0.015 (0.014-0.016)	0.016 (0.015-0.017)	0.017 (0.016-0.018)	0.017 (0.016-0.018)

¹ Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

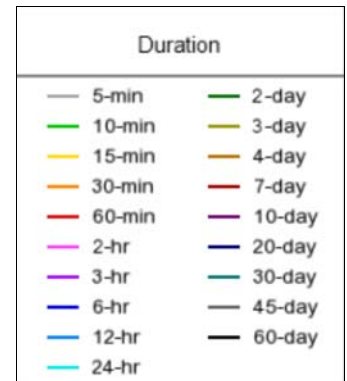
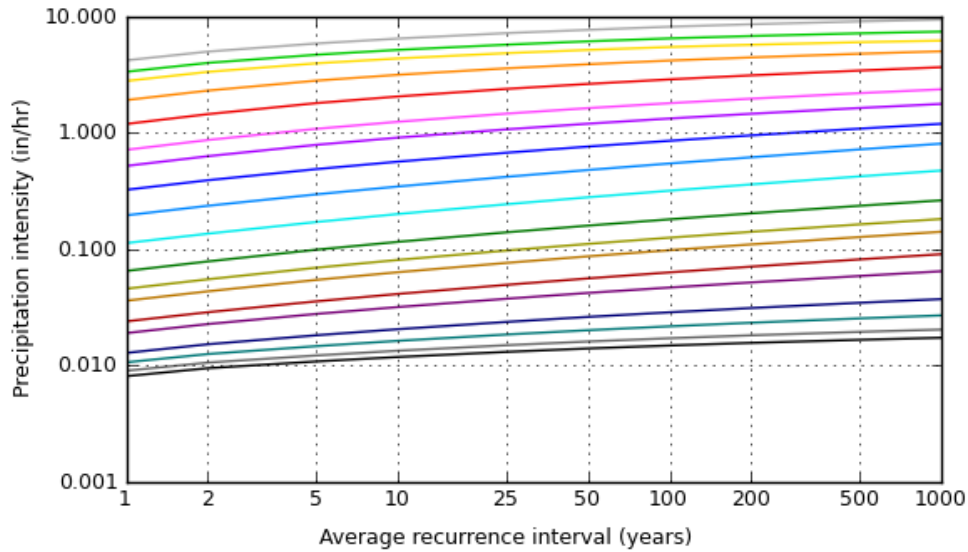
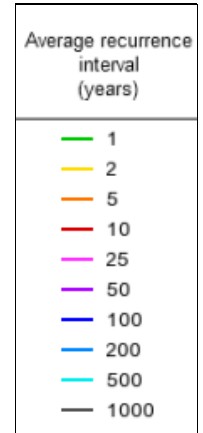
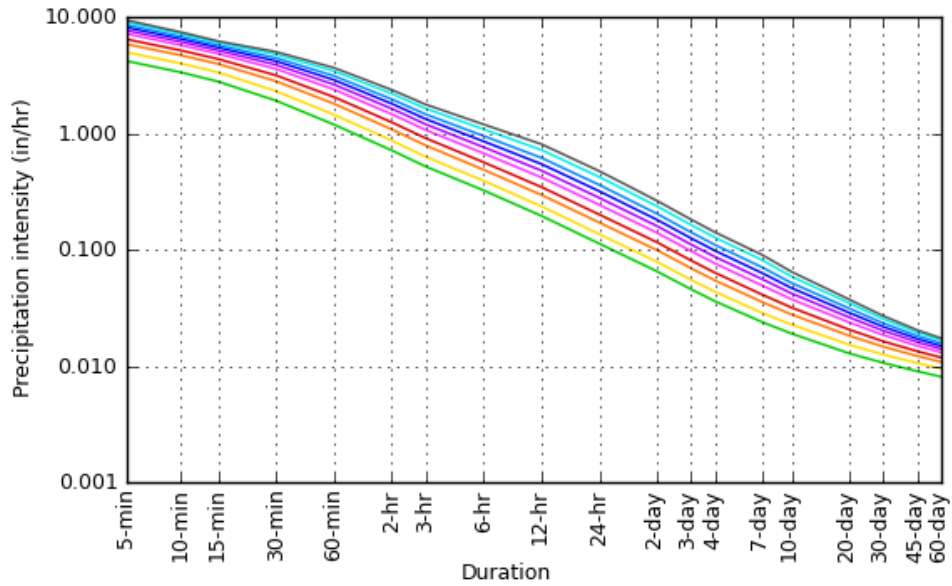
Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

[Back to Top](#)

PF graphical

PDS-based intensity-duration-frequency (IDF) curves
Latitude: 39.9765°, Longitude: -75.3442°



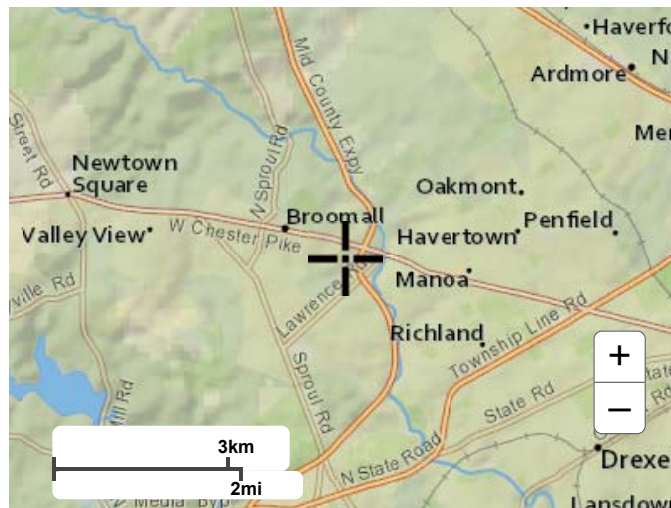
NOAA Atlas 14, Volume 2, Version 3

Created (GMT): Fri Sep 22 13:27:48 2017

[Back to Top](#)

Maps & aeriels

Small scale terrain



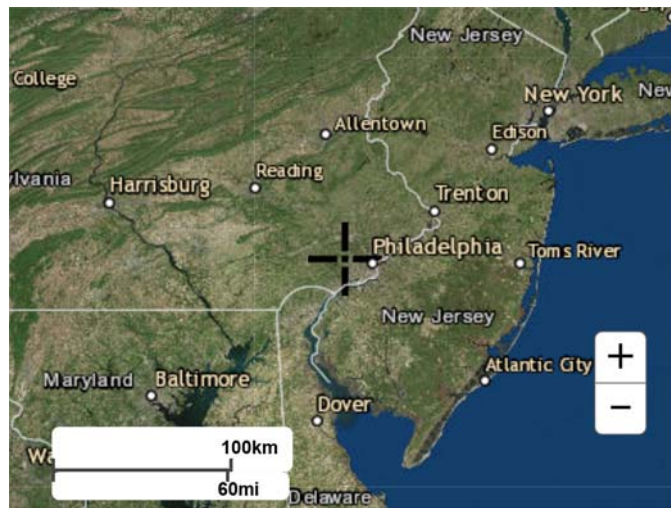
Large scale terrain



Large scale map



Large scale aerial

[Back to Top](#)

[US Department of Commerce](#)
[National Oceanic and Atmospheric Administration](#)
[National Weather Service](#)
[National Water Center](#)
1325 East West Highway
Silver Spring, MD 20910
Questions?: HDSC.Questions@noaa.gov

[Disclaimer](#)

Appendix F

Stormwater Peak Rate Control Analysis



Runoff Calculations CN Worksheet

Project: Marple Associates, LP

Date: 12/18/2017

Marple Township, Delaware County, PA

Prepared By: MAR

Checked By: RTW

Condition: Post-Development

Watershed: P-1

Soil Group	Land Use Description	CN (A)	% or Area (Acre) (B)	Product (A x B) (C)
A				
B	Open Space (Lawns), Good Condition	61	0.36	21.96
C				
D				
Impervious	Impervious	98	2.87	281.26
			3.23	303.22

$$CN (weighted) = \frac{Total (C)}{Total (B)} = \frac{303.22}{3.23} = 93.88$$

CN = 94



Runoff Calculations CN Worksheet

Project: Marple Associates, LP

Date: 12/18/2017

Marple Township, Delaware County, PA

Prepared By: MAR

Checked By: RTW

Condition: Post-Development

Watershed: P-2

Soil Group	Land Use Description	CN (A)	% or Area (Acre) (B)	Product (A x B) (C)
A				
B	Open Space (Lawns), Good Condition	61	0.10	6.10
C				
D				
Impervious	Impervious	98	2.64	258.72
			2.74	264.82

$$CN (weighted) = \frac{Total (C)}{Total (B)} = \frac{264.82}{2.74} = 96.65$$

CN = 97



Runoff Calculations CN Worksheet

Project: Marple Associates, LP

Date: 12/18/2017

Marple Township, Delaware County, PA

Prepared By: MAR

Checked By: RTW

Condition: Post-Development

Watershed: P-3

Soil Group	Land Use Description	CN (A)	% or Area (Acre) (B)	Product (A x B) (C)
A				
B	Open Space (Lawns), Good Condition	61	0.05	2.84
C				
D				
Impervious	Impervious	98	3.67	359.26
			3.71	362.10

$$CN (weighted) = \frac{Total (C)}{Total (B)} = \frac{362.10}{3.71} = 97.54$$

CN = 98



Runoff Calculations CN Worksheet

Project: Marple Associates, LP

Date: 12/18/2017

Marple Township, Delaware County, PA

Prepared By: MAR

Checked By: RTW

Condition: Post-Development

Watershed: P-4

Soil Group	Land Use Description	CN (A)	% or Area (Acre) (B)	Product (A x B) (C)
A				
B	Open Space (Lawns), Good Condition	61	0.55	33.55
C				
D				
Impervious	Impervious	98	1.55	151.90
			2.10	185.45

$$CN (weighted) = \frac{Total (C)}{Total (B)} = \frac{185.45}{2.10} = 88.31$$

CN = 88



Runoff Calculations CN Worksheet

Project: Marple Associates, LP

Date: 12/18/2017

Marple Township, Delaware County, PA

Prepared By: MAR

Checked By: RTW

Condition: Post-Development

Watershed: P-5

Soil Group	Land Use Description	CN (A)	% or Area (B)	Product (A x B) (C)
A				
B	Open Space (Lawns), Good Condition	61	0.25	15.25
C				
D				
Impervious	Impervious	98	1.22	119.56
			1.47	134.81

$$CN (weighted) = \frac{Total (C)}{Total (B)} = \frac{134.81}{1.47} = 91.71$$

CN = 92



Runoff Calculations CN Worksheet

Project: **Marple Associates, LP**

Date: **12/18/2017**

Marple Township, Delaware County, PA

Prepared By: **MAR**

Checked By: **RTW**

Condition: **Post-Development**

Watershed: **P-6**

Soil Group	Land Use Description	CN (A)	% or Area (B)	Product (A x B) (C)
A				
B	Open Space (Lawns), Good Condition	61	0.34	20.99
C				
D				
Impervious	Impervious	98	1.44	141.31
			1.79	162.30

$$CN (weighted) = \frac{Total (C)}{Total (B)} = \frac{162.30}{1.79} = 90.87$$

CN = 91



Runoff Calculations CN Worksheet

Project: Marple Associates, LP

Date: 12/18/2017

Marple Township, Delaware County, PA

Prepared By: MAR

Checked By: RTW

Condition: Post-Development

Watershed: P-7

Soil Group	Land Use Description	CN (A)	% or Area (B)	Product (A x B) (C)
A				
B	Open Space (Lawns), Good Condition	61	0.57	34.77
C				
D				
Impervious	Impervious	98	0.25	24.50
			0.82	59.27

$$CN (weighted) = \frac{Total (C)}{Total (B)} = \frac{59.27}{0.82} = 72.28$$

CN = 72



Time of Concentration (Tc) or (Tt) Calculations

Project: Marple Associates, LP
Marple Township, Delaware County, PA

Date: 12/18/2017
 Prepared By: MAR
 Checked By: RTW

Condition: Pre-Development
 Watershed: E-1

Note: Space for as many as three segments per flow type can be used for each worksheet.

Sheet Flow (Applicable to Tc only)

Segment ID	AB	BC	
1. Surface Description (table 3-1)	Dense grasses	Dense grasses	
2. Manning's roughness coeff., n (table 3-1)	0.240	0.240	
3. Flow length, L (total L ≤ 150 ft)	ft 20	60	
4. Two-yr 24-hr rainfall, P ₂	in 3.26	3.26	
5. Land slope, s*	ft/ft 0.4000	0.0909	
6. Tt = 0.007(nL) ^{0.8} / P ₂ ^{0.5} s ^{0.4}	Compute Tt hr 0.0196	+ 0.0855	+ = 0.1051
*S is averaged			

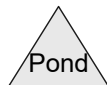
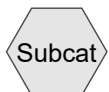
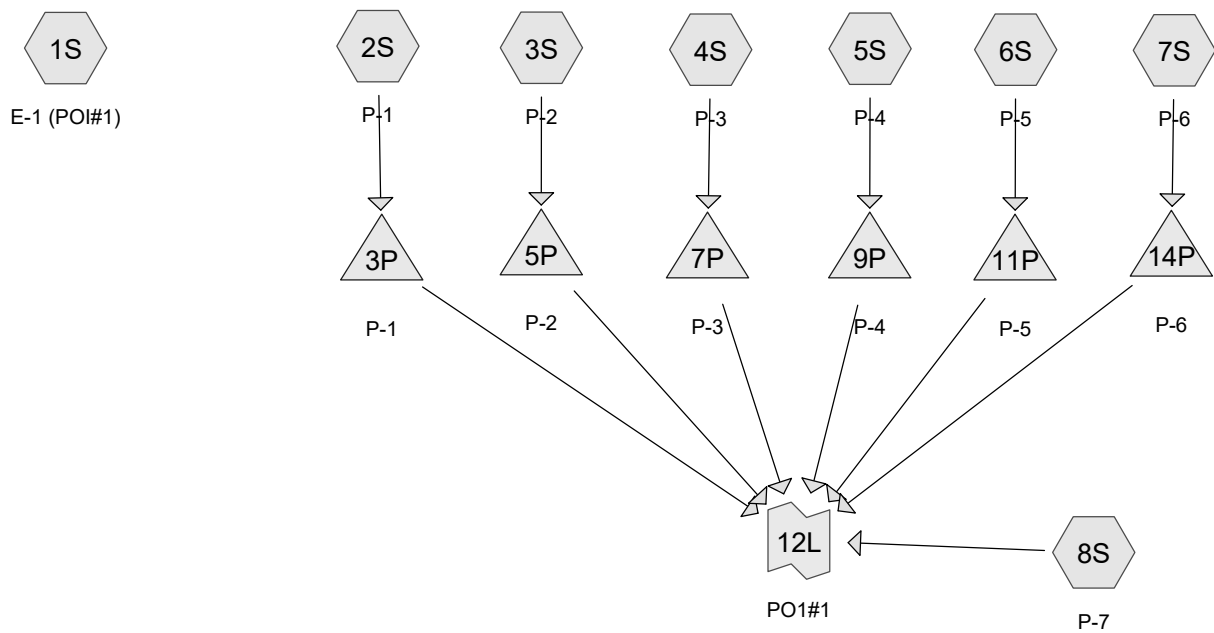
Shallow Concentrated Flow

Segment ID	CD	DE	EF
7. Surface Description (paved or unpaved)	Unpaved	Unpaved	Unpaved
8. Flow length, L	ft 169	502	743
9. Watercourse slope, s*	ft/ft 0.1124	0.0217	0.1100
10. Average velocity, V	ft/sec 5.41	2.38	5.35
11. Tt = L / 3600V	0.0087	+ 0.0586	+ 0.0386 = 0.1059

Channel Flow

Segment ID	FG		
12. Cross sectional flow area, a	ft ² 8.00		
13. Wetted perimeter, p	ft 11.32		
14. Hydraulic radius, r = a/wp	ft 0.7064		
15. Channel Slope, s	ft/ft 0.0150		
16. Manning's roughness coeff., n	0.035		
17. V = 1.49r ^{2/3} s ^{1/2} / n	4.1356		
18. Flow length, L	ft 37		
19. Tt = L / 3600V	0.0025	+	+ = 0.0025
20. Watershed or subarea T _c or T _t (add T _t in steps 6,11, and 19)			0.2134

Tc = **12.81** minutes



Routing Diagram for routings
 Prepared by {enter your company name here}, Printed 12/18/2017
 HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

routings*Type II 24-hr 1-YR Rainfall=2.71"*

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 2

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: E-1 (POI#1)	Runoff Area=15.860 ac 0.00% Impervious Runoff Depth=0.21" Tc=12.8 min CN=59 Runoff=1.85 cfs 0.279 af
Subcatchment2S: P-1	Runoff Area=3.230 ac 0.00% Impervious Runoff Depth=2.07" Tc=5.0 min CN=94 Runoff=11.56 cfs 0.557 af
Subcatchment3S: P-2	Runoff Area=2.740 ac 0.00% Impervious Runoff Depth=2.37" Tc=5.0 min CN=97 Runoff=10.60 cfs 0.541 af
Subcatchment4S: P-3	Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=2.48" Tc=5.0 min CN=98 Runoff=14.61 cfs 0.767 af
Subcatchment5S: P-4	Runoff Area=2.100 ac 0.00% Impervious Runoff Depth=1.56" Tc=5.0 min CN=88 Runoff=6.01 cfs 0.274 af
Subcatchment6S: P-5	Runoff Area=1.470 ac 0.00% Impervious Runoff Depth=1.89" Tc=5.0 min CN=92 Runoff=4.92 cfs 0.231 af
Subcatchment7S: P-6	Runoff Area=1.790 ac 0.00% Impervious Runoff Depth=1.80" Tc=5.0 min CN=91 Runoff=5.78 cfs 0.269 af
Subcatchment8S: P-7	Runoff Area=0.820 ac 0.00% Impervious Runoff Depth=0.64" Tc=10.0 min CN=72 Runoff=0.75 cfs 0.044 af
Pond 3P: P-1	Peak Elev=242.06' Storage=0.345 af Inflow=11.56 cfs 0.557 af Discarded=0.20 cfs 0.557 af Primary=0.00 cfs 0.000 af Outflow=0.20 cfs 0.557 af
Pond 5P: P-2	Peak Elev=255.21' Storage=0.334 af Inflow=10.60 cfs 0.541 af Discarded=0.17 cfs 0.541 af Primary=0.00 cfs 0.000 af Outflow=0.17 cfs 0.541 af
Pond 7P: P-3	Peak Elev=257.17' Storage=0.463 af Inflow=14.61 cfs 0.767 af Discarded=0.25 cfs 0.767 af Primary=0.00 cfs 0.000 af Outflow=0.25 cfs 0.767 af
Pond 9P: P-4	Peak Elev=258.62' Storage=0.158 af Inflow=6.01 cfs 0.274 af Discarded=0.14 cfs 0.274 af Primary=0.00 cfs 0.000 af Outflow=0.14 cfs 0.274 af
Pond 11P: P-5	Peak Elev=258.91' Storage=0.141 af Inflow=4.92 cfs 0.231 af Discarded=0.09 cfs 0.231 af Primary=0.00 cfs 0.000 af Outflow=0.09 cfs 0.231 af
Pond 14P: P-6	Peak Elev=251.52' Storage=0.147 af Inflow=5.78 cfs 0.269 af Outflow=0.28 cfs 0.269 af
Link 12L: PO1#1	Inflow=1.00 cfs 0.313 af Primary=1.00 cfs 0.313 af

Total Runoff Area = 31.720 ac Runoff Volume = 2.961 af Average Runoff Depth = 1.12"
88.30% Pervious = 28.010 ac 11.70% Impervious = 3.710 ac

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 1-YR Rainfall=2.71"

Printed 12/18/2017

Page 3

Summary for Subcatchment 1S: E-1 (POI#1)

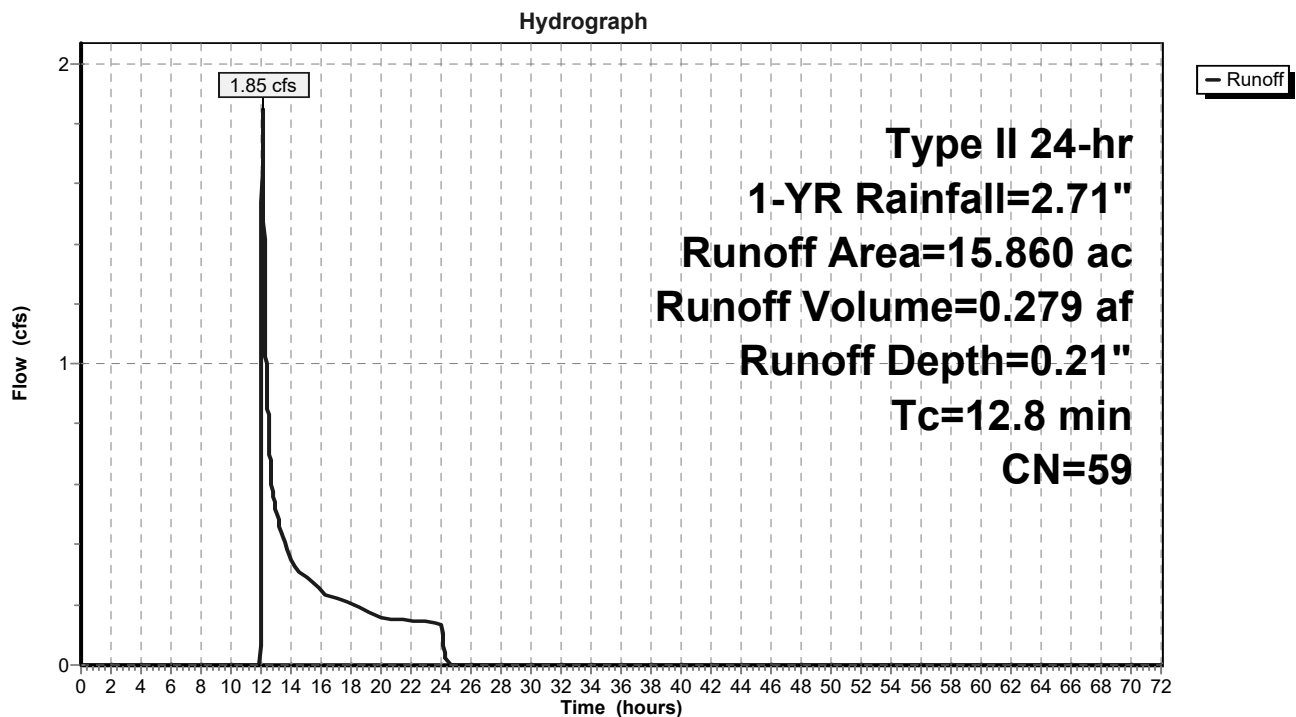
Runoff = 1.85 cfs @ 12.11 hrs, Volume= 0.279 af, Depth= 0.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 1-YR Rainfall=2.71"

Area (ac)	CN	Description
* 15.860	59	SEE CN WORKSHEETS
15.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.8					Direct Entry,

Subcatchment 1S: E-1 (POI#1)



routings*Type II 24-hr 2-YR Rainfall=3.26"*

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 24

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: E-1 (POI#1)	Runoff Area=15.860 ac 0.00% Impervious Runoff Depth=0.40" Tc=12.8 min CN=59 Runoff=5.65 cfs 0.524 af
Subcatchment2S: P-1	Runoff Area=3.230 ac 0.00% Impervious Runoff Depth=2.60" Tc=5.0 min CN=94 Runoff=14.31 cfs 0.700 af
Subcatchment3S: P-2	Runoff Area=2.740 ac 0.00% Impervious Runoff Depth=2.92" Tc=5.0 min CN=97 Runoff=12.87 cfs 0.666 af
Subcatchment4S: P-3	Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=3.03" Tc=5.0 min CN=98 Runoff=17.66 cfs 0.936 af
Subcatchment5S: P-4	Runoff Area=2.100 ac 0.00% Impervious Runoff Depth=2.05" Tc=5.0 min CN=88 Runoff=7.79 cfs 0.359 af
Subcatchment6S: P-5	Runoff Area=1.470 ac 0.00% Impervious Runoff Depth=2.41" Tc=5.0 min CN=92 Runoff=6.18 cfs 0.295 af
Subcatchment7S: P-6	Runoff Area=1.790 ac 0.00% Impervious Runoff Depth=2.31" Tc=5.0 min CN=91 Runoff=7.32 cfs 0.345 af
Subcatchment8S: P-7	Runoff Area=0.820 ac 0.00% Impervious Runoff Depth=0.97" Tc=10.0 min CN=72 Runoff=1.18 cfs 0.066 af
Pond 3P: P-1	Peak Elev=242.44' Storage=0.457 af Inflow=14.31 cfs 0.700 af Discarded=0.20 cfs 0.700 af Primary=0.00 cfs 0.000 af Outflow=0.20 cfs 0.700 af
Pond 5P: P-2	Peak Elev=255.60' Storage=0.433 af Inflow=12.87 cfs 0.666 af Discarded=0.17 cfs 0.666 af Primary=0.00 cfs 0.000 af Outflow=0.17 cfs 0.666 af
Pond 7P: P-3	Peak Elev=257.53' Storage=0.594 af Inflow=17.66 cfs 0.936 af Discarded=0.25 cfs 0.936 af Primary=0.00 cfs 0.000 af Outflow=0.25 cfs 0.936 af
Pond 9P: P-4	Peak Elev=258.95' Storage=0.222 af Inflow=7.79 cfs 0.359 af Discarded=0.14 cfs 0.359 af Primary=0.00 cfs 0.000 af Outflow=0.14 cfs 0.359 af
Pond 11P: P-5	Peak Elev=259.28' Storage=0.191 af Inflow=6.18 cfs 0.295 af Discarded=0.09 cfs 0.295 af Primary=0.00 cfs 0.000 af Outflow=0.09 cfs 0.295 af
Pond 14P: P-6	Peak Elev=251.95' Storage=0.194 af Inflow=7.32 cfs 0.345 af Outflow=0.32 cfs 0.345 af
Link 12L: PO1#1	Inflow=1.47 cfs 0.411 af Primary=1.47 cfs 0.411 af

Total Runoff Area = 31.720 ac Runoff Volume = 3.892 af Average Runoff Depth = 1.47"
88.30% Pervious = 28.010 ac 11.70% Impervious = 3.710 ac

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 25

Summary for Subcatchment 1S: E-1 (POI#1)

Runoff = 5.65 cfs @ 12.09 hrs, Volume= 0.524 af, Depth= 0.40"

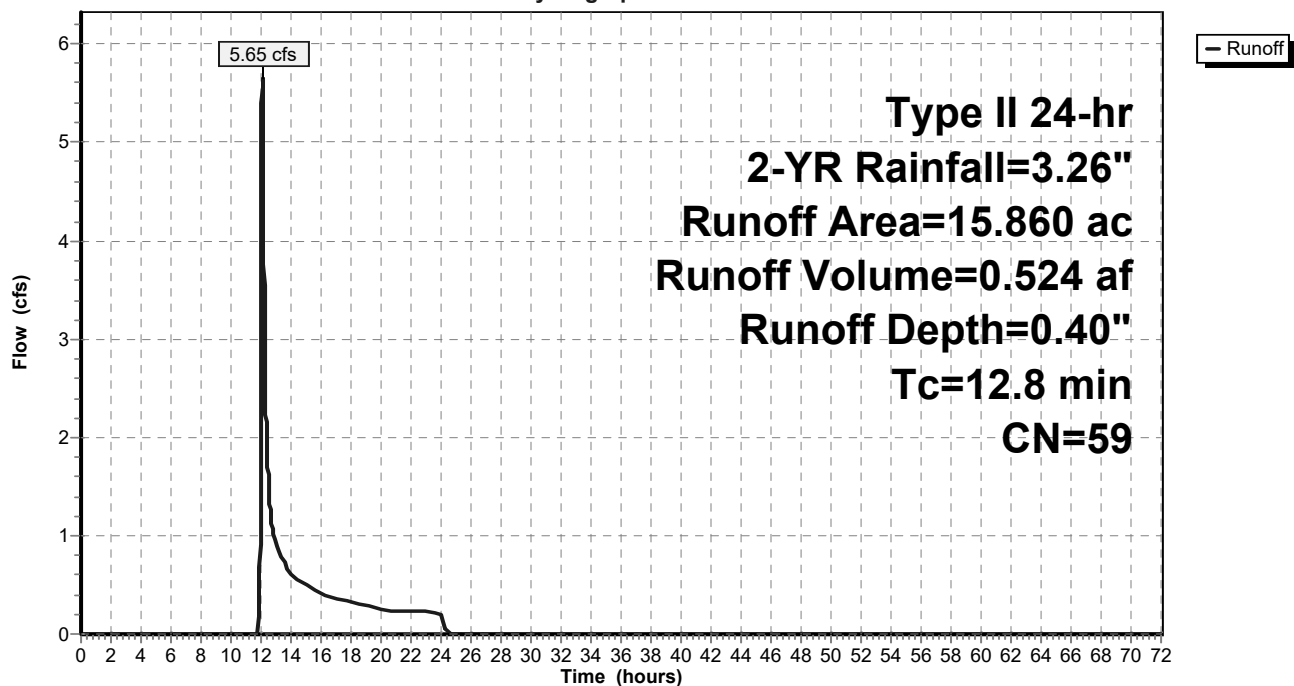
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-YR Rainfall=3.26"

Area (ac)	CN	Description
* 15.860	59	SEE CN WORKSHEETS
15.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.8					Direct Entry,

Subcatchment 1S: E-1 (POI#1)

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 26

Summary for Subcatchment 2S: P-1

Runoff = 14.31 cfs @ 11.96 hrs, Volume= 0.700 af, Depth= 2.60"

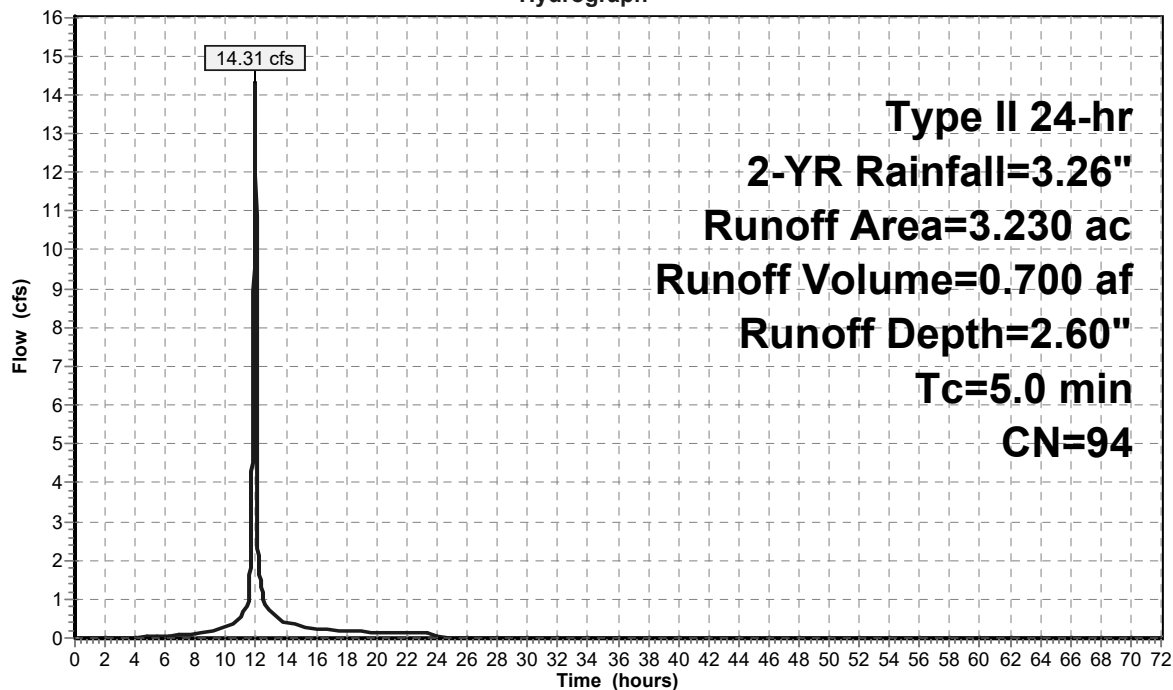
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-YR Rainfall=3.26"

Area (ac)	CN	Description
* 3.230	94	SEE CN WORKSHEETS
3.230		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 2S: P-1

Hydrograph



Runoff

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 27

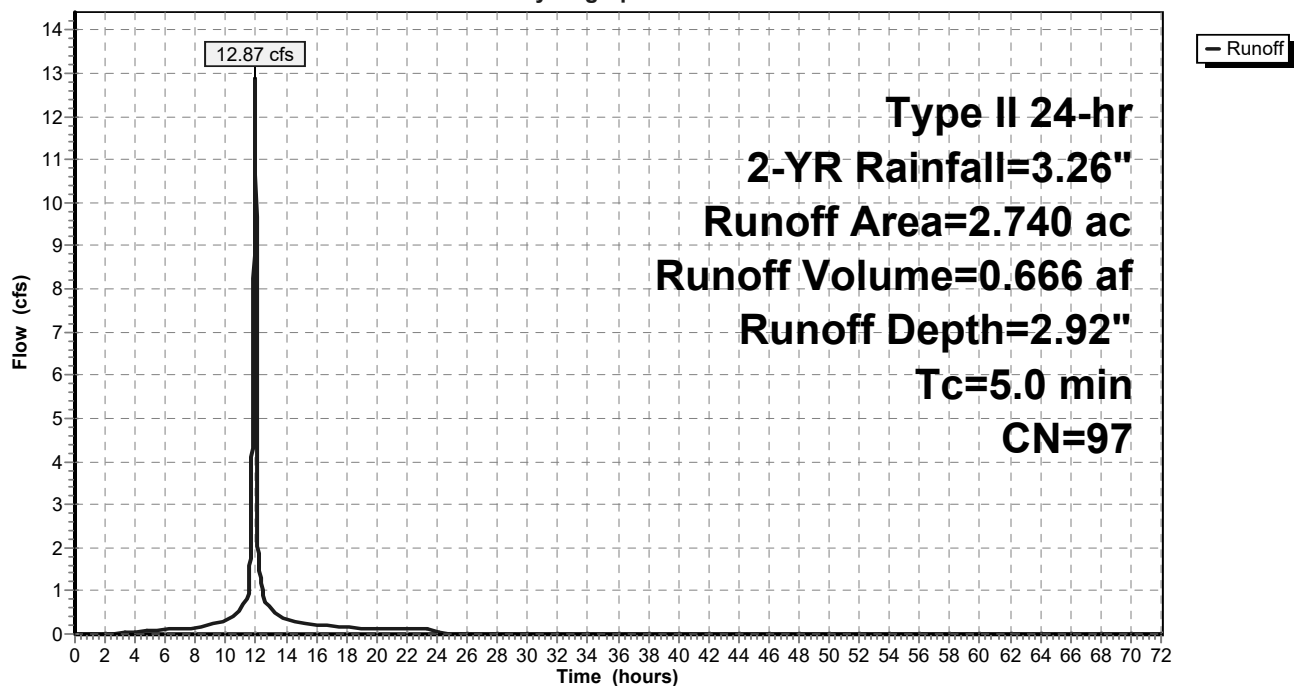
Runoff = 12.87 cfs @ 11.96 hrs, Volume= 0.666 af, Depth= 2.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-YR Rainfall=3.26"

Area (ac)	CN	Description
* 2.740	97	SEE CN WORKSHEETS
2.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 28

Summary for Subcatchment 4S: P-3

Runoff = 17.66 cfs @ 11.96 hrs, Volume= 0.936 af, Depth= 3.03"

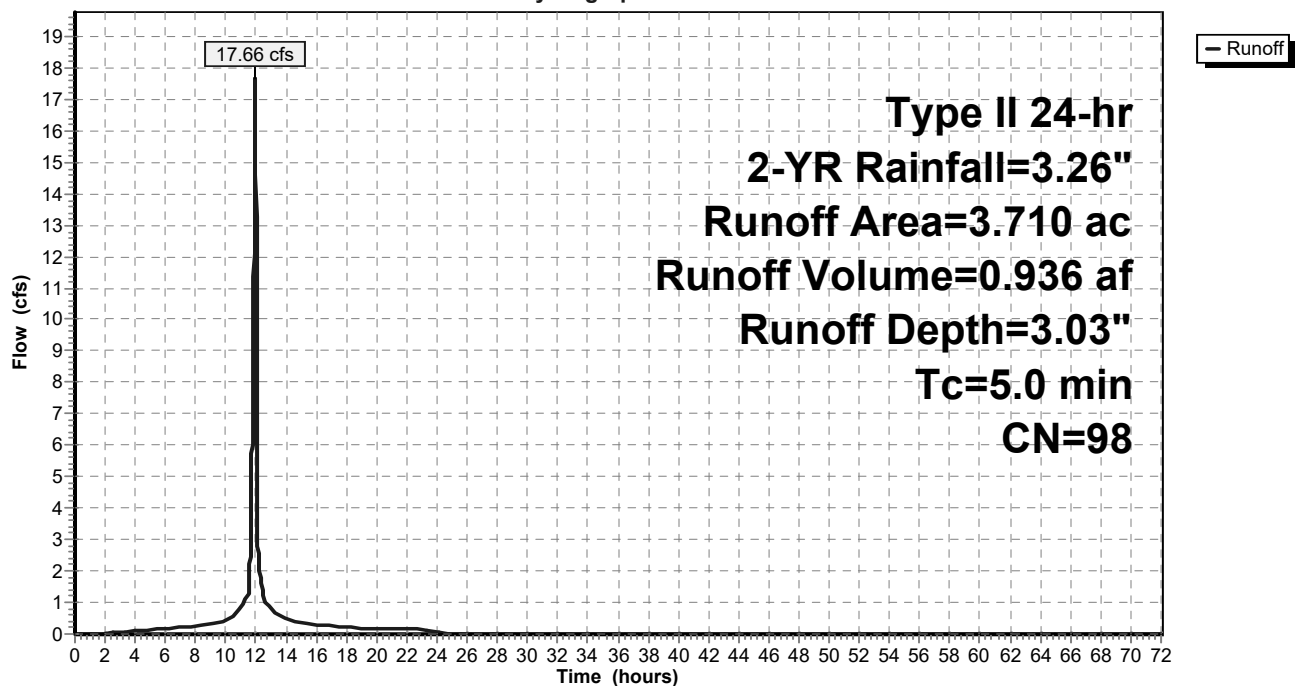
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-YR Rainfall=3.26"

Area (ac)	CN	Description
* 3.710	98	SEE CN WORKSHEETS
3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 4S: P-3

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 29

Summary for Subcatchment 5S: P-4

Runoff = 7.79 cfs @ 11.96 hrs, Volume= 0.359 af, Depth= 2.05"

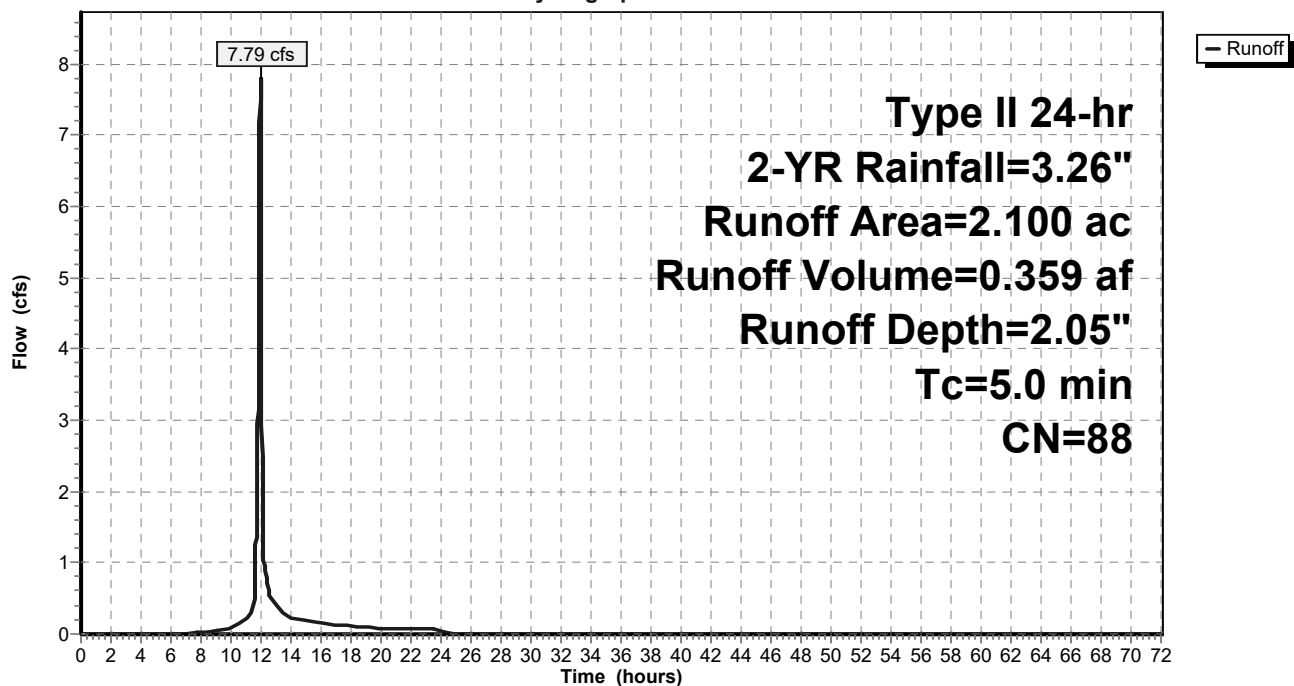
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-YR Rainfall=3.26"

Area (ac)	CN	Description
* 2.100	88	SEE CN WORKSHEETS
2.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 5S: P-4

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 30

Summary for Subcatchment 6S: P-5

Runoff = 6.18 cfs @ 11.96 hrs, Volume= 0.295 af, Depth= 2.41"

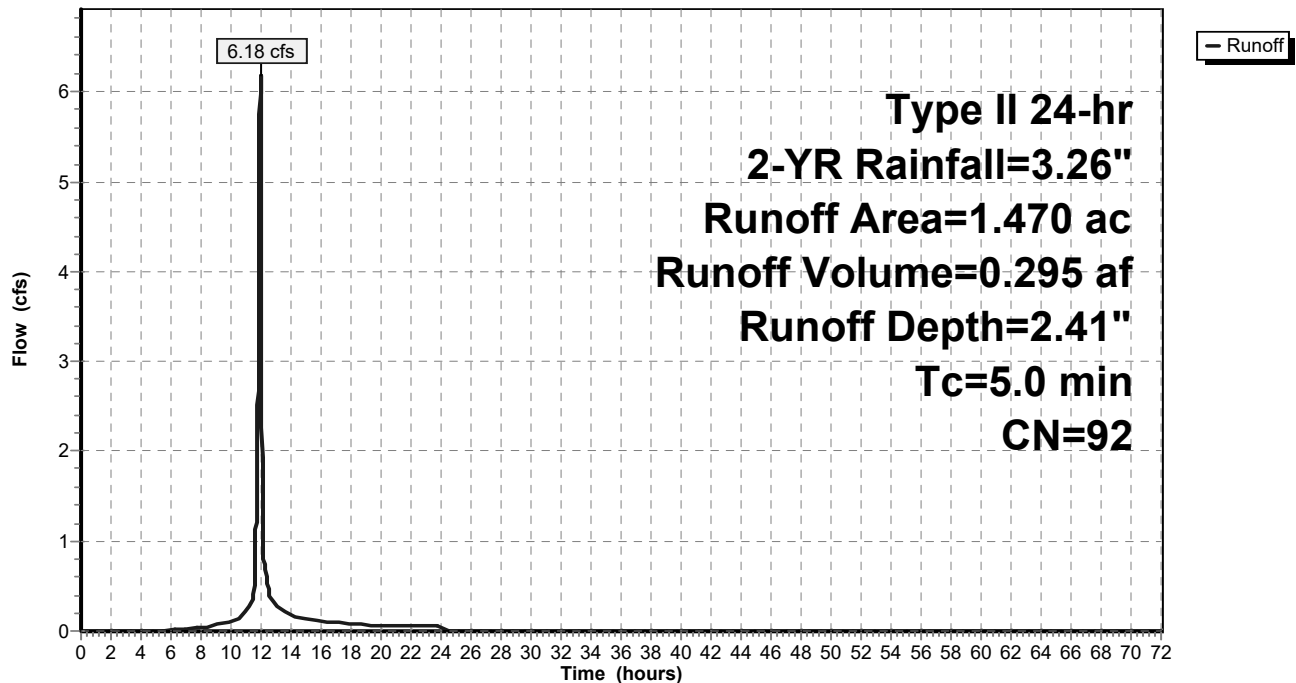
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-YR Rainfall=3.26"

Area (ac)	CN	Description
* 1.470	92	SEE CN WORKSHEETS
1.470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 6S: P-5

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 31

Summary for Subcatchment 7S: P-6

Runoff = 7.32 cfs @ 11.96 hrs, Volume= 0.345 af, Depth= 2.31"

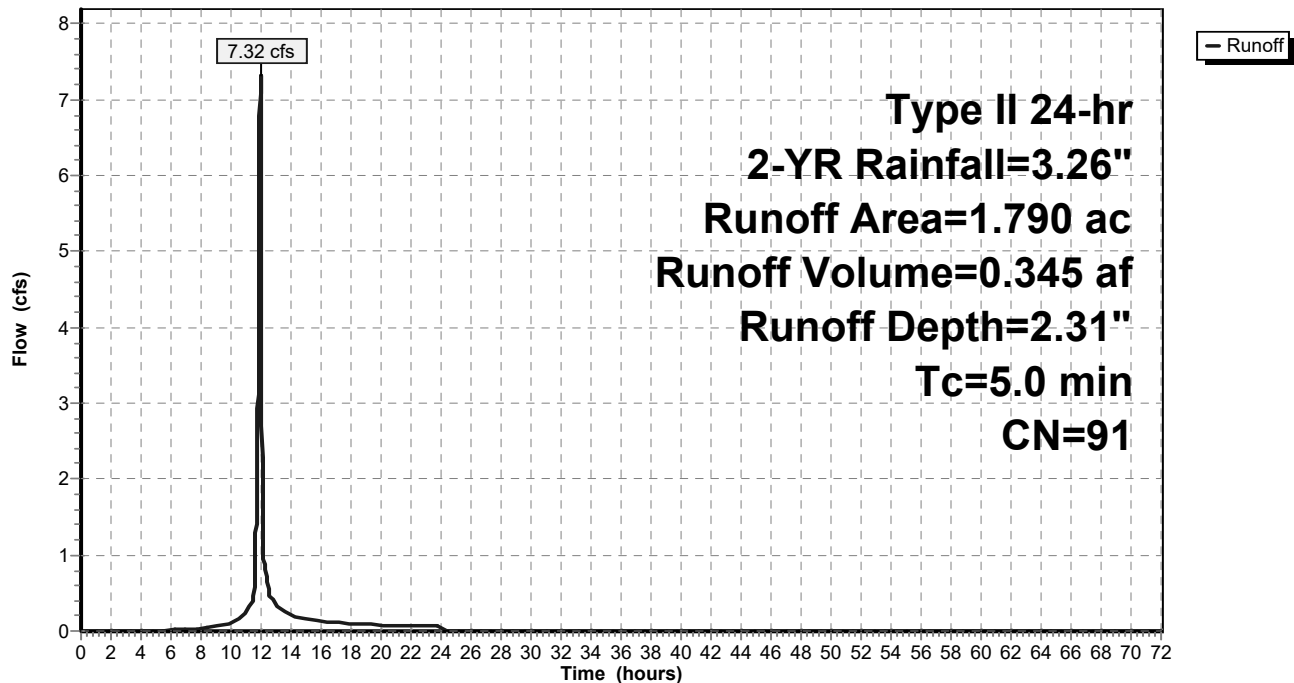
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-YR Rainfall=3.26"

Area (ac)	CN	Description
* 1.790	91	SEE CN WORKSHEETS
1.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 7S: P-6

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 32

Summary for Subcatchment 8S: P-7

Runoff = 1.18 cfs @ 12.03 hrs, Volume= 0.066 af, Depth= 0.97"

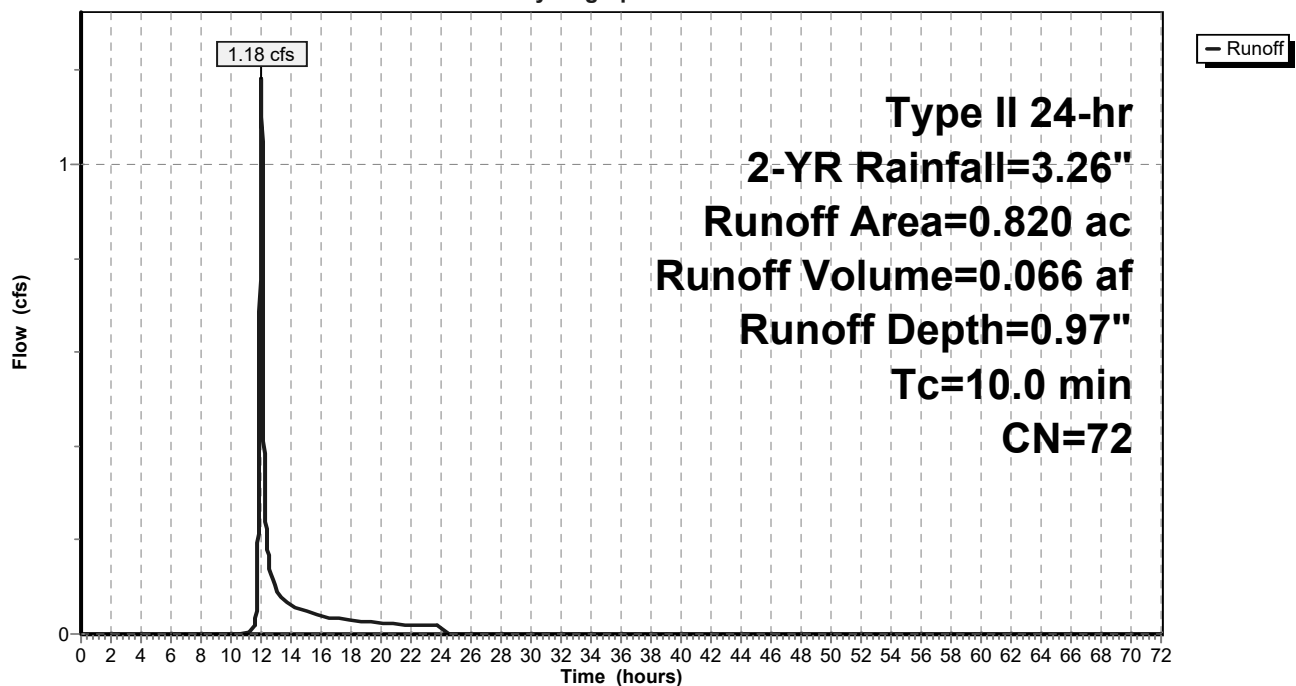
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 2-YR Rainfall=3.26"

Area (ac)	CN	Description
* 0.820	72	SEE CN WORKSHEETS
0.820		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry,

Subcatchment 8S: P-7

Hydrograph



routings

Type II 24-hr 2-YR Rainfall=3.26"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 33

Summary for Pond 3P: P-1

Inflow Area = 3.230 ac, 0.00% Impervious, Inflow Depth = 2.60" for 2-YR event
Inflow = 14.31 cfs @ 11.96 hrs, Volume= 0.700 af
Outflow = 0.20 cfs @ 9.71 hrs, Volume= 0.700 af, Atten= 99%, Lag= 0.0 min
Discarded = 0.20 cfs @ 9.71 hrs, Volume= 0.700 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 242.44' @ 17.45 hrs Surf.Area= 0.398 ac Storage= 0.457 af

Plug-Flow detention time= 929.2 min calculated for 0.700 af (100% of inflow)
Center-of-Mass det. time= 929.3 min (1,711.6 - 782.3)

Volume	Invert	Avail.Storage	Storage Description
#1	240.50'	0.462 af	6.00'W x 2,892.00'L x 4.50'H Stone 1.793 af Overall - 0.639 af Embedded = 1.154 af x 40.0% Voids
#2	241.00'	0.639 af	42.0" Round Pipe Storage Inside #1 L= 2,892.0'
		1.100 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	241.00'	18.0" Round Culvert L= 15.9' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 241.00' / 240.90' S= 0.0063 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	240.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	242.45'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.20 cfs @ 9.71 hrs HW=240.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.20 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=240.50' (Free Discharge)
↑**1=Culvert** (Controls 0.00 cfs)
↑**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

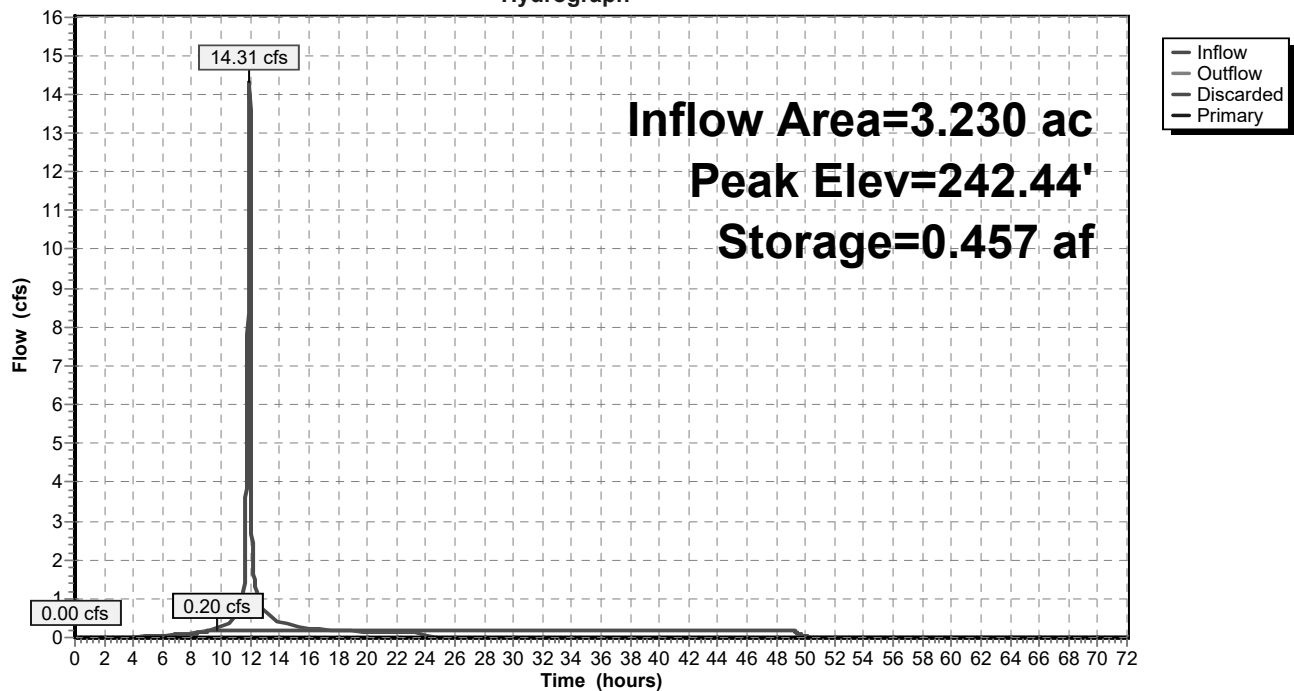
Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 34

Pond 3P: P-1

Hydrograph



routings

Type II 24-hr 2-YR Rainfall=3.26"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 35

Summary for Pond 5P: P-2

Inflow Area = 2.740 ac, 0.00% Impervious, Inflow Depth = 2.92" for 2-YR event
Inflow = 12.87 cfs @ 11.96 hrs, Volume= 0.666 af
Outflow = 0.17 cfs @ 8.69 hrs, Volume= 0.666 af, Atten= 99%, Lag= 0.0 min
Discarded = 0.17 cfs @ 8.69 hrs, Volume= 0.666 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 255.60' @ 17.56 hrs Surf.Area= 0.341 ac Storage= 0.433 af

Plug-Flow detention time= 986.6 min calculated for 0.666 af (100% of inflow)
Center-of-Mass det. time= 986.7 min (1,747.7 - 760.9)

Volume	Invert	Avail.Storage	Storage Description
#1	253.50'	0.396 af	6.00'W x 2,479.00'L x 4.50'H Stone 1.537 af Overall - 0.548 af Embedded = 0.989 af x 40.0% Voids
#2	254.00'	0.548 af	42.0" Round Pipe Storage Inside #1 L= 2,479.0'
		0.943 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	254.00'	18.0" Round Culvert L= 16.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 254.00' / 253.80' S= 0.0125 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	253.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	255.65'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.17 cfs @ 8.69 hrs HW=253.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.17 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=253.50' (Free Discharge)
↑**1=Culvert** (Controls 0.00 cfs)
↑**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

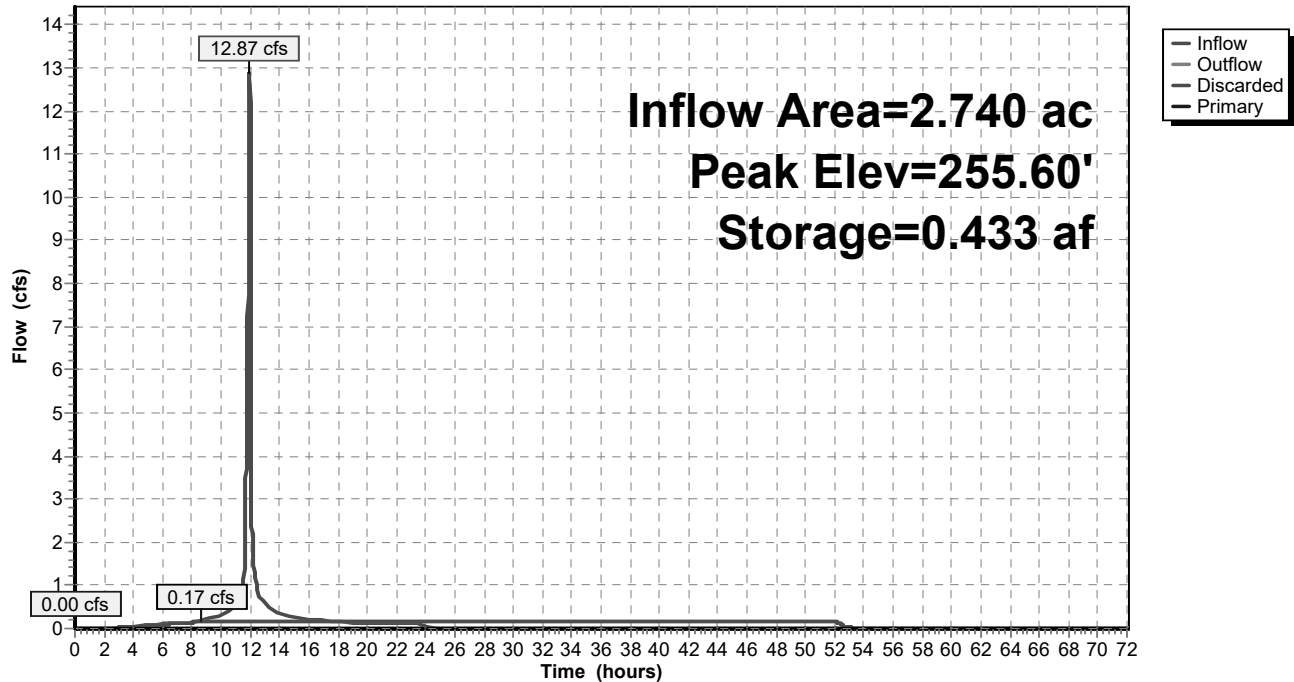
Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 36

Pond 5P: P-2

Hydrograph



routings

Type II 24-hr 2-YR Rainfall=3.26"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 37

Summary for Pond 7P: P-3

Inflow Area = 3.710 ac, 100.00% Impervious, Inflow Depth = 3.03" for 2-YR event
Inflow = 17.66 cfs @ 11.96 hrs, Volume= 0.936 af
Outflow = 0.25 cfs @ 8.52 hrs, Volume= 0.936 af, Atten= 99%, Lag= 0.0 min
Discarded = 0.25 cfs @ 8.52 hrs, Volume= 0.936 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 257.53' @ 17.18 hrs Surf.Area= 0.488 ac Storage= 0.594 af

Plug-Flow detention time= 934.7 min calculated for 0.936 af (100% of inflow)
Center-of-Mass det. time= 934.8 min (1,686.0 - 751.2)

Volume	Invert	Avail.Storage	Storage Description
#1	255.50'	0.565 af	6.00'W x 3,541.00'L x 4.50'H Stone 2.195 af Overall - 0.782 af Embedded = 1.413 af x 40.0% Voids
#2	256.00'	0.782 af	42.0" Round Pipe Storage Inside #1 L= 3,541.0'
		1.347 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	256.00'	18.0" Round Culvert L= 33.4' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 256.00' / 255.70' S= 0.0090 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	255.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	257.60'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.25 cfs @ 8.52 hrs HW=255.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.25 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=255.50' (Free Discharge)
↑**1=Culvert** (Controls 0.00 cfs)
↑**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

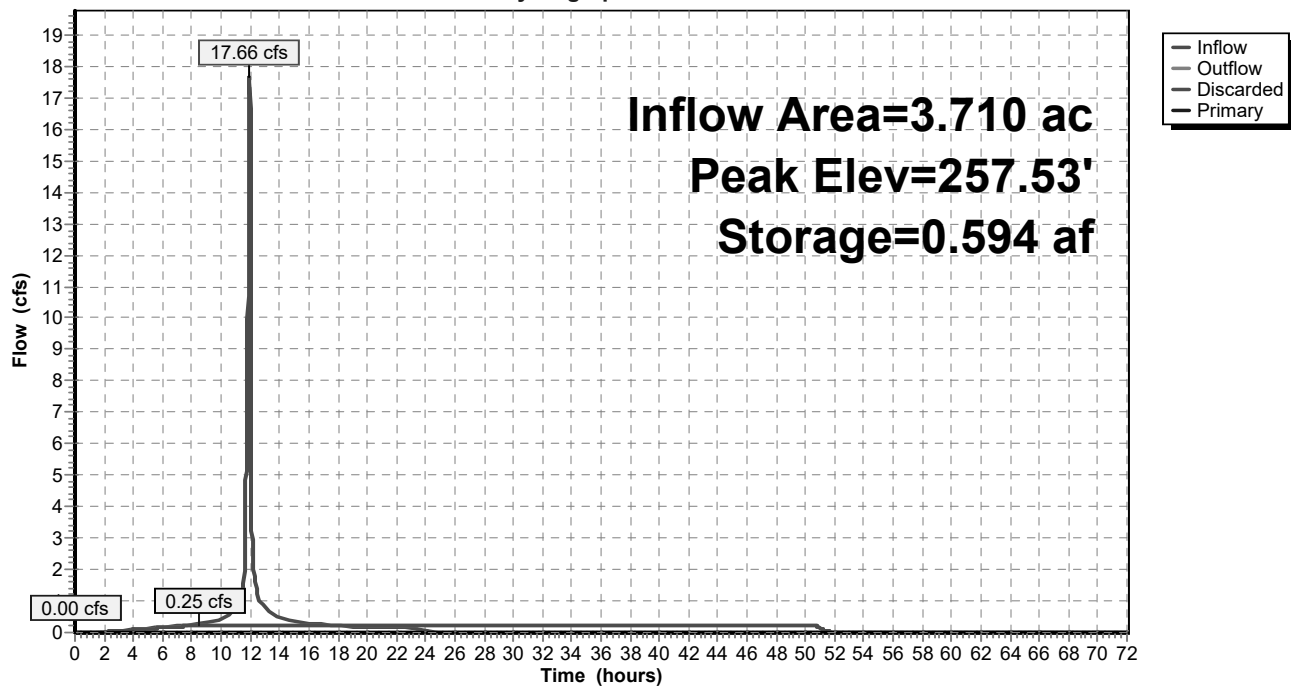
Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 38

Pond 7P: P-3

Hydrograph



routings

Type II 24-hr 2-YR Rainfall=3.26"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 39

Summary for Pond 9P: P-4

Inflow Area = 2.100 ac, 0.00% Impervious, Inflow Depth = 2.05" for 2-YR event
 Inflow = 7.79 cfs @ 11.96 hrs, Volume= 0.359 af
 Outflow = 0.14 cfs @ 10.83 hrs, Volume= 0.359 af, Atten= 98%, Lag= 0.0 min
 Discarded = 0.14 cfs @ 10.83 hrs, Volume= 0.359 af
 Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 Peak Elev= 258.95' @ 16.07 hrs Surf.Area= 0.279 ac Storage= 0.222 af

Plug-Flow detention time= 689.5 min calculated for 0.359 af (100% of inflow)
 Center-of-Mass det. time= 689.5 min (1,499.8 - 810.3)

Volume	Invert	Avail.Storage	Storage Description
#1	257.50'	0.189 af	87.00'W x 96.00'L x 3.50'H Stone 0.671 af Overall - 0.199 af Embedded = 0.472 af x 40.0% Voids
#2	258.00'	0.199 af	30.0" Round Pipe Storage x 19 Inside #1 L= 93.0'
#3	257.50'	0.053 af	31.50'W x 74.00'L x 3.50'H Stone 0.187 af Overall - 0.056 af Embedded = 0.131 af x 40.0% Voids
#4	258.00'	0.056 af	30.0" Round Pipe Storage x 7 Inside #3 L= 71.0'
#5	257.50'	0.033 af	31.50'W x 46.00'L x 3.50'H Stone 0.116 af Overall - 0.034 af Embedded = 0.083 af x 40.0% Voids
#6	258.00'	0.034 af	30.0" Round Pipe Storage x 7 Inside #5 L= 43.0'
		0.563 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	256.40'	18.0" Round Culvert L= 20.4' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 256.40' / 256.20' S= 0.0098 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	257.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	259.00'	0.6' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.14 cfs @ 10.83 hrs HW=257.54' (Free Discharge)

↑**2=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=257.50' (Free Discharge)

↑**1=Culvert** (Passes 0.00 cfs of 4.11 cfs potential flow)

↑**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

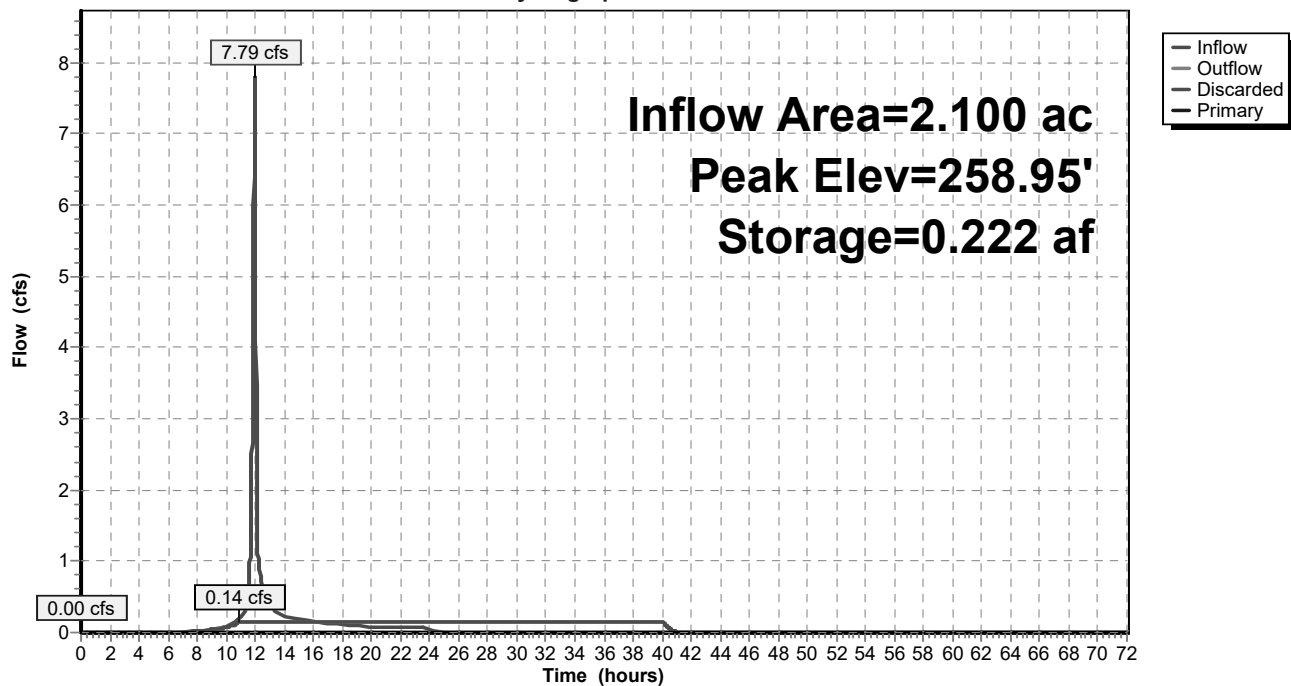
Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 40

Pond 9P: P-4

Hydrograph



routings

Type II 24-hr 2-YR Rainfall=3.26"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 41

Summary for Pond 11P: P-5

Inflow Area = 1.470 ac, 0.00% Impervious, Inflow Depth = 2.41" for 2-YR event
Inflow = 6.18 cfs @ 11.96 hrs, Volume= 0.295 af
Outflow = 0.09 cfs @ 10.14 hrs, Volume= 0.295 af, Atten= 99%, Lag= 0.0 min
Discarded = 0.09 cfs @ 10.14 hrs, Volume= 0.295 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 259.28' @ 17.25 hrs Surf.Area= 0.182 ac Storage= 0.191 af

Plug-Flow detention time= 868.5 min calculated for 0.295 af (100% of inflow)
Center-of-Mass det. time= 868.6 min (1,661.6 - 793.0)

Volume	Invert	Avail.Storage	Storage Description
#1	257.50'	0.175 af	4.50'W x 1,757.00'L x 3.50'H Stone 0.635 af Overall - 0.198 af Embedded = 0.437 af x 40.0% Voids
#2	258.00'	0.198 af	30.0" Round Pipe Storage Inside #1 L= 1,757.0'
		0.373 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	258.00'	18.0" Round Culvert L= 40.8' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 258.00' / 257.50' S= 0.0123 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	257.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	259.30'	1.3' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.09 cfs @ 10.14 hrs HW=257.54' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.09 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=257.50' (Free Discharge)
↑**1=Culvert** (Controls 0.00 cfs)
↑**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

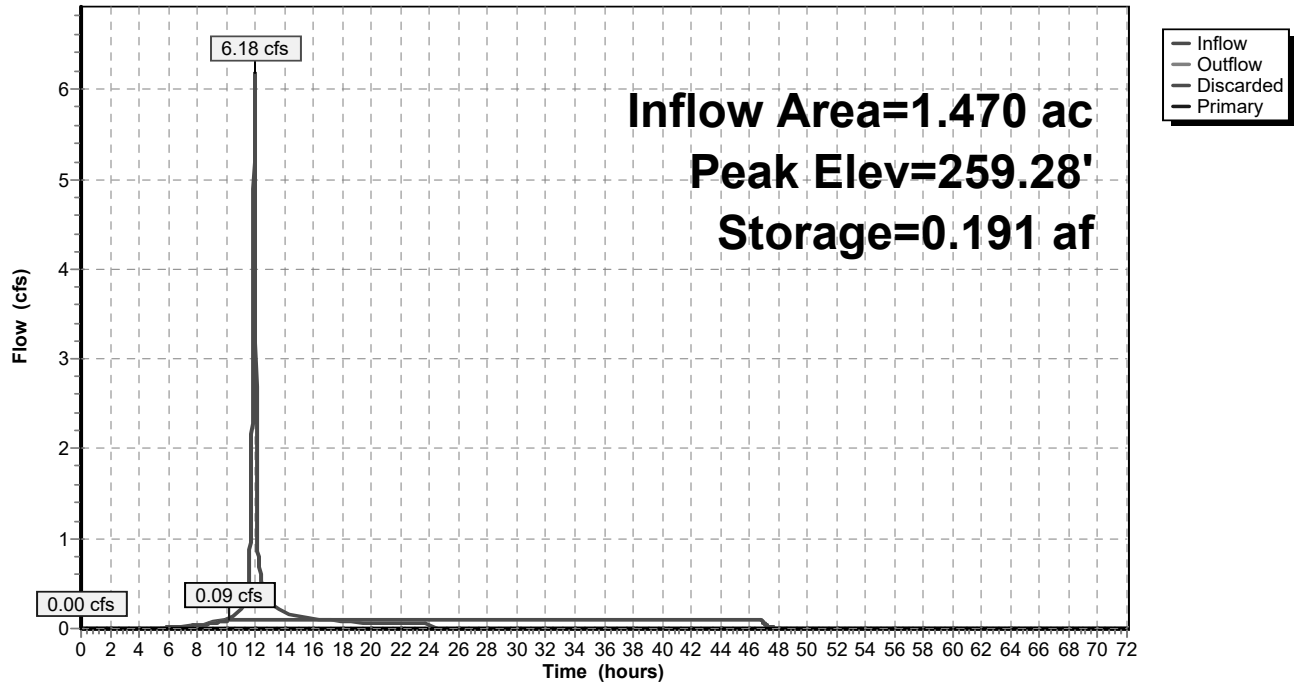
Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 42

Pond 11P: P-5

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 43

Summary for Pond 14P: P-6

Inflow Area = 1.790 ac, 0.00% Impervious, Inflow Depth = 2.31" for 2-YR event
Inflow = 7.32 cfs @ 11.96 hrs, Volume= 0.345 af
Outflow = 0.32 cfs @ 13.13 hrs, Volume= 0.345 af, Atten= 96%, Lag= 70.5 min
Primary = 0.32 cfs @ 13.13 hrs, Volume= 0.345 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 251.95' @ 13.13 hrs Surf.Area= 0.150 ac Storage= 0.194 af

Plug-Flow detention time= 336.2 min calculated for 0.345 af (100% of inflow)
Center-of-Mass det. time= 336.4 min (1,134.2 - 797.7)

Volume	Invert	Avail.Storage	Storage Description
#1	250.00'	0.165 af	28.00'W x 234.00'L x 4.50'H Stone 0.677 af Overall - 0.265 af Embedded = 0.411 af x 40.0% Voids
#2	250.00'	0.265 af	48.0" Round Pipe Storage x 4 Inside #1 L= 230.0'
		0.430 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	250.00'	18.0" Round Culvert L= 33.7' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 250.00' / 249.80' S= 0.0059 ' /' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	250.00'	3.0" Vert. Orifice/Grate C= 0.600
#3	Device 1	252.25'	1.2' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=0.32 cfs @ 13.13 hrs HW=251.95' (Free Discharge)

- 1=Culvert (Passes 0.32 cfs of 8.33 cfs potential flow)
- 2=Orifice/Grate (Orifice Controls 0.32 cfs @ 6.50 fps)
- 3=Sharp-Crested Rectangular Weir (Controls 0.00 cfs)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

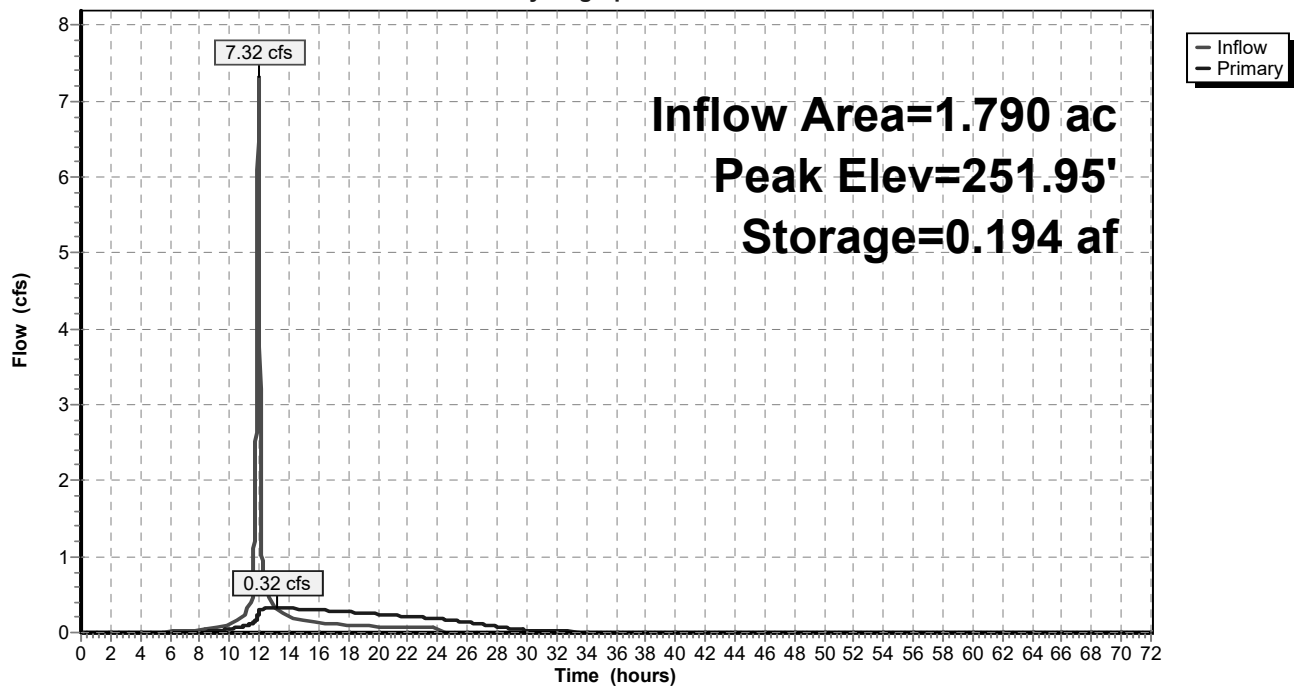
Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 44

Pond 14P: P-6

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 2-YR Rainfall=3.26"

Printed 12/18/2017

Page 45

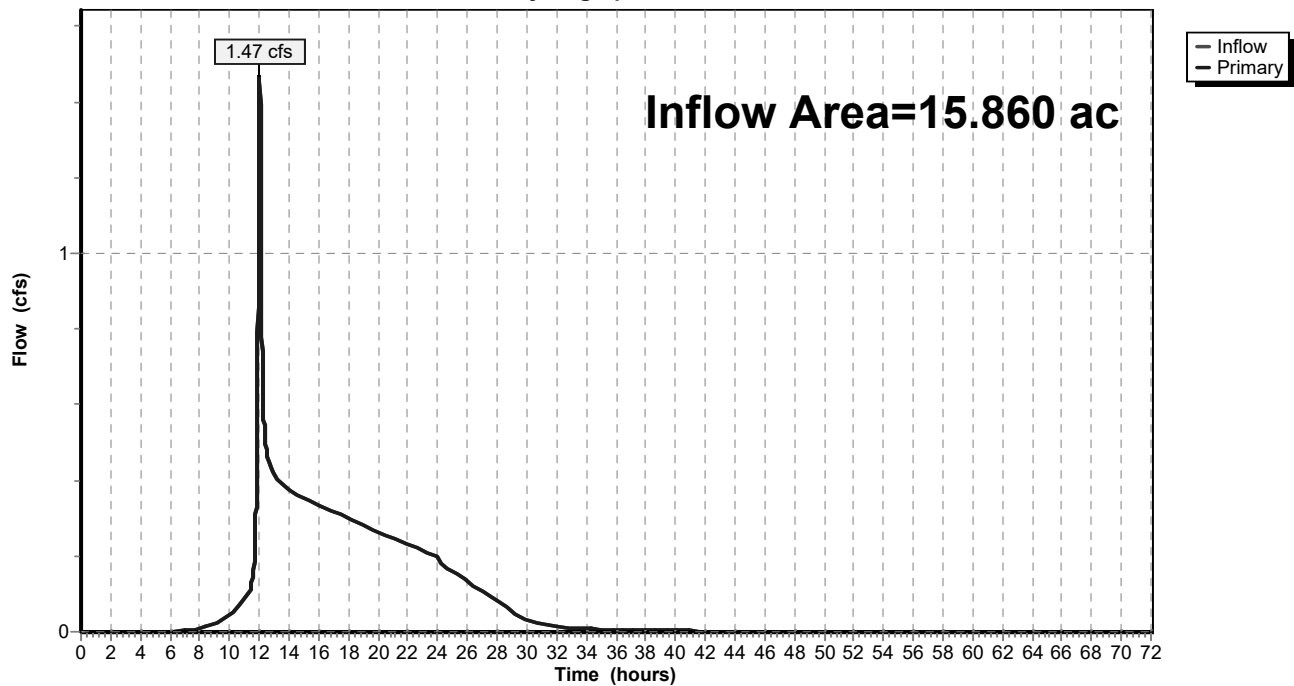
Summary for Link 12L: PO1#1

Inflow Area = 15.860 ac, 23.39% Impervious, Inflow Depth = 0.31" for 2-YR event
Inflow = 1.47 cfs @ 12.03 hrs, Volume= 0.411 af
Primary = 1.47 cfs @ 12.03 hrs, Volume= 0.411 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 12L: PO1#1

Hydrograph



routings*Type II 24-hr 5-YR Rainfall=4.11"*

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 46

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: E-1 (PO1#1)	Runoff Area=15.860 ac 0.00% Impervious Runoff Depth=0.77" Tc=12.8 min CN=59 Runoff=14.09 cfs 1.011 af
Subcatchment2S: P-1	Runoff Area=3.230 ac 0.00% Impervious Runoff Depth=3.43" Tc=5.0 min CN=94 Runoff=18.52 cfs 0.924 af
Subcatchment3S: P-2	Runoff Area=2.740 ac 0.00% Impervious Runoff Depth=3.76" Tc=5.0 min CN=97 Runoff=16.36 cfs 0.859 af
Subcatchment4S: P-3	Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=3.87" Tc=5.0 min CN=98 Runoff=22.35 cfs 1.198 af
Subcatchment5S: P-4	Runoff Area=2.100 ac 0.00% Impervious Runoff Depth=2.83" Tc=5.0 min CN=88 Runoff=10.57 cfs 0.495 af
Subcatchment6S: P-5	Runoff Area=1.470 ac 0.00% Impervious Runoff Depth=3.22" Tc=5.0 min CN=92 Runoff=8.12 cfs 0.395 af
Subcatchment7S: P-6	Runoff Area=1.790 ac 0.00% Impervious Runoff Depth=3.12" Tc=5.0 min CN=91 Runoff=9.68 cfs 0.466 af
Subcatchment8S: P-7	Runoff Area=0.820 ac 0.00% Impervious Runoff Depth=1.54" Tc=10.0 min CN=72 Runoff=1.93 cfs 0.105 af
Pond 3P: P-1	Peak Elev=242.80' Storage=0.565 af Inflow=18.52 cfs 0.924 af Discarded=0.20 cfs 0.770 af Primary=0.29 cfs 0.154 af Outflow=0.49 cfs 0.924 af
Pond 5P: P-2	Peak Elev=255.96' Storage=0.526 af Inflow=16.36 cfs 0.859 af Discarded=0.17 cfs 0.733 af Primary=0.25 cfs 0.126 af Outflow=0.42 cfs 0.859 af
Pond 7P: P-3	Peak Elev=257.92' Storage=0.737 af Inflow=22.35 cfs 1.198 af Discarded=0.25 cfs 1.049 af Primary=0.26 cfs 0.149 af Outflow=0.51 cfs 1.198 af
Pond 9P: P-4	Peak Elev=259.26' Storage=0.283 af Inflow=10.57 cfs 0.495 af Discarded=0.14 cfs 0.407 af Primary=0.24 cfs 0.089 af Outflow=0.38 cfs 0.495 af
Pond 11P: P-5	Peak Elev=259.49' Storage=0.218 af Inflow=8.12 cfs 0.395 af Discarded=0.09 cfs 0.316 af Primary=0.34 cfs 0.079 af Outflow=0.43 cfs 0.395 af
Pond 14P: P-6	Peak Elev=252.46' Storage=0.251 af Inflow=9.68 cfs 0.466 af Outflow=0.74 cfs 0.466 af
Link 12L: PO1#1	Inflow=2.26 cfs 1.167 af Primary=2.26 cfs 1.167 af

Total Runoff Area = 31.720 ac Runoff Volume = 5.453 af Average Runoff Depth = 2.06"
88.30% Pervious = 28.010 ac 11.70% Impervious = 3.710 ac

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 5-YR Rainfall=4.11"

Printed 12/18/2017

Page 47

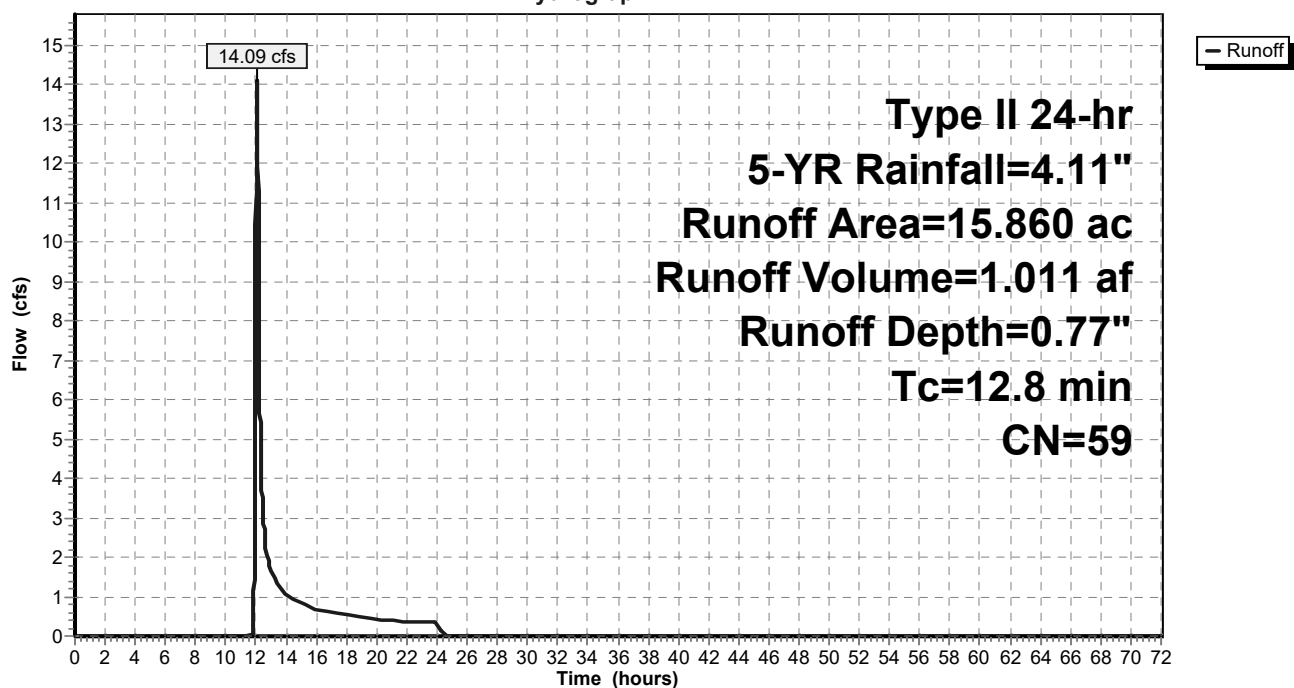
Runoff = 14.09 cfs @ 12.07 hrs, Volume= 1.011 af, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-YR Rainfall=4.11"

Area (ac)	CN	Description
* 15.860	59	SEE CN WORKSHEETS
15.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.8					Direct Entry,

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 5-YR Rainfall=4.11"

Printed 12/18/2017

Page 48

Summary for Subcatchment 2S: P-1

Runoff = 18.52 cfs @ 11.96 hrs, Volume= 0.924 af, Depth= 3.43"

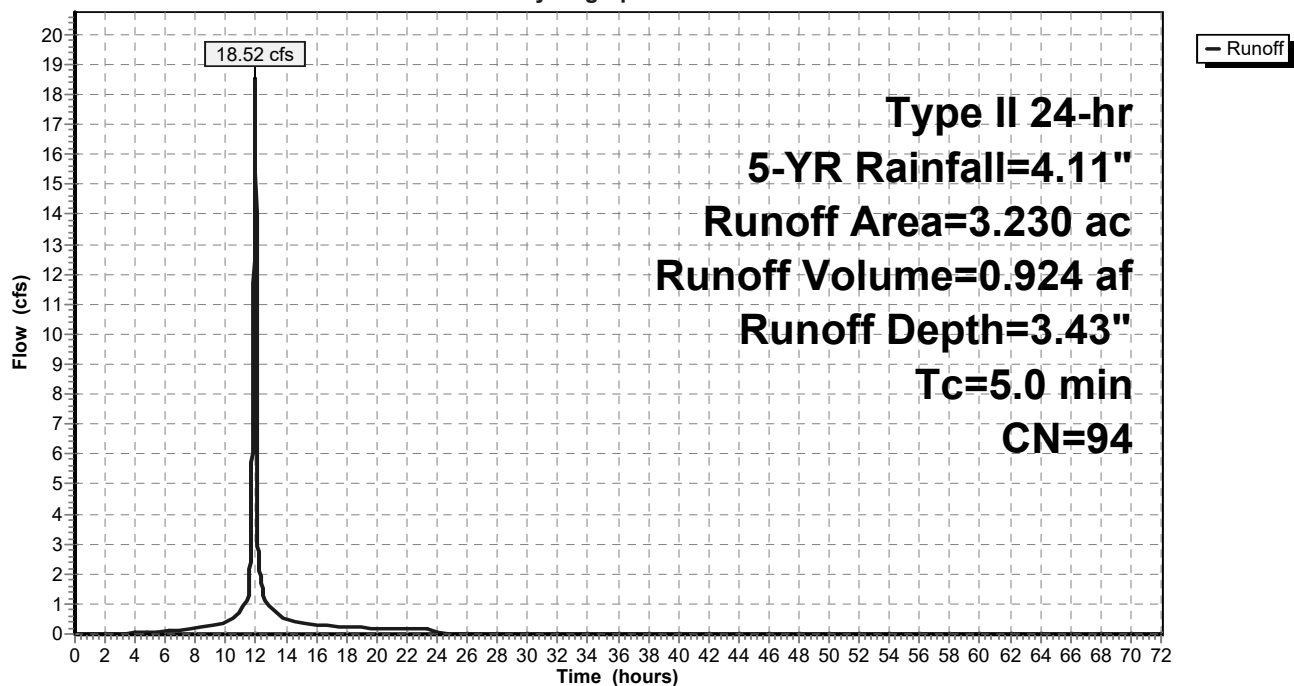
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-YR Rainfall=4.11"

Area (ac)	CN	Description
* 3.230	94	SEE CN WORKSHEETS
3.230		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 2S: P-1

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 5-YR Rainfall=4.11"

Printed 12/18/2017

Page 49

Summary for Subcatchment 3S: P-2

Runoff = 16.36 cfs @ 11.96 hrs, Volume= 0.859 af, Depth= 3.76"

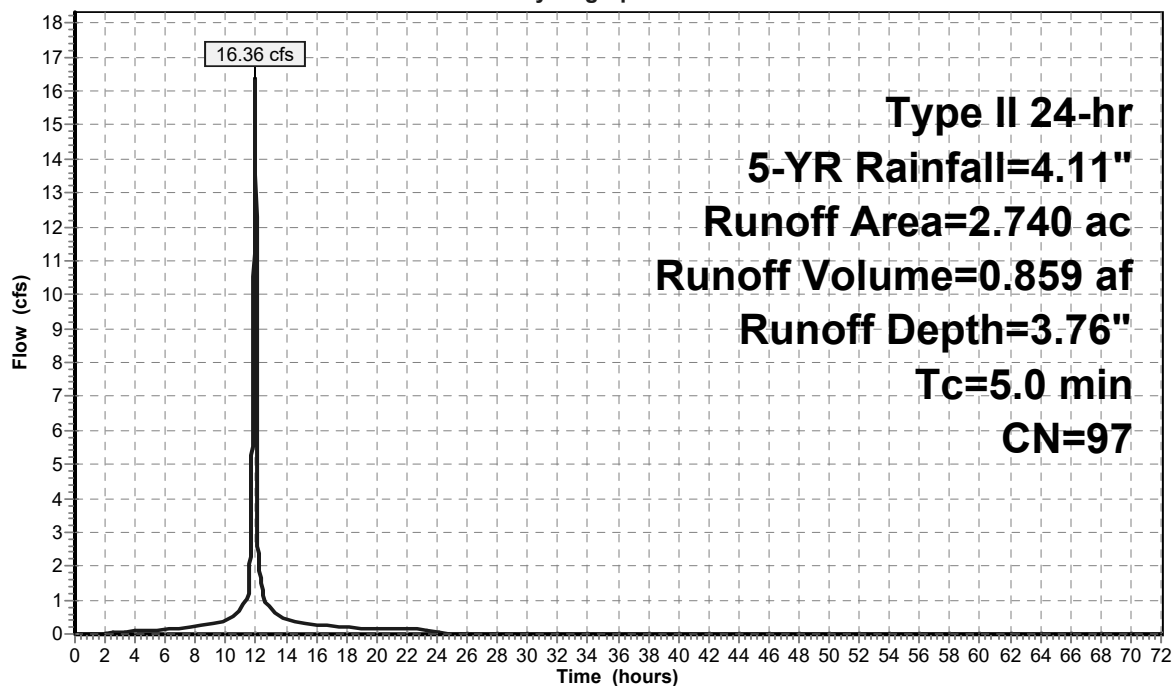
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-YR Rainfall=4.11"

Area (ac)	CN	Description
* 2.740	97	SEE CN WORKSHEETS
2.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 3S: P-2

Hydrograph



Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 5-YR Rainfall=4.11"

Printed 12/18/2017

Page 50

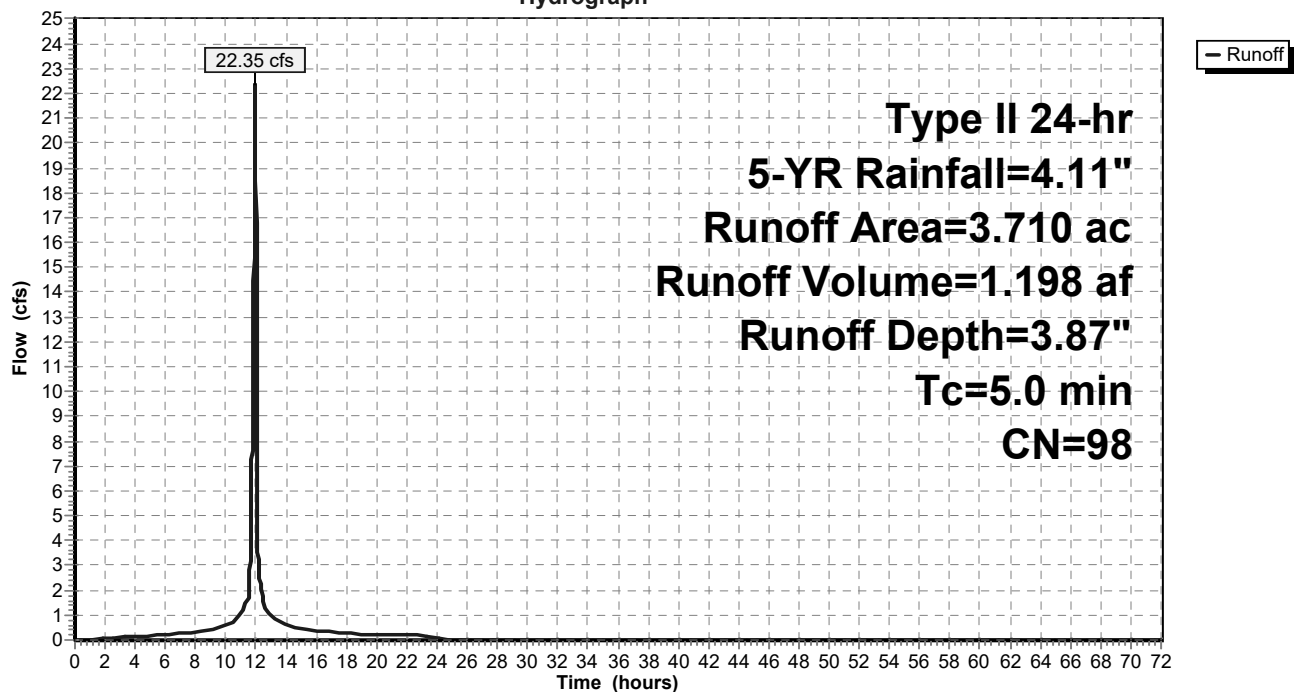
Runoff = 22.35 cfs @ 11.96 hrs, Volume= 1.198 af, Depth= 3.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-YR Rainfall=4.11"

Area (ac)	CN	Description
* 3.710	98	SEE CN WORKSHEETS
3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 5-YR Rainfall=4.11"

Printed 12/18/2017

Page 51

Summary for Subcatchment 5S: P-4

Runoff = 10.57 cfs @ 11.96 hrs, Volume= 0.495 af, Depth= 2.83"

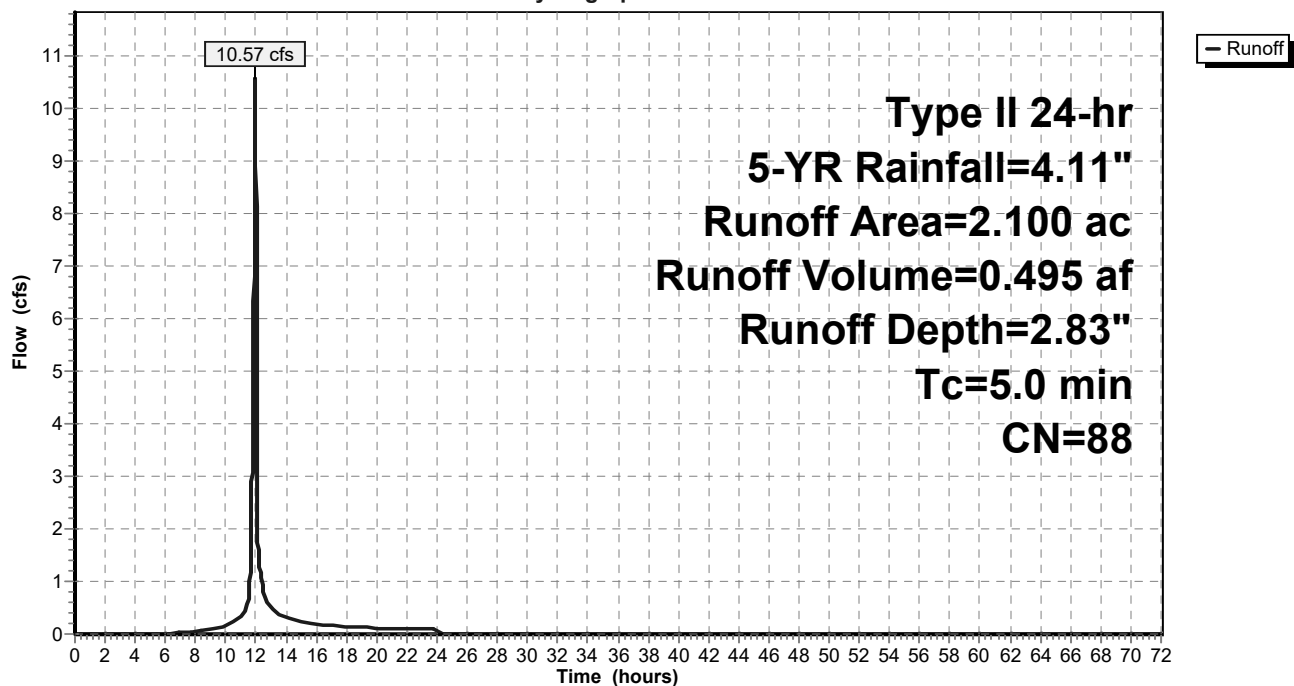
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-YR Rainfall=4.11"

Area (ac)	CN	Description
* 2.100	88	SEE CN WORKSHEETS
2.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 5S: P-4

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 5-YR Rainfall=4.11"

Printed 12/18/2017

Page 52

Summary for Subcatchment 6S: P-5

Runoff = 8.12 cfs @ 11.96 hrs, Volume= 0.395 af, Depth= 3.22"

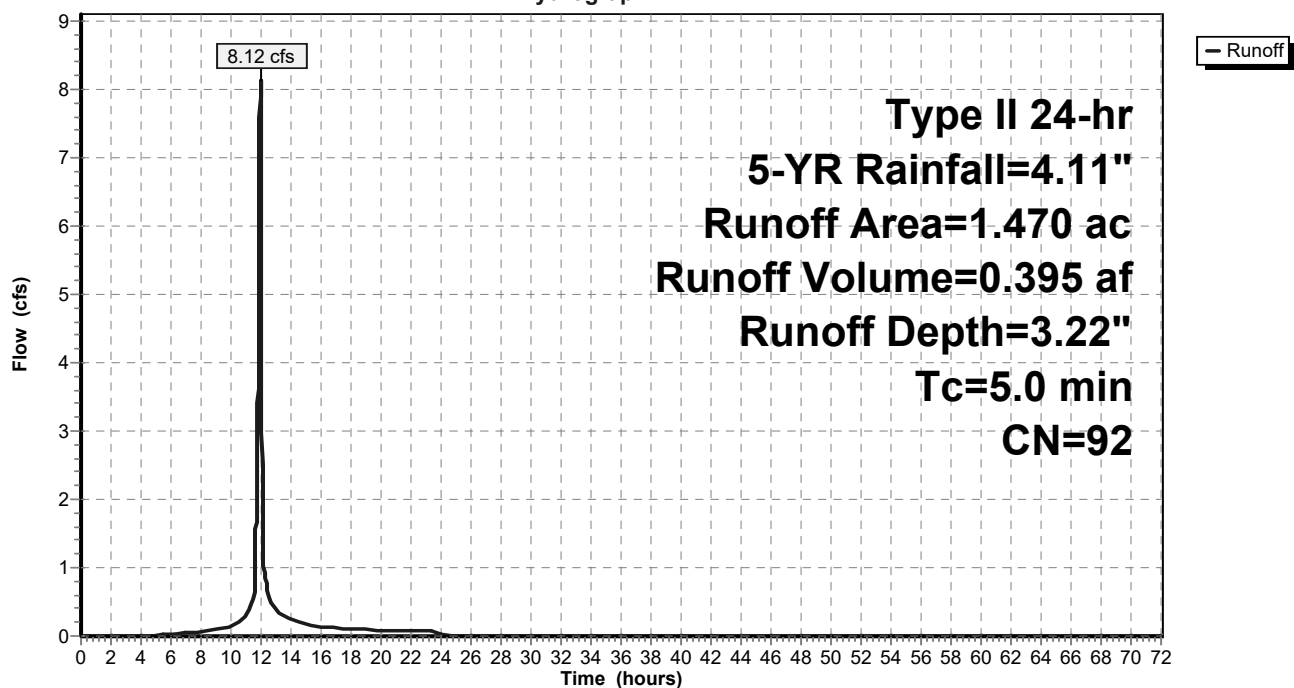
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-YR Rainfall=4.11"

Area (ac)	CN	Description
* 1.470	92	SEE CN WORKSHEETS
1.470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 6S: P-5

Hydrograph



Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 5-YR Rainfall=4.11"

Printed 12/18/2017

Page 53

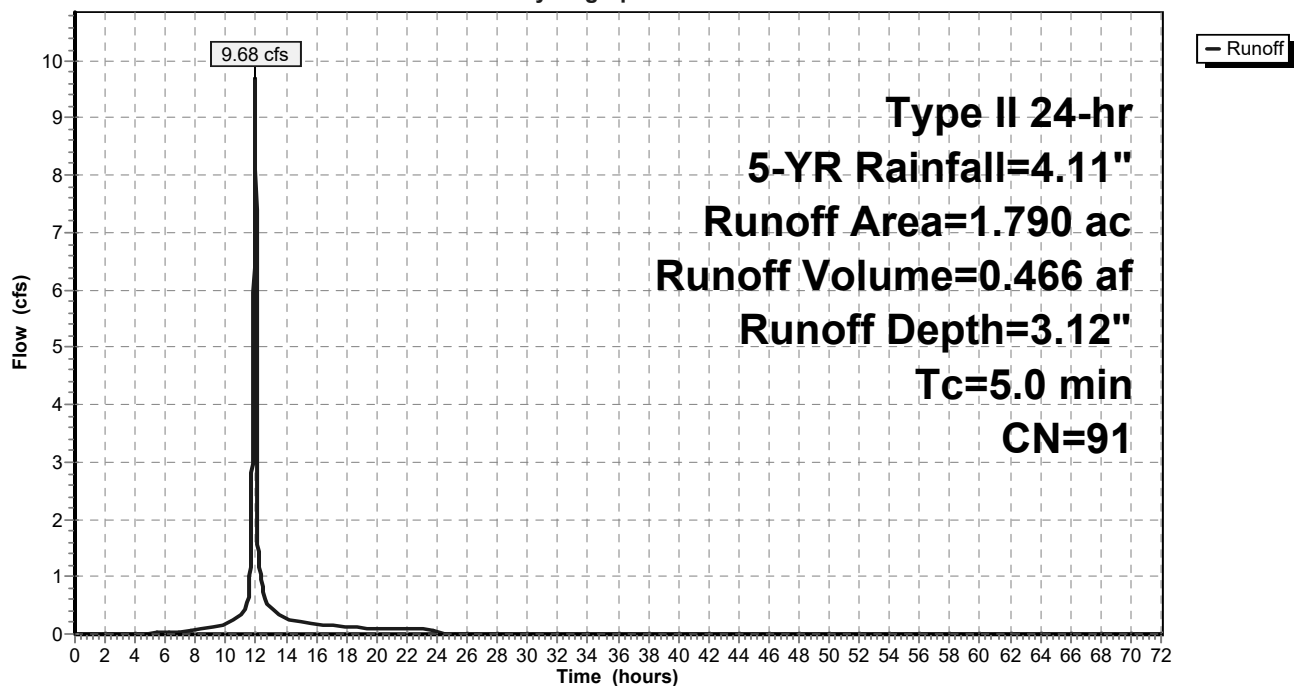
Runoff = 9.68 cfs @ 11.96 hrs, Volume= 0.466 af, Depth= 3.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-YR Rainfall=4.11"

Area (ac)	CN	Description
* 1.790	91	SEE CN WORKSHEETS
1.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 5-YR Rainfall=4.11"

Printed 12/18/2017

Page 54

Summary for Subcatchment 8S: P-7

Runoff = 1.93 cfs @ 12.02 hrs, Volume= 0.105 af, Depth= 1.54"

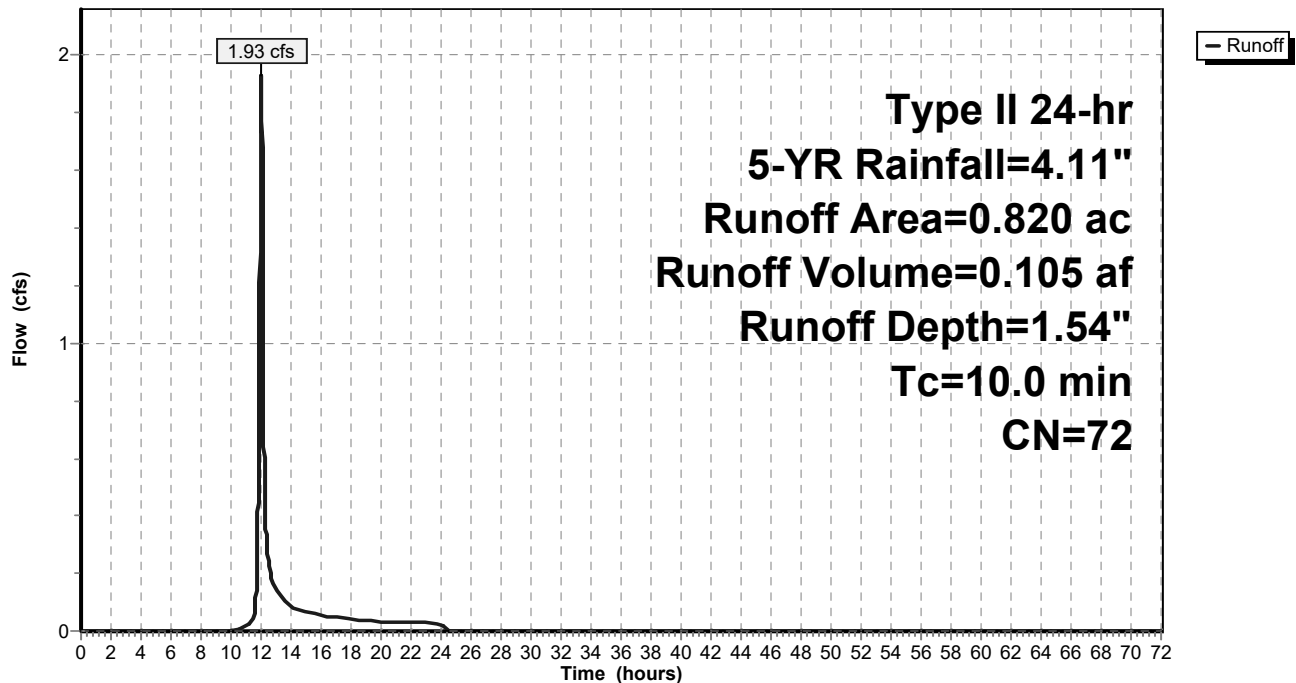
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 5-YR Rainfall=4.11"

Area (ac)	CN	Description
* 0.820	72	SEE CN WORKSHEETS
0.820		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry,

Subcatchment 8S: P-7

Hydrograph



routings

Type II 24-hr 5-YR Rainfall=4.11"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 55

Summary for Pond 3P: P-1

Inflow Area = 3.230 ac, 0.00% Impervious, Inflow Depth = 3.43" for 5-YR event
Inflow = 18.52 cfs @ 11.96 hrs, Volume= 0.924 af
Outflow = 0.49 cfs @ 14.04 hrs, Volume= 0.924 af, Atten= 97%, Lag= 124.8 min
Discarded = 0.20 cfs @ 8.68 hrs, Volume= 0.770 af
Primary = 0.29 cfs @ 14.04 hrs, Volume= 0.154 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 242.80' @ 14.04 hrs Surf.Area= 0.398 ac Storage= 0.565 af

Plug-Flow detention time= 864.8 min calculated for 0.924 af (100% of inflow)
Center-of-Mass det. time= 864.9 min (1,639.8 - 774.9)

Volume	Invert	Avail.Storage	Storage Description
#1	240.50'	0.462 af	6.00'W x 2,892.00'L x 4.50'H Stone 1.793 af Overall - 0.639 af Embedded = 1.154 af x 40.0% Voids
#2	241.00'	0.639 af	42.0" Round Pipe Storage Inside #1 L= 2,892.0'
		1.100 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	241.00'	18.0" Round Culvert L= 15.9' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 241.00' / 240.90' S= 0.0063 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	240.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	242.45'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.20 cfs @ 8.68 hrs HW=240.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.20 cfs)

Primary OutFlow Max=0.29 cfs @ 14.04 hrs HW=242.80' (Free Discharge)
↑**1=Culvert** (Passes 0.29 cfs of 7.66 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.29 cfs @ 1.94 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

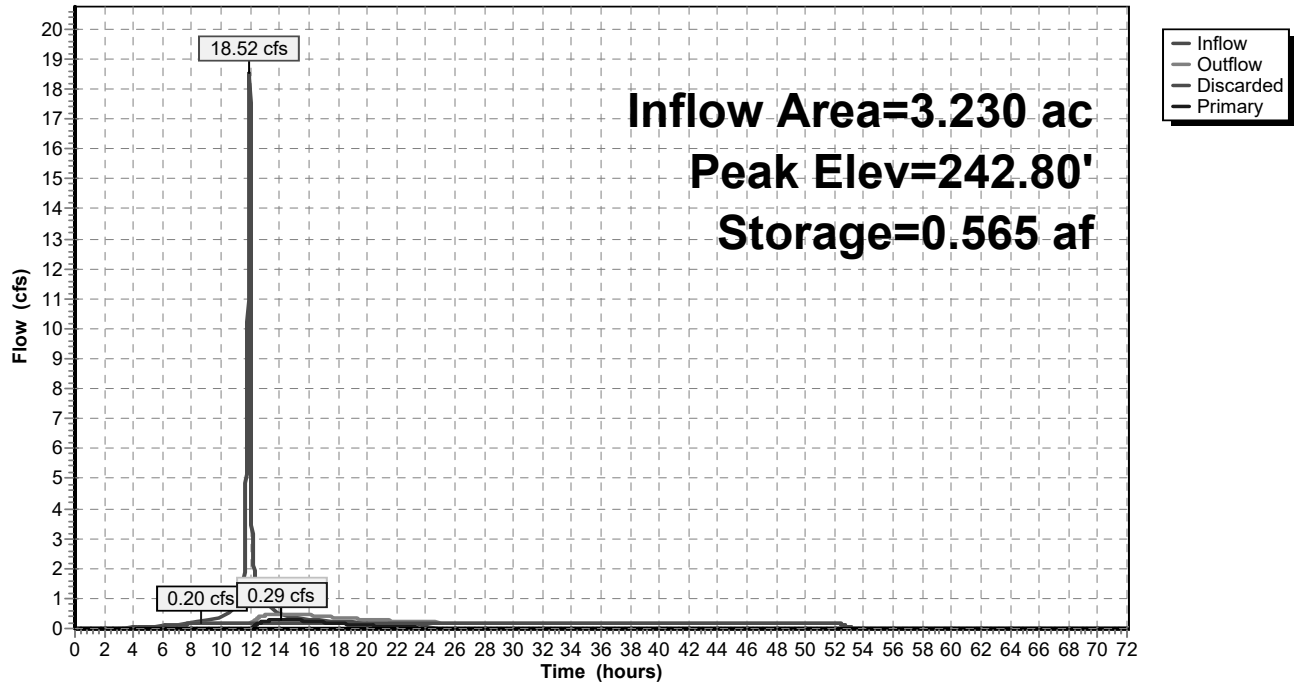
Type II 24-hr 5-YR Rainfall=4.11"

Printed 12/18/2017

Page 56

Pond 3P: P-1

Hydrograph



routings

Type II 24-hr 5-YR Rainfall=4.11"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 57

Summary for Pond 5P: P-2

Inflow Area = 2.740 ac, 0.00% Impervious, Inflow Depth = 3.76" for 5-YR event
Inflow = 16.36 cfs @ 11.96 hrs, Volume= 0.859 af
Outflow = 0.42 cfs @ 14.05 hrs, Volume= 0.859 af, Atten= 97%, Lag= 125.5 min
Discarded = 0.17 cfs @ 7.38 hrs, Volume= 0.733 af
Primary = 0.25 cfs @ 14.05 hrs, Volume= 0.126 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 255.96' @ 14.05 hrs Surf.Area= 0.341 ac Storage= 0.526 af

Plug-Flow detention time= 938.9 min calculated for 0.859 af (100% of inflow)
Center-of-Mass det. time= 939.1 min (1,694.4 - 755.3)

Volume	Invert	Avail.Storage	Storage Description
#1	253.50'	0.396 af	6.00'W x 2,479.00'L x 4.50'H Stone 1.537 af Overall - 0.548 af Embedded = 0.989 af x 40.0% Voids
#2	254.00'	0.548 af	42.0" Round Pipe Storage Inside #1 L= 2,479.0'
		0.943 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	254.00'	18.0" Round Culvert L= 16.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 254.00' / 253.80' S= 0.0125 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	253.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	255.65'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.17 cfs @ 7.38 hrs HW=253.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.17 cfs)

Primary OutFlow Max=0.25 cfs @ 14.05 hrs HW=255.96' (Free Discharge)
↑**1=Culvert** (Passes 0.25 cfs of 8.95 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.25 cfs @ 1.83 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

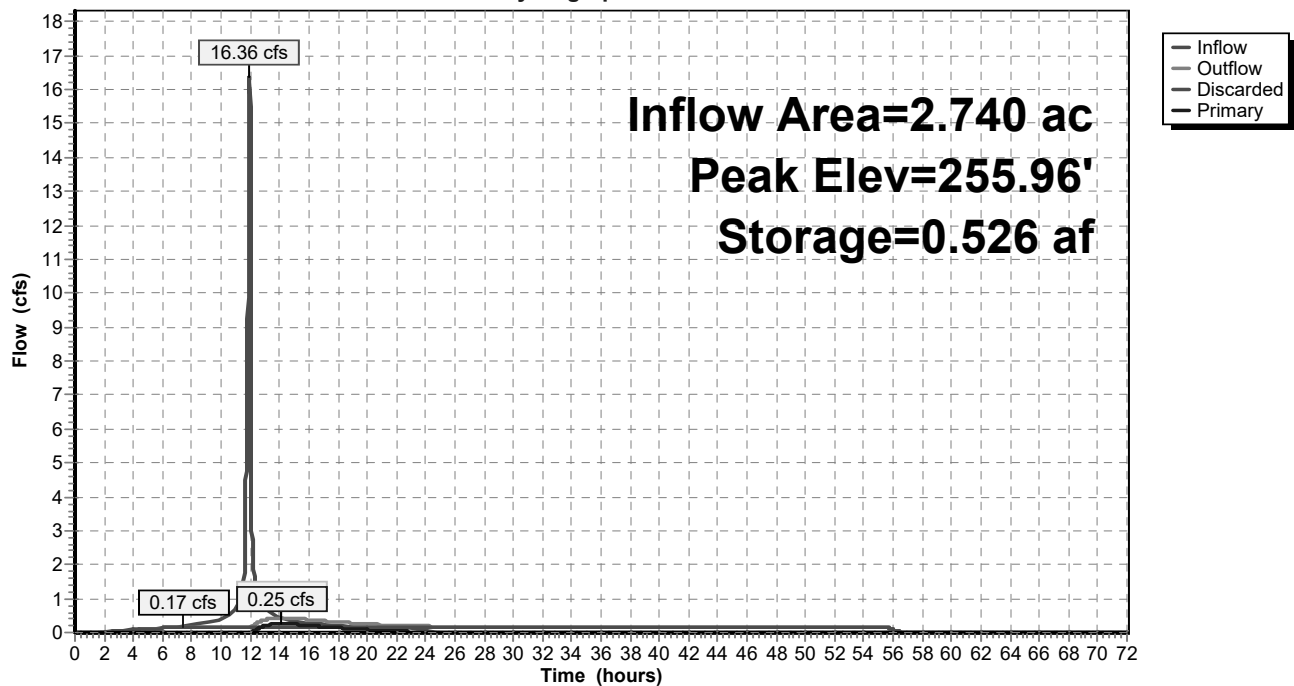
Type II 24-hr 5-YR Rainfall=4.11"

Printed 12/18/2017

Page 58

Pond 5P: P-2

Hydrograph



routings

Type II 24-hr 5-YR Rainfall=4.11"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 59

Summary for Pond 7P: P-3

Inflow Area = 3.710 ac, 100.00% Impervious, Inflow Depth = 3.87" for 5-YR event
Inflow = 22.35 cfs @ 11.96 hrs, Volume= 1.198 af
Outflow = 0.51 cfs @ 14.63 hrs, Volume= 1.198 af, Atten= 98%, Lag= 160.2 min
Discarded = 0.25 cfs @ 6.94 hrs, Volume= 1.049 af
Primary = 0.26 cfs @ 14.63 hrs, Volume= 0.149 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 257.92' @ 14.63 hrs Surf.Area= 0.488 ac Storage= 0.737 af

Plug-Flow detention time= 940.6 min calculated for 1.198 af (100% of inflow)
Center-of-Mass det. time= 940.8 min (1,687.3 - 746.5)

Volume	Invert	Avail.Storage	Storage Description
#1	255.50'	0.565 af	6.00'W x 3,541.00'L x 4.50'H Stone 2.195 af Overall - 0.782 af Embedded = 1.413 af x 40.0% Voids
#2	256.00'	0.782 af	42.0" Round Pipe Storage Inside #1 L= 3,541.0'
		1.347 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	256.00'	18.0" Round Culvert L= 33.4' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 256.00' / 255.70' S= 0.0090 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	255.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	257.60'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.25 cfs @ 6.94 hrs HW=255.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.25 cfs)

Primary OutFlow Max=0.26 cfs @ 14.63 hrs HW=257.92' (Free Discharge)
↑**1=Culvert** (Passes 0.26 cfs of 8.88 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.26 cfs @ 1.86 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

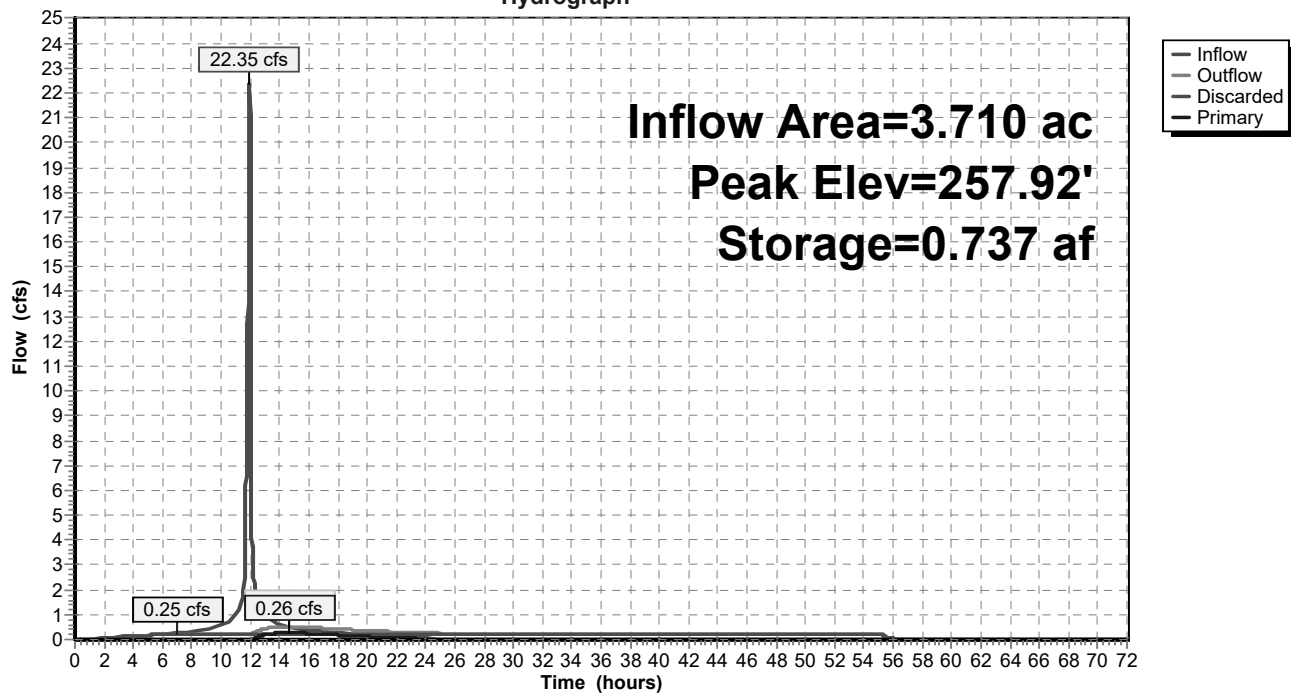
Type II 24-hr 5-YR Rainfall=4.11"

Printed 12/18/2017

Page 60

Pond 7P: P-3

Hydrograph



routings

Type II 24-hr 5-YR Rainfall=4.11"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 61

Summary for Pond 9P: P-4

Inflow Area = 2.100 ac, 0.00% Impervious, Inflow Depth = 2.83" for 5-YR event
 Inflow = 10.57 cfs @ 11.96 hrs, Volume= 0.495 af
 Outflow = 0.38 cfs @ 13.55 hrs, Volume= 0.495 af, Atten= 96%, Lag= 95.4 min
 Discarded = 0.14 cfs @ 10.20 hrs, Volume= 0.407 af
 Primary = 0.24 cfs @ 13.55 hrs, Volume= 0.089 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 Peak Elev= 259.26' @ 13.55 hrs Surf.Area= 0.279 ac Storage= 0.283 af

Plug-Flow detention time= 647.2 min calculated for 0.495 af (100% of inflow)
 Center-of-Mass det. time= 647.3 min (1,448.5 - 801.1)

Volume	Invert	Avail.Storage	Storage Description
#1	257.50'	0.189 af	87.00'W x 96.00'L x 3.50'H Stone 0.671 af Overall - 0.199 af Embedded = 0.472 af x 40.0% Voids
#2	258.00'	0.199 af	30.0" Round Pipe Storage x 19 Inside #1 L= 93.0'
#3	257.50'	0.053 af	31.50'W x 74.00'L x 3.50'H Stone 0.187 af Overall - 0.056 af Embedded = 0.131 af x 40.0% Voids
#4	258.00'	0.056 af	30.0" Round Pipe Storage x 7 Inside #3 L= 71.0'
#5	257.50'	0.033 af	31.50'W x 46.00'L x 3.50'H Stone 0.116 af Overall - 0.034 af Embedded = 0.083 af x 40.0% Voids
#6	258.00'	0.034 af	30.0" Round Pipe Storage x 7 Inside #5 L= 43.0'
		0.563 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	256.40'	18.0" Round Culvert L= 20.4' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 256.40' / 256.20' S= 0.0098 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	257.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	259.00'	0.6' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.14 cfs @ 10.20 hrs HW=257.54' (Free Discharge)

↑**2=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=0.24 cfs @ 13.55 hrs HW=259.26' (Free Discharge)

↑**1=Culvert** (Passes 0.24 cfs of 12.35 cfs potential flow)

↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.24 cfs @ 1.66 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

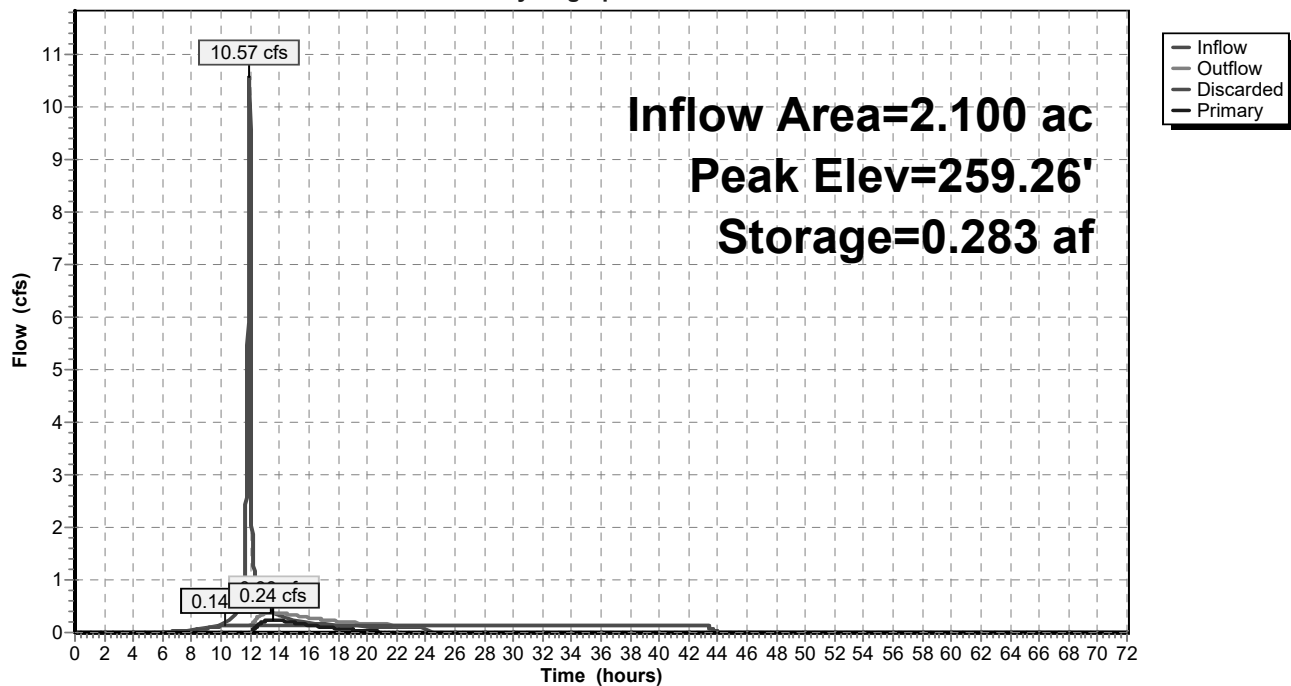
Type II 24-hr 5-YR Rainfall=4.11"

Printed 12/18/2017

Page 62

Pond 9P: P-4

Hydrograph



routings

Type II 24-hr 5-YR Rainfall=4.11"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 63

Summary for Pond 11P: P-5

Inflow Area = 1.470 ac, 0.00% Impervious, Inflow Depth = 3.22" for 5-YR event
Inflow = 8.12 cfs @ 11.96 hrs, Volume= 0.395 af
Outflow = 0.43 cfs @ 12.80 hrs, Volume= 0.395 af, Atten= 95%, Lag= 50.8 min
Discarded = 0.09 cfs @ 9.07 hrs, Volume= 0.316 af
Primary = 0.34 cfs @ 12.80 hrs, Volume= 0.079 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 259.49' @ 12.80 hrs Surf.Area= 0.182 ac Storage= 0.218 af

Plug-Flow detention time= 729.9 min calculated for 0.395 af (100% of inflow)
Center-of-Mass det. time= 729.8 min (1,514.7 - 784.9)

Volume	Invert	Avail.Storage	Storage Description
#1	257.50'	0.175 af	4.50'W x 1,757.00'L x 3.50'H Stone 0.635 af Overall - 0.198 af Embedded = 0.437 af x 40.0% Voids
#2	258.00'	0.198 af	30.0" Round Pipe Storage Inside #1 L= 1,757.0'
		0.373 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	258.00'	18.0" Round Culvert L= 40.8' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 258.00' / 257.50' S= 0.0123 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	257.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	259.30'	1.3' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.09 cfs @ 9.07 hrs HW=257.54' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.09 cfs)

Primary OutFlow Max=0.34 cfs @ 12.80 hrs HW=259.49' (Free Discharge)
↑**1=Culvert** (Passes 0.34 cfs of 7.34 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.34 cfs @ 1.43 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

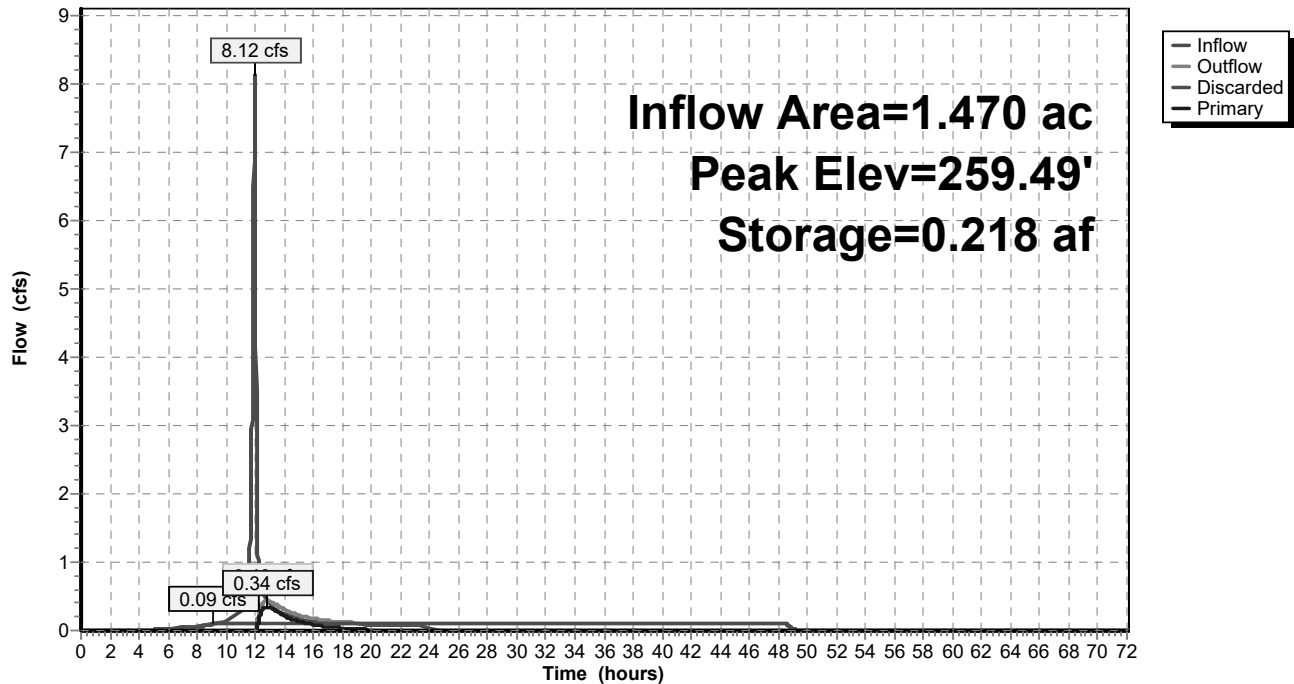
Type II 24-hr 5-YR Rainfall=4.11"

Printed 12/18/2017

Page 64

Pond 11P: P-5

Hydrograph



routings

Type II 24-hr 5-YR Rainfall=4.11"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 65

Summary for Pond 14P: P-6

Inflow Area = 1.790 ac, 0.00% Impervious, Inflow Depth = 3.12" for 5-YR event
Inflow = 9.68 cfs @ 11.96 hrs, Volume= 0.466 af
Outflow = 0.74 cfs @ 12.49 hrs, Volume= 0.466 af, Atten= 92%, Lag= 32.0 min
Primary = 0.74 cfs @ 12.49 hrs, Volume= 0.466 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 252.46' @ 12.49 hrs Surf.Area= 0.150 ac Storage= 0.251 af

Plug-Flow detention time= 343.0 min calculated for 0.466 af (100% of inflow)
Center-of-Mass det. time= 342.9 min (1,132.2 - 789.3)

Volume	Invert	Avail.Storage	Storage Description
#1	250.00'	0.165 af	28.00'W x 234.00'L x 4.50'H Stone 0.677 af Overall - 0.265 af Embedded = 0.411 af x 40.0% Voids
#2	250.00'	0.265 af	48.0" Round Pipe Storage x 4 Inside #1 L= 230.0'
		0.430 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	250.00'	18.0" Round Culvert L= 33.7' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 250.00' / 249.80' S= 0.0059 ' /' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	250.00'	3.0" Vert. Orifice/Grate C= 0.600
#3	Device 1	252.25'	1.2' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=0.73 cfs @ 12.49 hrs HW=252.46' (Free Discharge)

1=Culvert (Passes 0.73 cfs of 10.75 cfs potential flow)

2=Orifice/Grate (Orifice Controls 0.36 cfs @ 7.36 fps)

3=Sharp-Crested Rectangular Weir (Weir Controls 0.37 cfs @ 1.51 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

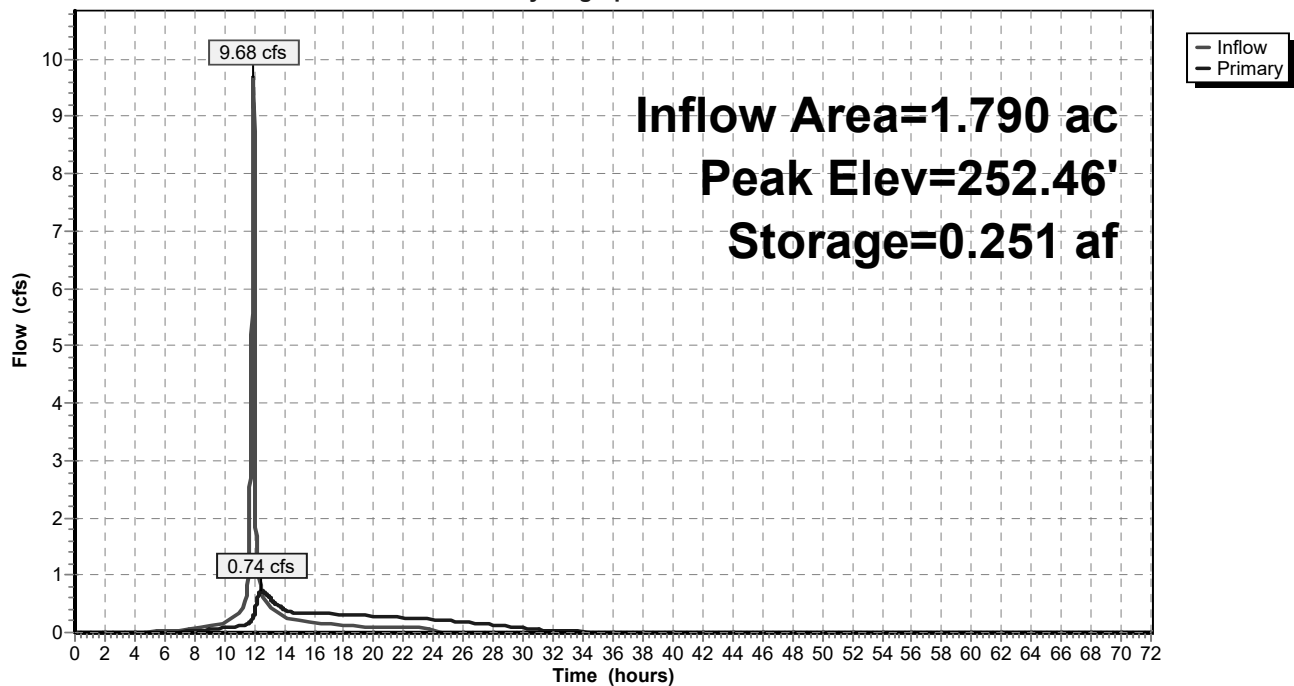
Type II 24-hr 5-YR Rainfall=4.11"

Printed 12/18/2017

Page 66

Pond 14P: P-6

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 5-YR Rainfall=4.11"

Printed 12/18/2017

Page 67

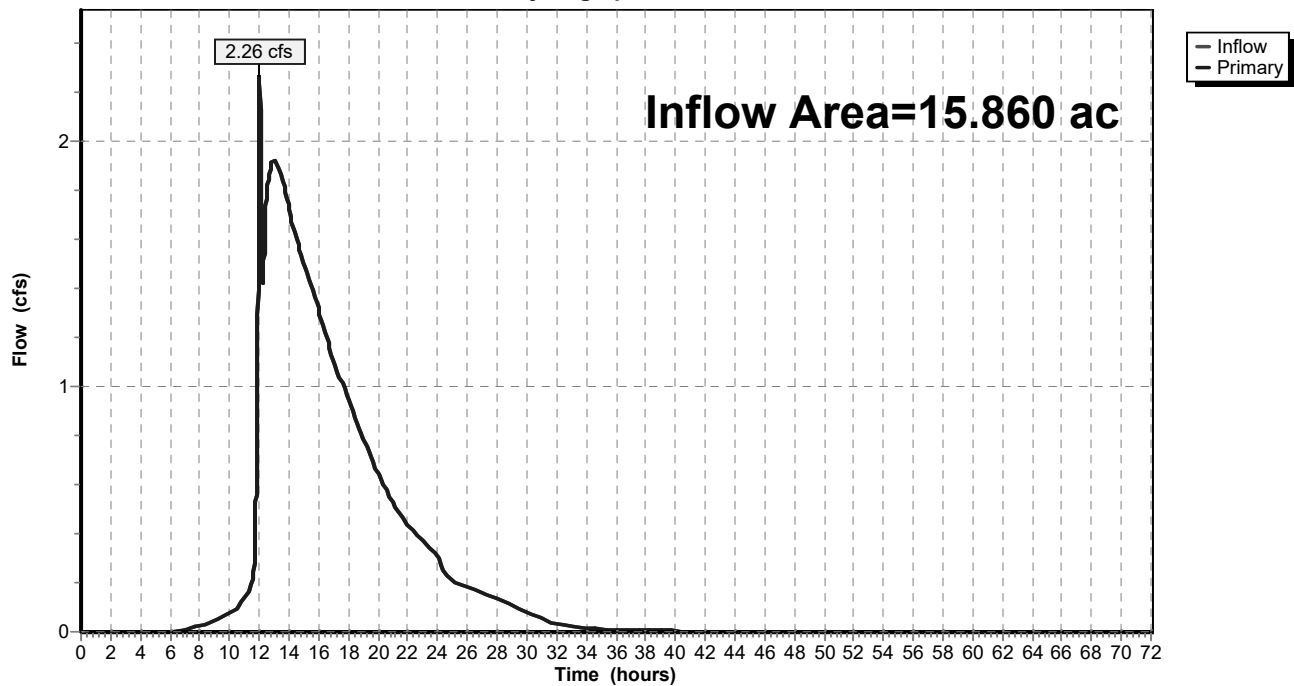
Summary for Link 12L: PO1#1

Inflow Area = 15.860 ac, 23.39% Impervious, Inflow Depth = 0.88" for 5-YR event
Inflow = 2.26 cfs @ 12.03 hrs, Volume= 1.167 af
Primary = 2.26 cfs @ 12.03 hrs, Volume= 1.167 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 12L: PO1#1

Hydrograph



routings

Type II 24-hr 10-YR Rainfall=4.81"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 68

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: E-1 (POI#1)	Runoff Area=15.860 ac 0.00% Impervious Runoff Depth=1.13" Tc=12.8 min CN=59 Runoff=22.55 cfs 1.491 af
Subcatchment2S: P-1	Runoff Area=3.230 ac 0.00% Impervious Runoff Depth=4.12" Tc=5.0 min CN=94 Runoff=21.96 cfs 1.109 af
Subcatchment3S: P-2	Runoff Area=2.740 ac 0.00% Impervious Runoff Depth=4.46" Tc=5.0 min CN=97 Runoff=19.23 cfs 1.018 af
Subcatchment4S: P-3	Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=4.57" Tc=5.0 min CN=98 Runoff=26.21 cfs 1.414 af
Subcatchment5S: P-4	Runoff Area=2.100 ac 0.00% Impervious Runoff Depth=3.49" Tc=5.0 min CN=88 Runoff=12.87 cfs 0.611 af
Subcatchment6S: P-5	Runoff Area=1.470 ac 0.00% Impervious Runoff Depth=3.90" Tc=5.0 min CN=92 Runoff=9.71 cfs 0.478 af
Subcatchment7S: P-6	Runoff Area=1.790 ac 0.00% Impervious Runoff Depth=3.80" Tc=5.0 min CN=91 Runoff=11.62 cfs 0.567 af
Subcatchment8S: P-7	Runoff Area=0.820 ac 0.00% Impervious Runoff Depth=2.05" Tc=10.0 min CN=72 Runoff=2.59 cfs 0.140 af
Pond 3P: P-1	Peak Elev=243.09' Storage=0.650 af Inflow=21.96 cfs 1.109 af Discarded=0.20 cfs 0.797 af Primary=0.62 cfs 0.312 af Outflow=0.82 cfs 1.109 af
Pond 5P: P-2	Peak Elev=256.24' Storage=0.597 af Inflow=19.23 cfs 1.018 af Discarded=0.17 cfs 0.753 af Primary=0.57 cfs 0.265 af Outflow=0.74 cfs 1.018 af
Pond 7P: P-3	Peak Elev=258.21' Storage=0.842 af Inflow=26.21 cfs 1.414 af Discarded=0.25 cfs 1.084 af Primary=0.59 cfs 0.330 af Outflow=0.84 cfs 1.414 af
Pond 9P: P-4	Peak Elev=259.48' Storage=0.328 af Inflow=12.87 cfs 0.611 af Discarded=0.14 cfs 0.423 af Primary=0.55 cfs 0.187 af Outflow=0.69 cfs 0.611 af
Pond 11P: P-5	Peak Elev=259.68' Storage=0.243 af Inflow=9.71 cfs 0.478 af Discarded=0.09 cfs 0.326 af Primary=0.95 cfs 0.152 af Outflow=1.04 cfs 0.478 af
Pond 14P: P-6	Peak Elev=252.77' Storage=0.284 af Inflow=11.62 cfs 0.567 af Outflow=1.72 cfs 0.566 af
Link 12L: PO1#1	Inflow=5.56 cfs 1.953 af Primary=5.56 cfs 1.953 af

Total Runoff Area = 31.720 ac Runoff Volume = 6.827 af Average Runoff Depth = 2.58"
88.30% Pervious = 28.010 ac 11.70% Impervious = 3.710 ac

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 10-YR Rainfall=4.81"

Printed 12/18/2017

Page 69

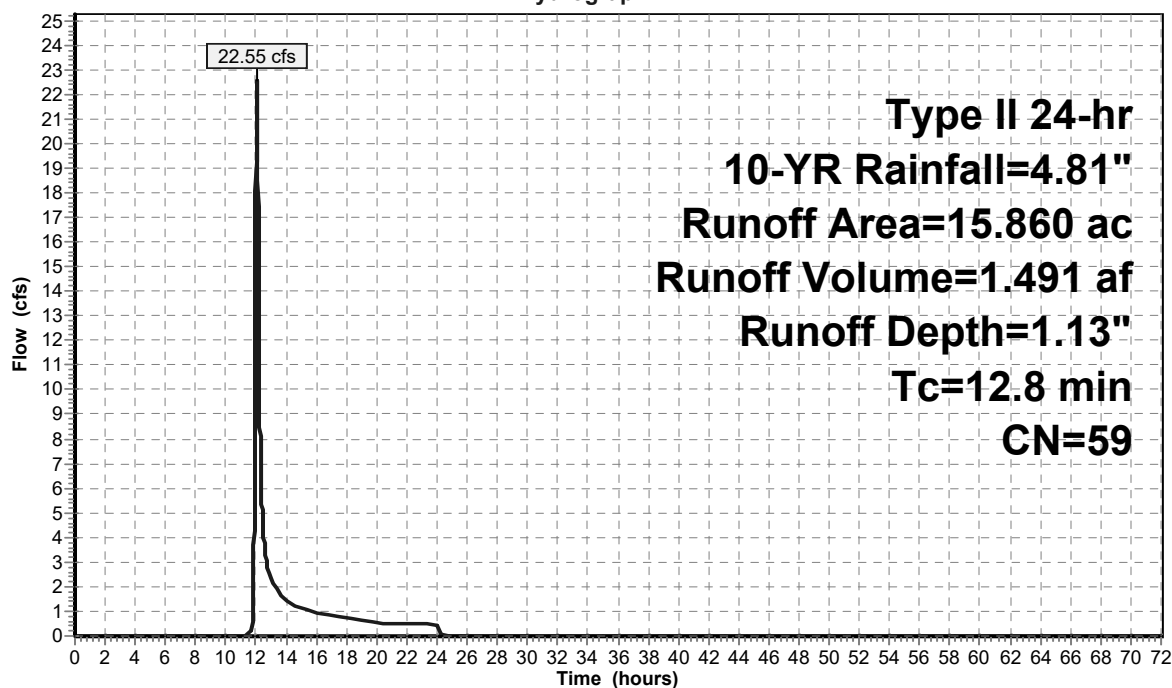
Runoff = 22.55 cfs @ 12.06 hrs, Volume= 1.491 af, Depth= 1.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-YR Rainfall=4.81"

Area (ac)	CN	Description
* 15.860	59	SEE CN WORKSHEETS
15.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.8					Direct Entry,

Hydrograph



Runoff

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 10-YR Rainfall=4.81"

Printed 12/18/2017

Page 70

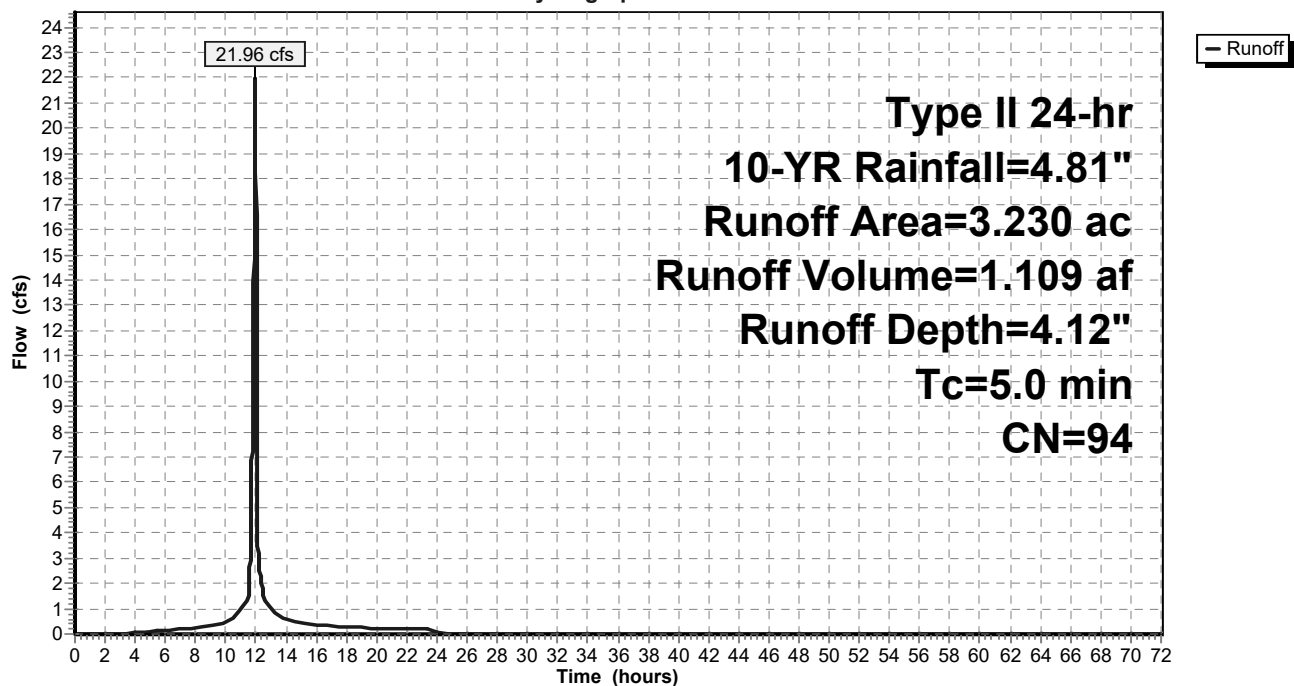
Runoff = 21.96 cfs @ 11.96 hrs, Volume= 1.109 af, Depth= 4.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-YR Rainfall=4.81"

Area (ac)	CN	Description
* 3.230	94	SEE CN WORKSHEETS
3.230		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Hydrograph



Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 10-YR Rainfall=4.81"

Printed 12/18/2017

Page 71

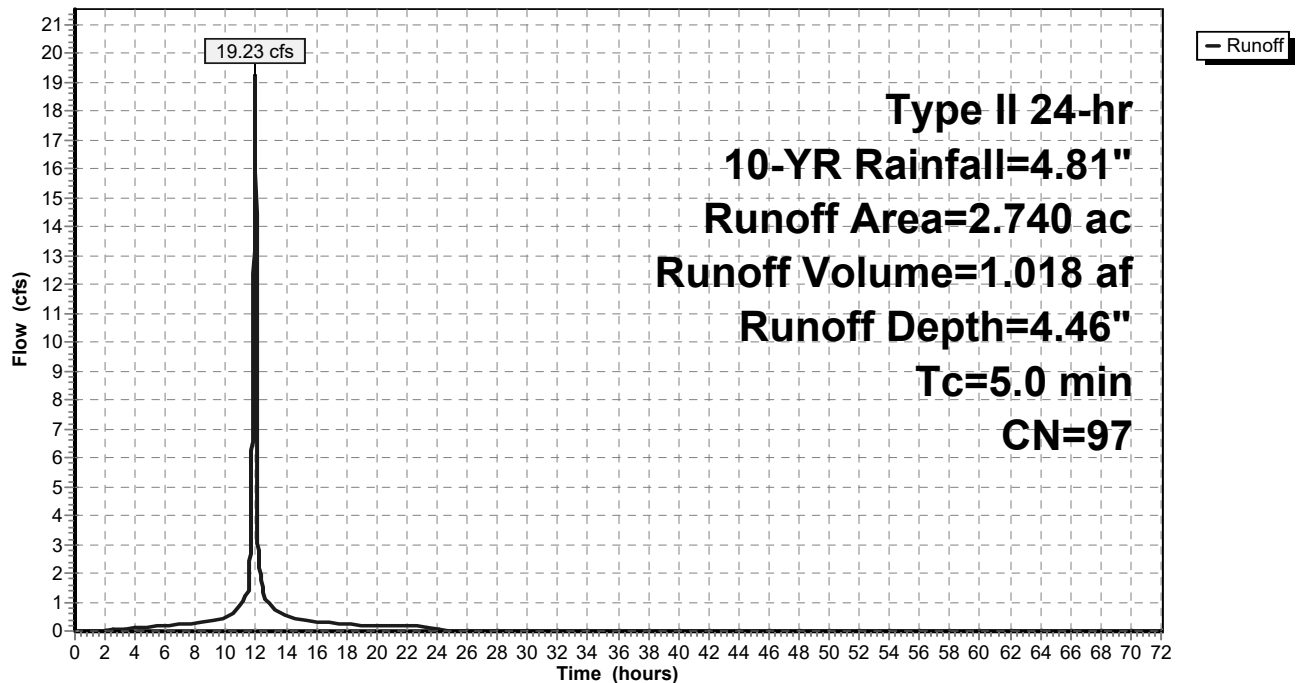
Runoff = 19.23 cfs @ 11.96 hrs, Volume= 1.018 af, Depth= 4.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-YR Rainfall=4.81"

Area (ac)	CN	Description
* 2.740	97	SEE CN WORKSHEETS
2.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 10-YR Rainfall=4.81"

Printed 12/18/2017

Page 72

Summary for Subcatchment 4S: P-3

Runoff = 26.21 cfs @ 11.96 hrs, Volume= 1.414 af, Depth= 4.57"

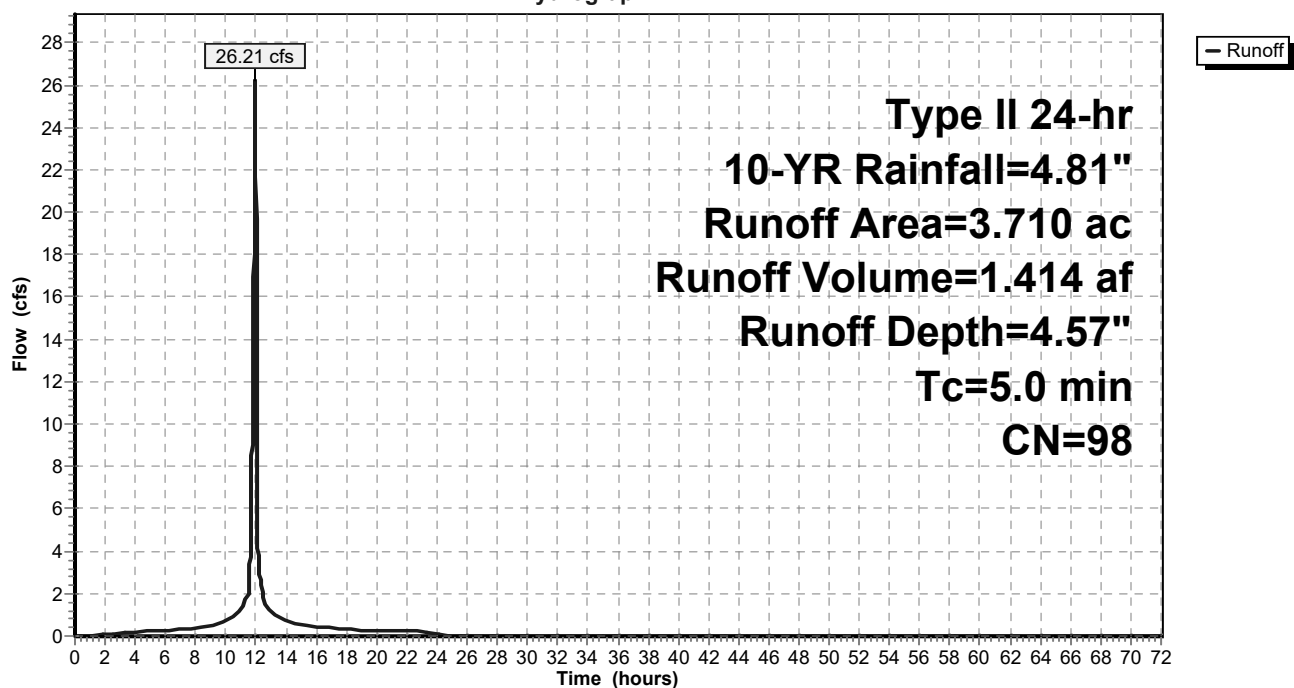
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-YR Rainfall=4.81"

Area (ac)	CN	Description
* 3.710	98	SEE CN WORKSHEETS
3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 4S: P-3

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 10-YR Rainfall=4.81"

Printed 12/18/2017

Page 73

Summary for Subcatchment 5S: P-4

Runoff = 12.87 cfs @ 11.96 hrs, Volume= 0.611 af, Depth= 3.49"

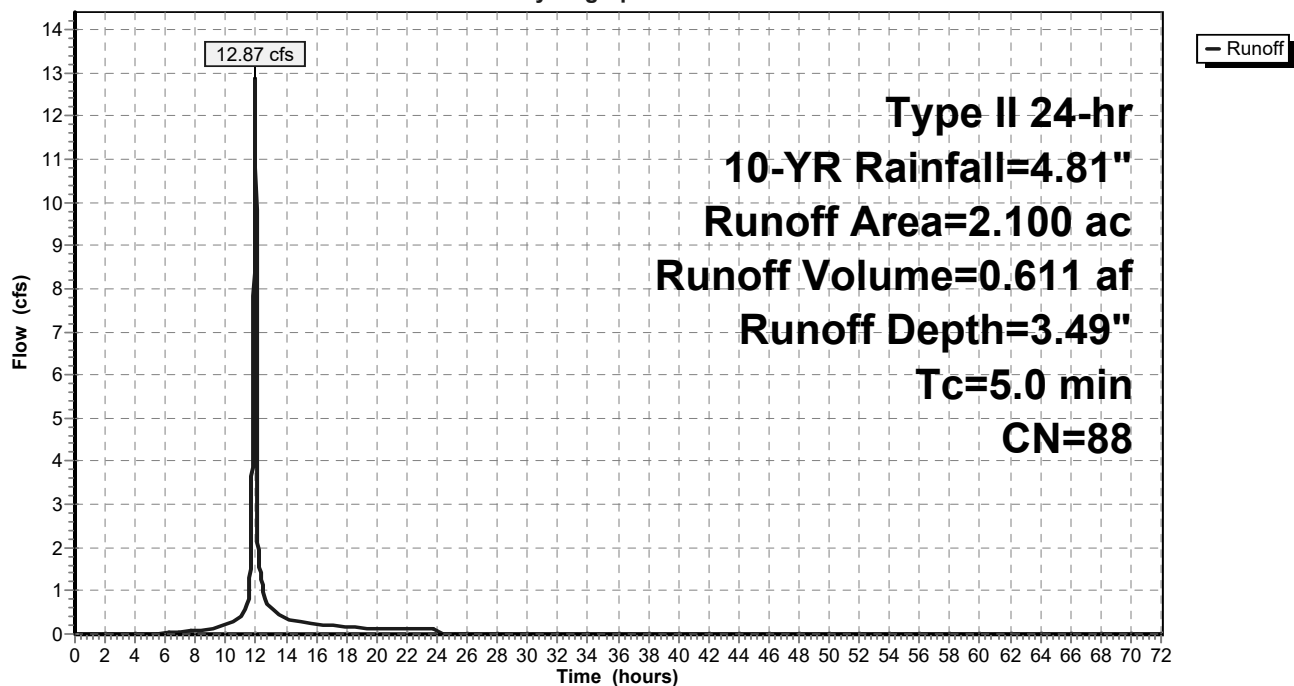
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-YR Rainfall=4.81"

Area (ac)	CN	Description
* 2.100	88	SEE CN WORKSHEETS
2.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 5S: P-4

Hydrograph



Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 10-YR Rainfall=4.81"

Printed 12/18/2017

Page 74

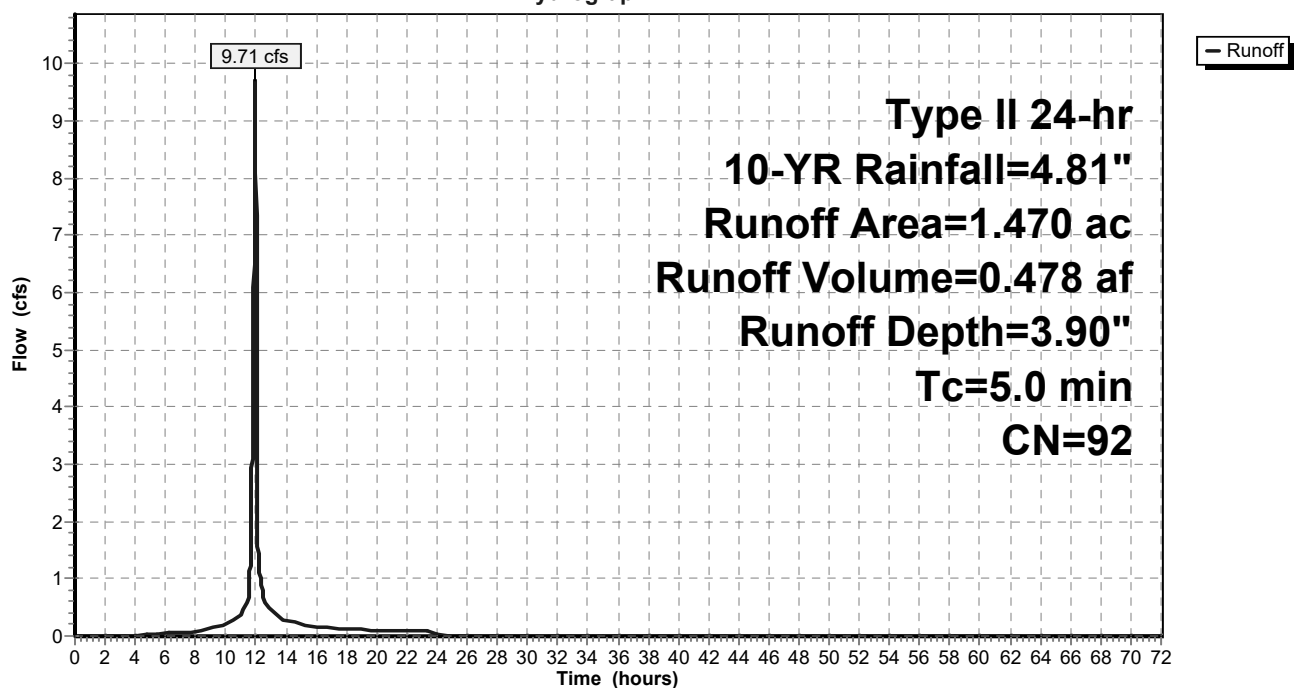
Runoff = 9.71 cfs @ 11.96 hrs, Volume= 0.478 af, Depth= 3.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-YR Rainfall=4.81"

Area (ac)	CN	Description
* 1.470	92	SEE CN WORKSHEETS
1.470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 10-YR Rainfall=4.81"

Printed 12/18/2017

Page 75

Summary for Subcatchment 7S: P-6

Runoff = 11.62 cfs @ 11.96 hrs, Volume= 0.567 af, Depth= 3.80"

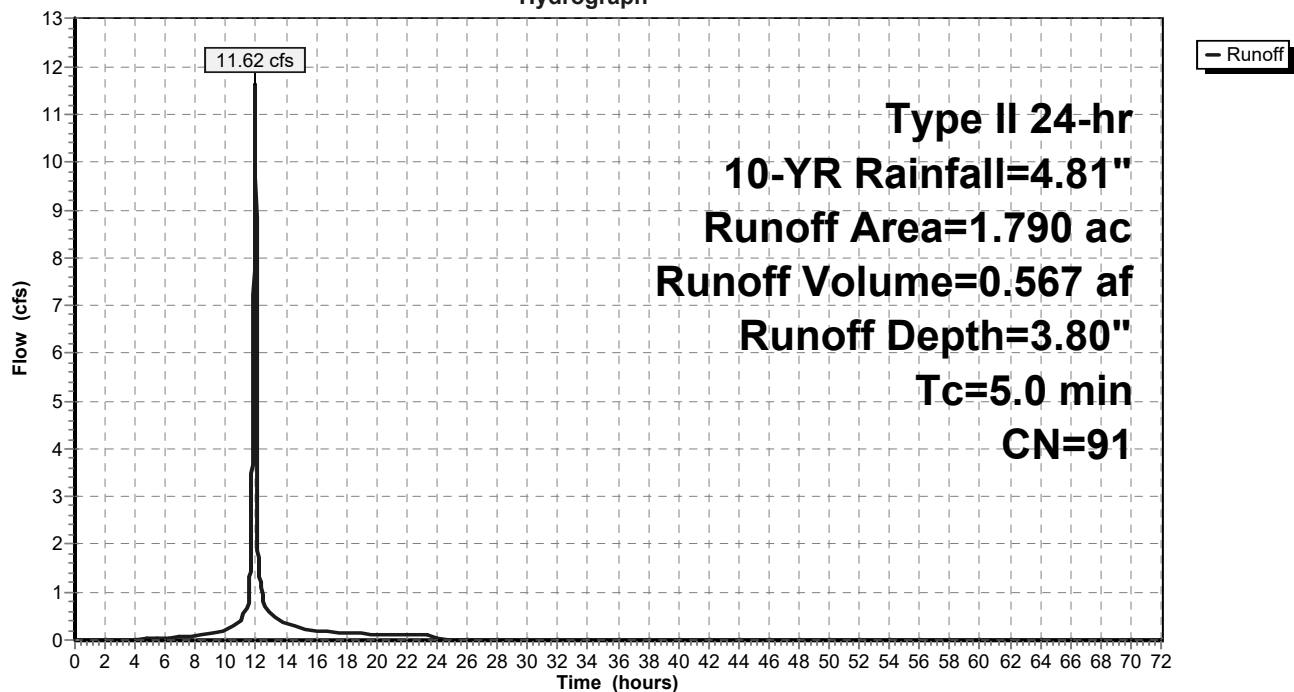
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-YR Rainfall=4.81"

Area (ac)	CN	Description
* 1.790	91	SEE CN WORKSHEETS
1.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 7S: P-6

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 10-YR Rainfall=4.81"

Printed 12/18/2017

Page 76

Summary for Subcatchment 8S: P-7

Runoff = 2.59 cfs @ 12.02 hrs, Volume= 0.140 af, Depth= 2.05"

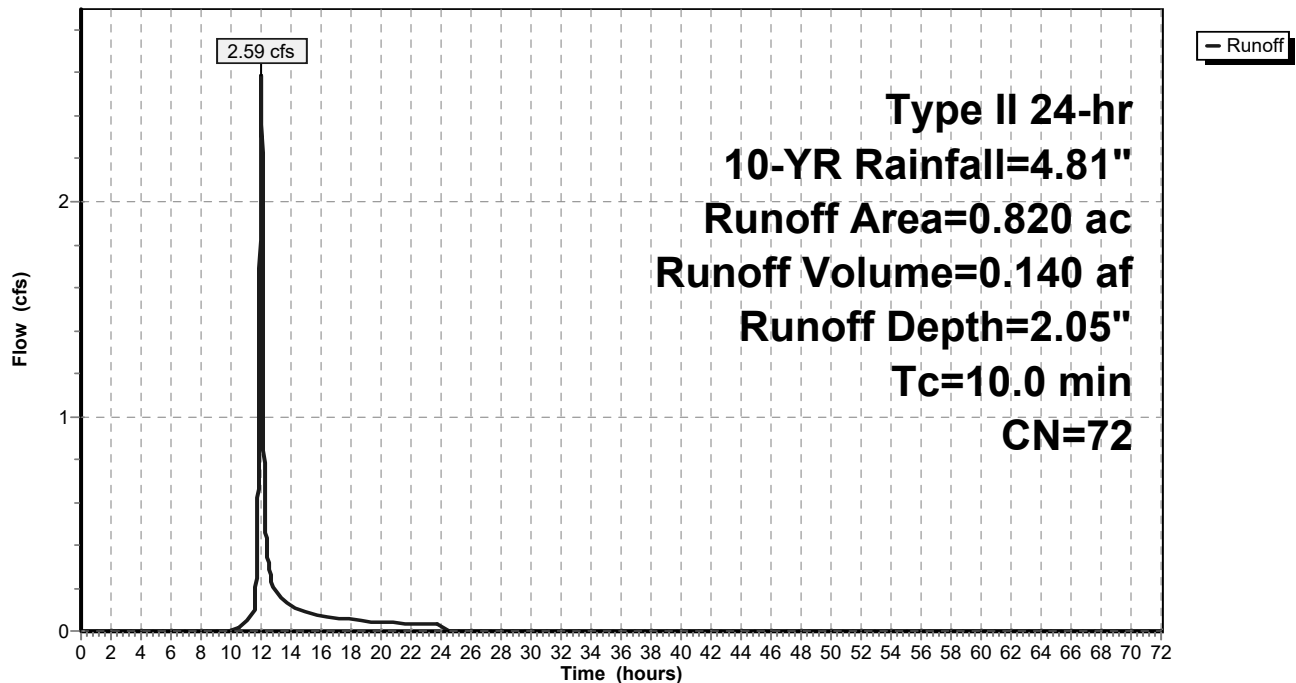
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 10-YR Rainfall=4.81"

Area (ac)	CN	Description
* 0.820	72	SEE CN WORKSHEETS
0.820		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry,

Subcatchment 8S: P-7

Hydrograph



routings

Type II 24-hr 10-YR Rainfall=4.81"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 77

Summary for Pond 3P: P-1

Inflow Area = 3.230 ac, 0.00% Impervious, Inflow Depth = 4.12" for 10-YR event
Inflow = 21.96 cfs @ 11.96 hrs, Volume= 1.109 af
Outflow = 0.82 cfs @ 13.35 hrs, Volume= 1.109 af, Atten= 96%, Lag= 83.4 min
Discarded = 0.20 cfs @ 7.94 hrs, Volume= 0.797 af
Primary = 0.62 cfs @ 13.35 hrs, Volume= 0.312 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 243.09' @ 13.35 hrs Surf.Area= 0.398 ac Storage= 0.650 af

Plug-Flow detention time= 774.1 min calculated for 1.109 af (100% of inflow)
Center-of-Mass det. time= 774.3 min (1,544.5 - 770.2)

Volume	Invert	Avail.Storage	Storage Description
#1	240.50'	0.462 af	6.00'W x 2,892.00'L x 4.50'H Stone 1.793 af Overall - 0.639 af Embedded = 1.154 af x 40.0% Voids
#2	241.00'	0.639 af	42.0" Round Pipe Storage Inside #1 L= 2,892.0'
		1.100 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	241.00'	18.0" Round Culvert L= 15.9' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 241.00' / 240.90' S= 0.0063 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	240.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	242.45'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.20 cfs @ 7.94 hrs HW=240.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.20 cfs)

Primary OutFlow Max=0.62 cfs @ 13.35 hrs HW=243.09' (Free Discharge)
↑**1=Culvert** (Passes 0.62 cfs of 8.89 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.62 cfs @ 2.61 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

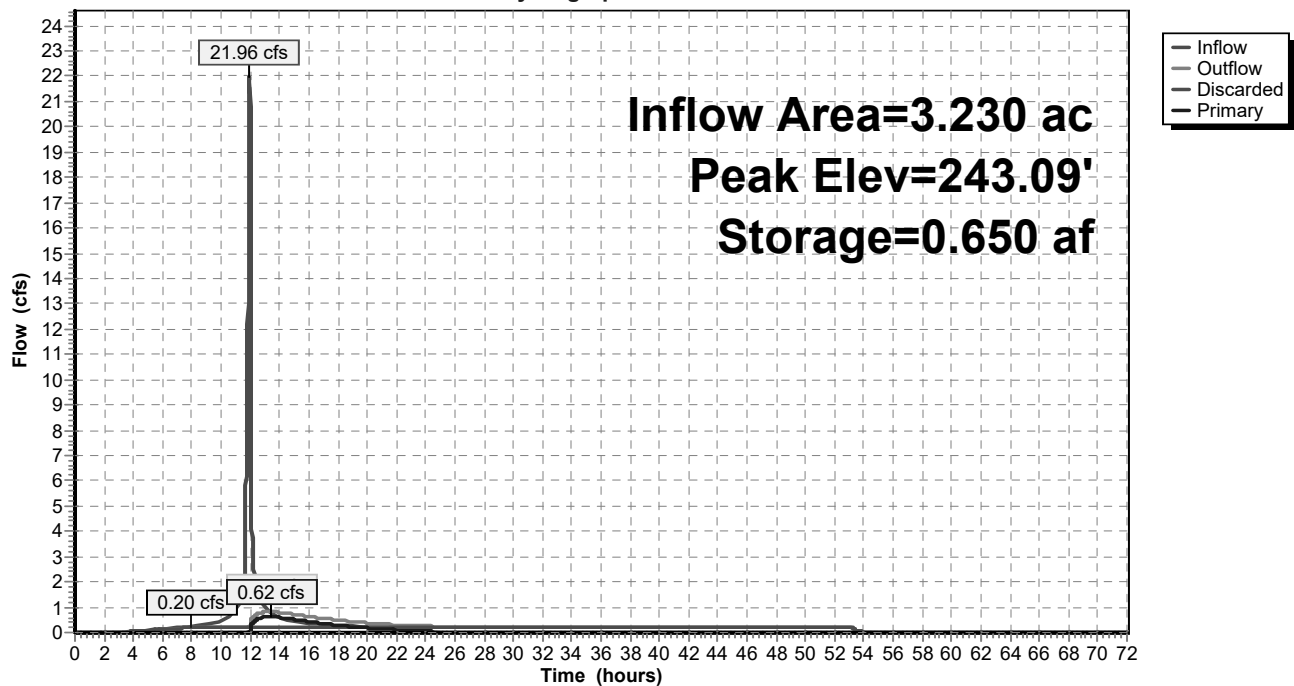
Type II 24-hr 10-YR Rainfall=4.81"

Printed 12/18/2017

Page 78

Pond 3P: P-1

Hydrograph



routings

Type II 24-hr 10-YR Rainfall=4.81"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 79

Summary for Pond 5P: P-2

Inflow Area = 2.740 ac, 0.00% Impervious, Inflow Depth = 4.46" for 10-YR event
Inflow = 19.23 cfs @ 11.96 hrs, Volume= 1.018 af
Outflow = 0.74 cfs @ 13.25 hrs, Volume= 1.018 af, Atten= 96%, Lag= 77.8 min
Discarded = 0.17 cfs @ 6.24 hrs, Volume= 0.753 af
Primary = 0.57 cfs @ 13.25 hrs, Volume= 0.265 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 256.24' @ 13.25 hrs Surf.Area= 0.341 ac Storage= 0.597 af

Plug-Flow detention time= 840.9 min calculated for 1.018 af (100% of inflow)
Center-of-Mass det. time= 840.9 min (1,592.6 - 751.7)

Volume	Invert	Avail.Storage	Storage Description
#1	253.50'	0.396 af	6.00'W x 2,479.00'L x 4.50'H Stone 1.537 af Overall - 0.548 af Embedded = 0.989 af x 40.0% Voids
#2	254.00'	0.548 af	42.0" Round Pipe Storage Inside #1 L= 2,479.0'
		0.943 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	254.00'	18.0" Round Culvert L= 16.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 254.00' / 253.80' S= 0.0125 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	253.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	255.65'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.17 cfs @ 6.24 hrs HW=253.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.17 cfs)

Primary OutFlow Max=0.57 cfs @ 13.25 hrs HW=256.24' (Free Discharge)
↑**1=Culvert** (Passes 0.57 cfs of 10.39 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.57 cfs @ 2.52 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

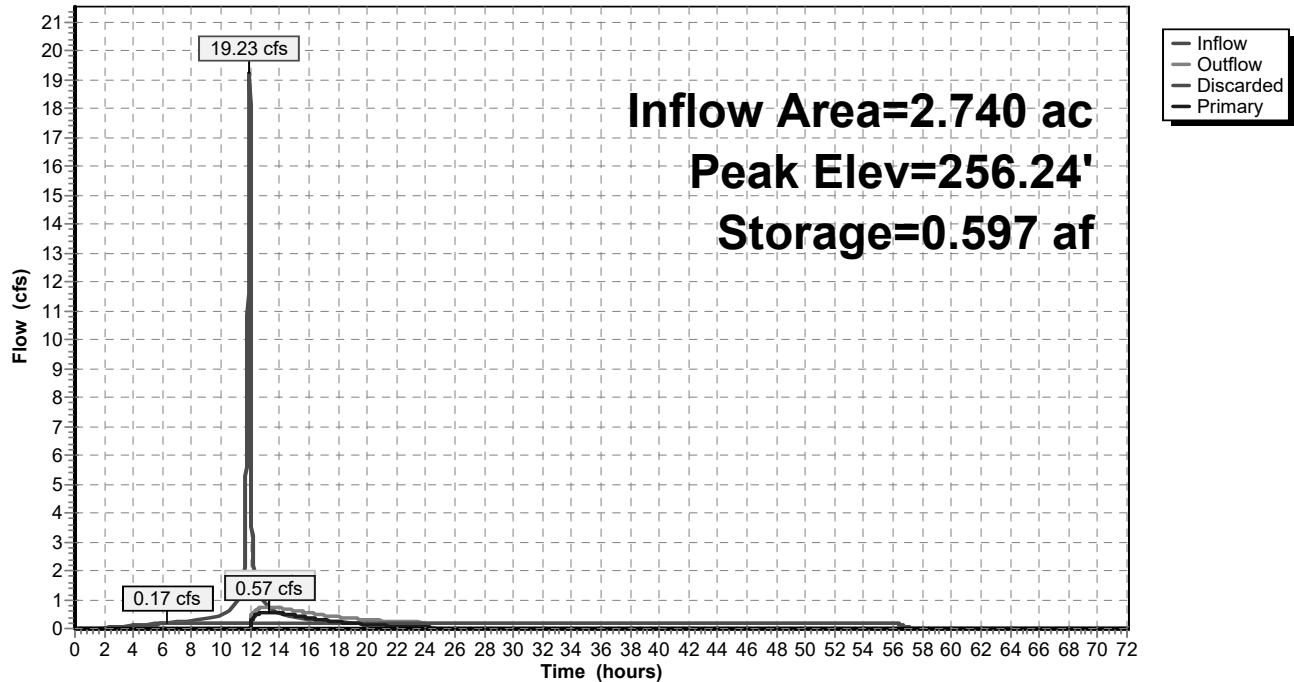
Type II 24-hr 10-YR Rainfall=4.81"

Printed 12/18/2017

Page 80

Pond 5P: P-2

Hydrograph



routings

Type II 24-hr 10-YR Rainfall=4.81"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 81

Summary for Pond 7P: P-3

Inflow Area = 3.710 ac, 100.00% Impervious, Inflow Depth = 4.57" for 10-YR event
Inflow = 26.21 cfs @ 11.96 hrs, Volume= 1.414 af
Outflow = 0.84 cfs @ 13.60 hrs, Volume= 1.414 af, Atten= 97%, Lag= 98.4 min
Discarded = 0.25 cfs @ 5.80 hrs, Volume= 1.084 af
Primary = 0.59 cfs @ 13.60 hrs, Volume= 0.330 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 258.21' @ 13.60 hrs Surf.Area= 0.488 ac Storage= 0.842 af

Plug-Flow detention time= 862.2 min calculated for 1.414 af (100% of inflow)
Center-of-Mass det. time= 862.1 min (1,605.8 - 743.7)

Volume	Invert	Avail.Storage	Storage Description
#1	255.50'	0.565 af	6.00'W x 3,541.00'L x 4.50'H Stone 2.195 af Overall - 0.782 af Embedded = 1.413 af x 40.0% Voids
#2	256.00'	0.782 af	42.0" Round Pipe Storage Inside #1 L= 3,541.0'
		1.347 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	256.00'	18.0" Round Culvert L= 33.4' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 256.00' / 255.70' S= 0.0090 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	255.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	257.60'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.25 cfs @ 5.80 hrs HW=255.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.25 cfs)

Primary OutFlow Max=0.59 cfs @ 13.60 hrs HW=258.21' (Free Discharge)
↑**1=Culvert** (Passes 0.59 cfs of 10.04 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.59 cfs @ 2.56 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

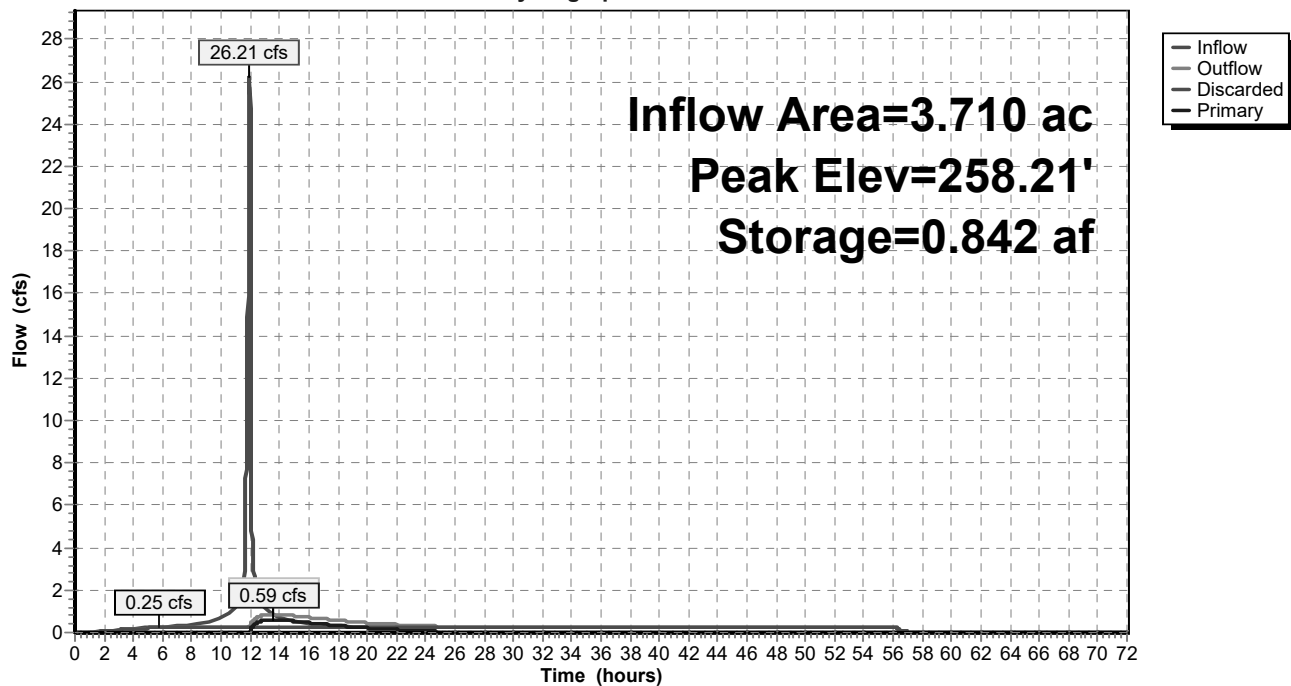
Type II 24-hr 10-YR Rainfall=4.81"

Printed 12/18/2017

Page 82

Pond 7P: P-3

Hydrograph



routings

Type II 24-hr 10-YR Rainfall=4.81"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 83

Summary for Pond 9P: P-4

Inflow Area = 2.100 ac, 0.00% Impervious, Inflow Depth = 3.49" for 10-YR event
 Inflow = 12.87 cfs @ 11.96 hrs, Volume= 0.611 af
 Outflow = 0.69 cfs @ 12.82 hrs, Volume= 0.611 af, Atten= 95%, Lag= 51.8 min
 Discarded = 0.14 cfs @ 9.57 hrs, Volume= 0.423 af
 Primary = 0.55 cfs @ 12.82 hrs, Volume= 0.187 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 Peak Elev= 259.48' @ 12.82 hrs Surf.Area= 0.279 ac Storage= 0.328 af

Plug-Flow detention time= 563.6 min calculated for 0.611 af (100% of inflow)
 Center-of-Mass det. time= 563.5 min (1,358.8 - 795.2)

Volume	Invert	Avail.Storage	Storage Description
#1	257.50'	0.189 af	87.00'W x 96.00'L x 3.50'H Stone 0.671 af Overall - 0.199 af Embedded = 0.472 af x 40.0% Voids
#2	258.00'	0.199 af	30.0" Round Pipe Storage x 19 Inside #1 L= 93.0'
#3	257.50'	0.053 af	31.50'W x 74.00'L x 3.50'H Stone 0.187 af Overall - 0.056 af Embedded = 0.131 af x 40.0% Voids
#4	258.00'	0.056 af	30.0" Round Pipe Storage x 7 Inside #3 L= 71.0'
#5	257.50'	0.033 af	31.50'W x 46.00'L x 3.50'H Stone 0.116 af Overall - 0.034 af Embedded = 0.083 af x 40.0% Voids
#6	258.00'	0.034 af	30.0" Round Pipe Storage x 7 Inside #5 L= 43.0'
		0.563 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	256.40'	18.0" Round Culvert L= 20.4' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 256.40' / 256.20' S= 0.0098 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	257.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	259.00'	0.6' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.14 cfs @ 9.57 hrs HW=257.54' (Free Discharge)

↑ **2=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=0.55 cfs @ 12.82 hrs HW=259.48' (Free Discharge)

↑ **1=Culvert** (Passes 0.55 cfs of 13.00 cfs potential flow)

↑ **3=Sharp-Crested Rectangular Weir** (Weir Controls 0.55 cfs @ 2.27 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

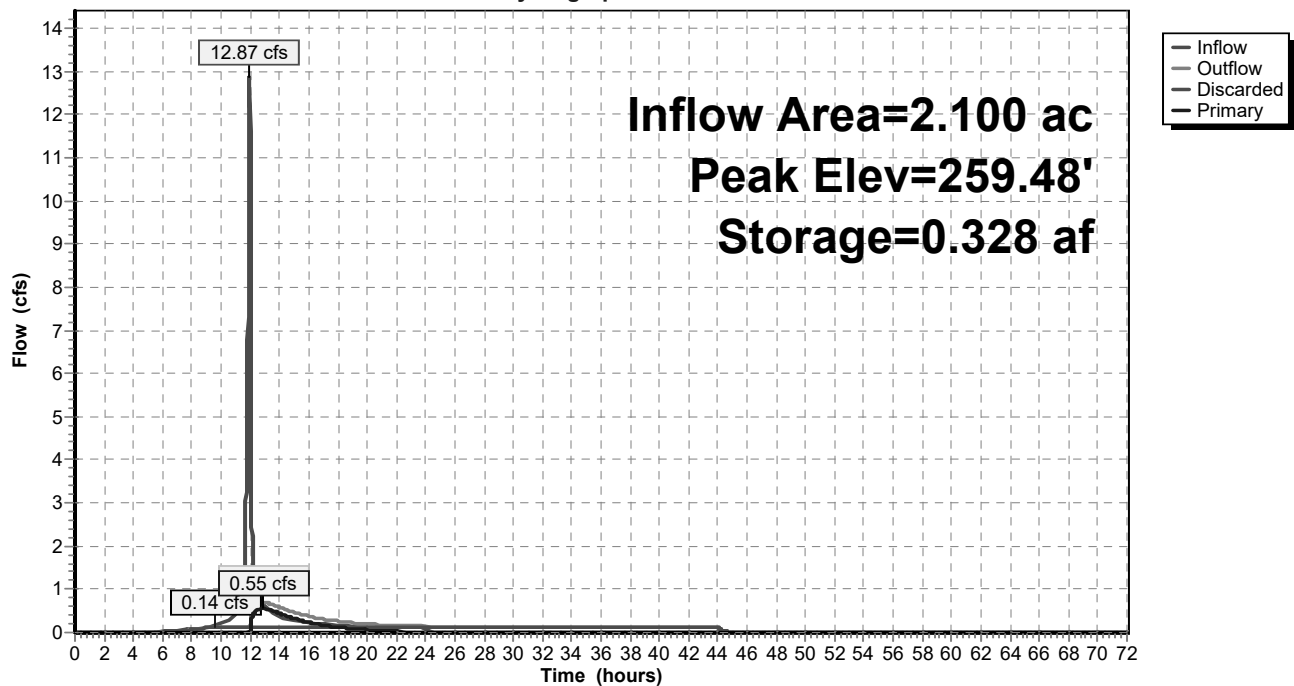
Type II 24-hr 10-YR Rainfall=4.81"

Printed 12/18/2017

Page 84

Pond 9P: P-4

Hydrograph



routings

Type II 24-hr 10-YR Rainfall=4.81"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 85

Summary for Pond 11P: P-5

Inflow Area = 1.470 ac, 0.00% Impervious, Inflow Depth = 3.90" for 10-YR event
Inflow = 9.71 cfs @ 11.96 hrs, Volume= 0.478 af
Outflow = 1.04 cfs @ 12.29 hrs, Volume= 0.478 af, Atten= 89%, Lag= 20.0 min
Discarded = 0.09 cfs @ 8.51 hrs, Volume= 0.326 af
Primary = 0.95 cfs @ 12.29 hrs, Volume= 0.152 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 259.68' @ 12.29 hrs Surf.Area= 0.182 ac Storage= 0.243 af

Plug-Flow detention time= 627.3 min calculated for 0.478 af (100% of inflow)
Center-of-Mass det. time= 627.3 min (1,407.0 - 779.7)

Volume	Invert	Avail.Storage	Storage Description
#1	257.50'	0.175 af	4.50'W x 1,757.00'L x 3.50'H Stone 0.635 af Overall - 0.198 af Embedded = 0.437 af x 40.0% Voids
#2	258.00'	0.198 af	30.0" Round Pipe Storage Inside #1 L= 1,757.0'
		0.373 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	258.00'	18.0" Round Culvert L= 40.8' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 258.00' / 257.50' S= 0.0123 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	257.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	259.30'	1.3' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.09 cfs @ 8.51 hrs HW=257.54' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.09 cfs)

Primary OutFlow Max=0.95 cfs @ 12.29 hrs HW=259.68' (Free Discharge)
↑**1=Culvert** (Passes 0.95 cfs of 8.22 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.95 cfs @ 2.02 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

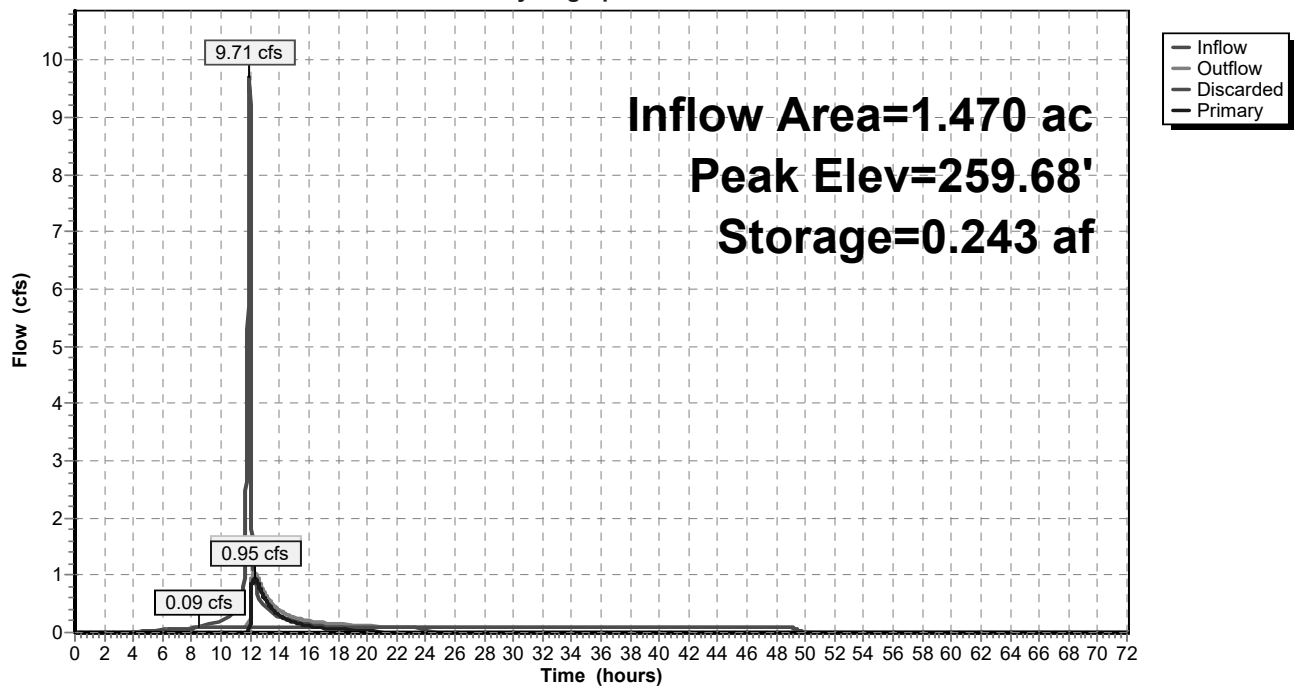
Type II 24-hr 10-YR Rainfall=4.81"

Printed 12/18/2017

Page 86

Pond 11P: P-5

Hydrograph



routings

Type II 24-hr 10-YR Rainfall=4.81"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 87

Summary for Pond 14P: P-6

Inflow Area = 1.790 ac, 0.00% Impervious, Inflow Depth = 3.80" for 10-YR event
Inflow = 11.62 cfs @ 11.96 hrs, Volume= 0.567 af
Outflow = 1.72 cfs @ 12.14 hrs, Volume= 0.566 af, Atten= 85%, Lag= 11.2 min
Primary = 1.72 cfs @ 12.14 hrs, Volume= 0.566 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 252.77' @ 12.14 hrs Surf.Area= 0.150 ac Storage= 0.284 af

Plug-Flow detention time= 308.3 min calculated for 0.566 af (100% of inflow)
Center-of-Mass det. time= 308.3 min (1,092.2 - 783.9)

Volume	Invert	Avail.Storage	Storage Description
#1	250.00'	0.165 af	28.00'W x 234.00'L x 4.50'H Stone 0.677 af Overall - 0.265 af Embedded = 0.411 af x 40.0% Voids
#2	250.00'	0.265 af	48.0" Round Pipe Storage x 4 Inside #1 L= 230.0'
		0.430 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	250.00'	18.0" Round Culvert L= 33.7' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 250.00' / 249.80' S= 0.0059 ' /' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	250.00'	3.0" Vert. Orifice/Grate C= 0.600
#3	Device 1	252.25'	1.2' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=1.72 cfs @ 12.14 hrs HW=252.77' (Free Discharge)

1=Culvert (Passes 1.72 cfs of 12.08 cfs potential flow)

2=Orifice/Grate (Orifice Controls 0.38 cfs @ 7.83 fps)

3=Sharp-Crested Rectangular Weir (Weir Controls 1.34 cfs @ 2.36 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

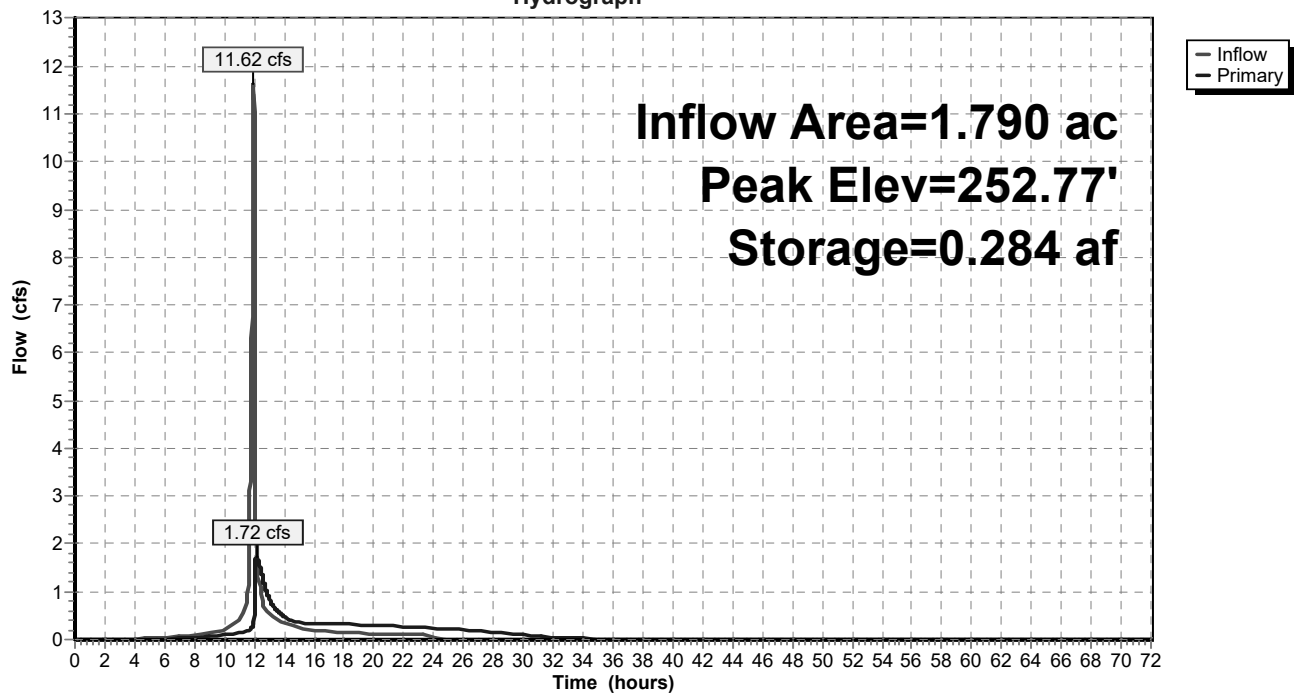
Type II 24-hr 10-YR Rainfall=4.81"

Printed 12/18/2017

Page 88

Pond 14P: P-6

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 10-YR Rainfall=4.81"

Printed 12/18/2017

Page 89

Summary for Link 12L: PO1#1

Inflow Area = 15.860 ac, 23.39% Impervious, Inflow Depth = 1.48" for 10-YR event

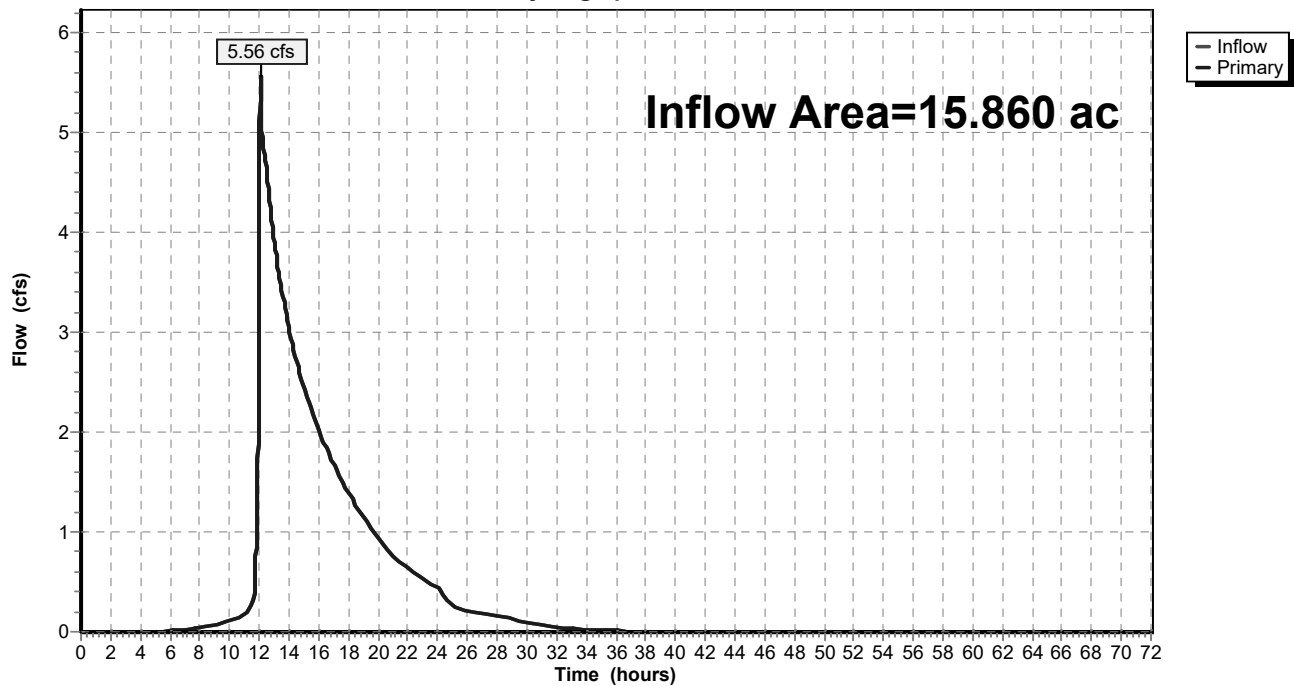
Inflow = 5.56 cfs @ 12.08 hrs, Volume= 1.953 af

Primary = 5.56 cfs @ 12.08 hrs, Volume= 1.953 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 12L: PO1#1

Hydrograph



routings

Type II 24-hr 25-YR Rainfall=5.84"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 90

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: E-1 (POI#1)	Runoff Area=15.860 ac 0.00% Impervious Runoff Depth=1.74" Tc=12.8 min CN=59 Runoff=36.69 cfs 2.296 af
Subcatchment2S: P-1	Runoff Area=3.230 ac 0.00% Impervious Runoff Depth=5.14" Tc=5.0 min CN=94 Runoff=27.00 cfs 1.383 af
Subcatchment3S: P-2	Runoff Area=2.740 ac 0.00% Impervious Runoff Depth=5.48" Tc=5.0 min CN=97 Runoff=23.43 cfs 1.252 af
Subcatchment4S: P-3	Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=5.60" Tc=5.0 min CN=98 Runoff=31.87 cfs 1.732 af
Subcatchment5S: P-4	Runoff Area=2.100 ac 0.00% Impervious Runoff Depth=4.47" Tc=5.0 min CN=88 Runoff=16.23 cfs 0.783 af
Subcatchment6S: P-5	Runoff Area=1.470 ac 0.00% Impervious Runoff Depth=4.91" Tc=5.0 min CN=92 Runoff=12.02 cfs 0.602 af
Subcatchment7S: P-6	Runoff Area=1.790 ac 0.00% Impervious Runoff Depth=4.80" Tc=5.0 min CN=91 Runoff=14.46 cfs 0.716 af
Subcatchment8S: P-7	Runoff Area=0.820 ac 0.00% Impervious Runoff Depth=2.86" Tc=10.0 min CN=72 Runoff=3.62 cfs 0.196 af
Pond 3P: P-1	Peak Elev=243.59' Storage=0.796 af Inflow=27.00 cfs 1.383 af Discarded=0.20 cfs 0.827 af Primary=1.08 cfs 0.556 af Outflow=1.28 cfs 1.383 af
Pond 5P: P-2	Peak Elev=256.74' Storage=0.719 af Inflow=23.43 cfs 1.252 af Discarded=0.17 cfs 0.775 af Primary=1.05 cfs 0.478 af Outflow=1.22 cfs 1.252 af
Pond 7P: P-3	Peak Elev=258.71' Storage=1.017 af Inflow=31.87 cfs 1.732 af Discarded=0.25 cfs 1.121 af Primary=1.06 cfs 0.611 af Outflow=1.31 cfs 1.732 af
Pond 9P: P-4	Peak Elev=259.89' Storage=0.407 af Inflow=16.23 cfs 0.783 af Discarded=0.14 cfs 0.442 af Primary=1.16 cfs 0.341 af Outflow=1.30 cfs 0.783 af
Pond 11P: P-5	Peak Elev=260.08' Storage=0.293 af Inflow=12.02 cfs 0.602 af Discarded=0.09 cfs 0.337 af Primary=2.56 cfs 0.265 af Outflow=2.65 cfs 0.602 af
Pond 14P: P-6	Peak Elev=253.31' Storage=0.340 af Inflow=14.46 cfs 0.716 af Outflow=3.96 cfs 0.716 af
Link 12L: PO1#1	Inflow=13.03 cfs 3.162 af Primary=13.03 cfs 3.162 af

Total Runoff Area = 31.720 ac Runoff Volume = 8.960 af Average Runoff Depth = 3.39"
88.30% Pervious = 28.010 ac 11.70% Impervious = 3.710 ac

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 25-YR Rainfall=5.84"

Printed 12/18/2017

Page 91

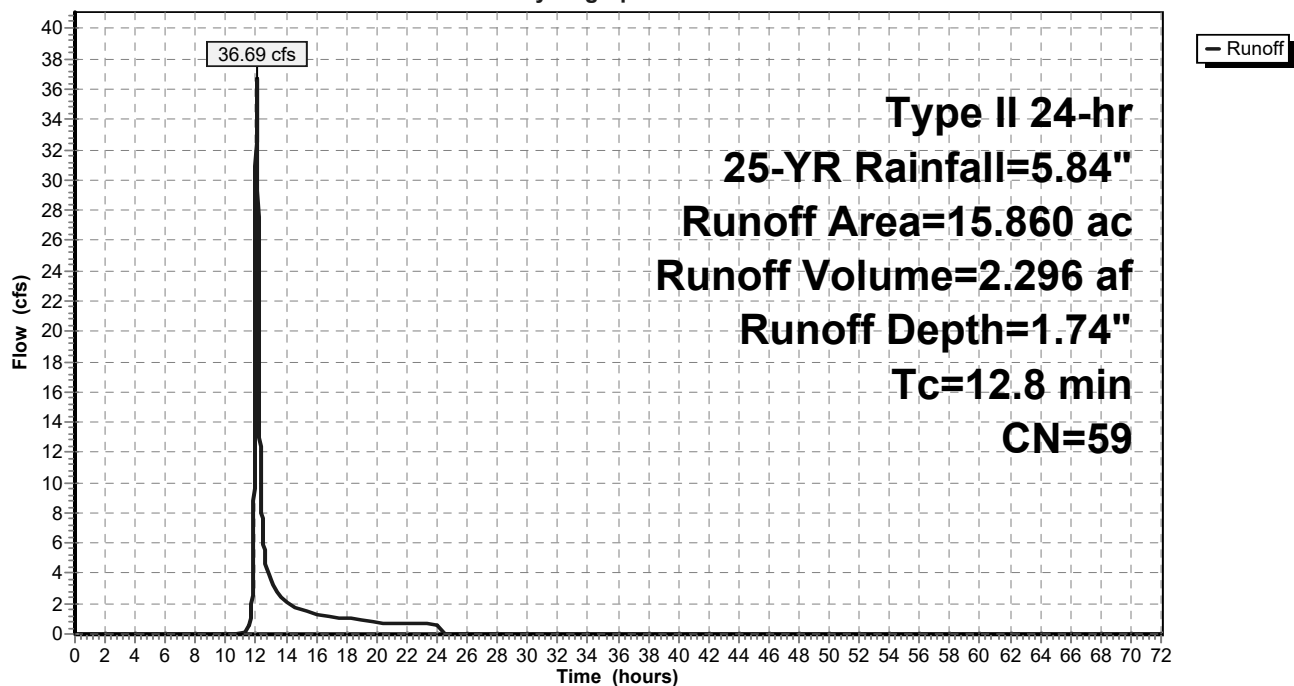
Runoff = 36.69 cfs @ 12.06 hrs, Volume= 2.296 af, Depth= 1.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-YR Rainfall=5.84"

Area (ac)	CN	Description
* 15.860	59	SEE CN WORKSHEETS
15.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.8					Direct Entry,

Hydrograph



Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 25-YR Rainfall=5.84"

Printed 12/18/2017

Page 92

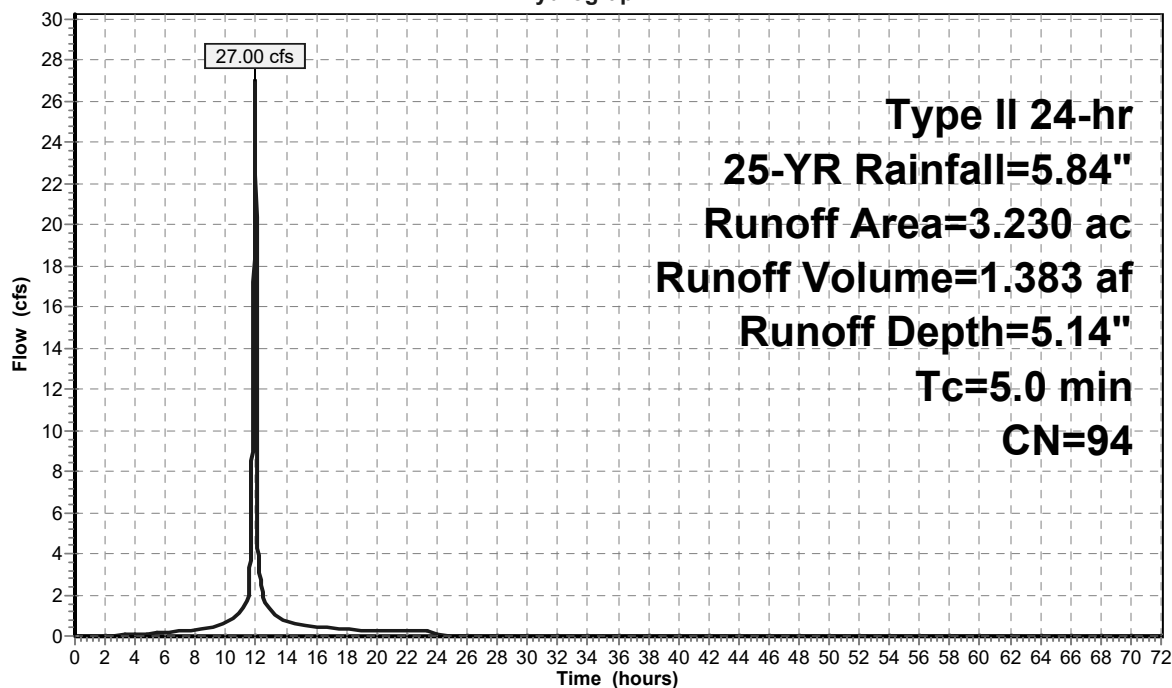
Runoff = 27.00 cfs @ 11.96 hrs, Volume= 1.383 af, Depth= 5.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-YR Rainfall=5.84"

Area (ac)	CN	Description
* 3.230	94	SEE CN WORKSHEETS
3.230		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Hydrograph



Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 25-YR Rainfall=5.84"

Printed 12/18/2017

Page 93

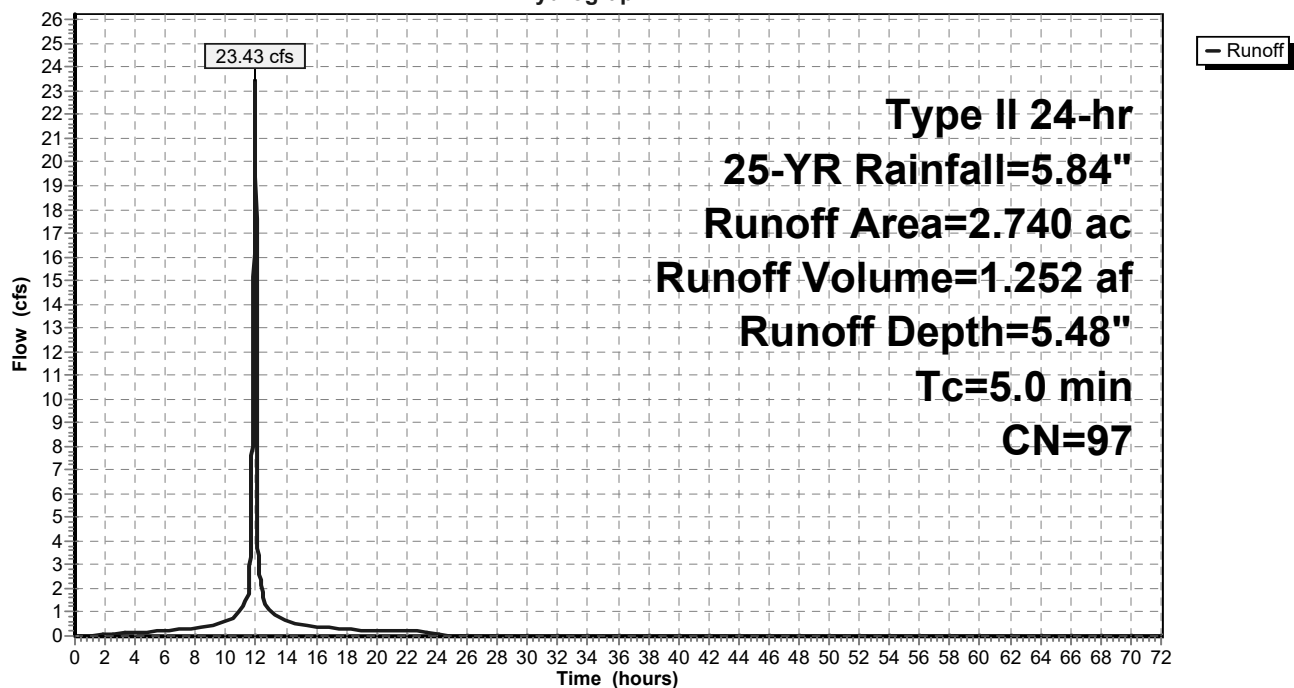
Runoff = 23.43 cfs @ 11.96 hrs, Volume= 1.252 af, Depth= 5.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-YR Rainfall=5.84"

Area (ac)	CN	Description
* 2.740	97	SEE CN WORKSHEETS
2.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 25-YR Rainfall=5.84"

Printed 12/18/2017

Page 94

Summary for Subcatchment 4S: P-3

Runoff = 31.87 cfs @ 11.96 hrs, Volume= 1.732 af, Depth= 5.60"

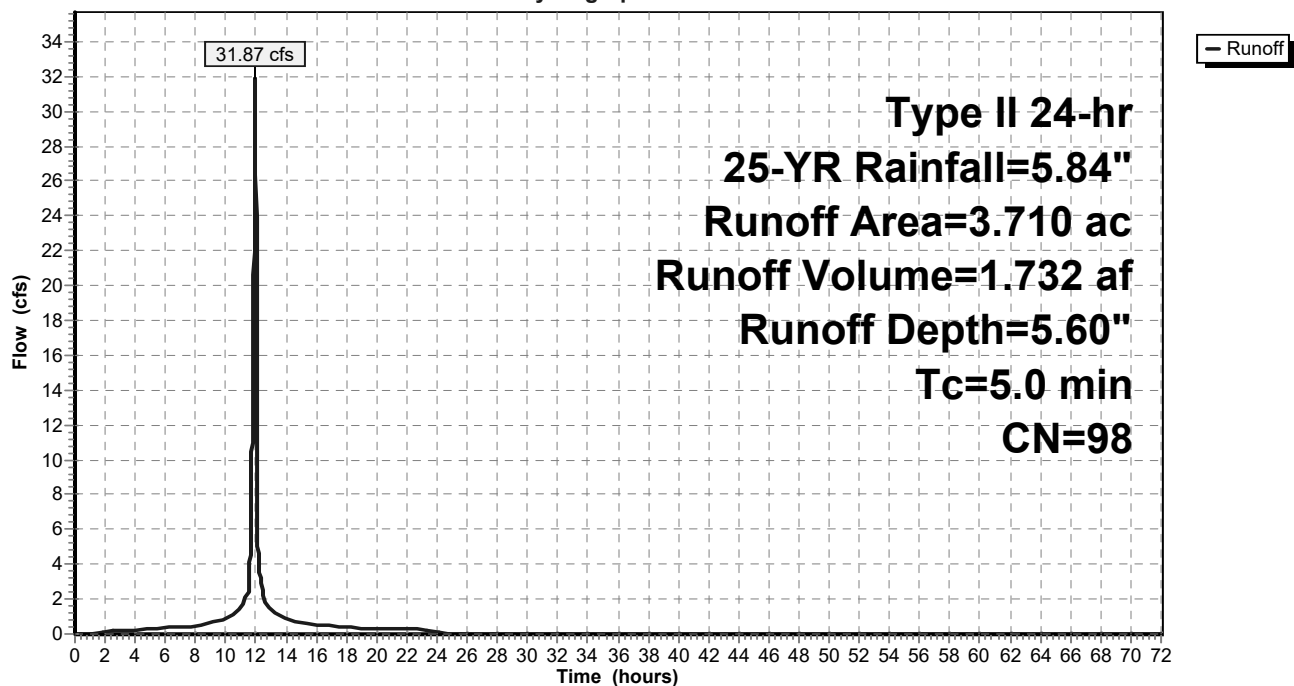
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-YR Rainfall=5.84"

Area (ac)	CN	Description
* 3.710	98	SEE CN WORKSHEETS
3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 4S: P-3

Hydrograph



Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 25-YR Rainfall=5.84"

Printed 12/18/2017

Page 95

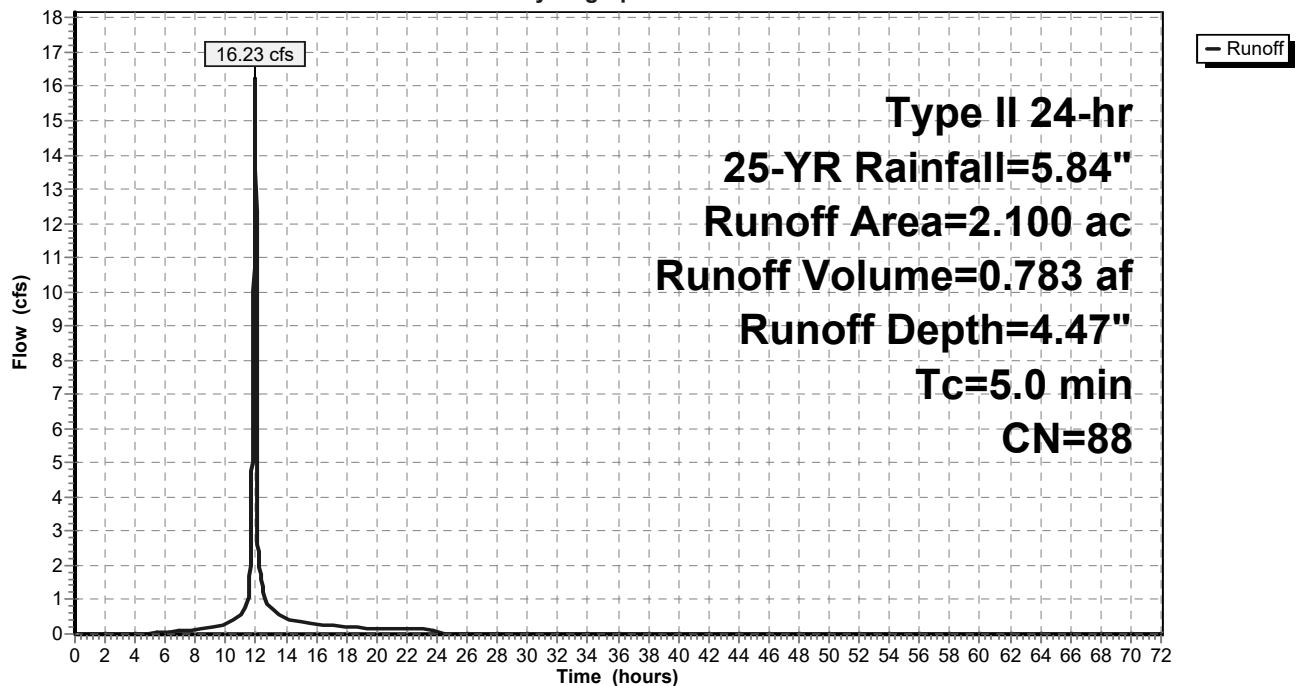
Runoff = 16.23 cfs @ 11.96 hrs, Volume= 0.783 af, Depth= 4.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-YR Rainfall=5.84"

Area (ac)	CN	Description
* 2.100	88	SEE CN WORKSHEETS
2.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Hydrograph



Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 25-YR Rainfall=5.84"

Printed 12/18/2017

Page 96

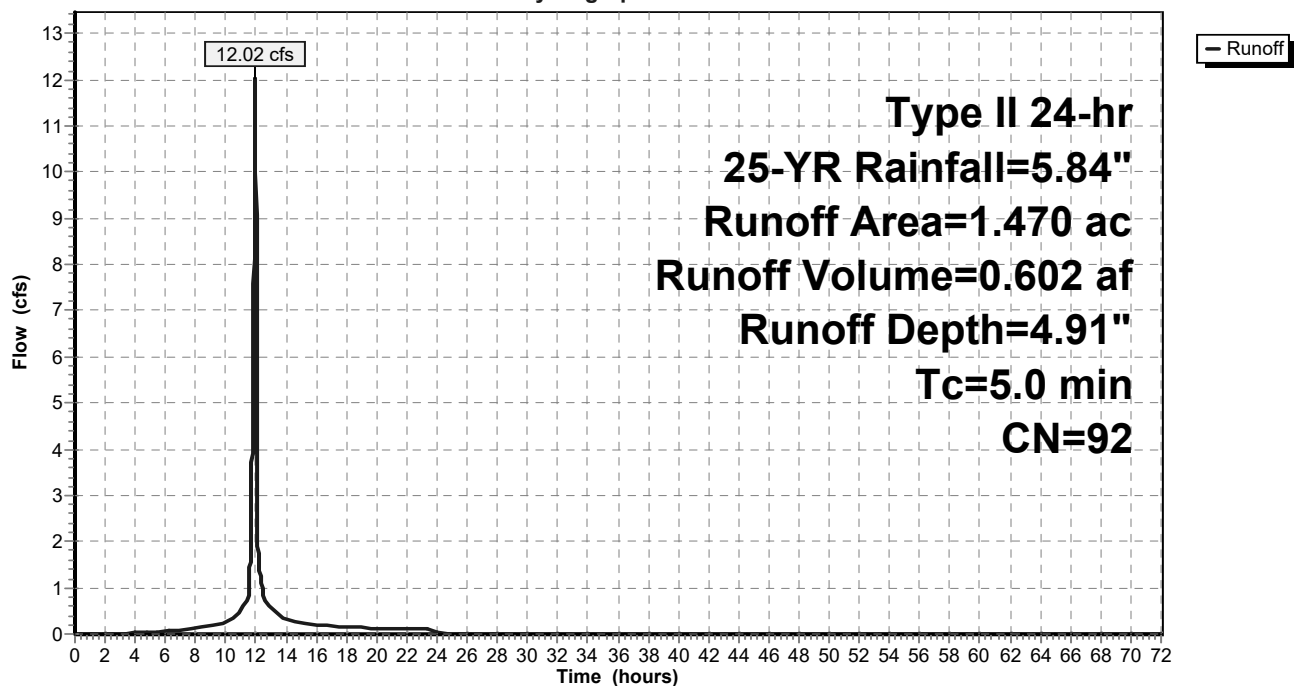
Runoff = 12.02 cfs @ 11.96 hrs, Volume= 0.602 af, Depth= 4.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-YR Rainfall=5.84"

Area (ac)	CN	Description
* 1.470	92	SEE CN WORKSHEETS
1.470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 25-YR Rainfall=5.84"

Printed 12/18/2017

Page 97

Summary for Subcatchment 7S: P-6

Runoff = 14.46 cfs @ 11.96 hrs, Volume= 0.716 af, Depth= 4.80"

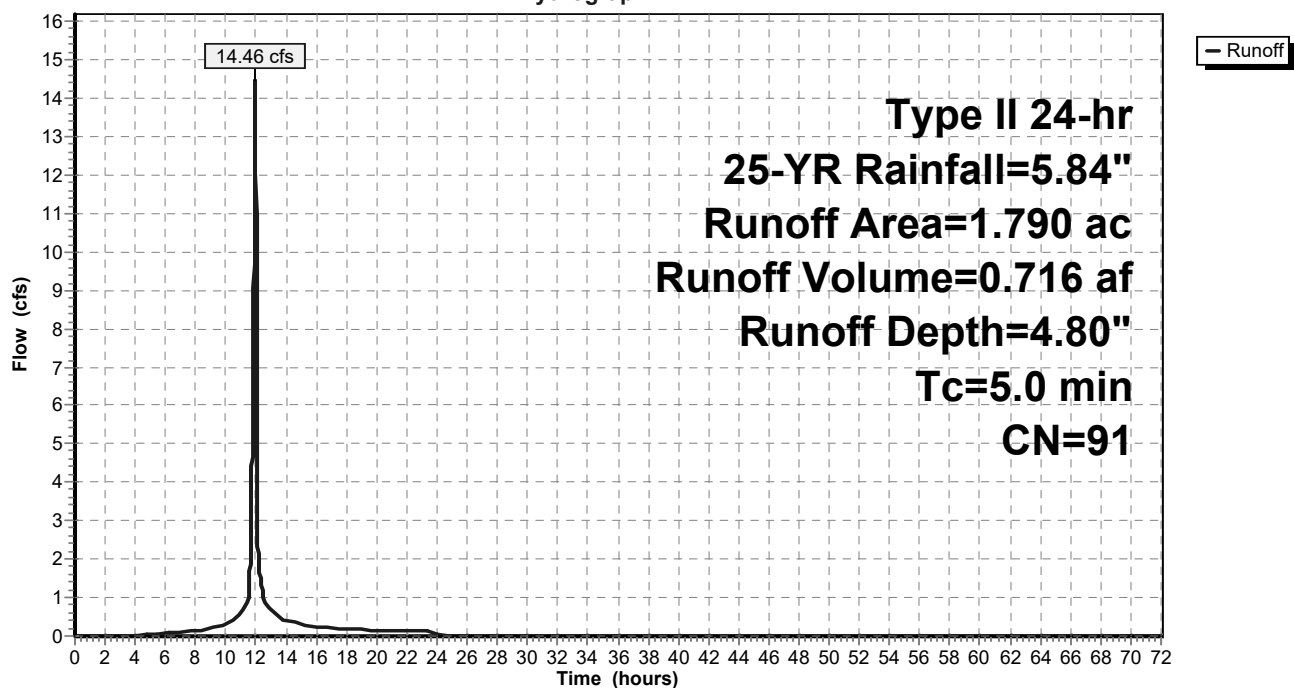
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-YR Rainfall=5.84"

Area (ac)	CN	Description
* 1.790	91	SEE CN WORKSHEETS
1.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 7S: P-6

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 25-YR Rainfall=5.84"

Printed 12/18/2017

Page 98

Summary for Subcatchment 8S: P-7

Runoff = 3.62 cfs @ 12.02 hrs, Volume= 0.196 af, Depth= 2.86"

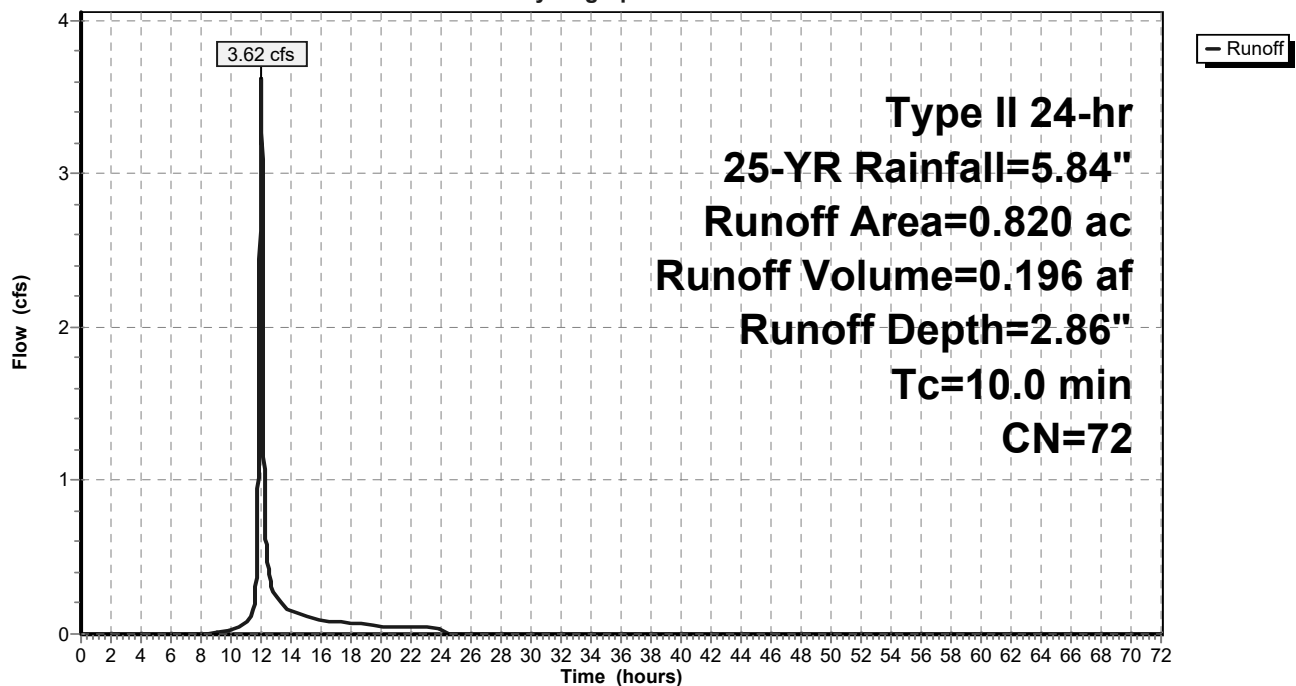
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 25-YR Rainfall=5.84"

Area (ac)	CN	Description
* 0.820	72	SEE CN WORKSHEETS
0.820		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry,

Subcatchment 8S: P-7

Hydrograph



routings

Type II 24-hr 25-YR Rainfall=5.84"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 99

Summary for Pond 3P: P-1

Inflow Area = 3.230 ac, 0.00% Impervious, Inflow Depth = 5.14" for 25-YR event
Inflow = 27.00 cfs @ 11.96 hrs, Volume= 1.383 af
Outflow = 1.28 cfs @ 12.93 hrs, Volume= 1.383 af, Atten= 95%, Lag= 58.5 min
Discarded = 0.20 cfs @ 6.59 hrs, Volume= 0.827 af
Primary = 1.08 cfs @ 12.93 hrs, Volume= 0.556 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 243.59' @ 12.93 hrs Surf.Area= 0.398 ac Storage= 0.796 af

Plug-Flow detention time= 681.0 min calculated for 1.383 af (100% of inflow)
Center-of-Mass det. time= 681.2 min (1,445.9 - 764.7)

Volume	Invert	Avail.Storage	Storage Description
#1	240.50'	0.462 af	6.00'W x 2,892.00'L x 4.50'H Stone 1.793 af Overall - 0.639 af Embedded = 1.154 af x 40.0% Voids
#2	241.00'	0.639 af	42.0" Round Pipe Storage Inside #1 L= 2,892.0'
		1.100 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	241.00'	18.0" Round Culvert L= 15.9' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 241.00' / 240.90' S= 0.0063 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	240.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	242.45'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.20 cfs @ 6.59 hrs HW=240.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.20 cfs)

Primary OutFlow Max=1.08 cfs @ 12.93 hrs HW=243.59' (Free Discharge)
↑**1=Culvert** (Passes 1.08 cfs of 11.54 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 1.08 cfs @ 3.49 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

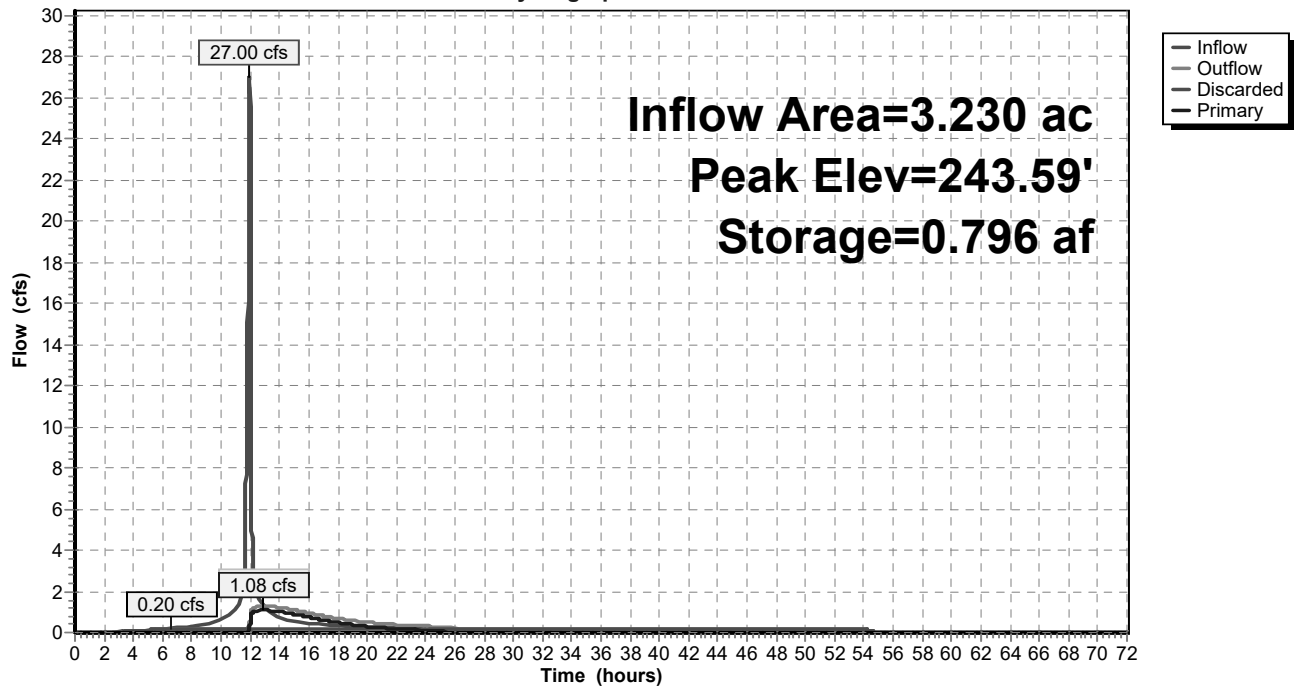
Type II 24-hr 25-YR Rainfall=5.84"

Printed 12/18/2017

Page 100

Pond 3P: P-1

Hydrograph



routings

Type II 24-hr 25-YR Rainfall=5.84"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 101

Summary for Pond 5P: P-2

Inflow Area = 2.740 ac, 0.00% Impervious, Inflow Depth = 5.48" for 25-YR event
Inflow = 23.43 cfs @ 11.96 hrs, Volume= 1.252 af
Outflow = 1.22 cfs @ 12.78 hrs, Volume= 1.252 af, Atten= 95%, Lag= 49.7 min
Discarded = 0.17 cfs @ 5.04 hrs, Volume= 0.775 af
Primary = 1.05 cfs @ 12.78 hrs, Volume= 0.478 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 256.74' @ 12.78 hrs Surf.Area= 0.341 ac Storage= 0.719 af

Plug-Flow detention time= 736.6 min calculated for 1.252 af (100% of inflow)
Center-of-Mass det. time= 736.6 min (1,484.4 - 747.8)

Volume	Invert	Avail.Storage	Storage Description
#1	253.50'	0.396 af	6.00'W x 2,479.00'L x 4.50'H Stone 1.537 af Overall - 0.548 af Embedded = 0.989 af x 40.0% Voids
#2	254.00'	0.548 af	42.0" Round Pipe Storage Inside #1 L= 2,479.0'
		0.943 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	254.00'	18.0" Round Culvert L= 16.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 254.00' / 253.80' S= 0.0125 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	253.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	255.65'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.17 cfs @ 5.04 hrs HW=253.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.17 cfs)

Primary OutFlow Max=1.05 cfs @ 12.78 hrs HW=256.74' (Free Discharge)
↑**1=Culvert** (Passes 1.05 cfs of 12.01 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 1.05 cfs @ 3.42 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

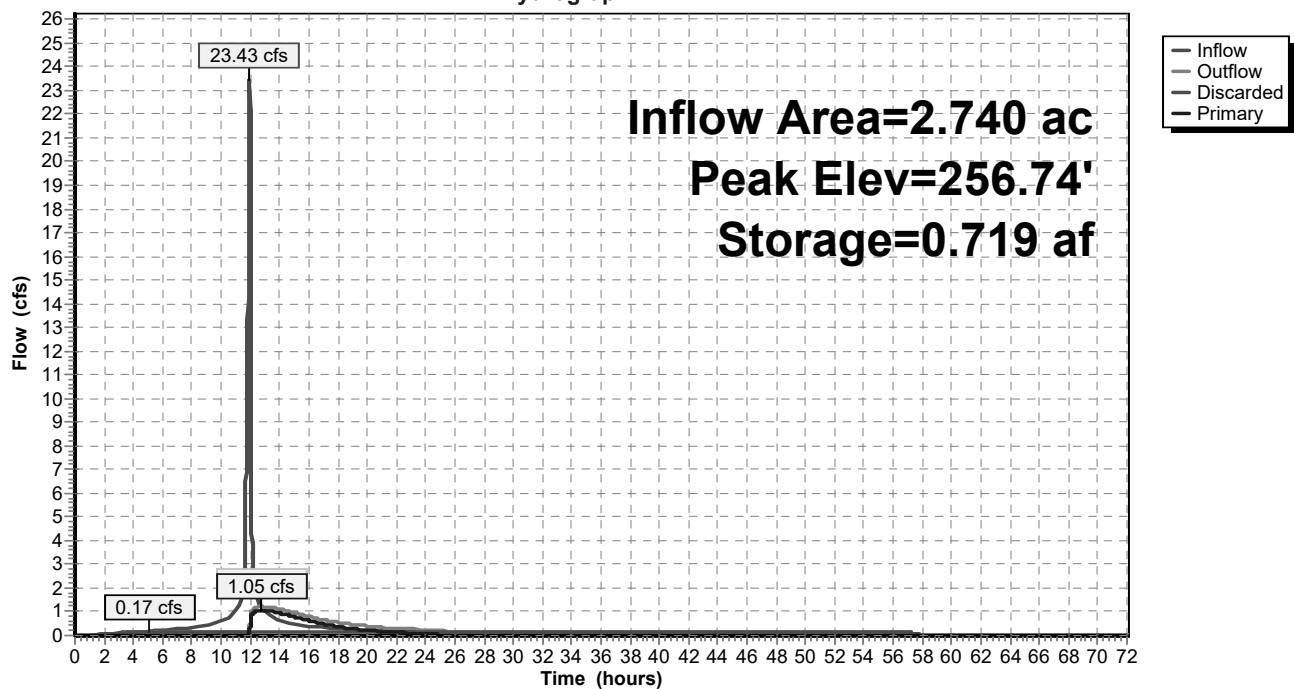
Type II 24-hr 25-YR Rainfall=5.84"

Printed 12/18/2017

Page 102

Pond 5P: P-2

Hydrograph



routings

Type II 24-hr 25-YR Rainfall=5.84"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 103

Summary for Pond 7P: P-3

Inflow Area = 3.710 ac, 100.00% Impervious, Inflow Depth = 5.60" for 25-YR event
Inflow = 31.87 cfs @ 11.96 hrs, Volume= 1.732 af
Outflow = 1.31 cfs @ 13.11 hrs, Volume= 1.732 af, Atten= 96%, Lag= 69.4 min
Discarded = 0.25 cfs @ 4.57 hrs, Volume= 1.121 af
Primary = 1.06 cfs @ 13.11 hrs, Volume= 0.611 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 258.71' @ 13.11 hrs Surf.Area= 0.488 ac Storage= 1.017 af

Plug-Flow detention time= 775.9 min calculated for 1.732 af (100% of inflow)
Center-of-Mass det. time= 775.9 min (1,516.4 - 740.5)

Volume	Invert	Avail.Storage	Storage Description
#1	255.50'	0.565 af	6.00'W x 3,541.00'L x 4.50'H Stone 2.195 af Overall - 0.782 af Embedded = 1.413 af x 40.0% Voids
#2	256.00'	0.782 af	42.0" Round Pipe Storage Inside #1 L= 3,541.0'
		1.347 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	256.00'	18.0" Round Culvert L= 33.4' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 256.00' / 255.70' S= 0.0090 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	255.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	257.60'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.25 cfs @ 4.57 hrs HW=255.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.25 cfs)

Primary OutFlow Max=1.07 cfs @ 13.11 hrs HW=258.71' (Free Discharge)
↑**1=Culvert** (Passes 1.07 cfs of 11.92 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 1.07 cfs @ 3.45 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

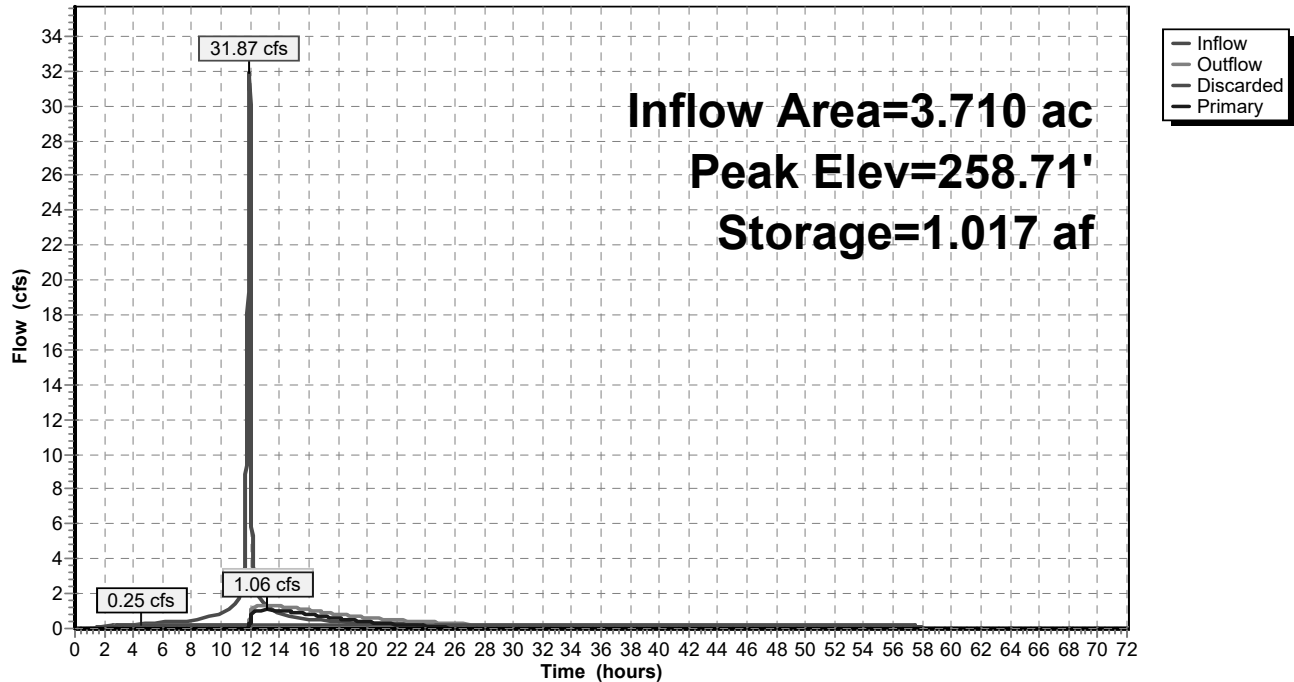
Type II 24-hr 25-YR Rainfall=5.84"

Printed 12/18/2017

Page 104

Pond 7P: P-3

Hydrograph



routings

Type II 24-hr 25-YR Rainfall=5.84"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 105

Summary for Pond 9P: P-4

Inflow Area = 2.100 ac, 0.00% Impervious, Inflow Depth = 4.47" for 25-YR event
 Inflow = 16.23 cfs @ 11.96 hrs, Volume= 0.783 af
 Outflow = 1.30 cfs @ 12.47 hrs, Volume= 0.783 af, Atten= 92%, Lag= 30.5 min
 Discarded = 0.14 cfs @ 8.71 hrs, Volume= 0.442 af
 Primary = 1.16 cfs @ 12.47 hrs, Volume= 0.341 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 Peak Elev= 259.89' @ 12.47 hrs Surf.Area= 0.279 ac Storage= 0.407 af

Plug-Flow detention time= 475.6 min calculated for 0.782 af (100% of inflow)
 Center-of-Mass det. time= 475.7 min (1,264.0 - 788.3)

Volume	Invert	Avail.Storage	Storage Description
#1	257.50'	0.189 af	87.00'W x 96.00'L x 3.50'H Stone 0.671 af Overall - 0.199 af Embedded = 0.472 af x 40.0% Voids
#2	258.00'	0.199 af	30.0" Round Pipe Storage x 19 Inside #1 L= 93.0'
#3	257.50'	0.053 af	31.50'W x 74.00'L x 3.50'H Stone 0.187 af Overall - 0.056 af Embedded = 0.131 af x 40.0% Voids
#4	258.00'	0.056 af	30.0" Round Pipe Storage x 7 Inside #3 L= 71.0'
#5	257.50'	0.033 af	31.50'W x 46.00'L x 3.50'H Stone 0.116 af Overall - 0.034 af Embedded = 0.083 af x 40.0% Voids
#6	258.00'	0.034 af	30.0" Round Pipe Storage x 7 Inside #5 L= 43.0'
		0.563 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	256.40'	18.0" Round Culvert L= 20.4' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 256.40' / 256.20' S= 0.0098 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	257.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	259.00'	0.6' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.14 cfs @ 8.71 hrs HW=257.54' (Free Discharge)

↑**2=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=1.16 cfs @ 12.47 hrs HW=259.89' (Free Discharge)

↑**1=Culvert** (Passes 1.16 cfs of 14.08 cfs potential flow)

↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 1.16 cfs @ 3.08 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

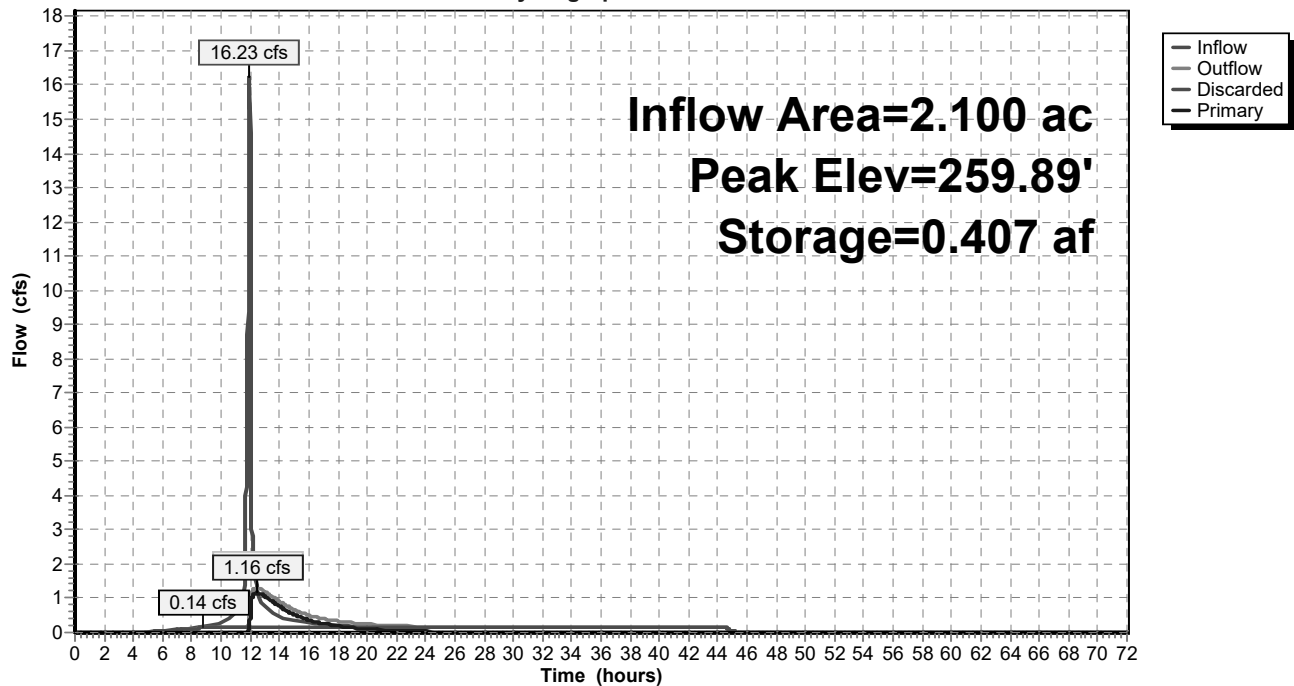
Type II 24-hr 25-YR Rainfall=5.84"

Printed 12/18/2017

Page 106

Pond 9P: P-4

Hydrograph



routings

Type II 24-hr 25-YR Rainfall=5.84"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 107

Summary for Pond 11P: P-5

Inflow Area = 1.470 ac, 0.00% Impervious, Inflow Depth = 4.91" for 25-YR event
Inflow = 12.02 cfs @ 11.96 hrs, Volume= 0.602 af
Outflow = 2.65 cfs @ 12.09 hrs, Volume= 0.602 af, Atten= 78%, Lag= 8.2 min
Discarded = 0.09 cfs @ 7.38 hrs, Volume= 0.337 af
Primary = 2.56 cfs @ 12.09 hrs, Volume= 0.265 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 260.08' @ 12.09 hrs Surf.Area= 0.182 ac Storage= 0.293 af

Plug-Flow detention time= 517.6 min calculated for 0.602 af (100% of inflow)
Center-of-Mass det. time= 517.7 min (1,291.3 - 773.6)

Volume	Invert	Avail.Storage	Storage Description
#1	257.50'	0.175 af	4.50'W x 1,757.00'L x 3.50'H Stone 0.635 af Overall - 0.198 af Embedded = 0.437 af x 40.0% Voids
#2	258.00'	0.198 af	30.0" Round Pipe Storage Inside #1 L= 1,757.0'
		0.373 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	258.00'	18.0" Round Culvert L= 40.8' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 258.00' / 257.50' S= 0.0123 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	257.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	259.30'	1.3' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.09 cfs @ 7.38 hrs HW=257.54' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.09 cfs)

Primary OutFlow Max=2.56 cfs @ 12.09 hrs HW=260.08' (Free Discharge)
↑**1=Culvert** (Passes 2.56 cfs of 9.80 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 2.56 cfs @ 2.88 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

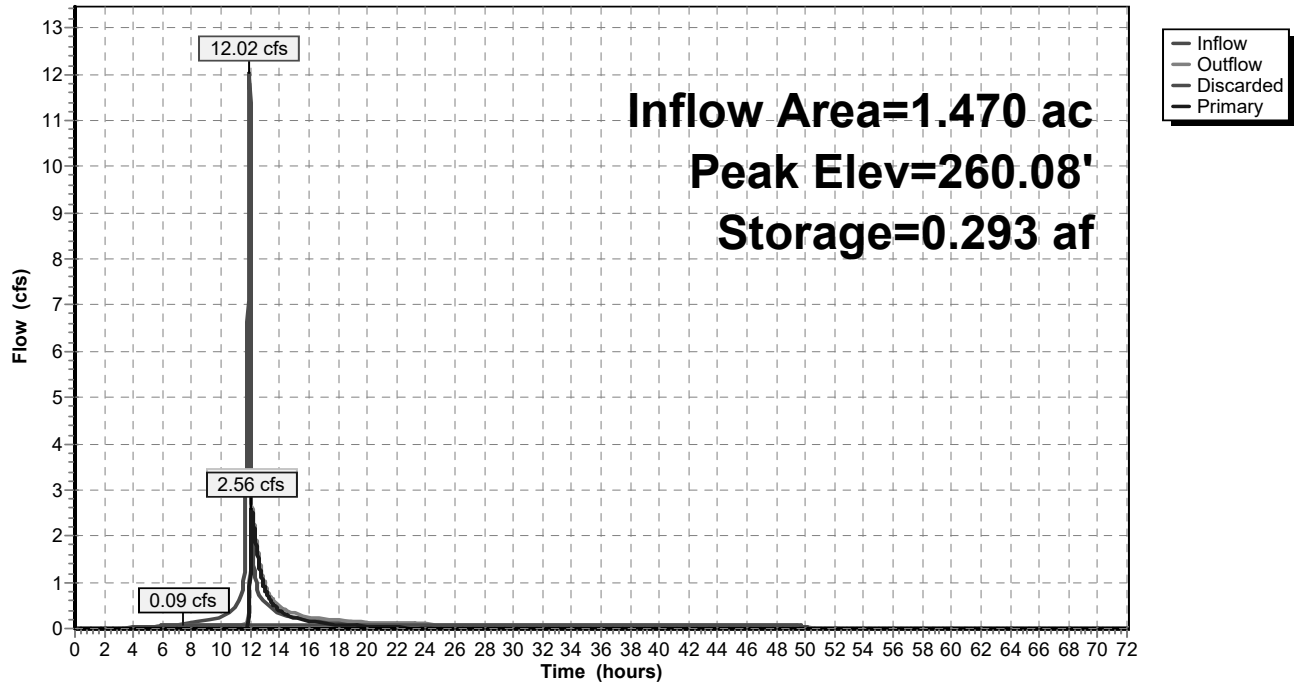
Type II 24-hr 25-YR Rainfall=5.84"

Printed 12/18/2017

Page 108

Pond 11P: P-5

Hydrograph



routings

Type II 24-hr 25-YR Rainfall=5.84"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 109

Summary for Pond 14P: P-6

Inflow Area = 1.790 ac, 0.00% Impervious, Inflow Depth = 4.80" for 25-YR event
Inflow = 14.46 cfs @ 11.96 hrs, Volume= 0.716 af
Outflow = 3.96 cfs @ 12.08 hrs, Volume= 0.716 af, Atten= 73%, Lag= 7.3 min
Primary = 3.96 cfs @ 12.08 hrs, Volume= 0.716 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 253.31' @ 12.08 hrs Surf.Area= 0.150 ac Storage= 0.340 af

Plug-Flow detention time= 271.4 min calculated for 0.716 af (100% of inflow)
Center-of-Mass det. time= 271.3 min (1,048.9 - 777.6)

Volume	Invert	Avail.Storage	Storage Description
#1	250.00'	0.165 af	28.00'W x 234.00'L x 4.50'H Stone 0.677 af Overall - 0.265 af Embedded = 0.411 af x 40.0% Voids
#2	250.00'	0.265 af	48.0" Round Pipe Storage x 4 Inside #1 L= 230.0'
		0.430 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	250.00'	18.0" Round Culvert L= 33.7' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 250.00' / 249.80' S= 0.0059 ' /' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	250.00'	3.0" Vert. Orifice/Grate C= 0.600
#3	Device 1	252.25'	1.2' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=3.95 cfs @ 12.08 hrs HW=253.31' (Free Discharge)

1=Culvert (Passes 3.95 cfs of 13.62 cfs potential flow)

2=Orifice/Grate (Orifice Controls 0.42 cfs @ 8.60 fps)

3=Sharp-Crested Rectangular Weir (Weir Controls 3.53 cfs @ 3.37 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

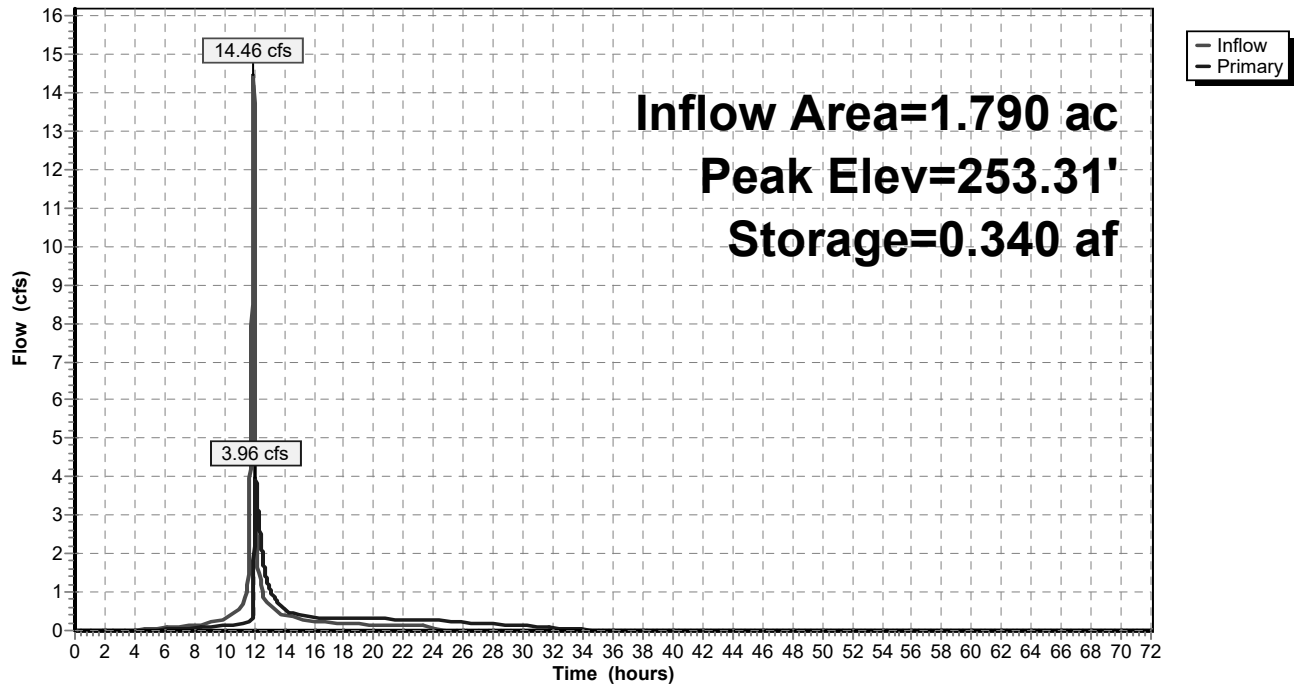
Type II 24-hr 25-YR Rainfall=5.84"

Printed 12/18/2017

Page 110

Pond 14P: P-6

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 25-YR Rainfall=5.84"

Printed 12/18/2017

Page 111

Summary for Link 12L: PO1#1

Inflow Area = 15.860 ac, 23.39% Impervious, Inflow Depth = 2.39" for 25-YR event

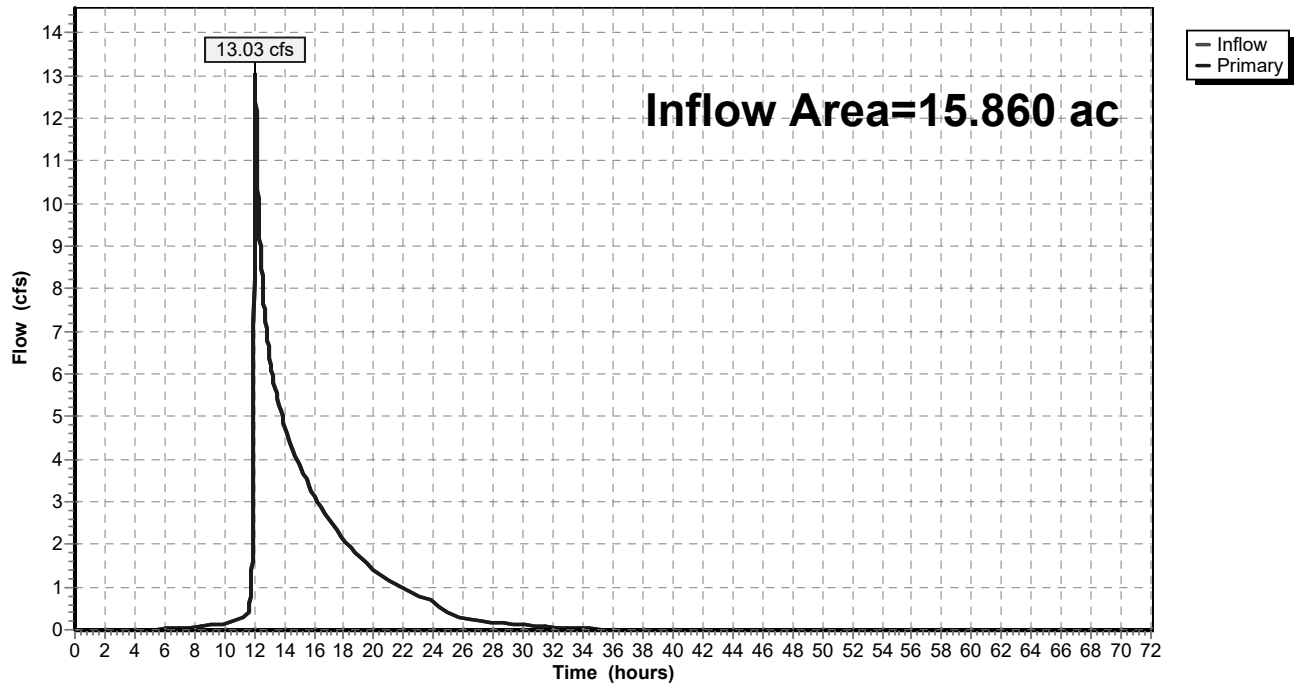
Inflow = 13.03 cfs @ 12.06 hrs, Volume= 3.162 af

Primary = 13.03 cfs @ 12.06 hrs, Volume= 3.162 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 12L: PO1#1

Hydrograph



routings

Type II 24-hr 50-YR Rainfall=6.70"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 112

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: E-1 (PO1#1)	Runoff Area=15.860 ac 0.00% Impervious Runoff Depth=2.30" Tc=12.8 min CN=59 Runoff=49.69 cfs 3.040 af
Subcatchment2S: P-1	Runoff Area=3.230 ac 0.00% Impervious Runoff Depth=5.99" Tc=5.0 min CN=94 Runoff=31.18 cfs 1.612 af
Subcatchment3S: P-2	Runoff Area=2.740 ac 0.00% Impervious Runoff Depth=6.34" Tc=5.0 min CN=97 Runoff=26.93 cfs 1.448 af
Subcatchment4S: P-3	Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=6.46" Tc=5.0 min CN=98 Runoff=36.60 cfs 1.998 af
Subcatchment5S: P-4	Runoff Area=2.100 ac 0.00% Impervious Runoff Depth=5.30" Tc=5.0 min CN=88 Runoff=19.02 cfs 0.928 af
Subcatchment6S: P-5	Runoff Area=1.470 ac 0.00% Impervious Runoff Depth=5.76" Tc=5.0 min CN=92 Runoff=13.95 cfs 0.705 af
Subcatchment7S: P-6	Runoff Area=1.790 ac 0.00% Impervious Runoff Depth=5.64" Tc=5.0 min CN=91 Runoff=16.81 cfs 0.842 af
Subcatchment8S: P-7	Runoff Area=0.820 ac 0.00% Impervious Runoff Depth=3.57" Tc=10.0 min CN=72 Runoff=4.51 cfs 0.244 af
Pond 3P: P-1	Peak Elev=244.05' Storage=0.921 af Inflow=31.18 cfs 1.612 af Discarded=0.20 cfs 0.847 af Primary=1.66 cfs 0.766 af Outflow=1.86 cfs 1.612 af
Pond 5P: P-2	Peak Elev=257.23' Storage=0.827 af Inflow=26.93 cfs 1.448 af Discarded=0.17 cfs 0.788 af Primary=1.63 cfs 0.660 af Outflow=1.80 cfs 1.448 af
Pond 7P: P-3	Peak Elev=259.18' Storage=1.167 af Inflow=36.60 cfs 1.998 af Discarded=0.25 cfs 1.144 af Primary=1.63 cfs 0.854 af Outflow=1.88 cfs 1.998 af
Pond 9P: P-4	Peak Elev=260.30' Storage=0.479 af Inflow=19.02 cfs 0.928 af Discarded=0.14 cfs 0.454 af Primary=1.65 cfs 0.474 af Outflow=1.79 cfs 0.928 af
Pond 11P: P-5	Peak Elev=260.45' Storage=0.333 af Inflow=13.95 cfs 0.705 af Discarded=0.09 cfs 0.343 af Primary=4.33 cfs 0.362 af Outflow=4.42 cfs 0.705 af
Pond 14P: P-6	Peak Elev=253.79' Storage=0.384 af Inflow=16.81 cfs 0.842 af Outflow=6.01 cfs 0.842 af
Link 12L: PO1#1	Inflow=19.45 cfs 4.201 af Primary=19.45 cfs 4.201 af

Total Runoff Area = 31.720 ac Runoff Volume = 10.818 af Average Runoff Depth = 4.09"
88.30% Pervious = 28.010 ac 11.70% Impervious = 3.710 ac

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 50-YR Rainfall=6.70"

Printed 12/18/2017

Page 113

Summary for Subcatchment 1S: E-1 (POI#1)

Runoff = 49.69 cfs @ 12.05 hrs, Volume= 3.040 af, Depth= 2.30"

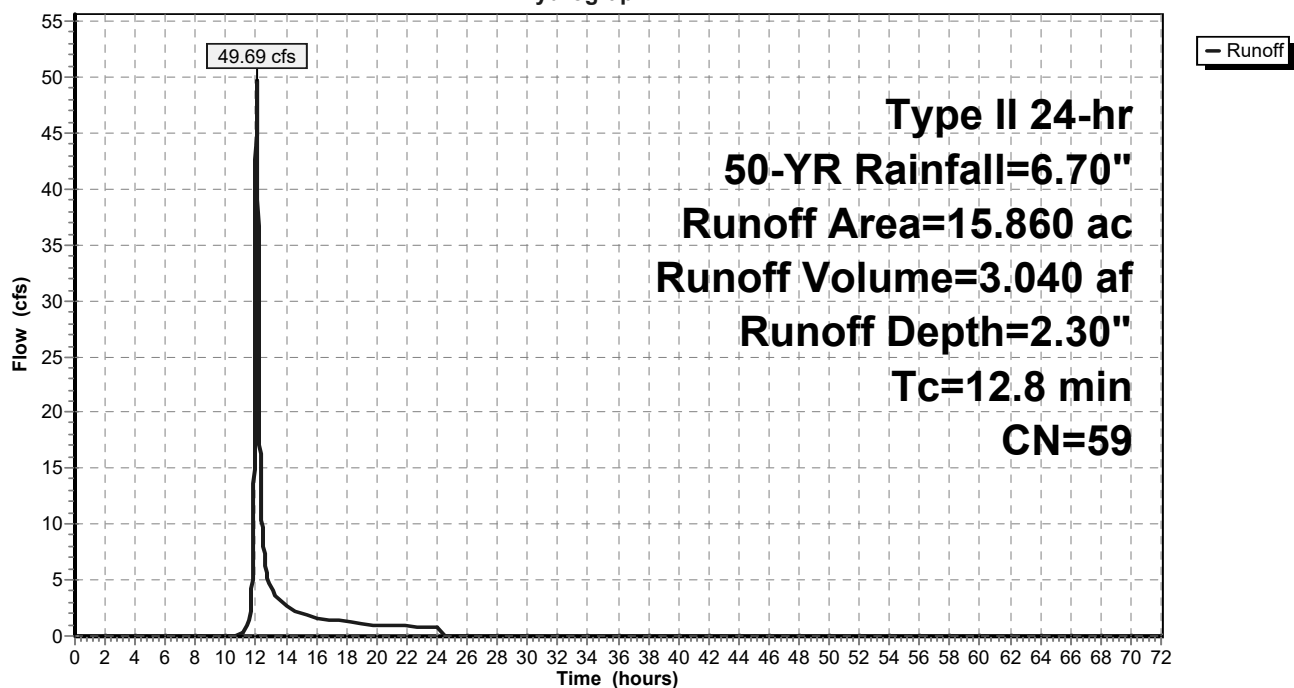
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 50-YR Rainfall=6.70"

Area (ac)	CN	Description
* 15.860	59	SEE CN WORKSHEETS
15.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.8					Direct Entry,

Subcatchment 1S: E-1 (POI#1)

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 50-YR Rainfall=6.70"

Printed 12/18/2017

Page 114

Summary for Subcatchment 2S: P-1

Runoff = 31.18 cfs @ 11.96 hrs, Volume= 1.612 af, Depth= 5.99"

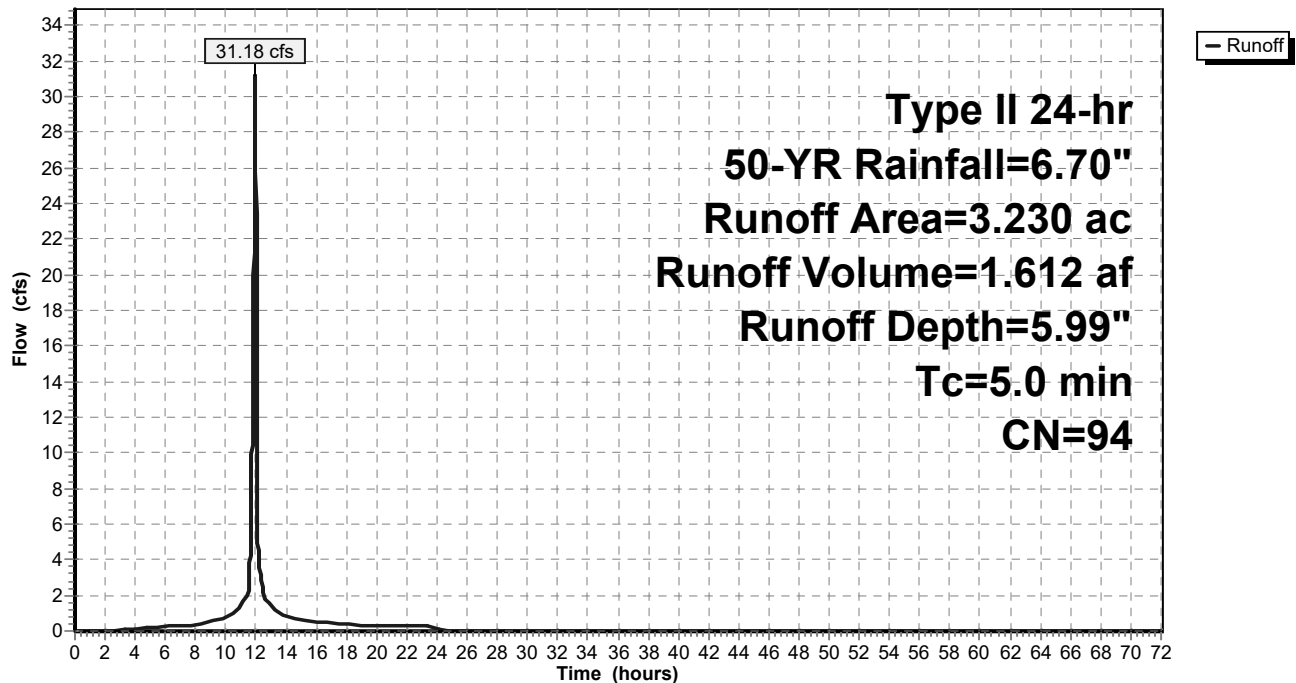
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 50-YR Rainfall=6.70"

Area (ac)	CN	Description
* 3.230	94	SEE CN WORKSHEETS
3.230		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 2S: P-1

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 50-YR Rainfall=6.70"

Printed 12/18/2017

Page 115

Summary for Subcatchment 3S: P-2

Runoff = 26.93 cfs @ 11.96 hrs, Volume= 1.448 af, Depth= 6.34"

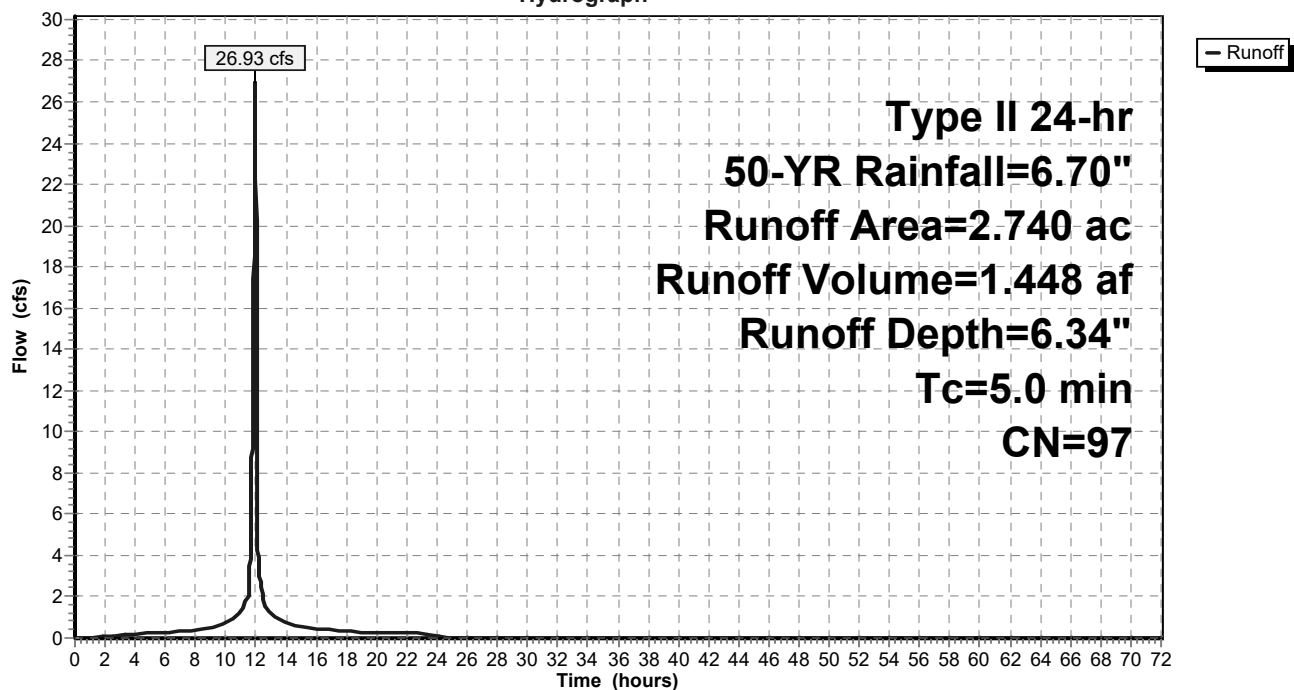
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 50-YR Rainfall=6.70"

Area (ac)	CN	Description
* 2.740	97	SEE CN WORKSHEETS
2.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 3S: P-2

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 50-YR Rainfall=6.70"

Printed 12/18/2017

Page 116

Summary for Subcatchment 4S: P-3

Runoff = 36.60 cfs @ 11.96 hrs, Volume= 1.998 af, Depth= 6.46"

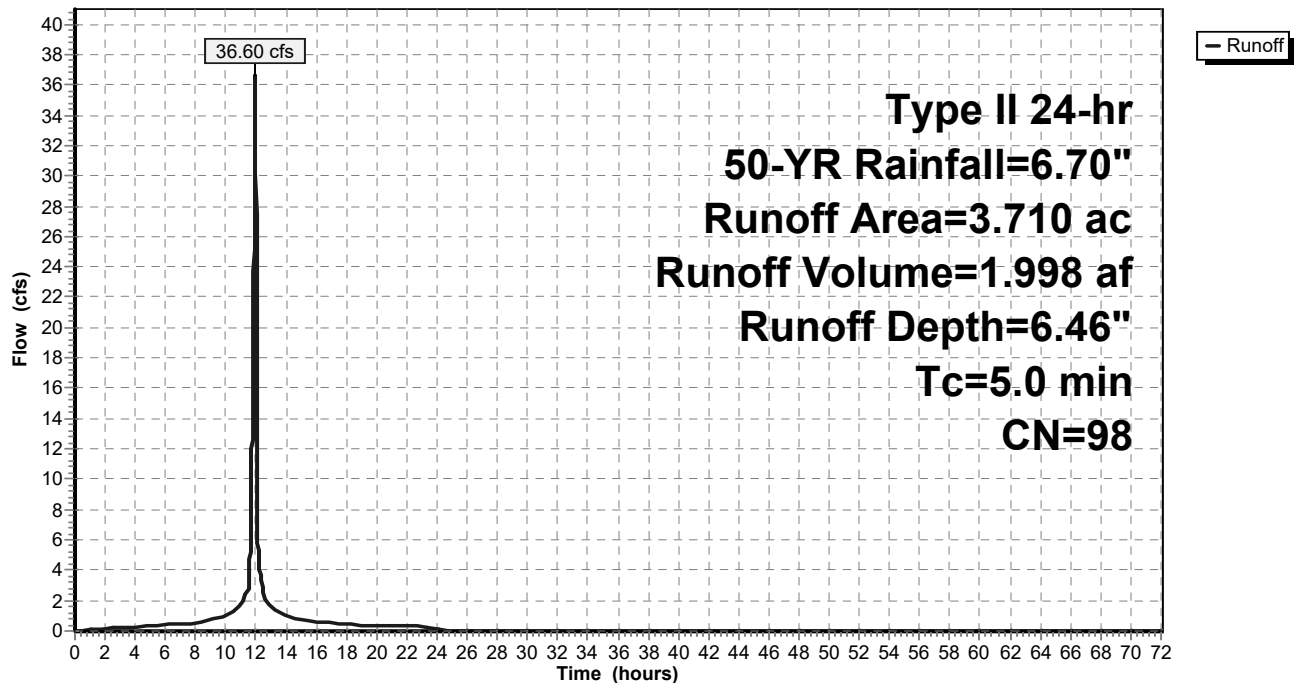
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 50-YR Rainfall=6.70"

Area (ac)	CN	Description
* 3.710	98	SEE CN WORKSHEETS
3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 4S: P-3

Hydrograph



Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 50-YR Rainfall=6.70"

Printed 12/18/2017

Page 117

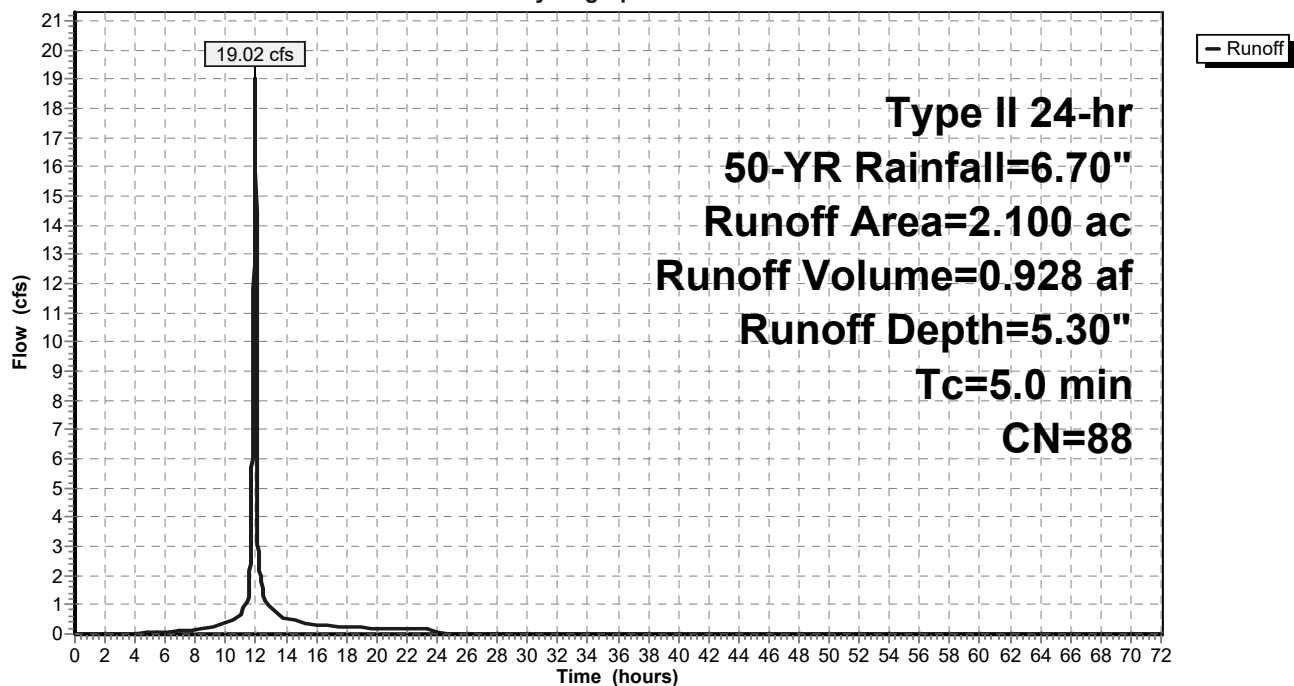
Runoff = 19.02 cfs @ 11.96 hrs, Volume= 0.928 af, Depth= 5.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 50-YR Rainfall=6.70"

Area (ac)	CN	Description
* 2.100	88	SEE CN WORKSHEETS
2.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 50-YR Rainfall=6.70"

Printed 12/18/2017

Page 118

Summary for Subcatchment 6S: P-5

Runoff = 13.95 cfs @ 11.96 hrs, Volume= 0.705 af, Depth= 5.76"

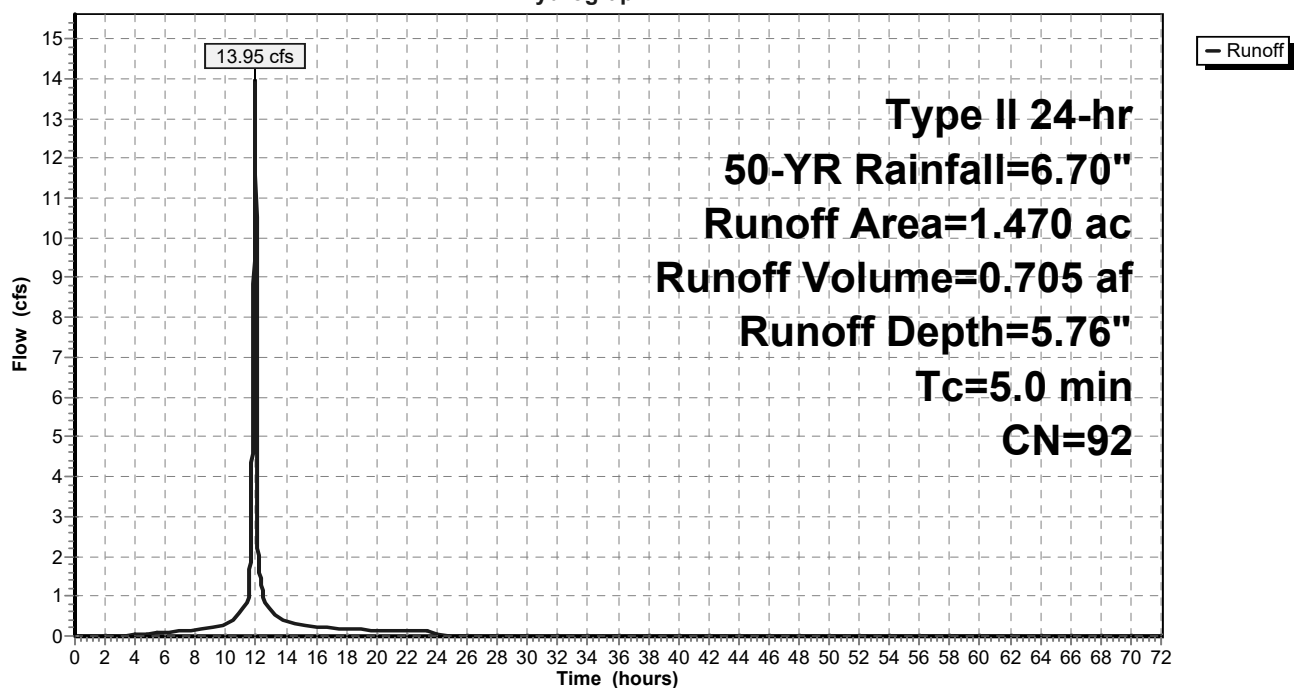
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 50-YR Rainfall=6.70"

Area (ac)	CN	Description
* 1.470	92	SEE CN WORKSHEETS
1.470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 6S: P-5

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 50-YR Rainfall=6.70"

Printed 12/18/2017

Page 119

Summary for Subcatchment 7S: P-6

Runoff = 16.81 cfs @ 11.96 hrs, Volume= 0.842 af, Depth= 5.64"

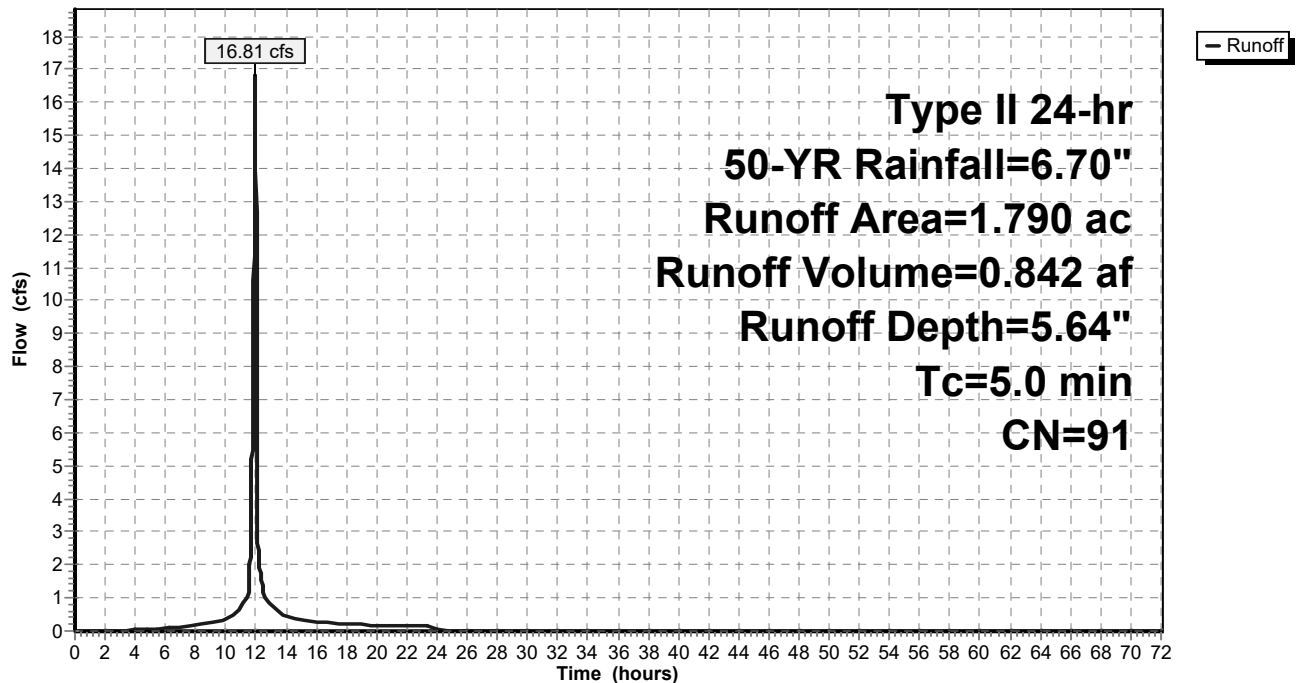
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 50-YR Rainfall=6.70"

Area (ac)	CN	Description
* 1.790	91	SEE CN WORKSHEETS
1.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 7S: P-6

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 50-YR Rainfall=6.70"

Printed 12/18/2017

Page 120

Summary for Subcatchment 8S: P-7

Runoff = 4.51 cfs @ 12.02 hrs, Volume= 0.244 af, Depth= 3.57"

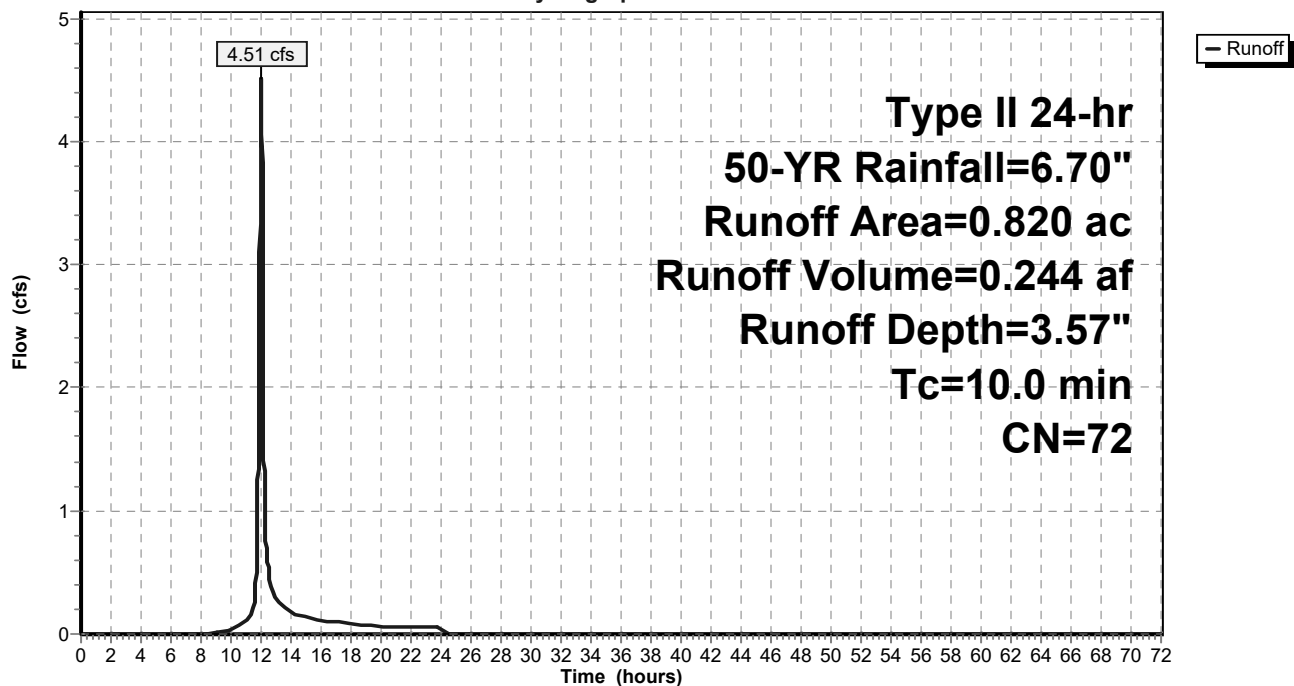
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 50-YR Rainfall=6.70"

Area (ac)	CN	Description
* 0.820	72	SEE CN WORKSHEETS
0.820		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry,

Subcatchment 8S: P-7

Hydrograph



routings

Type II 24-hr 50-YR Rainfall=6.70"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 121

Summary for Pond 3P: P-1

Inflow Area = 3.230 ac, 0.00% Impervious, Inflow Depth = 5.99" for 50-YR event
Inflow = 31.18 cfs @ 11.96 hrs, Volume= 1.612 af
Outflow = 1.86 cfs @ 12.61 hrs, Volume= 1.612 af, Atten= 94%, Lag= 39.1 min
Discarded = 0.20 cfs @ 5.76 hrs, Volume= 0.847 af
Primary = 1.66 cfs @ 12.61 hrs, Volume= 0.766 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 244.05' @ 12.61 hrs Surf.Area= 0.398 ac Storage= 0.921 af

Plug-Flow detention time= 625.4 min calculated for 1.612 af (100% of inflow)
Center-of-Mass det. time= 625.3 min (1,386.4 - 761.1)

Volume	Invert	Avail.Storage	Storage Description
#1	240.50'	0.462 af	6.00'W x 2,892.00'L x 4.50'H Stone 1.793 af Overall - 0.639 af Embedded = 1.154 af x 40.0% Voids
#2	241.00'	0.639 af	42.0" Round Pipe Storage Inside #1 L= 2,892.0'
		1.100 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	241.00'	18.0" Round Culvert L= 15.9' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 241.00' / 240.90' S= 0.0063 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	240.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	242.45'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.20 cfs @ 5.76 hrs HW=240.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.20 cfs)

Primary OutFlow Max=1.66 cfs @ 12.61 hrs HW=244.05' (Free Discharge)
↑**1=Culvert** (Passes 1.66 cfs of 12.91 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 1.66 cfs @ 4.14 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

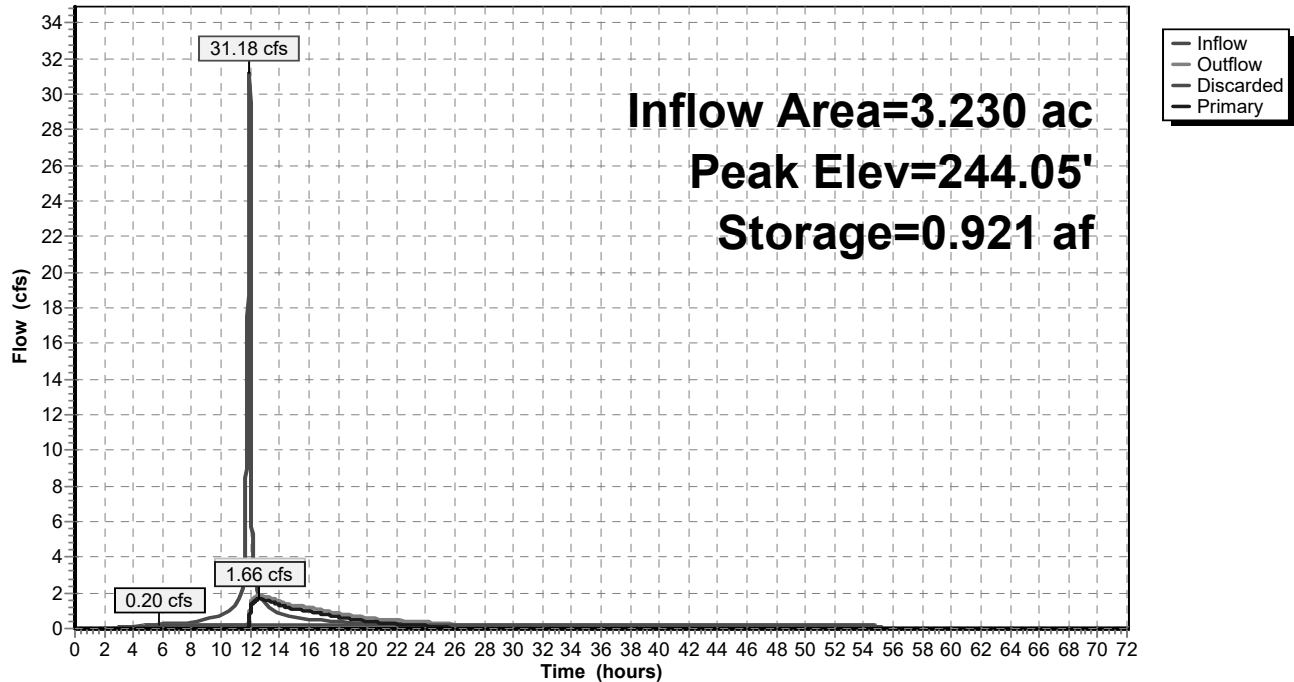
Type II 24-hr 50-YR Rainfall=6.70"

Printed 12/18/2017

Page 122

Pond 3P: P-1

Hydrograph



routings

Type II 24-hr 50-YR Rainfall=6.70"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 123

Summary for Pond 5P: P-2

Inflow Area = 2.740 ac, 0.00% Impervious, Inflow Depth = 6.34" for 50-YR event
Inflow = 26.93 cfs @ 11.96 hrs, Volume= 1.448 af
Outflow = 1.80 cfs @ 12.53 hrs, Volume= 1.448 af, Atten= 93%, Lag= 34.6 min
Discarded = 0.17 cfs @ 4.26 hrs, Volume= 0.788 af
Primary = 1.63 cfs @ 12.53 hrs, Volume= 0.660 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 257.23' @ 12.53 hrs Surf.Area= 0.341 ac Storage= 0.827 af

Plug-Flow detention time= 673.6 min calculated for 1.448 af (100% of inflow)
Center-of-Mass det. time= 673.6 min (1,418.8 - 745.2)

Volume	Invert	Avail.Storage	Storage Description
#1	253.50'	0.396 af	6.00'W x 2,479.00'L x 4.50'H Stone 1.537 af Overall - 0.548 af Embedded = 0.989 af x 40.0% Voids
#2	254.00'	0.548 af	42.0" Round Pipe Storage Inside #1 L= 2,479.0'
		0.943 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	254.00'	18.0" Round Culvert L= 16.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 254.00' / 253.80' S= 0.0125 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	253.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	255.65'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.17 cfs @ 4.26 hrs HW=253.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.17 cfs)

Primary OutFlow Max=1.63 cfs @ 12.53 hrs HW=257.23' (Free Discharge)
↑**1=Culvert** (Passes 1.63 cfs of 13.40 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 1.63 cfs @ 4.11 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

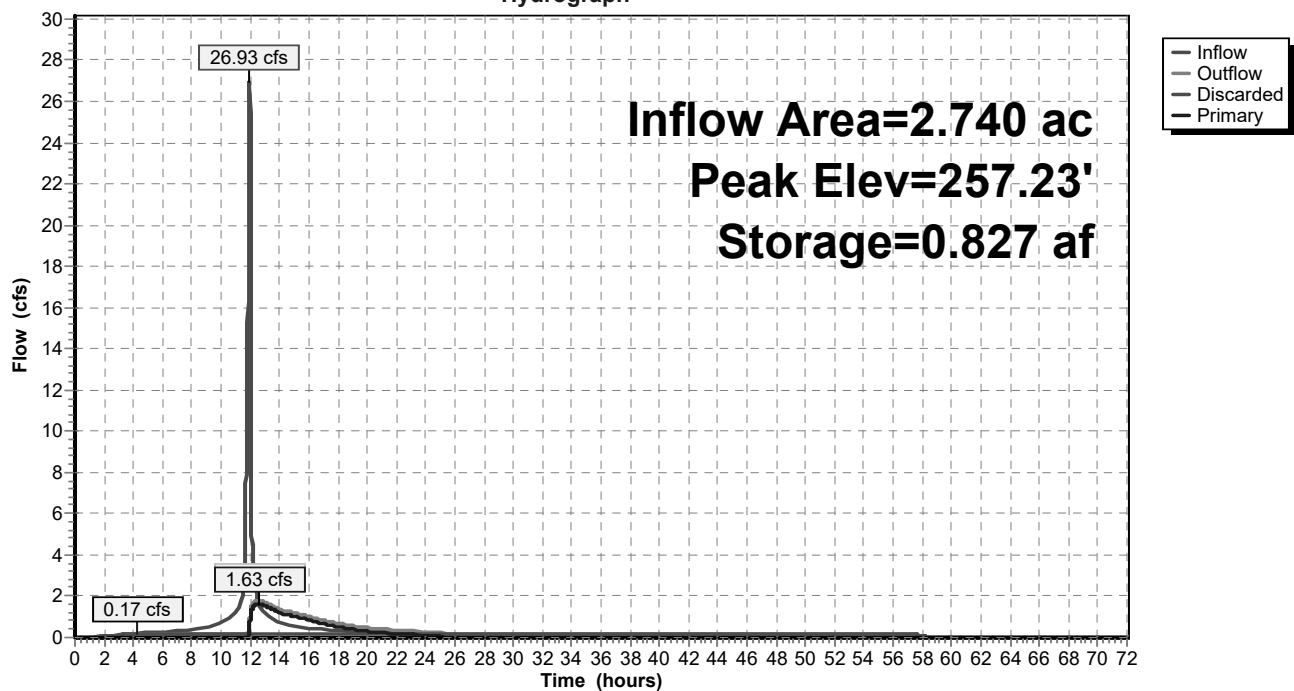
Type II 24-hr 50-YR Rainfall=6.70"

Printed 12/18/2017

Page 124

Pond 5P: P-2

Hydrograph



routings

Type II 24-hr 50-YR Rainfall=6.70"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 125

Summary for Pond 7P: P-3

Inflow Area = 3.710 ac, 100.00% Impervious, Inflow Depth = 6.46" for 50-YR event
Inflow = 36.60 cfs @ 11.96 hrs, Volume= 1.998 af
Outflow = 1.88 cfs @ 12.81 hrs, Volume= 1.998 af, Atten= 95%, Lag= 51.2 min
Discarded = 0.25 cfs @ 3.68 hrs, Volume= 1.144 af
Primary = 1.63 cfs @ 12.81 hrs, Volume= 0.854 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 259.18' @ 12.81 hrs Surf.Area= 0.488 ac Storage= 1.167 af

Plug-Flow detention time= 722.4 min calculated for 1.998 af (100% of inflow)
Center-of-Mass det. time= 722.3 min (1,460.8 - 738.4)

Volume	Invert	Avail.Storage	Storage Description
#1	255.50'	0.565 af	6.00'W x 3,541.00'L x 4.50'H Stone 2.195 af Overall - 0.782 af Embedded = 1.413 af x 40.0% Voids
#2	256.00'	0.782 af	42.0" Round Pipe Storage Inside #1 L= 3,541.0'
		1.347 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	256.00'	18.0" Round Culvert L= 33.4' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 256.00' / 255.70' S= 0.0090 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	255.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	257.60'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.25 cfs @ 3.68 hrs HW=255.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.25 cfs)

Primary OutFlow Max=1.63 cfs @ 12.81 hrs HW=259.18' (Free Discharge)
↑**1=Culvert** (Passes 1.63 cfs of 13.27 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 1.63 cfs @ 4.12 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

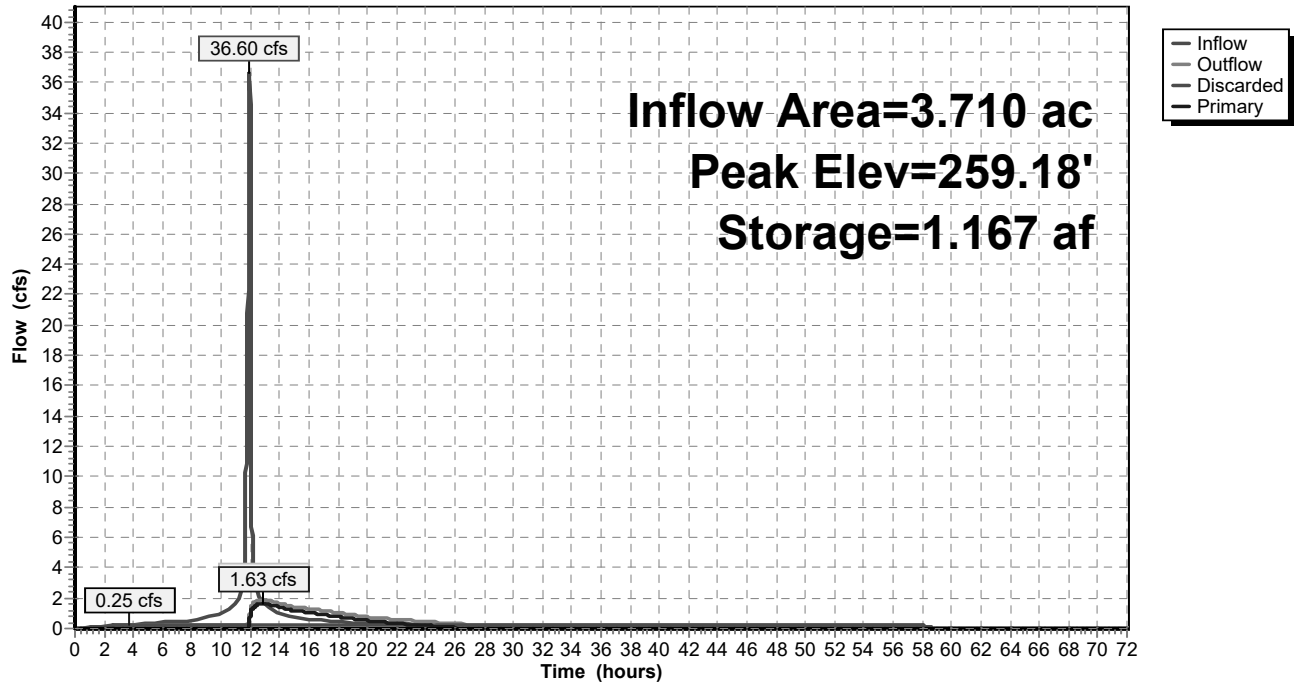
Type II 24-hr 50-YR Rainfall=6.70"

Printed 12/18/2017

Page 126

Pond 7P: P-3

Hydrograph



routings

Type II 24-hr 50-YR Rainfall=6.70"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 127

Summary for Pond 9P: P-4

Inflow Area = 2.100 ac, 0.00% Impervious, Inflow Depth = 5.30" for 50-YR event
 Inflow = 19.02 cfs @ 11.96 hrs, Volume= 0.928 af
 Outflow = 1.79 cfs @ 12.37 hrs, Volume= 0.928 af, Atten= 91%, Lag= 25.0 min
 Discarded = 0.14 cfs @ 8.15 hrs, Volume= 0.454 af
 Primary = 1.65 cfs @ 12.37 hrs, Volume= 0.474 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 Peak Elev= 260.30' @ 12.37 hrs Surf.Area= 0.279 ac Storage= 0.479 af

Plug-Flow detention time= 425.0 min calculated for 0.928 af (100% of inflow)
 Center-of-Mass det. time= 425.0 min (1,208.6 - 783.6)

Volume	Invert	Avail.Storage	Storage Description
#1	257.50'	0.189 af	87.00'W x 96.00'L x 3.50'H Stone 0.671 af Overall - 0.199 af Embedded = 0.472 af x 40.0% Voids
#2	258.00'	0.199 af	30.0" Round Pipe Storage x 19 Inside #1 L= 93.0'
#3	257.50'	0.053 af	31.50'W x 74.00'L x 3.50'H Stone 0.187 af Overall - 0.056 af Embedded = 0.131 af x 40.0% Voids
#4	258.00'	0.056 af	30.0" Round Pipe Storage x 7 Inside #3 L= 71.0'
#5	257.50'	0.033 af	31.50'W x 46.00'L x 3.50'H Stone 0.116 af Overall - 0.034 af Embedded = 0.083 af x 40.0% Voids
#6	258.00'	0.034 af	30.0" Round Pipe Storage x 7 Inside #5 L= 43.0'
		0.563 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	256.40'	18.0" Round Culvert L= 20.4' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 256.40' / 256.20' S= 0.0098 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	257.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	259.00'	0.6' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.14 cfs @ 8.15 hrs HW=257.54' (Free Discharge)

↑**2=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=1.65 cfs @ 12.37 hrs HW=260.30' (Free Discharge)

↑**1=Culvert** (Passes 1.65 cfs of 15.10 cfs potential flow)

↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 1.65 cfs @ 3.73 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

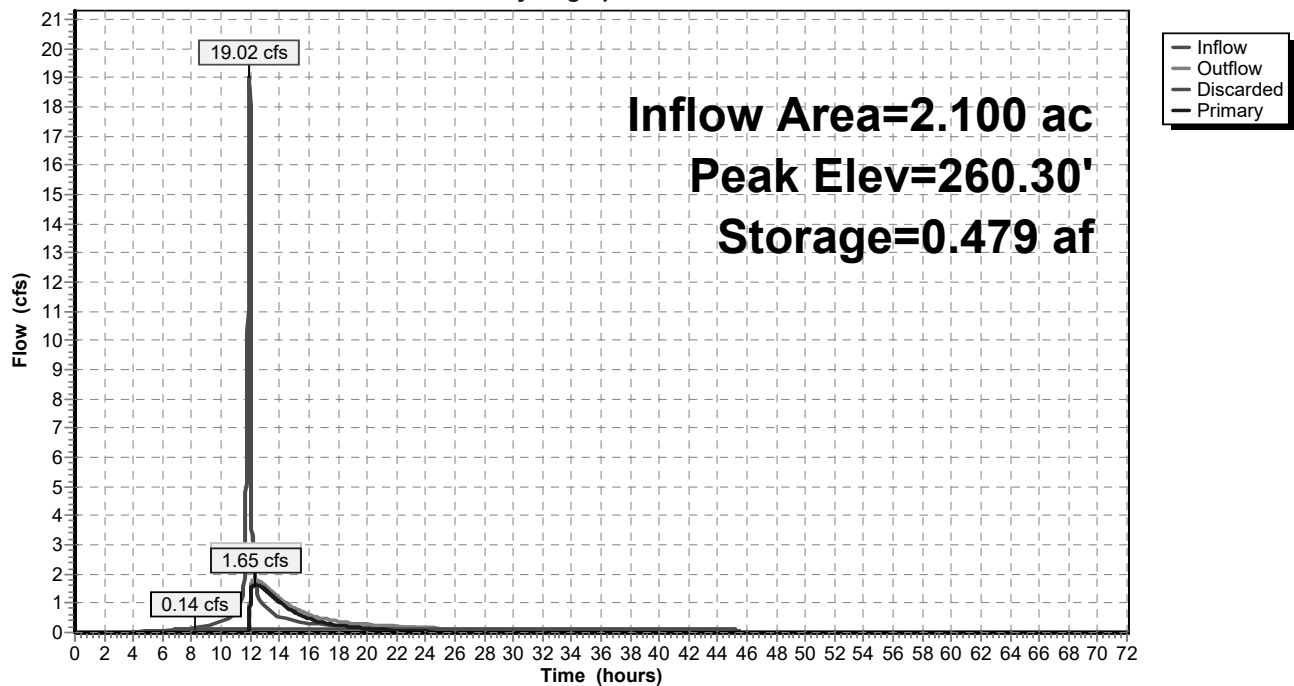
Type II 24-hr 50-YR Rainfall=6.70"

Printed 12/18/2017

Page 128

Pond 9P: P-4

Hydrograph



routings

Type II 24-hr 50-YR Rainfall=6.70"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 129

Summary for Pond 11P: P-5

Inflow Area = 1.470 ac, 0.00% Impervious, Inflow Depth = 5.76" for 50-YR event
Inflow = 13.95 cfs @ 11.96 hrs, Volume= 0.705 af
Outflow = 4.42 cfs @ 12.07 hrs, Volume= 0.705 af, Atten= 68%, Lag= 6.7 min
Discarded = 0.09 cfs @ 6.48 hrs, Volume= 0.343 af
Primary = 4.33 cfs @ 12.07 hrs, Volume= 0.362 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 260.45' @ 12.07 hrs Surf.Area= 0.182 ac Storage= 0.333 af

Plug-Flow detention time= 452.6 min calculated for 0.705 af (100% of inflow)
Center-of-Mass det. time= 452.8 min (1,222.3 - 769.5)

Volume	Invert	Avail.Storage	Storage Description
#1	257.50'	0.175 af	4.50'W x 1,757.00'L x 3.50'H Stone 0.635 af Overall - 0.198 af Embedded = 0.437 af x 40.0% Voids
#2	258.00'	0.198 af	30.0" Round Pipe Storage Inside #1 L= 1,757.0'
		0.373 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	258.00'	18.0" Round Culvert L= 40.8' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 258.00' / 257.50' S= 0.0123 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	257.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	259.30'	1.3' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.09 cfs @ 6.48 hrs HW=257.54' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.09 cfs)

Primary OutFlow Max=4.33 cfs @ 12.07 hrs HW=260.45' (Free Discharge)
↑**1=Culvert** (Passes 4.33 cfs of 11.10 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 4.33 cfs @ 3.51 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

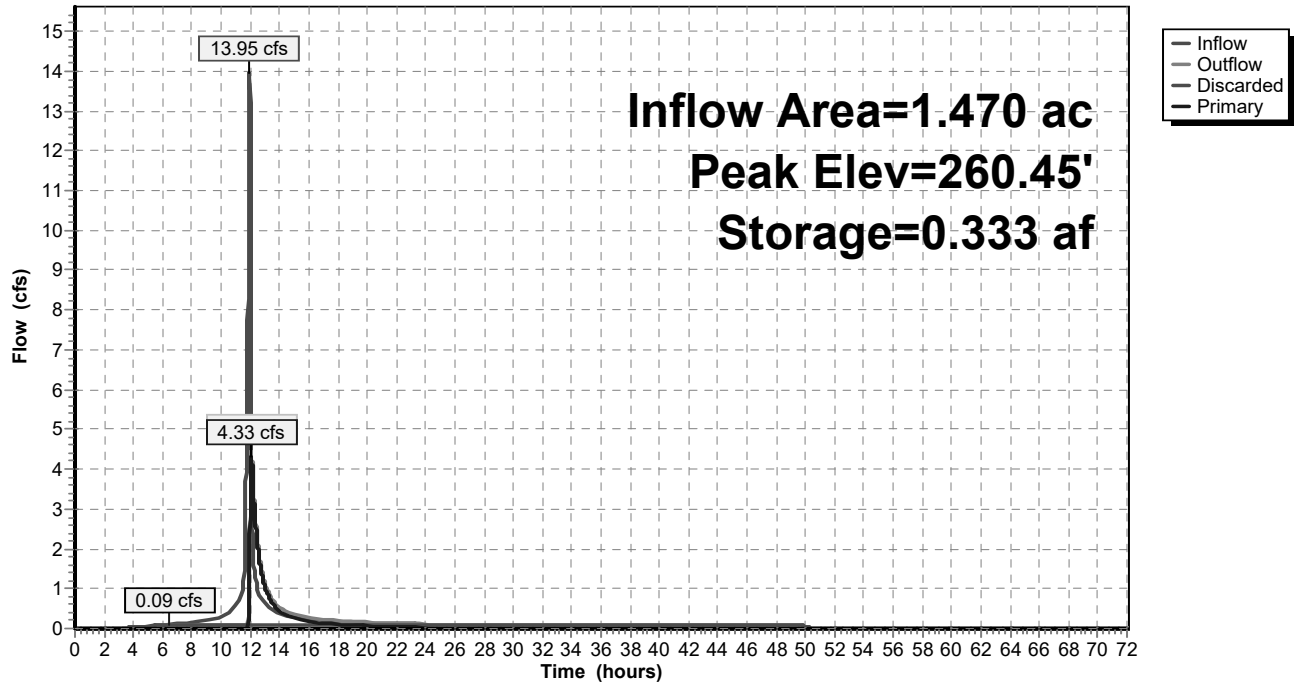
Type II 24-hr 50-YR Rainfall=6.70"

Printed 12/18/2017

Page 130

Pond 11P: P-5

Hydrograph



routings

Type II 24-hr 50-YR Rainfall=6.70"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 131

Summary for Pond 14P: P-6

Inflow Area = 1.790 ac, 0.00% Impervious, Inflow Depth = 5.64" for 50-YR event
Inflow = 16.81 cfs @ 11.96 hrs, Volume= 0.842 af
Outflow = 6.01 cfs @ 12.06 hrs, Volume= 0.842 af, Atten= 64%, Lag= 6.3 min
Primary = 6.01 cfs @ 12.06 hrs, Volume= 0.842 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 253.79' @ 12.06 hrs Surf.Area= 0.150 ac Storage= 0.384 af

Plug-Flow detention time= 249.0 min calculated for 0.842 af (100% of inflow)
Center-of-Mass det. time= 249.0 min (1,022.3 - 773.3)

Volume	Invert	Avail.Storage	Storage Description
#1	250.00'	0.165 af	28.00'W x 234.00'L x 4.50'H Stone 0.677 af Overall - 0.265 af Embedded = 0.411 af x 40.0% Voids
#2	250.00'	0.265 af	48.0" Round Pipe Storage x 4 Inside #1 L= 230.0'
		0.430 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	250.00'	18.0" Round Culvert L= 33.7' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 250.00' / 249.80' S= 0.0059 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	250.00'	3.0" Vert. Orifice/Grate C= 0.600
#3	Device 1	252.25'	1.2' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=6.01 cfs @ 12.06 hrs HW=253.79' (Free Discharge)

1=Culvert (Passes 6.01 cfs of 14.83 cfs potential flow)

2=Orifice/Grate (Orifice Controls 0.45 cfs @ 9.21 fps)

3=Sharp-Crested Rectangular Weir (Weir Controls 5.56 cfs @ 4.05 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

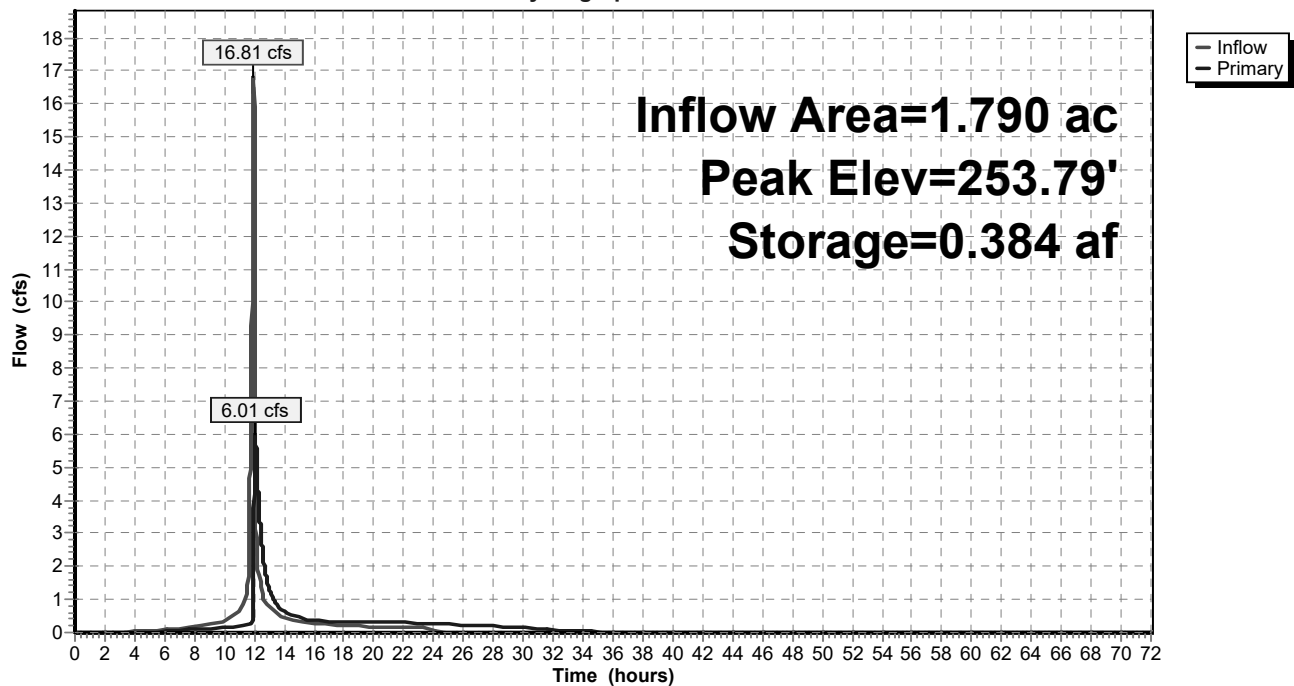
Type II 24-hr 50-YR Rainfall=6.70"

Printed 12/18/2017

Page 132

Pond 14P: P-6

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 50-YR Rainfall=6.70"

Printed 12/18/2017

Page 133

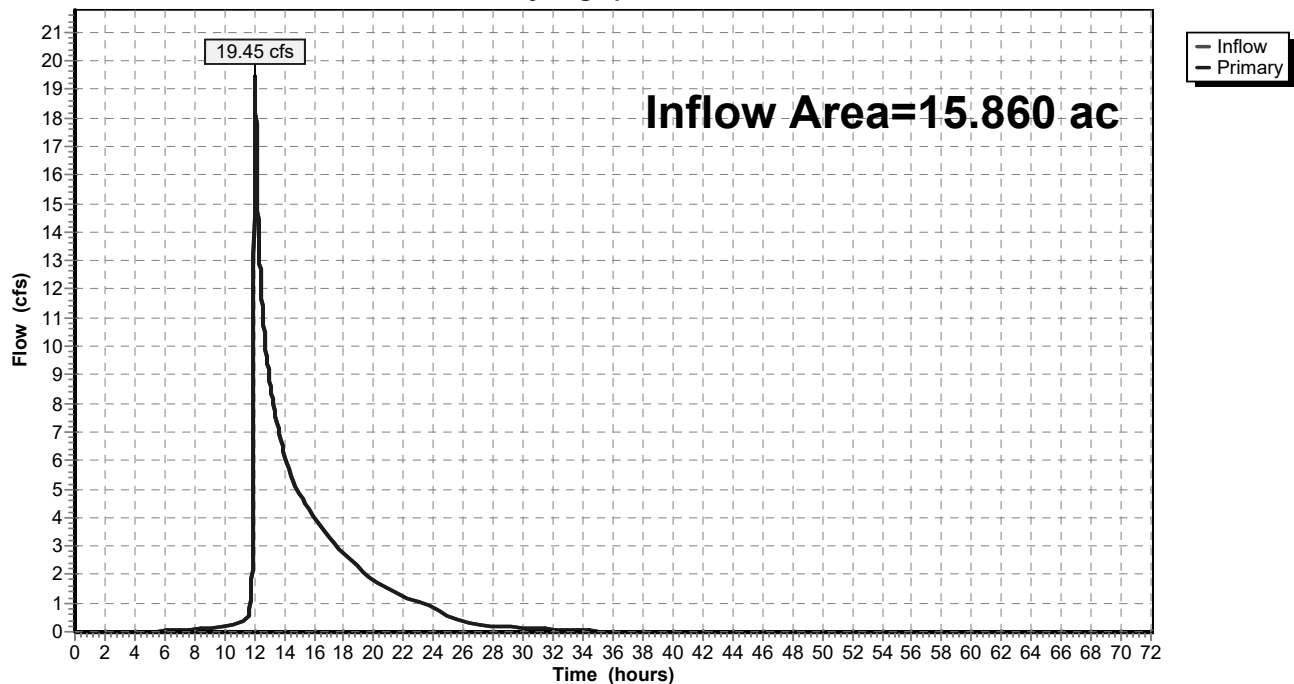
Summary for Link 12L: PO1#1

Inflow Area = 15.860 ac, 23.39% Impervious, Inflow Depth = 3.18" for 50-YR event
Inflow = 19.45 cfs @ 12.06 hrs, Volume= 4.201 af
Primary = 19.45 cfs @ 12.06 hrs, Volume= 4.201 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 12L: PO1#1

Hydrograph



routings

Type II 24-hr 100-YR Rainfall=7.64"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 134

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: E-1 (PO1#1)	Runoff Area=15.860 ac 0.00% Impervious Runoff Depth=2.96" Tc=12.8 min CN=59 Runoff=64.79 cfs 3.912 af
Subcatchment2S: P-1	Runoff Area=3.230 ac 0.00% Impervious Runoff Depth=6.92" Tc=5.0 min CN=94 Runoff=35.74 cfs 1.864 af
Subcatchment3S: P-2	Runoff Area=2.740 ac 0.00% Impervious Runoff Depth=7.28" Tc=5.0 min CN=97 Runoff=30.76 cfs 1.662 af
Subcatchment4S: P-3	Runoff Area=3.710 ac 100.00% Impervious Runoff Depth=7.40" Tc=5.0 min CN=98 Runoff=41.76 cfs 2.288 af
Subcatchment5S: P-4	Runoff Area=2.100 ac 0.00% Impervious Runoff Depth=6.22" Tc=5.0 min CN=88 Runoff=22.06 cfs 1.088 af
Subcatchment6S: P-5	Runoff Area=1.470 ac 0.00% Impervious Runoff Depth=6.69" Tc=5.0 min CN=92 Runoff=16.04 cfs 0.819 af
Subcatchment7S: P-6	Runoff Area=1.790 ac 0.00% Impervious Runoff Depth=6.57" Tc=5.0 min CN=91 Runoff=19.37 cfs 0.980 af
Subcatchment8S: P-7	Runoff Area=0.820 ac 0.00% Impervious Runoff Depth=4.38" Tc=10.0 min CN=72 Runoff=5.51 cfs 0.299 af
Pond 3P: P-1	Peak Elev=244.67' Storage=1.047 af Inflow=35.74 cfs 1.864 af Discarded=0.20 cfs 0.863 af Primary=2.70 cfs 1.001 af Outflow=2.90 cfs 1.864 af
Pond 5P: P-2	Peak Elev=257.90' Storage=0.929 af Inflow=30.76 cfs 1.662 af Discarded=0.17 cfs 0.799 af Primary=2.76 cfs 0.863 af Outflow=2.93 cfs 1.662 af
Pond 7P: P-3	Peak Elev=259.84' Storage=1.316 af Inflow=41.76 cfs 2.288 af Discarded=0.25 cfs 1.162 af Primary=2.74 cfs 1.126 af Outflow=2.99 cfs 2.288 af
Pond 9P: P-4	Peak Elev=260.92' Storage=0.554 af Inflow=22.06 cfs 1.088 af Discarded=0.14 cfs 0.466 af Primary=2.61 cfs 0.622 af Outflow=2.75 cfs 1.088 af
Pond 11P: P-5	Peak Elev=260.97' Storage=0.370 af Inflow=16.04 cfs 0.819 af Discarded=0.09 cfs 0.349 af Primary=6.80 cfs 0.470 af Outflow=6.89 cfs 0.819 af
Pond 14P: P-6	Peak Elev=254.44' Storage=0.426 af Inflow=19.37 cfs 0.980 af Outflow=8.57 cfs 0.980 af
Link 12L: PO1#1	Inflow=28.92 cfs 5.362 af Primary=28.92 cfs 5.362 af

Total Runoff Area = 31.720 ac Runoff Volume = 12.912 af Average Runoff Depth = 4.88"
88.30% Pervious = 28.010 ac 11.70% Impervious = 3.710 ac

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 135

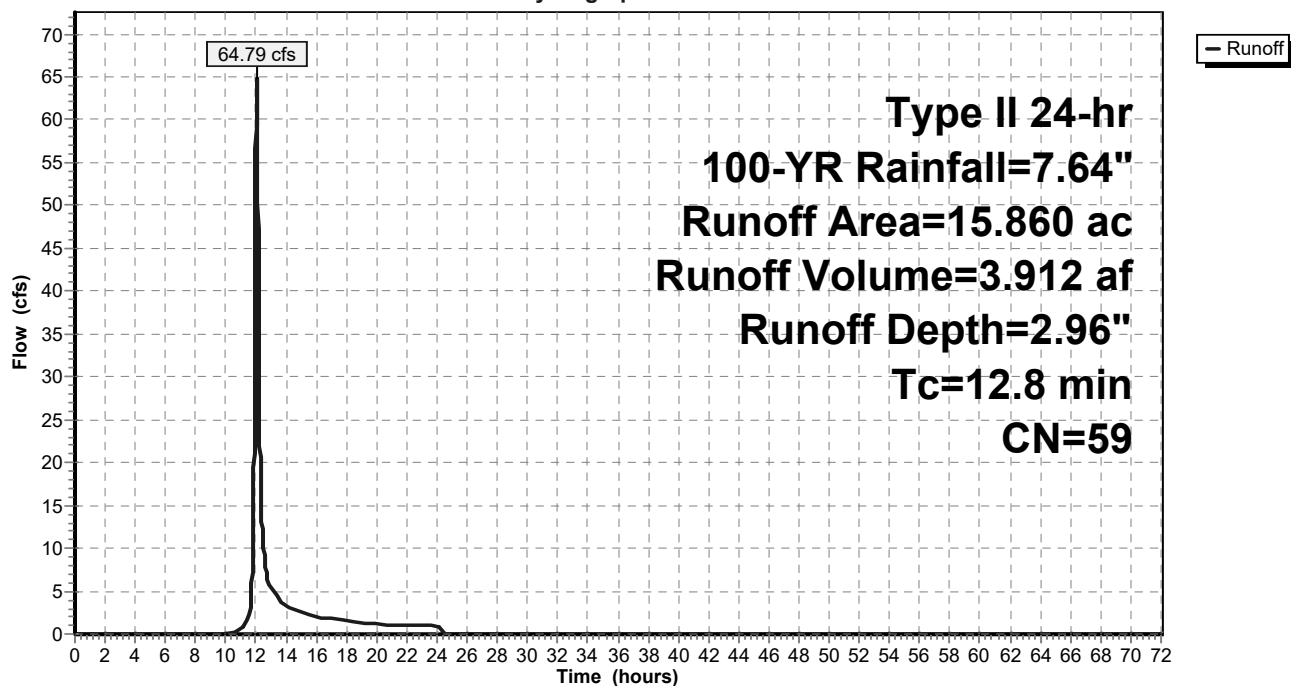
Runoff = 64.79 cfs @ 12.05 hrs, Volume= 3.912 af, Depth= 2.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-YR Rainfall=7.64"

Area (ac)	CN	Description
* 15.860	59	SEE CN WORKSHEETS
15.860		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.8					Direct Entry,

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 136

Summary for Subcatchment 2S: P-1

Runoff = 35.74 cfs @ 11.96 hrs, Volume= 1.864 af, Depth= 6.92"

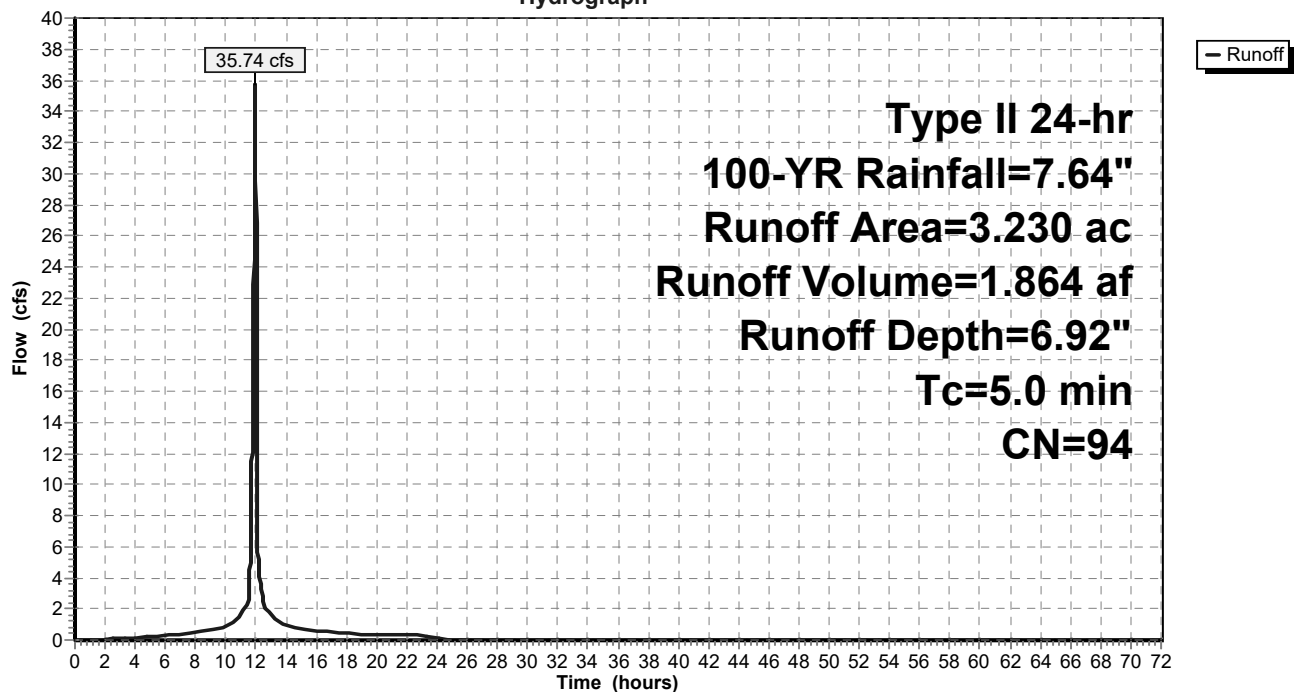
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-YR Rainfall=7.64"

Area (ac)	CN	Description
* 3.230	94	SEE CN WORKSHEETS
3.230		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 2S: P-1

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 137

Summary for Subcatchment 3S: P-2

Runoff = 30.76 cfs @ 11.96 hrs, Volume= 1.662 af, Depth= 7.28"

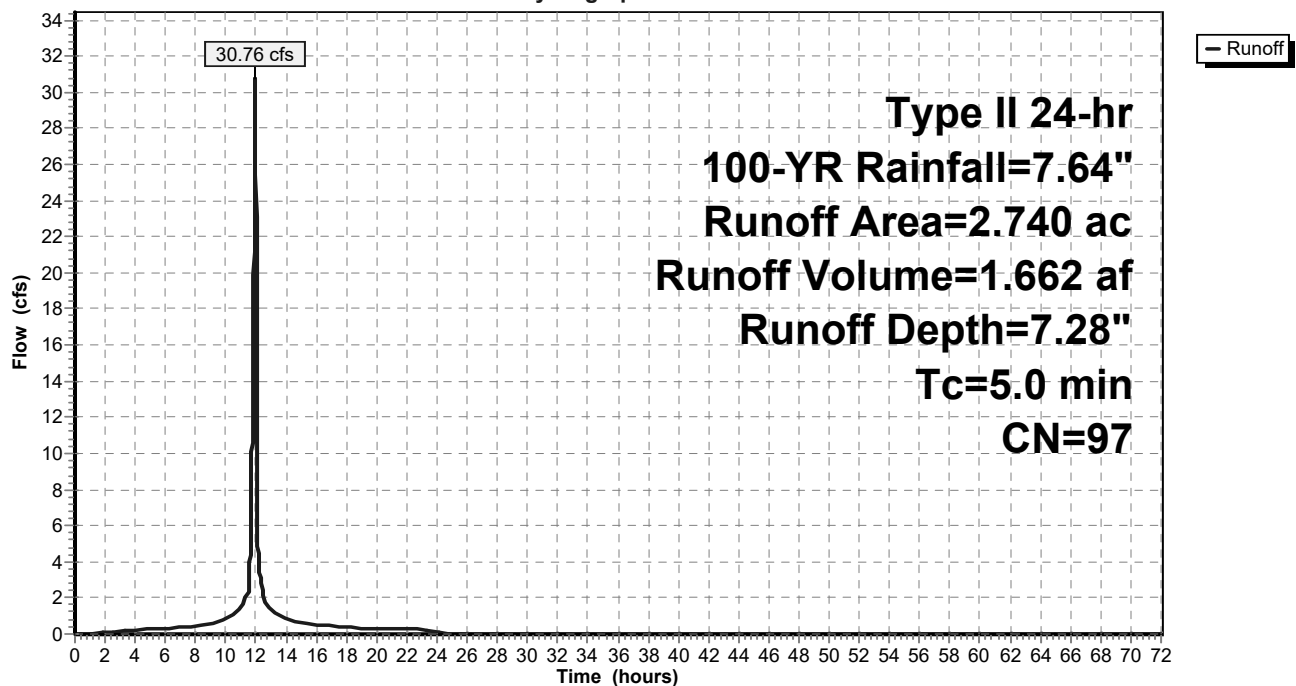
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-YR Rainfall=7.64"

Area (ac)	CN	Description
* 2.740	97	SEE CN WORKSHEETS
2.740		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 3S: P-2

Hydrograph



Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 138

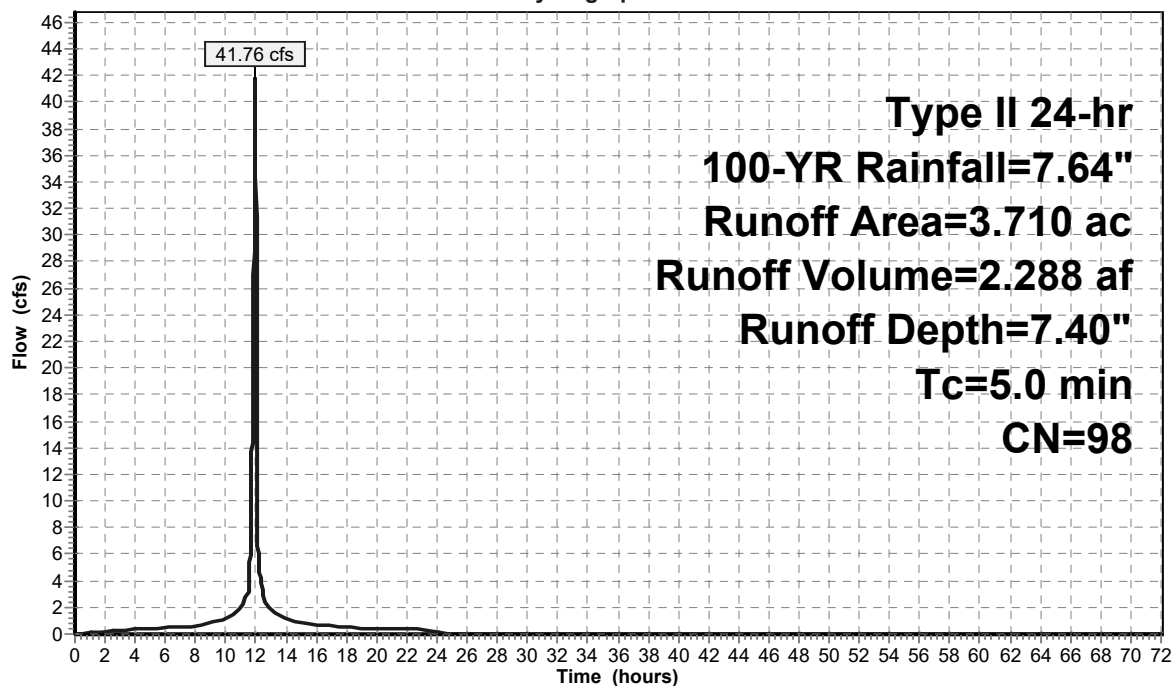
Runoff = 41.76 cfs @ 11.96 hrs, Volume= 2.288 af, Depth= 7.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-YR Rainfall=7.64"

Area (ac)	CN	Description
* 3.710	98	SEE CN WORKSHEETS
3.710		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 139

Summary for Subcatchment 5S: P-4

Runoff = 22.06 cfs @ 11.96 hrs, Volume= 1.088 af, Depth= 6.22"

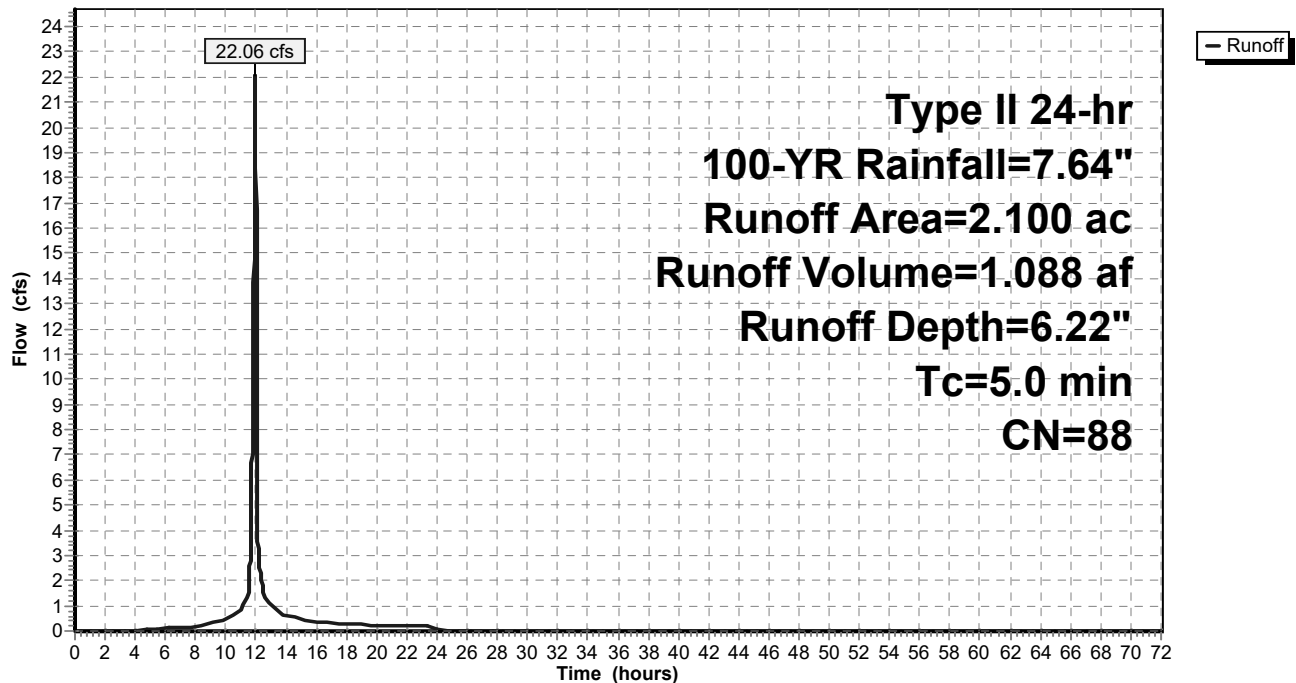
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-YR Rainfall=7.64"

Area (ac)	CN	Description
* 2.100	88	SEE CN WORKSHEETS
2.100		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 5S: P-4

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 140

Summary for Subcatchment 6S: P-5

Runoff = 16.04 cfs @ 11.96 hrs, Volume= 0.819 af, Depth= 6.69"

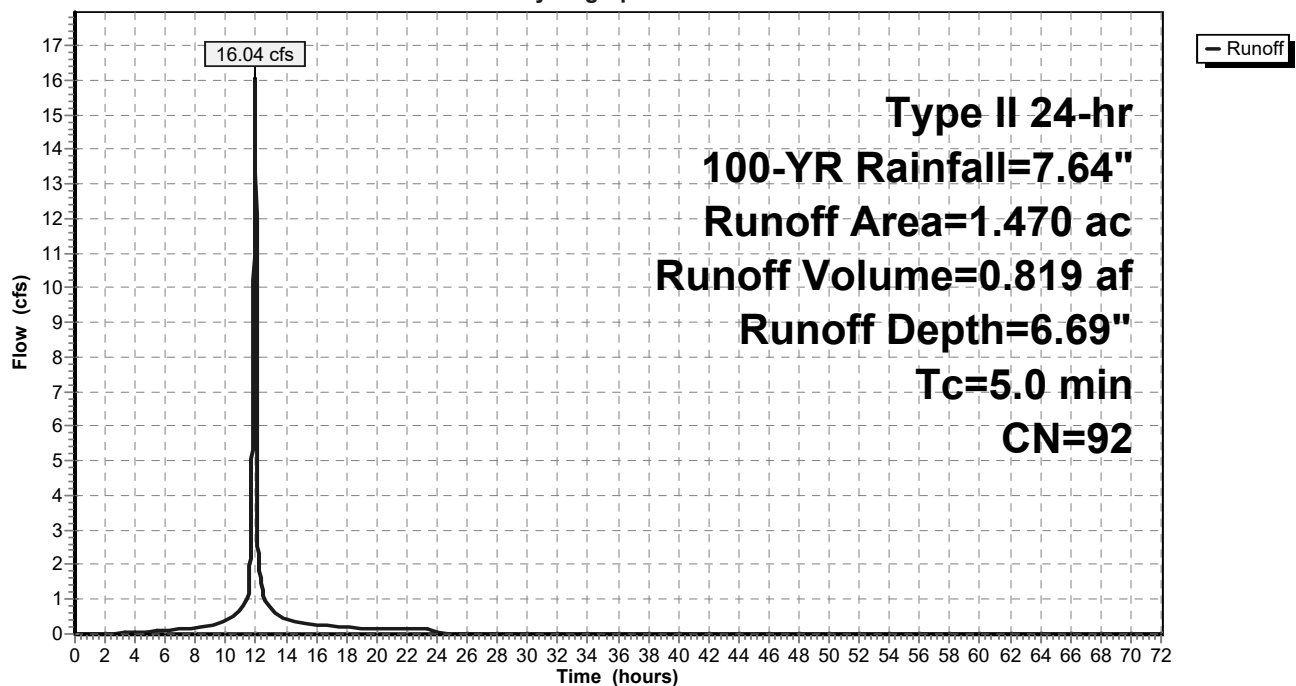
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-YR Rainfall=7.64"

Area (ac)	CN	Description
* 1.470	92	SEE CN WORKSHEETS
1.470		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 6S: P-5

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 141

Summary for Subcatchment 7S: P-6

Runoff = 19.37 cfs @ 11.96 hrs, Volume= 0.980 af, Depth= 6.57"

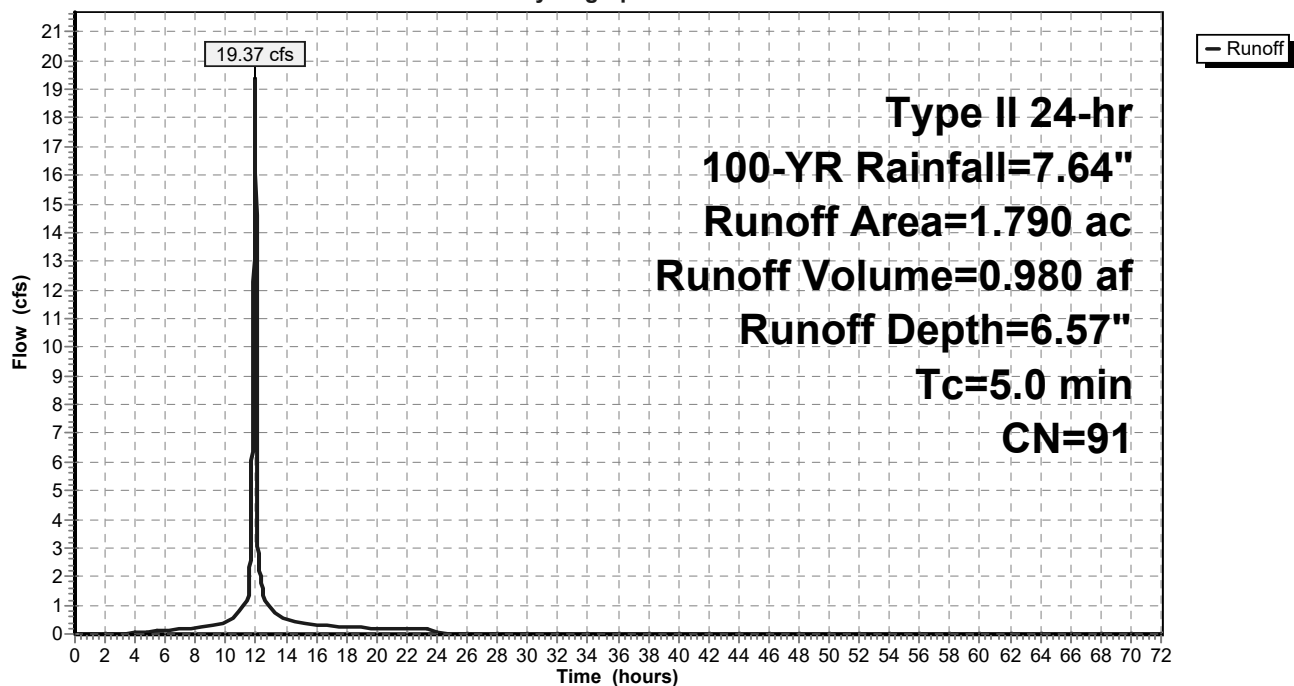
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-YR Rainfall=7.64"

Area (ac)	CN	Description
* 1.790	91	SEE CN WORKSHEETS
1.790		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					Direct Entry,

Subcatchment 7S: P-6

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 142

Summary for Subcatchment 8S: P-7

Runoff = 5.51 cfs @ 12.02 hrs, Volume= 0.299 af, Depth= 4.38"

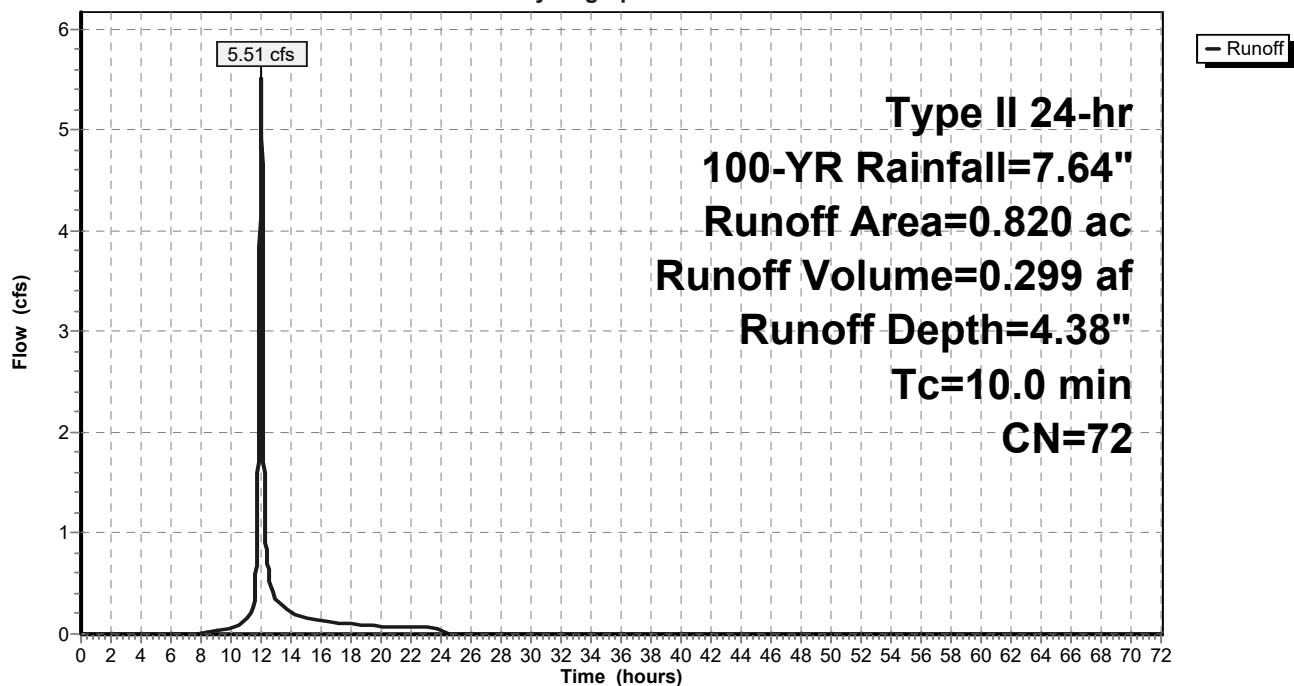
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type II 24-hr 100-YR Rainfall=7.64"

Area (ac)	CN	Description
* 0.820	72	SEE CN WORKSHEETS
0.820		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					Direct Entry,

Subcatchment 8S: P-7

Hydrograph



routings

Type II 24-hr 100-YR Rainfall=7.64"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 143

Summary for Pond 3P: P-1

Inflow Area = 3.230 ac, 0.00% Impervious, Inflow Depth = 6.92" for 100-YR event
Inflow = 35.74 cfs @ 11.96 hrs, Volume= 1.864 af
Outflow = 2.90 cfs @ 12.44 hrs, Volume= 1.864 af, Atten= 92%, Lag= 29.2 min
Discarded = 0.20 cfs @ 5.04 hrs, Volume= 0.863 af
Primary = 2.70 cfs @ 12.44 hrs, Volume= 1.001 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 244.67' @ 12.44 hrs Surf.Area= 0.398 ac Storage= 1.047 af

Plug-Flow detention time= 571.4 min calculated for 1.863 af (100% of inflow)
Center-of-Mass det. time= 571.6 min (1,329.4 - 757.8)

Volume	Invert	Avail.Storage	Storage Description
#1	240.50'	0.462 af	6.00'W x 2,892.00'L x 4.50'H Stone 1.793 af Overall - 0.639 af Embedded = 1.154 af x 40.0% Voids
#2	241.00'	0.639 af	42.0" Round Pipe Storage Inside #1 L= 2,892.0'
		1.100 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	241.00'	18.0" Round Culvert L= 15.9' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 241.00' / 240.90' S= 0.0063 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	240.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	242.45'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.20 cfs @ 5.04 hrs HW=240.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.20 cfs)

Primary OutFlow Max=2.69 cfs @ 12.44 hrs HW=244.66' (Free Discharge)
↑**1=Culvert** (Passes 2.69 cfs of 14.53 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 2.69 cfs @ 4.87 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

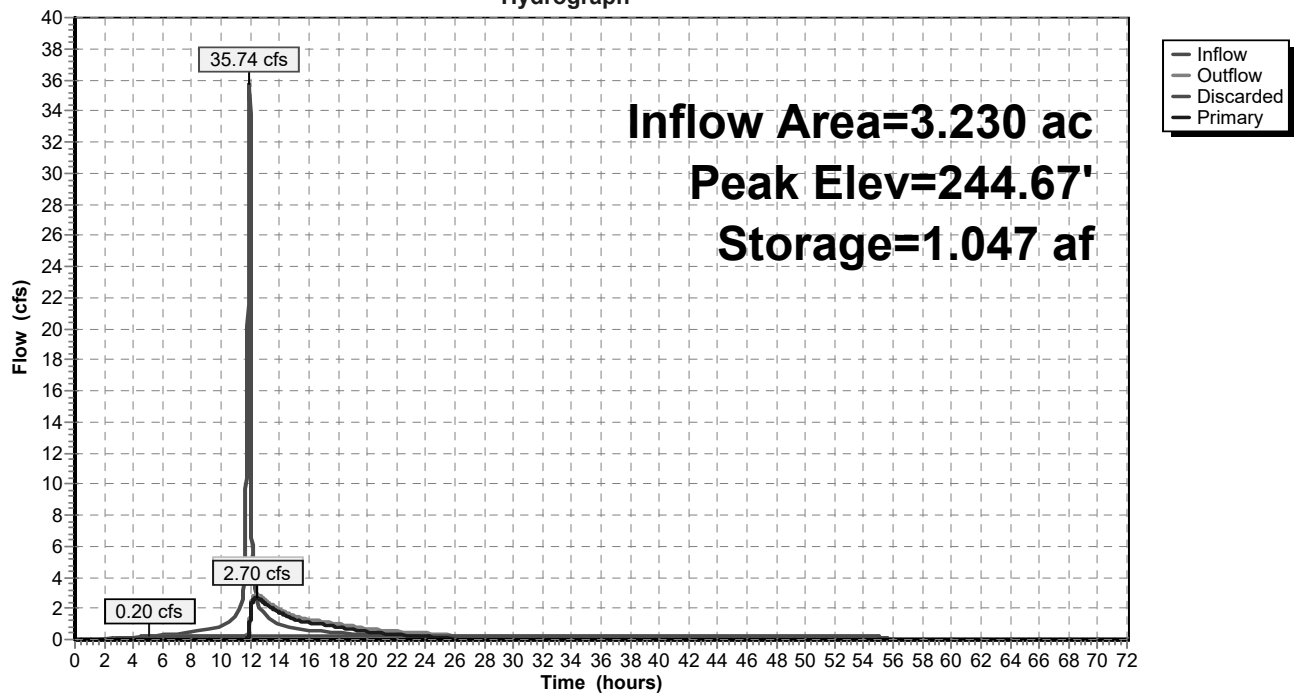
Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 144

Pond 3P: P-1

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 145

Summary for Pond 5P: P-2

Inflow Area = 2.740 ac, 0.00% Impervious, Inflow Depth = 7.28" for 100-YR event
Inflow = 30.76 cfs @ 11.96 hrs, Volume= 1.662 af
Outflow = 2.93 cfs @ 12.35 hrs, Volume= 1.662 af, Atten= 90%, Lag= 23.6 min
Discarded = 0.17 cfs @ 3.51 hrs, Volume= 0.799 af
Primary = 2.76 cfs @ 12.35 hrs, Volume= 0.863 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 257.90' @ 12.35 hrs Surf.Area= 0.341 ac Storage= 0.929 af

Plug-Flow detention time= 613.7 min calculated for 1.662 af (100% of inflow)
Center-of-Mass det. time= 613.9 min (1,356.8 - 742.9)

Volume	Invert	Avail.Storage	Storage Description
#1	253.50'	0.396 af	6.00'W x 2,479.00'L x 4.50'H Stone 1.537 af Overall - 0.548 af Embedded = 0.989 af x 40.0% Voids
#2	254.00'	0.548 af	42.0" Round Pipe Storage Inside #1 L= 2,479.0'
		0.943 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	254.00'	18.0" Round Culvert L= 16.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 254.00' / 253.80' S= 0.0125 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	253.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	255.65'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.17 cfs @ 3.51 hrs HW=253.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.17 cfs)

Primary OutFlow Max=2.76 cfs @ 12.35 hrs HW=257.90' (Free Discharge)
↑**1=Culvert** (Passes 2.76 cfs of 15.10 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 2.76 cfs @ 4.90 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

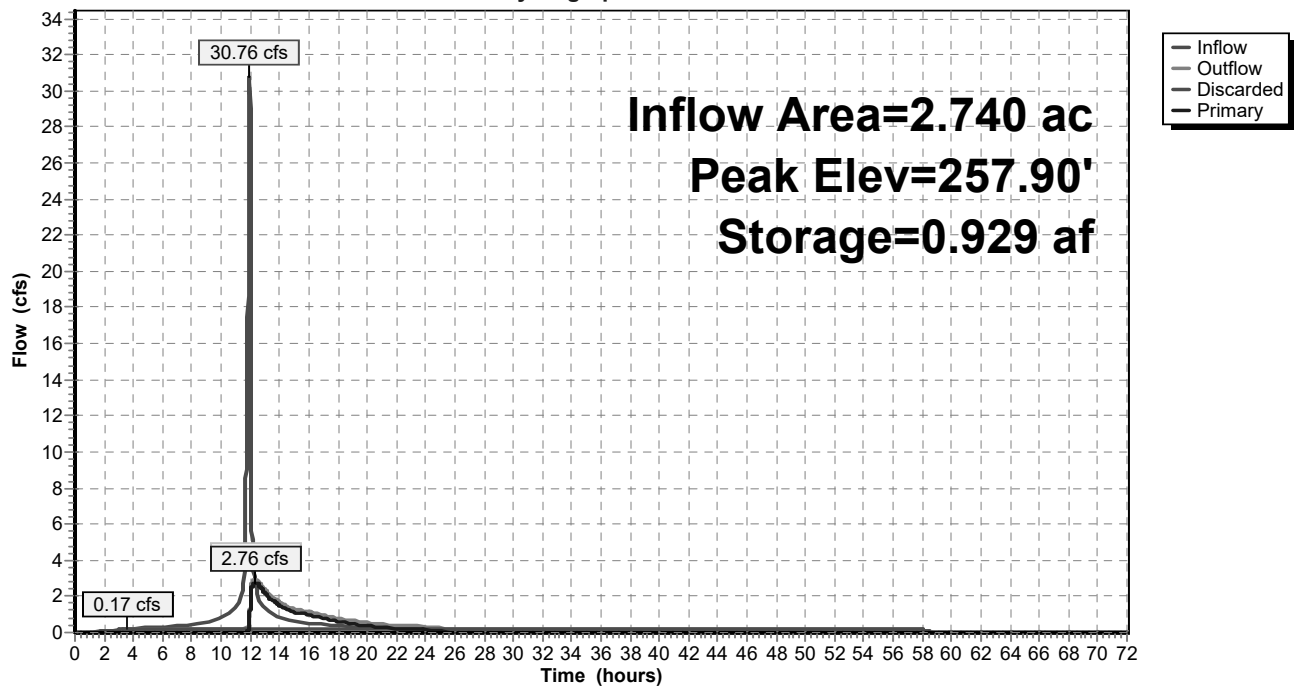
Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 146

Pond 5P: P-2

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 147

Summary for Pond 7P: P-3

Inflow Area = 3.710 ac, 100.00% Impervious, Inflow Depth = 7.40" for 100-YR event
Inflow = 41.76 cfs @ 11.96 hrs, Volume= 2.288 af
Outflow = 2.99 cfs @ 12.50 hrs, Volume= 2.288 af, Atten= 93%, Lag= 32.6 min
Discarded = 0.25 cfs @ 2.96 hrs, Volume= 1.162 af
Primary = 2.74 cfs @ 12.50 hrs, Volume= 1.126 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 259.84' @ 12.50 hrs Surf.Area= 0.488 ac Storage= 1.316 af

Plug-Flow detention time= 666.2 min calculated for 2.288 af (100% of inflow)
Center-of-Mass det. time= 666.2 min (1,402.8 - 736.6)

Volume	Invert	Avail.Storage	Storage Description
#1	255.50'	0.565 af	6.00'W x 3,541.00'L x 4.50'H Stone 2.195 af Overall - 0.782 af Embedded = 1.413 af x 40.0% Voids
#2	256.00'	0.782 af	42.0" Round Pipe Storage Inside #1 L= 3,541.0'
		1.347 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	256.00'	18.0" Round Culvert L= 33.4' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 256.00' / 255.70' S= 0.0090 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	255.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	257.60'	0.5' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.25 cfs @ 2.96 hrs HW=255.55' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.25 cfs)

Primary OutFlow Max=2.74 cfs @ 12.50 hrs HW=259.84' (Free Discharge)
↑**1=Culvert** (Passes 2.74 cfs of 14.96 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 2.74 cfs @ 4.89 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

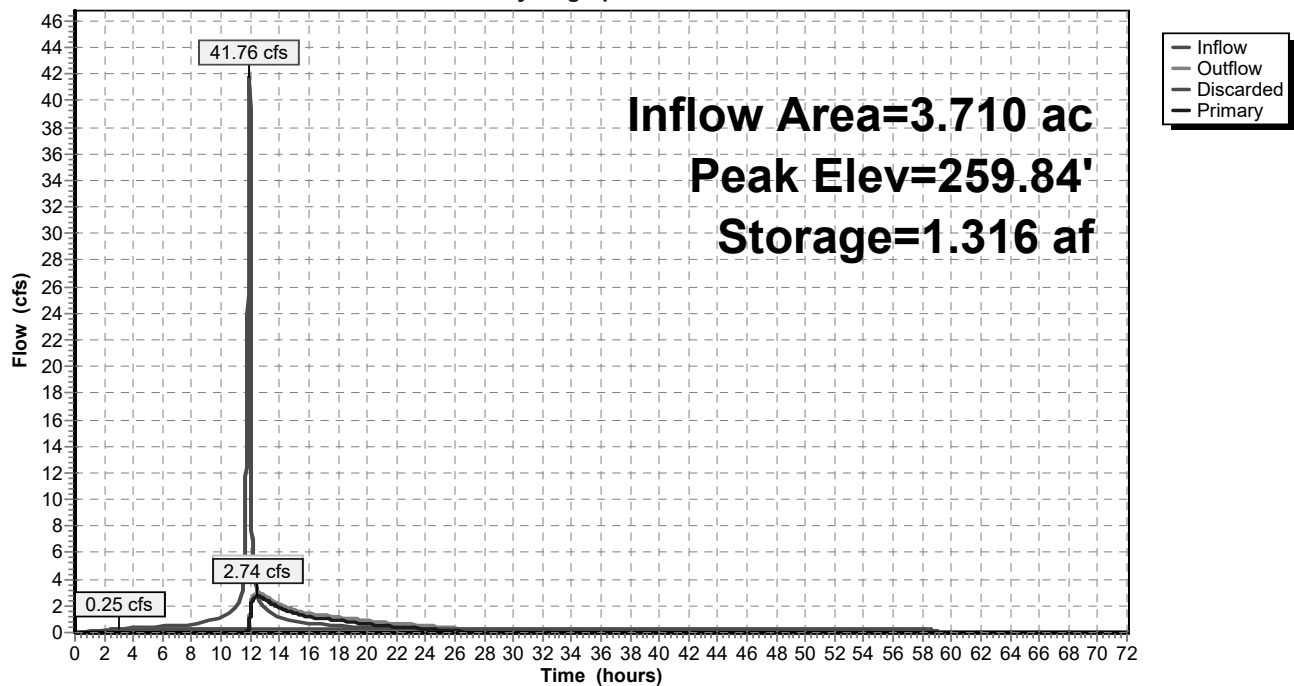
Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 148

Pond 7P: P-3

Hydrograph



routings

Type II 24-hr 100-YR Rainfall=7.64"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 149

Summary for Pond 9P: P-4

Inflow Area = 2.100 ac, 0.00% Impervious, Inflow Depth = 6.22" for 100-YR event
 Inflow = 22.06 cfs @ 11.96 hrs, Volume= 1.088 af
 Outflow = 2.75 cfs @ 12.20 hrs, Volume= 1.088 af, Atten= 88%, Lag= 14.4 min
 Discarded = 0.14 cfs @ 7.26 hrs, Volume= 0.466 af
 Primary = 2.61 cfs @ 12.20 hrs, Volume= 0.622 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
 Peak Elev= 260.92' @ 12.20 hrs Surf.Area= 0.279 ac Storage= 0.554 af

Plug-Flow detention time= 382.8 min calculated for 1.088 af (100% of inflow)
 Center-of-Mass det. time= 382.8 min (1,162.0 - 779.3)

Volume	Invert	Avail.Storage	Storage Description
#1	257.50'	0.189 af	87.00'W x 96.00'L x 3.50'H Stone 0.671 af Overall - 0.199 af Embedded = 0.472 af x 40.0% Voids
#2	258.00'	0.199 af	30.0" Round Pipe Storage x 19 Inside #1 L= 93.0'
#3	257.50'	0.053 af	31.50'W x 74.00'L x 3.50'H Stone 0.187 af Overall - 0.056 af Embedded = 0.131 af x 40.0% Voids
#4	258.00'	0.056 af	30.0" Round Pipe Storage x 7 Inside #3 L= 71.0'
#5	257.50'	0.033 af	31.50'W x 46.00'L x 3.50'H Stone 0.116 af Overall - 0.034 af Embedded = 0.083 af x 40.0% Voids
#6	258.00'	0.034 af	30.0" Round Pipe Storage x 7 Inside #5 L= 43.0'
		0.563 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	256.40'	18.0" Round Culvert L= 20.4' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 256.40' / 256.20' S= 0.0098 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	257.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	259.00'	0.6' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.14 cfs @ 7.26 hrs HW=257.54' (Free Discharge)

↑**2=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=2.60 cfs @ 12.20 hrs HW=260.92' (Free Discharge)

↑**1=Culvert** (Passes 2.60 cfs of 16.52 cfs potential flow)

↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 2.60 cfs @ 4.53 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

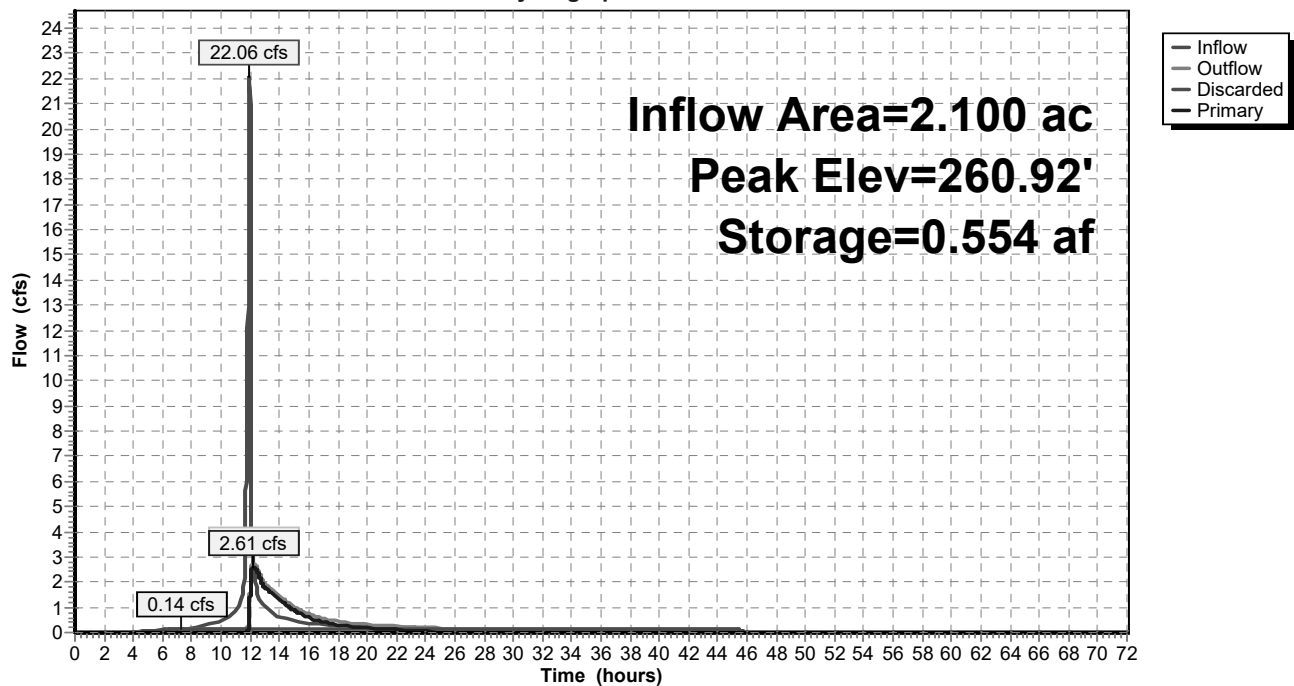
Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 150

Pond 9P: P-4

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 151

Summary for Pond 11P: P-5

Inflow Area = 1.470 ac, 0.00% Impervious, Inflow Depth = 6.69" for 100-YR event
Inflow = 16.04 cfs @ 11.96 hrs, Volume= 0.819 af
Outflow = 6.89 cfs @ 12.05 hrs, Volume= 0.819 af, Atten= 57%, Lag= 5.6 min
Discarded = 0.09 cfs @ 5.71 hrs, Volume= 0.349 af
Primary = 6.80 cfs @ 12.05 hrs, Volume= 0.470 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 260.97' @ 12.05 hrs Surf.Area= 0.182 ac Storage= 0.370 af

Plug-Flow detention time= 399.8 min calculated for 0.819 af (100% of inflow)
Center-of-Mass det. time= 400.0 min (1,165.8 - 765.8)

Volume	Invert	Avail.Storage	Storage Description
#1	257.50'	0.175 af	4.50'W x 1,757.00'L x 3.50'H Stone 0.635 af Overall - 0.198 af Embedded = 0.437 af x 40.0% Voids
#2	258.00'	0.198 af	30.0" Round Pipe Storage Inside #1 L= 1,757.0'
		0.373 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	258.00'	18.0" Round Culvert L= 40.8' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 258.00' / 257.50' S= 0.0123 ' / ' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Discarded	257.50'	0.500 in/hr Exfiltration over Surface area
#3	Device 1	259.30'	1.3' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Discarded OutFlow Max=0.09 cfs @ 5.71 hrs HW=257.54' (Free Discharge)
↑**2=Exfiltration** (Exfiltration Controls 0.09 cfs)

Primary OutFlow Max=6.80 cfs @ 12.05 hrs HW=260.97' (Free Discharge)
↑**1=Culvert** (Passes 6.80 cfs of 12.67 cfs potential flow)
↑**3=Sharp-Crested Rectangular Weir** (Weir Controls 6.80 cfs @ 4.22 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

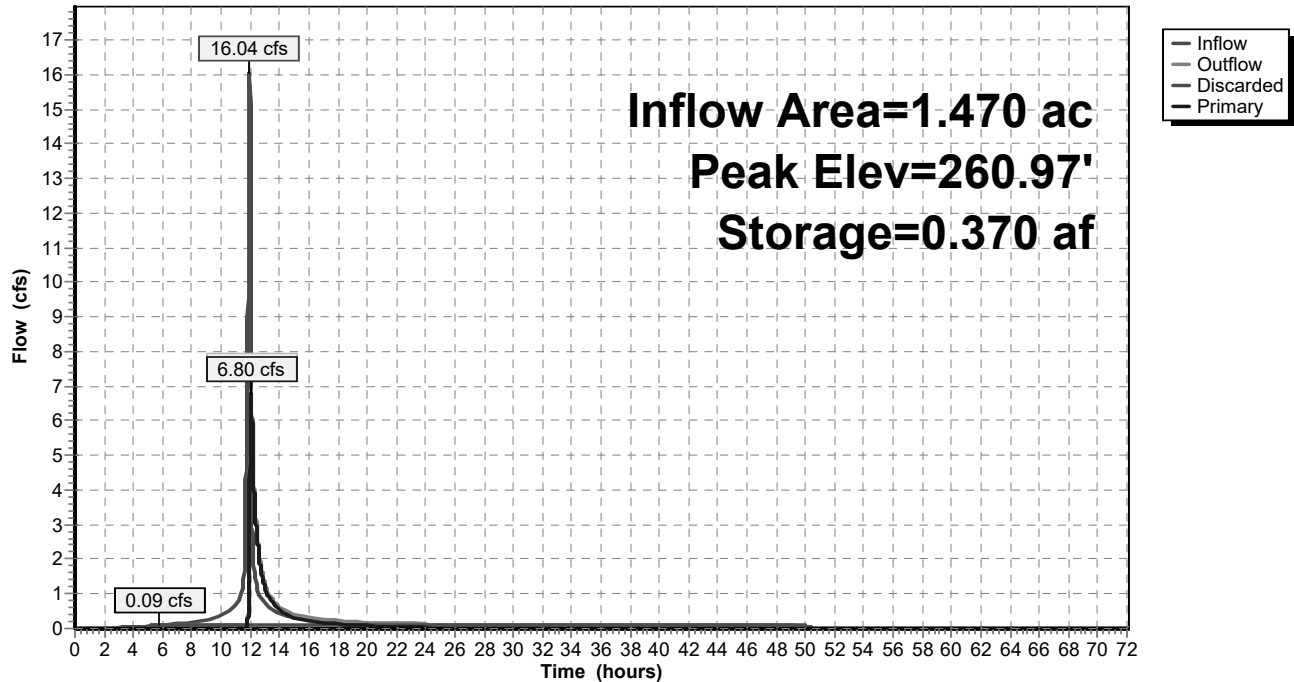
Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 152

Pond 11P: P-5

Hydrograph



routings

Type II 24-hr 100-YR Rainfall=7.64"

Prepared by {enter your company name here}

Printed 12/18/2017

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Page 153

Summary for Pond 14P: P-6

Inflow Area = 1.790 ac, 0.00% Impervious, Inflow Depth = 6.57" for 100-YR event
Inflow = 19.37 cfs @ 11.96 hrs, Volume= 0.980 af
Outflow = 8.57 cfs @ 12.05 hrs, Volume= 0.980 af, Atten= 56%, Lag= 5.5 min
Primary = 8.57 cfs @ 12.05 hrs, Volume= 0.980 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 254.44' @ 12.05 hrs Surf.Area= 0.150 ac Storage= 0.426 af

Plug-Flow detention time= 229.7 min calculated for 0.980 af (100% of inflow)
Center-of-Mass det. time= 230.0 min (999.5 - 769.4)

Volume	Invert	Avail.Storage	Storage Description
#1	250.00'	0.165 af	28.00'W x 234.00'L x 4.50'H Stone 0.677 af Overall - 0.265 af Embedded = 0.411 af x 40.0% Voids
#2	250.00'	0.265 af	48.0" Round Pipe Storage x 4 Inside #1 L= 230.0'
		0.430 af	Total Available Storage

Device	Routing	Invert	Outlet Devices
#1	Primary	250.00'	18.0" Round Culvert L= 33.7' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 250.00' / 249.80' S= 0.0059 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	250.00'	3.0" Vert. Orifice/Grate C= 0.600
#3	Device 1	252.25'	1.2' long Sharp-Crested Rectangular Weir 2 End Contraction(s)

Primary OutFlow Max=8.56 cfs @ 12.05 hrs HW=254.44' (Free Discharge)

1=Culvert (Passes 8.56 cfs of 16.34 cfs potential flow)

2=Orifice/Grate (Orifice Controls 0.49 cfs @ 10.00 fps)

3=Sharp-Crested Rectangular Weir (Weir Controls 8.07 cfs @ 4.84 fps)

routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

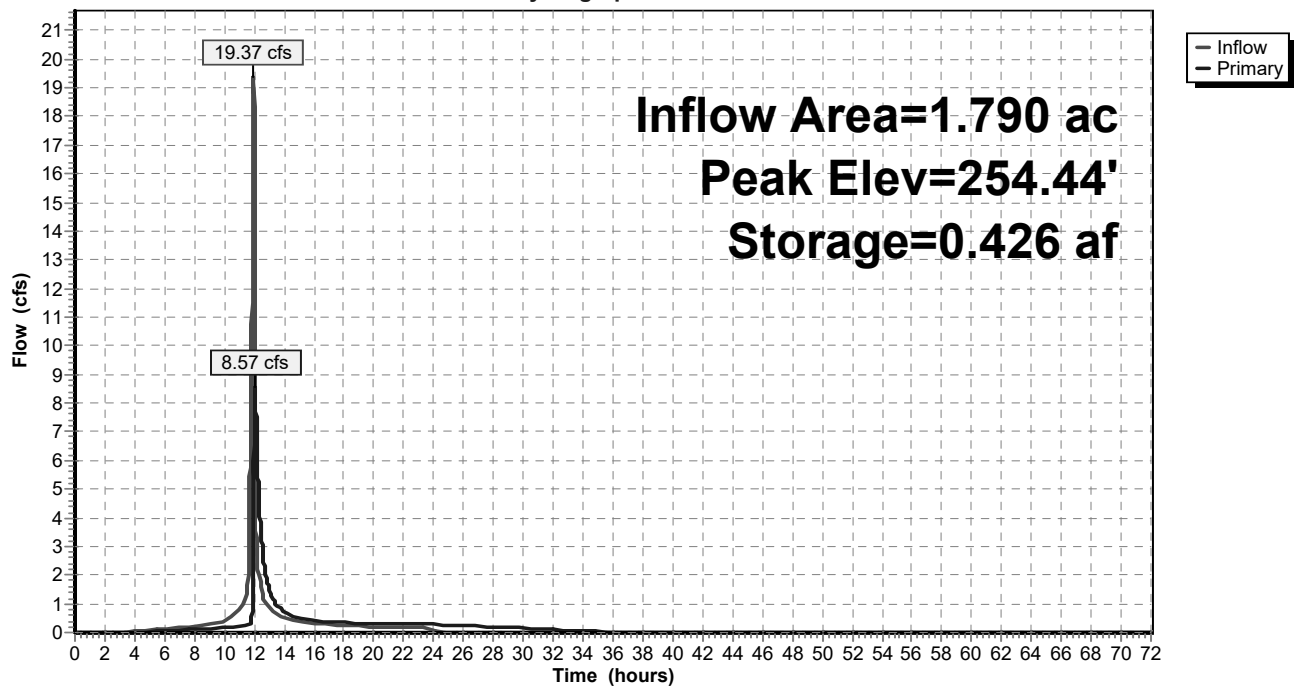
Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 154

Pond 14P: P-6

Hydrograph



routings

Prepared by {enter your company name here}

HydroCAD® 10.00-20 s/n 07556 © 2017 HydroCAD Software Solutions LLC

Type II 24-hr 100-YR Rainfall=7.64"

Printed 12/18/2017

Page 155

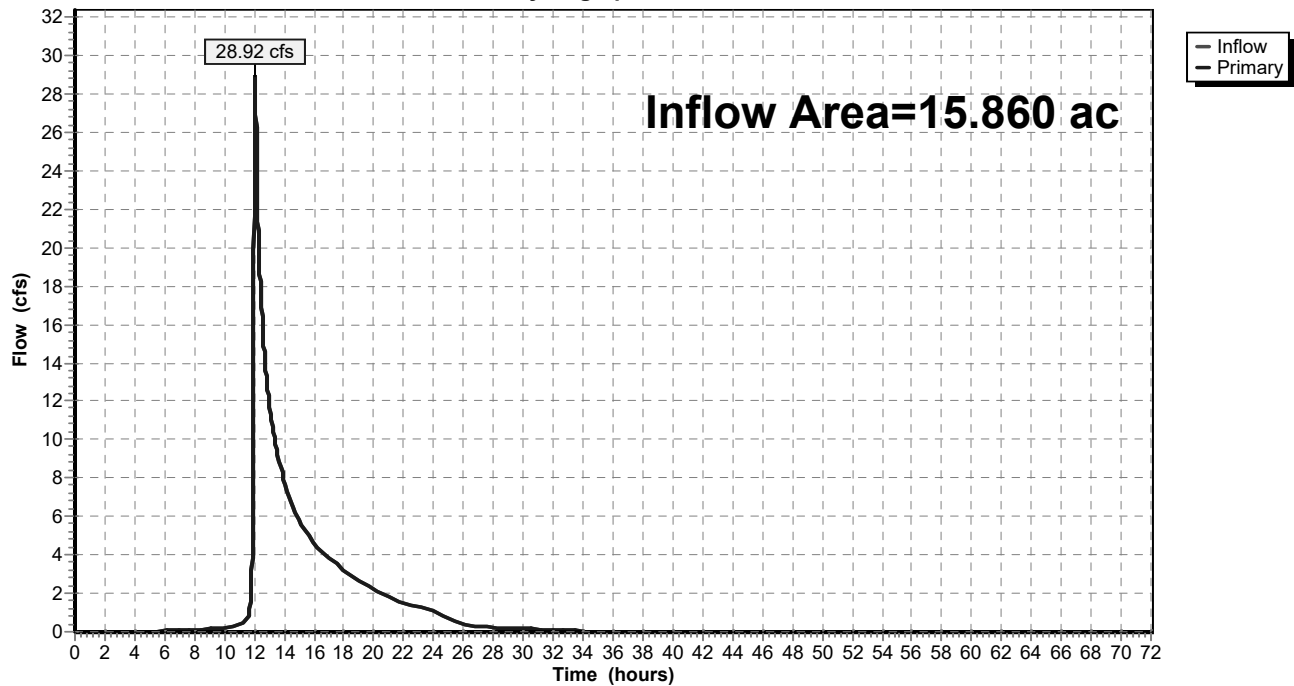
Summary for Link 12L: PO1#1

Inflow Area = 15.860 ac, 23.39% Impervious, Inflow Depth = 4.06" for 100-YR event
Inflow = 28.92 cfs @ 12.06 hrs, Volume= 5.362 af
Primary = 28.92 cfs @ 12.06 hrs, Volume= 5.362 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Link 12L: PO1#1

Hydrograph





Infiltration Time Analysis

Project: MARPLE ASSOCIATES, LP
MARPLE TOWNSHIP, DELAWARE COUNTY, PA

Date: 12/18/2017
Prepared By: MAR
Checked By: RTW

Basin #: P1

Permanent Pool Elevation = 242.45

Stage	Storage
242	14331
243	27225
242.45	20133

Recharge Volume = 20133 CF

Average Infiltration Rate = 2.34 in/hr
Factor of Safety = 6

Design Infiltration Rate = 0.39 in/hr

Basin Area = 17738 SF

Infiltration Time = Volume/(Rate x Area)

Infiltration Time = 34.92 hrs

34.92 hrs ≤ 72 hrs, ∴ OK



Infiltration Time Analysis

Project: MARPLE ASSOCIATES, LP
MARPLE TOWNSHIP, DELAWARE COUNTY, PA

Date: 12/18/2017
Prepared By: MAR
Checked By: RTW

Basin #: P2

Permanent Pool Elevation = 255.65

Stage	Storage
255	12284
256	23305
255.65	19447

Recharge Volume = 19447 CF

Average Infiltration Rate = 2.34 in/hr
Factor of Safety = 6

Design Infiltration Rate = 0.39 in/hr

Basin Area = 15280 SF

Infiltration Time = Volume/(Rate x Area)

Infiltration Time = 39.16 hrs

39.16 hrs ≤ 72 hrs, ∴ OK



Infiltration Time Analysis

Project: MARPLE ASSOCIATES, LP
MARPLE TOWNSHIP, DELAWARE COUNTY, PA

Date: 12/18/2017
Prepared By: MAR
Checked By: RTW

Basin #: P3

Permanent Pool Elevation = 257.60

Stage	Storage
257	17555
258	33323
257.60	27016

Recharge Volume = 27016 CF

Average Infiltration Rate = 2.34 in/hr
Factor of Safety = 6

Design Infiltration Rate = 0.39 in/hr

Basin Area = 22019 SF

Infiltration Time = Volume/(Rate x Area)

Infiltration Time = 37.75 hrs

37.75 hrs ≤ 72 hrs, ∴ OK



Infiltration Time Analysis

Project: MARPLE ASSOCIATES, LP
MARPLE TOWNSHIP, DELAWARE COUNTY, PA

Date: 12/18/2017
Prepared By: MAR
Checked By: RTW

Basin #: P4

Permanent Pool Elevation = 259.00

Stage	Storage
258	2439
259	10106
259.00	10106

Recharge Volume = 10106 CF

Average Infiltration Rate = 2.34 in/hr
Factor of Safety = 6

Design Infiltration Rate = 0.39 in/hr

Basin Area = 11924 SF

Infiltration Time = Volume/(Rate x Area)

Infiltration Time = 26.08 hrs

26.08 hrs ≤ 72 hrs, ∴ OK



Infiltration Time Analysis

Project: MARPLE ASSOCIATES, LP
MARPLE TOWNSHIP, DELAWARE COUNTY, PA

Date: 12/18/2017
Prepared By: MAR
Checked By: RTW

Basin #: P5

Permanent Pool Elevation = 259.30

Stage	Storage
259	6665
260	12327
259.30	8364

Recharge Volume = 8364 CF

Average Infiltration Rate = 2.34 in/hr
Factor of Safety = 6

Design Infiltration Rate = 0.39 in/hr

Basin Area = 11924 SF

Infiltration Time = Volume/(Rate x Area)

Infiltration Time = 21.58 hrs

21.58 hrs ≤ 72 hrs, ∴ OK

Appendix G

NPDES BMP Manual Worksheets



Date: **12/18/2017**
Prepared By:
Checked By:

Worksheet 1 . General Site Information

INSTRUCTIONS: Fill out Worksheet 1 for each watershed.

Date: 12/18/2017

Project Name: Marple Associates, LP

Municipality: Marple Township

County: Delaware

Total Area (acres): 25.43

Major River Basin Delaware River

<http://www.pawaterplan.dep.state.pa.us/StateWaterPlan/docroot/default.aspx>

Watershed: Darby-Cobbs Creeks

Sub-Basin: Lower Delaware River

Nearest Surface Water(s) to Receive Runoff: Langford Run

Chapter 93 - Designated Water Use / Existing Water Use: WWF-MF

<http://www.pacode.com/secure/data/025/chapter93/chap93toc.html>

Impaired according to Category 4 or 5 of the Integrated Water Quality Monitoring and Assessment Rep Yes ☒ No ☐
http://www.portal.state.pa.us/portal/server.pt/community/water_quality_standards/10556/integrated_water_quality_report_-_2010/682562

List Causes of Impairment: Category 4c: Other Habitat Alterations; Water/Flow Variability
Category 5: Unknown; Siltation; PCB

Is there an established TMDL that applies: Yes ☐ No ☒

Total Maximum Daily Loads (TMDLS):
http://www.dep.state.pa.us/watermanagement_apps/tmdl/
http://www.epa.gov/reg3wapd/tmdl/pa_tmdl/index.htm

Is project subject to, or part of:

Municipal Separate Storm Sewer System (MS4) Requirements? Yes ☐ No ☒
<http://www.stormwaterpa.org/swm-regs.html>

Existing or planned drinking water supply? Yes ☐ No ☒

If yes, distance from proposed discharge (miles): _____

Approved Act 167 Plan? Yes ☒ No ☐
<http://www.portal.state.pa.us/portal/server.pt?open=514&objID=554325&mode=2>

Existing River Conservation Program? Yes ☒ No ☐
<http://www.dcnr.state.pa.us/brc/rivers/riversconservation/registry/>

Worksheet 2 . Sensitive Resources

 Project Name: **Marple Associates, LP**
Instructions:

1. Provide Sensitive Resources Map according to non-structural BMP 5.4.1 in Chapter 5. This map should identify wetlands, woodlands, natural drainage ways, steep slopes, and other sensitive natural areas.

2. Summarize the existing extent of each sensitive resource in the Existing Sensitive Resources Table (below, using Acres). If none present, insert 0.

3. Summarize Total Protected Area as defined under BMPs in Chapter 5.

4. Do not count any area twice. For example, an area that is both a floodplain and a wetland may only be considered once.

Existing Natural Sensitive Resource	Mapped? Yes, No, N/A	Total Area (Ac)	Protected Area (Ac)
Waterbodies	N/A	0.00	
Floodplains	Yes	0.50	
Riparian Areas	N/A	0.00	
Wetlands	Yes	1.40	1.40
Woodlands	N/A	0.00	
Natural Drainage Ways	N/A	0.00	
Steep Slopes, 15%-25%	Yes	3.51	
Steep Slopes, over 25%	Yes	8.82	
Conservation Easement	Yes	5.30	5.30
Other:	N/A	0.00	
Total Existing:		19.53	6.70

Worksheet 3 . Non-Structural BMP Credits

Project Name: Marple Associates, LP

PROTECTED AREA

1.1 Area of Protected Sensitive/Special Value Features (see WS 2) 6.70 Ac

1.2 Area of Riparian Forest Buffer Protection (see WS 2) 0.00 Ac

page 21-SW BMP Manual) 2.40 Ac

TOTAL 9.10 **Ac**

Site Area	Minus	Protected Area	=	Stormwater Management Area
<u>25.43</u>	-	<u>9.10</u>	=	<u>16.33</u>

This is the area that requires stormwater management

VOLUME CREDITS

3.1 Minimum Soil Compaction (See Chapter 8, page 22 - SW BMP Manual)

Lawn	ft ²	x	1/4"	x	1/12	=	<u>0.00</u>	ft ³
Meadow	ft ²	x	1/3"	x	1/12	=	<u>0.00</u>	ft ³

3.3 Protect Existing Trees (See Chapter 8, Page 23 - SW BMP Manual)

For trees within 100 feet of impervious area:

Tree Canopy	ft ²	x	1/2"	x	1/12	=	<u>0.00</u>	ft ³

5.1 Disconnect Roof Leaders to Vegetated Areas (See Chapter 8 page 25 - SW BMP Manual)

For runoff directed to areas protected under 5.8.1 and 5.8.2

Roof Area	ft ²	x	1/3"	x	1/12	=	<u>0.00</u>	ft ³

For all other disconnected roof areas

Roof Area	ft ²	x	1/4"	x	1/12	=	<u>0.00</u>	ft ³

5.2 Disconnect Non-Roof Impervious to Vegetated Areas (See Chapter 8, page 26 - SW BMP Manual)

For runoff directed to areas protected under 5.8.1 and 5.8.2

Impervious Area	ft ²	x	1/3"	x	1/12	=	<u>0.00</u>	ft ³

For all other disconnected roof areas

Impervious Area	ft ²	x	1/4"	x	1/12	=	<u>0.00</u>	ft ³

TOTAL NON-STRUCTURAL VOLUME CREDIT* 0.00 ft³

*For use on Worksheet 5



Date: **12/18/2017**
 Prepared By: **0**
 Checked By: **0**

Worksheet 4 . Change in Runoff Volume for 2-Year Storm Event

Project Name: **Marple Associates, LP**
 Drainage Area: _____
 2-Year Rainfall: **3.26** in.
 Total Site Area: **25.43** Acres
 Protected Site Area: **9.10** Acres
 Managed Area: **16.33** Acres

Existing Conditions *

Cover Type/Condition	Soil Type	Area (sf)	Area (Ac)	CN	S	Ia (0.2 * S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Woodland		0						
Meadow	B	654,637	15.03	58	7.241	1.448	0.363	19,779
Meadow (20% Impervious)	B	320	0.01	58	7.241	1.448	0.363	10
Impervious (80%)	B	1,279	0.03	98	0.204	0.041	3.027	323
Open Space, Not Disturbed, Good Conditions	B	22,490	0.52	61	6.393	1.279	0.469	879
Impervious, Not Disturbed	B	1,477	0.03	98	0.204	0.041	3.027	373
Roadway Utilities Installation (to be restored in kind)	B	31,128	0.71	98	0.204	0.041	3.027	7,853
Total		711,330	16.33					29,215

* Per Chapter 3, the following must be implemented:

- Existing non-forested pervious areas must be considered meadow (good condition) or its equivalent.
- Twenty-percent (20%) of existing impervious area, when present, shall be considered meadow (good condition).

Developed Conditions

Cover Type/Condition	Soil Type	Area (sf)	Area (Ac)	CN	S	Ia (0.2 * S)	Q Runoff ¹ (in)	Runoff Volume ² (ft ³)
Woodland		0						
Impervious	B	574,344	13.19	98	0.204	0.041	3.027	144,891
Open Space (Lawns), Good Condition	B	81,892	1.88	61	6.393	1.279	0.469	3,199
Open Space, Not Disturbed, Good Conditions	B	22,490	0.52	61	6.393	1.279	0.469	879
Impervious, Not Disturbed	B	1,477	0.03	98	0.204	0.041	3.027	373
Roadway Utilities Installation (to be restored in kind)	B	31,128	0.71	98	0.204	0.041	3.027	7,853
Total		711,330	16.33					157,194

2-year Volume Increase (ft³): **127,979**

2-year Volume Increase = Developed Conditions Runoff Volume - Existing Conditions Runoff Volume

- Runoff (in) = $Q = (P - 0.2S)^2 / (P + 0.8S)$ where:
 P = 2-year Rainfall (in)
 S = (1000/CN) - 10
- Runoff Volume (CF) = $Q \times \text{Area} \times 1/12$
 Q = Runoff (in)
 Area = Land use area (s.f.)

Note: Runoff Volume must be calculated for EACH land use type/condition and HSGI.
The use of a weighted CN value for volume calculations is not acceptable.



Date: 12/18/2017
 Prepared By: 0
 Checked By: 0

Worksheet 5 . Structural BMP Volume Credits

Project Name: Marple Associates, LP

Sub-Basin: _____

Required Control Volume (ft³) - from Worksheet 4: 127,979

Non-structural Volume Credit (ft³) - from Worksheet 3: - 0
 (maximum is 25% of required volume)

Structural Volume Requirement (ft³) 127,979
 (Required Control Volume minus Non-structural Credit)

Proposed BMP	Area (ft ²)	Volume Reduction Permanently Removed (ft ³)
6.4.1 Porous Pavement		
6.4.2 Infiltration Basin	612,889	133,524
6.4.3 Infiltration Bed		
6.4.4 Infiltration Trench		
6.4.5 Rain Garden/Bioretenention		
6.4.6 Dry Well/Seepage Pit		
6.4.7 Constructed Filter		
6.4.8 Vegetated Swale		
6.4.9 Vegetated Filter Strip		
6.4.10 Berm		
6.5.1 Vegetated Roof		
6.5.2 Capture and Re-Use		
6.6.1 Constructed Wetlands		
6.6.2 Wet Pond/Retention Basin		
6.6.3 Dry Extended Detention Basin		
6.6.4 Water Quality Filters		
6.7.1 Riparian Buffer Restoration		
6.7.2 Landscape Restoration / Reforestation		1,030
6.7.3 Soil Amendment		
6.8.1 Level Spreader		
6.8.2 Special Storage Areas		
Other		

Total Structural Volume (ft³): 134,554
 Structural Volume Requirement (ft³): 127,979

DIFFERENCE -6,575



Date: **12/18/2017**
 Prepared By: **0**
 Checked By: **0**

Worksheet 10 . Water Quality Compliance For Nitrate

Project Name: **Marple Associates, LP**

Does the site design incorporate the following BMPs to address nitrate pollution? A summary "yes" rating is achieved if at least 2 Primary BMPs for nitrate are provided across the site or 4 secondary BMPs for nitrate are provided across the site (or the equivalent) "provided across the site" is taken to mean the specifications for that BMP set forward in Sections 5 and 6 are satisfied.

PRIMARY BMPs FOR NITRATE:

	YES	NO
NS BMP 5.4.2 - Protect / Conserve/ Enhance Riparian Buffers	☒	☐
NS BMP 5.5.4 - Cluster Uses at each Site	☐	☐
NS BMP 5.6.1 - Minimize Total Disturbed Area	☐	☐
NS BMP 5.6.3 - Re-Vegetate / Re-Forest Disturbed Areas (Native Species)	☒	☐
NS BMP 5.9.1 - Street Sweeping / Vacuuming	☐	☐
Structural BMP 6.7.1 - Riparian Buffer Restoration	☐	☐
Structural BMP 6.7.2 - Landscape Restoration	☐	☐

SECONDARY BMPs FOR NITRATE:

NS BMP 5.4.1 - Protect Sensitive / Special Value Features	☐	☐
NS BMP 5.4.3 - Protect / Utilize Natural Drainage Features	☐	☐
NS BMP 5.6.2 - Minimize Soil Compaction	☐	☐
Structural BMP 6.4.5 - Rain Garden / Bioretention	☐	☐
Structural BMP 6.4.8 - Vegetated Swale	☐	☐
Structural BMP 6.4.9 - Vegetated Filter Strip	☐	☐
Structural BMP 6.6.1 - Constructed Wetland	☐	☐
Structural BMP 6.7.1 - Riparian Buffer Restoration	☐	☐
Structural BMP 6.7.2 - Landscape Restoration	☐	☐
Structural BMP 6.7.3 - Soils Amendment / Restoration	☐	☐

Stormwater BMP Information Chart 5.B revised March 15, 2016

	Infiltration Information				Drainage Information				BMP Information									
	Measured Infiltration Rate ⁹ <i>in./hr.</i>	Factor of Safety ⁸ <i>Min. of 2</i>	Design Infiltration Rate <i>in./hr.</i>	Dewatering Time ¹ <i>hrs.</i>	Elevation of Limiting Zone - Water Table, Bedrock, etc. ²	Total Drainage Area to BMP <i>sq. ft.</i>	Total Impervious Drainage Area to BMP <i>sq. ft.</i>	Infiltration BMP Surface Area <i>sq. ft.</i>	Total Drainage Area Loading Ratio ⁵	Impervious Area Loading Ratio ⁷	Volume of Runoff Tributary to BMP During the 2yr/24hr Design Storm ⁶	Calculated Infiltration Volume (from storms up to and including 2yr/24hr) <i>cf</i>		Calculated Managed Volume (from storms up to and including 2yr/24hr) ⁸ <i>cf</i>	Maximum water surface elevation in BMP from 2yr storm ³	Infiltration Bottom of Bed/ Basin ³	Elevation of E&S Sediment Basin Bottom Test ⁴	Elevation of E&S Sediment Basin Bottom (if applies)
BMP 6.4.1	Pervious Pavement w/ Infiltration Bed																	
BMP 6.4.2	Infiltration Basin																	
	Basin P-1	2.34 (ave)	6	0.39	46.55	N/E ¹⁰	140,699	125,017	17,738	7.9:1	7.0:1 ¹¹	32,133	32,133	0	242.45	240.50	232.50	N/A
	Basin P-2	2.34 (ave)	6	0.39	51.20	N/E	119,354	114,998	15,280	7.8:1	7.5:1 ¹¹	29,237	29,237	0	255.65	253.50	230.50	N/A
	Basin P-3	2.34 (ave)	6	0.39	53.90	N/E ¹⁰	161,608	159,865	22,019	7.3:1	7.3:1 ¹¹	40,364	40,364	0	257.60	255.50	251.00	N/A
	Basin P-4	2.34 (ave)	6	0.39	30.46	N/E ¹⁰	91,476	67,518	11,924	7.7:1	5.7:1 ¹¹	17,955	17,955	0	259.00	257.50	255.90	N/A
	Basin P-5	2.34 (ave)	6	0.39	31.34	N/E	64,033	53,143	8,546	7.5:1	6.2:1 ¹¹	13,835	13,835	0	259.30	257.50	257.60	N/A
BMP 6.4.3	Subsurface Infiltration Bed																	
BMP 6.4.4	Infiltration Trench																	
BMP 6.4.5	Rain Garden/Bioretentation																	
BMP 6.4.6	Dry Well / Seepage Pit																	
Other																		
BMP 6.4.7	Constructed Filter																	
BMP 6.4.8	Vegetated Swale																	
BMP 6.4.9	Vegetated Filter Strip																	
BMP 6.4.10	Infiltr. Berm & Ret. Grading																	

All information should be based on the 2-year/24-hour storm

Provide page numbers from the stormwater narrative identifying the location of the above information.

¹ Can include active infiltration time - dewatering time should not exceed 72 hours after the 2-year/24-hour storm

² Depth to limiting zone is recommended to be at least 2 ft below infiltration testing elevation/proposed infiltration elevation.

³ A maximum of 2 feet of Hydraulic head is recommended.

⁴ Provide supporting field notes/documentation from soil evaluation.

⁵ This value should be greater than or equal to the Volume to be Infiltrated or Managed by the BMP.

⁶ A maximum of 8:1 is recommended.

⁷ A maximum of 5:1 is recommended; however, in carbonate geology areas, a maximum of 3:1 is recommended.

⁸ Calculated runoff volume that is managed in ways other than infiltration to address 25 PA Code Ch 102.8(g)(2)

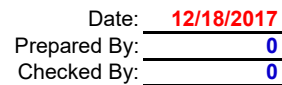
⁹ The infiltration testing information should be located on the plan view of the PCSM Plan and should include infiltration test elevation and rate.

¹⁰ Limiting zone due to groundwater was not encountered. Bedrock was encountered and will be excavated to a depth of 18" below the basin bottom and replaced with a soil modification layer.

¹¹ Impervious area to infiltration bed loading ratio exceeds recommended 5:1. See Loading Ratio Risk Assessment in the Appendix of the PCSM Report.

Any deviations from the recommendations above should be adequately justified by a qualified professional and included with the application.

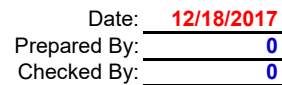
NOTE: This chart is for summary purposes only and should be consistent with all design calculations and worksheets.



Runoff Volume per BMP	

Developed Conditions

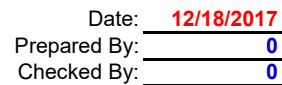
211



Runoff Volume per BMP	
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28	28
29	29
30	30
31	31
32	32
33	33
34	34
35	35
36	36
37	37
38	38
39	39
40	40
41	41
42	42
43	43
44	44
45	45
46	46
47	47
48	48
49	49
50	50
51	51
52	52
53	53
54	54
55	55
56	56
57	57
58	58
59	59
60	60
61	61
62	62
63	63
64	64
65	65
66	66
67	67
68	68
69	69
70	70
71	71
72	72
73	73
74	74
75	75
76	76
77	77
78	78
79	79
80	80
81	81
82	82
83	83
84	84
85	85
86	86
87	87
88	88
89	89
90	90
91	91
92	92
93	93
94	94
95	95
96	96
97	97
98	98
99	99
100	100

Developed Conditions

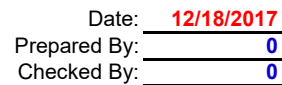
212



Runoff Volume per BMP	
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
10	10
11	11
12	12
13	13
14	14
15	15
16	16
17	17
18	18
19	19
20	20
21	21
22	22
23	23
24	24
25	25
26	26
27	27
28	28
29	29
30	30
31	31
32	32
33	33
34	34
35	35
36	36
37	37
38	38
39	39
40	40
41	41
42	42
43	43
44	44
45	45
46	46
47	47
48	48
49	49
50	50
51	51
52	52
53	53
54	54
55	55
56	56
57	57
58	58
59	59
60	60
61	61
62	62
63	63
64	64
65	65
66	66
67	67
68	68
69	69
70	70
71	71
72	72
73	73
74	74
75	75
76	76
77	77
78	78
79	79
80	80
81	81
82	82
83	83
84	84
85	85
86	86
87	87
88	88
89	89
90	90
91	91
92	92
93	93
94	94
95	95
96	96
97	97
98	98
99	99
100	100

Developed Conditions

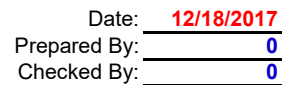
213



Runoff Volume per BMP	

Developed Conditions

214



Runoff Volume per BMP	
1	100
2	100
3	100
4	100
5	100
6	100
7	100
8	100
9	100
10	100
11	100
12	100
13	100
14	100
15	100
16	100
17	100
18	100
19	100
20	100
21	100
22	100
23	100
24	100
25	100
26	100
27	100
28	100
29	100
30	100
31	100
32	100
33	100
34	100
35	100
36	100
37	100
38	100
39	100
40	100
41	100
42	100
43	100
44	100
45	100
46	100
47	100
48	100
49	100
50	100
51	100
52	100
53	100
54	100
55	100
56	100
57	100
58	100
59	100
60	100
61	100
62	100
63	100
64	100
65	100
66	100
67	100
68	100
69	100
70	100
71	100
72	100
73	100
74	100
75	100
76	100
77	100
78	100
79	100
80	100
81	100
82	100
83	100
84	100
85	100
86	100
87	100
88	100
89	100
90	100
91	100
92	100
93	100
94	100
95	100
96	100
97	100
98	100
99	100
100	100

Developed Conditions

215



Revegetate and Reforest Recharge Volume Calculations

Project: Marple Associates, LP
Location: Marple Township, Delaware County, PA

Date: 12/19/2017
Prepared by: MAR
Checked By: RTW

Description: Revegetate and Reforest **TOTAL SITE**

Volume Credits			
<i>For Deciduous Trees:</i>			
Volume Reduction =	6	cf	
<i>For Evergreen Trees:</i>			
Volume Reduction =	10	cf	

Decidious Trees:

Number of Trees = **125**
Volume Reduction = **750** cf

Evergreen Trees:

Number of Trees = **28**
Volume Reduction = **280** cf

Recharge Volume = 1030 CF

Appendix H

Loading Ratio Risk Assessment

Marple Associates, LP
Langford Run Road
Marple Township, Delaware County, PA

Justification for exceeding 5:1 impervious area to Infiltration bed area ratio per the PADEP “A Risk-Based Approach for Sizing Stormwater Infiltration BMPs” by Domenic Rocco, P.E., CPESC, CPSWQ, Chief Stormwater Section, Watershed Management Program, PADEP – Southeast Region, dated 7/27/2009.

Background:

The BMP Manual states (Appendix C, pg 15 of 21):

The loading ratio of impervious area to bed bottom area must be considered. One of the more common reasons for infiltration system failure is the design of a system that attempts to infiltrate a substantial volume of water in a very small area. Infiltration systems work best when the water is “spread out”. The loading ratio describes the ratio of impervious drainage area to infiltration area (IDA:IA), or the ratio of total drainage area to infiltration area (TDA:IA). In general, the following Loading Ratio guidelines are recommended:

- *Maximum Impervious Loading Ratio of 5:1 relating impervious drainage area to infiltration area.*
- *A Maximum Total Loading Ratio of 8:1 relating total drainage area to infiltration area.*
- *Maximum Impervious Loading Ratio of 3:1 relating impervious drainage area to infiltration area for Karst areas. (The Manual does not provide a recommendation for total drainage area to infiltration area for Karst areas.)*

(Also see Computing Loading Ratios.)

Infiltration BMPs should be conservatively designed using low loading rates because the pores in the media and surrounding soil tend to become clogged. Rejuvenation of the pore space requires "rest" periods between runoff events. (Source: British Columbia – Ministry of the Environment)

The recommended loading ratios in the Manual, along with the general criteria listed below, have been provided as a guide to designers and as a way to mitigate for the risk of problems or failures of infiltration BMPs during their expected service life (~20 years). (see Potential Risk Levels)

Loading ratios, for all intents and purposes, are a “rule of thumb” approach for the design of stormwater infiltration systems. Loading ratios were not intended to be a rigid requirement. The loading ratio concept is a well-intended idea that has resulted in an unintended consequence and, as a result, DEP and county conservation districts are continuously working with design engineers on alternative and equitable sizing criteria for infiltration BMPs to overcome the various pitfalls of the loading ratio approach and to provide fair and flexible guidance to the design community for infiltration BMP sizing which is protective of our water resources.

Using loading ratios blindly disregards site and project specific characteristics in the design process. While

rule-of-thumb ratios may be adequate for planning and preliminary design, it is more appropriate to size an infiltration facility based on the actual physical capabilities of the individual system, as determined by on-site soils testing, geologic investigations and detailed calculations.

Potential Risk Level

Potential Risk Level:

Risk is defined as a state of uncertainty where some of the possibilities involve a loss, catastrophe, or other undesirable outcome. Risk is an intrinsic trait for almost any infiltration BMP and there are risks of various degrees and proportions. Risk level in non-karst areas is mostly attributed to the threat of failure of a BMP from stresses due to either hydraulic loading or pollutant loading (e.g. sediment clogging). There are also potential risks to groundwater and adjacent dwellings which are not covered in this discussion, but the Manual currently provides setbacks for these scenarios to help mitigate these risks. For the sake of this discussion, undesirable outcomes may include: (1) impaired performance/effectiveness, (2) reduced service life and (3) ultimate failure. The “Common Causes of Infiltration BMP Failures” are discussed in further detail in the BMP Manual (Append. C, Page 18). The key issue for the stormwater designer is to get a firm handle on the level of risk associated with their site and BMP selection.

Factors that influence risk include, but may not be limited to scale, functionality, site/project characteristics, and constructability.

- Scale includes BMP size and drainage area which are directly proportional
Rather than designing one large infiltration facility, to minimize drainage areas, the design incorporates five (5) infiltration BMPs each with a drainage area between 1 and 4 acres.

The total drainage area to surface bed area loading ratio will not exceed 8:1, which is the BMP Manual recommended maximum.

The impervious area to surface bed area loading ratio will not exceed 8:1, which exceeds the BMP Manual recommended maximum of 5:1 in non-karst areas. It will be demonstrated here that several stormwater elements have been incorporated into the infiltration basin design to justify the higher loading ratio.

- Functionality can include level of pretreatment, the type/function of the BMP, and sustainability
Due to the nature of the development and available space, traditional methods of pretreatment are not feasible. Instead, the following BMPs are proposed:
 - Sump and Snout: All structures immediately upstream of the infiltration basins will be equipped with sump and snouts. These features provide reductions in gross pollutants such as floatables and trash, as well as free oils, and sediment.
 - Street Sweeping: Per the BMP Manual, with the use of right equipment in conjunction with a proper scheduled program, street sweeping can provide significant water quality benefits and pollutant removal (TSS:85%; TP: 85%; NO3: 50%). A regular parking lot sweeping program will minimize pollutants entering the infiltration basins.
 - Maximize impervious areas from roof areas: runoff from roof top areas are essentially cleaner than runoff generated from impervious in parking lot areas.

- Site and project characteristics

These can include various factors, but commonly include geology, soils, topography, surface cover and their correlation with the proposed project. A detailed review of state mapping and geological testing were used to determine the suitability of the proposed infiltration BMPs. The site is not located in an area known for “karst” topography nor any evidence of karst was found during the soil testing phase. In addition, the infiltration BMPs were sited in areas of hydrologic Soil Group “B” soils. Group “B” soils have a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

- Risk related to Constructability

During construction of these BMPs, an engineer and/or geotechnical engineer will be present on site to aid in the construction process.

- Transmissivity

Transmissivity is a measure of the area of water moving past a specific zone in the soil over time. It is defined as the rate at which water is transmitted through a unit width of an aquifer under a unit hydraulic gradient. Because of the relatively narrow permeable layers that are typically found in Pennsylvania, transmissivity can often be the limiting parameter for large infiltration BMPs, rather than hydraulic conductivity (K).

To minimize the risk due to transmissivity, the following design elements were included in the design of the infiltration BMPs:

- Multiple infiltration BMPs were utilized in lieu of one large one.
- A limiting zone separation of 2 feet or more has been maintained.
- A factor of safety of 6 has been utilized, while allowing the BMPs to dewater in less than 72 hours for the 100-yr storm.
- The routings and sizing of the BMP do not account for infiltration. This conservative approach will make the BMPs oversized, which will help in the event the infiltration time is reduced over time.

Conclusion:

As discussed above, several design features have been included in the infiltration basin design to minimize the risk potential for utilizing a higher impervious to surface bed loading ratio, as follows:

- The total drainage area to surface bed area will not be greater than the recommended 8:1.
- Pre-treatment has been provided.
- A factor of safety of 6 has been utilized for design.
- BMPs are oversized by not accounting for infiltration rates during the routings and sizing process.

Appendix I

Downstream Stability Analysis



Downstream Stability Analysis

Date: 12/19/2017

Project: **Marple Associates,LP**

Prepared by: **MAR**

Location: **Marple Township, Delaware County, PA**

Checked By: **RTW**

Outfall =	EX-FES						
L =	15.00 ft						
Q (100-yr Storm) =	58.17 cfs						
Soil Series =	Wehadkee						
Soil Classifications ¹ =	Erosion Resistant						
Channel Lining =	Established Vegetative Cover						
Max. Permissible Velocity ² =	10.00 fps						

$$Q = \frac{1.486}{n} a r^{2/3} s^{1/2}$$

d =	0.41 ft						
L =	15.00 ft						
T =	55.82 ft						
z =	50:1						
s =	0.040 ft/ft						
n =	0.030						
A =	14.45 sf						
Wp =	55.83 ft						
Hr =	0.26						
Q =	58.17 cfs						

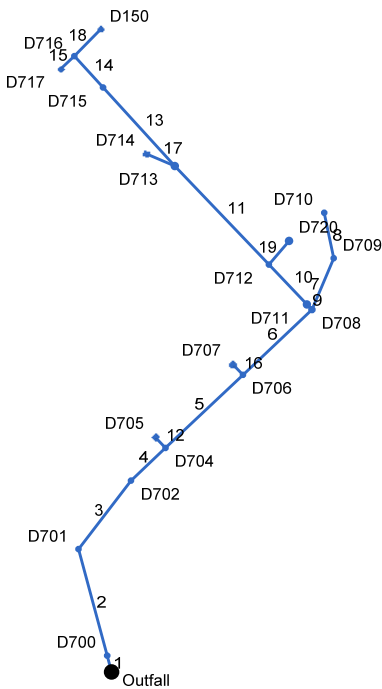
Actual Velocity (Q/A) =	4.02 fps						
Max. Permissible Velocity ³ =	10.00 fps						
Vel _{max} >= Vel _{act}	∴ OK						

1. Per PADEP Erosion and Sediment Pollution Control Program Manual Table E.1 "Limitations of PA Soils".
2. Per USDA NRCS "Chapter 8 Threshold Channel Design", Table 8-4.

Appendix J

Conveyance Design

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



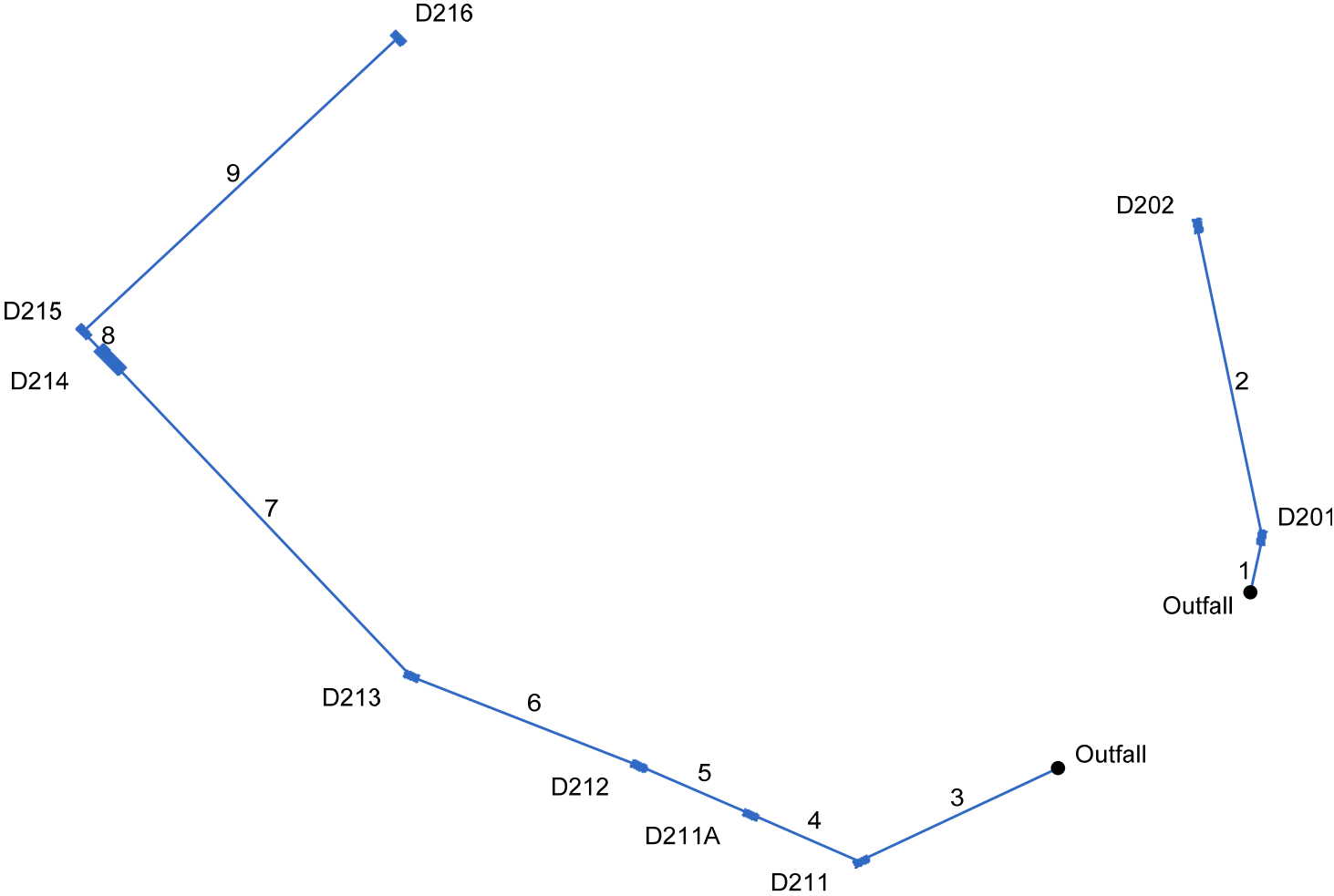
Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	EX FES-D700	58.17	36	Cir	18.400	191.56	191.70	0.761	194.03	194.17	0.20	194.17	End	Manhole
2	D700-D701	58.17	24	Cir	119.600	194.95	215.30	17.015	196.09	217.29	n/a	217.29	1	Manhole
3	D701-D702	58.17	36	Cir	93.520	221.00	221.94	1.005	223.16	224.41	0.26	224.41	2	Manhole
4	D702-D704	58.17	36	Cir	51.450	222.04	223.00	1.866	224.41	225.47	1.36	225.47	3	Manhole
5	D704-D706	55.47	36	Cir	115.180	223.10	225.00	1.650	225.47	227.41	n/a	227.41	4	Manhole
6	D706-D708	52.71	36	Cir	102.782	225.10	227.00	1.849	227.41	229.36	n/a	229.36	5	Manhole
7	D708-D709	31.99	24	Cir	60.510	228.00	230.33	3.851	229.36	232.22	1.04	232.22	6	Manhole
8	D709-D710	31.99	24	Cir	50.432	230.43	232.00	3.113	232.22	233.89	1.68	233.89	7	Manhole
9	D708-D711	20.72	24	Cir	7.850	248.50	248.60	1.274	249.79	250.23	n/a	250.23	6	Manhole
10	D711-D712	20.72	24	Cir	59.640	248.70	249.30	1.006	250.23	250.93	n/a	250.93	9	Manhole
11	D712-D713	12.15	24	Cir	147.560	251.67	253.43	1.193	252.62	254.68	n/a	254.68	10	Manhole
12	D704-D705	2.70	18	Cir	15.920	240.90	241.00	0.628	241.46	241.62	n/a	241.62	4	Manhole
13	D713-D715	9.41	18	Cir	115.260	253.93	255.53	1.388	254.86	256.71	n/a	256.71	11	Manhole
14	D715-D716	9.41	18	Cir	45.980	255.63	256.10	1.022	256.71	257.28	n/a	257.28	13	Manhole
15	D716-D717	2.61	18	Cir	20.418	256.20	256.40	0.979	257.28	257.01	0.23	257.01	14	Manhole
16	D706-D707	2.76	18	Cir	16.020	253.80	254.00	1.248	254.28	254.63	n/a	254.63	5	Manhole
17	D713-D714	2.74	18	Cir	33.360	255.70	256.00	0.899	256.22	256.63	n/a	256.63	11	Manhole
18	D716-D150	6.80	18	Cir	40.757	257.50	258.00	1.227	258.29	259.01	n/a	259.01	14	Manhole
19	D712-D720	8.57	18	Cir	33.660	249.80	250.00	0.594	251.00	251.20	0.50	251.70	10	Manhole
Project File: RUN 700.stm									Number of lines: 19			Run Date: 12/19/2017		
NOTES: Return period = 100 Yrs.														

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	18.400	0.00	0.00	0.00	0.00	0.00	0.0	2.2	0.0	58.17	58.18	9.35	36	0.76	191.56	191.70	194.03	194.17	195.00	198.00	EX FES-D700
2	1	119.600	0.00	0.00	0.00	0.00	0.00	0.0	2.1	0.0	58.17	93.30	24.92	24	17.02	194.95	215.30	196.09	217.29	198.00	257.30	D700-D701
3	2	93.520	0.00	0.00	0.00	0.00	0.00	0.0	1.9	0.0	58.17	66.86	10.00	36	1.01	221.00	221.94	223.16	224.41	257.30	263.10	D701-D702
4	3	51.450	0.00	0.00	0.00	0.00	0.00	0.0	1.8	0.0	58.17	91.10	9.54	36	1.87	222.04	223.00	224.41	225.47	263.10	264.10	D702-D704
5	4	115.180	0.00	0.00	0.00	0.00	0.00	0.0	1.6	0.0	55.47	85.66	9.19	36	1.65	223.10	225.00	225.47	227.41	264.10	261.30	D704-D706
6	5	102.782	0.00	0.00	0.00	0.00	0.00	0.0	1.3	0.0	52.71	90.68	8.93	36	1.85	225.10	227.00	227.41	229.36	261.30	258.65	D706-D708
7	6	60.510	0.00	0.00	0.00	0.00	0.00	0.0	0.1	0.0	31.99	44.38	12.25	24	3.85	228.00	230.33	229.36	232.22	258.65	256.00	D708-D709
8	7	50.432	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	31.99	39.91	10.60	24	3.11	230.43	232.00	232.22	233.89	256.00	255.85	D709-D710
9	6	7.850	0.00	0.00	0.00	0.00	0.00	0.0	1.3	0.0	20.72	27.66	8.61	24	1.27	248.50	248.60	249.79	250.23	258.65	258.60	D708-D711
10	9	59.640	0.00	0.00	0.00	0.00	0.00	0.0	1.2	0.0	20.72	24.58	7.79	24	1.01	248.70	249.30	250.23	250.93	258.60	258.60	D711-D712
11	10	147.560	0.00	0.00	0.00	0.00	0.00	0.0	0.7	0.0	12.15	26.76	7.09	24	1.19	251.67	253.43	252.62	254.68	258.60	259.85	D712-D713
12	4	15.920	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	2.70	9.02	4.17	18	0.63	240.90	241.00	241.46	241.62	264.10	264.25	D704-D705
13	11	115.260	0.00	0.00	0.00	0.00	0.00	0.0	0.4	0.0	9.41	13.40	7.25	18	1.39	253.93	255.53	254.86	256.71	259.85	262.50	D713-D715
14	13	45.980	0.00	0.00	0.00	0.00	0.00	0.0	0.2	0.0	9.41	11.50	6.58	18	1.02	255.63	256.10	256.71	257.28	262.50	263.75	D715-D716
15	14	20.418	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	2.61	11.26	2.88	18	0.98	256.20	256.40	257.28	257.01	263.75	263.30	D716-D717
16	5	16.020	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	2.76	12.71	4.83	18	1.25	253.80	254.00	254.28	254.63	261.30	261.40	D706-D707
17	11	33.360	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	2.74	10.79	4.50	18	0.90	255.70	256.00	256.22	256.63	259.85	260.95	D713-D714
18	14	40.757	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	6.80	12.60	6.32	18	1.23	257.50	258.00	258.29	259.01	263.75	264.45	D716-D150
19	10	33.660	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	8.57	8.77	5.65	18	0.59	249.80	250.00	251.00	251.20	258.60	257.60	D712-D720
Project File: RUN 700.stm																Number of lines: 19				Run Date: 12/19/2017		
NOTES:Intensity = 44.06 / (Inlet time + 8.70) ^ 0.64; Return period =Yrs. 100 ; c = cir e = ellip b = box																						

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



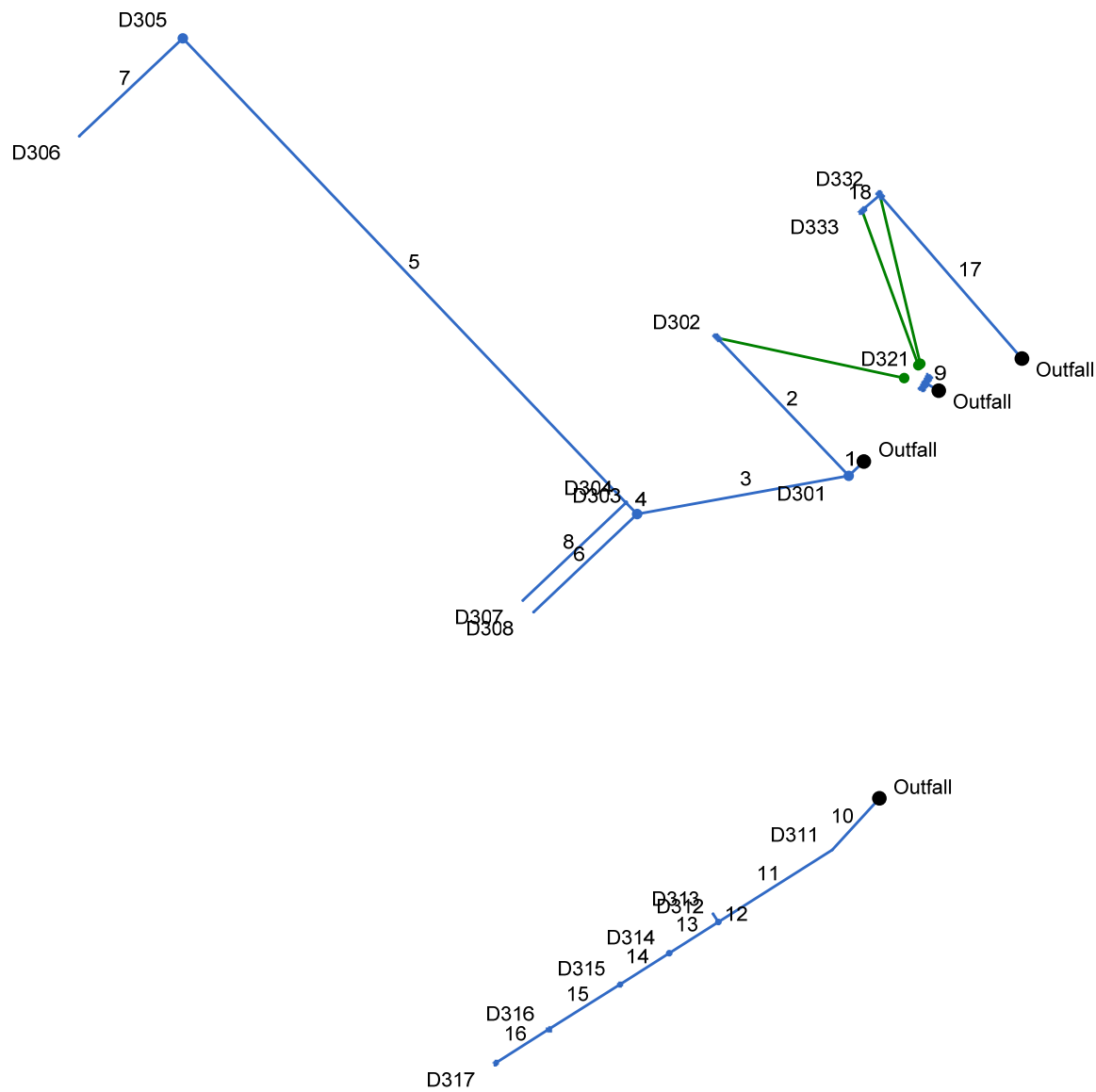
Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	D200-D201	2.14	18	Cir	15.140	261.00	261.19	1.255	261.62	261.74	n/a	261.74 j	End	Curb-Horiz
2	D201-D202	1.41	18	Cir	86.890	261.29	263.90	3.004	261.74	264.34	n/a	264.34 j	1	Curb-Horiz
3	D210-D211	9.68	24	Cir	59.370	260.50	260.96	0.775	262.33	262.07	0.54	262.07	End	Grate
4	D211-D211A	9.54	24	Cir	31.850	261.06	261.30	0.754	262.07	262.40	0.22	262.40	3	Grate
5	D211A-D212	8.25	24	Cir	32.968	261.40	261.65	0.758	262.40	262.67	n/a	262.67	4	Grate
6	D212-D213	8.03	24	Cir	66.416	261.75	262.25	0.753	262.67	263.26	0.29	263.26	5	Grate
7	D213-D214	5.28	18	Cir	118.688	262.75	263.64	0.750	263.53	264.52	0.18	264.52	6	Curb-Horiz
8	D214-D215	2.04	18	Cir	10.362	263.74	264.05	2.992	264.52	264.59	n/a	264.59 j	7	Curb-Horiz
9	D215-D216	1.03	18	Cir	116.640	266.00	271.83	4.998	266.21	272.21	0.13	272.21	8	Curb-Horiz
Project File: RUN 200.stm									Number of lines: 9			Run Date: 12/19/2017		
NOTES: Return period = 100 Yrs. ; j - Line contains hyd. jump.														

Storm Sewer Tabulation

Station		Len (ft)	Drng Area		Rnoff coeff (C)	Area x C		Tc		Rain (I) (in/hr)	Total flow (cfs)	Cap full (cfs)	Vel (ft/s)	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr (ac)	Total (ac)		Incr (min)	Total (min)	Inlet (min)	Syst (min)					Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	15.140	0.12	0.31	0.93	0.11	0.28	5.0	6.8	7.5	2.14	12.74	3.36	18	1.25	261.00	261.19	261.62	261.74	265.05	265.15	D200-D201
2	1	86.890	0.19	0.19	0.91	0.17	0.17	5.0	5.0	8.1	1.41	19.72	3.18	18	3.00	261.29	263.90	261.74	264.34	265.15	267.00	D201-D202
3	End	59.370	0.03	1.79	0.99	0.03	1.44	5.0	9.8	6.7	9.68	21.57	4.31	24	0.77	260.50	260.96	262.33	262.07	265.75	266.20	D210-D211
4	3	31.850	0.20	1.76	0.99	0.20	1.41	5.0	9.6	6.7	9.54	21.27	5.68	24	0.75	261.06	261.30	262.07	262.40	266.20	266.25	D211-D211A
5	4	32.968	0.05	1.56	0.99	0.05	1.22	5.0	9.5	6.8	8.25	21.34	5.17	24	0.76	261.40	261.65	262.40	262.67	266.25	267.00	D211A-D212
6	5	66.416	0.42	1.51	0.99	0.42	1.17	5.0	9.1	6.9	8.03	21.26	5.37	24	0.75	261.75	262.25	262.67	263.26	267.00	267.15	D212-D213
7	6	118.688	0.65	1.09	0.71	0.46	0.75	5.0	8.5	7.0	5.28	9.85	5.27	18	0.75	262.75	263.64	263.53	264.52	267.15	267.15	D213-D214
8	7	10.362	0.29	0.44	0.56	0.16	0.29	5.0	8.3	7.1	2.04	19.68	2.88	18	2.99	263.74	264.05	264.52	264.59	267.15	269.30	D214-D215
9	8	116.640	0.15	0.15	0.84	0.13	0.13	5.0	5.0	8.1	1.03	25.43	4.98	18	5.00	266.00	271.83	266.21	272.21	269.30	275.95	D215-D216
Project File: RUN 200.stm																Number of lines: 9				Run Date: 12/19/2017		
NOTES:Intensity = 44.06 / (Inlet time + 8.70) ^ 0.64; Return period =Yrs. 100 ; c = cir e = ellip b = box																						

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	D300-D301	16.79	30	Cir	10.830	259.00	259.07	0.646	260.36	260.45	0.56	260.45	End	Manhole
2	D301-D302	2.26	18	Cir	98.120	260.07	260.59	0.530	260.61	261.16	0.21	261.16	1	Grate
3	D301-D303	14.98	24	Cir	110.360	259.57	260.14	0.516	260.99	261.56	0.53	262.09	1	Manhole
4	D303-D304	12.09	24	Cir	8.236	260.24	260.32	0.972	262.09	261.57	0.53	261.57	3	Manhole
5	D304-D305	6.46	18	Cir	330.756	260.82	264.00	0.961	261.64	264.98	0.43	264.98	4	Manhole
6	D303-D308	3.15	12	Cir	73.525	263.00	264.47	1.999	263.54	265.23	0.38	265.23	3	None
7	D305-D306	6.53	15	Cir	73.336	264.25	265.72	2.004	264.99	266.75	0.57	266.75	5	None
8	D304-D307	6.53	15	Cir	73.354	263.00	264.47	2.004	263.74	265.50	0.57	265.50	4	None
9	D320-D321	5.08	18	Cir	8.358	258.92	259.00	0.957	259.90	259.87	n/a	259.87 j	End	Grate
10	D310-D311	2.31	12	Cir	36.020	262.00	262.43	1.194	262.78	263.08	n/a	263.08 j	End	None
11	D311-D312	2.33	12	Cir	69.330	262.43	263.12	0.995	263.08	263.77	0.43	263.77	10	Grate
12	D312-D313	3.15	12	Cir	4.950	263.22	263.32	2.020	263.77	264.08	0.38	264.08	11	None
13	D312-D314	0.22	12	Cir	29.998	263.22	263.55	1.100	263.77	263.74	0.03	263.74	11	Grate
14	D314-D315	0.18	12	Cir	30.001	263.65	263.80	0.500	263.82	263.97	0.03	264.00	13	Grate
15	D315-D316	0.13	12	Cir	43.270	263.90	264.11	0.500	264.05	264.26	0.02	264.29	14	Grate
16	D316-D317	0.08	12	Cir	32.442	264.21	264.38	0.500	264.33	264.49	0.04	264.53	15	Grate
17	D330-D332	2.82	18	Cir	111.640	258.00	258.69	0.618	258.72	259.33	n/a	259.33 j	End	Curb-Horiz
18	D332-D333	0.81	18	Cir	12.108	258.79	258.85	0.496	259.33	259.18	n/a	259.18	17	Curb-Horiz

Project File: RUN 300.stm

Number of lines: 18

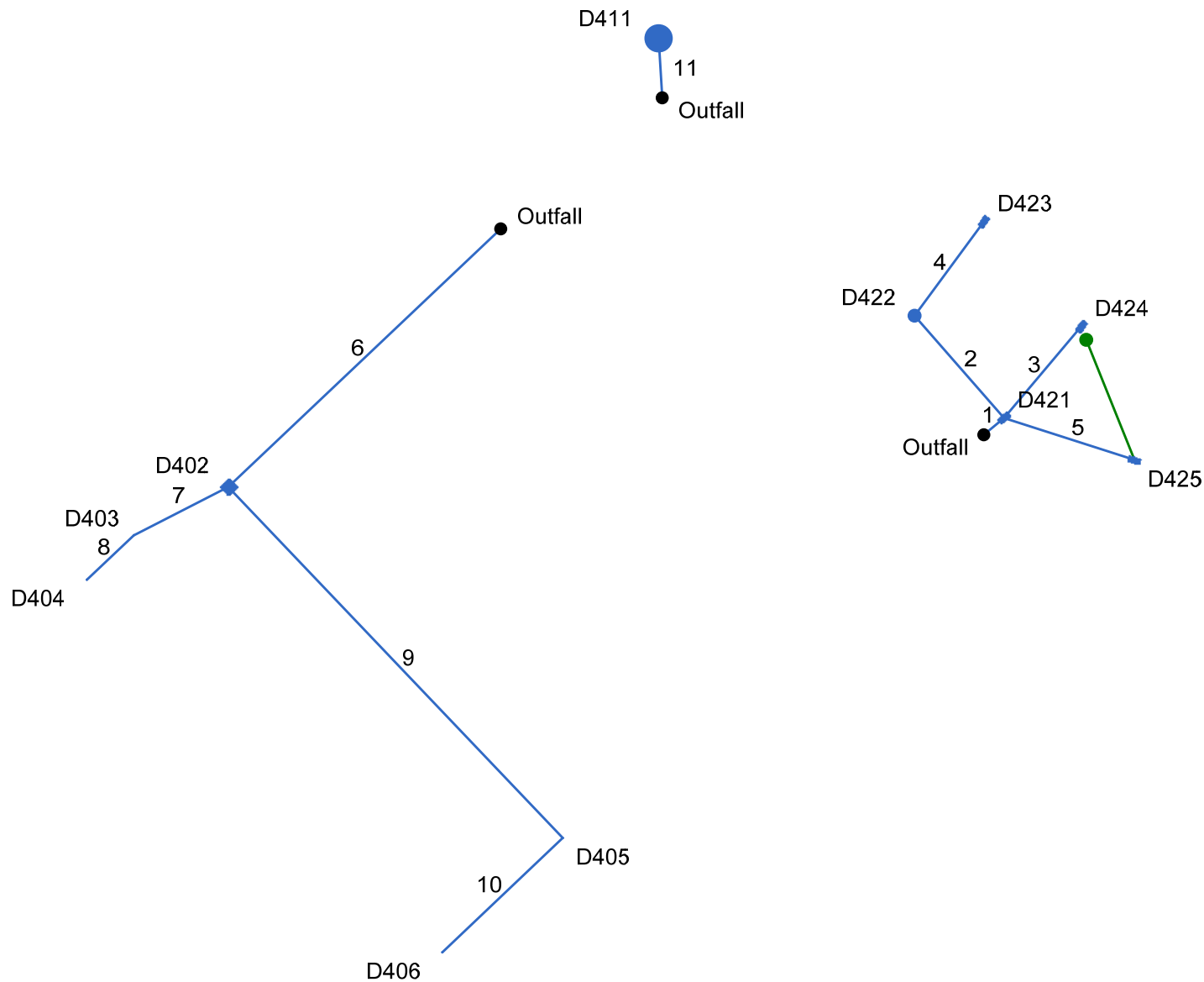
Run Date: 12/19/2017

NOTES: Return period = 100 Yrs. ; j - Line contains hyd. jump.

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	10.830	0.00	2.29	0.00	0.00	2.27	0.0	7.2	7.4	16.79	35.72	6.09	30	0.65	259.00	259.07	260.36	260.45	263.75	264.05	D300-D301
2	1	98.120	0.28	0.28	0.99	0.28	0.28	5.0	5.0	8.1	2.26	8.28	3.84	18	0.53	260.07	260.59	260.61	261.16	264.05	264.95	D301-D302
3	1	110.360	0.00	2.01	0.00	0.00	1.99	0.0	6.8	7.5	14.98	17.61	6.29	24	0.52	259.57	260.14	260.99	261.56	264.05	266.65	D301-D303
4	3	8.236	0.00	1.62	0.00	0.00	1.60	0.0	6.7	7.5	12.09	24.15	4.93	24	0.97	260.24	260.32	262.09	261.57	266.65	266.80	D303-D304
5	4	330.756	0.00	0.81	0.00	0.00	0.80	0.0	5.2	8.1	6.46	11.15	5.91	18	0.96	260.82	264.00	261.64	264.98	266.80	267.65	D304-D305
6	3	73.525	0.39	0.39	0.99	0.39	0.39	5.0	5.0	8.1	3.15	5.46	6.05	12	2.00	263.00	264.47	263.54	265.23	266.65	268.00	D303-D308
7	5	73.336	0.81	0.81	0.99	0.80	0.80	5.0	5.0	8.1	6.53	9.90	7.33	15	2.00	264.25	265.72	264.99	266.75	267.65	269.00	D305-D306
8	4	73.354	0.81	0.81	0.99	0.80	0.80	5.0	5.0	8.1	6.53	9.90	7.33	15	2.00	263.00	264.47	263.74	265.50	266.80	268.20	D304-D307
9	End	8.358	0.63	0.63	0.99	0.62	0.62	5.0	5.0	8.1	5.08	11.13	4.48	18	0.96	258.92	259.00	259.90	259.87	262.65	262.70	D320-D321
10	End	36.020	0.00	0.43	0.00	0.00	0.43	0.0	17.0	5.4	2.31	4.22	3.90	12	1.19	262.00	262.43	262.78	263.08	266.65	267.00	D310-D311
11	10	69.330	0.00	0.43	0.00	0.00	0.43	0.0	16.7	5.5	2.33	3.85	4.30	12	1.00	262.43	263.12	263.08	263.77	267.00	267.50	D311-D312
12	11	4.950	0.39	0.39	0.99	0.39	0.39	5.0	5.0	8.1	3.15	5.48	5.99	12	2.02	263.22	263.32	263.77	264.08	267.50	267.60	D312-D313
13	11	29.998	0.01	0.04	0.99	0.01	0.04	5.0	15.5	5.7	0.22	4.05	1.30	12	1.10	263.22	263.55	263.77	263.74	267.50	267.50	D312-D314
14	13	30.001	0.01	0.03	0.99	0.01	0.03	5.0	13.8	5.9	0.18	2.73	1.94	12	0.50	263.65	263.80	263.82	263.97	267.50	267.50	D314-D315
15	14	43.270	0.01	0.02	0.99	0.01	0.02	5.0	10.3	6.6	0.13	2.73	1.78	12	0.50	263.90	264.11	264.05	264.26	267.50	267.50	D315-D316
16	15	32.442	0.01	0.01	0.99	0.01	0.01	5.0	5.0	8.1	0.08	2.73	1.55	12	0.50	264.21	264.38	264.33	264.49	267.50	267.50	D316-D317
17	End	111.640	0.27	0.37	0.94	0.25	0.35	5.0	5.4	8.0	2.82	8.94	3.65	18	0.62	258.00	258.69	258.72	259.33	263.05	264.40	D330-D332
18	17	12.108	0.10	0.10	0.99	0.10	0.10	5.0	5.0	8.1	0.81	8.01	2.09	18	0.50	258.79	258.85	259.33	259.18	264.40	264.20	D332-D333
Project File: RUN 300.stm																Number of lines: 18				Run Date: 12/19/2017		
NOTES:Intensity = 44.06 / (Inlet time + 8.70) ^ 0.64; Return period =Yrs. 100 ; c = cir e = ellip b = box																						

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	D420-D421	7.48	18	Cir	9.050	254.00	254.09	0.994	255.38	255.15	n/a	255.15	End	Curb-Horiz
2	D421-D422	4.92	18	Cir	47.150	254.19	254.62	0.912	255.15	255.47	n/a	255.47 j	1	Curb-Horiz
3	D421-D424	1.32	18	Cir	41.650	254.19	254.40	0.504	255.15	254.83	0.15	254.83	1	Curb-Horiz
4	D422-D423	0.97	18	Cir	40.570	254.72	254.93	0.518	255.47	255.30	n/a	255.30	2	Curb-Horiz
5	D421-D425	0.82	18	Cir	47.510	254.19	254.50	0.652	255.15	254.84	0.12	254.84	1	Curb-Horiz
6	D400-D402	7.31	18	Cir	130.274	258.00	258.65	0.500	262.49*	263.03*	0.27	263.29	End	Manhole
7	D402-D403	3.78	12	Cir	36.916	263.00	263.55	1.490	263.68	264.38	0.15	264.38	6	None
8	D403-D404	3.79	12	Cir	22.405	263.55	263.89	1.518	264.38	264.72	n/a	264.72	7	None
9	D402-D405	3.76	12	Cir	168.303	259.15	261.67	1.497	263.29*	264.89*	0.36	265.25	6	None
10	D405-D406	3.79	12	Cir	57.711	261.67	262.82	1.993	265.25*	265.80*	0.36	266.17	9	None
11	D410-D411	10.12	24	Cir	20.720	256.00	256.21	1.013	257.14	257.35	n/a	257.35 j	End	Curb-Horiz

Project File: RUN 400.stm

Number of lines: 11

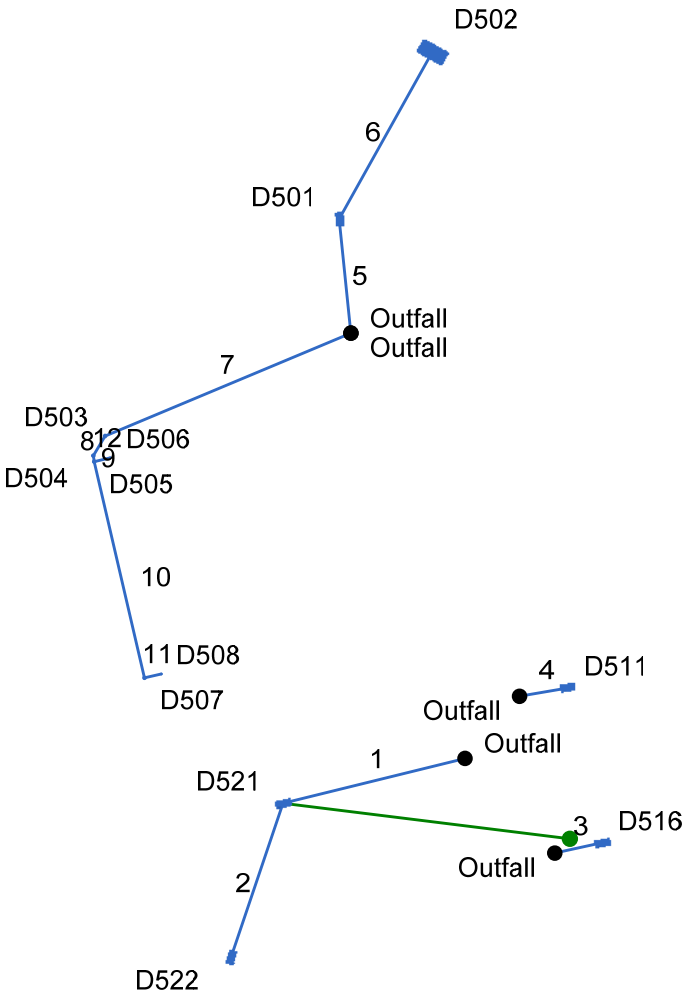
Run Date: 12/19/2017

NOTES: Return period = 100 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

Storm Sewer Tabulation

Station		Len (ft)	Drng Area		Rnoff coeff (C)	Area x C		Tc		Rain (I) (in/hr)	Total flow (cfs)	Cap full (cfs)	Vel (ft/s)	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr (ac)	Total (ac)		Incr (min)	Total (min)	Inlet (min)	Syst (min)					Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	9.050	0.09	1.02	0.99	0.09	0.99	5.0	6.7	7.6	7.48	11.34	5.00	18	0.99	254.00	254.09	255.38	255.15	259.10	258.70	D420-D421
2	1	47.150	0.53	0.65	0.98	0.52	0.64	5.0	6.2	7.7	4.92	10.86	4.43	18	0.91	254.19	254.62	255.15	255.47	258.70	259.00	D421-D422
3	1	41.650	0.17	0.17	0.95	0.16	0.16	5.0	5.0	8.1	1.32	8.08	2.13	18	0.50	254.19	254.40	255.15	254.83	258.70	258.05	D421-D424
4	2	40.570	0.12	0.12	0.99	0.12	0.12	5.0	5.0	8.1	0.97	8.18	1.99	18	0.52	254.72	254.93	255.47	255.30	259.00	258.10	D422-D423
5	1	47.510	0.11	0.11	0.92	0.10	0.10	5.0	5.0	8.1	0.82	9.19	1.73	18	0.65	254.19	254.50	255.15	254.84	258.70	258.95	D421-D425
6	End	130.274	0.00	0.94	0.00	0.00	0.93	0.0	5.8	7.9	7.31	8.04	4.14	18	0.50	258.00	258.65	262.49	263.03	262.40	266.15	D400-D402
7	6	36.916	0.00	0.47	0.00	0.00	0.47	0.0	5.1	8.1	3.78	4.71	6.05	12	1.49	263.00	263.55	263.68	264.38	266.15	267.60	D402-D403
8	7	22.405	0.47	0.47	0.99	0.47	0.47	5.0	5.0	8.1	3.79	4.75	5.46	12	1.52	263.55	263.89	264.38	264.72	267.60	267.80	D403-D404
9	6	168.303	0.00	0.47	0.00	0.00	0.47	0.0	5.2	8.1	3.76	4.72	4.78	12	1.50	259.15	261.67	263.29	264.89	266.15	264.90	D402-D405
10	9	57.711	0.47	0.47	0.99	0.47	0.47	5.0	5.0	8.1	3.79	5.45	4.83	12	1.99	261.67	262.82	265.25	265.80	264.90	266.30	D405-D406
11	End	20.720	1.28	1.28	0.97	1.24	1.24	5.0	5.0	8.1	10.12	24.67	5.48	24	1.01	256.00	256.21	257.14	257.35	260.20	259.90	D410-D411
Project File: RUN 400.stm																Number of lines: 11				Run Date: 12/19/2017		
NOTES:Intensity = 44.06 / (Inlet time + 8.70) ^ 0.64; Return period =Yrs. 100 ; c = cir e = ellip b = box																						

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	D520-D521	2.83	18	Cir	55.950	254.00	255.24	2.216	254.64	255.88	n/a	255.88 j	End	Grate
2	D521-D522	0.65	18	Cir	48.579	255.34	256.31	1.997	255.88	256.61	n/a	256.61 j	1	Curb-Horiz
3	D515-D516	4.02	18	Cir	14.410	251.70	251.80	0.694	252.47	252.57	n/a	252.57 j	End	Curb-Horiz
4	D510-D511	1.28	18	Cir	14.390	253.00	253.10	0.695	253.42	253.52	n/a	253.52	End	Curb-Horiz
5	D500-D501	2.09	18	Cir	34.340	254.00	254.17	0.495	254.55	254.72	n/a	254.72	End	Curb-Horiz
6	D501-D502	1.09	18	Cir	57.120	254.27	254.56	0.508	254.72	254.95	n/a	254.95 j	5	Grate
7	D500-D503	0.78	6	Cir	79.390	254.00	255.72	2.167	254.44	256.16	0.18	256.16	End	Manhole
8	D503-D504	0.78	6	Cir	6.886	255.72	255.86	2.033	256.16	256.30	n/a	256.30	7	Manhole
9	D504-D505	0.79	6	Cir	1.799	255.86	255.90	2.223	256.30	256.34	0.29	256.34	8	Manhole
10	D505-D507	0.40	6	Cir	66.415	256.00	256.62	0.940	256.34	256.95	n/a	256.95 j	9	Manhole
11	D507-D508	0.40	6	Cir	5.000	256.72	256.77	1.000	257.02	257.09	0.14	257.09	10	None
12	D505-D506	0.40	6	Cir	5.000	256.00	256.05	0.940	256.34	256.37	n/a	256.37 j	9	None
Project File: RUN 500.stm									Number of lines: 12			Run Date: 12/19/2017		
NOTES: Return period = 100 Yrs. ; j - Line contains hyd. jump.														

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (l)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	55.950	0.33	0.41	0.92	0.30	0.38	5.0	7.2	7.4	2.83	16.94	3.94	18	2.22	254.00	255.24	254.64	255.88	257.45	258.50	D520-D521
2	1	48.579	0.08	0.08	0.99	0.08	0.08	5.0	5.0	8.1	0.65	16.08	1.86	18	2.00	255.34	256.31	255.88	256.61	258.50	259.65	D521-D522
3	End	14.410	0.53	0.53	0.93	0.49	0.49	5.0	5.0	8.1	4.02	9.48	4.41	18	0.69	251.70	251.80	252.47	252.57	255.80	255.00	D515-D516
4	End	14.390	0.18	0.18	0.87	0.16	0.16	5.0	5.0	8.1	1.28	9.48	3.14	18	0.69	253.00	253.10	253.42	253.52	256.95	256.60	D510-D511
5	End	34.340	0.21	0.45	0.67	0.14	0.28	5.0	6.5	7.6	2.09	8.00	3.58	18	0.50	254.00	254.17	254.55	254.72	258.70	257.10	D500-D501
6	5	57.120	0.24	0.24	0.56	0.13	0.13	5.0	5.0	8.1	1.09	8.11	2.74	18	0.51	254.27	254.56	254.72	254.95	257.10	257.80	D501-D502
7	End	79.390	0.00	0.10	0.00	0.00	0.10	0.0	5.6	7.9	0.78	0.89	4.28	6	2.17	254.00	255.72	254.44	256.16	258.70	260.90	D500-D503
8	7	6.886	0.00	0.10	0.00	0.00	0.10	0.0	5.6	7.9	0.78	0.87	4.28	6	2.03	255.72	255.86	256.16	256.30	260.90	261.02	D503-D504
9	8	1.799	0.00	0.10	0.00	0.00	0.10	0.0	5.6	7.9	0.79	0.91	4.28	6	2.22	255.86	255.90	256.30	256.34	261.02	261.05	D504-D505
10	9	66.415	0.00	0.05	0.00	0.00	0.05	0.0	5.0	8.1	0.40	0.59	2.91	6	0.94	256.00	256.62	256.34	256.95	261.05	259.90	D505-D507
11	10	5.000	0.05	0.05	0.99	0.05	0.05	5.0	5.0	8.1	0.40	0.61	3.16	6	1.00	256.72	256.77	257.02	257.09	259.90	259.95	D507-D508
12	9	5.000	0.05	0.05	0.99	0.05	0.05	5.0	5.0	8.1	0.40	0.59	2.92	6	0.94	256.00	256.05	256.34	256.37	261.05	261.10	D505-D506
Project File: RUN 500.stm																Number of lines: 12				Run Date: 12/19/2017		
NOTES:Intensity = 44.06 / (Inlet time + 8.70) ^ 0.64; Return period =Yrs. 100 ; c = cir e = ellip b = box																						

[illegible]

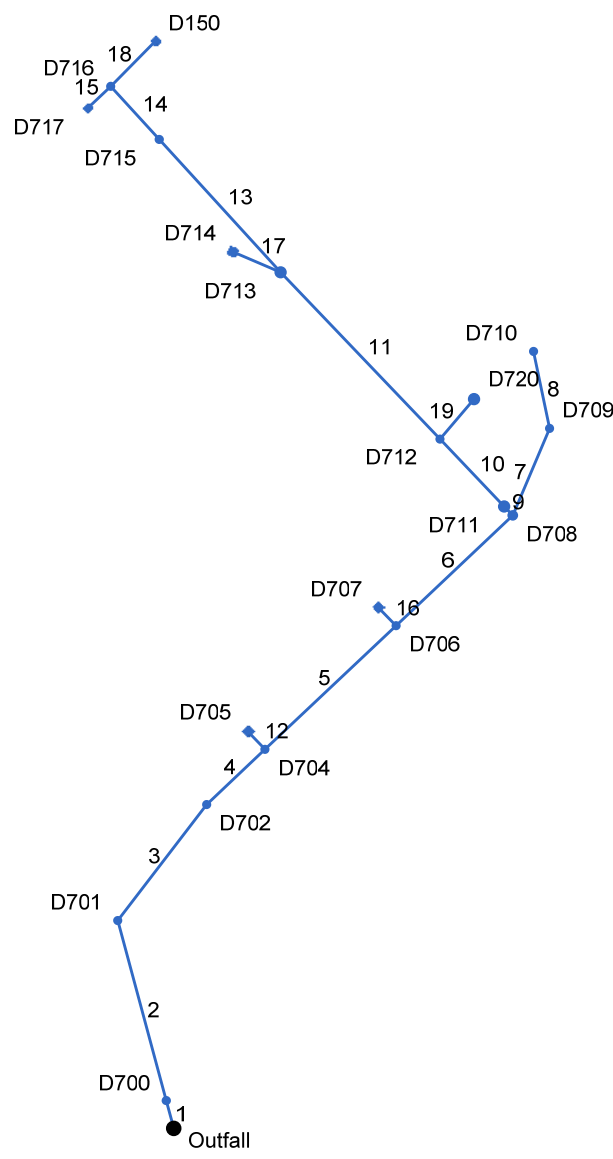
Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	D600-D601	13.51	24	Cir	57.110	246.00	246.28	0.490	247.32	247.63	0.08	247.71	End	Manhole
2	D601-D602	13.86	24	Cir	185.930	246.38	247.31	0.500	247.73	248.66	0.56	249.22	1	Manhole
3	D602-D604	11.20	18	Cir	69.874	247.91	250.90	4.279	249.22	252.18	n/a	252.18 j	2	Manhole
4	D604-D606	10.93	18	Cir	202.059	251.00	255.35	2.153	252.18	256.62	n/a	256.62	3	Manhole
5	D606-D607	1.21	18	Cir	10.073	260.00	260.05	0.496	260.39	260.46	n/a	260.46	4	Curb-Horiz
6	D606-D608	10.04	18	Cir	148.227	255.45	257.18	1.167	256.62	258.40	0.66	258.40	4	Manhole
7	D608-D609	0.56	18	Cir	7.244	261.00	261.04	0.552	261.26	261.32	n/a	261.32	6	Curb-Horiz
8	D602-D603	3.23	18	Cir	10.962	247.81	247.86	0.456	249.22	248.54	n/a	248.54	2	Curb-Horiz
9	D608-D610	9.65	18	Cir	100.161	257.28	258.80	1.518	258.40	260.00	n/a	260.00	6	Curb-Horiz
10	D610-D611	8.04	18	Cir	123.150	258.90	259.52	0.503	260.12	260.74	0.42	261.17	9	Manhole
11	D611-D613	7.78	18	Cir	96.691	259.62	260.10	0.496	261.17	261.59	0.15	261.74	10	Grate
12	D613-D614	1.51	18	Cir	73.527	260.20	261.67	1.999	261.74	262.13	n/a	262.13 j	11	Manhole
13	D614-D615	1.53	18	Cir	16.725	261.77	261.86	0.538	262.21	262.32	n/a	262.32	12	Curb-Horiz
14	D604-D605	0.56	18	Cir	23.150	252.50	253.00	2.160	252.69	253.28	0.10	253.28	3	Curb-Horiz
15	D611-D612	0.40	6	Cir	11.886	261.00	261.12	1.010	261.30	261.44	0.14	261.44	10	None
16	D620-D621	4.84	18	Cir	37.007	244.70	245.00	0.811	245.59	245.85	n/a	245.85 j	End	None
Project File: RUN 600.stm									Number of lines: 16				Run Date: 12/19/2017	
NOTES: Return period = 100 Yrs. ; j - Line contains hyd. jump.														

Storm Sewer Tabulation

Station		Len (ft)	Drng Area		Rnoff coeff (C)	Area x C		Tc		Rain (I) (in/hr)	Total flow (cfs)	Cap full (cfs)	Vel (ft/s)	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr (ac)	Total (ac)		Incr	Total	Inlet (min)	Syst (min)					Size (in)	Slope (%)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	
1	End	57.110	0.00	2.26	0.00	0.00	2.00	0.0	9.7	6.7	13.51	17.16	6.06	24	0.49	246.00	246.28	247.32	247.63	264.30	263.30	D600-D601
2	1	185.930	0.00	2.26	0.00	0.00	2.00	0.0	9.0	6.9	13.86	17.33	6.13	24	0.50	246.38	247.31	247.73	248.66	263.30	253.30	D601-D602
3	2	69.874	0.00	1.86	0.00	0.00	1.61	0.0	8.8	7.0	11.20	23.53	6.90	18	4.28	247.91	250.90	249.22	252.18	253.30	256.00	D602-D604
4	3	202.059	0.00	1.79	0.00	0.00	1.54	0.0	8.2	7.1	10.93	16.69	7.11	18	2.15	251.00	255.35	252.18	256.62	256.00	265.40	D604-D606
5	4	10.073	0.15	0.15	0.99	0.15	0.15	5.0	5.0	8.1	1.21	8.01	3.17	18	0.50	260.00	260.05	260.39	260.46	265.40	264.70	D606-D607
6	4	148.227	0.00	1.64	0.00	0.00	1.39	0.0	7.8	7.2	10.04	12.29	6.67	18	1.17	255.45	257.18	256.62	258.40	265.40	265.65	D606-D608
7	6	7.244	0.07	0.07	0.99	0.07	0.07	5.0	5.0	8.1	0.56	8.45	2.61	18	0.55	261.00	261.04	261.26	261.32	265.65	265.15	D608-D609
8	2	10.962	0.40	0.40	0.99	0.40	0.40	5.0	5.0	8.1	3.23	7.68	2.99	18	0.46	247.81	247.86	249.22	248.54	253.30	253.00	D602-D603
9	6	100.161	0.25	1.57	0.96	0.24	1.32	5.0	7.5	7.3	9.65	14.01	6.60	18	1.52	257.28	258.80	258.40	260.00	265.65	263.80	D608-D610
10	9	123.150	0.00	1.32	0.00	0.00	1.08	0.0	7.1	7.4	8.04	8.07	5.21	18	0.50	258.90	259.52	260.12	260.74	263.80	264.85	D610-D611
11	10	96.691	0.87	1.27	0.97	0.84	1.03	5.0	6.7	7.5	7.78	8.02	4.41	18	0.50	259.62	260.10	261.17	261.59	264.85	263.60	D611-D613
12	11	73.527	0.00	0.40	0.00	0.00	0.19	0.0	5.3	8.0	1.51	16.09	2.07	18	2.00	260.20	261.67	261.74	262.13	263.60	265.05	D613-D614
13	12	16.725	0.40	0.40	0.47	0.19	0.19	5.0	5.0	8.1	1.53	8.34	3.44	18	0.54	261.77	261.86	262.21	262.32	265.05	265.05	D614-D615
14	3	23.150	0.07	0.07	0.99	0.07	0.07	5.0	5.0	8.1	0.56	16.72	3.44	18	2.16	252.50	253.00	252.69	253.28	256.00	256.65	D604-D605
15	10	11.886	0.05	0.05	0.99	0.05	0.05	5.0	5.0	8.1	0.40	0.61	3.17	6	1.01	261.00	261.12	261.30	261.44	264.85	264.83	D611-D612
16	End	37.007	0.60	0.60	0.99	0.59	0.59	5.0	5.0	8.1	4.84	9.45	4.57	18	0.81	244.70	245.00	245.59	245.85	262.05	262.00	D620-D621
Project File: RUN 600.stm																Number of lines: 16				Run Date: 12/19/2017		
NOTES:Intensity = 44.06 / (Inlet time + 8.70) ^ 0.64; Return period =Yrs. 100 ; c = cir e = ellip b = box																						

Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Storm Sewer Summary Report

Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	EX FES-D700	58.17	36	Cir	18.400	191.56	191.70	0.761	194.03	194.17	0.20	194.17	End	Manhole
2	D700-D701	58.17	24	Cir	119.600	194.95	215.30	17.015	196.09	217.29	n/a	217.29	1	Manhole
3	D701-D702	58.17	36	Cir	93.520	221.00	221.94	1.005	223.16	224.41	0.26	224.41	2	Manhole
4	D702-D704	58.17	36	Cir	51.450	222.04	223.00	1.866	224.41	225.47	1.36	225.47	3	Manhole
5	D704-D706	55.47	36	Cir	115.180	223.10	225.00	1.650	225.47	227.41	n/a	227.41	4	Manhole
6	D706-D708	52.71	36	Cir	102.782	225.10	227.00	1.849	227.41	229.36	n/a	229.36	5	Manhole
7	D708-D709	31.99	24	Cir	60.510	228.00	230.33	3.851	229.36	232.22	1.04	232.22	6	Manhole
8	D709-D710	31.99	24	Cir	50.432	230.43	232.00	3.113	232.22	233.89	1.68	233.89	7	Manhole
9	D708-D711	20.72	24	Cir	7.850	248.50	248.60	1.274	249.79	250.23	n/a	250.23	6	Manhole
10	D711-D712	20.72	24	Cir	59.640	248.70	249.30	1.006	250.23	250.93	n/a	250.93	9	Manhole
11	D712-D713	12.15	24	Cir	147.560	251.67	253.43	1.193	252.62	254.68	n/a	254.68	10	Manhole
12	D704-D705	2.70	18	Cir	15.920	240.90	241.00	0.628	241.46	241.62	n/a	241.62	4	Manhole
13	D713-D715	9.41	18	Cir	115.260	253.93	255.53	1.388	254.86	256.71	n/a	256.71	11	Manhole
14	D715-D716	9.41	18	Cir	45.980	255.63	256.10	1.022	256.71	257.28	n/a	257.28	13	Manhole
15	D716-D717	2.61	18	Cir	20.418	256.20	256.40	0.979	257.28	257.01	0.23	257.01	14	Manhole
16	D706-D707	2.76	18	Cir	16.020	253.80	254.00	1.248	254.28	254.63	n/a	254.63	5	Manhole
17	D713-D714	2.74	18	Cir	33.360	255.70	256.00	0.899	256.22	256.63	n/a	256.63	11	Manhole
18	D716-D150	6.80	18	Cir	40.757	257.50	258.00	1.227	258.29	259.01	n/a	259.01	14	Manhole
19	D712-D720	8.57	18	Cir	33.660	249.80	250.00	0.594	251.00	251.20	0.50	251.70	10	Manhole
Project File: RUN 700.stm									Number of lines: 19			Run Date: 12/19/2017		
NOTES: Return period = 100 Yrs.														

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Dn	Up	Dn	Up	Dn	Up	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	18.400	0.00	0.00	0.00	0.00	0.00	0.0	2.2	0.0	58.17	58.18	9.35	36	0.76	191.56	191.70	194.03	194.17	195.00	198.00	EX FES-D700
2	1	119.600	0.00	0.00	0.00	0.00	0.00	0.0	2.1	0.0	58.17	93.30	24.92	24	17.02	194.95	215.30	196.09	217.29	198.00	257.30	D700-D701
3	2	93.520	0.00	0.00	0.00	0.00	0.00	0.0	1.9	0.0	58.17	66.86	10.00	36	1.01	221.00	221.94	223.16	224.41	257.30	263.10	D701-D702
4	3	51.450	0.00	0.00	0.00	0.00	0.00	0.0	1.8	0.0	58.17	91.10	9.54	36	1.87	222.04	223.00	224.41	225.47	263.10	264.10	D702-D704
5	4	115.180	0.00	0.00	0.00	0.00	0.00	0.0	1.6	0.0	55.47	85.66	9.19	36	1.65	223.10	225.00	225.47	227.41	264.10	261.30	D704-D706
6	5	102.782	0.00	0.00	0.00	0.00	0.00	0.0	1.3	0.0	52.71	90.68	8.93	36	1.85	225.10	227.00	227.41	229.36	261.30	258.65	D706-D708
7	6	60.510	0.00	0.00	0.00	0.00	0.00	0.0	0.1	0.0	31.99	44.38	12.25	24	3.85	228.00	230.33	229.36	232.22	258.65	256.00	D708-D709
8	7	50.432	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	31.99	39.91	10.60	24	3.11	230.43	232.00	232.22	233.89	256.00	255.85	D709-D710
9	6	7.850	0.00	0.00	0.00	0.00	0.00	0.0	1.3	0.0	20.72	27.66	8.61	24	1.27	248.50	248.60	249.79	250.23	258.65	258.60	D708-D711
10	9	59.640	0.00	0.00	0.00	0.00	0.00	0.0	1.2	0.0	20.72	24.58	7.79	24	1.01	248.70	249.30	250.23	250.93	258.60	258.60	D711-D712
11	10	147.560	0.00	0.00	0.00	0.00	0.00	0.0	0.7	0.0	12.15	26.76	7.09	24	1.19	251.67	253.43	252.62	254.68	258.60	259.85	D712-D713
12	4	15.920	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	2.70	9.02	4.17	18	0.63	240.90	241.00	241.46	241.62	264.10	264.25	D704-D705
13	11	115.260	0.00	0.00	0.00	0.00	0.00	0.0	0.4	0.0	9.41	13.40	7.25	18	1.39	253.93	255.53	254.86	256.71	259.85	262.50	D713-D715
14	13	45.980	0.00	0.00	0.00	0.00	0.00	0.0	0.2	0.0	9.41	11.50	6.58	18	1.02	255.63	256.10	256.71	257.28	262.50	263.75	D715-D716
15	14	20.418	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	2.61	11.26	2.88	18	0.98	256.20	256.40	257.28	257.01	263.75	263.30	D716-D717
16	5	16.020	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	2.76	12.71	4.83	18	1.25	253.80	254.00	254.28	254.63	261.30	261.40	D706-D707
17	11	33.360	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	2.74	10.79	4.50	18	0.90	255.70	256.00	256.22	256.63	259.85	260.95	D713-D714
18	14	40.757	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	6.80	12.60	6.32	18	1.23	257.50	258.00	258.29	259.01	263.75	264.45	D716-D150
19	10	33.660	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	8.57	8.77	5.65	18	0.59	249.80	250.00	251.00	251.20	258.60	257.60	D712-D720
Project File: RUN 700.stm																Number of lines: 19				Run Date: 12/19/2017		
NOTES:Intensity = 44.06 / (Inlet time + 8.70) ^ 0.64; Return period =Yrs. 100 ; c = cir e = ellip b = box																						

Appendix K

Plan Preparer Experience and Training

**PLAN PREPARER RECORD OF TRAINING AND EXPERIENCE IN POST
DEVELOPMENT STORMWATER MANAGEMENT METHODS AND TECHNIQUES**

NAME OF PLAN PREPARER: Ryan T. Whitmore, P.E. - PA License PE-076556

FORMAL EDUCATION:

Name of College or Technical Institute: Pennsylvania State University
Curriculum or Program: Civil Engineering
Dates of Attendance: **From:** Fall 1999 **To:** Spring 2004
Degree Received Bachelor of Science in Civil Engineering

OTHER TRAINING:

Name of Training: _____
Presented By: _____
Date: _____

EMPLOYMENT HISTORY:

Current Employer: LANDCORE Engineering Consultants,PC
Telephone: 215-836-2510

Former Employer: Chester Valley Engineers, Inc.
Telephone: 610-644-4623

RECENT PCSM PLANS PREPARED:

Name of Project:	<u>Atwater Lots 3, 4 & 5</u>	<u>MS Exton, LLC</u>	<u>Exton Elementary School</u>
County:	<u>Chester</u>	<u>Chester</u>	<u>Chester</u>
Municipality:	<u>East Whiteland</u>	<u>West Whiteland</u>	<u>West Whiteland</u>
Permit Number:	_____	_____	_____
Approving Agency:	<u>CCCD/PADEP - SE Region</u>	<u>CCCD/PADEP - SE Region</u>	<u>CCCD/PADEP - SE Region</u>

Appendix L

Infiltration Testing Report



November 21, 2017
EEI Project No: 30149.00

Mr. Ed Pereira
National Developers, Incorporated
4605 West Chester Pike
Newtown Square, PA 19073

Phone: 610.325.2198
Email: EDP@ndidelco.com

**Re: Stormwater Infiltration Testing Letter
Langford Run Road Shopping Center
Marple Township, Delaware County, PA**

Dear Mr. Pereira:

Earth Engineering Incorporated (EEI) has prepared this letter to present the results of the infiltration testing performed at the above-referenced site. The purpose of this investigation was to provide preliminary infiltration data for the design of stormwater infiltration facilities utilizing double ring and cased borehole infiltration testing. The infiltration data was collected at the direction of the project Civil Engineer, Landcore Engineering Consultants, P.C. (Landcore). The scope of work was completed in general accordance with EEI proposal BB-16456, dated October 10th, 2017. This letter presents the results of our work.

SITE DESCRIPTION AND EXISTING FEATURES

The subject site is an approximately 31 acre area located on the southwest quadrant of the intersection of Veteran's Memorial Highway (Interstate 476) and West Chester Pike (Route 3), in Marple Township, Delaware County, Pennsylvania. The site is bordered to the north by Route 3, to the east by the I-476 South onramp, to the south by Langford Road and to the west a residential development, Cambridge Road, Dartmouth Lane and Vassar Road.

The subject site is a former development that has undergone extensive earthwork prior to being abandoned. Construction of the former development terminated before any structures were constructed. An open stormwater retention basin and associated stormwater utilities and sanitary sewer exist at the south end the site. Additionally, multiple large stockpiles of material occupy the center of the site. Vegetation at the site include consists of grass and brush throughout the front and center portions of the site and densely wooded areas towards the rear of the site. An existing creek and wetlands run along the southwest edge and southern portion of the site.

According to the topographic information depicted on an untitled testing location plan provided by Landcore, the overall topography of the site slopes moderately downward from the northwest to the southeast. As previously mentioned, previous earthwork activities have resulted in manmade grading features such as stockpiles, diversion ditches, berms, a stormwater basin. Extensive modification of the natural landscape in the form of deep cuts on the north end of the investigated areas and deep fills towards the center and southern end of the investigated areas was evident. The maximum relief across the site is approximately 125 feet. This relief corresponds to elevations ranging from approximately 309 feet to 184 feet.

FIELD INVESTIGATION

Exploratory Test Pits and Test Borings

A total of forty (40) exploratory infiltration test locations were evaluated at the proposed test locations for potential stormwater management areas. Fourteen (14) of these locations consisted of test pits and the remaining twenty six (26) consisted of test borings. The test pit locations are denoted as test pit locations TP-200 through TP-205, TP-207, TP-211 through TP-214 and TP-237 through TP-238. Two (2) double ring infiltration (DRI) tests were completed at each of the infiltration test pits for a total of twenty eight (28) tests. The DRI tests were completed at the locations and depths as directed by Landcore on October 31st, November 1st and November 2nd, 2017, by Wayne Carmint Landscaping utilizing a Case CX 210 Trackhoe. The tests were seated at the proposed test depths of approximately 0.9 feet to 8.0 feet below grade where feasible. The infiltration test depths at test pit locations TP-237 through TP-239 were adjusted in the field to depths ranging from 5.0 to 7.0 feet below grade in order to maintain a minimum 2 foot buffer to the underlying limiting zone

Twenty-six (26) exploratory test borings, denoted as B-206, B-208 through B-210 and B-215 through B-236, were conducted to evaluate the soils for stormwater management within deeper proposed test areas which, were impractical to complete with the trackhoe. The test borings were completed on October 25th, 26th, 27th, 31st, November 1st and 2nd, 2017, by Corcoran Drilling of Haverford, Pennsylvania utilizing a Mobile B-57 truck mounted drill rig. The borings were advanced using 2-inch outer-diameter, split-barrel (spoon) samplers and 6 inch outer-diameter solid-stem augers. Split-barrel sampling was conducted with an auto trip hammer. The borings were conducted in accordance with ASTM Standard D1586. Standard Penetration Test (SPT) values were recorded for each sample. The SPT values, which are a measure of soil density and consistency, are the number of blows required to drive the 2-inch outer diameter split-barrel sampler 1 foot using a 140-pound safety hammer dropped 30 inches. The number of blows required to advance the sampler over the 12-inch interval from 6 to 18 inches is considered the "N" value, or the SPT value.

The exposed soil profiles at the infiltration test pits and borings were examined to obtain limiting zone information such as the groundwater table, soil mottling, very dense weathered rock or other restrictive features.

A limiting zone is defined as a horizon or condition of the soil or underlying strata which includes:

- A seasonal high water table (SHWT), whether perched or regional, determined by direct observation of the water table or soil mottling;
- Rock with open joints, fractures or solution channels, masses of loose rock fragments including gravel, with insufficient fine soil to fill the voids between the fragments;

- Rock formation, other stratum, or soil condition which is so slowly permeable that it effectively limits the downward passage of effluent.

After examination of the soils at the test pit locations, evidence of various limiting zones were generally observed in the form of very dense weathered rock with insufficient fine soil and bedrock. Limited amounts of mottled fine grained soils were also observed. The type and depth of limiting zones encountered at the site are summarized in Table I.

The test locations were staked and surveyed by Landcore. Soil Boring Logs and Test Pit Logs are enclosed that provide additional morphological detail and other pertinent information for design of the stormwater management facility.

Infiltration Testing

Double Ring Method

A total of forty-four (44) double ring infiltration tests were conducted at the site. Two (2) tests were conducted at each of their respective test pits to provide infiltration rates for design of the infiltration facilities. The proposed infiltration test depths ranged from 0.9 feet to 8.0 feet below existing grade. Field adjusted test depths were required due to limiting zones at three of the test pit locations, TP-237, TP-238 and TP-239, in order to maintain at least 2.0 feet of clearance above the underlying limiting zone.

The infiltration tests are denoted in this report denoted with a "DR" followed by the number of the test pit and the letter of the infiltration test. For example the two double ring infiltration tests conducted at test pit location TP-200 are designated as DR-200A and DR-200B. The testing apparatus has two concentric rings that are 4 inches and 8 inches in diameter. Procedures used for the infiltration testing are in general accordance with the Pennsylvania Stormwater Best Management Practices (PA BMP) Manual, Appendix C. Additional details are provided on the enclosed *Double Ring Infiltration* Logs. The test depths and measured infiltration rates are also summarized in Table II.

Cased Borehole Method

A total of twenty-two (22) cased borehole infiltration tests, denoted as CB-206, C-208 through CB-210, CB-215 through CB-230, CB-235 and CB-236 were conducted to determine the infiltration rates for design of the stormwater infiltration facilities. One test was completed adjacent to the corresponding boring location. Testing was not completed at boring locations B-231 through B-234 due to extremely shallow bedrock. The proposed infiltration test depths provided by Landcore ranged from 9.7 to 19.8 feet below existing grade. Due to limiting zones, field adjusted test depths were required at boring locations B-208, B-215 through B-219, B-221, B-223, B-225 through B-228, B-230, B-235 and B-236.

Approximately six (6) inch diameter boreholes were augered down to the infiltration test depth adjacent to the associated boring and test pit location. The testing apparatus consisted of a three (3) inch diameter beveled PVC casing which was driven approximately 2 inches into the soils at the base of the borehole, after removing the loose cuttings. The annulus of the pipe was sealed with bentonite and soil cuttings. Additional details regarding the infiltration testing is provided on the attached Infiltration Testing Logs. A summary of the infiltration test depths and measured rates at each location are provided in Table II.

SUBSURFACE CONDITIONS

Soils

The site has been almost completely altered by prior earthwork operations which have left behind man-made soils that consist predominantly of recently placed existing FILL (reworked residual soils and weathered rock) towards the center and southern portion of the site and cuts into the existing soil and weathered rock on the northeast portion of the site. As per the Natural Resources and Conservation Service (NRCS) online *Web Soil Survey*, Glenelg channery silt loam (GeC2) is mapped throughout the entire investigated area. Glenelg series is described as very deep well drained soils formed in residuum weathered from micaceous schist.

Due to the extensive previous earthwork activities, only the soils at test locations B-217, B-218 and B-226 through B-230 were approximately consistent with Glenelg series. The majority of the areas upslope (north and west) of these locations consist of recently cut soil and material that resulted in very stony soils with relatively shallow rock. The areas downslope (south and east) consist of recently placed soils that are generally consistent with cut soils from the area.

Specific information regarding the soil morphological features including the abundance, size and, contrast of redox features (mottling) as well as other information pertinent to the design of stormwater management facilities is provided on the enclosed *Soil Description Logs*. For reference, a summary of the type and depths of limiting zones and infiltration test data is provided in Table I and Table II in the *Summary and Conclusions* section of this letter.

Bedrock

Bedrock is typically defined as bucket refusal or auger refusal on the moderately to freshly weathered rock. Bucket and auger refusal was encountered at test locations B-216, B-217, B-218, B-228, B-229, B-233, B-235 and TP-237 at depths ranging from 7.2 to 18.5 feet below existing grade. The locations and depth of the encountered bedrock are included in Table I.

Groundwater

Groundwater measurements were taken upon excavation and up to 24 hours after completion of the borings and up to 5.25 hours after excavation of the test pits. Groundwater was not observed at any of the test locations. Additionally, evidence of prolonged saturation with water as indicated by mottling and/or fully saturated soils was only observed at boring location B-215. The depths to mottled soil which, is considered limiting zone for infiltration, is summarized in Table I below. Note that groundwater elevations may fluctuate with daily, seasonal and climatic variations.

Data Summary

The following table summarizes the type and depth of limiting zones. Additional detail regarding the soils and limiting zones is provided on the enclosed Soil Description Logs.

TABLE I – COMPARISON OF INFILTRATION DEPTHS AND LIMITING ZONES					
Test Pit Number	^{1.)} Ground Surface Elevation (ft)	Limiting Zone (ft)	^{2.)} Limiting Zone Depth (ft)	Limiting Zone Elevation (ft)	^{2.)} Infiltration Test Depth (ft)
TP-200	236.5	not encountered	n/a	n/a	1.5
TP-201	234.5	not encountered	n/a	n/a	2.0
TP-202	232.3	not encountered	n/a	n/a	1.8
TP-203	233.4	not encountered	n/a	n/a	0.9
TP-204	243.4	very dense weathered rock	6.5 to 9.0	236.9 to 234.4	2.4
TP-205	248.9	not encountered	n/a	n/a	0.9
B-206	259.7	not encountered	n/a	n/a	9.7
TP-207	255.3	not encountered	n/a	n/a	5.3
B-208	264.4	very dense weathered rock	12.0 to 18.0	252.4 to 246.2	10.0
B-209	262.2	very dense weathered rock	14.5 to 18.0	247.7 to 244.2	12.2
B-210	262.0	very dense weathered rock	16.5 to 18.0	245.5 to 244.0	11.0
TP-211	258.7	not encountered	n/a	n/a	6.7
TP-212	253.7	not encountered	n/a	n/a	0.7
TP-213	260.0	not encountered	n/a	n/a	4.0
TP-214	262.2	not encountered	n/a	n/a	8.2
B-215	265.6	mottled	10.0 to 14.0	255.6 to 251.6	8.0
		very dense weathered rock	15.0 to 16.9	250.6 to 248.7	
B-216	267.9	very dense weathered rock & bedrock	10.0 to 18.5	257.9 to 249.4	8.2
B-217	266.1	very dense weathered rock & bedrock	6.5 to 8.6	259.6 to 257.5	4.5
B-218	268.2	very dense weathered rock & bedrock	5.0 to 11.3	263.2 to 256.9	3.0
B-219	269.4	very dense	15.5 to 18.3	253.9 to 251.1	13.5
B-220	268.4	not encountered	n/a	n/a	14.4
B-221	266.0	very dense weathered rock	12.0 to 16.0	254.0 to 250.0	10.0
B-222	264.0	Not encountered	n/a	n/a	10.0
B-223	269.7	very dense weathered rock	15.5 to 20.0	254.2 to 249.7	13.0
B-224	271.2	very dense weathered rock	18.5 to 20.0	252.7 to 251.2	15.2

TABLE I – COMPARISON OF INFILTRATION DEPTHS AND LIMITING ZONES

Test Pit Number	^{1.)} Ground Surface Elevation (ft)	Limiting Zone (ft)	^{2.)} Limiting Zone Depth (ft)	Limiting Zone Elevation (ft)	^{2.)} Infiltration Test Depth (ft)
B-225	270.7	very dense weathered rock	8.0 to 20.0	262.7 to 250.7	6.0
B-226	270.1	very dense weathered rock	6.5 to 18.3	263.6 to 251.8	4.5
B-227	272.3	very dense weathered rock	4.5 to 16.5	267.8 to 255.8	2.5
B-228	272.7	very dense weathered rock & bedrock	6.0 to 11.0	266.7 to 261.7	4.0
B-229	273.2	very dense weathered rock & bedrock	15.0 to 15.7	258.2 to 257.5	13.0
B-230	273.8	very dense weathered rock	16.5 to 20.9	257.3 to 252.9	14.5
B-231	275.1	very dense weathered rock	1.0 to 17.0	274.1 to 258.1	no test
B-232	274.7	very dense weathered rock	1.0 to 17.1	273.7 to 257.6	no test
B-233	274.0	very dense weathered rock & bedrock	2.5 to 7.2	271.5 to 266.8	no test
B-234	274.8	very dense weathered rock & bedrock	0.0 to 8.8	274.8 to 266.0	no test
B-235	272.2	very dense weathered rock & bedrock	7.0 to 20.5	265.2 to 251.7	5.0
B-236	274.5	very dense weathered rock	5.5 to 25.3	269.0 to 249.2	3.5
TP-237	264.4	very dense weathered rock & bedrock	7.5 to 10.5	256.9 to 253.9	5.5
TP-238	258.5	very dense weathered rock	7.0 to 11.0	251.5 to 247.5	5.0
TP-239	259.5	very dense weathered rock	9.0 to 12.0	250.5 to 247.5	7.0

^{1.)} Ground surface elevations provided by Landcore.

^{2.)} Referenced depths were measured from existing site grades at the time of the investigation.

The following table provides a summary of the infiltration rates measured during the investigation. The measured infiltration rates that are reported in the table below do not include the factor of safety required to determine the design rate.

TABLE II – INFILTRATION RATES AT TEST LOCATIONS

Infiltration Test Number	^{1.)} Ground Surface Elevation (ft)	^{2.)} Infiltration Test Depth (ft)	Test Interval (min)	Final Drop in Water Level (in)	Infiltration Rate (in/hr)
DR-200A	236.5	1.5	10	0.625	3.750
DR-200B	236.5	1.5	10	0.750	4.500
DR-201A	234.5	2.0	10	0.375	2.250
DR-201B	234.5	2.0	10	0.625	3.750
DR-202A	232.8	1.8	30	0.750	1.500
DR-202B	232.8	1.8	30	1.000	2.000
DR-203A	233.4	0.9	30	1.250	2.500
DR-203B	233.4	0.9	30	1.000	2.000

TABLE II – INFILTRATION RATES AT TEST LOCATIONS

Infiltration Test Number	^{1.)} Ground Surface Elevation (ft)	^{2.)} Infiltration Test Depth (ft)	Test Interval (min)	Final Drop in Water Level (in)	Infiltration Rate (in/hr)
DR-204A	243.4	2.4	30	0.125	0.250
DR-204B	243.4	2.4	30	0.000	0.000
DR-205A	248.9	0.9	30	0.875	1.750
DR-205B	248.9	0.9	30	0.500	1.000
CB-206	259.7	9.7	30	0.000	0.000
DR-207A	255.3	5.3	30	1.250	2.500
DR-207B	255.3	5.3	30	0.875	1.750
CB-208	264.4	10.0	30	3.600	0.610
CB-209	262.2	12.2	30	0.000	0.000
CB-210	262.0	11.0	30	0.000	0.000
DR-211A	258.7	6.7	30	0.750	1.500
DR-211B	258.7	6.7	30	0.500	1.000
DR-212A	253.7	0.7	30	0.875	1.750
DR-212B	253.7	0.7	30	0.625	1.250
DR-213A	260.0	4.0	30	0.125	0.250
DR-213B	260.0	4.0	30	0.125	0.250
DR-214A	262.2	8.2	30	0.125	0.250
DR-214B	262.2	8.2	30	0.375	0.750
CB-215	265.6	8.0	30	0.000	0.000
CB-216	267.9	8.0	30	3.600	0.610
CB-217	266.1	4.5	30	4.800	0.880
CB-218	268.2	3.0	30	4.800	0.880
CB-219	269.4	13.5	30	3.000	0.490
CB-220	268.4	14.4	30	1.200	0.180
CB-221	266.0	10.0	30	4.800	0.880
CB-222	264.0	10.0	30	0.000	0.000
CB-223	269.7	13.0	30	2.400	0.380
CB-224	271.2	15.2	30	3.600	0.610
CB-225	270.7	6.0	30	3.600	0.610
CB-226	270.1	4.5	30	3.600	0.610
CB-227	272.3	2.5	30	2.400	0.380
CB-228	272.7	4.0	30	3.000	0.490

TABLE II – INFILTRATION RATES AT TEST LOCATIONS

Infiltration Test Number	^{1.)} Ground Surface Elevation (ft)	^{2.)} Infiltration Test Depth (ft)	Test Interval (min)	Final Drop in Water Level (in)	Infiltration Rate (in/hr)
CB-229	273.2	13.0	30	1.800	0.280
CB-230	273.8	14.5	30	3.600	0.610
CB-235	272.2	5.0	30	1.800	0.280
CB-236	274.5	3.5	30	4.800	0.880
DR-237A	264.4	5.5	10	2.625	15.750
DR-237B	264.4	5.5	10	3.000	18.000
DR-238A	258.5	5.0	10	1.375	8.250
DR-238B	258.5	5.0	10	1.500	9.000
DR-239A	259.5	7.0	10	1.750	10.500
DR-239B	259.5	7.0	10	1.625	9.750

^{1.)} Ground surface elevations provided by Landcore, Inc.

^{2.)} Referenced depths were measured from existing site grades at the time of the investigation.

CONCLUSIONS

As indicated in Table II, the measured infiltration rates range from 0.00 to 18.00 inches per hour within the various soils and materials encountered at the site. As per the BMP Manual, the recommended measured infiltration rate range for soils to be considered for stormwater infiltration is 0.10 inches per hour to 10.00 inches per hour. Additionally, stormwater infiltration facilities should maintain at least 2.0 feet above limiting zones.

Based on the requirements established in the PA BMP Manual, several of the test locations are feasible as proposed. These include test locations TP-200 through TP-205, TP-207 and TP-211 through TP-214, B-220 and B-224. Several of the remaining locations are not suitable as proposed but, have some depth which may permit the required the limiting zone clearance and infiltration rates. These areas include B-206, B-208 through B-210, B-215, B-216 through B-219, B-221, B-223, B-225 through B-230, B-233, B-235, B-236 and TP-237 through TP-239. Finally, some locations are not feasible for infiltration since they do not have any depth that meet the minimum 2.0 feet of clearance above limiting zones. These locations include B-231, B-232, and B-234.

SPECIAL CONSIDERATIONS

Cased borehole testing that was completed within existing FILL materials described as medium dense silty sand often resulted in measured infiltration rates of 0.00 inches per hour (B-206, B-209, B-210, B-215 and B-222). Typically, measured rates of 0.00 inches per hour would be indicative of a limiting zone. However, test that were completed within similar existing FILL materials using the double ring method typically resulted in suitable infiltration rates with measured rates that range from 0.00 to 4.50 inches per hour. Only one instance of 0.00 in/hr was measured with DRI testing within the existing FILL. Consequently, the existing fill material may be suitable in existing FILL where cased borehole tests yielded rates of 0.00 inches per hour. If possible, these materials should be further tested with double ring infiltration testins (which is typically the preferred method) to confirm the materials' suitability for infiltration.

After discussing the preliminary stormwater plans and results with Landcore, EEI understands that the proposed basin design may have an impervious loading ratio of up to 8:1 which, exceeds the maximum BMP recommended loading ratio of 5. If the site constraints require a loading ratio of up to 8:1, we recommend using the draft paper by Dominic Rocco, P.E., CPESC, SCPWQ, of the Pennsylvania Department of Environmental Protection, titled *A Risk-Based Approach for Sizing Stormwater Infiltration BMPs*, dated July 27, 2009, for guidance on exceeding the recommended impervious loading ratio. The guidance provided in the referenced document is intended to responsibly assist plan preparers to justify higher than recommended impervious loading ratios of up to 8:1. When opting for a elevated loading ratio, the referenced paper recommends evaluating each basin on a case by case bases and that the designer implement at least three of the following factors, including but not limited to: thick permeable soil layer (greater clearance above limiting zones), higher than minimum infiltration rates, safety factor of 3 or more, relatively small drainage areas, relatively small basins, low sediment load from contributing stormwater and pretreatment.

The infiltration rates shown above are raw field measured values and do not include a safety factor for design purposes. The determination of the appropriate design value for the stormwater management system including application of the appropriate factors of safety is the responsibility of the project civil engineer. According to the PA Stormwater BMP Manual, a minimum factor of safety of 2.0 is recommended for most cases, or 3 as noted above.

LIMITATIONS

The information contained in this letter is based upon the subsurface data collected and on details stated in this letter. Should conditions arise which differ from those specifically stated herein, our office should be notified immediately so that our conclusions can be reviewed and revised, if necessary.

The scope of work for this project was limited to providing infiltration test results for the proposed stormwater infiltration facilities, as discussed herein. This report offers no facts or opinions related to potential impacts resulting from infiltrating stormwater at this location on structures and surrounding areas. No conclusions or recommendations related to geotechnical conditions at the site are discussed or inferred herein. It is emphasized that this stormwater infiltration investigation was conducted for the proposed improvements at the proposed Langford Run Road Shopping Center in Marple Township, Delaware County, Pennsylvania. Earth Engineering Incorporated does not assume any responsibility in using this report for drainage system consideration or designs other than at the specific site addressed.

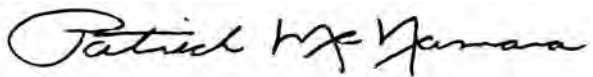
Langford Run Road SC
EEI Project No.: 30149.00
November 21, 2017
Page 10

We trust this is the information you require. If you have any questions regarding the information contained herein, please call.

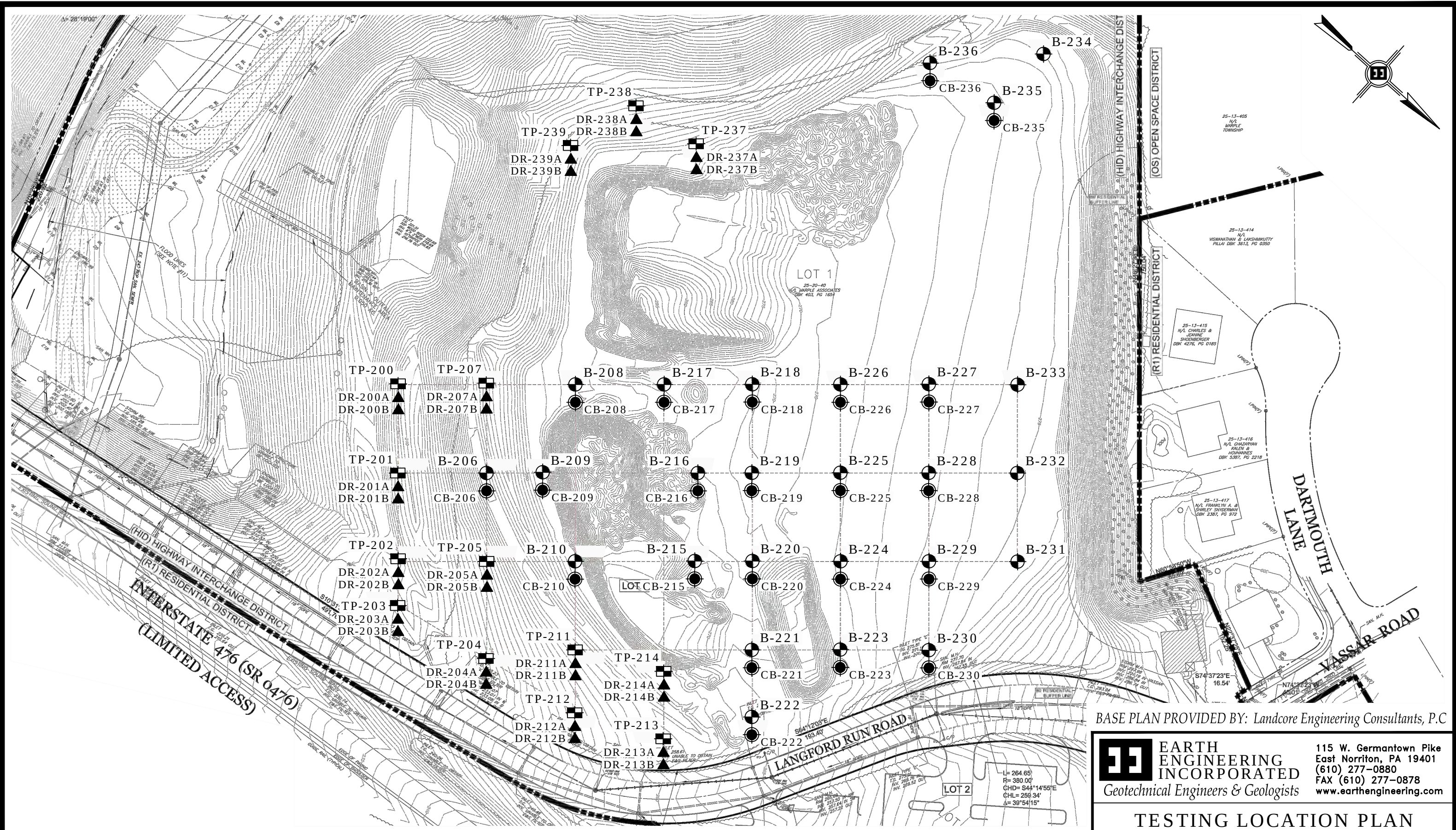
Sincerely,
EARTH ENGINEERING INCORPORATED



A. Nathaniel Hadley, SEO
Soil Scientist/Project Manager.



Patrick M. McNamara, P.E.
Director of Geotechnical Investigations



GRAPHIC SCALE: 1" = 100'

KEY:



INDICATES APPROXIMATE TEST BORING LOCATION



INDICATES APPROXIMATE CASSED BOREHOLE INFILTRATION TEST LOCATION



INDICATES APPROXIMATE TEST PIT LOCATION



INDICATES APPROXIMATE DOUBLE RING INFILTRIMETER TEST LOCATION

BASE PLAN PROVIDED BY: Landcore Engineering Consultants, P.C

EARTH ENGINEERING INCORPORATED
Geotechnical Engineers & Geologists

115 W. Germantown Pike
East Norriton, PA 19401
(610) 277-0880
FAX (610) 277-0878
www.earthengineering.com

TESTING LOCATION PLAN

PREPARED FOR

LANGFORD RUN ROAD SHOPPING CENTER

MARPLE TOWNSHIP DELAWARE COUNTY PENNSYLVANIA

Scale: 1" = 100' Date: 11-6-2017 Drawn By: CMA Checked By: ---

Drawing Number: 30149.00-B-101 Approved By: --- 258

Double Ring Infiltrometer Test Results

Test Hole Number	Surface Elevation (feet)	*Infiltration Depth (feet)	Drop in Water within Inner Ring during Presoak Period (inches)		Drop in Water within Inner Ring at Time (inches)								** Infiltration Rate inches/hour
					30 minutes	60 minutes	90 minutes	120 minutes					
DR-204A	243.4	2.4	0.500	0.375	0.250	0.250	0.125	0.125					0.25
DR-204B	243.4	2.4	0.250	0.125	0.125	0.125	0.000	0.000					0.00
DR-211A	258.7	6.7	1.375	1.125	1.000	0.875	0.750	0.750					1.50
DR-211B	258.7	6.7	0.875	0.625	0.625	0.500	0.500	0.500					1.00
DR-212A	253.7	0.7	1.625	1.250	1.125	1.000	0.875	0.875					1.75
DR-212B	253.7	0.7	1.250	1.000	0.875	0.750	0.625	0.625					1.25

Test Hole Number	Surface Elevation (feet)	*Infiltration Depth (feet)	Drop in Water within Inner Ring during Presoak Period (inches)		Drop in Water within Inner Ring at Time (inches)								** Infiltration Rate inches/hour
					30 minutes	60 minutes	90 minutes	120 minutes					
DR-213A	260.0	4.0	0.500	0.375	0.250	0.250	0.125	0.125					0.25
DR-213B	260.0	4.0	0.375	0.250	0.250	0.125	0.125	0.125					0.25
DR-214A	262.2	8.2	0.500	0.375	0.250	0.250	0.125	0.125					0.25
DR-214B	262.2	8.2	1.000	0.750	0.625	0.500	0.375	0.375					0.75

* Infiltration depths were measured from existing site grades at the time of the investigation.

** Measured infiltration rates do not include a factor of safety for the design infiltration rate.

 Indicates the final reading that was used to determine the infiltration rate at the corresponding location.



**EARTH
ENGINEERING
INCORPORATED**

Geotechnical Engineers & Geologists

115 West Germantown Pike
PHONE 610-277-0880

East Norriton, PA 19401
FAX 610-277-0878

INFILTRATION TESTING LOG

Project Name: Langford Run Road Shopping Center

Project Number: 30149.00

Date of Testing: 10/31/2017

EI Representative: C. Ardizzi

Drawn/ Compiled by: C. Ardizzi

Date Compiled: 11/3/2017

Double Ring Infiltrometer Test Results

Test Hole Number	Surface Elevation (feet)	*Infiltration Depth (feet)	Drop in Water within Inner Ring during Presoak Period (inches)		Drop in Water within Inner Ring at Time (inches)								** Infiltration Rate inches/hour
					30 minutes	60 minutes	90 minutes	120 minutes	150 minutes				
DR-207A	255.3	5.3	2.000	1.750	1.625	1.500	1.375	1.250	1.250				2.50
DR-207B	255.3	5.3	1.375	1.250	1.125	1.000	0.875	0.875	0.875				1.75

Test Hole Number	Surface Elevation (feet)	*Infiltration Depth (feet)	Drop in Water within Inner Ring during Presoak Period (inches)		Drop in Water within Inner Ring at Time (inches)								** Infiltration Rate inches/hour
					10 minutes	20 minutes	30 minutes	40 minutes	50 minutes				
DR-237A	264.4	5.5	>6.000	>6.000	3.000	2.750	2.750	2.625	2.625				15.75
DR-237B	264.4	5.5	>6.000	>6.000	3.500	3.250	3.125	3.000	3.000				18.00
DR-238A	258.5	5.0	>6.000	5.250	1.500	1.500	1.375	1.375					8.25
DR-238B	258.5	5.0	>6.000	>6.000	1.750	1.625	1.500	1.500					9.00
DR-239A	259.5	7.0	>6.000	>6.000	2.250	2.000	1.875	1.750	1.750				10.50
DR-239B	259.5	7.0	1.000	0.750	2.125	1.875	1.750	1.625	1.625				9.75

* Infiltration depths were measured from existing site grades at the time of the investigation.

** Measured infiltration rates do not include a factor of safety for the design infiltration rate.

 Indicates the final reading that was used to determine the infiltration rate at the corresponding location.



**EARTH
ENGINEERING
INCORPORATED**

Geotechnical Engineers & Geologists

115 West Germantown Pike
PHONE 610-277-0880

East Norriton, PA 19401
FAX 610-277-0878

INFILTRATION TESTING LOG

Project Name: Langford Run Road Shopping Center

Project Number: 30149.00

Date of Testing: 11/1/2017

EEI Representative: C. Ardizzi

Drawn/ Compiled by: C. Ardizzi

Date Compiled: 11/3/2017

Double Ring Infiltrometer Test Results

Test Hole Number	Surface Elevation (feet)	*Infiltration Depth (feet)	Drop in Water within Inner Ring during Presoak Period (inches)		Drop in Water within Inner Ring at Time (inches)								** Infiltration Rate inches/hour
			30 minutes	60 minutes	10 minutes	20 minutes	30 minutes	40 minutes					
DR-200A	236.5	1.5	2.375	2.000	0.750	0.625	0.625	0.625					3.75
DR-200B	236.5	1.5	2.625	2.375	0.875	0.750	0.750	0.750					4.50
DR-201A	234.5	2.0	2.250	1.875	0.625	0.500	0.375	0.375					2.25
DR-201B	234.5	2.0	2.750	2.375	0.875	0.750	0.750	0.625					3.75

Test Hole Number	Surface Elevation (feet)	*Infiltration Depth (feet)	Drop in Water within Inner Ring during Presoak Period (inches)		Drop in Water within Inner Ring at Time (inches)								** Infiltration Rate inches/hour
			30 minutes	60 minutes	30 minutes	60 minutes	90 minutes	120 minutes					
DR-202A	232.8	1.8	1.125	1.000	1.000	0.875	0.875	0.750					1.50
DR-202B	232.8	1.8	1.375	1.250	1.250	1.125	1.000	1.000					2.00
DR-203A	233.4	0.9	2.000	1.625	1.500	1.375	1.250	1.250					2.50
DR-203B	233.4	0.9	1.500	1.250	1.250	1.125	1.125	1.000					2.00
DR-205A	248.9	0.9	1.750	1.250	1.125	1.000	0.875	0.875					1.75
DR-205B	248.9	0.9	1.000	0.625	0.625	0.500	0.500	0.500					1.00

* Infiltration depths were measured from existing site grades at the time of the investigation.

** Measured infiltration rates do not include a factor of safety for the design infiltration rate.

 Indicates the final reading that was used to determine the infiltration rate at the corresponding location.



**EARTH
ENGINEERING
INCORPORATED**

Geotechnical Engineers & Geologists

115 West Germantown Pike
PHONE 610-277-0880

East Norriton, PA 19401
FAX 610-277-0878

INFILTRATION TESTING LOG

Project Name: Langford Run Road Shopping Center

Project Number: 30149.00

Date of Testing: 11/2/2017

EEI Representative: C. Ardizzi

Drawn/ Compiled by: C. Ardizzi

Date Compiled: 11/3/2017

Infiltration Test Results - Cased Borehole Method	

[illegible]

~~202~~

Infiltration Test Results - Cased Borehole Method	

[illegible]

~~203~~

Infiltration Test Results - Cased Borehole Method	

[illegible]

204

Infiltration Test Results - Cased Borehole Method	

[illegible]

~~205~~

Infiltration Test Results - Cased Borehole Method	

[illegible]

* Test depths are measured from existing site grades at the time of the investigation.

** Test depths were adjusted from the original proposed depths due to limiting zones as discussed with the civil engineer.

*** Infiltration Rate: $K_v = [A/(G * D * t)] * \ln(H_1/H_2)$, where

 Indicates the final reading that was used to determine the infiltration rate at the corresponding location.

K_v = infiltration rate (in./hr.) at field saturation; A = casing cross-sectional area (in.²); D = casing diameter (in.); G = 2.75 (shape factor, dimensionless)

t = time for head to change from H_1 to H_2 (hrs.); H_1 = initial water column height (in.); H_2 = initial water column height - final drop in water height (in.)

Measured infiltration rates do not include a design safety factor.



INFILTRATION TESTING LOG

Project Name: Langford Run Road

Project Number: 30149.00

Date of Testing: 10/26/2017

EI Representative: J. Kufra

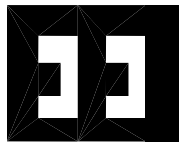
Drawn/Compiled by: J. Kufra

Date Compiled: 11/3/2017

Infiltration Test Results - Cased Borehole Method	

[illegible]

207



TEST PIT LOG

PIT NO.	TP-200
SHEET	1 OF 1
DATE: START	11/2/17
END	11/2/17
SURFACE ELEV. (FT)	236.5

PROJECT NAME Langford Run Road Shopping Center

PROJECT LOCATION Marple Township, Delaware County, PA

PROJECT NUMBER 30149.00

INSPECTOR NAME C. Ardizzi

EQUIPMENT USED Case CX210 Trackhoe

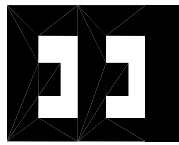
EXCAVATING COMPANY J. Glisson/Wayne Carmint Landscaping

WATER: DEPTH: Dry TIME: 0.25 hr

WATER: DEPTH: Dry TIME: 4.00 hrs

DEPTH (FT)	USCS	H ₂ O CONTENT **	GRAPHIC LOG	DESCRIPTION	REMARKS
				DEPTH ELEVATION	
1.2				Topsoil (14")	
				Sandy silt to silty sand; trace gravel, roots, organics, cobbles, boulders; dark brown, brown, tan, gray (FILL)	Medium dense; moist; easy excavating
6.0					End of test pit at 6.0'
					LIMITING ZONES: None encountered; Infiltration tests situated at 1.5' below existing grade (elevation 235.0')

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

TEST PIT LOG

PIT NO.	TP-201
SHEET	1 OF 1
DATE: START	11/2/17
END	11/2/17
SURFACE	
ELEV. (FT)	234.5

PROJECT NAME Langford Run Road Shopping Center

PROJECT LOCATION Marple Township, Delaware County, PA

PROJECT NUMBER 30149.00

INSPECTOR NAME C. Ardizzi

EQUIPMENT USED Case CX210 Trackhoe

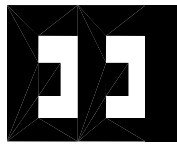
EXCAVATING COMPANY J. Glisson/Wayne Carmint Landscaping

WATER: DEPTH: Dry TIME: 0.25 hr

WATER: DEPTH: Dry TIME: 3.50 hrs

DEPTH (FT)	USCS	H ₂ O CONTENT **	GRAPHIC LOG	DESCRIPTION	REMARKS
				DEPTH ELEVATION	
1.5				Topsoil (18")	
	ml/sm	m		Sandy silt to silty sand; trace gravel, roots, cobbles; brown, gray (FILL)	Medium dense; moist; easy excavating
5.5				Silty sand; trace gravel; dark brown, brown, orange brown, gray (Decomposed Schist)	Medium dense; dry to moist; easy to moderate excavating
7.5	sm	d/m			End of test pit at 7.5'
					LIMITING ZONES: None encountered; Infiltration tests situated at 2.0' below existing grade (elevation 232.5')

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

TEST PIT LOG

PIT NO.	TP-202
SHEET	1 OF 1
DATE: START	11/2/17
END	11/2/17
SURFACE ELEV. (FT)	232.3

PROJECT NAME Langford Run Road Shopping Center

PROJECT LOCATION Marple Township, Delaware County, PA

PROJECT NUMBER 30149.00

INSPECTOR NAME C. Ardizzi

EQUIPMENT USED Case CX210 Trackhoe

EXCAVATING COMPANY J. Glisson/Wayne Carmint Landscaping

WATER: DEPTH: Dry TIME: 0.25 hr

WATER: DEPTH: Dry TIME: 4.00 hrs

DEPTH (FT)	USCS	H ₂ O CONTENT **	GRAPHIC LOG	DESCRIPTION	REMARKS
0.0				DEPTH ELEVATION	
				Sandy silt to silty sand; trace gravel, roots, organics, glass; brown, dark gray, gray (FILL)	Loose to medium dense; moist; easy excavating
4.5	ml/sm	m		4.5 227.8	
				Sandy silt to silty sand; trace gravel; dark brown, brown (Decomposed Schist)	Medium dense; dry to moist; easy to moderate excavating
6.5	ml/sm	d/m		6.5 225.8	
					End of test pit at 6.5'
					LIMITING ZONES: None encountered; Infiltration tests situated at 1.8' below existing grade (elevation 230.5')

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

TEST PIT LOG

PIT NO.	TP-203
SHEET	1 OF 1
DATE: START	11/2/17
END	11/2/17
SURFACE ELEV. (FT)	233.4

PROJECT NAME Langford Run Road Shopping Center

PROJECT LOCATION Marple Township, Delaware County, PA

PROJECT NUMBER 30149.00

INSPECTOR NAME C. Ardizzi

EQUIPMENT USED Case CX210 Trackhoe

EXCAVATING COMPANY J. Glisson/Wayne Carmint Landscaping

WATER: DEPTH: Dry TIME: 0.25 hr

WATER: DEPTH: Dry TIME: 4.75 hrs

DEPTH (FT)	USCS	H ₂ O CONTENT **	GRAPHIC LOG	DESCRIPTION	REMARKS
0.3				0.3 Topsoil (3") Sandy silt to silty sand; trace gravel, roots, organics, cobbles; brown, gray (FILL)	233.1 Loose to medium dense; moist; easy excavating
6.0				6.0	227.4 End of test pit at 6.0'
LIMITING ZONES: None encountered; Infiltration tests situated at 0.9' below existing grade (elevation 232.5')					

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

TEST PIT LOG

PIT NO.	TP-204
SHEET	1 OF 1
DATE: START	10/31/17
END	10/31/17
SURFACE ELEV. (FT)	243.4

PROJECT NAME Langford Run Road Shopping Center

PROJECT LOCATION Marple Township, Delaware County, PA

PROJECT NUMBER 30149.00

INSPECTOR NAME C. Ardizzi

EQUIPMENT USED Case CX210 Trackhoe

EXCAVATING COMPANY J. Glisson/Wayne Carmint Landscaping

WATER: DEPTH: Dry TIME: 0.25 hr

WATER: DEPTH: Dry TIME: 3.50 hrs

DEPTH (FT)	USCS	H ₂ O CONTENT **	GRAPHIC LOG	DESCRIPTION	REMARKS
0.0				DEPTH ELEVATION	
				Sandy silt to silty sand; trace gravel, roots, organics, cobbles; brown, gray (FILL)	Medium dense; moist; easy excavating
6.5	ml/sm	m		6.5 236.9	
				Silty sand; some gravel, cobbles; saprolitic; tan, brown, gray (Weathered Schist)	Very dense; dry to moist; hard excavating
9.0	sm	d/m		9.0 234.4	
					End of test pit at 9.0'
					LIMITING ZONES: Very dense weathered rock 6.5' - 9.0'; Infiltration tests situated at 2.4' below existing grade (elevation 241.0')

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

TEST PIT LOG

PIT NO.	TP-205
SHEET	1 OF 1
DATE: START	11/2/17
END	11/2/17
SURFACE ELEV. (FT)	248.9

PROJECT NAME Langford Run Road Shopping Center

PROJECT LOCATION Marple Township, Delaware County, PA

PROJECT NUMBER 30149.00

INSPECTOR NAME C. Ardizzi

EQUIPMENT USED Case CX210 Trackhoe

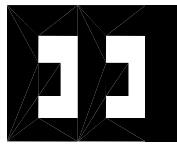
EXCAVATING COMPANY J. Glisson/Wayne Carmint Landscaping

WATER: DEPTH: Dry TIME: 0.25 hr

WATER: DEPTH: Dry TIME: 5.25 hrs

DEPTH (FT)	USCS	H ₂ O CONTENT **	GRAPHIC LOG	DESCRIPTION	REMARKS
0.0				DEPTH ELEVATION Sandy silt to silty sand; trace gravel, roots, organics, cobbles; brown, gray, dark gray (FILL)	Medium dense; moist; easy excavating
6.0	ml/sm	m		6.0 242.9	End of test pit at 6.0'
					LIMITING ZONES: None encountered; Infiltration tests situated at 0.9' below existing grade (elevation 248.0')

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-206
SHEET	1 OF 1
DATE: START	11/1/17
END	11/1/17
SURFACE ELEV. (FT)	259.7

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufra

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

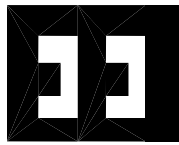
AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 20.0' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 11/1/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 8.0 hr DATE: 11/1/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DESCRIPTION	REMARKS
0.0	S-1	2 3 4	1.6'	-	SM	M		Silty fine micaceous sand, trace gravel, concrete, fine roots; Brown, grey brown (Fill)	Easy drilling 0' - 18.5'
2.0	S-2	6 7 7	1.7'	-	SM	M			
4.0	S-3	3 4 4	1.8'	-	SM	M			
6.0	S-4	6 7 9	1.6'	-	SM	M			
8.0	S-5	6 9 10	1.7'	-	SM	M			
10.0	S-6	12 13 15	1.4'	-	SM	M			
12.0	S-7	4 5 8	1.6'	-	SM	M			
14.0	S-8	5 6 9	1.4'	-	SM	M			
16.0	S-9	8 7 8	1.5'	-	SM	M			
18.0	S-10	8 13 21	0.7'	-	SM	M			
20.0		25						Silty sand with trace to some gravel, saprolitic; Brown, grey brown (Decomposed schist)	End of boring at 20.0'
									Limiting Zones not encountered
									Seat infiltration test at proposed depth of 9.7'

** D = DRY, M = MOIST, W = WET



TEST PIT LOG

PIT NO.	TP-207
SHEET	1 OF 1
DATE: START	11/1/17
END	11/1/17
SURFACE ELEV. (FT)	255.3

PROJECT NAME Langford Run Road Shopping Center

PROJECT LOCATION Marple Township, Delaware County, PA

PROJECT NUMBER 30149.00

INSPECTOR NAME C. Ardizzi

EQUIPMENT USED Case CX210 Trackhoe

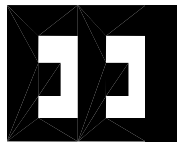
EXCAVATING COMPANY J. Glisson/Wayne Carmint Landscaping

WATER: DEPTH: Dry TIME: 0.25 hr

WATER: DEPTH: Dry TIME: 3.50 hrs

DEPTH (FT)	USCS	H ₂ O CONTENT **	GRAPHIC LOG	DEPTH ELEVATION	REMARKS
0.3				0.3 Topsoil (3") 255.0 Sandy silt to silty sand; trace gravel, roots, organics, cobbles; brown, orange brown, gray, dark gray (FILL)	Medium dense; moist; easy excavating
10.0				10.0 245.3	End of test pit at 10.0'
					LIMITING ZONES: None encountered; Infiltration tests situated at 5.3' below existing grade (elevation 250.0')

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-208
SHEET	1 OF 1
DATE: START	10/31/17
END	10/31/17
SURFACE ELEV. (FT)	264.4

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufra

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

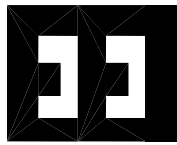
AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 18.0' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/31/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 11/1/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.0	S-1	3 4 5	1.6'	-	SM	M		0.0		Micaceous Silty sand, trace gravel; Brown, grey brown (Fill)	Easy drilling 0' - 8'
2.0	S-2	6 7 13	1.5'	-	SM	M					
4.0	S-3	7 8 7	1.8'	-	SM	M					
6.0	S-4	7 9 12	1.6'	-	SM	M		6.0	258.4	Silty fine sand, trace gravel; Orange- brown, brown	Easy to Moderate drilling 8.0' - 12.0'
8.0	S-5	7 13 15	1.5'	-	SM	M				Silty fine sand, trace gravel; Orange- brown, brown (Saprolitic schist)	
10.0	S-6	7 10 14	1.6'	-	SM	M					
12.0	S-7	20 50/5"	0.9'	-	SM	M		12.0	252.4	Silty fine sand, trace to some gravel; Brown (Weathered schist)	Difficult drilling 12.0' - 18.0'
14.0	S-8	32 50/4"	0.7'	-	SM	M					
14.8											
16.0	S-9	50/2"	0.0'	-	SM	M					End of boring at 18.0'
16.2											
								18.0	246.4		Limiting Zone: Very dense weathered rock at 12.0' to 18.0' Seat infiltration test at adjusted depth of 10.0'

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-209
SHEET	1 OF 1
DATE: START	11/2/17
END	11/2/17
SURFACE ELEV. (FT)	262.2

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufra

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

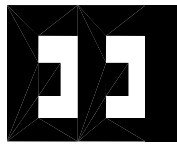
AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 18.0' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 11/2/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 8.0 hr DATE: 11/2/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DESCRIPTION	REMARKS
0.0		2						DEPTH	ELEVATION
0.0	S-1	3	1.7'	-	SM	M		Silty fine sand, trace fine roots, gravel, brick, concrete; Brown (Fill)	Easy drilling 0' - 14.5'
2.0	S-2	5	1.8'	-	SM	M			
4.0	S-3	5	1.6'	-	SM	M			
6.0	S-4	11	1.4'	-	SM	M			
8.0	S-5	4	0.8'	-	SM	M			
10.0	S-6	4	1.4'	-	SM	M			
12.0	S-7	4	1.0'	-	SM	M			
14.0	S-8	5	1.3'	-	SM	M		14.5	247.7
16.0	S-9	16	1.5'	-	SM	M			
18.0		21						18.0	244.2
									Difficult drilling 14.5' - 16.0'
									End of boring at 18.0'
									Limiting Zone: Very dense weathered rock at 14.5' to 18.0'
									Seat infiltration test at adjusted depth of 12.2'

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-210
SHEET	1 OF 1
DATE: START	11/1/17
END	11/1/17
SURFACE	
ELEV. (FT)	262.0

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufra

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 18.0' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 11/1/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 11/2/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%)	USCS RQD (%)	AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DESCRIPTION	REMARKS
0.0		1				SM			DEPTH	ELEVATION
0.0	S-1	2	1.4'	-		SM	M		Silty fine sand, trace gravel, concrete, stone, organics, coal; Brown, grey (Fill)	
2.0		3								
2.0	S-2	4	1.6'	-		SM	M			
4.0		5								
4.0		3								
4.0	S-3	6	1.7'	-		SM	M			
6.0		9								
6.0		9								
6.0	S-4	7	1.4'	-		SM	M			
8.0		5								
8.0		5								
8.0	S-5	6	1.5'	-		SM	M			
10.0		7								
10.0		6								
10.0	S-6	4	1.4'	-		SM	M			
12.0		2								
12.0		2								
12.0	S-7	3	1.4'	-		SM	M			
14.0		4								
14.0		5								
14.0	S-8	4	0.7'	-		SM	M			
16.0		5								
16.0		5								
16.0	S-9	2	0.3'	-		SM	M			
16.9		50/5"							16.5	245.5
									Micaceous Silty sand, trace to some gravel; Brown, grey brown (Weathered schist)	Moderate to Difficult drilling 16.5' - 18.0'
									18.0	244.0
										End of boring at 18.0'
										Limiting zone: very dense weathered rock at 16.5' to 18.0'
										Seat Infiltration test at 11.0' as proposed

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

TEST PIT LOG

PIT NO.	TP-211
SHEET	1 OF 1
DATE: START	10/31/17
END	10/31/17
SURFACE ELEV. (FT)	258.7

PROJECT NAME Langford Run Road Shopping Center

PROJECT LOCATION Marple Township, Delaware County, PA

PROJECT NUMBER 30149.00

INSPECTOR NAME C. Ardizzi

EQUIPMENT USED Case CX210 Trackhoe

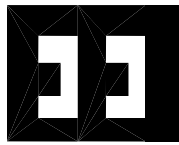
EXCAVATING COMPANY J. Glisson/Wayne Carmint Landscaping

WATER: DEPTH: Dry TIME: 0.25 hr

WATER: DEPTH: Dry TIME: 4.00 hrs

DEPTH (FT)	USCS	H ₂ O CONTENT **	GRAPHIC LOG	DESCRIPTION	REMARKS
0.2				DEPTH: 0.2 ELEVATION: 258.5 Topsoil (2") Sandy silt to silty sand; trace gravel, roots, organics, cobbles; brown (FILL)	Medium dense; moist; easy excavating
12.0				DEPTH: 12.0 ELEVATION: 246.7	End of test pit at 12.0' LIMITING ZONES: None encountered; Infiltration tests situated at 6.7' below existing grade (elevation 252.0')

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

TEST PIT LOG

PIT NO.	TP-212
SHEET	1 OF 1
DATE: START	10/31/17
END	10/31/17
SURFACE ELEV. (FT)	253.7

PROJECT NAME Langford Run Road Shopping Center

PROJECT LOCATION Marple Township, Delaware County, PA

PROJECT NUMBER 30149.00

INSPECTOR NAME C. Ardizzi

EQUIPMENT USED Case CX210 Trackhoe

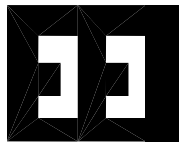
EXCAVATING COMPANY J. Glisson/Wayne Carmint Landscaping

WATER: DEPTH: Dry TIME: 0.25 hr

WATER: DEPTH: Dry TIME: 3.00 hrs

DEPTH (FT)	USCS	H ₂ O CONTENT **	GRAPHIC LOG	DESCRIPTION	REMARKS
0.2				DEPTH ELEVATION 0.2 Topsoil (2") 253.5 Sandy silt to silty sand; trace gravel, roots, cobbles, boulders; brown, gray (FILL)	Medium dense; moist; easy excavating
6.0				6.0 247.7	End of test pit at 6.0'
					LIMITING ZONES: None encountered; Infiltration tests situated at 0.7' below existing grade (elevation 253.0')

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

TEST PIT LOG

PIT NO.	TP-213
SHEET	1 OF 1
DATE: START	10/31/17
END	10/31/17
SURFACE ELEV. (FT)	260.0

PROJECT NAME Langford Run Road Shopping Center

PROJECT LOCATION Marple Township, Delaware County, PA

PROJECT NUMBER 30149.00

INSPECTOR NAME C. Ardizzi

EQUIPMENT USED Case CX210 Trackhoe

EXCAVATING COMPANY J. Glisson/Wayne Carmint Landscaping

WATER: DEPTH: Dry TIME: 0.25 hr

WATER: DEPTH: Dry TIME: 4.50 hrs

DEPTH (FT)	USCS	H ₂ O CONTENT **	GRAPHIC LOG	DESCRIPTION	REMARKS
0.0				DEPTH ELEVATION Sandy silt to silty sand; trace gravel, roots, brick, asphalt, cobbles, boulders; brown, orange brown, gray (FILL)	Medium dense; moist; easy to moderate excavating
8.0	ml/sm	m		8.0 252.0	End of test pit at 8.0'
					LIMITING ZONES: None encountered; Infiltration tests situated at 4.0' below existing grade (elevation 256.0')

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

TEST PIT LOG

PIT NO.	TP-214
SHEET	1 OF 1
DATE: START	10/31/17
END	10/31/17
SURFACE ELEV. (FT)	262.2

PROJECT NAME Langford Run Road Shopping Center

PROJECT LOCATION Marple Township, Delaware County, PA

PROJECT NUMBER 30149.00

INSPECTOR NAME C. Ardizzi

EQUIPMENT USED Case CX210 Trackhoe

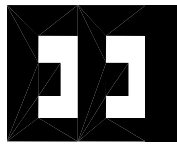
EXCAVATING COMPANY J. Glisson/Wayne Carmint Landscaping

WATER: DEPTH: Dry TIME: 0.25 hr

WATER: DEPTH: Dry TIME: 3.50 hrs

DEPTH (FT)	USCS	H ₂ O CONTENT **	GRAPHIC LOG	DESCRIPTION	REMARKS
0.0				DEPTH ELEVATION Sandy silt to silty sand; trace gravel, roots, organics, cobbles; brown, gray, dark gray, orange brown (FILL)	Medium dense; moist; easy to moderate excavating
12.5	ml/sm	m		12.5 249.7	End of test pit at 12.5'
					LIMITING ZONES: None encountered; Infiltration tests situated at 8.2' below existing grade (elevation 254.0')

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-215
SHEET	1 OF 1
DATE: START	11/1/17
END	11/1/17
SURFACE ELEV. (FT)	265.6

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufra

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

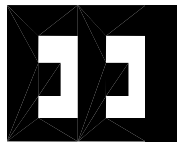
AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 16.9' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 11/1/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 11/2/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.0	S-1	1 2 2	1.4'	-	SM	M		0.0	265.6	Silty fine sand, trace gravel, stone, organics; Brown, orange-brown, grey (Fill)	Easy drilling 0' - 10'
2.0	S-2	5 13 14	1.7'	-	SM	M					
4.0	S-3	4 9 11	1.6'	-	SM	M					
6.0	S-4	10 12 13	1.7'	-	SM	M					
8.0	S-5	12 13 13	1.8'	-	SM	M					
10.0	S-6	4 7 10	2.0'	-	ML	M		10.0	255.6	Fine sandy silt, trace gravel; Orange-brown, brown, grey, mottled	Easy drilling 10' -14'
12.0	S-7	10 11 15	1.9'	-	ML	M					
14.0	S-8	11 15 25	0.3'	-	SM	M		15.0	250.6	Silty sand, trace to some gravel; Orange-brown, brown, grey, grey-brown (Weathered schist)	Moderate to Difficult drilling 14.0' -16.0'
16.0	S-9	34 50/5"	0.8'	-	SM	M		16.9	248.7		End of boring at 16.9'
16.9											Limiting Zones: Mottled 10.0' to 14.0'; Very dense 15.0' to 16.9 Infiltration test seated at adjusted depth of 8.0'

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-216
SHEET	1 OF 1
DATE: START	11/1/17
END	11/1/17
SURFACE ELEV. (FT)	267.9

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufta

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 18.5' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 11/1/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 11/2/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.0	S-1	8	1.6'	-	SM	M				Micaceous Silty sand, trace gravel; Brown (Fill)	Easy drilling 0' - 6.5'
1.8		18									
2.0		20									
2.0	S-2	14	1.5'	-	SM	M					
3.0		16									
4.0		20									
4.0	S-3	4	1.6'	-	SM	M		4.0	263.9	Silty fine sand; Orange-brown, brown (Residual)	
5.0		9									
6.0		10									
6.0	S-4	7	1.7'	-	SM	M		6.5	261.4	Micaceous silty fine sand, trace gravel; Orange-brown, brown, pale brown (Decomposed schist)	Easy to Moderate drilling 6.5' - 10.0'
7.0		7									
8.0		7									
8.0	S-5	7	1.4'	-	SM	M					
9.0		9									
10.0		10									
10.0	S-6	46	0.8'	-	SM	M		10.0	257.9	Micaceous silty sand, some gravel; Grey- brown (Weathered schist)	Difficult drilling from 10.0' to 18.5'
10.9		50/5"									
12.0											
12.0	S-7	50/5"	0.4'	-	SM	M					
12.4											
14.0											
14.0	S-8	35	0.4'	-	SM	M					
14.8		50/3									
								18.5	249.4		End of boring with auger refusal at 18.5'
											Limiting Zones: very dense weathered rock at 10.0' to 18.5'
											Seat infiltration test at adjusted depth of 8.0'.

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-217
SHEET	1 OF 1
DATE: START	10/31/17
END	10/31/17
SURFACE ELEV. (FT)	266.1

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufra

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 8.6' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/31/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 11/1/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.0	S-1	2 6 10 10	1.7'	-	SM	M				Micaceous silty sand; Orange-brown, brown (Decomposed schist)	Easy drilling 0.0' to 6.5'
2.0	S-2	12 15 16 18	2.0'	-	SM	M					
4.0	S-3	21 12 11 16	1.5'	-	SM	M					
6.0	S-4	17 26 50/5"	1.3'	-	SM	M		6.5	259.6	Micaceous silty sand, some gravel; Grey-brown, brown (Weathered schist)	
7.4											
8.0											
8.3	S-5	50/4"	0.2'	-	SM	NA		8.6	257.5		End of boring with auger refusal at 8.6'
											Limiting zone: Very dense weathered rock at 6.5'
											Seat infiltration test at adjusted depth of 4.5'.

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-218
SHEET	1 OF 1
DATE: START	10/27/17
END	10/27/17
SURFACE ELEV. (FT)	268.2

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufta

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

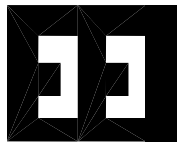
AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 11.3' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/27/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/28/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%)	USCS RQD (%)	AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS	
0.0	S-1	2	1.6'	-	SM		M				Micaceous silty sand; Orange-brown, brown (Decomposed schist)	Easy to moderate drilling from 0.0' to 5.5'.	
2.0		3											
		3											
	S-2	3	1.7'	-	SM		M		2.5	265.7	Micaceous silty sand, trace gravel; Brown, grey brown (Decomposed schist)	Difficult drilling from 5.5' to 11.3'	
4.0		5											
		9											
	S-3	14	1.5'	-	SM		M		5.0	263.2	Micaceous silty sand, trace to some gravel; Brown, grey brown (Weathered schist)		
6.0		20											
		30											
6.4	S-4	50/5"	0.3'		GM		M						
8.0	S-5	50/2"	0.1'	-	GM		M					End of boring with auger refusal at 11.3'.	
8.2													
									11.3	256.9		Limiting zone: Very dense weathered rock at 5.0'. Seat infiltration test at adjusted depth of 3.0'	

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-219
SHEET	1 OF 1
DATE: START	10/27/17
END	10/27/17
SURFACE ELEV. (FT)	269.4

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufta

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

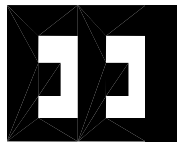
AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 18.3' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/27/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/28/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.0	S-1	25 21 10	1.5'	-	SM	M		0.0		Micaceous silty sand, trace gravel; Brown (Fill)	
2.0	S-2	18 25 26	1.7'	-	SM	M					
4.0	S-3	4 4 7	1.4'	-	ML	M					
6.0	S-4	7 9 12	2.0'	-	ML	M		6.0	263.4	Silty fine sand; Orange-brown, brown, pale brown	
8.0	S-5	12 11 11	1.4'	-	SM	M		8.5	260.9	Micaceous Silty sand, trace gravel, saprolitic; Brown, orange-brown, grey-brown (Decomposed Schist)	
10.0	S-6	7 5 6	1.0'	-	SM	M					
12.0	S-7	8 8 11	1.4'	-	SM	M					
14.0	S-8	11 17 20	1.8'	-	SM	M		15.5	253.9		
16.0	S-9	50/5"	0.3'		GM	M				Micaceous Silty sand, some gravel; Brown-grey, brown (Weathered schist)	
16.4											
18.0											
18.3	S-10	50/4"	0.2'		GM	M		18.3	251.1		End of boring at 18.3'
											Limiting zone: very dense weathered rock at 15.5'
											Seat infiltration test at adjusted depth of 13.5'.

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-220
SHEET	1 OF 1
DATE: START	10/27/17
END	10/27/17
SURFACE ELEV. (FT)	268.4

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufta

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

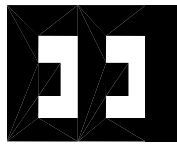
AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 19.0' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/27/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/28/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.0	S-1	29	0.3'	-	SM	M				Silty sand, trace to some gravel, trace cobbles and boulders; Orange-brown, brown, dark grey, grey-brown (Fill)	Difficult drilling from 0.0' to 1.5' Easy to moderate drilling from 1.5' to 8.0'
0.9		50/5"									
2.0	S-2	5	1.4'	-	SM	M					
4.0		12									
6.0	S-3	8	1.3'	-	SM	M					Difficult drilling from 8.0' to 13.5'
8.0	S-4	13	0.8'	-	ML	M					
10.0	S-5	12	0.8'	-	GM	M		8.0	260.4	Silty fine sand, trace to some gravel, cobbles, boulders; Orange-brown, brown	
11.4	S-6	10	0.5'	-	GM	M					
13.0		50/4"									Easy to moderate drilling from 13.5' to 19.0'
15.0	S-7	4	2.0'	-	SM	M		13.5	254.9	Silty fine micaceous sand, trace gravel; Orange-brown, brown (Decomposed to saprolitic schist)	
17.0	S-8	5	1.8'	-	SM	M					
19.0	S-9	8	2.0'	-	SM	M		19.0	249.4		
											End of boring at 19.0'.
											Limiting zones: not encountered
											Seat infiltration test at proposed depth of 14.4'

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-221
SHEET	1 OF 1
DATE: START	10/31/17
END	10/31/17
SURFACE ELEV. (FT)	266.0

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufta

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 16.0' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/31/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 11/1/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.0	S-1	4 4 5	1.7'	-	SM	M		0.0	266.0	Silty fine sand, trace gravel, organics; Brown, grey-brown (Fill)	Easy drilling from 0.0' to 8.5'
2.0	S-2	11 9 13	1.5'	-	ML	M		2.0	265.0		
4.0	S-3	7 4 5	0.5'	-	SM	M		4.0	264.0		
6.0	S-4	15 19 13	1.5'	-	SM	M		6.0	263.0		
8.0	S-5	6 8 12	2.0'	-	CL	M		8.5	257.5	Silty fine sand, trace clay, well rounded gravel and angular to subangular gravel; Red-brown, orange-brown	Moderate drilling from 8.5' to 12.0'
10.0	S-6	8 11 12	1.5'	-	SM	M		10.0	256.0		
12.0	S-7	27 29 23	0.7'	-	GM	M		12.0	254.0	Silty fine sand, trace clay, well rounded gravel and angular to subangular gravel; Red-brown, orange-brown (Weathered Schist)	Difficult drilling from 12.0' to 16.0'
14.0	S-8	18 19 23	1.0'	-	SM	M		14.0	252.0		
16.0		34						16.0	250.0		End of boring at 16.0'. Limiting Zone: Very dense weathered rock at 12.0' to 16.0'. Seat infiltration test at adjusted depth of 10.0'

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-222
SHEET	1 OF 1
DATE: START	10/31/17
END	10/31/17
SURFACE ELEV. (FT)	264.0

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufta

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

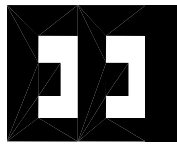
AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 14.0' ; WATER: DEPTH: --- TIME: --- DATE: 10/31/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: --- TIME: --- DATE: 10/31/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DESCRIPTION	REMARKS
0.0		6						Asphalt millings	
1.0	S-1	15 8	1.4'	-	SM	W		Silty fine sand, trace gravel; Brown (Fill)	Easy drilling from 0.0' to 10.0'.
2.0	S-2	11 14 16	1.3'	-	SM	M			
4.0	S-3	4 6 9	1.7'	-	ML	M			
6.0	S-4	6 8 9 10	1.4'	-	ML	M		Fine sandy silt to silty fine sand, trace gravel; Brown, red-brown, orange-brown	
8.0	S-5	6 7 7 9	1.3'	-	CL-ML	M			
10.0	S-6	4 10 19 14	1.6'	-	SM	M			Easy to moderate drilling from 10.0' to 12.0'
12.0	S-7	11 12 11 12	1.7'	-	SM	M			
14.0								Silty fine micaceous sand; Orange-brown, brown	End of boring at 14.0'.
									Limiting Zones not encountered
									Seat infiltration test at 10.0'

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-223
SHEET	1 OF 1
DATE: START	10/26/17
END	10/26/17
SURFACE ELEV. (FT)	269.7

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufta

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

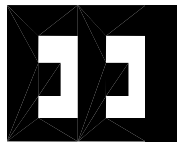
AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 20.0' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/26/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/27/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DESCRIPTION	REMARKS
0.0		3			SM			DEPTH	ELEVATION
0.0	S-1	4		-	SM	M		Silty fine sand with trace gravel to silty sand with trace gravel and clay; Orange-brown, brown (Fill)	Easy drilling from 0.0' to 14.5'.
2.0		10							
2.0	S-2	15		-	SM	M			
4.0		14							
4.0		11							
6.0	S-3	4		-	SM	M			
6.0		5							
6.0		5							
8.0	S-4	4		-	ML	M			
8.0		5							
8.0		7							
10.0	S-5	8		-	SC	M			
10.0		8							
10.0		7						10.0	259.7
12.0	S-6	3		-	SM	M		Micaceous silty sand, trace gravel; Brown-grey saprolite, brown (Decomposed schist)	
12.0		7							
12.0		9							
14.0	S-7	9		-	SM	M			
14.0		9							
14.0		14							
15.8	S-8	10		-	SM	M			
15.8		23							
15.8		36						15.5	254.2
16.0		50/4"							
16.3	S-9	50/4"	0.2'	-	GM	M		Micaceous silty sand with some gravel; Brown, brown-grey (Weathered schist)	
18.0									
18.0									
18.2	S-10	50/2"	0.0'	-		NA			
20.0								20.0	249.7
									End of boring at 20.0'
									Limiting zones: Very dense weathered rock at 15.5' to 20.0'
									Seat infiltration test at adjusted depth of 13.0

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-224
SHEET	1 OF 1
DATE: START	10/25/17
END	10/25/17
SURFACE ELEV. (FT)	271.2

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufta

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

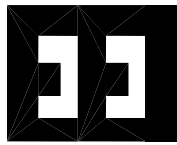
AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 21.0' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/25/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/26/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.0	S-1	5 14 17	1.8'	-	SM	M		0.0	271.2	Silty sand, trace gravel, trace fine roots and stone; Brown, orange-brown (Fill)	Easy drilling from 0.0' to 7.5'
2.0	S-2	7 9 13	1.4'	-	SM	M		2.0	269.8		
4.0	S-3	4 5 6	0.3'	-	SM	M		4.0	267.4		
6.0	S-4	6 7 5	0.8'	-	SM	M		6.0	265.0		
8.0	S-5	4 4 5	1.1'	-	SM	M		8.0	262.6		
10.0	S-6	5 6 8	0.0'	-		NA		10.0	260.2	Silty fine sand, trace gravel, saprolite; Orange-brown, brown, pale brown (Decomposed Schist)	Easy drilling from 7.5' to 18.0'
12.0	S-7	14 15 18	1.5'	-	SM	M		12.0	257.8		
14.0	S-8	7 8 9	1.8'	-	SW-SM	M		14.0	255.4		
16.0	S-9	14 13 16	1.4'	-	SM	M		16.0	253.0		
18.0	S-10	15 37 33	2.0'	-	GM	M		18.0	250.6		
20.0		35						20.0	251.2		End of boring at 20.0'
											Limiting Zone: Very dense weathered rock 18.5'
											Seat infiltration test at proposed depth of 15.2'

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-225
SHEET	1 OF 1
DATE: START	10/26/17
END	10/26/17
SURFACE ELEV. (FT)	270.7

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufta

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 20.0' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/26/2017

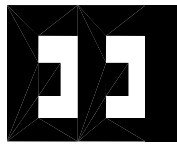
CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/27/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.0	S-1	3	1.8'	-	SM	M				Silty sand; Brown (Fill)	Easy drilling from 0.0' to 8.0'
1.0		12									
2.0		12									
2.0	S-2	8	1.5'	-	SM	M		2.0	268.7	Micaceous Silty sand; Orange-brown, brown, pale brown (Decomposed schist)	
3.0		9									
4.0		7									
4.0	S-3	3	1.7'	-	SM	M					
5.0		4									
6.0		5									
6.0	S-4	10	2.0'	-	SM	M					
7.0		17									
8.0		25									
8.0	S-5	33	1.6'	-	SM	M		8.0	262.7	Micaceous Silty sand, trace to some gravel; Brown, grey brown (Saprolitic to weathered schist)	Moderate to hard drilling from 8.0' to 15.5'
9.0		34									
10.0		28									
10.0	S-6	16	1.8'	-	SM	M					
11.0		29									
12.0		27									
12.0	S-7	15	1.8'	-	SM	M					
13.0		13									
14.0		16									
14.0	S-8	29	1.9'	-	GM	M					
15.0		29									
16.0		38									
16.0	S-9	40	-	-	SM	M					Difficult drilling from 15.5' to 20.0'
17.0		50/4"									
18.0											
20.0								20.0	250.7		End of boring at 20.0'

** D = DRY, M = MOIST, W = WET

Limiting zones: Very dense weathered rock from 8.0' to 20.0'
Seat infiltration test at adjusted depth of 6.0'



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-226
SHEET	1 OF 1
DATE: START	10/27/17
END	10/27/17
SURFACE ELEV. (FT)	270.1

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufta

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 18.3' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/27/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/27/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.0	S-1	3 5 5	1.5'	-	SM	M				Silty fine micaceous sand, trace gravel; Orange-brown, brown (Decomposed schist)	East drilling from 0.0 to 6.5'
2.0	S-2	5 7 7	1.5'	-	SM	M					
4.0	S-3	5 10 11	1.5'	-	SM	M					
6.0	S-4	14 23 32	1.6'	-	SM	M		6.5	263.6	Micaceous Silty sand, trace to some gravel; Orange-brown, brown, grey- brown, grey (Weathered schist)	Difficult drilling from 6.5' to 18.3'
8.0	S-5	31 42 50/5"	1.4'	-	GM	M					
9.4											
13.0											
15.0	S-6	48 33 19	1.8'	-	GM	M					
18.0											
18.3	S-7	50/4"	0.3'	-	SM	M		18.3	251.8		End of boring at 18.3'
											Limiting Zones: Very dense weathered rock at 6.5' to 18.3'
											Seat infiltration test at adjusted depth of 4.5'.

** D = DRY, M = MOIST, W = WET



BORING LOG

BORING NO. B-227
SHEET 1 OF 1
DATE: START 10/27/17
END 10/27/17
SURFACE
ELEV. (FT) 272.3

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%)		H ₂ O CONTENT	GRAPHIC LOG	DESCRIPTION		REMARKS
				RQD (%)	USCS AASHTO			DEPTH	ELEVATION	
0.0	S-1	3	1.7'	-	SM	M		Silty fine micaceous sand, trace gravel (Decomposed schist)	Easy drilling from 0.0' to 4.5'	
2.0		5								
4.0	S-2	8	1.4'	-	SM	M		Micaceous silty sand, trace to some gravel; Brown, orange-brown, brown-grey (Saprolitic to weathered schist)	Difficult drilling from 4.5' to 16.5'	
6.0		6								
8.0	S-3	13	1.6'	-	GM	M		Micaceous silty sand, trace to some gravel; Brown, orange-brown, brown-grey (Saprolitic to weathered schist)	Difficult drilling from 4.5' to 16.5'	
10.0		29								
12.0	S-4	24	0.8'	-	GM	M		Micaceous silty sand, trace to some gravel; Brown, orange-brown, brown-grey (Saprolitic to weathered schist)	Difficult drilling from 4.5' to 16.5'	
14.0		36								
16.0	S-5	50/3"	0.3'	-	SM	M		Micaceous silty sand, trace to some gravel; Brown, orange-brown, brown-grey (Saprolitic to weathered schist)	Difficult drilling from 4.5' to 16.5'	
18.0		50/3"								
20.0	S-6	50/5"	0.3'	-	SM	M		Micaceous silty sand, trace to some gravel; Brown, orange-brown, brown-grey (Saprolitic to weathered schist)	Difficult drilling from 4.5' to 16.5'	
22.0		50/5"								
24.0								Micaceous silty sand, trace to some gravel; Brown, orange-brown, brown-grey (Saprolitic to weathered schist)	Difficult drilling from 4.5' to 16.5'	
26.0										
28.0								Micaceous silty sand, trace to some gravel; Brown, orange-brown, brown-grey (Saprolitic to weathered schist)	Difficult drilling from 4.5' to 16.5'	
30.0										
32.0								Micaceous silty sand, trace to some gravel; Brown, orange-brown, brown-grey (Saprolitic to weathered schist)	Difficult drilling from 4.5' to 16.5'	
34.0										
36.0								Micaceous silty sand, trace to some gravel; Brown, orange-brown, brown-grey (Saprolitic to weathered schist)	Difficult drilling from 4.5' to 16.5'	
38.0										
40.0								Micaceous silty sand, trace to some gravel; Brown, orange-brown, brown-grey (Saprolitic to weathered schist)	Difficult drilling from 4.5' to 16.5'	
42.0										
44.0								Micaceous silty sand, trace to some gravel; Brown, orange-brown, brown-grey (Saprolitic to weathered schist)	Difficult drilling from 4.5' to 16.5'	
46.0										
48.0								Micaceous silty sand, trace to some gravel; Brown, orange-brown, brown-grey (Saprolitic to weathered schist)	Difficult drilling from 4.5' to 16.5'	
50.0										
52.0								Micaceous silty sand, trace to some gravel; Brown, orange-brown, brown-grey (Saprolitic to weathered schist)	Difficult drilling from 4.5' to 16.5'	
54.0										
56.0								End of boring at 16.5'	Limiting Zone: Very dense weathered rock from 4.5' to 16.5'	
58.0										
60.0								Seat infiltration test at adjusted depth of 2.5'		
62.0										
64.0										
66.0										
68.0										
70.0										
72.0										
74.0										
76.0										
78.0										
80.0										
82.0										
84.0										
86.0										
88.0										
90.0										
92.0										
94.0										
96.0										
98.0										
100.0										
102.0										
104.0										
106.0										
108.0										
110.0										
112.0										
114.0										
116.0										
118.0										
120.0										
122.0										
124.0										
126.0										
128.0										
130.0										
132.0										
134.0										
136.0										
138.0										
140.0										
142.0										
144.0										
146.0										
148.0										
150.0										
152.0										
154.0										
156.0										
158.0										
160.0										
162.0										
164.0										
166.0										
168.0										
170.0										
172.0										
174.0										
176.0										
178.0										
180.0										
182.0										
184.0										
186.0										
188.0										
190.0										
192.0										
194.0										
196.0										
198.0										
200.0										
202.0										
204.0										
206.0										
208.0										
210.0										
212.0										
214.0										
216.0										
218.0										
220.0										
222.0										
224.0										
226.0										
228.0										
230.0										
232.0										
234.0										
236.0										
238.0										
240.0										
242.0										
244.0										
246.0										
248.0										
250.0										
252.0										
254.0										
256.0										
258.0										
260.0										
262.0										
264.0										
266.0										
268.0										
270.0										
272.0										
274.0										
276.0										
278.0										
280.0										
282.0										
284.0										
286.0										
288.0										
290.0										
292.0										
294.0										
296.0										
298.0										
300.0										
302.0										
304.0										
306.0										
308.0										
310.0										
312.0										
314.0										
316.0										
318.0										
320.0										
322.0										
324.0										
326.0										
328.0										
330.0										
332.0										
334.0										
336.0										
338.0										
340.0										
342.0										
344.0										
346.0										
348.0										
350.0										
352.0										
354.0										
356.0										
358.0										
360.0										
362.0										
364.0										
366.0										
368.0										
370.0										
372.0										
374.0										
376.0										
378.0										
380.0										
382.0										
384.0										
386.0										
388.0										
390.0										
392.0										
394.0										
396.0										
398.0										
400.0										
402.0										
404.0										
406.0										
408.0										
410.0										
412.0										
414.0										
416.0										
418.0										
420.0										
422.0										
424.0										
426.0										
428.0										
430.0										
432.0										
434.0										
436.0										
438.0										
440.0										

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-228
SHEET	1 OF 1
DATE: START	10/26/17
END	10/26/17
SURFACE ELEV. (FT)	272.7

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufta

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

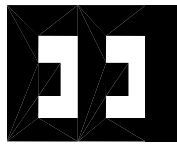
AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 11.0' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/26/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/27/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%)	USCS RQD (%)	AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.0	S-1	3	1.8'	-	SM		M		6.0	266.7	Micaceous silty sand, trace gravel; Orange-brown, brown, grey-brown (Saprolitic schist)	Easy to moderate drilling from 0.0 to 6.0'
2.0		4 11										
4.0		3 5 11										
6.0	S-3	12 15	1.7'	-	SM		M		6.0	266.7	Micaceous silty sand, some gravel; Brown-grey, brown (Weathered schist)	Difficult drilling from 6.0' to 11.0'
6.4		17 33										
8.0	S-4	50/5"	0.3'	-	GM		M		6.0	266.7	Micaceous silty sand, some gravel; Brown-grey, brown (Weathered schist)	Difficult drilling from 6.0' to 11.0'
8.2		50/2"										
	S-5	50/2"	0.1'	-	SM		M		11.0	261.7	End of boring with auger refusal at 11.0'	Limiting Zone: Very dense weathered rock from 6.0' to 11.0' Seat infiltration test at adjusted depth of 4.0'

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-229
SHEET	1 OF 1
DATE: START	10/25/17
END	10/25/17
SURFACE ELEV. (FT)	273.2

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufra

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

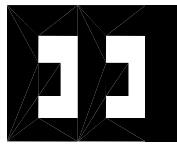
AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 15.7' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/25/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/26/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.0	S-1	2 3 4	1.6'	-	SM	M				Silty fine sand, trace gravel; Orange-brown, brown (Decomposed to saprolitic schist)	Easy drilling from 0.0' to 6.5'
2.0	S-2	4 4 12	0.7'	-	SM	M					
4.0	S-3	3 5 5	1.8'	-	SM	M					
6.0	S-4	7 7 10	1.5'	-	SM	M					Moderate drilling from 6.5' to 15.0'
8.0	S-5	10 10 12	1.3'	-	SM	M					
10.0	S-6	9 9 12	1.3'	-	SM	M					
12.0	S-7	9 9 6	1.4'	-	SM	M					
14.0	S-8	20 26 50/5"	1.2'	-	GM	M					
15.0								15.0	258.2		
15.5								15.7	257.5	Silty sand, some gravel; Brown, brown-grey (Weathered schist)	Difficult drilling from 15.0' to 15.7'
											End of boring with auger refusal at 15.7'
											Limiting Zone: Very dense weathered rock from 15.0' to 15.7'.
											Seat infiltration test at adjusted depth of 13.0'

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-230
SHEET	1 OF 1
DATE: START	10/26/17
END	10/26/17
SURFACE ELEV. (FT)	273.8

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufra

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 20.9' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/26/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/27/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.0	S-1	5 5 6	1.7'	-	SM	NA				Silty fine micaceous sand, saprolite; Orange-brown, brown (Decomposed schist)	easy drilling 0.0' to 6.5'
2.0	S-2	5 6 7	1.6'	-	SM	NA					
4.0	S-3	4 4 4	1.5'	-	SM	NA					
6.0	S-4	7 8 11 14	1.8'	-	SM	NA		6.5	267.3	Micaceous silty sand, trace gravel; Orange-brown, brown (Decomposed schist)	moderate drilling 6.5' to 16.5'
8.0	S-5	13 13 22 27	1.6'	-	SM	NA					
10.0	S-6	10 13 15 16	1.7'	-	SM	NA					
12.0	S-7	14 15 19 24	1.7'	-	SM	NA					
14.0	S-8	26 19 10 27	1.5'	-	SM	NA					
16.0	S-9	32 50/5"	0.5'	-	SM	NA		16.5	257.3	Silty fine micaceous sand, some gravel; Brown, grey, grey-brown (Weathered schist)	difficult drilling from 16.5' to 20.9'
18.0	S-10	31 50/5"		-	GM	NA					
18.9								20.9	252.9		End of boring with auger refusal
											Limiting Zone: Very dense weathered rock and bedrock 16.5' to 20.9';
											Seat infiltration at adjusted depth of 14.5'

** D = DRY, M = MOIST, W = WET



BORING LOG

PROJECT NAME <u>Langford Run Rd.</u>		PROJECT LOCATION <u>Marple Township</u>	
PROJECT NUMBER <u>30149.00</u>		INSPECTOR NAME <u>J. Kufta</u>	
EQUIPMENT USED <u>Mobile B-57 Truck Mounted Drill Rig</u>		DRILLER NAME/COMPANY <u>B. Corcoran/Corcoran Drilling</u>	
DRILLING METHODS <u>2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer</u>			
AUGER: SIZE: <u>6" O.D. Solid</u> ;	AUGER DEPTH: <u>17.0'</u> ;	WATER: DEPTH: <u>Dry</u>	TIME: <u>0.25 hr</u> DATE: <u>10/25/2017</u>
CHECKED BY: <u>A. Hadley</u> ;	DATE: <u>11/6/2017</u>	DEPTH: <u>Dry</u>	TIME: <u>5 hrs</u> DATE: <u>10/25/2017</u>
		NOT ENCOUNTERED ☐	

299



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-232
SHEET	1 OF 1
DATE: START	10/26/17
END	10/26/17
SURFACE ELEV. (FT)	274.7

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufta

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 17.1' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/26/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/27/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT.)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.0		8			SM						
	S-1	16	1.6'	-		M				Micaceous silty sand, some gravel; Brown-grey, brown (Weathered schist)	
2.0		36									
2.1	S-2	50/1"	0.1'	-	SM	M					Difficult drilling from 1.0' to 17.1'
4.0											
4.1	S-3	50/1"	0.0'	-		NA					
6.0											
6.1	S-4	50/1"	0.0'	-		NA					
11.0											
11.0	S-5	25/0"	0.0'	-		NA					
17.0											
17.1	S-6	50/1"	0.0'	-		NA		17.1	257.6		End of boring at 17.1'
											Limiting Zone: Very dense weathered rock at 1.0' to 17.1'
											No infiltration test due to shallow rock

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-233
SHEET	1 OF 1
DATE: START	10/27/17
END	10/27/17
SURFACE ELEV. (FT)	274.0

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufta

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 7.2' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/27/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/28/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%)	USCS RQD (%)	AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DESCRIPTION	REMARKS
0.0		1							DEPTH	ELEVATION
	S-1	5 9 10	1.6'	-	SM		M		Micaceous silty sand, trace to some gravel; Brown, grey-brown (Saprolitic to weathered schist)	
2.0										
2.9	S-2	8 50/5"	0.3'	-	SM		NA			Difficult drilling from 2.5' to 7.2'
4.0										
4.7	S-3	33 50/2"	0.3'	-	GM		NA			
6.0										
6.0	S-4	25/0"					NA		7.2	266.8
										End of boring with auger refusal
										Limiting Zone: Very dense weathered rock and bedrock 2.5' to 7.2'
										No infiltration test due to shallow rock

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-234
SHEET	1 OF 1
DATE: START	10/25/17
END	10/25/17
SURFACE ELEV. (FT)	274.8

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufra

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 8.8' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/25/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/26/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FL)	RECOVERY(%)	USCS RQD (%)	AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DESCRIPTION	REMARKS
0.0	S-1	41	0.7'	-	SM	NA			DEPTH	ELEVATION
0.7		50/2"							Silty fine sand, some gravel; Brown-grey, grey (Weathered schist)	Difficult drilling from 0.0' to 8.8'
2.0										
2.3	S-2	50/3"	0.2'	-	GM	NA				
4.0										
4.1	S-3	50/1"	0.0'	-		NA				
6.0										
6.1	S-4	50/1"	0.0'	-		NA				
8.0										
8.0	S-5	25/0"	0.0'	-		NA			8.8	266.0
										End of boring with auger refusal at 8.8'
										Limiting Zone: Very dense weathered rock and bedrock at 0.0' to 8.8'
										No infiltration due to shallow rock

** D = DRY, M = MOIST, W = WET



BORING LOG

BORING NO. B-235
SHEET 1 OF 1
DATE: START 10/25/17
END 10/26/17
SURFACE
ELEV. (FT) 272.2

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00INSPECTOR NAME J. KufraEQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY **B. Corcoran/Corcoran Drilling**

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 20.5' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/25/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/26/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (Ft.)	RECOVERY(%)	RQD (%)	USCS	AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DESCRIPTION		REMARKS
										DEPTH	ELEVATION	
0.0	S-1	9	1.6'	-	-	SM		M		Silty fine micaceous sand, trace to some gravel; Pale brown, brown, grey-brown (Saprolitic schist)	265.2	moderate drilling from 0.0' to 7.0'
2.0		24										
	S-2	8	1.6'	-	-	SM		M		Silty fine micaceous sand, trace to some gravel; Pale brown, brown, grey-brown (Saprolitic schist)	265.2	moderate drilling from 0.0' to 7.0'
		15										
	S-3	19	1.7'	-	-	SM		M		Silty fine micaceous sand, trace to some gravel; Pale brown, brown, grey-brown (Saprolitic schist)	265.2	moderate drilling from 0.0' to 7.0'
		18										
	S-4	21	1.3'	-	-	SM		M		Silty fine micaceous sand, trace to some gravel; Pale brown, brown, grey-brown (Saprolitic schist)	265.2	moderate drilling from 0.0' to 7.0'
		43										
7.3		50/4"								Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	moderate to difficult drilling from 7.0' to 12.0'
8.0	S-5	12	1.5'	-	-	ML		M		Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	moderate to difficult drilling from 7.0' to 12.0'
		9										
	S-6	37	0.5'	-	-	SM		NA		Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	moderate to difficult drilling from 7.0' to 12.0'
		50/3"										
10.0	S-7	25	0.4'	-	-	SM		M		Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
		8										
10.8		50/3"								Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
12.0	S-7	25	0.4'	-	-	SM		M		Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
		8										
12.7		50/2"								Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
	S-8	37	0.1'	-	-	SM		M		Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
		50/3"										
17.0		50/1"								Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
17.1		50/1"								Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey-brown (Weathered schist)	265.2	difficult drilling from 12.0' to 20.5'
										Silty fine micaceous sand, some gravel; Pale brown, grey		

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

BORING LOG

BORING NO.	B-236
SHEET	1 OF 2
DATE: START	10/25/17
END	10/26/17
SURFACE ELEV. (FT)	274.5

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00

INSPECTOR NAME J. Kufta

EQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

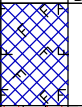
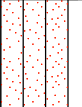
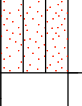
DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 25.3' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/25/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/26/2017

NOT ENCOUNTERED ☐

DEPTH (FT)	SAMPLE NO./ TYPE/CORE RUN	BLOWS/0.5 FT. ON SAMPLER	RECOVERY (FT)	RECOVERY(%) RQD (%)	USCS AASHTO	H ₂ O CONTENT	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.0		1									
	S-1	6 9	1.8'	-	GM	M				Micaceous Silty sand; Brown (Fill)	Easy drilling from 0.0' to 2.0'
2.0								2.0	272.5		
	S-2	10 16 23	1.6'	-	SM	M				Micaceous Silty sand, trace to some gravel; Orange-brown, brown, grey (Decomposed Schist)	Moderate drilling from 2.0' to 6.0'
4.0											
	S-3	6 6 20	1.6'	-	GM	M					
6.0								5.5	269.0		
6.3	S-4	50/3"	0.2'	-	SM	M					Difficult drilling from 6.0' to 25.0
8.0											
	S-5	20 24 20	1.5'	-	SM	M					
10.0											
10.3	S-6	50/4"	0.2'	-	SM	M					
15.0											
15.1	S-7	50/1"	0.0'	-		NA					
20.0											
20.1	S-8	50/1"	0.0'	-		NA					
25.0											

** D = DRY, M = MOIST, W = WET

PROJECT NAME Langford Run Rd.

PROJECT LOCATION Marple Township

PROJECT NUMBER 30149.00INSPECTOR NAME J. KufraEQUIPMENT USED Mobile B-57 Truck Mounted Drill Rig

DRILLER NAME/COMPANY B. Corcoran/Corcoran Drilling

DRILLING METHODS 2" Split Spoon Sampling, Cathead - Rope and Pulley Safety Hammer

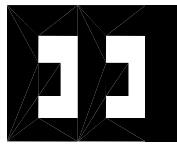
AUGER: SIZE: 6" O.D. Solid ; AUGER DEPTH: 25.3' ; WATER: DEPTH: Dry TIME: 0.25 hr DATE: 10/25/2017

CHECKED BY: A. Hadley ; DATE: 11/6/2017 DEPTH: Dry TIME: 24 hr DATE: 10/26/2017

NOT ENCOUNTERED ☐

[illegible]

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

TEST PIT LOG

PIT NO.	TP-237
SHEET	1 OF 1
DATE: START	11/1/17
END	11/1/17
SURFACE ELEV. (FT)	264.4

PROJECT NAME Langford Run Road Shopping Center

PROJECT LOCATION Marple Township, Delaware County, PA

PROJECT NUMBER 30149.00

INSPECTOR NAME C. Ardizzi

EQUIPMENT USED Case CX210 Trackhoe

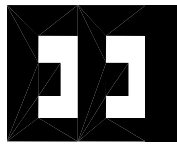
EXCAVATING COMPANY J. Glisson/Wayne Carmint Landscaping

WATER: DEPTH: Dry TIME: 0.25 hr

WATER: DEPTH: Dry TIME: 3.50 hrs

DEPTH (FT)	USCS	H ₂ O CONTENT **	GRAPHIC LOG	DEPTH	ELEVATION	DESCRIPTION	REMARKS
0.3				0.3	264.1	Topsoil (4")	
	ml/sm	m				Sandy silt; trace gravel, roots; brown, gray (FILL)	Loose to medium dense; moist; easy excavating
1.5				1.5	262.9	Silty sand; trace gravel; orange brown, brown, gray (Decomposed Schist)	Medium dense; moist; easy excavating
	sm	m					
7.5				7.5	256.9	Silty sand; some gravel, cobbles; saprolitic; brown, gray (Weathered Schist)	Very dense; dry to moist; hard excavating
	sm	d/m					
10.5				10.5	253.9		Bucket refusal at 10.5'
							End of test pit at 10.5'
							LIMITING ZONES: Very dense weathered rock 7.5' - 10.5'; Bedrock at 10.5'; Infiltration tests situated at 5.5' below existing grade (elevation 258.9')

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

TEST PIT LOG

PIT NO.	TP-238
SHEET	1 OF 1
DATE: START	11/1/17
END	11/1/17
SURFACE ELEV. (FT)	258.5

PROJECT NAME Langford Run Road Shopping Center

PROJECT LOCATION Marple Township, Delaware County, PA

PROJECT NUMBER 30149.00

INSPECTOR NAME C. Ardizzi

EQUIPMENT USED Case CX210 Trackhoe

EXCAVATING COMPANY J. Glisson/Wayne Carmint Landscaping

WATER: DEPTH: Dry TIME: 0.25 hr

WATER: DEPTH: Dry TIME: 4.00 hrs

DEPTH (FT)	USCS	H ₂ O CONTENT **	GRAPHIC LOG	DESCRIPTION	REMARKS
0.2				DEPTH ELEVATION 0.2 Topsoil (2") 258.3 Sandy silt; trace gravel, roots; orange brown (FILL)	Loose to medium dense; moist; easy excavating
1.5	ml	m		1.5 Sandy silt to silty sand; trace gravel; brown, dark brown (Decomposed Schist) 257.0	Medium dense; moist; easy to moderate excavating
7.0	ml/sm	m		7.0 Silty sand; some gravel, cobbles; saprolitic; brown, gray, orange brown (Weathered Schist) 251.5	Very dense; dry to moist; hard excavating
11.0	sm	d/m		11.0 247.5	End of test pit at 11.0'
					LIMITING ZONES: Very dense weathered rock 7.0' - 11.0'; Infiltration tests situated at 5.0' below existing grade (elevation 253.5')

** D = DRY, M = MOIST, W = WET



EARTH ENGINEERING INCORPORATED

Geotechnical Engineers & Geologists

TEST PIT LOG

PIT NO.	TP-239
SHEET	1 OF 1
DATE: START	11/1/17
END	11/1/17
SURFACE ELEV. (FT)	259.5

PROJECT NAME Langford Run Road Shopping Center

PROJECT LOCATION Marple Township, Delaware County, PA

PROJECT NUMBER 30149.00

INSPECTOR NAME C. Ardizzi

EQUIPMENT USED Case CX210 Trackhoe

EXCAVATING COMPANY J. Glisson/Wayne Carmint Landscaping

WATER: DEPTH: Dry TIME: 0.25 hr

WATER: DEPTH: Dry TIME: 5.00 hrs

DEPTH (FT)	USCS	H ₂ O CONTENT **	GRAPHIC LOG	DEPTH DESCRIPTION ELEVATION	REMARKS
0.3				0.3 Topsoil (4") 259.2	
	ml/sm	m		Sandy silt to silty sand; trace gravel, roots, organics, cobbles; brown, gray, dark gray (FILL)	Loose to medium dense; moist; easy excavating
3.5				3.5 Silty sand; trace gravel; orange brown, brown, gray (Decomposed Schist) 256.0	Medium dense; moist; easy excavating
	sm	m			
9.0				9.0 Silty sand; some gravel, cobbles; saprolitic; gray, brown (Weathered Schist) 250.5	Very dense; dry to moist; hard excavating
	sm	d/m			
12.0				12.0 247.5	End of test pit at 12.0'
					LIMITING ZONES: Very dense weathered rock 9.0' - 12.0'; Infiltration tests situated at 7.0' below existing grade (elevation 252.5')

* D = DRY, M = MOIST, W = WET

Soil Map—Delaware County, Pennsylvania
(30149.00 - Langford Run Road)



MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

Special Point Features



Blowout



Borrow Pit



Clay Spot



Closed Depression



Gravel Pit



Gravelly Spot



Landfill



Lava Flow



Marsh or swamp



Mine or Quarry



Miscellaneous Water



Perennial Water



Rock Outcrop



Saline Spot



Sandy Spot



Severely Eroded Spot



Sinkhole



Slide or Slip



Sodic Spot



Spoil Area



Stony Spot



Very Stony Spot



Wet Spot



Other



Special Line Features

Water Features



Streams and Canals

Transportation



Rails



Interstate Highways



US Routes



Major Roads



Local Roads

Background



Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service

Web Soil Survey URL:

Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Delaware County, Pennsylvania

Survey Area Data: Version 13, Oct 27, 2017

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Mar 19, 2011—Sep 22, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
Ch	Chewacla silt loam	2.8	9.3%
GeC	Glenelg channery silt loam, 8 to 15 percent slopes	1.1	3.7%
GeC2	Glenelg channery silt loam, 8 to 15 percent slopes, moderately eroded	16.0	52.2%
GeD	Glenelg channery silt loam, 15 to 25 percent slopes	1.2	4.0%
GeD2	Glenelg channery silt loam, 15 to 25 percent slopes, moderately eroded	2.1	6.8%
Me	Made land, schist and gneiss materials	1.1	3.5%
Mn	Melvin silt loam	2.5	8.2%
We	Wehadkee silt loam	3.8	12.3%
Totals for Area of Interest		30.6	100.0%

Appendix M

Declaration of Restrictive Covenants for Conservation Easement

10/2/09 (2d)

DECLARATION OF RESTRICTIVE COVENANTS FOR CONSERVATION

THIS DECLARATION OF RESTRICTIVE COVENANTS FOR CONSERVATION (hereinafter "Declaration") made this ____ day of October 2009, by Marple Associates, a Pennsylvania Limited Partnership, (hereinafter "Declarant").

WITNESSETH:

WHEREAS, Declarant is the fee simple owner of a certain tract of land located in Marple Township, Delaware County, Pennsylvania, being a part of the property conveyed to Declarant by Deed recorded in Deed Book Volume 403, Page 1654, in the Office of the Recorder of Deeds of Delaware County, Pennsylvania (The Property). The Property is legally described in Exhibit "A" attached hereto and made a part hereof; and

WHEREAS, a Conservation Area Plan depicting the Property designated as Lot 2 and consisting of 24.124 acres, a Conservation Area of 0.136 acres (Conservation Area 1), a Conservation Area of 0.281 acres (Conservation Area 2), a Conservation Area of 4.943 Acres (Conservation Area 3), a Conservation Area of 1.327 acres (Conservation Area 4), and a Conservation Area of .008 acres (Conservation Area 5) (Collectively The Conservation Areas) is attached hereto, made a part hereof, and marked Exhibit "B"; and

WHEREAS, a legal description of Conservation Area 1, Conservation Area 2, Conservation Area 3, Conservation Area 4 and Conservation Area 5 are attached hereto, made a part hereof, and marked Exhibits C-1, C-2, C-3, C-4 and C-5 respectively; and

WHEREAS, the United States Department of the Army, Corps of Engineers, through its Philadelphia District, Regulatory Branch, (hereinafter "USACE"), and the Declarant have agreed that the Declarant would make the Conservation Areas located on the Property subject to the conservation-based covenants described in this Declaration as a condition of the attached Department of the Army Permit issued for Marple Associates, Langford Run Site, Marple Township, Delaware County, PA [PADEP Permit No. E23-345 and CENAP-OP-R-2009-937-11 (PASPGP-3)] ; and

WHEREAS, the Declarant agrees to the creation of these conservation-based covenants and intends that the Conservation Areas shall be preserved and maintained in a natural condition in perpetuity.

NOW THEREFORE, in consideration of the mutually-held interests in preservation of the environment, as well as the terms, conditions and restrictions contained herein, and pursuant to the laws of the Commonwealth of Pennsylvania, Declarant does agree to the following terms and conditions:

1. PURPOSE

The purpose of this Declaration of Restrictive Covenants for Conservation is:

To preserve and protect the native flora, fauna, soils, water table and drainage patterns, and other conservation values of the Conservation Areas;

To view the Conservation Areas in their scenic and open condition; and in general,

To assure that the Conservation Areas, including their air space and subsurface, will be retained in perpetuity in their natural condition as provided herein and to prevent any use of the Conservation Areas that will impair or interfere with their natural resource functions and values. Declarant intends that this Declaration will confine the use of the Conservation Areas to such activities as are consistent with the purpose of this Declaration.

To accomplish the purpose of this Declaration, the following rights are created in accordance with Pennsylvania common law:

A. To allow the Declarant, the USACE or the Pennsylvania Department of Environmental Protection (hereinafter "PADEP") the right to enter upon the Conservation Areas to inspect the Conservation Areas at reasonable times to monitor compliance with and otherwise enforce the terms of this Declaration; provided that, except in cases where Declarant determines that immediate entry is necessary to prevent, terminate, or mitigate a violation of this Declaration; such entry shall, when practicable, be upon reasonable prior notice to USACE and PADEP.

B. To allow the Declarant, the USACE or the PADEP to enforce the terms of this Declaration by appropriate legal proceedings in accordance with Pennsylvania common law, so as to prevent any activity on or use of the Conservation Areas that are inconsistent with the purpose of this Declaration and to require the restoration of such areas or features of the Conservation Areas that may be damaged by any inconsistent activity or use.

C. To allow the Declarant, or its authorized representatives, to enter upon the Conservation Areas at reasonable times and upon prior notice and written approval by the USACE to take any appropriate environmental or conservation management measures consistent with the terms and purposes of this Declaration, including

- 1) planting of native trees, shrubs, grasses and forbs; or**
- 2) restoring, altering or maintaining the topography, hydrology, drainage, structural integrity, bed, water quantity, water quality or other relevant feature of any stream, wetland, water body or buffer on the Conservation Areas.**

2. DURATION

This Declaration shall remain in effect in perpetuity, shall run with the Property regardless of ownership or use, and is binding upon Declarant, its successors and assigns, as the case may be, as long as said party shall have any interest in any part of the Conservation Areas.

3. PERMITTED USES

This Declaration will not prevent the Declarant, its successors and assigns, from making use of the areas of the Property other than the Conservation Areas that are not expressly prohibited herein and are not inconsistent with the purpose of this Declaration.

As to those areas of the Property which are not within the Conservation Areas, Declarant reserves to itself, its successors and assigns, all rights accruing from its ownership of the Property, including, but not limited to, the right to engage in or permit or invite others to engage in, all development, redevelopment, improvement, building and uses of the Property subject to all necessary Federal, State and local approvals required by law.

4. RESTRICTIONS

Any activity on or use of the Conservation Areas by the Declarant, its successors and assigns, inconsistent with the purpose of the Declaration is prohibited. Without limiting the generality of the foregoing, and except for the approved activities under 1.C above, or as necessary to accomplish mitigation approved under the aforementioned permit, the following activities and uses are expressly prohibited in, on, over or under the Conservation Areas, subject to all of the express terms and conditions below:

- A. Structures. The construction of man-made structures on, in, over or above the ground or any water body, including but not**

limited to the construction, removal, placement, preservation, maintenance, alteration, or decoration of any buildings, roads, utility lines, billboards or other advertising. This restriction does not include deer stands, bat boxes, bird nesting boxes, bird feeders, duck blinds, and the placement of signs for safety purposes or boundary demarcation.

- B. **Demolition.** The demolition of fencing structures constructed for the purpose of demarcation of the Conservation Areas or for public safety.
- C. **Soils.** The removal, excavation, disturbance, or dredging of soil, sand, peat, gravel or aggregate material of any kind; or any change in the topography of the land, including any discharges of dredged or fill material, ditching, extraction, drilling, driving of piles, mining, or excavation of any kind.
- D. **Drainage.** The drainage or disturbance of the water level or the water table, except for pre-existing or approved project-related stormwater discharges and any maintenance associated with those stormwater discharges. All pre-existing or approved project-related drainage/stormwater discharge features are shown on Exhibit "B".
- E. **Wastes or Debris.** The storage, dumping, depositing, abandoning, discharging, or releasing of any gaseous, liquid, solid or hazardous waste substance, materials or debris of whatever nature on, in, over or under ground or into surface or ground water, except for pre-existing or approved project-related stormwater discharges and any maintenance associated with those stormwater discharges.
- F. **Non-Native Species.** The planting or introduction of non-native species.
- G. **Herbicides, Insecticides and Pesticides.** The use of insecticides, pesticides, or herbicides or other chemicals, except for as may be necessary to control invasive species that threaten the natural character of the Conservation Areas. State-approved municipal application programs necessary to protect the public health and welfare are not included in this prohibition.
- H. **Removal of Vegetation.** The mowing, cutting, pruning, removal, disturbance, destruction, or the collection of any trees, shrubs, or other vegetation, except for pruning, cutting or removal for:
 - 1) safety purposes; or

- 2) control in accordance with accepted scientific forestry management practices for diseased or dead vegetation;
or
 - 3) control of non-native species and noxious weeds;
or
 - 4) scientific or nature study.
- I. **Agricultural, Livestock and Other Activities.** Unless currently used for these purposes, conversion of, or expansion into, any portion of the Conservation Areas for use for agricultural, horticultural, aqua-cultural, silvicultural, livestock production or grazing activities. This prohibition also includes conversion from one type of these activities to another (e.g., from agricultural to silvicultural).
 - J. **Other Material Impairment.** Other acts, uses or discharges which adversely affect fish or wildlife habitat or the preservation of lands, wetlands or water areas within the Conservation Areas.

5. INSPECTION, ENFORCEMENT AND ACCESS RIGHTS

The USACE, the PADEP, and its/their authorized representatives, shall have the right to enter and go upon the Property, to inspect the Conservation Areas and take actions necessary to verify compliance with this Declaration. When practicable, such entry shall be upon prior reasonable notice to the Declarant, its successors and assigns. The Declarant, its successors and assigns, grants to the USACE, the U.S. Department of Justice, and/or PADEP, a discretionary right to enforce this Declaration in a judicial action against any person(s) or entity(ies) violating or attempting to violate these restrictive covenants: provided, however, that no violation of these restrictive covenants shall result in a forfeiture or reversion of title. In any enforcement action, an enforcing agency shall be entitled to a complete restoration for any violation, as well as any other judicial remedy such as civil penalties. Nothing herein shall limit the right of the USACE to modify, suspend, or revoke the Permit.

6. RECORDING AND EXECUTION BY PARTIES

Declarant agrees to record this Declaration in the Office of the Recorder of Deeds of Delaware County, Pennsylvania and provide the USACE with proof of recordation prior to the start of the work authorized by the attached permit. Declarant executed a prior Declaration of Restrictions (The Prior Declaration of Restrictions), recorded in the Office of the Recorder of Deeds of Delaware County, in Record Book 04277-0537, in connection with a prior permit – State Programmatic General Permit – 2 (PASPGP-2). USACE and PADEP agree that upon recording this Declaration of Restrictive Covenants for Conservation, The Prior Declaration of Restrictions will be extinguished, terminated and marked

satisfied of record. USACE and PADEP agree to execute the documents required by the Office of the Recorder of Deeds of Delaware County, PA, to mark The Prior Declaration of Restrictions extinguished, terminated and satisfied of record.

7. NOTICE OF TRANSFER OF PROPERTY INTERESTS

No transfer of the rights of this Declaration, or of any other property interests pertaining to the Conservation Areas or underlying property it occupies, shall occur without thirty (30) calendar days prior written notice to the PADEP and the USACE.

8. MODIFICATIONS

The restrictions contained in this Declaration are required by the attached Department of the Army Permit. There shall be no changes or alterations to the provisions in this Declaration without prior written approval from the appropriate district commander of the USACE.

9. RESERVED RIGHTS

- A. Declarant and any holders of easements or other property rights for the operation and maintenance of pre-existing or project-related structures or infrastructure such as utilities, drainage ditches, or stormwater facilities that are present, on, over or under the Conservation Areas reserve the right, within the terms and conditions of their permits, their agreements, and the law, to continue with such operation and maintenance. All pre-existing or approved project-related structures or infrastructure shall be shown on the Conservation Area Plan, Exhibit "B" attached hereto.
- B. If the authorized project requires any related or unanticipated utility relocation, drainage ditches, or stormwater controls within the identified Conservation Areas, said activities must be applied for by the Declarant, project proponent, respective utility, or other appropriate party and may be permitted by the USACE.
- C. Declarant, its successors and assigns, accepts the obligation to place any other responsible party on reasonable prior notice of their need to request such permission.

10. SEVERABILITY

If any portion of this Declaration of Restrictive Covenants for Conservation or the application thereof to any person or circumstance, is found to be invalid, the remainder of the provisions of this instrument, or application of such provision to

persons or circumstances other than those as to which it is found to be invalid, as the case may be, shall not be affected thereby.

11. MITIGATION

If the work required by the Mitigation Plan dated March 27, 2009, under the Department of Army permit for the authorized project occurs within the Conservation Areas, then the Declarant, its successors and assigns, is allowed to construct the mitigation work in accordance with the authorized Mitigation Plan, which is incorporated herein by reference thereto.

IN WITNESS WHEREOF, Declarant has executed this Declaration of Restrictive Covenants for Conservation the day and year first above written.

**MARPLE ASSOCIATES,
A PENNSYLVANIA LIMITED PARTNERSHIP**

**BY: _____
Claude de Botton, General Partner**

COMMONWEALTH OF PENNSYLVANIA :
: SS
COUNTY OF :

On October , 2009, before me, a Notary Public for the Commonwealth aforesaid, personally appeared Claude de Botton, who acknowledged himself to be the General Partner of the Grantor, being authorized to do so, executed, in my presence, the foregoing instrument for the purposes therein contained.

IN WITNESS WHEREOF, I have hereunto set my hand and official seal.

Notary Public

My commission expires: _____

(SEAL)

APPROVED AS TO LEGALITY AND FORM

JOSEPH A. DAMICO, JR., ESQUIRE
PENNSYLVANIA LICENSE #08901
ATTORNEY FOR THE GRANTOR

Joseph A. Damico, Jr.

THE STAMP AND SIGNATURE OF THE OFFICE OF
THE RECORDER OF DEEDS OF DELAWARE COUNTY,
PENNSYLVANIA, WILL BE PLACED ON THE DECLARATION.

Appendix N
Drainage Maps
(Attached To Report)