SECTION 5

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STORMWATER REPORT

SITE DEVELOPMENT PERMITTING
14 STERLING ROAD
BILLERICA, MA 01862

Prepared For:

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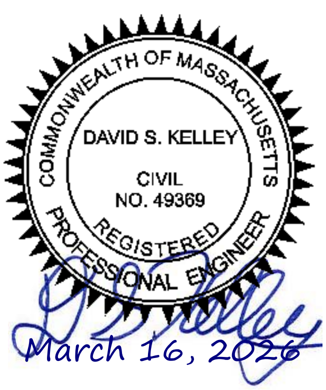
CEC Project 347-159



MARCH 2026

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1.0 PROJECT NARRATIVE

1.1 INTRODUCTION

On behalf of Sterling Road, LLC (the "Applicant"), Civil & Environmental Consultants, Inc. (CEC) has prepared this stormwater report and analysis to demonstrate compliance with the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards and the Town of Billerica Stormwater Management Policy. This Stormwater Management Report describes the proposed design as depicted on the Site Plans prepared by CEC, dated March 2026.

The Applicant plans to develop a portion of a parcel of land located at 14 Sterling Road, in Billerica, Massachusetts (the "Site"). The project includes importing soil fill to expand the existing gravel contractor yard (construction equipment staging area) and construct associated stormwater improvements (the "Project").

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1.2 EXISTING CONDITIONS

1.2.1 Site Overview

The approximately 23-acre site is located at 14 Sterling Road in Billerica, Massachusetts (Parcel ID 38-28-3), and is located within the Industrial Zoning District as identified on the Town of Billerica Zoning Map. The Applicant previously developed a portion of the Site into a Contractors Yard by constructing the corporate headquarters and operations facility that exists today, which consists of two commercial/industrial buildings, a fueling station, outdoor equipment staging areas, and associated features such as paved drives, paved employee parking, gravel construction equipment staging areas, a soil absorption system (SAS), a stormwater management system including two infiltration basins and other ancillary subsurface utilities. The existing site conditions include approximately 1.3 acres of roof area associated with the two existing buildings, approximately 2.6 acres of paved impervious areas associated with the access drives and pedestrian walkways, and gravel surfaces within the outdoor equipment staging areas.

Bordering vegetated wetland (BVW) resource areas and intermittent streams exist on the site and nearby on the abutting property to the west. In general, the BVW and associated buffer zones extend along the western property boundary. The existing wetland resource area was initially delineated by Tighe & Bond, Inc. in 2016 and approved by the Billerica Conservation Commission (BCC) with the issuance of an Order of Resource Area Delineation (ORAD) on October 31, 2016 (DEP #109-1304/BBL #1304). The initial site development included filing a Notice of Intent with the BCC due to proposed disturbances within the 100-foot buffer zone to the BVW. Site features originally permitted within the 100-foot buffer zone include the western stormwater management basin, a concrete block retaining wall, and 2H:1V fill slopes abutting the wall on either side. The BCC approved the project and issued an Order of Conditions (OOC) on February 14, 2018. The certificate of compliance for the aforementioned OOC was issued on April 16, 2025. Subsequently, an additional study of the existing resource area was performed by Three Oaks Environmental in 2025 and an updated resource area delineation was submitted to the BCC in an Abbreviated Notice of Resource Area Delineation (ANRAD) submittal prepared by CEC and dated July 22, 2025. Following peer review, the BCC approved the updated delineation with the issuance of an ORAD dated November 17, 2025 (DEP #109-1603/BBL #1603). This updated, and approved, resource area delineation is shown on the accompanying Site Plans prepared by CEC.

Currently, stormwater runoff from the undeveloped portion of the site flows westerly overland and off-site towards the abutting wooded area and the BVW to the southwest of the Site. Stormwater runoff from the developed eastern portion of the site flows through the existing on-site stormwater management system. Deep sump and hooded catch basins, located throughout the Site, collect surface runoff and convey the flow to the existing stormwater basins. Stormwater runoff from existing paved areas flows through these catch basins and through water quality units before discharging into the stormwater basins. The existing eastern stormwater basin stores and infiltrates all incoming flow. The existing western stormwater basin infiltrates incoming flow and also includes an outlet control structure (OCS) to attenuate peak flows. Stormwater in excess of the storage and infiltration capacity of the existing western basin is discharged through the OCS towards the wooded area and BVW to the south of the Site.

1.2.2 Geotechnical Conditions

According to the Natural Resources Conservation Service (NRCS) Web Soil Survey, the surficial soils at the site are classified as Urban Land (#602) and a variety of fine sandy loams (Ridgebury, Paxton, and Woodbridge, #71B, #307B, and #311B, respectively). Urban land refers to land that has been excavated and filled. The fine sandy loam profiles refer to coarse-loamy lodgment till derived from gneiss, granite, and/or schist.

Based on the review of the geotechnical conditions for the Site, two hydrologic soil groups (HSGs) were utilized in the hydrologic analysis, HSG C and HSG D. HSG C was only utilized in areas classified as Paxton fine sandy loam (#307B), as indicated on the NRCS soil report.

Test pits were previously completed by Tighe & Bond to verify the estimated seasonal high groundwater elevation as well as characteristics of the in-situ soil. The results of the test pit observations were included on the Notice of Intent site plans prepared by Tighe & Bond and approved by the BCC with the issuance of the order of conditions, as described in Section 1.2.1. The data indicates that the in-situ soil is classified as loamy sand; therefore, an infiltration rate of 2.41 inches per hour (i.e. the Rawl's rate for loamy sand) was utilized for design purposes in accordance with the Massachusetts Stormwater Handbook. Groundwater elevations were determined to be approximately 36 inches to 48 inches below existing grade based on redoximorphic features observed in the in-situ soil.

Refer to Appendix D for the NRCS Soil Information and Test Pit Logs. The test pit locations and the results of the soil test pit logs are shown on CEC's Site Plans (sheets C400 & C401)for reference.

1.2.3 Flood Zone

The Site is not located within any Special Flood Hazard Areas (SFHA) as shown on the Federal Emergency Agency (FEMA) Flood Insurance Rate Map (FIRM) for Middlesex County, Map #25017C0258F, effective July 7, 2014. Refer to Figure 3 for the FEMA Flood Insurance Rate Map Firmette.

1.2.4 Watershed Basin

The Site is located within the watershed of the Concord River (MA82A-07). Stormwater runoff from the site, after being routed through the on-site stormwater management system, generally flows to the south and through a series of tributary wetlands, streams, and brooks before flowing through Greenough Pond in Carlisle and joining the Concord River. The EPA classifies the Concord River as an impaired waterbody, and the MassDEP has imposed total maximum daily load (TMDL) for the impairment related to pathogens (*E. coli*, fecal coliform).

The project does not include any untreated discharges from sanitary sewer waste; therefore, we do not anticipate the proposed project would contribute to any existing impairments of the Concord River watershed. Stormwater discharges associated with the project are treated in accordance with applicable MassDEP and Billerica stormwater performance standards and requirements, as described in Section 4.0 of this report.

1.3 PROPOSED PROJECT

The Project includes clearing approximately 5.6 acres of wooded area and importing an estimated 97,000 cubic yards of fill soil in order to construct an earthen pad, to be used to expand the existing Contractor Yard area, and associated stormwater management infrastructure. The earthen pad will include a compacted gravel surface and will be used to expand the existing contractor yard for general equipment and material staging. There are no new paved areas proposed as a part of this project; however, the proposed gravel surface is expected to consist of a densely graded aggregate designed to minimize rutting and therefore has been modeled as an impervious surface for the purposes of the stormwater analysis and supporting calculations. The slope of the proposed ground surface within the land use area will vary from a minimum slope of one percent to a maximum slope of five percent. The exterior sides of the earthen pad will extend downward to existing grade at a maximum slope of 2H:1V, which will be stabilized with compacted rip-rap. The project also involves the filling of the existing western stormwater basin; therefore, the proposed stormwater management system also includes the installation of 240 subsurface pre-cast concrete infiltration chambers, located within the footprint of the now filled in western stormwater basin. Vehicular access to the Site and the newly developed area will be provided by the existing paved facility entrance drive located at 14 Sterling Road and the existing paved and unpaved access routes throughout the existing facility.

Similar to the previously permitted site development, the proposed project will include alterations and associated disturbances within the 100-foot buffer zone to the nearby BVW. To ensure that the Project is in compliance with the BCC fifty-foot no-disturbance wetland buffer, no work or disturbance is proposed within fifty feet of the existing resource areas. The proposed site features which are located within the 100-foot buffer zone include portions of the new stormwater infiltration basin and associated outlet control structure, as well as portions of the proposed earthen pad and gravel areas, including the perimeter 2H:1V slopes which will be stabilized with compacted rip-rap.

New stormwater management improvements will be constructed as part of the proposed development that will provide stormwater quality improvements and provide stormwater detention and recharge, meeting the Massachusetts Department of Environmental Protection Stormwater Standards and the Town of Billerica Stormwater Requirements as described herein.

2.0 STORMWATER MANAGEMENT SYSTEMS

2.1 DESCRIPTION OF RUNOFF CONTROLS

The stormwater management improvements consist of components designed to manage runoff from the Site. These components attenuate runoff discharge peaks, provide groundwater recharge, minimize erosion, minimize the transport of sediments, improve water quality, and minimize impacts to downstream resource areas.

The stormwater management system implements treatment trains of the Best Management Practices designed to meet an average annual pollutant removal equivalent of ninety (90) percent of the average annual load of total suspended solids (TSS) and sixty (60) percent of the average annual load of Total Phosphorous (TP) related to the total postconstruction impervious surface area on the site, in accordance with the Massachusetts Department of Environmental Protection Stormwater Management Standards and Billerica Stormwater Management Regulations. The proposed stormwater management system will implement the following specific control measures:

- Proprietary particle separators (Contech Cascade Separator® water quality units): The Cascade Separator® Water Quality Units provide efficient removal of free oils, debris, and total suspended solids (TSS). Although not the main objective of the water quality unit, some removal of heavy metals and other nutrients is also achieved. Runoff from the compacted gravel and impervious areas of the Site will be directed to the water quality units to receive the required pre-treatment before being routed through the infiltration features (either the subsurface concrete infiltration chambers or the infiltration basin) before eventually discharging off-site. The water quality units allow for safe and easy removal of collected material and should be inspected and cleaned in accordance with the Operations and Maintenance (O&M) Plan and per manufacturer's recommendations. See the O&M Plan included in Appendix A of this report for supporting information.

- Subsurface Pre-Cast Concrete Storage and Infiltration Chambers: Stormwater runoff, which currently flows to the existing western stormwater basin, consists of clean runoff from the roof of the maintenance facility and runoff from the impervious areas surrounding the facility, will be routed to an open bottom, subsurface infiltration system comprised of pre-cast concrete chambers and crushed stone. The pre-cast concrete chambers are manufactured by Retain-It®. These pre-cast concrete subsurface infiltration chambers are proposed to be located within the approximate footprint of the existing western stormwater basin. The runoff from the Project will be conveyed to these subsurface pre-cast concrete chambers through a series of deep sump and hooded catch basins and culvert pipes. Runoff from the impervious areas around the facility will be routed through the existing water quality unit (WQU-P4) before discharging into the pre-cast concrete infiltration chambers.

Similarly, runoff from the northern portion of the proposed compacted gravel area will be collected within deep sump and hooded catch basins and routed through a new water quality unit (WQU-P6) before discharging into the subsurface concrete infiltration chamber system. The subsurface concrete infiltration chamber system has been sized for design storm events up to and including the 24-hour, 100-year storm event. Stormwater flow in excess of the infiltration capacity of the chamber system will discharge off-site through a new outlet control structure, associated piping, and a flared end section with a rip-rap level spreader. The use of these pre-cast concrete chambers for treatment of stormwater is accepted as a good practice and is in accordance with sound professional standards. See Appendix F6 of this report for supporting information.

- Infiltration basin: Infiltration basins reduce runoff volume, remove fine sediment and associated pollutants, recharge groundwater, and provide attenuation of peak flows. Infiltration basins are stormwater impoundments designed to capture and infiltrate, at a minimum, the water quality volume over several days, but do not retain a permanent pool. The proposed infiltration basin will be vegetated with loam and vegetative cover to reduce soil erosion and scouring of the basin.

  One new infiltration basin is proposed for the Project, located at the southern edge of the new development area, north of the existing SAS leaching field. Water quality and pre-treatment will be provided by deep sump hooded catch basins and the proposed proprietary water quality unit (WQU-P5) prior to discharge into the proposed infiltration basin. The bottom of the infiltration basin has been designed to provide a minimum of 2-feet of separation from the estimated seasonal high groundwater elevation. The basin has been sized to contain design storm events up to and including the 24-hour, 100-year storm event with runoff discharging through a new outlet control structure, associated piping, and flared end section with a rip-rap level spreader. An emergency rip-rap spillway channel has been provided to safely pass stormwater in the event the outlet control structures become clogged or otherwise fail, or in the event of an extreme storm which produces runoff in excess of the 24-hour, 100-year design storm event or the outlet structure capacity.

- Rip-rap Outlet Protection/Lever Spreaders: Rip-rap outlet protection will be placed at each stormwater outfall to reduce flow rates and velocities to non-erosive velocities to prevent erosion to the adjacent undisturbed lands and to transition the outlet flow to the natural topography where appropriate.

2.2 CONSTRUCTION SEQUENCE PLAN

The purpose of the Construction Sequence Plan is to develop an approximate working schedule for the implementation of the proposed stormwater improvements. Prior to initiating work, the siltation control barriers will be installed along the limit of work. After the appropriate permits are obtained, and the siltation control barriers are inspected and approved by the appropriate entities, the construction project will commence in the following sequence:

1. Install necessary siltation barriers as shown on the design drawings, installed before any work commences.
2. Perform tree clearing, grubbing, and topsoil removal as shown on the Site Plans.
3. Relocate the existing post and rail fence with conservation signage to the limit of work as shown on the Site Plans.
4. Construct the temporary sediment basin as shown on the interim stormwater control plan.
5. Install the proposed stormwater infrastructure necessary to re-route stormwater flow from the existing infiltration basin to the temporary sediment basin as shown on the interim stormwater control plan.
6. Install the subsurface concrete infiltration chamber system, outlet control structure, outlet culvert pipe, flared end section and rip-rap level spreader, placing fill as needed along the outlet culvert alignment.
7. Construct the new infiltration basin and associated pre-treatment infrastructure as shown on the design drawings.
8. Install the outlet control structure, outlet culvert pipe, flared end section and rip-rap level spreader, placing fill as needed along the outlet culvert alignment.
9. Place fill soils and install the dense-grade gravel surface to achieve the finish grades of the earthen pad, as shown on the Site Plans.
10. Install proposed final landscaping, including topsoil and seed within grassed areas and compacted riprap stabilization on the 2H:1V slope along the perimeter of the earthen pad.
11. Only with approval from the appropriate entities, remove existing erosion control measures upon achieving site stabilization.

Construction-period runoff will be collected and treated in accordance with the Construction Period Pollution Prevention and Erosion & Sediment Control Plan included in Appendix B of this report.

2.3 DEWATERING

Groundwater is not anticipated to be encountered during earthwork operations at the site and dewatering is not expected to be necessary. However, should dewatering be required, the contractor is to perform dewater in accordance with local, state and federal dewatering requirements.

3.0 STORMWATER ANALYSIS

3.1 METHOD OF ANALYSIS

A hydrologic analysis has been performed for the Site comparing existing conditions (pre-development) and proposed conditions (post-development) conditions using a software program developed by HydroCAD. This program analyzes site hydrology by the graphic peak discharge method documented in Technical Release No. 20 and Technical Release No. 55 published by the United States Department of Agriculture (USDA) Soil Conservation Service.

The following variables were developed for the contributing watersheds (drainage areas) in order to complete the analysis:

- **Rainfall Depth:** A hydrologic analysis was performed for the 24-hour 2-year, 10-year, 25-year, and 100-year, using the Atlas-14, Type III storm events (3.19, 4.99, 6.11, and 7.85 inches respectively) for each drainage area. Refer to Atlas Rainfall Data in Appendix F1 of this report for additional information.

- **Runoff Curve Number (RCN):** The RCN is a hydrologic characteristic that contributes to the peak rate of runoff and volume from a given storm event. It is dependent upon soil conditions and land use. Generally, higher curve numbers are associated with less pervious soils and, hence, greater amounts of runoff. As previously noted in this report, based on the review of the NRCS Web Soil Survey and results of the onsite geotechnical soil borings, Hydrologic Soil Groups C and D were used in determining RCNs for the existing onsite soils. The HSG is not relevant within existing and proposed impervious areas as the runoff curve number of 98 is controlled by surface conditions and is not impacted by the underlying soil conditions.

- **Time of Concentration (Tc):** The Tc is defined as the time it takes runoff to travel from the hydraulically most distant part of the watershed to the downstream point of interest. This parameter is dependent on the characteristics of the ground surface and condition of the travel path. Times of concentration were calculated for the various drainage areas using the HydroCAD program, with a minimum Tc of six (6) minutes used in accordance with the protocol outlined in Technical Release No. 55.

3.2 DRAINAGE AREAS

To perform the stormwater analysis, the contributing drainage areas for pre-development (existing) and post-development (proposed) conditions were delineated. The delineation of the drainage areas was determined by the topography depicted on the Existing Conditions Plan and on the

Proposed Site Plans. Descriptions of the pre-development and post-development drainage areas are as follows:

- **Pre-Development:** The Site was evaluated for pre-development conditions prior to the commencement of the construction of the Project. Available aerial imagery and topographic information from the Existing Conditions Plan were used to identify the cover types and pre-development drainage patterns. The Site is comprised of four (4) pre-development drainage areas and the stormwater runoff was evaluated for one (1) design point; the existing intermittent stream located southwest of the Site (Design Point A). The existing infiltration basin was modeled using available record and as-built information of the basin geometry and outlet control structure. Refer to Figure HYD-PRE, Appendix E1 of this report, for the pre-development conditions drainage areas. A summary of pre-development drainage areas are listed below:

Table 3-1: Pre-Development Conditions

PRE -DEVELOPMENT CONDITIONS				
Drainage Area	**Design Point**	**Area (ac.)**	**Weighted Curve Number**	**Time of Concentration (minutes)**
X-A1	DP-A (Existing Intermittent Stream)	4.841	91	5.7
X-A2		2.371	71	12.4
X-A3		3.046	72	20.0
X-A4		2.647	76	9.8

- **Proposed Conditions:** The Site was evaluated under proposed conditions following the completion of the proposed project. Proposed information and topography from the proposed Site Plans was used to identify the cover types and the post-development drainage patterns. As proposed, the Site is comprised of twelve (12) post-development drainage areas. Stormwater runoff from the perimeter portions of the Site will remain unchanged and will either continue to flow unmitigated or will be collected and routed through the new infiltration basin or through the proposed subsurface pre-cast concrete chamber infiltration system prior to discharging off-site to the intermittent stream (Design Point A). Stormwater runoff from the roof of the existing maintenance facility will be routed directly to the proposed subsurface pre-cast concrete chamber infiltration system. Runoff from existing paved areas around the facility will continue to be routed through the existing deep sump hooded catch basins and the existing water quality unit (WQU-P2) before discharging to the proposed subsurface pre-cast concrete chamber infiltration system. Refer to Figure HYD-POST, Appendix E2 of this report, for the proposed conditions drainage areas map. A summary of post-development drainage areas are listed below:

Table 3-2: Post-Development Conditions

POST -DEVELOPMENT CONDITIONS				
Drainage Area	**Design Point**	**Area (ac.)**	**Curve Number**	**Time of Concentration (minutes)**
P-A1	DP-A (Existing Intermittent Stream)	2.999	97	6.0
P-A2a		0.275	96	6.0
P-A2b		0.606	98	6.0
P-A2c		0.946	98	6.0
P-A3a		0.905	98	6.5
P-A3b		0.372	97	6.0
P-A3c		1.014	98	6.6
P-A3d		1.023	98	6.5
P-A3e		0.787	97	6.0
P-A4		1.322	88	6.0
P-A5		1.813	87	6.0
P-A6		0.844	79	6.0

3.3 RESULTS OF ANALYSIS

A stormwater analysis was performed for the 24-hour 2-year, 10-year, 25-year, and 100-year storm events. Based on the calculations, it has been determined that there will not be an increase in stormwater runoff discharge rates off-site after the proposed construction is complete and after the stormwater management system components, including the subsurface infiltration system, are properly installed. Detailed stormwater calculations are included in Appendix E of this report. Compliance for pre-development and post-development conditions was evaluated at Design Point A. Peak stormwater rates of runoff for pre- and post-development conditions are summarized in Table 3.3 below.

Table 3-3: Project Stormwater Runoff Rates

PEAK RUNOFF RATES (cfs)								
	2-Year		10-Year		25-Year		100-Year	
Design Point	Ex.	Prop.	Ex.	Prop.	Ex.	Prop.	Ex.	Prop.
DP-A	6.39	3.96	16.25	7.96	25.82	16.85	38.34	32.36

3.3.1 Hydrology

The proposed drainage infrastructure has been designed to convey storm events up to and including the 24-hour, 100-year storm event. Refer to the post-development HydroCAD report output provided in Appendix E2 of this report for supporting calculations.

3.3.2 Interim Conditions

As described in Section 2.2 of this report, interim stormwater controls are proposed as part of the proposed development to manage stormwater flows from the existing maintenance facility area during construction of the new subsurface concrete infiltration chamber system. The interim stormwater design consists of installing several drainage manholes and a combination of permanent and temporary culvert pipes to re-direct stormwater flows from the existing basin to a temporary sediment basin located to the southeast of the proposed expanded contractor yard. The interim stormwater basin has been designed to control and attenuate peak flow rates from the design storm events up to and including the 25-year, 24-hour storm event. Supporting calculations for the design of the interim stormwater basin are provided in Appendix E3 of this report.

3.3.3 Future Conditions

The proposed stormwater management system has been designed and sized to accommodate potential future development of the facility, which would not expand the limits of disturbance beyond those shown on the accompanying Site Plans, while still maintaining peak rates of runoff below the proposed post-development conditions shown in these calculations. At this time, the Applicant does not have any immediate plans to proceed with the future development of the Site.

4.0 STORMWATER CONTROL SYSTEM DESIGN CRITERIA

4.1 MASSDEP STORMWATER MANAGEMENT POLICY

Stormwater discharge from the proposed Project is subject to the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Policy (the Policy). The Policy is designed “to protect the wetlands and waters of the Commonwealth from adverse impacts of storm water runoff.” To accomplish this goal, the Policy establishes ten performance standards to control stormwater quantity and quality. These standards establish the level of required controls that can be achieved with site planning, structural and non-structural controls, and other best management practices (BMPs). The MassDEP Stormwater Checklist is provided in Appendix C of this report. Stormwater modeling methodology is discussed in detail in Section 3.0 of this report. Results of the stormwater modeling of the existing and proposed conditions are provided in Appendix E of this report.

4.1.1 MassDEP Stormwater Management Standards

The following section documents compliance with the MassDEP Stormwater Management Standards.

Standard 1
No new stormwater conveyances (e.g., outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

The project is designed so that there are no new stormwater conveyances that could discharge untreated stormwater into, or cause erosion to, wetlands or waters of the Commonwealth. Outlet protection from pipe discharges have been designed to provide non-erosive velocities prior to discharging to natural grade or vegetated surfaces. The stormwater management system has been designed to provide water quality treatment providing TSS removal for impervious areas in accordance with the Policy.

Standard 2
Stormwater management systems must be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. This Standard may be waived for discharges to land subject to coastal storm flowage as defined in 310 CMR 10.04.

The post-development peak discharge rates do not exceed pre-development peak discharge rates for the 24-hour, 2-, 10-, 25-, and 100-year design storm events. Stormwater modeling methodology is discussed in detail in Section 3.0 of this report. The model outputs are provided in Appendix E of this report. Summaries of the model results are provided above in Table 3-3 Project Stormwater Runoff Rates.

Standard 3

Loss of annual recharge to groundwater should be minimized through the use of infiltration measures to the maximum extent practicable. The annual recharge from the post-development site should approximate the annual recharge from the pre-development or existing site conditions, based on soil types.

The project is designed to comply with this criterion. The Project will result in the addition of approximately 5.8 acres of new compacted dense grade gravel area, which, to be conservative, was modeled and treated as impervious areas for the purposes of demonstrating compliance with the Policy. In accordance with the stormwater standards, 0.25-inches of recharge must be provided for the increase in impervious areas on the Site for HSG C soils and 0.10-inches for HSG D soils. Accordingly, a total of 13,303 cubic feet (cf) of groundwater recharge is required based on the increase of 'impervious areas' within each HSG. The proposed subsurface pre-cast concrete infiltration chambers provide a total of 36,642 cf of groundwater recharge, which exceeds the regulatory minimum requirement. Refer to the Groundwater Recharge Calculations in Appendix F3 of this report for supporting calculations.

Based on the soil analysis, an infiltration rate of 2.41 inches per hour was utilized for the proposed subsurface pre-cast concrete infiltration chamber system as well as the infiltration basin. Each of the infiltration systems have been designed to provide the drawdown of stormwater below the low flow outlets in less than 72 hours. Refer to the Groundwater Recharge Calculations in Appendix F3 of this report for supporting calculations.

Standard 4

For new development, stormwater management systems must be designed to remove 80% of the average annual load (post-development conditions) of Total Suspended Solids (TSS). It is presumed that this standard is met when:

A. *Suitable nonstructural practices for source control and pollution prevention are implemented;*
B. *Stormwater management best practices (BMPs) are sized to capture the prescribed runoff volume; and*
C. *Stormwater management BMPs are maintained as designed.*

In accordance with Massachusetts Stormwater Standards and with the Town of Billerica Stormwater Management Regulations for new development, the project has been designed to remove a minimum of ninety (90) percent of the average annual load of TSS. The project utilizes several methods of storm water management devices to reduce TSS generation including existing deep sump hooded catch basins, an existing proprietary water quality unit, new proprietary Contech water quality units, new subsurface pre-cast concrete infiltration chambers, and a new infiltration basin, consistent with the regulations set forth in the Policy. The estimated TSS removal rate from the proposed BMP treatment train for each system meets or exceeds the ninety (90) percent requirement. Refer to the TSS Removal Calculation Worksheets in Appendix F4 of this report for supporting calculations.

A comprehensive Stormwater Management Operations and Maintenance Plan (O&M) has been developed and is included in Appendix A of this report.

In accordance with Massachusetts Stormwater Standards and with the Town of Billerica Stormwater Management Regulations, the project has been designed to meet the annual pollutant removal requirements by removing a minimum of ninety (90) percent of the average annual load of TSS, as described above, and by infiltrating one (1) inch of runoff from impervious areas, as detailed under Standard 3 of this report. Refer to the Groundwater Recharge Calculations, in Appendix F3 of this report for supporting calculations.

Standard 5

Stormwater discharges from areas with higher potential pollutant loads require the use of specific stormwater management BMPs. The use of infiltration practices without pre-treatment is prohibited.

The Site includes uses that may be considered Land Uses with Higher Potential Pollutant Loads (LUHPPL). Accordingly, the proposed stormwater management system has been designed to treat the one (1) inch Water Quality Volume and provide forty-four (44) percent TSS removal pre-treatment prior to infiltration. Pretreatment for the subsurface pre-cast concrete infiltration chamber system is provided by utilizing deep sump hooded catch basins and proprietary water quality units (WQU-P2, existing, and proposed WQU-P6). Pretreatment for the proposed infiltration basin is provided by the implementation of a sediment forebay and new proprietary water quality unit (WQU-P5). Refer to the Water Quality Flow Rate Calculations and the TSS Calculation Worksheets, in Appendix F2 and F4 of this report, respectively, for supporting calculations.

Standard 6

Stormwater discharges to critical areas must utilize certain stormwater management BMPs approved for critical areas. Critical areas are Outstanding Resources Waters (ORWs), shellfish beds, bathing beaches, cold water fisheries, and recharge areas for public water supplies.

This project does not discharge to critical areas.

Standard 7

Redevelopment of previously developed sites must meet the Stormwater Management Standards to the maximum extent practicable. Where it is not practicable to meet all the Standards, new (retrofitted or expanded) stormwater management systems must be designed to improve existing conditions.

The project fully complies with the MassDEP Stormwater Standards.

Standard 8

Erosion and sediment controls must be implemented to prevent impacts during construction, or land disturbance activities.

Erosion and sediment controls are integral to the Project improvements. The erosion control plan includes silt fence with straw bales which will be installed down-gradient of the proposed work area as well as around the perimeter of the work area. Catch basin silt sacks will also be installed within existing catch basins located on-site and adjacent to the work area that could potentially receive stormwater flows during construction. Additionally, temporary stabilized construction exits will also be installed at the access points between the proposed work area and the existing Site. The Project's Erosion and Sediment Control Plan will be followed throughout the duration of construction. The measures contained therein will be utilized to prevent erosion, control sediments, and stabilize exposed soils. Refer to the Construction Period Pollution Prevention and Erosion & Sediment Control Plan, in Appendix B of this report as well as the accompanying Site Plans for detailed erosion control information.

Standard 9

All stormwater management systems must have an operations and maintenance plan to ensure that systems function as designed.

A comprehensive Stormwater Management Operations and Maintenance Plan (O&M) has been developed. The Manufacturer's O&M Procedures for the proprietary water quality units and stormwater chambers are included in the O&M Plan for reference. Refer to the Stormwater Management Operations and Maintenance Plan, in Appendix A of this report for additional information pertaining to the Site's O&M Plan.

Standard 10

All illicit discharges to the stormwater management system are prohibited.

There are no illicit discharges at the Site. If found, any illicit discharges will be eliminated, and the Project will not be constructed with any illicit connections. A draft of the Illicit Discharge Statement is provided in Appendix F7 of this report.

4.2 BILLERICA STORMWATER MANAGEMENT POLICY

In addition to compliance with the MassDEP Policy, described above in Section 4.1.1, the Project's stormwater discharge is also subject to the Town of Billerica stormwater regulations, promulgated under the Board of Health Rules and Regulations, Chapter 6: Stormwater Management Regulations. Performance standards for stormwater management systems are specified in §6.7.

The following section documents compliance with the Town of Billerica stormwater performance standards.

§6.7.001 *At a minimum, stormwater management shall be designed in accordance with the requirements of the NPDES Small MS4 General Permit for Massachusetts and the Stormwater Management Standards described in the Stormwater Handbook using current Best Management Practices (BMP). In case of conflicting requirements with applicable federal and state statutes and regulations, the more restrictive or more protective of human health and the environment shall take precedence. The applicant must submit the computations required to document compliance with the Standards as described in Volume 3, Chapter 1 of the Stormwater Handbook as amended.*

Refer to Section 4.1.1 for descriptions of how the proposed project complies with the Massachusetts Stormwater Management Standards. Supporting calculations for compliance with these standards are provided in Appendix F of this report.

§6.7.002 *The applicant may propose alternative BMPs not listed in the Stormwater Handbook, subject to a full technical review and approval by the Board of Health and/or its agent. The performance of specific proprietary commercial devices and systems must be provided by the manufacturer and shall be verified by independent third-party sources and data, such as through International Stormwater BMP Database. The Board of Health and/or its agent will use the process established by the D.E.P. in the Stormwater Handbook to approve or deny the use of proprietary BMPs.*

The proposed project utilizes proprietary stormwater treatment devices consisting of Cascade Separators manufactured by Contech. Performance and design criteria for each device are provided in the Contech Water Quality Unit Documentation section in Appendix F6 of this report.

§6.7.003 *All stormwater from public rights of way, LUHPPLs, impervious areas within Industrial, Industrial Park, Commercial, and Highway Business Zoning Districts, and where a potential pollution problem exists, as deemed by the Board of Health and/or its agent, shall pass through a pre-treatment device to reduce oil, sediment, and trash loadings. All stormwater treatment devices within LUHPPL's shall be fitted with emergency shut-off valves where appropriate to isolate the* *system in the event of an emergency spill or other unexpected event. All stormwater treatment devices shall have a convenient vehicular access and if necessary a twenty foot (20') wide access easement. All stormwater shall be conveyed in ditches or storm drain lines to stormwater BMPs for water quality treatment, infiltration, and/or flow attenuation. Permanent easements and provisions for vehicular access shall be provided along the entire length of ditches and storm drain lines.*

The proposed land use is classified as a LUHPPL; therefore, stormwater runoff is routed through pre-treatment devices prior to discharge into the proposed subsurface pre-cast concrete chamber infiltration system or the two infiltration basins. Emergency shut-off valves are proposed to be installed in select stormwater structures, where appropriate, and located to provide for convenient vehicular access. Refer to the accompanying Site Plans for the types and locations of these emergency shut-off valves.

§6.7.004 Lot Drainage

(1) Lots shall be prepared and graded in such a manner that development of one shall not cause detrimental drainage on another, into the Right-of-Way, or add runoff to the MS4; if provision is necessary to carry drainage to or across a lot, an easement or drainage right-of-way of a minimum width of twenty feet (20') with additional allowance as needed for proper side slope shall be provided.

(2) The Applicant shall furnish evidence that adequate provision has been made for the proper drainage of surface and underground waters from any lot or lots. Use of on-lot drywells for disposal of roof runoff is encouraged. Stormwater shall not discharge overland across lot lines. Drainage conveyances and easements shall be provided to convey stormwater to the nearest permanent stream or municipal drainage system after being treated for impairments. Any connection to the MS4 will require a stormwater review by the DPW and associated permits.

As previously described in Section 2.1 of this report, the proposed project includes various stormwater management features to control runoff and attenuate peak stormwater runoff rates and flows prior to discharging off-site. The project does not discharge stormwater directly into a municipal right-of-way or an MS4.

§6.7.005 General Criteria

All projects and activities that meet the Scope and Applicability of Section 1 of the Stormwater Management By-law must meet the following general performance criteria unless otherwise provided for in these Regulations:

(1) LID site planning and design strategies must be utilized to the maximum extent feasible.

(2) The selection, design and construction of all pre-treatment, treatment and infiltration BMPs shall be in accordance with Massachusetts Stormwater Handbook as amended, and

shall be consistent with all elements of the Massachusetts Stormwater Standards including but not limited to those regarding new stormwater conveyances, peak runoff rates, recharge, land uses with higher potential pollutant loads, discharges to Zone II or interim wellhead protection areas, sediment and erosion control, reduction of the creation of impervious area, and illicit discharges.

(3) Tree Protection and Preservation. Trees can be an important tool for retention and detention of stormwater runoff. Trees provide additional benefits, including cleaner air, reduction of heat island effects, carbon sequestration, reduced noise pollution, reduced pavement maintenance needs, and cooler cars in shaded parking lots. The Town therefore deems that the preservation and protection of certain trees on private property and the effort to replant trees to replace those removed to the extent practicable are public purposes that protect the public health, welfare, environment, and aesthetics.

To comply with the intent of the Billerica Stormwater Management Policy to the maximum extent feasible, implementation of LID techniques and devices, the Project proposes the installation of a subsurface pre-cast concrete chamber infiltration system. This subsurface infiltration system reduces the amount of land needed to be disturbed for the Project and reduces the impacts to the nearby natural vegetation. In addition, the proposed open air infiltration basins provide smaller footprints than the typical wet detention basins and therefore they reduce the alteration of natural vegetation required to create the Projects stormwater management system.

As described above in Section 4.1.1. of this report, the BMPs used in the Project are designed in accordance with Massachusetts Stormwater Handbook design requirements.

The Project will provide a fifty (50) foot buffer to on-site resource areas, in an attempt to preserve as much of the on-site vegetation as is practicable, while complying with applicable State and local regulations and creating a Project that meets the needs and requirements of the Applicant.

§6.7.006 Performance Standards for New Development

(1) Stormwater management systems on new development shall be designed to meet an average annual pollutant removal equivalent to 90% of the average annual load of Total Suspended Solids (TSS) related to the total post-construction impervious area on the site AND 60% of the average annual load of Total Phosphorus (TP) related to the total postconstruction impervious surface area on the site. Average annual pollutant removal requirements shall be achieved through one of the following methods:

   i. installing stormwater BMPs that meet the pollutant removal percentages required in 6.7.007 (1) based on calculations developed consistent with E.P.A. Region 1's BMP Accounting and Tracking Tool (2016) or other BMP performance evaluation tool provided by E.P.A. Region 1, where available. If E.P.A. Region 1 tools do not address the planned or installed BMP performance, then any federally or State-approved

BMP design guidance or performance standards (e.g., State stormwater handbooks and design guidance manuals) may be used to calculate BMP performance; or

ii. *retaining the volume of runoff equivalent to, or greater than, one (1.0) inch multiplied by the total post-construction impervious surface area on the new development site; or meeting a combination of retention and treatment that achieves the above standards.*

The proposed infiltration features are designed to retain and infiltrate the volume of runoff equivalent to one inch of runoff from the total post-construction impervious surfaces. Refer to Section 4.1.1, Standard 4, of this report for additional information pertaining to compliance with this standard.

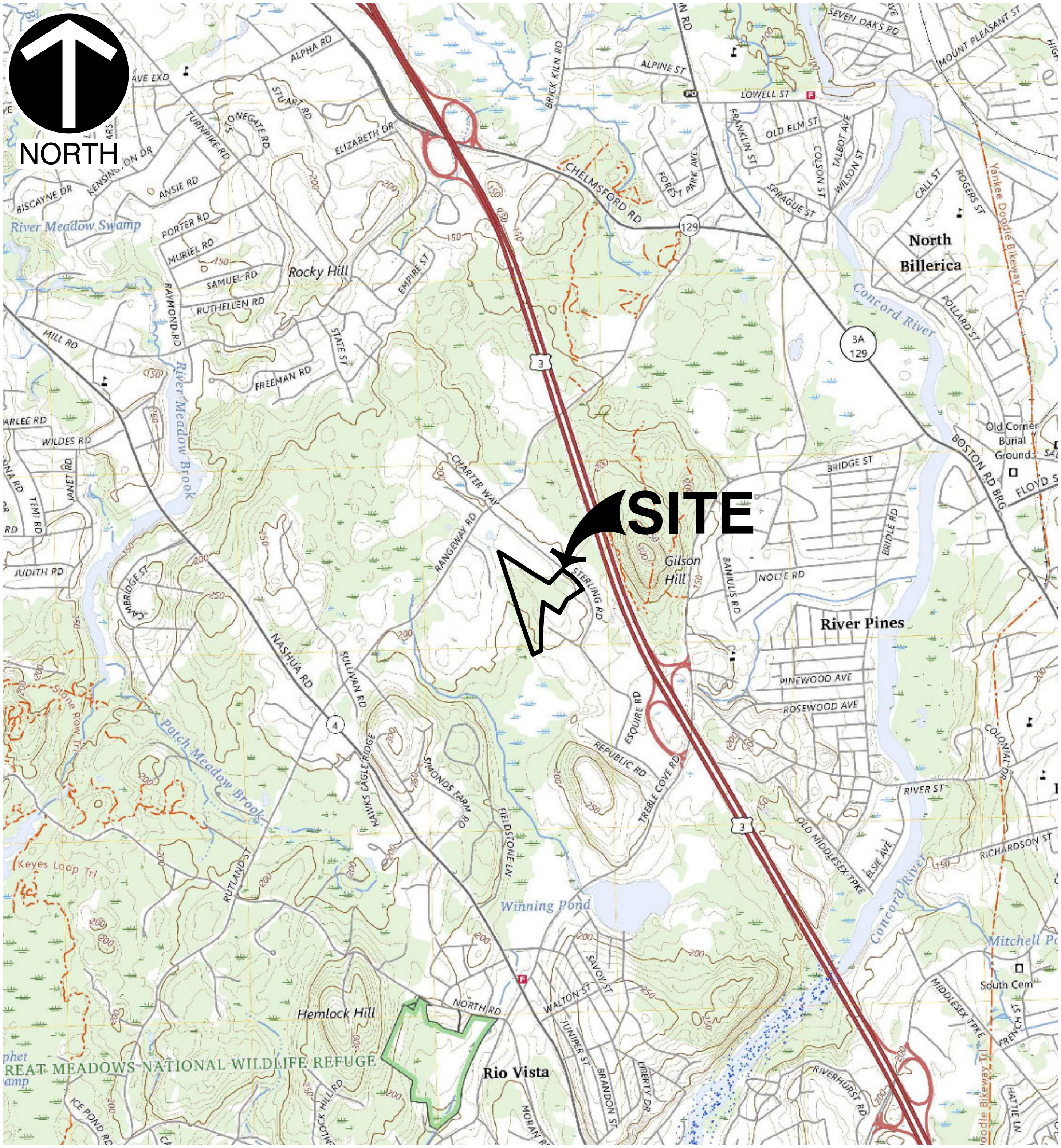
§6.7.007 Performance Standards for Redevelopment Sites

This section is not applicable to this Project, as this is not a Redevelopment Project.

§6.7.008 Performance Standards for Redevelopment Projects offsite Mitigation.

This section is not applicable to this Project, as this is not a Redevelopment Project.

FIGURES



REFERENCE

1. U.S.G.S. TOPOGRAPHIC MAP, BILLERICA, MA QUADRANGLE, DATED: 2024,

SCALE IN FEET

0 2500 5000

Civil & Environmental Consultants, Inc.

31 Bellows Road
Raynham, MA 02767

Ph: 774.501.2176

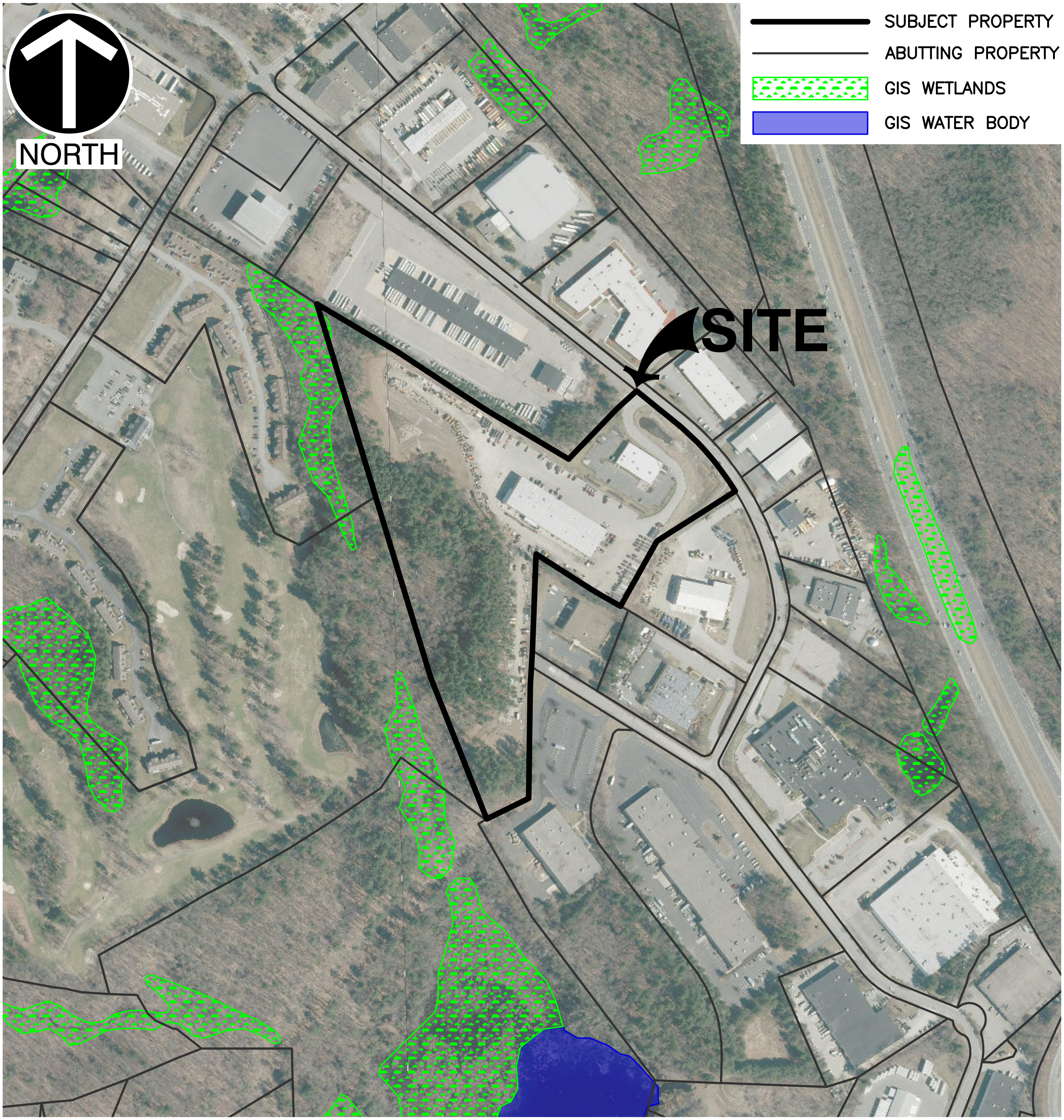
www.cecinc.com

STERLING ROAD, LLC
14 STERLING ROAD
NORTH BILLERICA, MASSACHUSETTS

SITE LOCUS

DRAWN BY: KFH	CHECKED BY: KFH	APPROVED BY: DSK	FIGURE NO.: 1
DATE: MARCH 2026	DWG SCALE: 1"=2,500'	PROJECT NO: 347-159	

\\cecinc.com\global\Projects\340-000\347-159\-CADD\Dwg\SW01 - Site Plans for Permitting\347159-SW01-Site Locus.dwg{LAYOUT1} LS:(2/5/2026 - mchin) - LP: 3/6/2026 9:41 AM



REFERENCE

1. AERIAL IMAGERY RETRIEVED FROM MASSGIS DATABASE. DATED 2023.
2. WETLANDS AND WATER BODIES RETRIEVED FROM MASSGIS. SEE SITE PERMITTING DRAWINGS FOR COMPREHENSIVE WETLAND DELINEATION.

SCALE IN FEET
0 500 1000

CEC
Civil & Environmental Consultants, Inc.
31 Bellows Road
Raynham, MA 02767
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14 STERLING ROAD
NORTH BILLERICA, MASSACHUSETTS

AERIAL SITE LOCUS

DRAWN BY: MRC	CHECKED BY: KFH	APPROVED BY: DSK	FIGURE NO.: 2
DATE: MARCH 2026	DWG SCALE: 1"=500'	PROJECT NO: 347-159	

\\cecinc.com\global\Projects\340-000\347-159\-CADD\Dwg\SW01 - Site Plans for Permitting\347159-SW01-Aerial Site Locus.dwg{LAYOUT1 (2)} LS:(2/26/2026 - mchin) - LP: 3/6/2026 9:40 AM

National Flood Hazard Layer FIRMette

FEMA

71°18'42"W 42°34'14"N

71°18'4"W 42°33'47"N

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- B 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

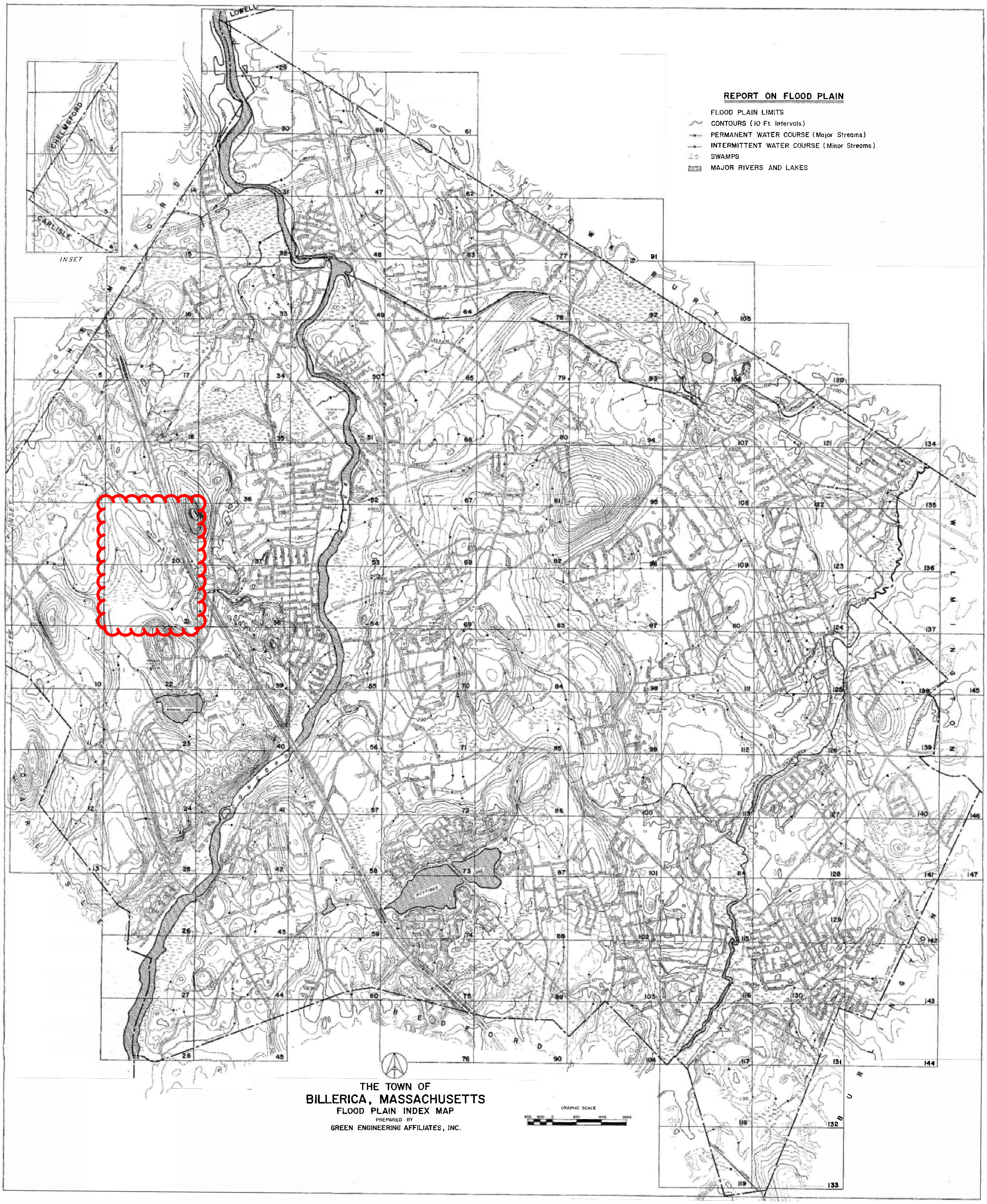
N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

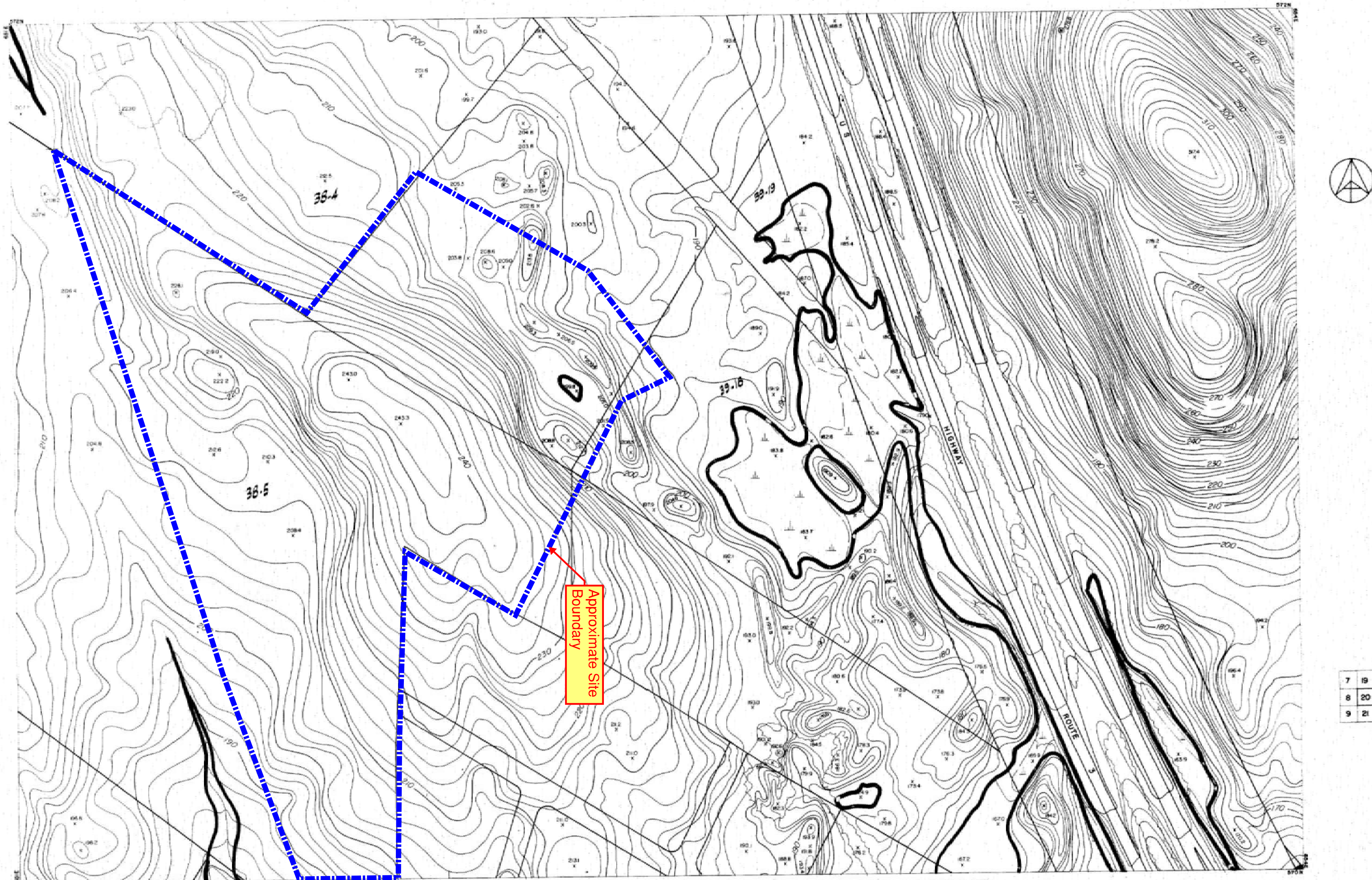
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 1/28/2026 at 4:07 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.


REPORT ON FLOOD PLAIN
FLOOD PLAIN LIMITS
CONTOURS (10 Ft. Intervals)
PERMANENT WATER COURSE (Major Streams)
INTERMITTENT WATER COURSE (Minor Streams)
SWAMPS
MAJOR RIVERS AND LAKES
LOWELL
CHELMSFORD
CARLISLE
INSET
BEDFORD
THE TOWN OF
BILLERICA, MASSACHUSETTS
FLOOD PLAIN INDEX MAP
PREPARED BY
GREEN ENGINEERING AFFILIATES, INC.
GRAPHIC SCALE

TOWN OF BILLERICA, MASSACHUSETTS



Refer to map 21 for continuation

PREPARED FROM PHOTOGRAPHY DATED MAY 11, 1971
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AVERAGE FLIGHT ALTITUDE 3400 FEET A.S.L.
HORIZONTAL AND VERTICAL DATUM IS M.G.S. & U.S.G.S.

100 0 100 200 300 FEET

TWO FOOT CONTOUR INTERVAL

LEGEND

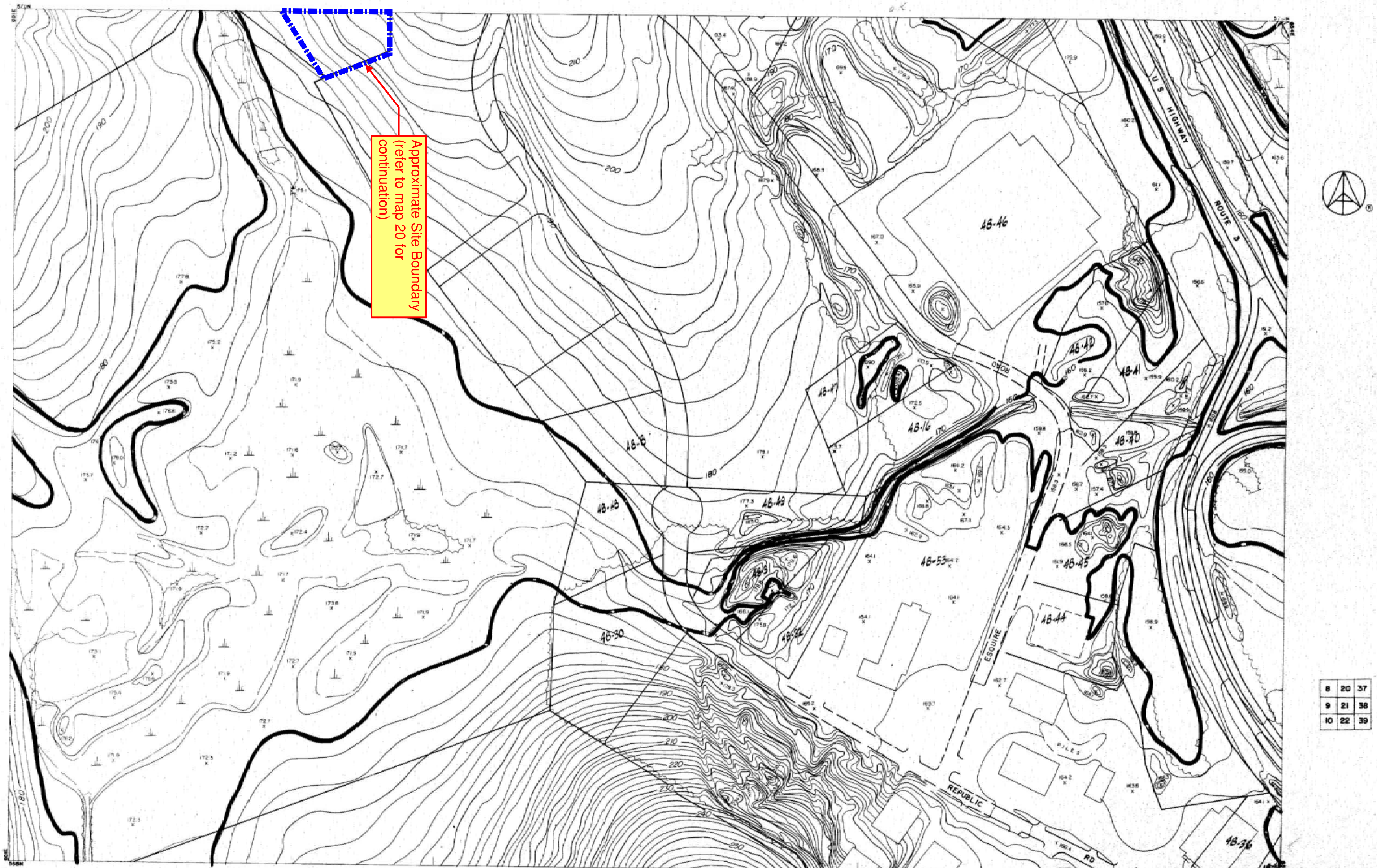
FLOOD PLAIN LIMIT (Outside Edge of Line)

LOT LINES

11-10 TAX MAP NO. – LOT NO.

PREPARED BY
GREEN ENGINEERING AFFILIATES, INC.
BOSTON, MASS.

TOWN OF BILLERICA, MASSACHUSETTS



PREPARED FROM PHOTOGRAPHY DATED MAY 11, 1971
CAMERA: WILD RC-8 FOCAL LENGTH 152.58 MM.
AVERAGE FLIGHT ALTITUDE 3400 FEET A.S.L.
HORIZONTAL AND VERTICAL DATUM IS M.G.S. & U.S.G.S.

100 0 100 200 300 FEET
TWO FOOT CONTOUR INTERVAL

LEGEND
FLOOD PLAIN LIMIT (Outside Edge of Line)
LOT LINES
11-10 TAX MAP NO. - LOT NO.

PREPARED BY
GREEN ENGINEERING AFFILIATES, INC.
BOSTON, MASS.

APPENDIX A

STORMWATER MANAGEMENT
OPERATION & MAINTENANCE PLAN

LONG-TERM POLLUTION PREVENTION AND STORMWATER MANAGEMENT SYSTEM OPERATION AND MAINTENANCE PLAN

14 STERLING ROAD
NORTH BILLERICA, MASSACHUSETTS

Prepared For:

STERLING ROAD, LLC

Prepared By:

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
31 BELLOWS ROAD
RAYNHAM, MASSACHUSETTS 02767

CEC Project 347-159

MARCH 2026

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APPENDICES

1.0 INTRODUCTION AND PURPOSE

The following Long-Term Operations and Maintenance (O&M) Plan has been prepared for the stormwater management system at the W.L. French Headquarters facility located at 14 Sterling Road, in Billerica, Massachusetts. The purpose of the plan is to provide guidance and procedures for proper pollution prevention and stormwater management system maintenance following construction completion. This plan has been adapted from the site's current O&M Plan prepared by Tighe & Bond, dated July 24, 2017 and last revised January 16, 2018. Upon completion of the proposed project, this updated O&M Plan will supersede the prior plan. This plan includes O&M guidelines and procedures applicable to the previously permitted stormwater management features located on the site, such as the existing paved drives and the stormwater management system, comprised of deep sump hooded catch basins, proprietary water quality units and infiltration basins, as well as new stormwater management features proposed as part of the project such as the subsurface concrete infiltration chamber system.

The proposed project has been designed in compliance with the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Standard and the Town of Billerica Stormwater Regulations to maintain or improve stormwater runoff quality and quantity. The stormwater management system components shall be maintained as recommended in the Massachusetts Stormwater Handbook.

A Stormwater Maintenance Agreement is required per Section 6.6.012 of the Town of Billerica Stormwater Management Regulations. This agreement, between the property Owner and the Town of Billerica Board of Health, allows the Town to assume responsibility for the inspection and maintenance of the stormwater management system, should the responsible party described in Section 2 of this O&M Plan be unresponsive. This O&M Plan is referenced as part of the Stormwater Maintenance Agreement provided as part of the Stormwater Management Permit Application for the project. Changes in property ownership, or changes to this O&M Plan, must be provided to the Town of Billerica Board of Health within 30 days of said changes.

Since there are no prescribed access and maintenance easements by the property Owner to the Town, none are indicated on the Site Plans referenced in this O&M Plan. However, per the above referenced and agreed upon Stormwater Maintenance Agreement, the Town has the authority to access the onsite stormwater management systems, should the property Owner not be performing the required inspections and maintenance.

2.0 RESPONSIBLE PARTIES

Stormwater management systems with multiple components, such as the one proposed for the Project, assures the cleanest possible discharges of stormwater to the environment. However, these systems must be routinely maintained to keep them in good working order. This plan identifies potential sources of pollution that may affect the quality of stormwater discharges and describes the implementation of Long-Term Pollution Prevention practices to reduce potential pollutants in stormwater discharges. The party identified below will be responsible for the operation and maintenance of the stormwater management system and Site. Schedules and procedures for inspection and maintenance of the existing and proposed stormwater management system components are provided in the following sections.

Sterling Road, LLC (Sterling) is responsible for maintaining and servicing the proposed driveway, buildings, paved and unpaved parking and storage areas, landscaping, utility infrastructure and the stormwater management facilities post construction. During construction, the contractor will be responsible for stormwater management system maintenance in accordance with the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan.

Property Owner:
Sterling Road, LLC
14 Sterling Road
North Billerica, MA 01862

Maintenance Contact:
Jessica French Goyette Vice President
W.L. French Excavating Corporation
14 Sterling Road
North Billerica, MA 01862
Phone: (978) 600-2103

Subcontractor(s):
Company or Organization Name: ______________________________
Name: ______________________________
Address: ______________________________
City, State, Zip: ______________________________
Telephone Number: ______________________________
Fax/Email: ______________________________
Area of Control: ______________________________

Subcontractor(s):

Company or Organization Name: ______________________________

Name: ______________________________

Address: ______________________________

City, State, Zip: ______________________________

Telephone Number: ______________________________

Fax/Email: ______________________________

Area of Control: ______________________________

3.0 LONG TERM POLLUTION PREVENTION PLAN

3.1 GOOD HOUSEKEEPING

The goal of the good housekeeping policy is to keep the site in a clean orderly condition. A disorderly site can lead to improper materials management, and can reduce the efficiency of any response to potential pollution problems.

The following good housekeeping measures will be followed at the site to aid in pollution prevention:

- Promptly clean and remove any spills or contamination from vehicles.
- Perform preventative maintenance on all equipment and on the structural components of the stormwater system.

3.2 POTENTIAL SOURCES OF POLLUTION

Table 1: Summary of Construction Site Pollutants

Pollutant-Generating Activity	**Pollutants or Pollutant Constituents** (that could be discharged if exposed to stormwater)	**Location on Site**
Site work	Soil particles and fines	Where disturbance is proposed
Paving and construction areas	Petroleum, concrete, vehicle fluids, paints, solvents	Where paving and construction is proposed
General Construction Areas	Petroleum, concrete, vehicle fluids, paints, solvents	Where construction is proposed
Solid waste storage	Construction debris, trash	In dumpster locations
Fertilizing	Fertilizers	In areas of proposed seeding
Equipment use	Hydraulic Oils/fluids	Leaks/broken hoses from equipment
Equipment use	Antifreeze/coolant	Leaks/broken hoses from equipment
Portable toilets	Sewage	Where portable toilets are located

Pollutant-Generating Activity	Pollutants or Pollutant Constituents (that could be discharged if exposed to stormwater)	Location on Site
Staging areas	Sediment, gasoline, fuel oil, concrete, vehicle fluids, paints, solvents, fertilizers, adhesives, antifreeze/coolant, hydraulic oil/fluid, etc.	
Concrete Wash Out	Particles and Fines	Concrete wash out area

3.3 SPILL PREVENTION AND RESPONSE

The site superintendent responsible for day-to-day operations will be the spill prevention and cleanup coordinator.

- Manufacturer's recommended methods for cleanup will be clearly posted and site personnel will be made aware of the procedures and the location of the information and clean up supplies.
- Materials and equipment necessary for spill cleanup will be kept in the material storage areas on site. Equipment and materials will include but not be limited to brooms, dustpans, mops, rags, gloves, goggles, kitty litter, sand, sawdust and plastic or metal trash containers specifically for this purpose.
- All spills will be cleaned up immediately after discovery.
- The spill area will be kept well ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with hazardous substances.
- Spills of toxic or hazardous material will be reported to the appropriate state or local government agency regardless of size.
- The Spill Prevention Plan will be adjusted to include measures to prevent this type of spill from recurring and how to cleanup the spill if it recurs. A description of the spill, its cause and the cleanup measures will be included.

3.3.1 Federal and State Spill Notification

In accordance with 310 CMR 40.0320, the site superintendent shall notify the Massachusetts Department of Environmental Protection (Northeast Region) - (978) 694-3200, the Local Emergency Planning Committee (LEPC) and any other authorities or agencies within two hours if an accident or other type of incident results in a release to:

- Land

    - 10 Gallons for more Oils (PCB<500 ppm)
    - 1 Gal or more Oils (PCB $\geq$500 ppm)
- Waterways
    - Any quantity of Oils
- Or, triggers the exposure to toxic chemical levels as listed in 301 CMR 40.1600, Revised Massachusetts Contingency Plan

The site superintendent shall notify the National Response Center (NRC) at (800) 424-8802 where a leak, spill, or other release containing a hazardous substance or oil in an amount equal to or in excess of a reportable quantity consistent with Part 2.3.3.4c and established under either 40 CFR Part 110, 40 CFR Part 117, or 40 CFR Part 302, occurs during a 24-hour period.

In either event, the site superintendent will work with state and federal agencies to ensure that all appropriate forms and reports are submitted in a timely manner.

- Note: Trigger volumes for other chemical spills vary. Contact the MassDEP or a Licensed Site Professional (LSP) for specific guidance on reporting thresholds and requirements for other chemicals.

In addition to the above reporting, 40 CFR 112.4 requires that information be submitted to the United States Environmental Protection Agency (USEPA) Region I Regional Administrator (RA) whenever the facility releases:

a) More than 1,000 gallons of oil in a single event, or release; or
b) More than forty-two (42) gallons of oil in each of two release incidents within a 12-month period.

3.3.2 Local Notification

The following local agencies will be called to provide emergency assistance at the facility on the judgment of the site superintendent:

Table 2: Local Notification Contact Information

Fire Department: 911 or (978) 671-0940	**Police Department**: 911 or (978) 671-0900
Hospital: Lowell General (978) 937-6000	**Dept. of Public Works**: (978) 671-1313

3.4 ON-SITE FUELING OF EQUIPMENT OR VEHICLES

The existing facility contains a fueling area with two above ground, pad-mounted, double walled fuel tanks. The fuel area is equipped with a separate storm drainage collection system which provides additional treatment and containment features. Oil/grit chambers are included to remove floatable contaminants from the storm drainage flow. An isolation valve is included and is intended to be operated by trained operators in the event of a fuel spill. Procedures for the operation of the valve are located within the facility.

3.5 WASHING OF EQUIPMENT AND VEHICLES

All washing of equipment and vehicles performed on site will be located inside Building 2. All wash waters will be collected through the building wash water recycling system.

3.6 STORAGE, HANDLING, AND DISPOSAL OF CONSTRUCTION PRODUCTS, MATERIALS, AND WASTES

3.6.1 Building Products

- Site contractor/project manager shall designate a waste collection area on the site that does not receive a substantial amount of runoff from upland areas and does not drain directly to a water body.
- Ensure that containers have lids so they can be covered before periods of rain, and keep containers in a covered area whenever possible.
- Schedule waste collection to prevent the containers from overfilling.
- Clean up spills immediately. For hazardous materials, follow cleanup instructions on the package. Use an absorbent material such as sawdust or kitty litter to contain the spill.
- During the demolition phase of construction, provide extra containers and schedule more frequent pickups.
- Collect, remove, and dispose of all construction site wastes at authorized disposal areas.

3.6.2 Pesticides, Herbicides, Insecticides, Fertilizers, and Landscaping Materials

- Store new and used materials in a neat, orderly manner in their appropriate containers in a covered area. If storage in a covered area is not possible, the materials shall be covered with polyethylene or polypropylene sheeting to protect them from the elements.
- Storage area should include precautions to contain any potential spills.
- Immediately contain and clean up any spills with absorbent materials.

3.6.3 Diesel Fuel, Oil, Hydraulic Fluids, Other Petroleum Products, and Other Chemicals

- Store new and used petroleum products for vehicles in a neat, orderly manner in their appropriate containers in a covered area. If storage in a covered area is not possible, the

materials shall be covered with polyethylene or polypropylene sheeting to protect them from the elements.
- Storage area should include precautions to contain any potential spills.
- Immediately contain and clean up any spills with absorbent material.
- Have equipment available in fuel storage areas and in vehicles to contain and clean up any spills that occur.

3.6.4 Hazardous or Toxic Waste

- Store new and used materials in a neat, orderly manner in their appropriate containers in a covered area. If storage in a covered area is not possible, the materials shall be covered with polyethylene or polypropylene sheeting to protect them from the elements.
- Storage areas should include precautions to contain any potential spills.
- Immediately contain and clean up any spills with absorbent materials.
- Have equipment available in fuel storage areas and in vehicles to contain and clean up any spills that occur.
- To prevent leaks, empty and clean hazardous waste containers before disposing of them.
- Never remove the original product label from the container because it contains important safety information. Follow the manufacturer's recommended method of disposal, which should be printed on the label.
- Never mix excess products when disposing of them, unless specifically recommended by the manufacturer.

3.6.5 Construction and Domestic Waste

- All materials shall be collected and stored in securely lidded receptacles, no construction waste materials will be buried. Clean up immediately if containers overflow.

3.6.6 Sanitary Waste

- Portable sanitary units will be provided throughout the course of the project for use by the site contractor/project manager’s employees. A licensed sanitary waste management contractor will regularly collect all sanitary waste from the portable units. Position portable toilets so that they are secure and will not be tipped or knocked over.

3.7 WASHING OF APPLICATORS AND CONTAINERS USED FOR PAINT, CONCRETE, OR OTHER MATERIALS

- The contractors should be encouraged where possible, to use washout facilities at their own plant or dispatch facility from stucco, paint, concrete, form release oils, curing compounds, and other construction materials.
- If washout of these materials is done on site:
  - Direct all wash water into a leak-proof container or leak-proof pit. The container or pit must be designed so that no overflows can occur due to inadequate sizing or precipitation.
  - Handle washout or cleanout wastes as follows:
    - Do not dump liquid wastes in the storm sewers
    - Dispose of liquid wastes in accordance with applicable requirements in CGP Part 2.3.3.3.
    - Remove and dispose of hardened concrete waste consistent with the handling of other construction wastes in Section 3.6.5.
  - Attempts should be made to locate washout area as far away as possible from surface waters and stormwater inlets or conveyances, and to the extend practicable, designate areas to use for these activities and conduct such activities only in these areas.
- Inspect washout facilities daily to detect leaks or tears and to identify when materials need to be removed.

3.8 FERTILIZERS

- Store new and used materials in a neat, orderly manner in their appropriate containers in a covered area. If storage in a covered area is not possible, the materials shall be covered with polyethylene or polypropylene sheeting to protect them from the elements.
- Storage area should include precautions to contain any potential spills.
- Immediately contain and clean up any spills with absorbent materials.
- Apply at a rate and in amounts consistent with manufacturer's specifications, or
- document departures from the manufacturer's specifications.
- Apply at the appropriate time of year for the site, and preferably timed to coincide as closely as possible to the period of maximum vegetation uptake and growth
- Avoid applying before heavy rains that could cause excessive nutrients to be discharged
- Never apply to frozen ground
- Never apply to stormwater conveyance channels with flowing water
- Follow all federal, state, tribal, and local requirements regarding fertilizer application.

4.0 STORMWATER MANAGEMENT SYSTEM

The on-site stormwater management system is comprised of a series of deep-sump hooded catch basins, drain manholes, proprietary water quality units, infiltration basins, a subsurface concrete infiltration chamber system, and stormwater outfalls. In general, runoff from the project area, including building rooftops, paved and unpaved parking areas, is collected and piped to one of the infiltration basins or to the subsurface concrete infiltration chamber system. The pre-existing lower (northeastern) basin is solely for infiltration and does not include an outfall, while the proposed southern basin and the proposed subsurface concrete infiltration chamber system includes an outlet control structure which discharges to a stormwater outfall.

See the attached Figure A1 for the location of the various described components of the Stormwater Management System.

4.1 INSPECTIONS

Inspections will be performed in accordance with the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Handbook. Figure 1, attached to this O&M Plan, identifies the location of each BMP to be inspected and maintained as described in this Section.

The following stormwater management system features will be evaluated during each inspection:

4.1.1 Vegetated Surfaces

Inspection Frequency: Semi-Annually in Spring and Fall
Special Inspection Event(s): Spring Snow Melt

All vegetative surfaces will be observed to identify locations of settlement and erosion. Remove sediment, debris, and invasive vegetation when observed.

4.1.2 Pavement, Driveway and Walkway Sweeping

Inspection Frequency: Semi-Annually
Special Inspection Event(s): Spring Snow Melt

All pavement surfaces will be inspected semi-annually for deterioration or spalling. Additionally, the pavement surface will be regularly monitored to make sure it drains properly after storms. Cleanings should be conducted on a quarterly basis to prevent clogging. For best management practices, high-efficiency vacuum sweeping machines should be used to clean and maintain the surface.

4.1.3 Deep-Sump, Hooded Catch Basins

Inspection Frequency: Quarterly
Special Inspection Event(s): Rainfall greater than 0.5 inches

Deep sump catch basins should be inspected at least four times per year. The visual inspection should ascertain that the catch basin is functioning properly (i.e. no blockages or obstructions to the outlet and/or hood) and to measure the amount of solid materials that have accumulated in the sump. This can be done with a calibrated dipstick, tape measure or other measuring instrument so that the depth of deposition in the sump can be tracked. Inspections should be completed visually from the ground level. If further investigation is warranted that requires entering the structure, all applicable Confined Space Entry safety regulations and procedures must be followed per 29 CFR 1910.146. Deep sump catch basins should be cleaned four times per year or whenever the depth of the sediment is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin. Cleanings should also be conducted at the end of the foliage and snow-removal seasons. Clamshell buckets can be used to remove sediment. However, vacuum trucks will remove more trapped sediment, are more expedient, and are less likely to damage hoods on outlet pipes. Disposal of sediment removed from catch basins must be disposed of in accordance with local, state and federal requirements.

4.1.4 Proprietary Water Quality Treatment Devices

Inspection Frequency: Semi-Annually or Per manufacturer recommendations
Special Inspection Event(s): Rainfall greater than 0.5 inches
Structural Water Quality Units (WQU) will be observed in accordance with manufacturer recommendations. Units are to be cleaned and maintained as directed by the manufacturer. Manufacturer recommended O&M requirements are provided in Appendix A-1.

4.1.5 Sediment Forebays

Inspection Frequency: Monthly
Special Inspection Event(s): Rainfall greater than 0.5 inches

Sediment forebays should be inspected monthly to identify depths of sediment and occurrence of debris which would impact functionality as well as for unwanted vegetation. Sediment forebays should be cleaned at least four times per year or when sediment depth exceeds three (3) to six (6) inches. After removing sediment, damaged vegetation will be replaced by re-seeding or sodding. Additionally, the outlet catch basin grate, outlet pipe and the overflow weir shall be observed for signs of clogging during storm events and erosion. Any trash, debris or unwanted vegetation encountered at each inspection will be removed.

4.1.6 Surface Infiltration Basins

Inspection Frequency: Semi-annually
Special Inspection Event(s): Rainfall greater than 0.5 inches

Surface Infiltration basins should be inspected and cleaned at least two times per year or when sediment depth exceeds three (3) inches. Surface infiltration basins should also be inspected semi-annually for standing water. If standing water is observed for longer than 72 hours, a pump should be placed in the basin and discharged through the outlet pipe. After the system is dewatered, it should be observed by a Professional Engineer. A Professional Engineer should provide an opinion as to why the infiltrations basin is not draining and provide recommendations to restore infiltration capacity to the system. Additionally, surface infiltration basins shall be observed to identify depths of sediment and occurrence of debris which would impact functionality. The outlet control structure, if applicable, shall be observed for signs of clogging during storm events and erosion. Any trash, debris or unwanted vegetation encountered at each inspection will be removed.

4.1.7 Subsurface Concrete Infiltration Chamber System

Inspection Frequency: Semi-Annually or Per manufacturer recommendations
Special Inspection Event(s): Rainfall greater than 0.5 inches
The RetainIt subsurface concrete infiltration chamber system will be observed in accordance with manufacturer recommendations. Units are to be cleaned and maintained as directed by the manufacturer. Manufacturer recommended O&M requirements are provided in Appendix A-2.

4.1.8 Stormwater System Outfalls

Inspection Frequency: Semi-annually
Special Inspection Event(s): Rainfall greater than 0.5 inches

System outfalls should be inspected twice a year as well as after every major storm, for slope integrity, soil moisture, vegetated health, soil stability, soil compaction, soil erosion, ponding and sediment accumulation. If the rip rap has been displaced, undermined or damaged, it should be replaced immediately. The channel immediately below the outlet should be checked to see that erosion is not occurring. The downstream channel will be kept clear of obstructions, such as fallen trees, debris, leaves and sediment that could change flow patterns and/or tail water depths in pipes. Repairs must be carried out immediately to avoid additional damage to the outlet protection apron.

5.0 SNOW MANAGEMENT & DE-ICING

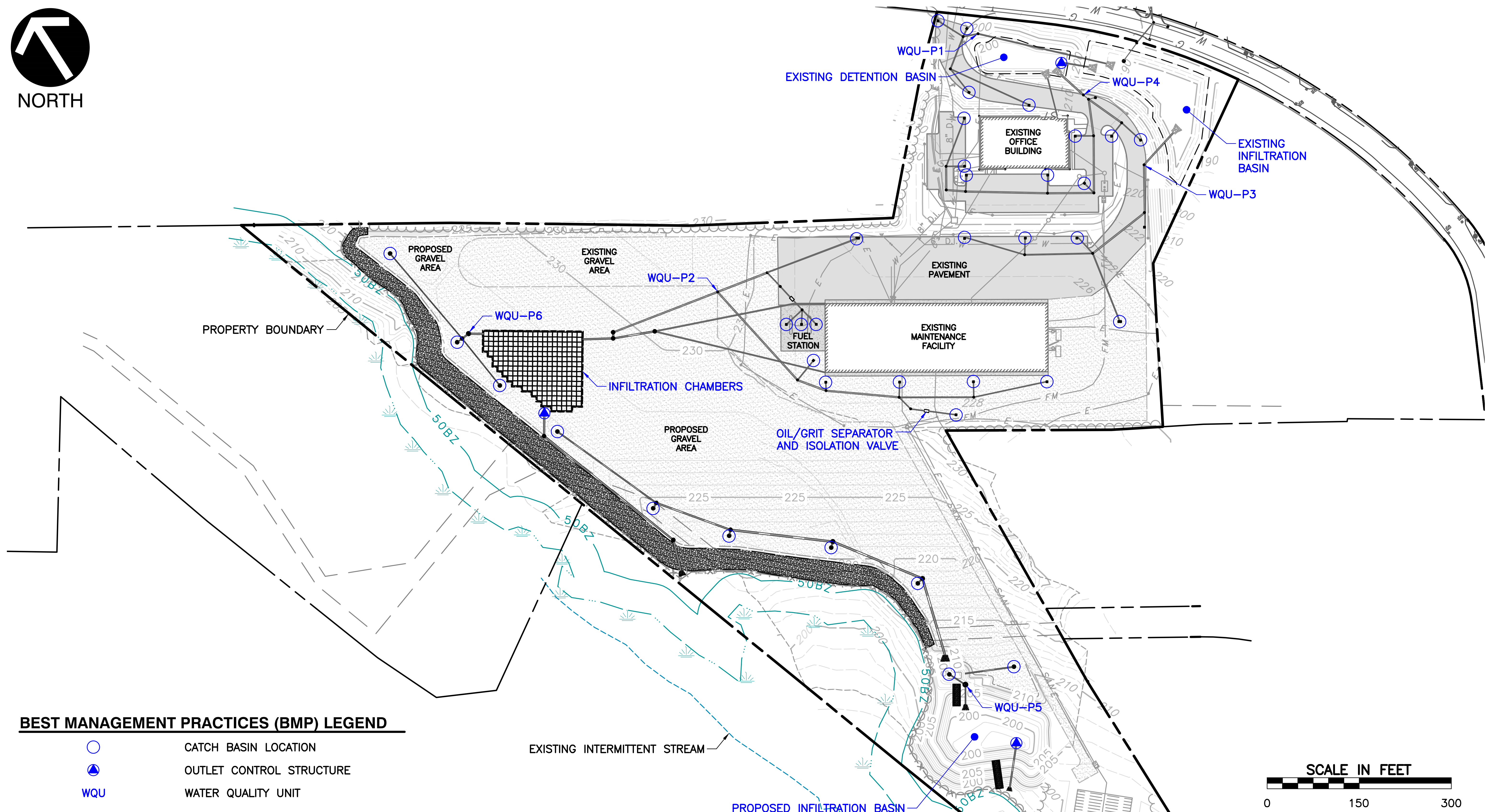
Snow removal will occur along the proposed paved and unpaved access roads only. Snow storage should not be in or adjacent to wetland areas, in infiltration basins, pushed beyond the 2:1 rip-rap slope along the western property line, nor blocking drainage to surface inlets (e.g. catch basins).

The amount of salt and deicing chemicals to be used on the paved areas of the site shall be reduced to the minimum amount needed to provide safe pedestrian and vehicle travel. The following practices should be followed to control the amount of salt and deicing materials that come into contact with stormwater runoff:

- Devices used for spreading salt and deicing chemicals should be capable of varying the rate of application based on the site-specific conditions.
- Sand and salt should be stockpiled under covered storage facilities that prevent precipitation and adjacent runoff from coming in contact with the deicing materials.
- Applications of chemical de-icing may be applied along with sand for the roads, main entrances, stop sign areas, and sidewalks.
- Apply only as needed using minimum quantities. Small quantities of deicers mixed with sand or sprayed on hard to maintain areas.

Sweep or clean up accumulated sand from sidewalks, steps, roads and other paved surfaces, as soon as possible after the paved surfaces clear.

FIGURES



BEST MANAGEMENT PRACTICES (BMP) LEGEND

○	CATCH BASIN LOCATION
▲	OUTLET CONTROL STRUCTURE
WQU	WATER QUALITY UNIT

CEC
Civil & Environmental Consultants, Inc.
31 Bellows Road
Raynham, MA 02767
Ph: 774.501.2176
www.cecinc.com

SITE DEVELOPMENT PERMITTING
14 STERLING ROAD, BILLERICA, MA
W.L. FRENCH EXCAVATING CORPORATION

BMP LOCATION MAP

DRAWN BY: KFH	CHECKED BY: DSK	APPROVED BY: DSK	FIGURE NO.: A-1
DATE: MARCH 2026	DWG SCALE: 1"=150'	PROJECT NO: 347-159	

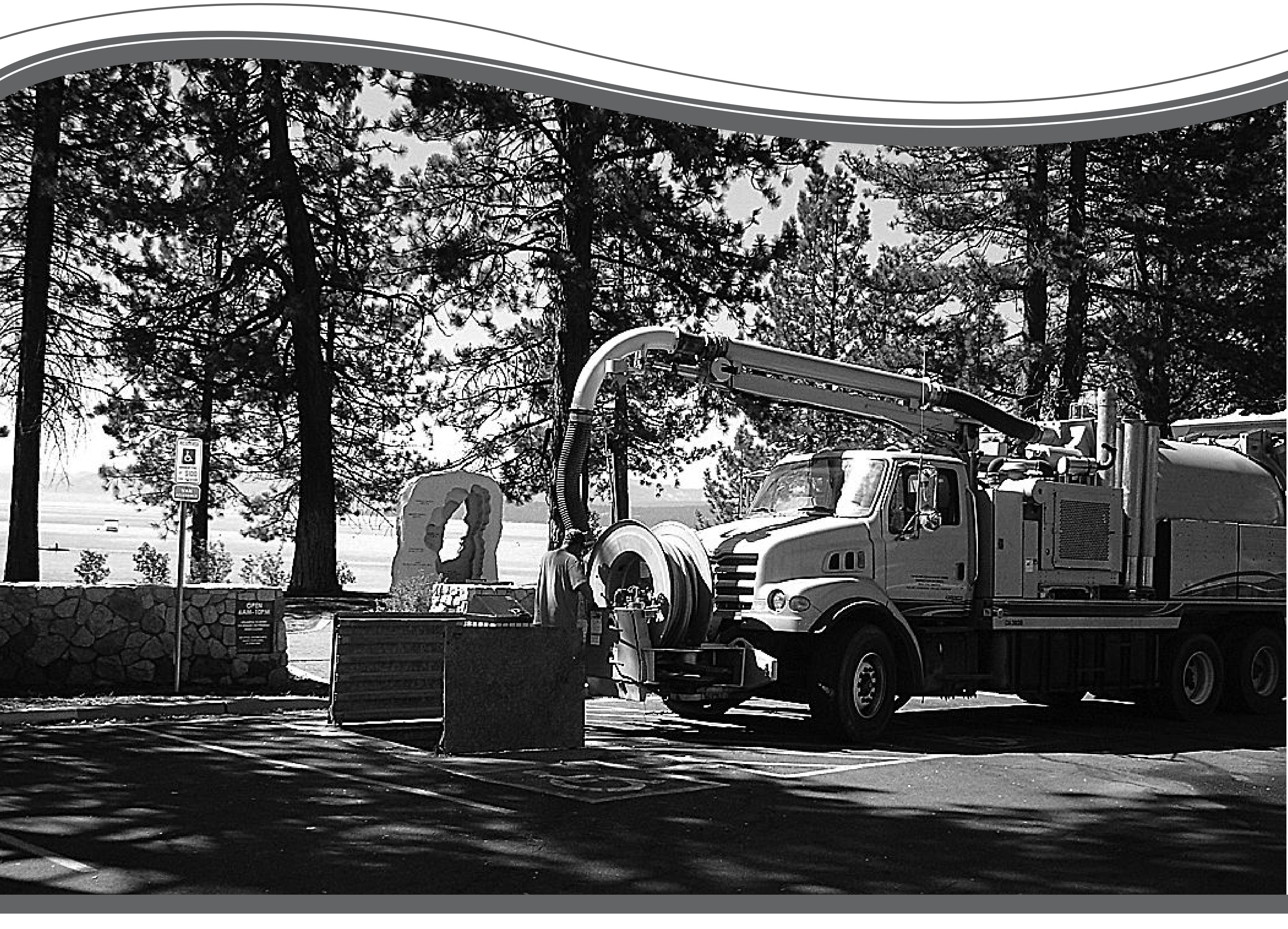
ENGINEERING, SURVEYING AND LANDSCAPE ARCHITECTURE IN THE STATE OF NORTH CAROLINA WILL BE PROVIDED BY CEC SURVEYING AND LANDSCAPE ARCHITECTS OF NC, PLLC. SERVICES IN PUERTO RICO WILL BE PROVIDED BY CEC ENGINEERS & CONSULTANTS, LLC. LANDSCAPE ARCHITECTURE SERVICES IN THE STATE OF OHIO WILL BE PROVIDED BY CEC LANDSCAPE ARCHITECTS, LLC.

APPENDIX A-1

WATER QUALITY UNITS
MANUFACTURER O&M REQUIREMENTS

CONTECH® ENGINEERED SOLUTIONS

Cascade Separator® Inspection and Maintenance Guide



CASCADE separator®

Maintenance

The Cascade Separator® system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects sediment and debris will depend upon on-site activities and site pollutant characteristics. For example, unstable soils or heavy winter sanding will cause the sediment storage sump to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (i.e. spring and fall). However, more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment wash-down areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

A visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet chamber, flumes or outlet channel. The inspection should also quantify the accumulation of hydrocarbons, trash and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided in this Inspection and Maintenance Guide.

Access to the Cascade Separator unit is typically achieved through one manhole access cover. The opening allows for inspection and cleanout of the center chamber (cylinder) and sediment storage sump, as well as inspection of the inlet chamber and slanted skirt. For large units, multiple manhole covers allow access to the chambers and sump.

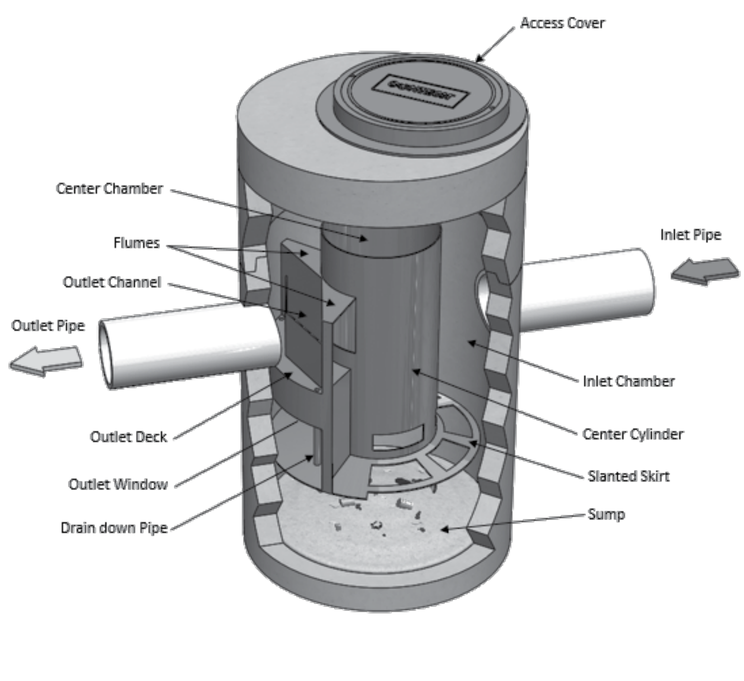
The Cascade Separator system should be cleaned before the level of sediment in the sump reaches the maximum sediment depth and/or when an appreciable level of hydrocarbons and trash has accumulated. If sorbent material is used, it must be replaced when significant discoloration has occurred. Performance may be impacted when maximum sediment storage capacity is exceeded. Contech recommends maintaining the system when sediment level reaches 50% of maximum storage volume. The level of sediment is easily determined by measuring the distance from the system outlet invert (standing water level) to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Finer, silty particles at the top of the pile typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the chart in this document to determine if the height of the sediment pile off the bottom of the sump floor exceeds 50% of the maximum sediment storage.

Cleaning

Cleaning of a Cascade Separator system should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole cover and insert the vacuum tube down through the center chamber and into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The areas outside the center chamber and the slanted skirt should also be washed off if pollutant build-up exists in these areas.

In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. Then the system should be power washed to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and to ensure proper safety precautions. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the Cascade Separator system must be done in accordance with local regulations. In many locations, disposal of evacuated sediments may be handled in the same manner as disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal. If any components are damaged, replacement parts can be ordered from the manufacturer.



Cascade Separator® Maintenance Indicators and Sediment Storage Capacities

Model Number	Diameter		Distance from Water Surface to Top of Sediment Pile		Sediment Storage Capacity	
	ft	m	ft	m	y^3	m^3
CS-3	3	0.9	1.5	0.5	0.4	0.3
CS-4	4	1.2	2.5	0.8	0.7	0.5
CS-5	5	1.3	3	0.9	1.1	0.8
CS-6	6	1.8	3.5	1	1.6	1.2
CS-8	8	2.4	4.8	1.4	2.8	2.1
CS-10	10	3.0	6.2	1.9	4.4	3.3
CS-12	12	3.6	7.5	2.3	6.3	4.8

Note: The information in the chart is for standard units. Units may have been designed with non-standard sediment storage depth.

A Cascade Separator unit can be easily cleaned in less than 30 minutes.

A vacuum truck excavates pollutants from the systems.

Cascade Separator® Inspection & Maintenance Log

Cascade Model:			Location:		
Date	Depth Below Invert to Top of Sediment[1]	Floatable Layer Thickness[2]	Describe Maintenance Performed	Maintenance Personnel	Comments

1. The depth to sediment is determined by taking a measurement from the manhole outlet invert (standing water level) to the top of the sediment pile. Once this measurement is recorded, it should be compared to the chart in the maintenance guide to determine if the height of the sediment pile off the bottom of the sump floor exceeds 50% of the maximum sediment storage. Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile.
2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

SUPPORT

- Drawings and specifications are available at www.ContechES.com.
- Site-specific design support is available from our engineers.

CONTECH ENGINEERED SOLUTIONS
800-925-5240
www.ContechES.com

APPENDIX A-2

RETAINIT SUBSURFACE CONCRETE INFILTRATION CHAMBER SYSTEM
MANUFACTURER O&M REQUIREMENTS

retain-it®
Stormwater Management Systems

OWNERS MAINTENANCE MANUAL

retain-it, LLC
560 Salmon Brook Street
Granby, CT 06035
(860) 413-3050

retain-it ®

Owners Maintenance Manual

Table of Contents

Description

retain-it ® is a subsurface Storm Water Management system constructed of precast concrete structures. They are installed in a side by side configuration creating a continuous internal flow channel integrated throughout the system. Systems are constructed with designated inlet and outlet modules, some with multiple inlets and outlets depending on the site storm water system layout. Infiltration systems typically have an inlet and sidewalls/ base constructed on a stone infiltration blanket with geofabric installed at the native soil interface. Other systems incorporate outlet flow control devices. Detention systems are typically lined with a watertight membrane and have inlet and outlet control devices.

The retain-it ® system can consist of multiple varying layouts, with no two the same. Given this, it should be noted that the operation and maintenance requirements are very similar regardless of the intended layout. It is important that the end user know the specific elements of each system so as to understand how best to optimize it's operation.

Installation per Design: Operation is simple to follow where the installation was performed in accordance with the design specifications, drawings and calculations. Specifics shall be identified in the design drawings. As-built drawings will benefit the locating of specific design modules where the system has been buried below a parking lot area. Optional access manholes or removable grates may be installed above every inlet/outlet pipe and at critical design elements designated by the design.

Daily Operation and Long Term Maintenance: In general, daily usage of the system is self sufficient and will operate without requiring any outside assistance, except for periodic inspection to verify optimal performance and maintenance for removal of collected pollutants. A longer term maintenance program should incorporate a more thorough inspection of the all elements of the system to verify proper operating condition. This is more important with the infiltration type of systems where the soil infiltration surface may become restricted due to fine particle build up. Long term maintenance should include provisions for cleaning and removal of collected solids, oils and debris from the system.

System Operation: The system operational function is initiated according to rainfall runoff flows entering the structure. Internally, the runoff flows in a set pattern or sequence throughout the module layout in accordance with the hydraulic design conditions. The flows primarily operate on system head derived from the changes in elevation from the internal water surface and the outlet invert elevation. Some designs incorporate internal flow controls to satisfy hydraulic conditions that enhance water quality treatment or other intended purposes. Modified systems may incorporate a pump, but in general there are no mechanical apparatus required.

End user operations primarily consist of inspection and maintenance of the system over time.

Periodic Inspection: Important note - All storm water management systems react differently depending on the conditions that are characteristic to the contributing water shed. Variables such as storm intensity, runoff flow rates, site geology, surface stabilization and pollution load will affect the system operation. As does the inspection and maintenance frequency to ensure optimum effectiveness.

Inspections should be done periodically, with a greater number scheduled during the system start up and less frequently as the operator becomes familiar with the system performance characteristics. It is recommended that the end user keep records of the performance using the inspection log record sheet found in the back of this manual. These records shall identify the cycle of maintenance “system calibration” required for the specific applications based on the contributing water shed variables operating under “normal” conditions.

Please note that immediate maintenance may be required during “non-normal” events such as during adverse weather conditions or emergency fuel spills. See information on emergency spills in this manual.

Visual inspection of all assessable components shall be performed throughout the lifetime of the system. Access has been supplied at critical points to monitor hydraulic performance and removed pollutants buildup.

Standard Maintenance:

After construction has been completed and all disturbed surfaces have been stabilized by means of vegetation, asphalt or concrete surfaces, and all drainage system components have been constructed and are free of construction debris and sediments; then the storm water management system can be considered in an operational status.

Periodic visual inspections will help to identify issues of concern.The usual indicators are signs of slow flows, backed up water, visible oil, trash and debris or an excessive amount of sediment in the storage area.

Normal operational flows can be observed to flow freely at the predicted design elevations, from the inlet to the outlet module, following a serpintine path thru the storage and attenuation modules. Note that some modules are designed to permanently retain water where others may hold water and slowly release it over a typical 24 hour period. During a storm water event, the flows and water surface elevations will fluctuate from a low flow to a high flow/ storage status. The storage modules should fill during the event and drain down within a 24 hour period after the event has stopped. All pipes, orifices, weirs and standpipes should pass flows freely and at optimum capacity.

Standard maintenance is performed using a vacuum truck to suction the accumulated sediments, oils and greases and trash and debris from the system. Whereas an on-site maintenance staff can remove these items by hand, it is preferred that the vacuum truck be used as dictated by specific system conditions. When a specialized module designed to have a permanent water level is used, the vacuum truck should pump the liquid level down to inspect the below water elevation structures and sump storage areas.

Oils and greases can be handled by on-site staff by utilizing absorbent products that soak up the oils (and not) converting the oils from a liquid into a manageable solid form. These oil soaked absorbent materials should be disposed of in an approved manner.

Sediments, trash and debris shall be removed and disposed of in an approved manner.

Any indications of hazardous material, determined by visual inspection, testing, smell or abnormality, should be reported and handled per appropriate regulations.

Flow Conditions

System operators should familiarize themselves with proper hydraulic flow condition indicators, acceptable depths of sedimentation, debris and trash build up, and concentrations of oils and greases.

Hydraulic flow conditions are those that are established by the design as either a flow/storage or as a water quality treatment function. Both have performance characteristics that can be visually identified so as to determine the effective and efficient operation of the system.

The engineering design drawings should note the various expected water surface level elevations that are achieved during different design storms within the various modules. Since it is difficult for a visual inspection to coincide with the exact time given water elevations are predicted, the following guidelines are given for evaluation.

Visual Inspection Guide:

<u>Internal Flow Evaluation</u>

Low flow: water should flow freely from the inlet to the outlet, travelling the intended attenuation path thru the system with the water surface elevation below the structure beam height (12" deep), the system should drain completely 24 hours after a storm event,

Medium flow: the system should hold and maintain a water level during the 24 hour storm event and yet continually fill as the storm increases or drain downward as the event recedes. Flow within the system should occur freely from inlet to outlet only being restricted when a flow control structure has been integrally designed in place. Flow control devices may result in a water level backing up either temporarily or permanently; noting devices such as water quality modules may require a permanent water level to operate properly (see water quality treatment). Other system applications should drain completely 24 hours after a storm event.

High flow: the system should fill to the maximum design storm water level elevation (hydraulic grade line) per design. In most cases, that is the highest storage elevation available in the system, at the underside of the module top slab, or the invert of the overflow pipe. As the storm event recedes, the water level should begin to drain down via flow thru the system and discharge. The system should drain completely within 24 hours after a storm event.

Pollutant Storage Capacities

<u>Oil and Grease</u>

Oil and Grease Collection (with optional Oil water separator module specified) - Oil and grease accumulation is generally a function related to vehicle parking lot and drive areas, oil generating land uses or emergency spill conditions. It is important to maintain the system from accumulating excessive volumes of oils in that they may wash over into other sections of the system potentially clogging and reducing the infiltration capacity, blocking control devices and contaminating the overall system. The following standards apply.

Oil should not accumulate more than a visible sheen on the water surface in the oil water separation module only. A sheen is described as a fine, thin oil layer on the water surface identified by the glossy rainbow colors. A dipstick (dry wooden stick) can be used as a probe to determine the thickness of oil on the surface.

Accumulated oils could be associated with insufficient maintenance or a potential large volume oil resource. Any accumulation of oil should be promptly maintained by an experienced waste handler. Emergency spills such as those generated by an accidental spill shall be contained and removed immediately before the next storm event. Spills shall be handled in accordance with local environmental regulations. See spill and accumulated oil maintenance procedures.

Sediments

Sediments (with optional primary grit module or sedimentation modules specified) - Sediments shall be periodically removed from the system as they accumulate within the designated storage modules. The inlet modules are generally equipped with a sediment storage sump located in the base of the inlet structure. Inspection should be performed after major storm events or a minimum of annually, unless a different inspection cycle has been determined to be sufficient. Inspection shall consist of using a probe to determine the presence of and depth of the accumulated solids. Access is via the 24" manhole.

Note that excessive volumes of sediments will reduce the performance and efficiency of the system. Regional accumulations of solids such as those associated with ice and snow, may result in large springtime volumes of sand and gravels used for traction and ice control.

Trash and Debris

Trash and Debris (with optional trash and debris module specified) - Trash and debris accumulates in the inlet module in three forms; floating debris, neutrally buoyant, and heavy material. The floating debris is visible from the access manhole floating on the water surface in the form of but not limited to wood, paper, plastic, foam, bottles and cans. The neutrally buoyant material resides below the surface and combines with the natural flow regime of the system. It is hard to detect and can only be recognized when at a high concentration appears as a thickening of the water viscosity. Heavier material will simply settle to the sump base and combine with the sediments.

Note that trash and debris typically cause the most problems when they become lodged in a flow control device such as an outlet elbow, riser pipe, and orifice or weir structure. This can be detected visibly when the system is pumped down during maintenance. It can also be evaluated as a condition when flow is impeded and the water level backs up higher than the design elevations.

Emergency Spill Conditions (with optional emergency spill control module specified):

Emergency spill conditions are defined as an excessive accumulation of hydrocarbons such as oil, gasoline, diesel fuel, transmission oil or antifreeze usually resulting from an accidental discharge. Excessive accumulation is described as any amount larger than a thin "sheen" visible on the water surface.

Care should be given in handling these types of fluids. The incident should be reported to the appropriate authorities and should be mitigated by a hazardous waste consultant approved for such matters.

retain-it ®

Maintenance Log

Storm Water Management System

Location: ID #:

Date	Inspection Notes	Inspector

Note the following conditions:

Inlet Module

Outlet Module

Water Quality Module

Oil Elbow

Oil Accumulation

Sedimentation Accumulation

Trash and Debris Quantity

Flow Conditions

Flow Control Outlet Structure

Overflow Pipe

APPENDIX A-3

STORMWATER OPERATIONS AND MAINTENANCE LOG

CEC

Stormwater Operations and Maintenance Log

Project Name: Site Development Permitting
Project Location: 14 Sterling Road, Billerica, MA
Project Number: 347-159

Date: Mar. 2026
Prepared By: KFH
Approved By:

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning or Repair Needed (List Items if Required)	Date of Cleaning or Repair	Performed By
Vegetated Areas	Inspect twice per year, typically in the spring and fall.			Perform maintenance on a regular basis during the growing season. Mow grassed areas on a regular basis to maintain growth. Plant alternative mixture of grass species in the event of unsuccessful establishment. Grass vegetation should not be cut to a height less than six inches. Maintain planted areas adjacent to pavement to prevent soil washout and immediately clean any soil deposited on pavement. Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming. Remove trash, sediment debris and invasive vegetation.			
Pavement Sweeping	Sweep a minimum of twice per year, typically between March and November.			Paved areas will be swept annually at a minimum, and as otherwise needed. Remove residual sand from winter sanding each spring.			
Deep Sump and Hooded Trench Drains	Inspect four times per year. Clean four times per year, in the spring and fall, or whenever sediment buildup exceeds two (2) feet in depth.			Remove trash and deposits. During cleanings, confirm the oil/debris trap (hood) is installed properly, is free of clogs, and is functional. Reinstall or replace as needed. Take care not to damage the oil/debris trap (hood) during cleaning.			
Proprietary Water Quality Treatment Devices	Inspect twice per year or as required by the manufacturer.			Clean twice per year or as required by the manufacturer. Remove sediment and other trapped pollutants at the frequency or level specified by the manufacturer. No use of clamshell buckets without prior approval. Increase inspection frequency, as needed, based on observed sediment loading.			
Sediment Forebay	Monthly. Four times per year and when sediment depth is between three to inches.			Remove sediment four times per year and when sediment depth is between three to six inches.			
Infiltration Basins	Inspect for proper operation at least twice per year. At least twice per year inspect the outlet structure for accumulated sediment and side slopes and spillway for erosion. Make any necessary repairs immediately			Remove sediment once per year or when buildup exceeds three (3) inches in depth.			
Subsurface Concrete Infiltration Chamber System	Inspect monthly for the first three months. Then, at a minimum, the treatment structure is to be inspected twice annually and the infiltrating structure is to be inspected annually as required by the manufacturer.			Remove sediment once per year or when buildup exceeds three (3) inches in depth.			

Stormwater Supervisor Contact Information:____

APPENDIX B

CONSTRUCTION PERIOD POLLUTION PREVENTION & EROSION & SEDIMENT CONTROL PLAN

CONSTRUCTION PERIOD POLLUTION PREVENTION
AND
EROSION AND SEDIMENTATION CONTROL PLAN

SITE DEVELOPMENT PERMITTING
14 STERLING ROAD
BILLERICA, MASSACHUSETTS

Applicant:

STERLING ROAD, LLC
14 STERLING ROAD
BILLERICA, MA 01862

Prepared By:

CIVIL & ENVIRONMENTAL CONSULTANTS, INC.
31 BELLOWS ROAD
RAYNHAM, MASSACHUSETTS 02767

CEC Project 347-159

MARCH 2026

CONSTRUCTION PERIOD POLLUTION PREVENTION AND EROSION AND SEDIMENTATION CONTROL PLAN

INTRODUCTION

The greatest potential for sediment generation will occur during construction. An extensive erosion and sedimentation control program is proposed and will be diligently implemented during construction of the Project. The erosion control program will minimize erosion and sedimentation that could potentially impact resource areas. Water quality will be maintained by minimizing erosion of exposed soils and siltation. Erosion control barriers will be installed and exposed soil areas revegetated as soon as possible after work in an area is completed.

This Erosion and Sedimentation Control Plan includes preliminary measures and requirements for management and implementation of erosion and sediment controls during construction. A detailed Stormwater Pollution Prevention Plan (SWPPP) will be prepared, and a Notice of Intent (NOI) will be filed with the United States Environmental Protection Agency (USEPA) in accordance with USEPA's National Pollutant Discharge Elimination System (NPDES) General Permit program for stormwater discharges from construction sites prior to the commencement of any construction activity. The SWPPP will contain elements from this Erosion and Sediment Control Plan and will include additional and more detailed inspection and maintenance procedures as well as maintenance logs, forms, and additional erosion and sediment control measures.

Responsible Party for Plan Compliance:
Sterling Road, LLC
14 Sterling Road
Billerica, Massachusetts 01862

Emergency Contact Information:
To be determined.

CONSTRUCTION AND WASTE MATERIALS EXPECTED ON-SITE

Construction Materials & Waste

Construction materials staged on site are to be protected by measures to minimize the exposure to stormwater or precipitation. Provided measures either can be a cover or similarly effective means to minimize the discharge of pollutants from these areas. Examples of effective means include locating activities away from resource areas and stormwater inlets or conveyances and directing wash waters to a sediment basin or sediment trap, using filtration devices, such as filter bags or sand filters, or using other similarly effective controls.

The contractor will utilize and secure dumpsters / roll offs as deemed appropriate for sorting, temporary storage and disposal of waste. Waste disposal will be completed by the Contractor or by a waste disposal firm. Containers will be removed and replaced if appropriate when they are adequately filled or at the end of a specific construction task as deemed necessary by the construction supervisor.

The Contractor shall keep waste container lids closed when not in use and close lids at the end of the business day for those containers that are actively used throughout the day. For waste containers that do not have lids, provide either (1) cover (e.g., a tarp, plastic sheeting, temporary roof) to minimize exposure of wastes to precipitation, or (2) a similarly effective means designed to minimize the discharge of pollutants(e.g., secondary containment).

On business days, clean up and dispose of waste in designated waste containers. Clean up immediately if containers overflow.

Hazardous Waste

No Hazardous or toxic waste is anticipated to be present on site. If utilized or found to be present, the Plan will be modified. If applicable, any hazardous or toxic waste will be properly stored, managed and removed from the site pursuant to appropriate regulations, manufactures recommendations and Material Safety Data Sheets (MSDS).

Sanitary Waste

Portable sanitary facilities will be utilized at the site and pumped out at a time-frame sufficient to keep odor and material from disturbing personnel at the site or every 4 weeks.

For sanitary waste, position portable toilets so that they are secure and will not be tipped or knocked over and located away from waters of the U.S. and stormwater inlets or conveyances. Units will be inspected at least once per month and emptied regularly and as needed.

EROSION CONTROL MEASURES

The adjacent resource areas will be protected during construction by implementing siltation control measures, including the placement of silt fence with straw bales as close as feasible to the downgradient limit of construction activity. Temporary stabilized construction exits will be constructed as well. The project may also implement other stabilization methods such as erosion netting and hydroseeding.

Short and Long Term Goals and Criteria

Short and long-term goals will include a variety of stabilizing sediment and erosion controls around the limit of work. All construction-phase erosion and sediment controls have been designed to retain sediment on-site to the extent practicable and limit runoff and the discharge of pollutants (sediment) from exposed areas of the Site.

Litter and solid construction debris potentially exposed to the stormwater will be prevented from becoming a pollution source through routine monitoring and the use of laborers to "pick" as necessary.

Inspections

An experienced Construction Monitor will conduct inspections of construction areas once every 7 calendar days and within 24 hours of the occurrence of a storm event of 0.25 inches or greater, or the occurrence of runoff from snowmelt sufficient to cause a discharge. Storm event information from a weather station representative of the Site's location may be used to determine if a storm event of 0.25 inches or greater has occurred on the Site. Total rainfall will be measured for any day of rainfall during normal business hours that measures 0.25 inches or greater. Construction areas an experienced Construction Monitor will inspect include:

- Disturbed areas of the construction Site that have not been finally stabilized,
- Areas used for storage of materials that are exposed to precipitation,
- Structural control measures,
- Locations where vehicles enter or exit the Site, and
- The stormwater management system and discharge outlets.

Disturbed areas and areas used for storage of materials that are exposed to precipitation will be inspected for evidence of, or the potential for, pollutants entering the drainage system.

Sediment and erosion control measures identified will be observed to ensure that they are operating correctly. The discharge locations or points will be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to receiving waters. Locations where vehicles enter or exit the Site will be inspected for evidence of offsite sediment tracking.

Based on the results of these routine inspections, the Contractor will correct any deficiencies found as soon as practicable. Results of the inspections, corrective actions taken in response to any deficiencies, and any opportunities for improvement that are identified will be documented in an inspection report.

Stabilization Practices

The construction site activities will include numerous stabilizing practices. Sediment and erosion controls such as erosion netting, mulching and hydro seeding may act as interim practices. Erosion netting material may include single net straw blankets or coconut blankets. Permanent stabilization practices will include the use of a hydro seeding over vegetative support soil where additional exposure threatens stormwater quality. Seeding will be carried out with a seed mixture equal to the "Roadside Slope Mix" included below. All siltation barriers will remain in place until all exposed areas are re-vegetated.

Planting Schedule For Exposed Areas

1. All exposed areas will receive 6 inches of topsoil or compost material.

2. Seed will be equal to "Roadside Slope Mix" as specified by the Mass. Highway Department. Please refer to chart below for specifications. This mixture will be spread at a rate of 5 pounds per 1,000 square feet.

TABLE 1
ROADSIDE SLOPE MIX

Common Name	Germination Proportion	Purity Minimum	Minimum
Creeping Red Fescue	50%	85%	95%
Kentucky 3	30%	85%	95%
Domestic Rye	10%	90%	98%
Red Top	5%	85%	92%
Ladino Clover	5%	85%	96%

Specific Perimeter Controls

Erosion Control Blankets	
Description: Erosion control blankets will be used to minimize erosion on slopes of 3:1 or greater (as needed).	
Installation	When construction activities have permanently ceased or will be temporarily inactive for 14 or more calendar days.

Maintenance Requirements	Inspect for erosion. Re-grade and secure blankets as necessary.
Design Specifications	See Site Plans and Details.

Compost Silt Socks with Silt Fences	
Description: Compost Silt Socks will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site. Overlapping Silt Socks will be set to overlap at minimum twelve (12) inches. Silt Socks are to be anchored by two (2) inch by two (2) inch by thirty-six (36) inch hard wood stakes set downhill (away from construction) side and driven at least 12 (twelve) inches into the ground. Loose compost may be backfilled along the upslope side. In areas where high runoff velocities or high sediment loads are expected, Compost Silt Socks will be backed up with silt fencing.	
Installation	Prior to commencement of earth disturbance activities.
Maintenance Requirements	Remove sediment before it has accumulated to one-half of effective height of compost silt sock. Routinely inspect silt socks daily for signs of damage or vandalism. Inspection should be conducted within twenty-four (24) hours of a runoff event. Repair or replace as necessary for the duration of the project.
Design Specifications	See Site Plans and Details

Sediment Track-Out Controls

Gravel Construction Exit	
Description: A temporary crushed-stone construction exit will be constructed as detailed on the construction drawings. A cross slope will be placed in the entrance to direct runoff to a settling area and conveyance channels. If deemed necessary after construction begins, a wash pad may be included to wash off vehicle wheels before leaving the project site. Vehicle use will be restricted to properly designated exit points.	
Installation	Prior to commencement of earth disturbance activities.
Maintenance Requirements	Where sediment has been tracked-out from the site onto paved roads, sidewalks, or other paved areas outside of the site, remove the deposited sediment by the end of the same business day in which the track-out occurs or by the end of the next business day if track-out occurs on a non-business day.

	Remove the track-out by sweeping, shoveling, or vacuuming these surfaces, or by using other similarly effective means of sediment removal. Hosing or sweeping tracked-out sediment into any stormwater conveyance, storm drain inlet, or water of the U.S. is prohibited.
Design Specifications	See Site Plans and Details

Specific Storm Drain Inlet Controls

Silt Sacks	
Description: Silt Sacks will be installed in all existing catch basins along the project frontage indication on the site plans before commencing work.	
Installation	Prior to commencement of earth disturbance activities.
Maintenance Requirements	Routinely inspect silt sacks daily for signs of damage or vandalism. Inspection should be conducted within twenty-four (24) hours of a runoff event. Repair or replace as necessary for the duration of the project until upstream areas have been permanently stabilized. Regular maintenance includes lifting the inlet protection and cleaning around and under them as sediment collects.
Design Specifications	See Site Plans and Details.

Stockpile Controls

Compost Silt Socks	
Description: Compost silt socks will be placed to trap sediment along all downgradient perimeter areas of stockpiles. In areas where high runoff velocities or high sediment loads are expected, silt socks will be backed up with silt fencing.	
Installation	Prior to placement of stockpile materials.
Maintenance Requirements	Remove sediment before it has accumulated to one-half of the above-ground height of any perimeter control. Inspect daily for signs of damage or vandalism. Repair or replace as necessary for the duration of the project.
Design Specifications	See Site Plans and Details.

Stockpile Controls

Vegetation Stabilization	
Description: Annual grasses, such as annual rye, will be used to ensure rapid germination and production of root mass. Permanent stabilization will be completed with the planting of perennial grasses or legumes. Establishment of temporary and permanent vegetative cover may be established by hydro-seeding or sodding. A suitable topsoil, good seedbed preparation, and adequate lime, fertilizer and water will be provided for effective establishment of these vegetative stabilization methods.	
Installation	When construction activities have permanently ceased or will be temporarily inactive for 14 or more calendar days.
Maintenance Requirements	Inspect for erosion. Re-grade and secure as necessary.
Design Specifications	All new lawn areas and disturbed areas shall receive a minimum of 6 inches topsoil of the proper pH and organic content suitable for the healthy growth of lawns. These areas shall be seeded with a fine blade lawn grass seed.

NON-STRUCTURAL PRACTICES

Good Housekeeping

Non-structural controls are as effective as structural controls in sediment control. Non-structural controls to be used at the construction Site include:

- Regular sweeping of paved surfaces; and
- Prompt cleanup of any waste or spilled waste materials.

Exposure Minimization

Exposure will be minimized by providing both permanent and temporary soil stabilization over areas that have been completely constructed, or areas that will not be revisited within a 30-day period.

Where practicable, industrial materials and activities will be protected from exposure to rain, snow, snowmelt, or runoff.

Preventative Maintenance

A preventative maintenance program includes the timely inspection and maintenance of stormwater management devices. Examples of preventative maintenance include:

- Removal of obstructions, if any, from inlets and outlets.
- Removal of accumulated sediment and vacuuming water from sumps.
- Repairing and re-planting slope areas that experience erosion.

RECORD KEEPING

The following records will be maintained on the Site:

1. Dates when major grading activities occur,
2. Dates when construction activities temporarily or permanently cease on a portion of the Site,
3. Dates when stabilization measures are initiated, and
4. In addition, the following records will also be kept:
    - The Order of Conditions; and any additional permit conditions/approvals,
    - All inspection reports, and
    - Any spill reports.

APPENDIX B-1

CONSTRUCTION BMP MAINTENANCE LOG

Construction BMPs Maintenance Log

Project Name: Site Development Permitting
Project Location: 14 Sterling Road, Billerica, MA
Project Number: 347-159

Date: Mar. 2026
Prepared By: KFH
Approved By:

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning or Repair Needed (List Items if Required)	Date of Cleaning or Repair	Performed By
Pavement Sweeping	To be monitored as needed			Paved areas within the active construction site can be swept on a regular basis to remove larger sediment particles from construction activities. Pavement areas adjacent to the Site will be swept if dirt and debris is tracked from the active construction site.			
Catch Basin Inlet Protection (Silt Sack Sediment Trap)	Inspect at least once every 7 calendar days or once every 14 calendar days and within 24 hours of the occurrence of storm event of 0.25 inches or greater.			Inspect for proper operation. If clogged, remove accumulated sediment and properly dispose of to maintain the capacity of the catch basin.			
Erosion Control Barrier (Silt Fence / Silt Sock)	Inspect at least once every 7 calendar days or once every 14 calendar days and within 24 hours of the occurrence of storm event of 0.25 inches or greater.			Inspect for deterioration or failure. Remove sediment when buildup exceeds 6 inches or half the barrier height. The underside of straw bales should be kept in close contact with the earth and reset as necessary.			
Stabilized Construction Exit	Inspect at least once every 7 calendar days or once every 14 calendar days and within 24 hours of the occurrence of storm event of 0.25 inches or greater.			The exit shall be maintained in a condition that will prevent tracking of sediment onto public rights-of-way. The contractor shall sweep or wash pavement at exits which have experienced mud-tracking onto the pavement or traveled way. When wheel washing is required, it shall be done on an area stabilized with aggregate that drains into an approved sediment trapping device. When the construction exit becomes ineffective, the stone shall be removed along with the collected soil material and redistributed on-site in a stable manner. The exit should then be reconstructed. All sediment shall be prevented from entering storm drains, ditches, or waterways.			
Vegetated Slope Stabilization	Inspect at least once every 7 calendar days or once every 14 calendar days and within 24 hours of the occurrence of storm event of 0.25 inches or greater.			Inspect for erosion. Re-grade and re-seed as necessary.			

Stormwater Supervisor Contact Information:____

APPENDIX C

MASSDEP STORMWATER CHECKLIST

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

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[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

D S Kelley March 16, 2026
Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- [x] No disturbance to any Wetland Resource Areas
- [ ] Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- [ ] Reduced Impervious Area (Redevelopment Only)
- [ ] Minimizing disturbance to existing trees and shrubs
- [ ] LID Site Design Credit Requested:
  - [ ] Credit 1
  - [ ] Credit 2
  - [ ] Credit 3
- [ ] Use of “country drainage” versus curb and gutter conveyance and pipe
- [ ] Bioretention Cells (includes Rain Gardens)
- [ ] Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- [ ] Treebox Filter
- [ ] Water Quality Swale
- [ ] Grass Channel
- [ ] Green Roof
- [x] Other (describe): Infiltration basin and sediment forebay to manage surface runoff

Standard 1: No New Untreated Discharges

- [x] No new untreated discharges
- [x] Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- [x] Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist (continued)

Standard 2: Peak Rate Attenuation

- ☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.
- ☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.
- ☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

- ☒ Soil Analysis provided.
- ☒ Required Recharge Volume calculation provided.
- ☐ Required Recharge volume reduced through use of the LID site Design Credits.
- ☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

  ☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

- ☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.
- ☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.
- ☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.
- ☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:
  - ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
  - ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
  - ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
  - ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.
- ☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.
- ☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:
- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

  ☐ is within the Zone II or Interim Wellhead Protection Area

  ☐ is near or to other critical areas

  ☒ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)

  ☒ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☒ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☒ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☒ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

N/A ☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

N/A ☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

N/A ☐ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

N/A ☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

N/A ☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

APPENDIX D

GEOTECHNICAL INFORMATION

NRCS Custom Soil Resource Report
Test Pit Logs

United States Department of Agriculture

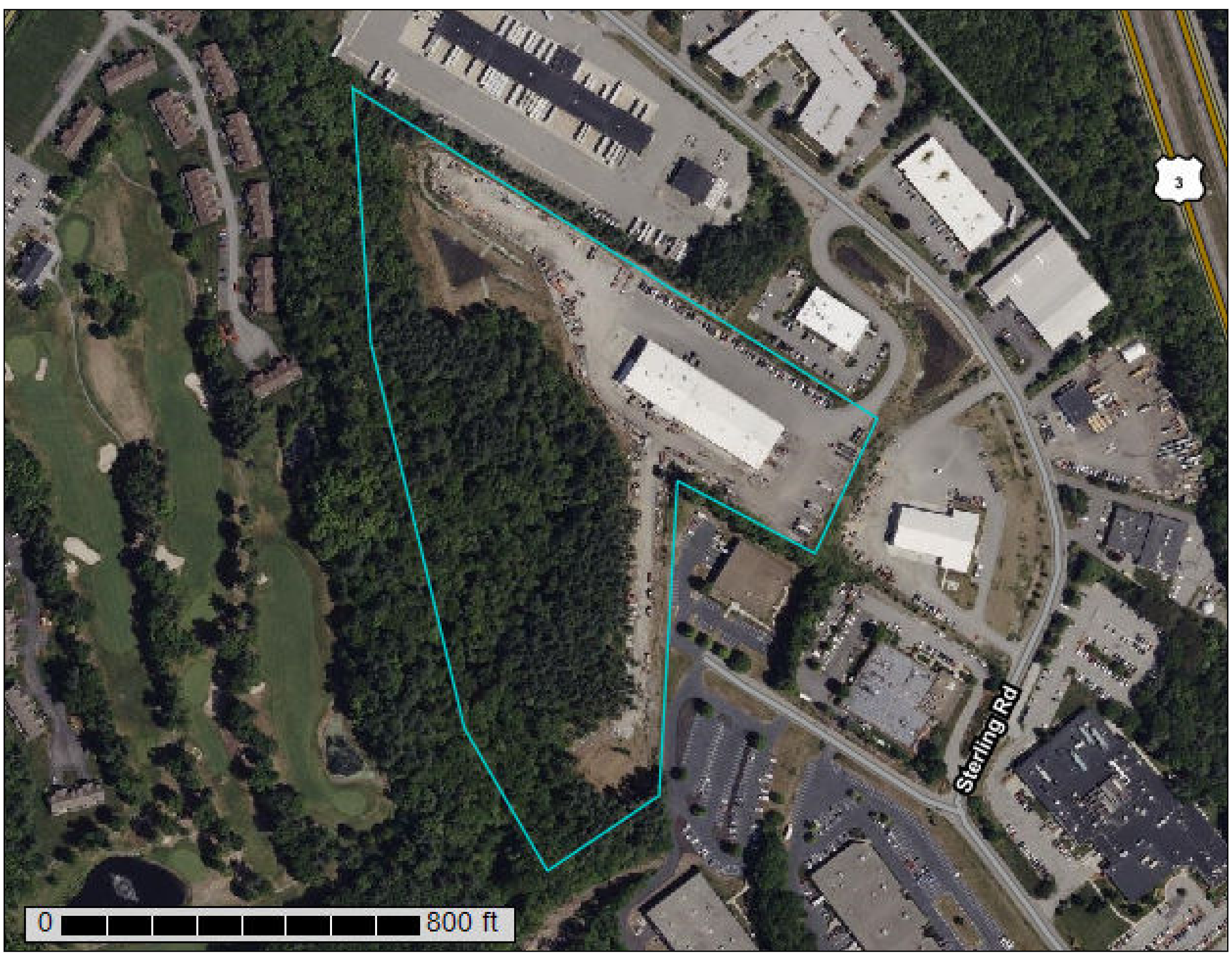
NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Middlesex County, Massachusetts



December 30, 2025

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

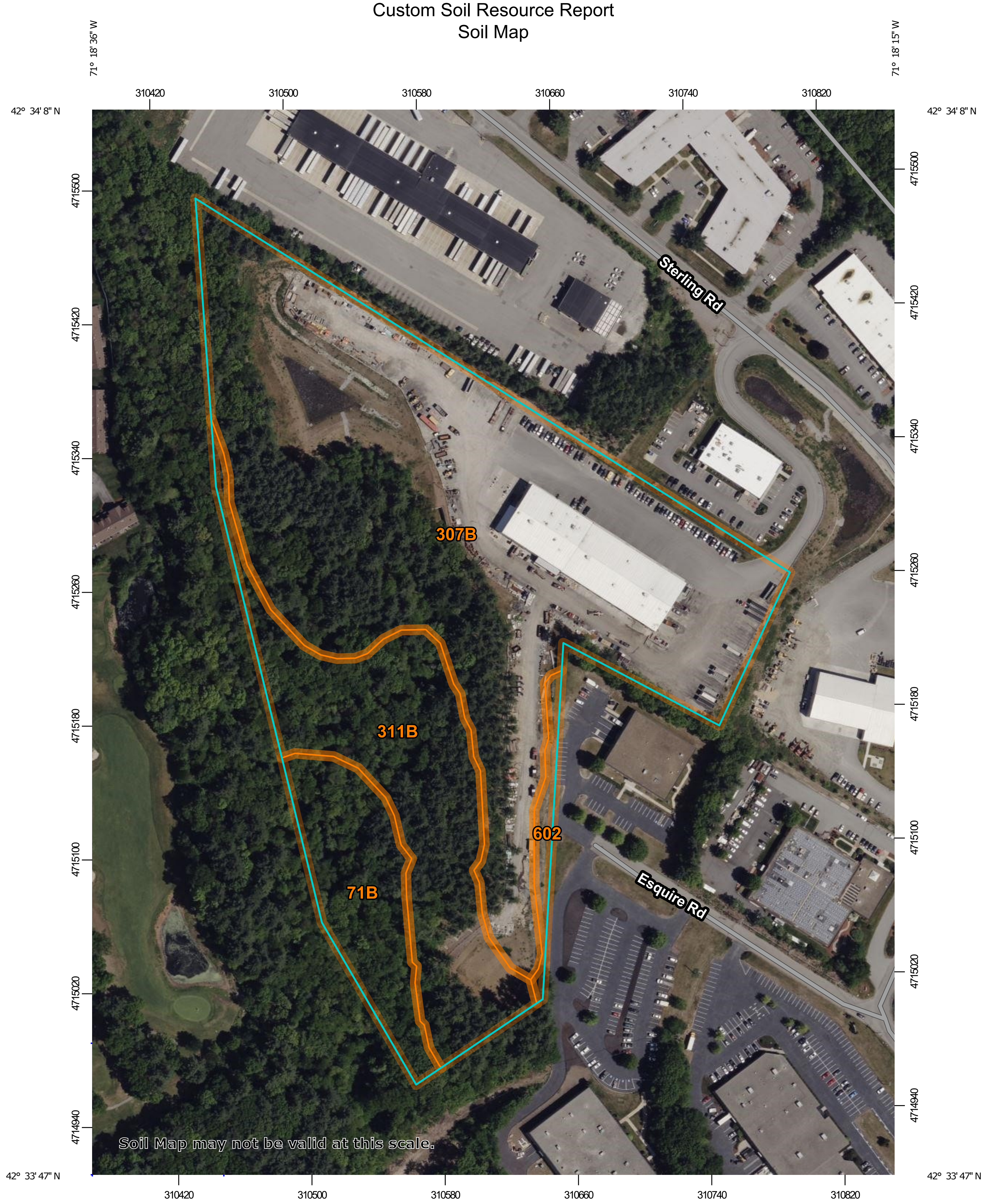
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:3,100 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0, 45, 90, 180, 270

Feet: 0, 150, 300, 600, 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

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 1:24,000.

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: Middlesex County, Massachusetts
Survey Area Data: Version 25, Sep 5, 2025

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

Date(s) aerial images were photographed: May 22, 2022—Jun 5, 2022

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
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	2.1	9.5%
307B	Paxton fine sandy loam, 0 to 8 percent slopes, extremely stony	15.1	68.3%
311B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	4.6	20.6%
602	Urban land	0.4	1.6%
Totals for Area of Interest		**22.1**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Middlesex County, Massachusetts

71B—Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony

Map Unit Setting

National map unit symbol: 2w69c
Elevation: 0 to 1,290 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Ridgebury, extremely stony, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ridgebury, Extremely Stony

Setting

Landform: Ground moraines, drainageways, drumlins, hills, depressions
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Typical profile

Oe - 0 to 1 inches: moderately decomposed plant material
A - 1 to 6 inches: fine sandy loam
Bw - 6 to 10 inches: sandy loam
Bg - 10 to 19 inches: gravelly sandy loam
Cd - 19 to 66 inches: gravelly sandy loam

Properties and qualities

Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 15 to 35 inches to densic material
Drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: F144AY009CT - Wet Till Depressions
Hydric soil rating: Yes

Minor Components

Woodbridge, extremely stony

Percent of map unit: 10 percent
Landform: Ground moraines, drumlins, hills
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex
Across-slope shape: Linear
Hydric soil rating: No

Whitman, extremely stony

Percent of map unit: 8 percent
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Paxton, extremely stony

Percent of map unit: 2 percent
Landform: Ground moraines, drumlins, hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Hydric soil rating: No

307B—Paxton fine sandy loam, 0 to 8 percent slopes, extremely stony

Map Unit Setting

National map unit symbol: 2w675
Elevation: 0 to 1,580 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Paxton, extremely stony, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Paxton, Extremely Stony

Setting

Landform: Ground moraines, drumlins, hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex

Parent material: Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Typical profile

Oe - 0 to 2 inches: moderately decomposed plant material
A - 2 to 10 inches: fine sandy loam
Bw1 - 10 to 17 inches: fine sandy loam
Bw2 - 17 to 28 inches: fine sandy loam
Cd - 28 to 67 inches: gravelly fine sandy loam

Properties and qualities

Slope: 0 to 8 percent
Surface area covered with cobbles, stones or boulders: 9.0 percent
Depth to restrictive feature: 20 to 43 inches to densic material
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)
Depth to water table: About 18 to 37 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: C
Ecological site: F144AY007CT - Well Drained Dense Till Uplands
Hydric soil rating: No

Minor Components

Woodbridge, extremely stony

Percent of map unit: 10 percent
Landform: Ground moraines, drumlins, hills
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Charlton, extremely stony

Percent of map unit: 5 percent
Landform: Hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Ridgebury, extremely stony

Percent of map unit: 4 percent
Landform: Ground moraines, drainageways, drumlins, hills, depressions
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Concave

Across-slope shape: Concave
Hydric soil rating: Yes

Whitman, extremely stony
Percent of map unit: 1 percent
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

311B—Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony

Map Unit Setting
National map unit symbol: 2t2qr
Elevation: 0 to 1,440 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Farmland of statewide importance

Map Unit Composition
Woodbridge, very stony, and similar soils: 82 percent
Minor components: 18 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Woodbridge, Very Stony

Setting
Landform: Ground moraines, drumlins, hills
Landform position (two-dimensional): Summit, backslope, footslope
Landform position (three-dimensional): Side slope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

Typical profile
Oe - 0 to 2 inches: moderately decomposed plant material
A - 2 to 9 inches: fine sandy loam
Bw1 - 9 to 20 inches: fine sandy loam
Bw2 - 20 to 32 inches: fine sandy loam
Cd - 32 to 67 inches: gravelly fine sandy loam

Properties and qualities
Slope: 0 to 8 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: 20 to 43 inches to densic material
Drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.14 in/hr)

Depth to water table: About 19 to 27 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 4.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: C/D
Ecological site: F144AY037MA - Moist Dense Till Uplands
Hydric soil rating: No

Minor Components

Paxton, very stony

Percent of map unit: 10 percent
Landform: Ground moraines, drumlins, hills
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Convex, linear
Across-slope shape: Linear, convex
Hydric soil rating: No

Ridgebury, very stony

Percent of map unit: 8 percent
Landform: Ground moraines, drainageways, drumlins, hills, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Head slope, base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

602—Urban land

Map Unit Setting

National map unit symbol: 9950
Elevation: 0 to 3,000 feet
Mean annual precipitation: 32 to 50 inches
Mean annual air temperature: 45 to 50 degrees F
Frost-free period: 110 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Setting

Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Excavated and filled land

Minor Components

Udorthents, wet substratum

Percent of map unit: 5 percent
Hydric soil rating: No

Rock outcrop

Percent of map unit: 5 percent
Landform: Ledges
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Head slope
Down-slope shape: Concave
Across-slope shape: Concave

Udorthents, loamy

Percent of map unit: 5 percent
Hydric soil rating: No

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DEPTH FROM SURFACE	SOIL HORIZON	SOIL MATRIX: COLOR-MOIST	REDOXIMORPHIC FEATURES DEPTH	COLOR	%	SOIL TEXTURE	GRAVEL	COBBLES\ STONES	SOIL STRUCTURE	SOIL CONSISTENCE
0 - 3"	A	10 YR 4/4	-	-	-	SANDY LOAM	-	-	WEAK BLOCKY	VERY FRIABLE
3 - 14"	B	10 YR 5/8	-	-	-	SANDY LOAM	-	-	BLOCKY	FRIABLE
14 - 90"	C1	10 YR 5/1	-	-	-	FINE SANDY LOAM	10%	-	MASSIVE	FRIABLE

ADDITIONAL NOTES: GROUNDWATER WEEPING @ 7'. NO STANDING WATER. END OF PIT @ 7.5' DUE TO COLLAPSING TRENCH

TP-02: 5/3/17 (8:15am) - Matthew Wzorek (Tighe & Bond), License #SE13598

DEPTH FROM SURFACE	SOIL HORIZON	SOIL MATRIX: COLOR-MOIST	REDOXIMORPHIC FEATURES DEPTH	COLOR	%	SOIL TEXTURE	GRAVEL	COBBLES\ STONES	SOIL STRUCTURE	SOIL CONSISTENCE
0 - 1"	O	-	-	-	-	-	-	-	-	-
1 - 8"	A	10 YR 4/4	-	-	-	SANDY LOAM	-	-	WEAK BLOCKY	VERY FRIABLE
8 - 24"	B	10 YR 5/8	-	-	-	SANDY LOAM	3%	-	BLOCKY	FRIABLE
24 - 120"	C	10 YR 5/1	-	-	-	FINE SANDY LOAM	10%	-	MASSIVE	FRIABLE

ADDITIONAL NOTES: STAINING @ 2.5' DUE TO TEXTURAL CHANGE. GROUNDWATER WEEPING @ 7.5'. END OF TEST PIT @ 10'

TP-03: 5/3/17 (9:00am) - Matthew Wzorek (Tighe & Bond), License #SE13598

DEPTH FROM SURFACE	SOIL HORIZON	SOIL MATRIX: COLOR-MOIST	REDOXIMORPHIC FEATURES DEPTH	COLOR	%	SOIL TEXTURE	GRAVEL	COBBLES\ STONES	SOIL STRUCTURE	SOIL CONSISTENCE
0 - 6"	A	10 YR 4/4	-	-	-	SANDY LOAM	-	-	BLOCKY	FRIABLE
6 - 16"	B	10 YR 5/8	-	-	-	SANDY LOAM	-	-	BLOCKY	FRIABLE
16 - 120"	C	10 YR 5/1	-	-	-	GRAVELLY SANDY LOAM	15%	-	MASSIVE	FRIABLE

ADDITIONAL NOTES: GROUNDWATER WEEPING @ 7'. NO STANDING WATER. END OF PIT @ 10'

TP-04: 5/3/17 (9:30am) - Matthew Wzorek (Tighe & Bond), License #SE13598

DEPTH FROM SURFACE	SOIL HORIZON	SOIL MATRIX: COLOR-MOIST	REDOXIMORPHIC FEATURES DEPTH	COLOR	%	SOIL TEXTURE	GRAVEL	COBBLES\ STONES	SOIL STRUCTURE	SOIL CONSISTENCE
0 - 1"	O	-	-	-	-	-	-	-	-	-
1 - 8"	A	10 YR 4/4	-	-	-	SANDY LOAM	-	-	BLOCKY	FRIABLE
8 - 22"	B	10 YR 5/8	-	-	-	SANDY LOAM	-	-	BLOCKY	FRIABLE
22 - 120"	C	10 YR 5/1	90"	-	-	GRAVELLY SANDY LOAM	15%	-	MASSIVE	FRIABLE

ADDITIONAL NOTES: GROUNDWATER WEEPING @ 7.5'. TOP OF MOTTLING @ 7.5'. NO STANDING WATER. END OF EXCAVATION @ 10'

TP-05: 5/3/17 (11:00am) - Matthew Wzorek (Tighe & Bond), License #SE13598

DEPTH FROM SURFACE	SOIL HORIZON	SOIL MATRIX: COLOR-MOIST	REDOXIMORPHIC FEATURES DEPTH	COLOR	%	SOIL TEXTURE	GRAVEL	COBBLES\ STONES	SOIL STRUCTURE	SOIL CONSISTENCE
0 - 2"	O	-	-	-	-	-	-	-	-	-
2 - 5"	A	10 YR 3/2	-	-	-	SANDY LOAM	-	-	WEAK BLOCKY	VERY FRIABLE
5 - 24"	B	10 YR 5/6	-	-	-	SANDY LOAM	-	-	BLOCKY	FRIABLE
24 - 120"	C	10 YR 6/1	-	-	-	GRAVELLY SANDY LOAM	15%	<5%	MASSIVE	FRIABLE

ADDITIONAL NOTES: NO MOTTLING OR GROUNDWATER ENCOUNTERED. END OF EXCAVATION @ 10'

TP-06: 5/4/17 (7:15am) - Matthew Wzorek (Tighe & Bond), License #SE13598

DEPTH FROM SURFACE	SOIL HORIZON	SOIL MATRIX: COLOR-MOIST	REDOXIMORPHIC FEATURES DEPTH	COLOR	%	SOIL TEXTURE	GRAVEL	COBBLES\ STONES	SOIL STRUCTURE	SOIL CONSISTENCE
0 - 1"	O	-	-	-	-	-	-	-	-	-
1 - 2"	A	10 YR 3/2	-	-	-	SANDY LOAM	-	-	WEAK BLOCKY	VERY FRIABLE
2 - 15"	B	10 YR 5/6	-	-	-	SANDY LOAM	-	-	BLOCKY	FRIABLE
15 - 120"	C	10 YR 6/1	-	-	-	GRAVELLY SANDY LOAM	15%	<5%	MASSIVE	FRIABLE

ADDITIONAL NOTES: NO MOTTLING OR GROUNDWATER ENCOUNTERED. END OF EXCAVATION @ 10'

TP-07: 5/3/17 (11:45am) - Matthew Wzorek (Tighe & Bond), License #SE13598

DEPTH FROM SURFACE	SOIL HORIZON	SOIL MATRIX: COLOR-MOIST	REDOXIMORPHIC FEATURES DEPTH	COLOR	%	SOIL TEXTURE	GRAVEL	COBBLES\ STONES	SOIL STRUCTURE	SOIL CONSISTENCE
0 - 3"	O	-	-	-	-	-	-	-	-	-
3 - 5"	A	10 YR 3/2	-	-	-	SANDY LOAM	-	-	WEAK BLOCKY	VERY FRIABLE
5 - 20"	B	10 YR 5/6	-	-	-	SANDY LOAM	-	-	BLOCKY	FRIABLE
20 - 120"	C	10 YR 6/1	-	-	-	GRAVELLY SANDY LOAM	15%	<5%	MASSIVE	FRIABLE

ADDITIONAL NOTES: NO MOTTLING OR GROUNDWATER ENCOUNTERED. END OF EXCAVATION @ 10'

TP-08: 5/4/17 (8:15am) - Matthew Wzorek (Tighe & Bond), License #SE13598

DEPTH FROM SURFACE	SOIL HORIZON	SOIL MATRIX: COLOR-MOIST	REDOXIMORPHIC FEATURES DEPTH	COLOR	%	SOIL TEXTURE	GRAVEL	COBBLES\ STONES	SOIL STRUCTURE	SOIL CONSISTENCE
0 - 1"	O	-	-	-	-	-	-	-	-	-
1 - 3"	A	10 YR 3/2	-	-	-	SANDY LOAM	-	-	WEAK BLOCKY	VERY FRIABLE
3 - 16"	B	10 YR 5/6	-	-	-	SANDY LOAM	-	-	BLOCKY	FRIABLE
16 - 120"	C	10 YR 6/1	-	-	-	GRAVELLY SANDY LOAM	15%	<5%	MASSIVE	FRIABLE

ADDITIONAL NOTES: NO MOTTLING OR GROUNDWATER ENCOUNTERED. END OF EXCAVATION @ 10'

TP-09: 5/4/17 (9:00am) - Matthew Wzorek (Tighe & Bond), License #SE13598

DEPTH FROM SURFACE	SOIL HORIZON	SOIL MATRIX: COLOR-MOIST	REDOXIMORPHIC FEATURES DEPTH	COLOR	%	SOIL TEXTURE	GRAVEL	COBBLES\ STONES	SOIL STRUCTURE	SOIL CONSISTENCE
0 - 1"	O	-	-	-	-	-	-	-	-	-
1 - 6"	A	10 YR 3/2	-	-	-	SANDY LOAM	-	-	BLOCKY	VERY FRIABLE
6 - 28"	B	10 YR 5/4	-	-	-	GRAVELLY LOAMY SAND	20%	-	SINGLE GRAIN	LOOSE
28 - 78"	C1	10 YR 6/4	34"	7.5YR 4/6	25%	VERY FINE SANDY LOAM	-	-	MASSIVE	VERY FRIABLE
78 - 90"	C2	10 YR 6/3	-	-	-	COURSE LOAMY SAND	-	-	SINGLE GRAIN	LOOSE

ADDITIONAL NOTES: GROUNDWATER SEEPING @ 36" ABOVE C1 LAYER. STANDING GROUND WATER BELOW C1 LAYER @ 6.5'. END OF EXCAVATION AT 9' DUE TO TRENCH COLLAPSE

TP-10: 5/4/17 (9:30am) - Matthew Wzorek (Tighe & Bond), License #SE13598

DEPTH FROM SURFACE	SOIL HORIZON	SOIL MATRIX: COLOR-MOIST	REDOXIMORPHIC FEATURES DEPTH	COLOR	%	SOIL TEXTURE	GRAVEL	COBBLES\ STONES	SOIL STRUCTURE	SOIL CONSISTENCE
0 - 2"	O	-	-	-	-	-	-	-	-	-
2 - 6"	A	10 YR 3/2	-	-	-	SANDY LOAM	-	-	WEAK BLOCKY	VERY FRIABLE
6 - 18"	B	10 YR 5/6	-	-	-	GRAVELLY LOAMY SAND	15%	-	BLOCKY	FRIABLE
18 - 84"	C1	10 YR 6/3	-	-	-	GRAVELLY LOAMY SAND	20%	10%	WEAK BLOCKY	VERY FRIABLE
84 - 96"	C2	10 YR 6/1	84"	7.5YR 4/6	10%	FINE SANDY LOAM	10%	-	BLOCKY	FRIABLE

ADDITIONAL NOTES: END OF EXCAVATION AT 9' DUE TO TRENCH COLLAPSE

Located within limits of existing western infiltration basin & proposed subsurface infiltration chambers (Refer to Site Plan C400)

TP-1A: 10/5/17 (1:00pm) - Timothy Grace (Tighe & Bond), License #SE14117

DEPTH FROM SURFACE	SOIL HORIZON	SOIL MATRIX: COLOR-MOIST	REDOXIMORPHIC FEATURES DEPTH	COLOR	%	SOIL TEXTURE	GRAVEL	COBBLES\ STONES	SOIL STRUCTURE	SOIL CONSISTENCE
0 - 3"	O	-	-	-	-	-	-	-	-	-
3 - 5"	A	10 YR 5/6	-	-	-	SANDY LOAM	10%	5%	GRANULAR	FRIABLE
5 - 16"	Bw	10 YR 6/6	-	-	-	LOAMY SAND	10%	10%	SINGLE GRAIN	LOOSE
16 - 31"	BC	10 YR 6/6	-	-	-	LOAMY SAND	15%	15%	SINGLE GRAIN	LOOSE
31 - 120"	Cd	10 YR 6/6	36"	10YR 7/8	5%	SAND	25%	20%	SINGLE GRAIN	LOOSE

ADDITIONAL NOTES: VERY DENSE Cd LAYER

TP-3A: 10/5/17 (12:10pm) - Timothy Grace (Tighe & Bond), License #SE14117

DEPTH FROM SURFACE	SOIL HORIZON	SOIL MATRIX: COLOR-MOIST	REDOXIMORPHIC FEATURES DEPTH	COLOR	%	SOIL TEXTURE	GRAVEL	COBBLES\ STONES	SOIL STRUCTURE	SOIL CONSISTENCE
0 - 3"	O	-	-	-	-	-	-	-	-	-
3 - 5"	A	2.5 YR 5/6	-	-	-	LOAMY SAND	5%	-	GRANULAR	FRIABLE
5 - 18"	Bw	10 YR 5/6	-	-	-	SANDY LOAM	10%	5%	MASSIVE	FRIABLE
18 - 120"	Cd	2.5 Y 6/3	45"	7.5YR 7/8	5%	SANDY LOAM	20%	10%	MASSIVE	FRIABLE

ADDITIONAL NOTES: VERY DENSE Cd LAYER

Located within limits of proposed infiltration basin P1 (Refer to Site Plan C401)

TP-4A: 10/5/17 (8:16am) - Timothy Grace (Tighe & Bond), License #SE14117

DEPTH FROM SURFACE	SOIL HORIZON	SOIL MATRIX: COLOR-MOIST	REDOXIMORPHIC FEATURES DEPTH	COLOR	%	SOIL TEXTURE	GRAVEL	COBBLES\ STONES	SOIL STRUCTURE	SOIL CONSISTENCE
0 - 3"	O	-	-	-	-	-	-	-	-	-
3 - 8"	A	2.5 YR 5/6	-	-	-	LOAMY SAND	5%	-	GRANULAR	FRIABLE
8 - 40"	Bw	2.5 YR 8/1	36"	10YR 6/8	2%	SAND	10%	5%	SINGLE GRAIN	LOOSE
40 - 120"	Cd	2.5 Y 8/1	60"	10YR 6/8	10%	SAND	20%	10%	SINGLE GRAIN	LOOSE

ADDITIONAL NOTES: VERY DENSE Cd LAYER

TP-5A: 10/5/17 (9:18am) - Timothy Grace (Tighe & Bond), License #SE14117

DEPTH FROM SURFACE	SOIL HORIZON	SOIL MATRIX: COLOR-MOIST	REDOXIMORPHIC FEATURES DEPTH	COLOR	%	SOIL TEXTURE	GRAVEL	COBBLES\ STONES	SOIL STRUCTURE	SOIL CONSISTENCE
0 - 2"	O	-	-	-	-	-	-	-	-	-
2 - 8"	A	2.5 YR 5/4	-	-	-	LOAMY SAND	-	-	GRANULAR	FRIABLE
8 - 32"	Bw	2.5 YR 7/2	-	-	-	LOAMY SAND	5%	-	MASSIVE	FRIABLE
32 - 96"	Cd	2.5 Y 7/1	48"	10YR 6/8	5%	SAND	15%	10%	SINGLE GRAIN	LOOSE

ADDITIONAL NOTES: MOIST @ 96". VERY DENSE MATERIAL FROM 36"+

TP-6A: 10/5/17 (10:37am) - Timothy Grace (Tighe & Bond), License #SE14117

DEPTH FROM SURFACE	SOIL HORIZON	SOIL MATRIX: COLOR-MOIST	REDOXIMORPHIC FEATURES DEPTH	COLOR	%	SOIL TEXTURE	GRAVEL	COBBLES\ STONES	SOIL STRUCTURE	SOIL CONSISTENCE
0 - 8"	A	2.5 YR 4/3	-	-	-	LOAMY SAND	5%	-	GRANULAR	FRIABLE
8 - 25"	Bw	2.5 YR 6/6	-	-	-	LOAMY SAND	5%	5%	MASSIVE	FRIABLE
25 - 132"	Cd	2.5 Y 7/2	48"	10YR 6/8	10%	SAND	15%	10%	SINGLE GRAIN	LOOSE

ADDITIONAL NOTES: VERY DENSE Cd LAYER. WET MATERIAL AT 120"

Tighe&Bond
Engineers | Environmental Specialists

COMMONWEALTH OF MASSACHUSETTS — FRANCIS J. HOEY III — CIVIL — No. 401.. — PROFESSIONAL ENGINEER

COMMONWEALTH OF MASSACHUSETTS — BRIAN S. HUNTLEY — CIVIL — No. 48273 — PROFESSIONAL ENGINEER

W.L. FRENCH EXCAVATING INC.

Headquarters & Operations Center

Billerica, Massachusetts

VERIFY SCALE
BAR IS 1 INCH ON ORIGINAL DRAWING
0 — 1 INCH
IF NOT ONE INCH ON THIS SHEET, ADJUST SCALES ACCORDINGLY

Mark	Date	Description
1	09/2018	ISSUED FOR CONSTRUCTION

PROJECT NO: D5007
FILE:
DRAWN BY: TJG/ELD
CHECKED: BSH/JEC
APPROVED BY: FJH

SOIL TEST PIT LOGS

SCALE: NO SCALE

G-3.0

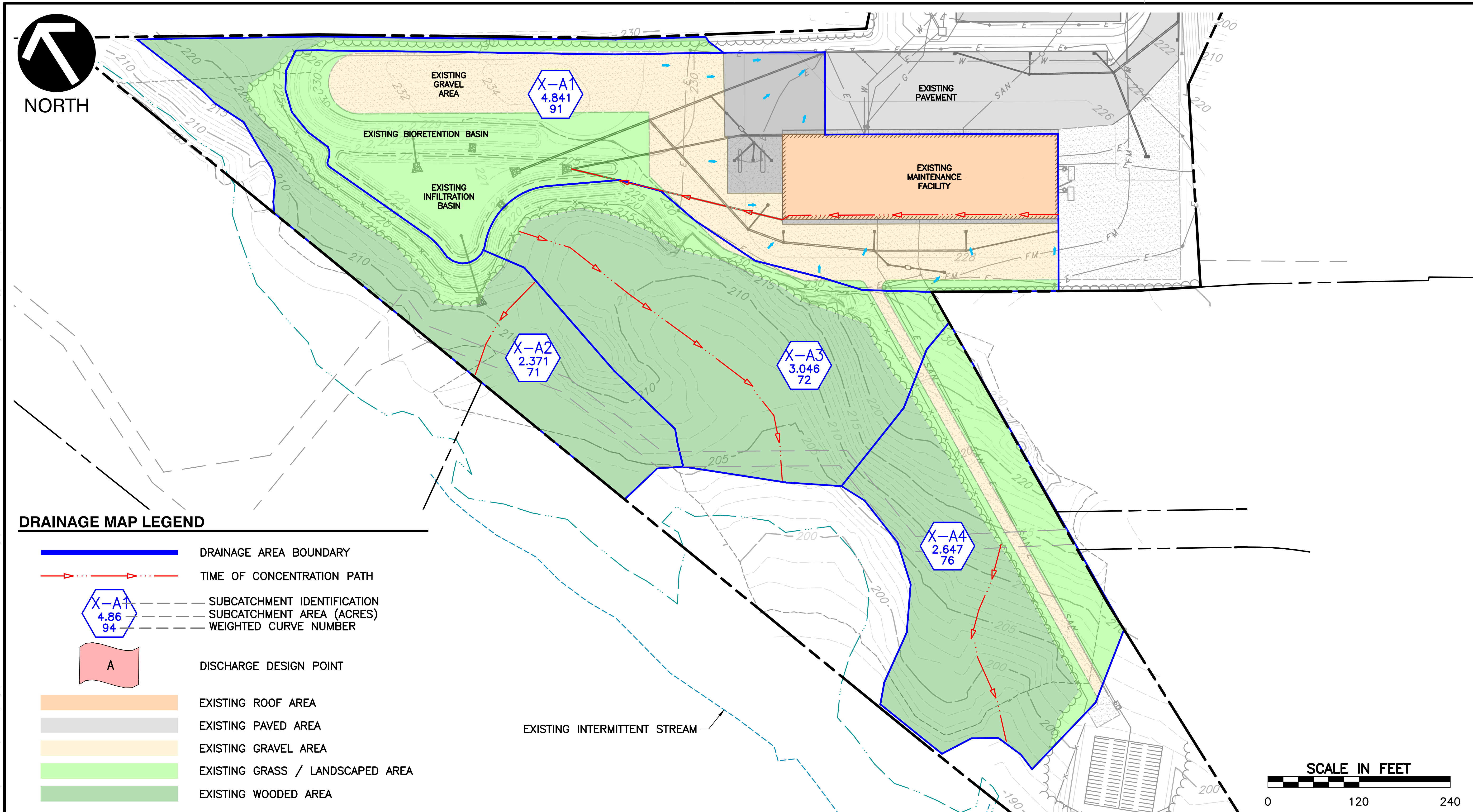
APPENDIX E

HYDROCAD ANALYSIS

E1: Figure HYD-PRE – Existing Conditions Drainage Area Map
Pre-Development HydroCAD Report
E2: Figure HYD-POST – Proposed Conditions Drainage Area Map
Post-Development HydroCAD Report
E3: Figure HYD-INT – Interim Conditions Drainage Area Map
Interim Conditions HydroCAD Report

APPENDIX E1

EXISTING CONDITIONS DRAINAGE AREA MAP
AND
PRE-DEVELOPMENT HYDROCAD ANALYSIS



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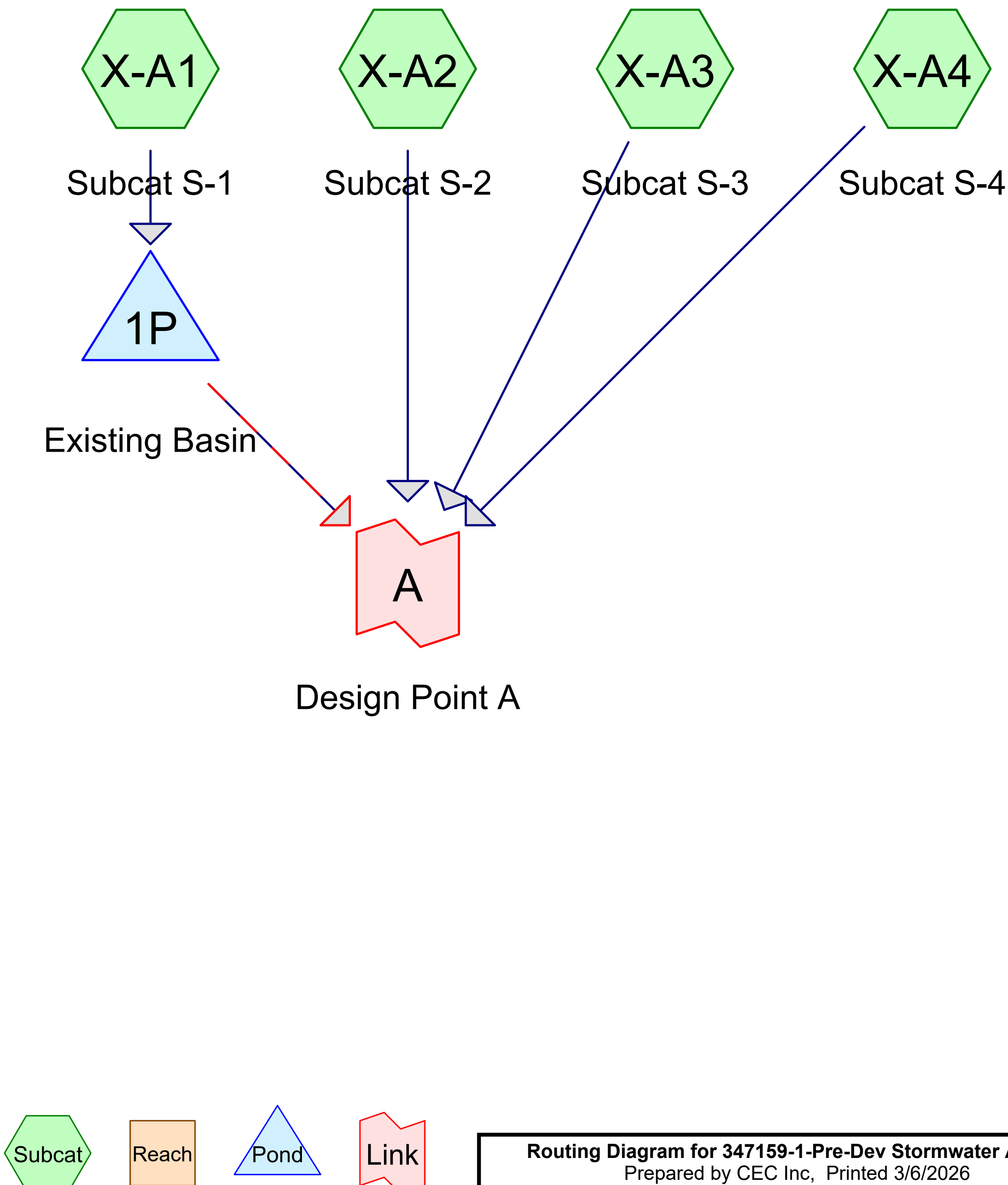
SITE DEVELOPMENT PERMITTING
14 STERLING ROAD, BILLERICA, MA
STERLING ROAD, LLC

PRE-DEVELOPMENT DRAINAGE MAP

DRAWN BY: KFH	CHECKED BY: DSK	APPROVED BY: DSK	FIGURE NO.: HYD-PRE
DATE: MARCH 2026	DWG SCALE: 1"=120'	PROJECT NO: 347-159	

ENGINEERING, SURVEYING AND LANDSCAPE ARCHITECTURE IN THE STATE OF NORTH CAROLINA WILL BE PROVIDED BY CEC SURVEYING AND LANDSCAPE ARCHITECTS OF NC, PLLC. SERVICES IN PUERTO RICO WILL BE PROVIDED BY CEC ENGINEERS & CONSULTANTS, LLC. LANDSCAPE ARCHITECTURE SERVICES IN THE STATE OF OHIO WILL BE PROVIDED BY CEC LANDSCAPE ARCHITECTS, LLC.

\\cecinc.com\global\Projects\340-000\347-159\-CADD\Dwg\SW01 - Site Plans for Permitting\347159-SW01-HYD-Pre-Development Drainage Map.dwg{LAYOUT1} LS:(2/19/2026 - khampton) - LP: 3/6/2026 5:13 PM



Routing Diagram for 347159-1-Pre-Dev Stormwater Analysis
Prepared by CEC Inc, Printed 3/6/2026

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-year 24hr	Type III 24-hr		Default	24.00	1	3.19	2
2	10-year 24hr	Type III 24-hr		Default	24.00	1	4.99	2
3	25-year 24hr	Type III 24-hr		Default	24.00	1	6.11	2
4	100-year 24hr	Type III 24-hr		Default	24.00	1	7.85	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
3.283	74	>75% Grass cover, Good, HSG C (X-A1, X-A2, X-A3, X-A4)
0.193	80	>75% Grass cover, Good, HSG D (X-A2, X-A4)
2.235	98	EX Gravel Surface, Impervious, HSG C (X-A1, X-A2, X-A3, X-A4)
0.507	98	Paved parking, HSG C (X-A1)
0.933	98	Roofs, HSG C (X-A1)
4.337	70	Woods, Good, HSG C (X-A1, X-A2, X-A3, X-A4)
1.417	77	Woods, Good, HSG D (X-A2, X-A3, X-A4)
12.905	**80**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
11.295	HSG C	X-A1, X-A2, X-A3, X-A4
1.610	HSG D	X-A2, X-A3, X-A4
0.000	Other	
12.905		**TOTAL AREA**

Summary for Subcatchment X-A1: Subcat S-1

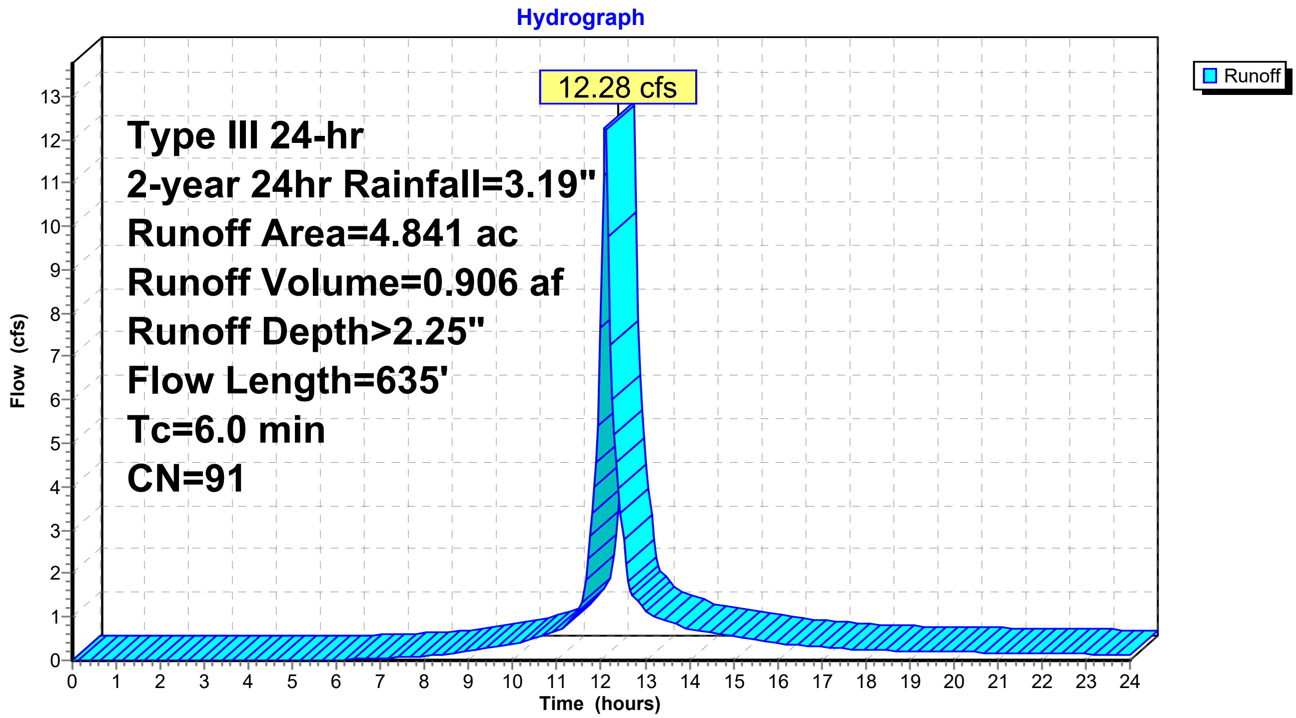
Runoff = 12.28 cfs @ 12.09 hrs, Volume= 0.906 af, Depth> 2.25"
Routed to Pond 1P : Existing Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
1.412	74	>75% Grass cover, Good, HSG C
1.988	98	EX Gravel Surface, Impervious, HSG C
0.507	98	Paved parking, HSG C
0.933	98	Roofs, HSG C
0.000	70	Woods, Good, HSG C
4.841	91	Weighted Average
1.412		29.17% Pervious Area
3.429		70.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.19"
3.5	300	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.0	285	0.0060	4.60	8.14	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
5.7	635	Total, Increased to minimum Tc = 6.0 min			

Subcatchment X-A1: Subcat S-1



Summary for Subcatchment X-A2: Subcat S-2

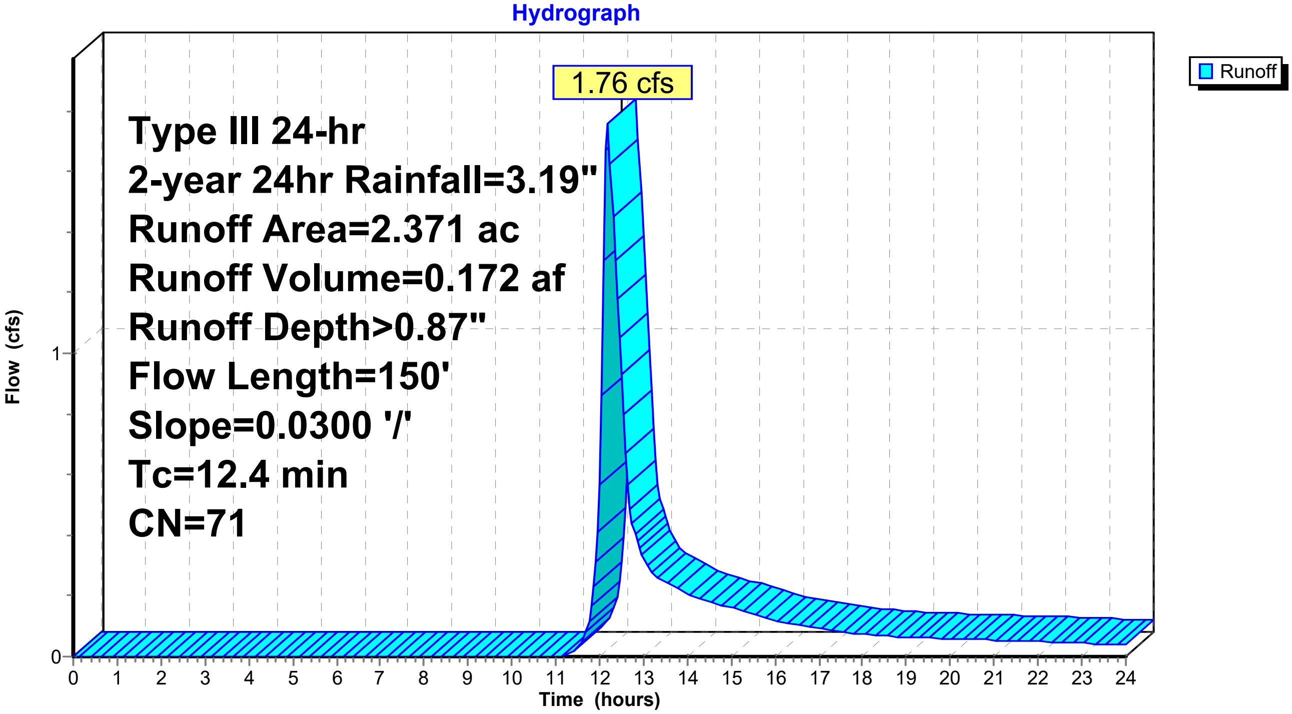
Runoff = 1.76 cfs @ 12.19 hrs, Volume= 0.172 af, Depth> 0.87"
Routed to Link A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
0.585	74	>75% Grass cover, Good, HSG C
0.002	80	>75% Grass cover, Good, HSG D
0.013	98	EX Gravel Surface, Impervious, HSG C
1.732	70	Woods, Good, HSG C
0.041	77	Woods, Good, HSG D
2.371	71	Weighted Average
2.359		99.47% Pervious Area
0.013		0.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.19"
1.9	100	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.4	150	Total			

Subcatchment X-A2: Subcat S-2



Summary for Subcatchment X-A3: Subcat S-3

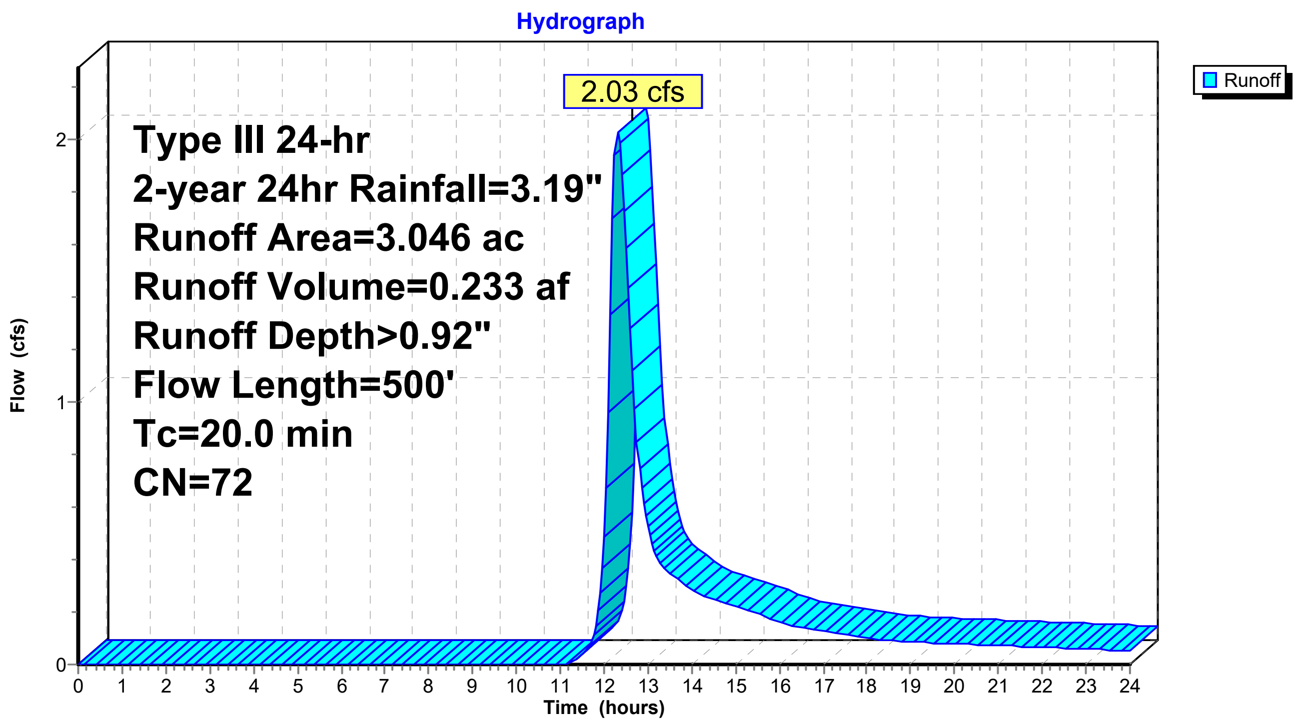
Runoff = 2.03 cfs @ 12.31 hrs, Volume= 0.233 af, Depth> 0.92"
Routed to Link A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
0.626	74	>75% Grass cover, Good, HSG C
0.066	98	EX Gravel Surface, Impervious, HSG C
2.059	70	Woods, Good, HSG C
0.295	77	Woods, Good, HSG D
3.046	72	Weighted Average
2.980		97.82% Pervious Area
0.066		2.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.19"
10.6	450	0.0200	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.0	500	Total			

Subcatchment X-A3: Subcat S-3



Summary for Subcatchment X-A4: Subcat S-4

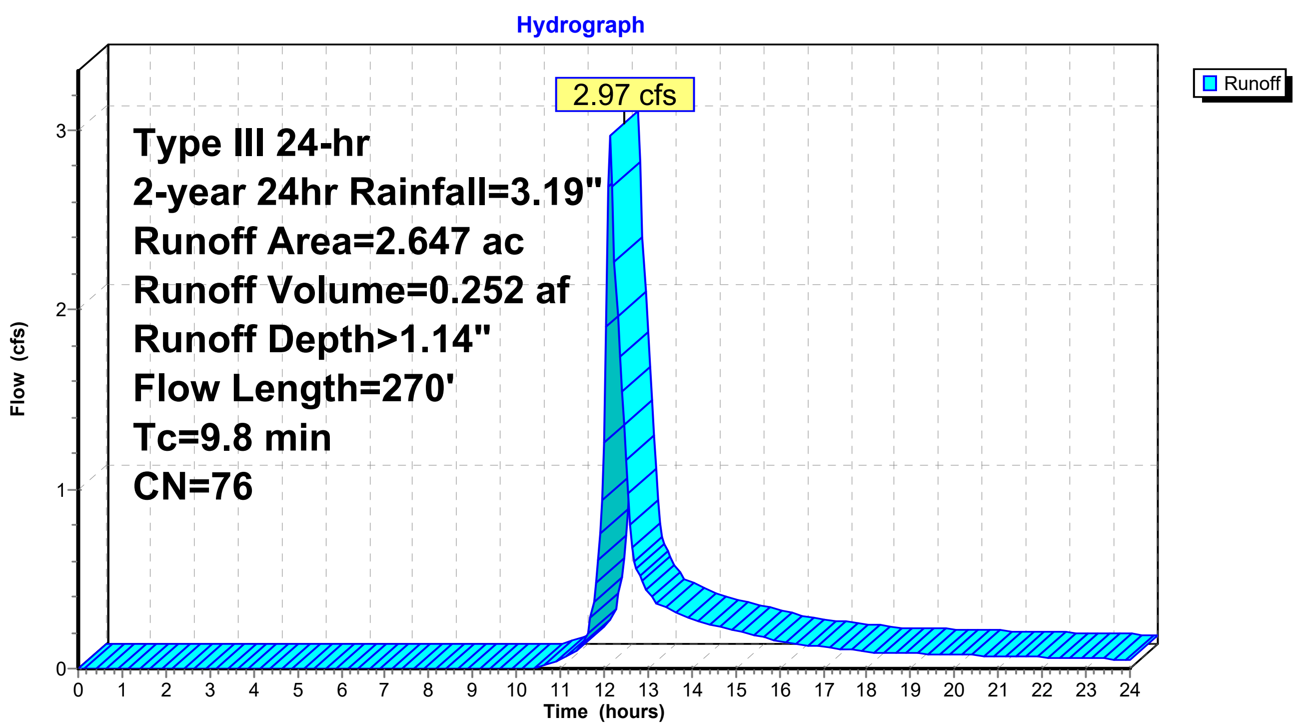
Runoff = 2.97 cfs @ 12.15 hrs, Volume= 0.252 af, Depth> 1.14"
Routed to Link A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
0.661	74	>75% Grass cover, Good, HSG C
0.191	80	>75% Grass cover, Good, HSG D
0.167	98	EX Gravel Surface, Impervious, HSG C
0.546	70	Woods, Good, HSG C
1.081	77	Woods, Good, HSG D
2.647	76	Weighted Average
2.479		93.67% Pervious Area
0.167		6.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	50	0.0900	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.19"
3.0	220	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.8	270	Total			

Subcatchment X-A4: Subcat S-4



Summary for Pond 1P: Existing Basin

Inflow Area = 4.841 ac, 70.83% Impervious, Inflow Depth > 2.25" for 2-year 24hr event
Inflow = 12.28 cfs @ 12.09 hrs, Volume= 0.906 af
Outflow = 1.29 cfs @ 12.89 hrs, Volume= 0.863 af, Atten= 90%, Lag= 47.9 min
Discarded = 0.65 cfs @ 12.89 hrs, Volume= 0.694 af
Primary = 0.64 cfs @ 12.89 hrs, Volume= 0.168 af
Routed to Link A : Design Point A
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link A : Design Point A

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 221.70' @ 12.89 hrs Surf.Area= 11,679 sf Storage= 17,347 cf

Plug-Flow detention time= 189.2 min calculated for 0.863 af (95% of inflow)
Center-of-Mass det. time= 162.3 min (964.4 - 802.1)

Volume	Invert	Avail.Storage	Storage Description
#1	220.00'	88,900 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
220.00	8,700	0	0
222.00	12,200	20,900	20,900
224.00	16,900	29,100	50,000
226.00	22,000	38,900	88,900

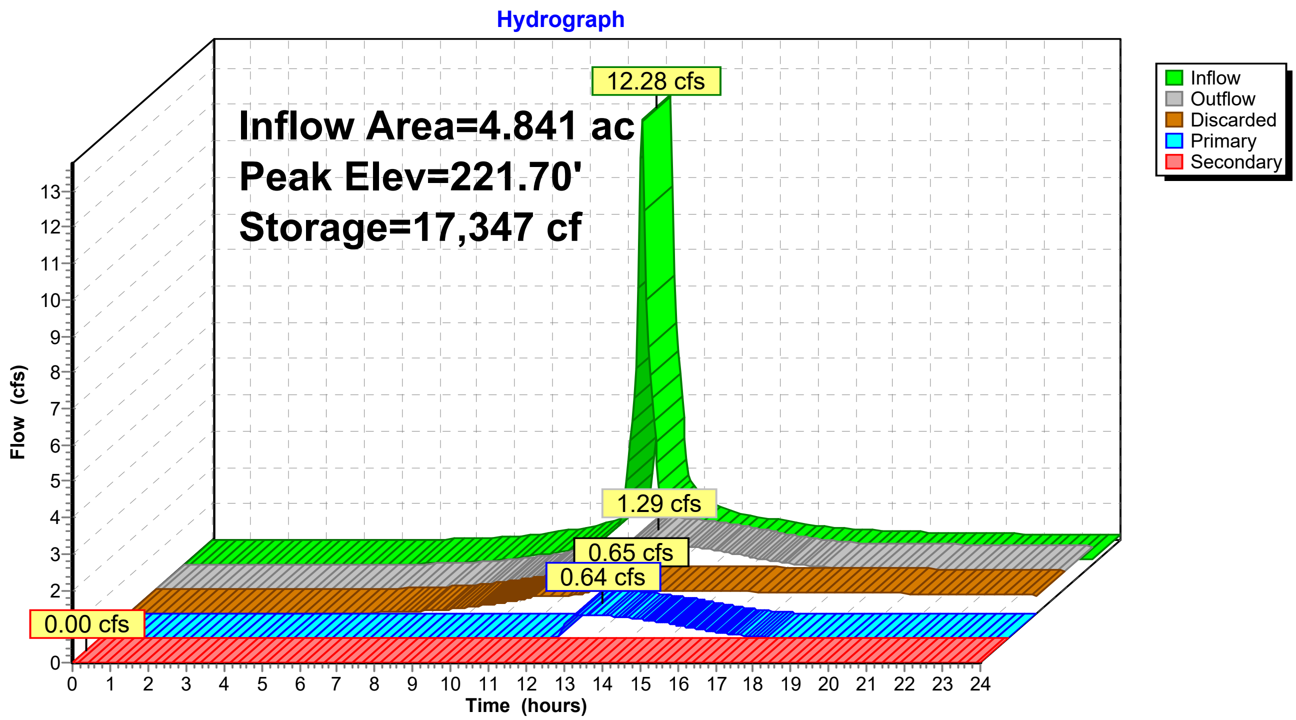
Device	Routing	Invert	Outlet Devices
#1	Secondary	225.10'	**8.0' long + 3.0 '/' SideZ x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#2	Primary	217.00'	**12.0" Round Culvert** L= 90.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 217.00' / 210.00' S= 0.0778 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Device 2	221.00'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	222.50'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 in 27.0" Grate (25% open area) Limited to weir flow at low heads
#5	Discarded	220.00'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.65 cfs @ 12.89 hrs HW=221.70' (Free Discharge)
└**5=Exfiltration** (Exfiltration Controls 0.65 cfs)

Primary OutFlow Max=0.64 cfs @ 12.89 hrs HW=221.70' (Free Discharge)
└**2=Culvert** (Passes 0.64 cfs of 7.75 cfs potential flow)
  ├**3=Orifice/Grate** (Orifice Controls 0.64 cfs @ 3.24 fps)
  └**4=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=220.00' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Existing Basin

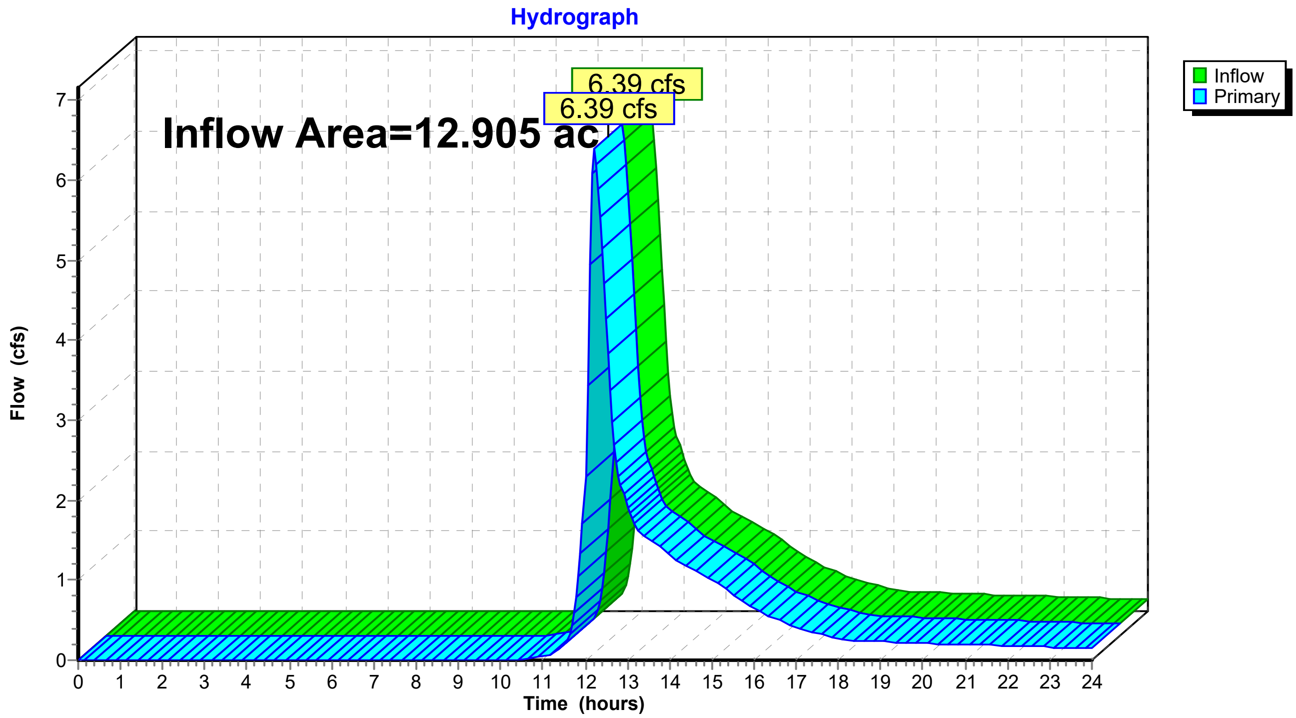


Summary for Link A: Design Point A

Inflow Area =	12.905 ac, 28.48% Impervious, Inflow Depth > 0.77" for 2-year 24hr event				
Inflow =	6.39 cfs @	12.21 hrs,	Volume=	0.825 af	
Primary =	6.39 cfs @	12.21 hrs,	Volume=	0.825 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link A: Design Point A



Summary for Subcatchment X-A1: Subcat S-1

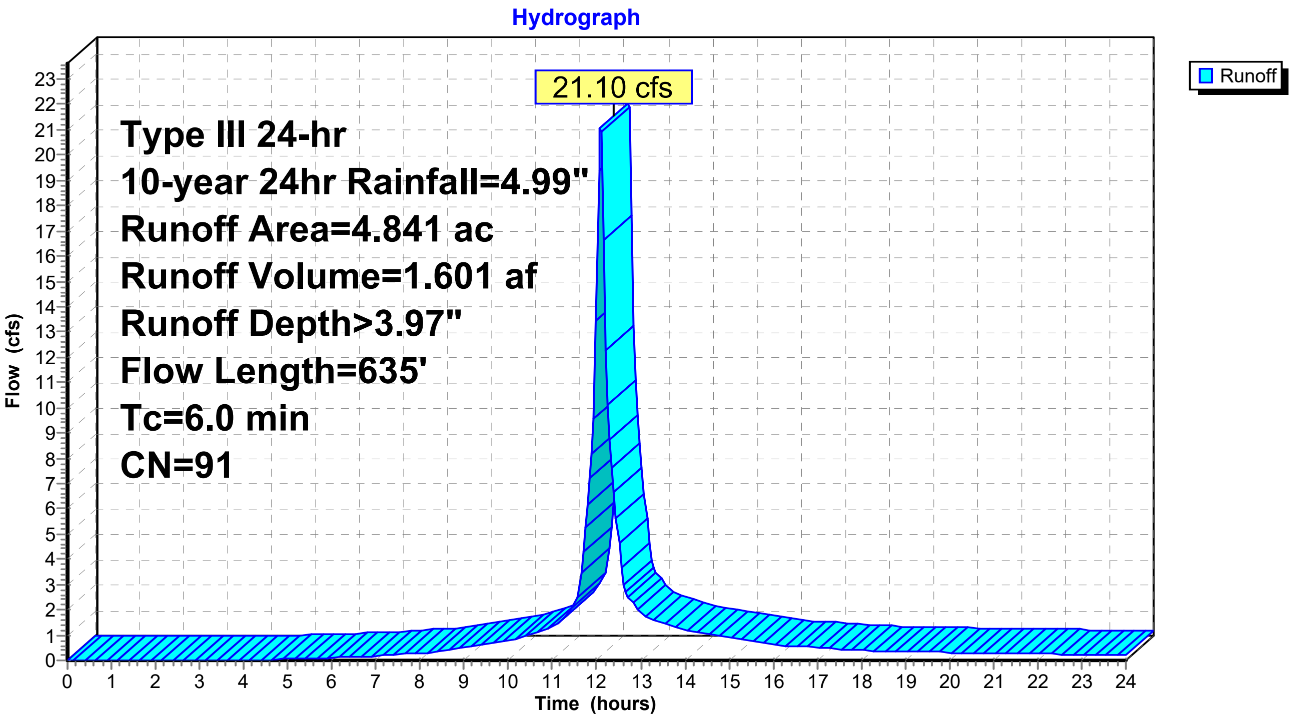
Runoff = 21.10 cfs @ 12.09 hrs, Volume= 1.601 af, Depth> 3.97"
Routed to Pond 1P : Existing Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
1.412	74	>75% Grass cover, Good, HSG C
1.988	98	EX Gravel Surface, Impervious, HSG C
0.507	98	Paved parking, HSG C
0.933	98	Roofs, HSG C
0.000	70	Woods, Good, HSG C
4.841	91	Weighted Average
1.412		29.17% Pervious Area
3.429		70.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.19"
3.5	300	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.0	285	0.0060	4.60	8.14	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
5.7	635	Total, Increased to minimum Tc = 6.0 min			

Subcatchment X-A1: Subcat S-1



Summary for Subcatchment X-A2: Subcat S-2

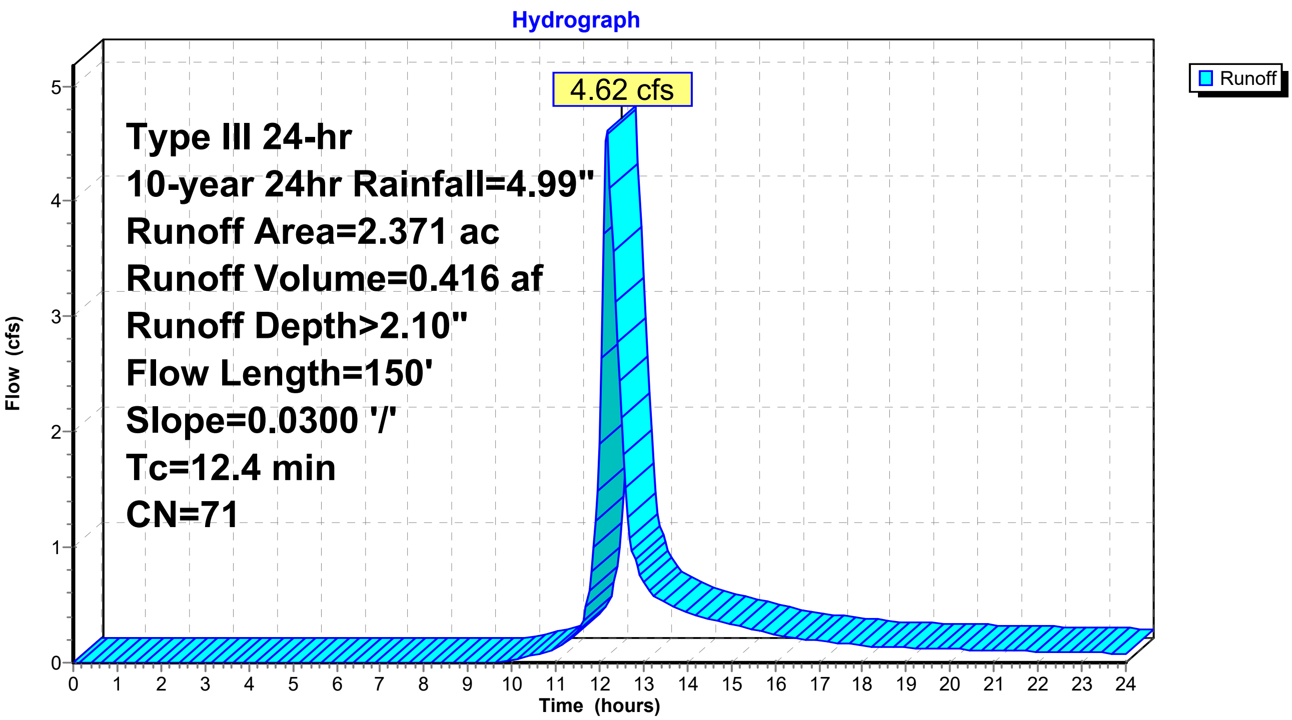
Runoff = 4.62 cfs @ 12.18 hrs, Volume= 0.416 af, Depth> 2.10"
Routed to Link A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
0.585	74	>75% Grass cover, Good, HSG C
0.002	80	>75% Grass cover, Good, HSG D
0.013	98	EX Gravel Surface, Impervious, HSG C
1.732	70	Woods, Good, HSG C
0.041	77	Woods, Good, HSG D
2.371	71	Weighted Average
2.359		99.47% Pervious Area
0.013		0.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.19"
1.9	100	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.4	150	Total			

Subcatchment X-A2: Subcat S-2



Summary for Subcatchment X-A3: Subcat S-3

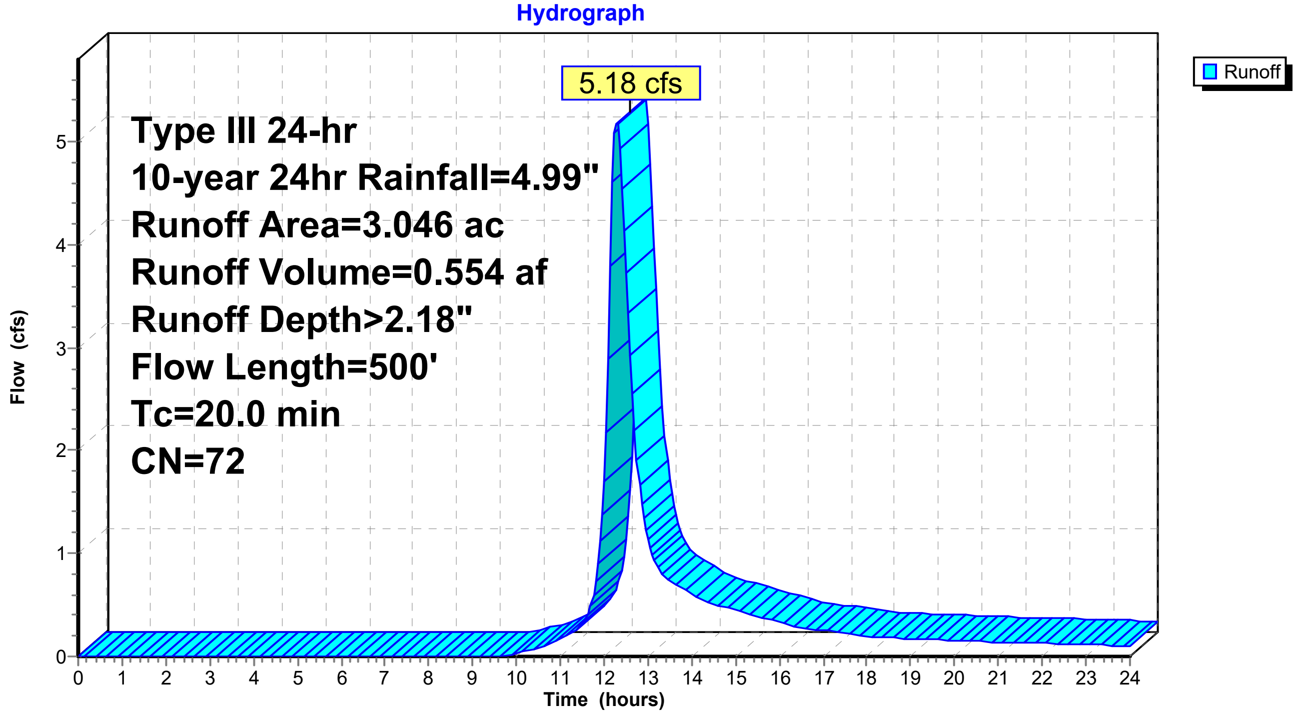
Runoff = 5.18 cfs @ 12.29 hrs, Volume= 0.554 af, Depth> 2.18"
Routed to Link A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
0.626	74	>75% Grass cover, Good, HSG C
0.066	98	EX Gravel Surface, Impervious, HSG C
2.059	70	Woods, Good, HSG C
0.295	77	Woods, Good, HSG D
3.046	72	Weighted Average
2.980		97.82% Pervious Area
0.066		2.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.19"
10.6	450	0.0200	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.0	500	Total			

Subcatchment X-A3: Subcat S-3



Summary for Subcatchment X-A4: Subcat S-4

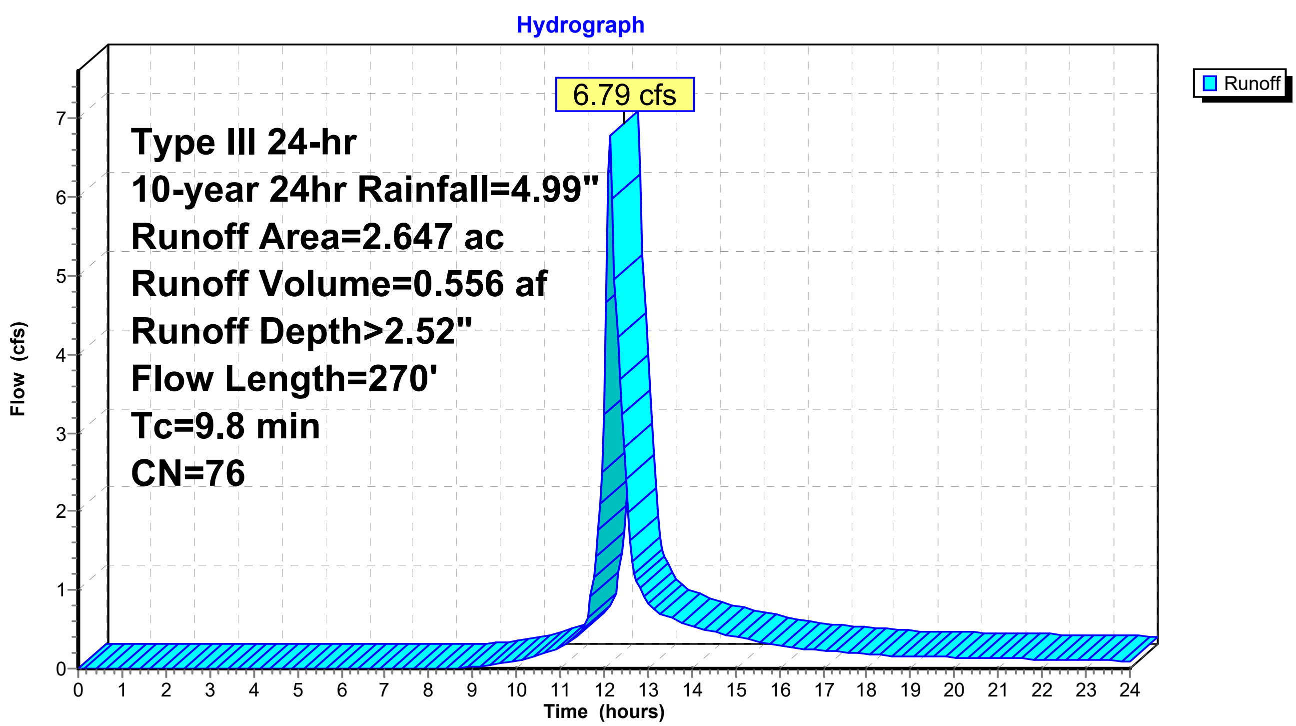
Runoff = 6.79 cfs @ 12.14 hrs, Volume= 0.556 af, Depth> 2.52"
Routed to Link A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
0.661	74	>75% Grass cover, Good, HSG C
0.191	80	>75% Grass cover, Good, HSG D
0.167	98	EX Gravel Surface, Impervious, HSG C
0.546	70	Woods, Good, HSG C
1.081	77	Woods, Good, HSG D
2.647	76	Weighted Average
2.479		93.67% Pervious Area
0.167		6.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	50	0.0900	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.19"
3.0	220	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.8	270	Total			

Subcatchment X-A4: Subcat S-4



Summary for Pond 1P: Existing Basin

Inflow Area = 4.841 ac, 70.83% Impervious, Inflow Depth > 3.97" for 10-year 24hr event
Inflow = 21.10 cfs @ 12.09 hrs, Volume= 1.601 af
Outflow = 4.31 cfs @ 12.52 hrs, Volume= 1.450 af, Atten= 80%, Lag= 25.7 min
Discarded = 0.78 cfs @ 12.52 hrs, Volume= 0.832 af
Primary = 3.53 cfs @ 12.52 hrs, Volume= 0.618 af
Routed to Link A : Design Point A
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link A : Design Point A

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 222.75' @ 12.52 hrs Surf.Area= 13,958 sf Storage= 30,682 cf

Plug-Flow detention time= 179.0 min calculated for 1.447 af (90% of inflow)
Center-of-Mass det. time= 132.9 min (919.4 - 786.4)

Volume	Invert	Avail.Storage	Storage Description
#1	220.00'	88,900 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
220.00	8,700	0	0
222.00	12,200	20,900	20,900
224.00	16,900	29,100	50,000
226.00	22,000	38,900	88,900

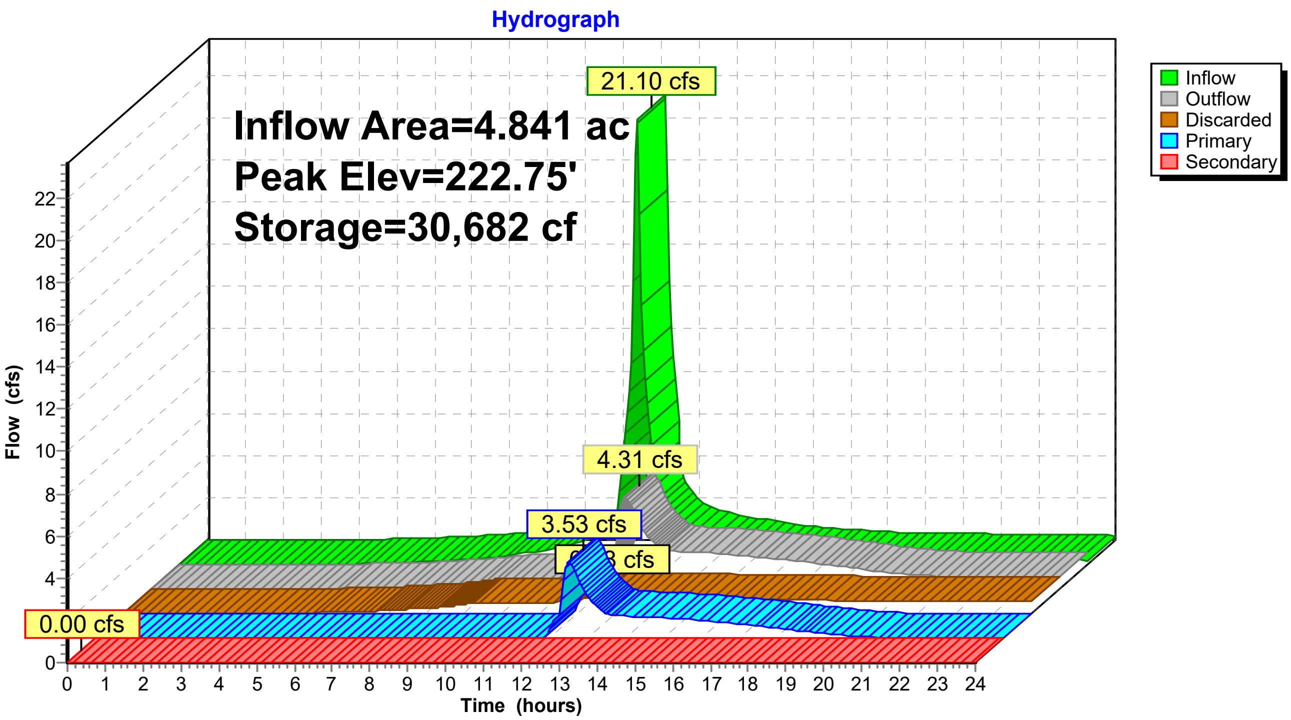
Device	Routing	Invert	Outlet Devices
#1	Secondary	225.10'	**8.0' long + 3.0 '/' SideZ x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#2	Primary	217.00'	**12.0" Round Culvert** L= 90.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 217.00' / 210.00' S= 0.0778 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Device 2	221.00'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	222.50'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 in 27.0" Grate (25% open area) Limited to weir flow at low heads
#5	Discarded	220.00'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.78 cfs @ 12.52 hrs HW=222.75' (Free Discharge)
└─**5=Exfiltration** (Exfiltration Controls 0.78 cfs)

Primary OutFlow Max=3.55 cfs @ 12.52 hrs HW=222.75' (Free Discharge)
└─**2=Culvert** (Passes 3.55 cfs of 8.66 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 1.16 cfs @ 5.89 fps)
  └─**4=Orifice/Grate** (Orifice Controls 2.39 cfs @ 2.39 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=220.00' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Existing Basin

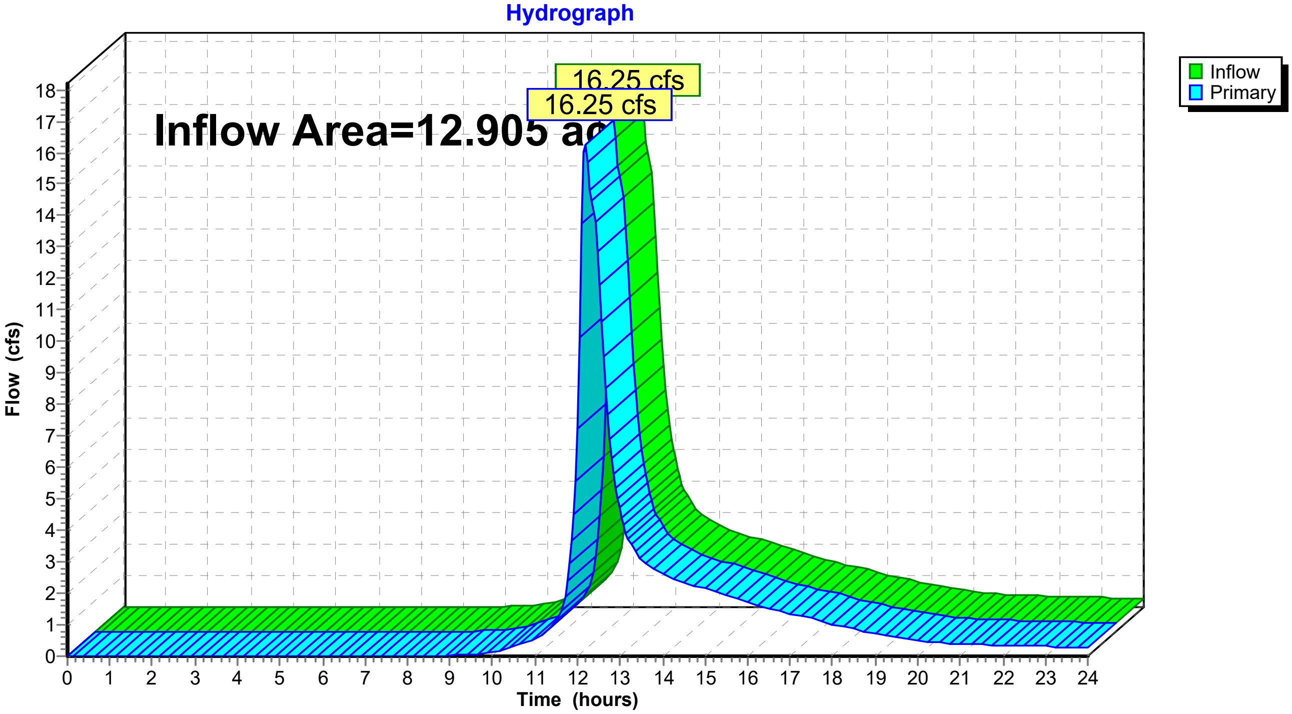


Summary for Link A: Design Point A

Inflow Area = 12.905 ac, 28.48% Impervious, Inflow Depth > 1.99" for 10-year 24hr event
Inflow = 16.25 cfs @ 12.18 hrs, Volume= 2.144 af
Primary = 16.25 cfs @ 12.18 hrs, Volume= 2.144 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link A: Design Point A



Summary for Subcatchment X-A1: Subcat S-1

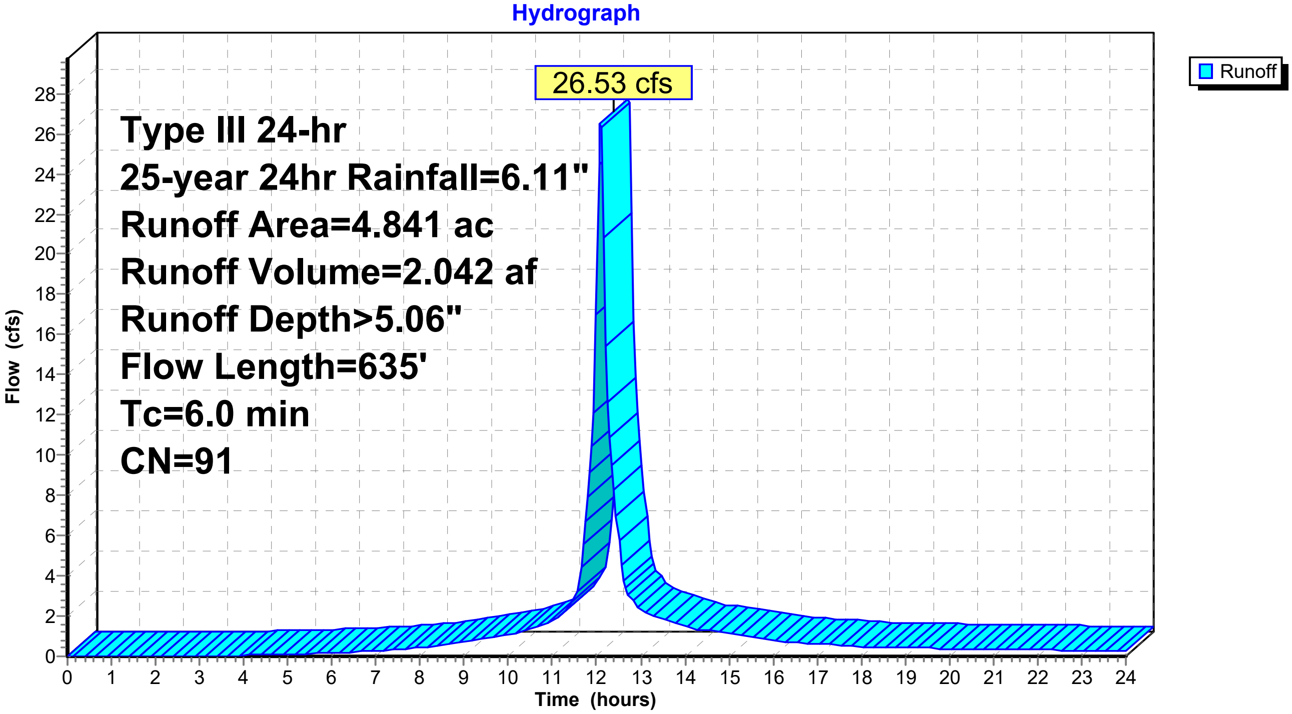
Runoff = 26.53 cfs @ 12.09 hrs, Volume= 2.042 af, Depth> 5.06"
Routed to Pond 1P : Existing Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
1.412	74	>75% Grass cover, Good, HSG C
1.988	98	EX Gravel Surface, Impervious, HSG C
0.507	98	Paved parking, HSG C
0.933	98	Roofs, HSG C
0.000	70	Woods, Good, HSG C
4.841	91	Weighted Average
1.412		29.17% Pervious Area
3.429		70.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.19"
3.5	300	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.0	285	0.0060	4.60	8.14	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
5.7	635	Total, Increased to minimum Tc = 6.0 min			

Subcatchment X-A1: Subcat S-1



Summary for Subcatchment X-A2: Subcat S-2

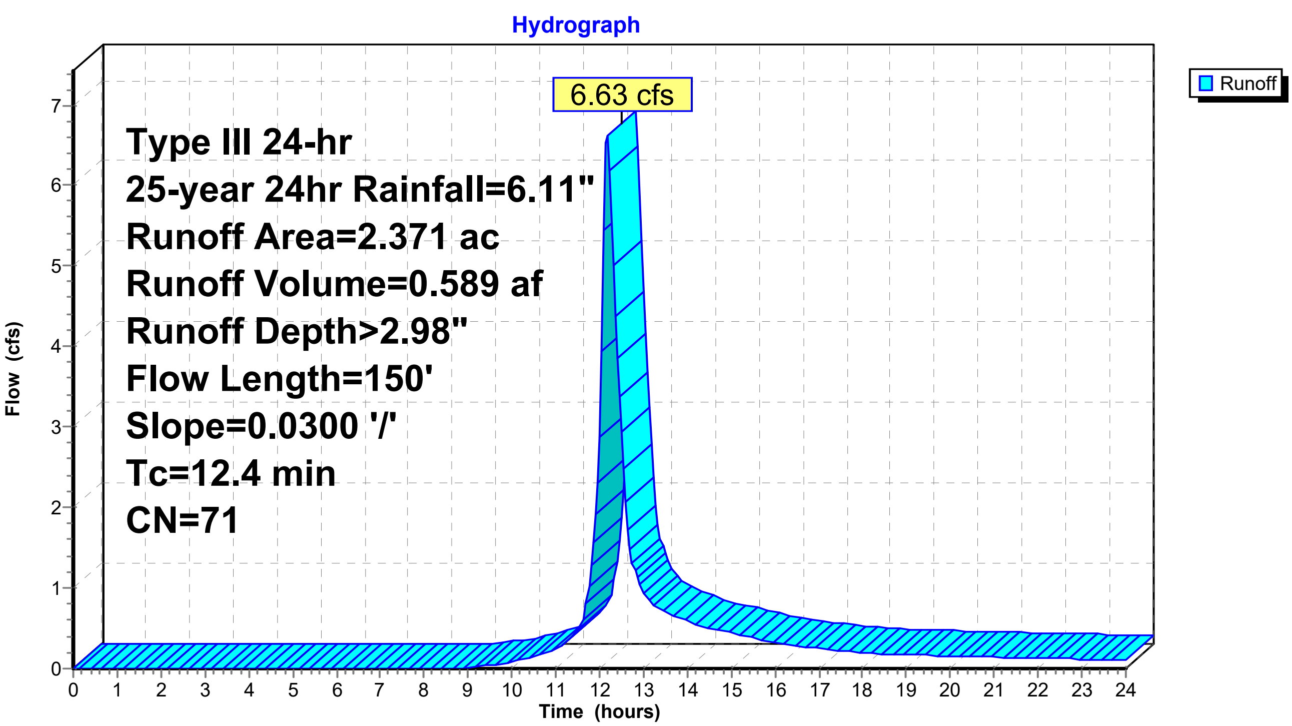
Runoff = 6.63 cfs @ 12.18 hrs, Volume= 0.589 af, Depth> 2.98"
Routed to Link A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
0.585	74	>75% Grass cover, Good, HSG C
0.002	80	>75% Grass cover, Good, HSG D
0.013	98	EX Gravel Surface, Impervious, HSG C
1.732	70	Woods, Good, HSG C
0.041	77	Woods, Good, HSG D
2.371	71	Weighted Average
2.359		99.47% Pervious Area
0.013		0.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.19"
1.9	100	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.4	150	Total			

Subcatchment X-A2: Subcat S-2



Summary for Subcatchment X-A3: Subcat S-3

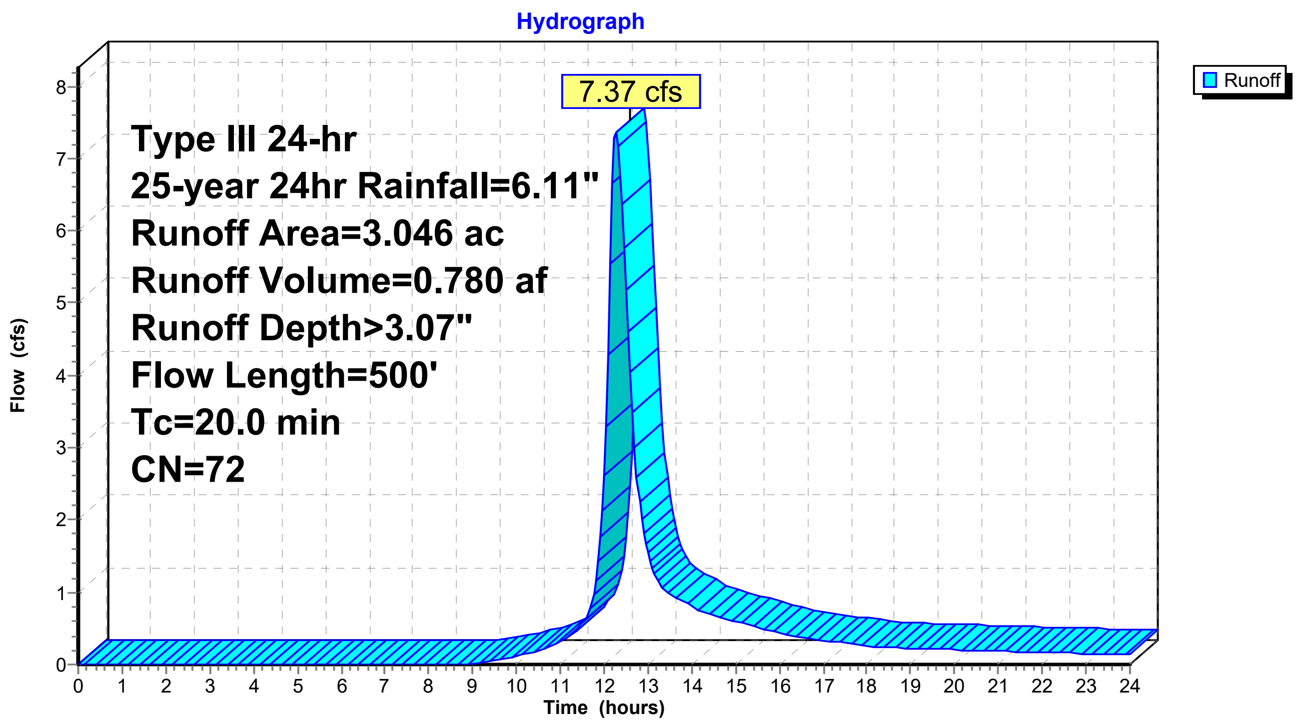
Runoff = 7.37 cfs @ 12.28 hrs, Volume= 0.780 af, Depth> 3.07"
Routed to Link A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
0.626	74	>75% Grass cover, Good, HSG C
0.066	98	EX Gravel Surface, Impervious, HSG C
2.059	70	Woods, Good, HSG C
0.295	77	Woods, Good, HSG D
3.046	72	Weighted Average
2.980		97.82% Pervious Area
0.066		2.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.19"
10.6	450	0.0200	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.0	500	Total			

Subcatchment X-A3: Subcat S-3



Summary for Subcatchment X-A4: Subcat S-4

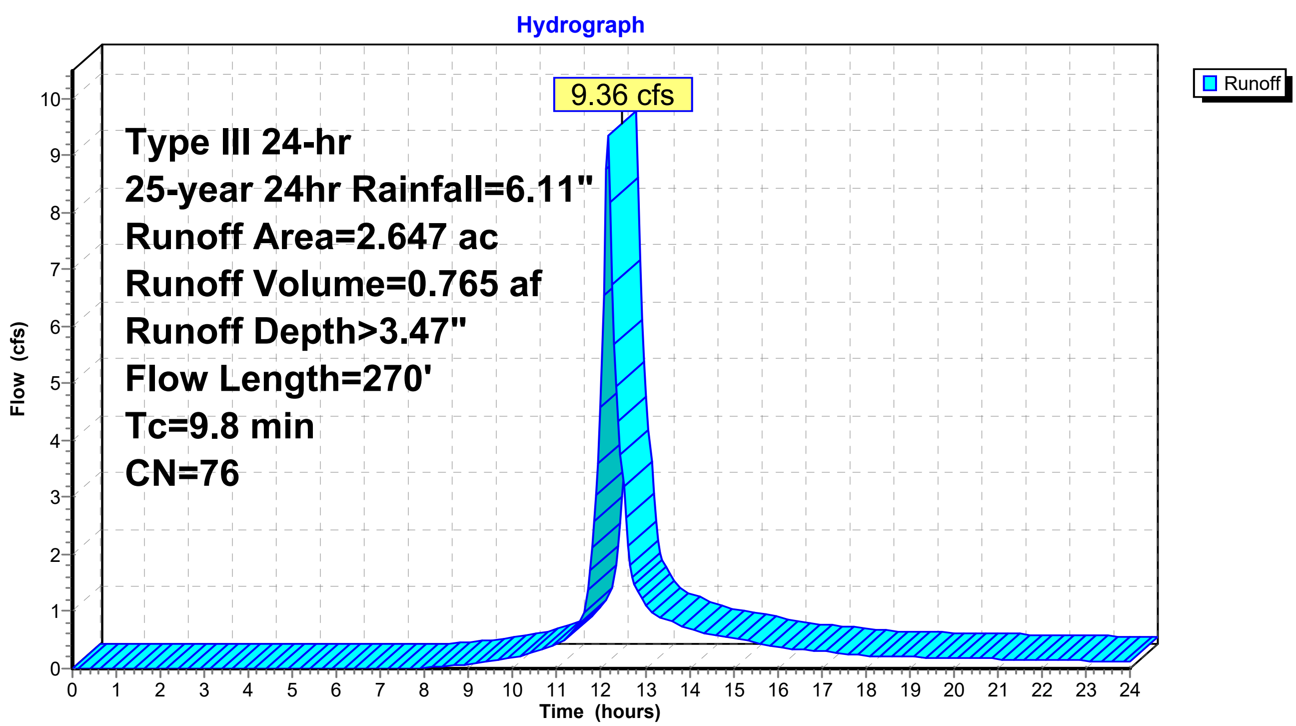
Runoff = 9.36 cfs @ 12.14 hrs, Volume= 0.765 af, Depth> 3.47"
Routed to Link A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
0.661	74	>75% Grass cover, Good, HSG C
0.191	80	>75% Grass cover, Good, HSG D
0.167	98	EX Gravel Surface, Impervious, HSG C
0.546	70	Woods, Good, HSG C
1.081	77	Woods, Good, HSG D
2.647	76	Weighted Average
2.479		93.67% Pervious Area
0.167		6.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	50	0.0900	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.19"
3.0	220	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.8	270	Total			

Subcatchment X-A4: Subcat S-4



Summary for Pond 1P: Existing Basin

Inflow Area = 4.841 ac, 70.83% Impervious, Inflow Depth > 5.06" for 25-year 24hr event
Inflow = 26.53 cfs @ 12.09 hrs, Volume= 2.042 af
Outflow = 6.27 cfs @ 12.48 hrs, Volume= 1.857 af, Atten= 76%, Lag= 23.5 min
Discarded = 0.84 cfs @ 12.48 hrs, Volume= 0.888 af
Primary = 5.42 cfs @ 12.48 hrs, Volume= 0.969 af
Routed to Link A : Design Point A
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link A : Design Point A

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 223.22' @ 12.48 hrs Surf.Area= 15,077 sf Storage= 37,595 cf

Plug-Flow detention time= 158.1 min calculated for 1.853 af (91% of inflow)
Center-of-Mass det. time= 113.3 min (893.4 - 780.0)

Volume	Invert	Avail.Storage	Storage Description
#1	220.00'	88,900 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
220.00	8,700	0	0
222.00	12,200	20,900	20,900
224.00	16,900	29,100	50,000
226.00	22,000	38,900	88,900

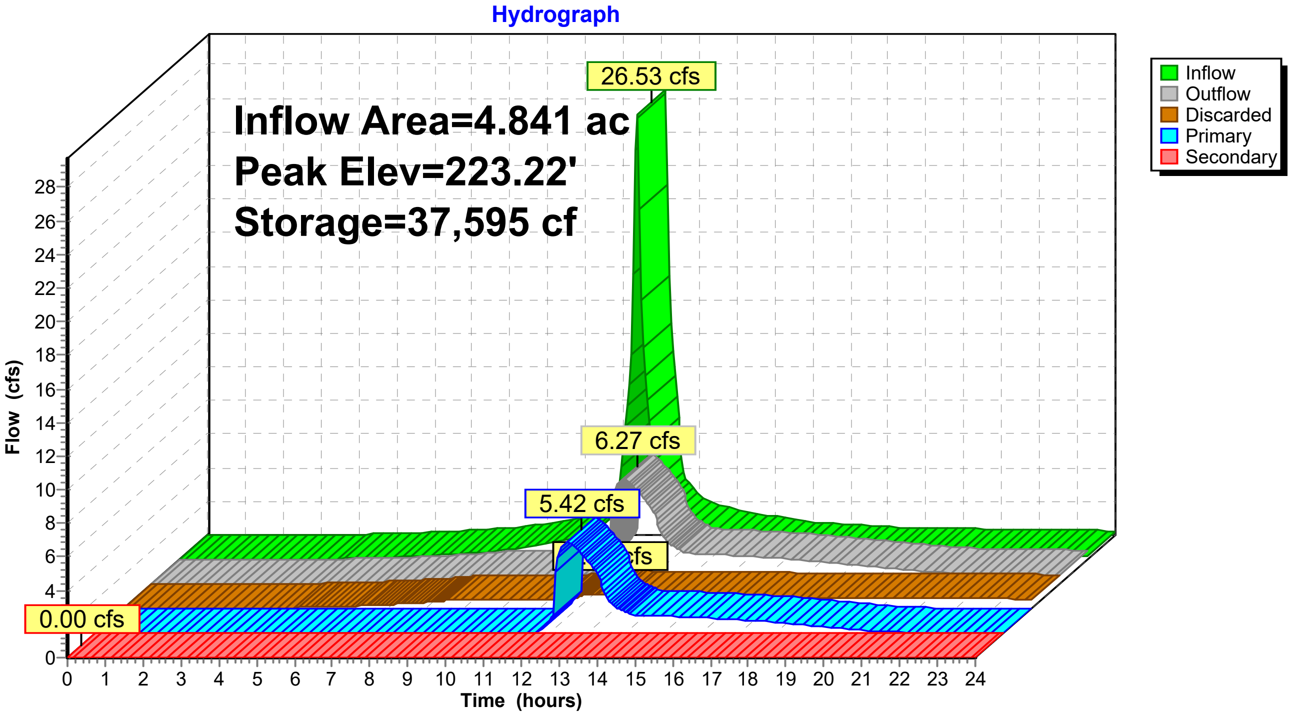
Device	Routing	Invert	Outlet Devices
#1	Secondary	225.10'	**8.0' long + 3.0 '/' SideZ x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#2	Primary	217.00'	**12.0" Round Culvert** L= 90.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 217.00' / 210.00' S= 0.0778 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Device 2	221.00'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	222.50'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 in 27.0" Grate (25% open area) Limited to weir flow at low heads
#5	Discarded	220.00'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.84 cfs @ 12.48 hrs HW=223.22' (Free Discharge)
└**5=Exfiltration** (Exfiltration Controls 0.84 cfs)

Primary OutFlow Max=5.42 cfs @ 12.48 hrs HW=223.22' (Free Discharge)
└**2=Culvert** (Passes 5.42 cfs of 9.05 cfs potential flow)
  ├**3=Orifice/Grate** (Orifice Controls 1.33 cfs @ 6.76 fps)
  └**4=Orifice/Grate** (Orifice Controls 4.09 cfs @ 4.09 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=220.00' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

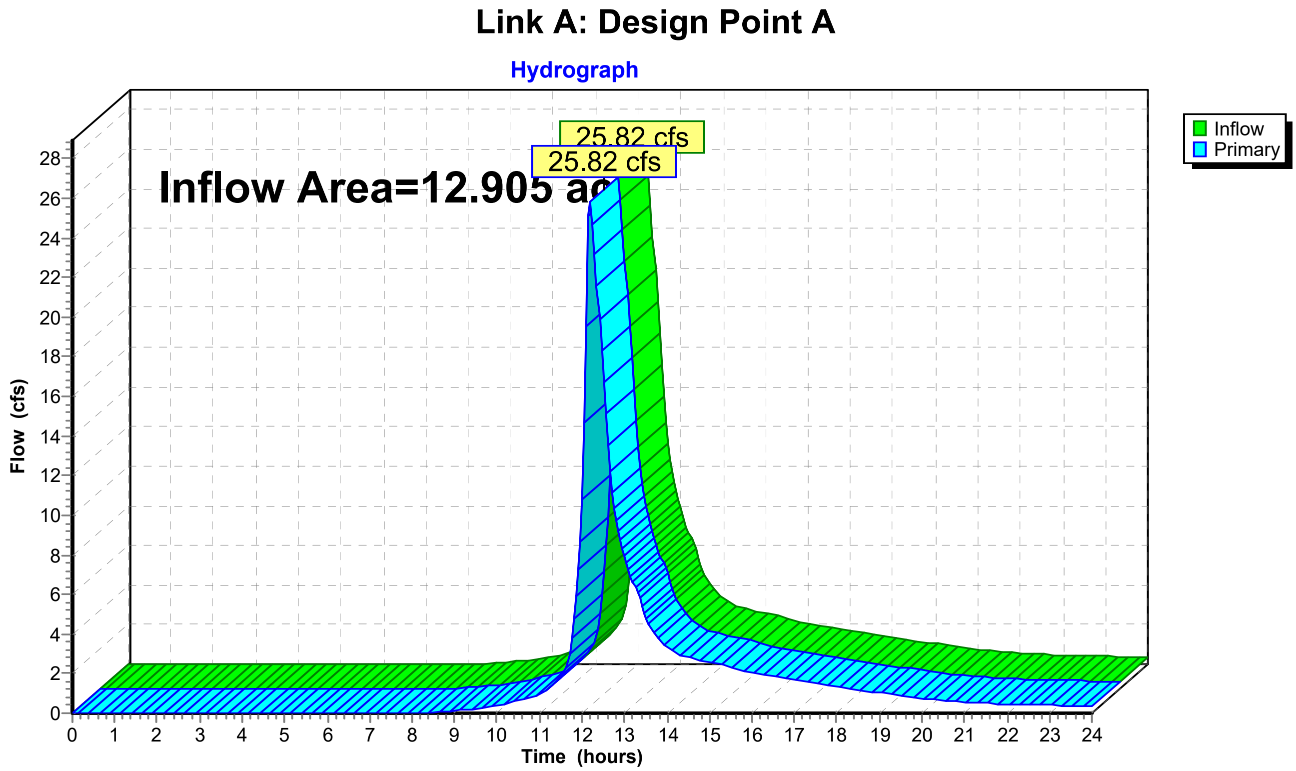
Pond 1P: Existing Basin



Summary for Link A: Design Point A

Inflow Area = 12.905 ac, 28.48% Impervious, Inflow Depth > 2.88" for 25-year 24hr event
Inflow = 25.82 cfs @ 12.19 hrs, Volume= 3.102 af
Primary = 25.82 cfs @ 12.19 hrs, Volume= 3.102 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



Summary for Subcatchment X-A1: Subcat S-1

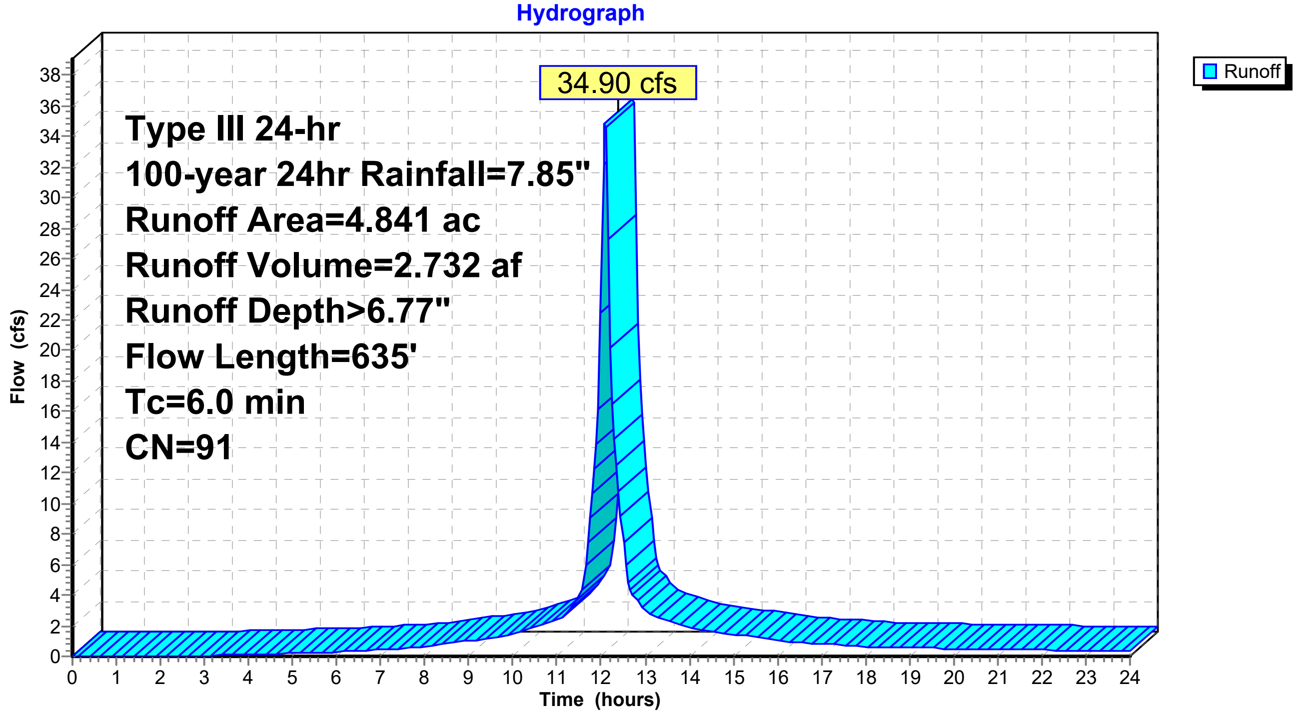
Runoff = 34.90 cfs @ 12.09 hrs, Volume= 2.732 af, Depth> 6.77"
Routed to Pond 1P : Existing Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
1.412	74	>75% Grass cover, Good, HSG C
1.988	98	EX Gravel Surface, Impervious, HSG C
0.507	98	Paved parking, HSG C
0.933	98	Roofs, HSG C
0.000	70	Woods, Good, HSG C
4.841	91	Weighted Average
1.412		29.17% Pervious Area
3.429		70.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.19"
3.5	300	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.0	285	0.0060	4.60	8.14	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
5.7	635	Total, Increased to minimum Tc = 6.0 min			

Subcatchment X-A1: Subcat S-1



Summary for Subcatchment X-A2: Subcat S-2

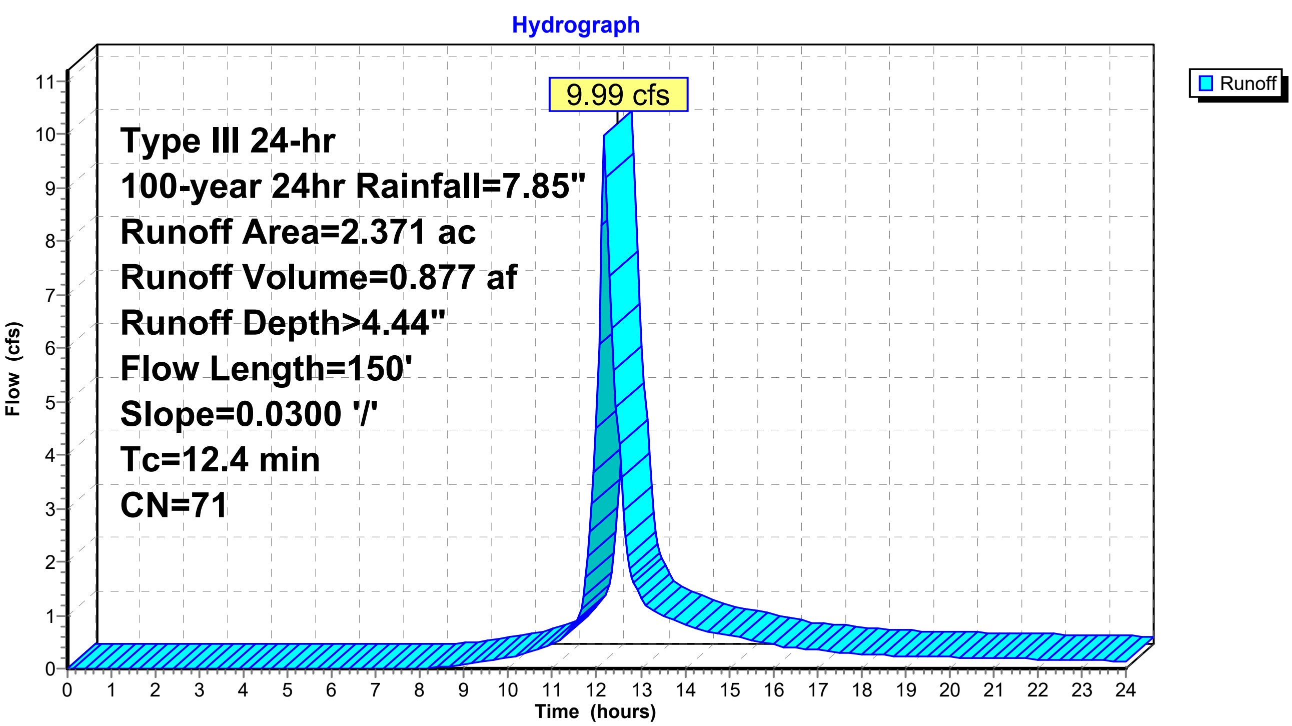
Runoff = 9.99 cfs @ 12.17 hrs, Volume= 0.877 af, Depth> 4.44"
Routed to Link A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
0.585	74	>75% Grass cover, Good, HSG C
0.002	80	>75% Grass cover, Good, HSG D
0.013	98	EX Gravel Surface, Impervious, HSG C
1.732	70	Woods, Good, HSG C
0.041	77	Woods, Good, HSG D
2.371	71	Weighted Average
2.359		99.47% Pervious Area
0.013		0.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.5	50	0.0300	0.08		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.19"
1.9	100	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.4	150	Total			

Subcatchment X-A2: Subcat S-2



Summary for Subcatchment X-A3: Subcat S-3

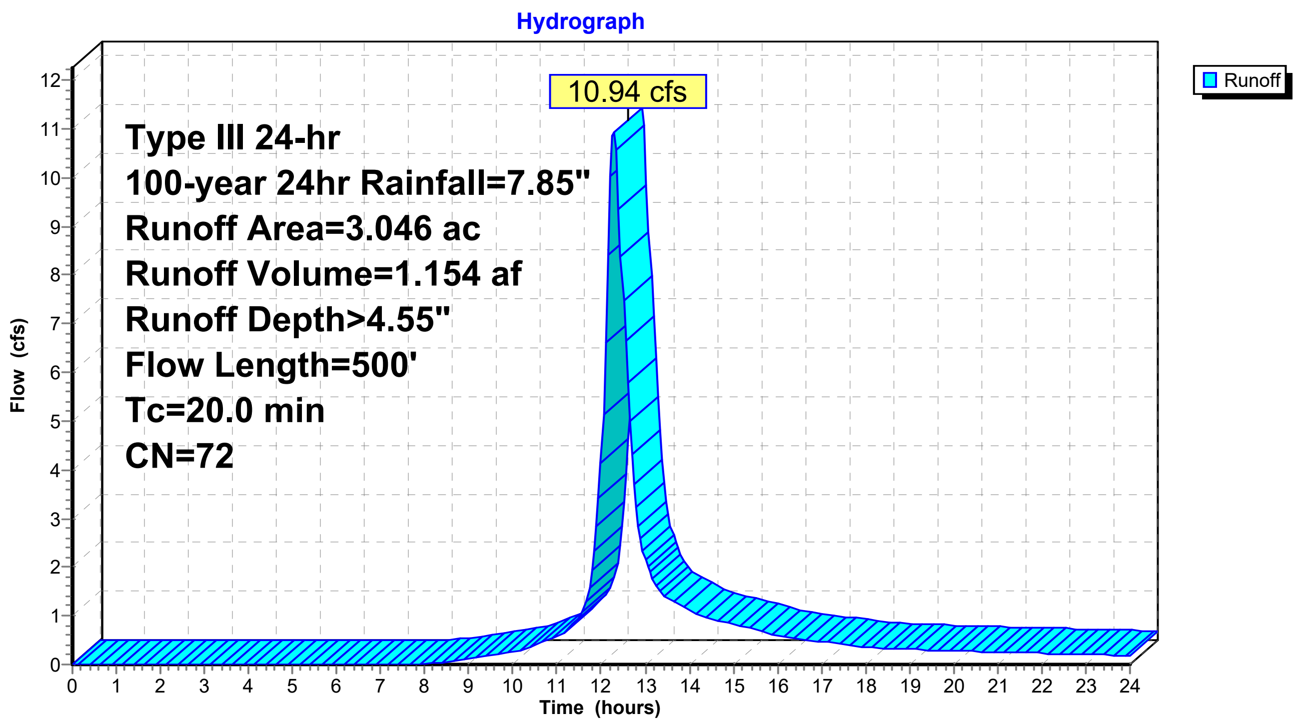
Runoff = 10.94 cfs @ 12.28 hrs, Volume= 1.154 af, Depth> 4.55"
Routed to Link A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
0.626	74	>75% Grass cover, Good, HSG C
0.066	98	EX Gravel Surface, Impervious, HSG C
2.059	70	Woods, Good, HSG C
0.295	77	Woods, Good, HSG D
3.046	72	Weighted Average
2.980		97.82% Pervious Area
0.066		2.18% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	50	0.0400	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.19"
10.6	450	0.0200	0.71		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
20.0	500	Total			

Subcatchment X-A3: Subcat S-3



Summary for Subcatchment X-A4: Subcat S-4

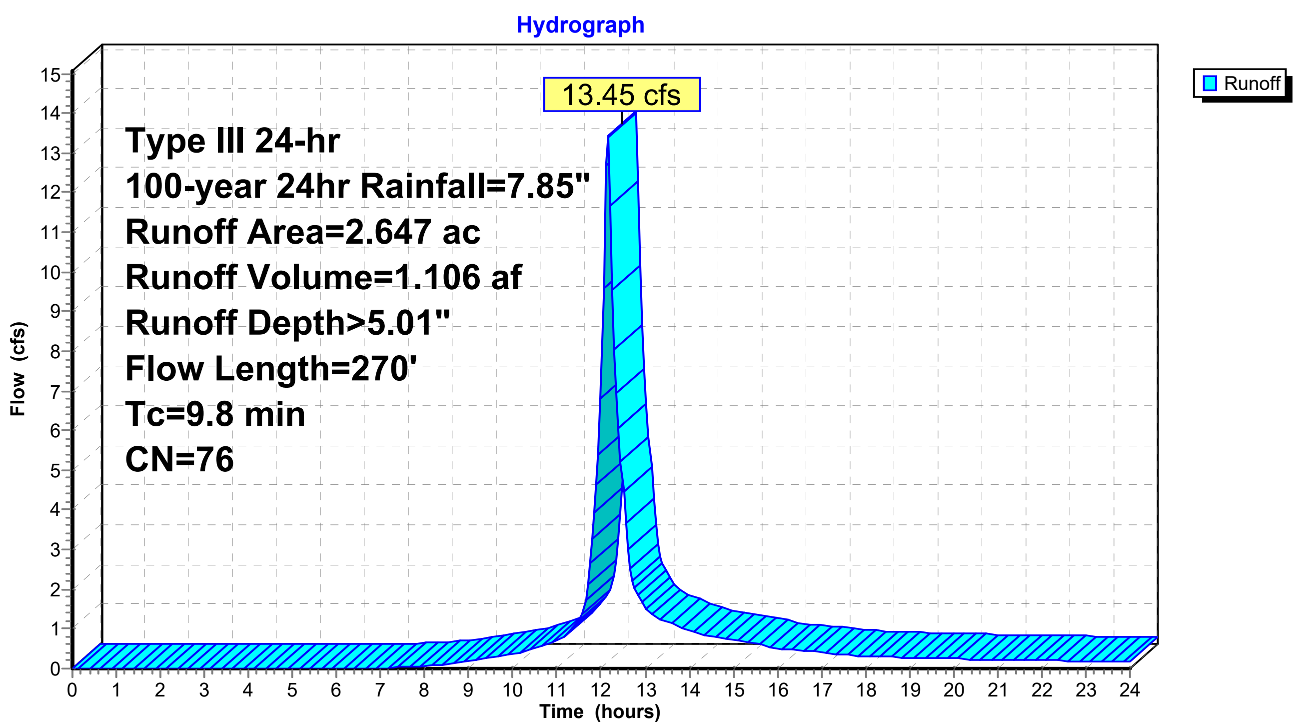
Runoff = 13.45 cfs @ 12.14 hrs, Volume= 1.106 af, Depth> 5.01"
Routed to Link A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
0.661	74	>75% Grass cover, Good, HSG C
0.191	80	>75% Grass cover, Good, HSG D
0.167	98	EX Gravel Surface, Impervious, HSG C
0.546	70	Woods, Good, HSG C
1.081	77	Woods, Good, HSG D
2.647	76	Weighted Average
2.479		93.67% Pervious Area
0.167		6.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.8	50	0.0900	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.19"
3.0	220	0.0600	1.22		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.8	270	Total			

Subcatchment X-A4: Subcat S-4



Summary for Pond 1P: Existing Basin

Inflow Area = 4.841 ac, 70.83% Impervious, Inflow Depth > 6.77" for 100-year 24hr event
Inflow = 34.90 cfs @ 12.09 hrs, Volume= 2.732 af
Outflow = 8.41 cfs @ 12.47 hrs, Volume= 2.508 af, Atten= 76%, Lag= 23.1 min
Discarded = 0.94 cfs @ 12.47 hrs, Volume= 0.969 af
Primary = 7.47 cfs @ 12.47 hrs, Volume= 1.539 af
Routed to Link A : Design Point A
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link A : Design Point A

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 224.00' @ 12.47 hrs Surf.Area= 16,903 sf Storage= 50,018 cf

Plug-Flow detention time= 142.5 min calculated for 2.508 af (92% of inflow)
Center-of-Mass det. time= 100.4 min (873.0 - 772.7)

Volume	Invert	Avail.Storage	Storage Description
#1	220.00'	88,900 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
220.00	8,700	0	0
222.00	12,200	20,900	20,900
224.00	16,900	29,100	50,000
226.00	22,000	38,900	88,900

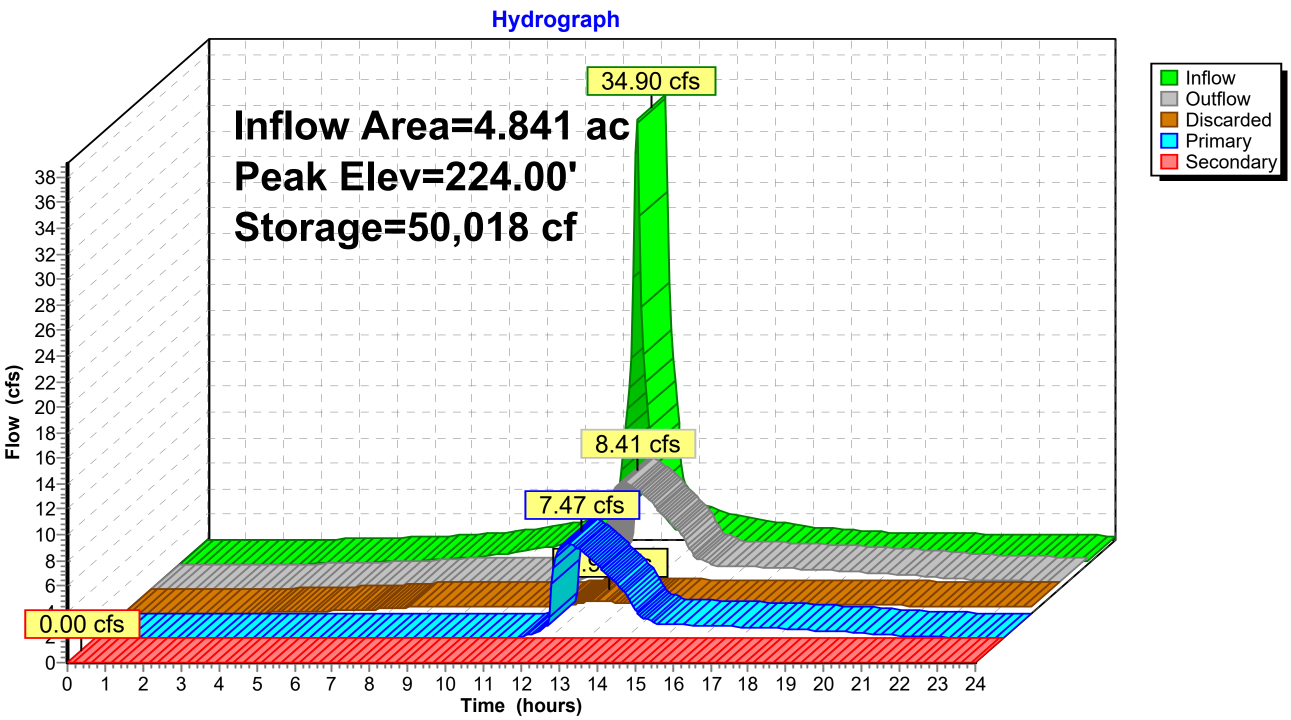
Device	Routing	Invert	Outlet Devices
#1	Secondary	225.10'	**8.0' long + 3.0 '/' SideZ x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#2	Primary	217.00'	**12.0" Round Culvert** L= 90.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 217.00' / 210.00' S= 0.0778 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Device 2	221.00'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 2	222.50'	**2.0" x 2.0" Horiz. Orifice/Grate X 6.00 columns** X 6 rows C= 0.600 in 27.0" Grate (25% open area) Limited to weir flow at low heads
#5	Discarded	220.00'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.94 cfs @ 12.47 hrs HW=224.00' (Free Discharge)
└─**5=Exfiltration** (Exfiltration Controls 0.94 cfs)

Primary OutFlow Max=7.46 cfs @ 12.47 hrs HW=224.00' (Free Discharge)
└─**2=Culvert** (Passes 7.46 cfs of 9.64 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 1.57 cfs @ 7.98 fps)
  └─**4=Orifice/Grate** (Orifice Controls 5.89 cfs @ 5.89 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=220.00' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond 1P: Existing Basin

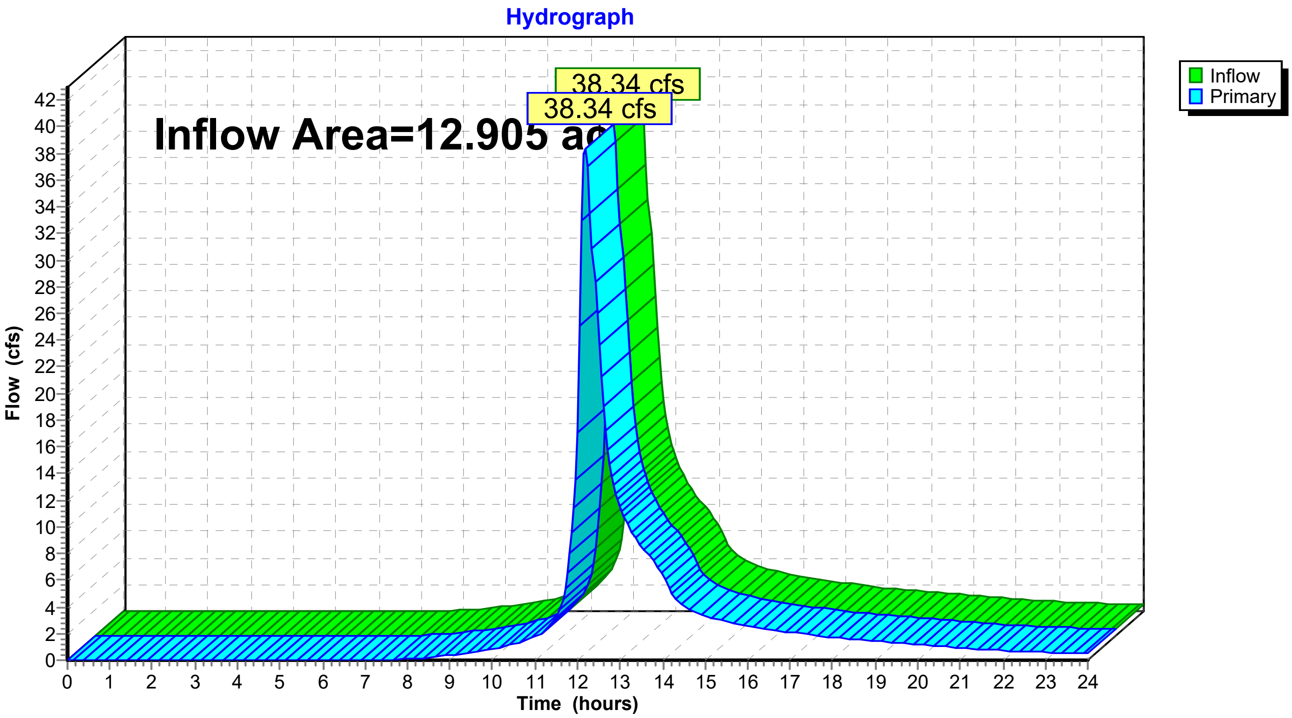


Summary for Link A: Design Point A

Inflow Area = 12.905 ac, 28.48% Impervious, Inflow Depth > 4.35" for 100-year 24hr event
Inflow = 38.34 cfs @ 12.18 hrs, Volume= 4.676 af
Primary = 38.34 cfs @ 12.18 hrs, Volume= 4.676 af, Atten= 0%, Lag= 0.0 min

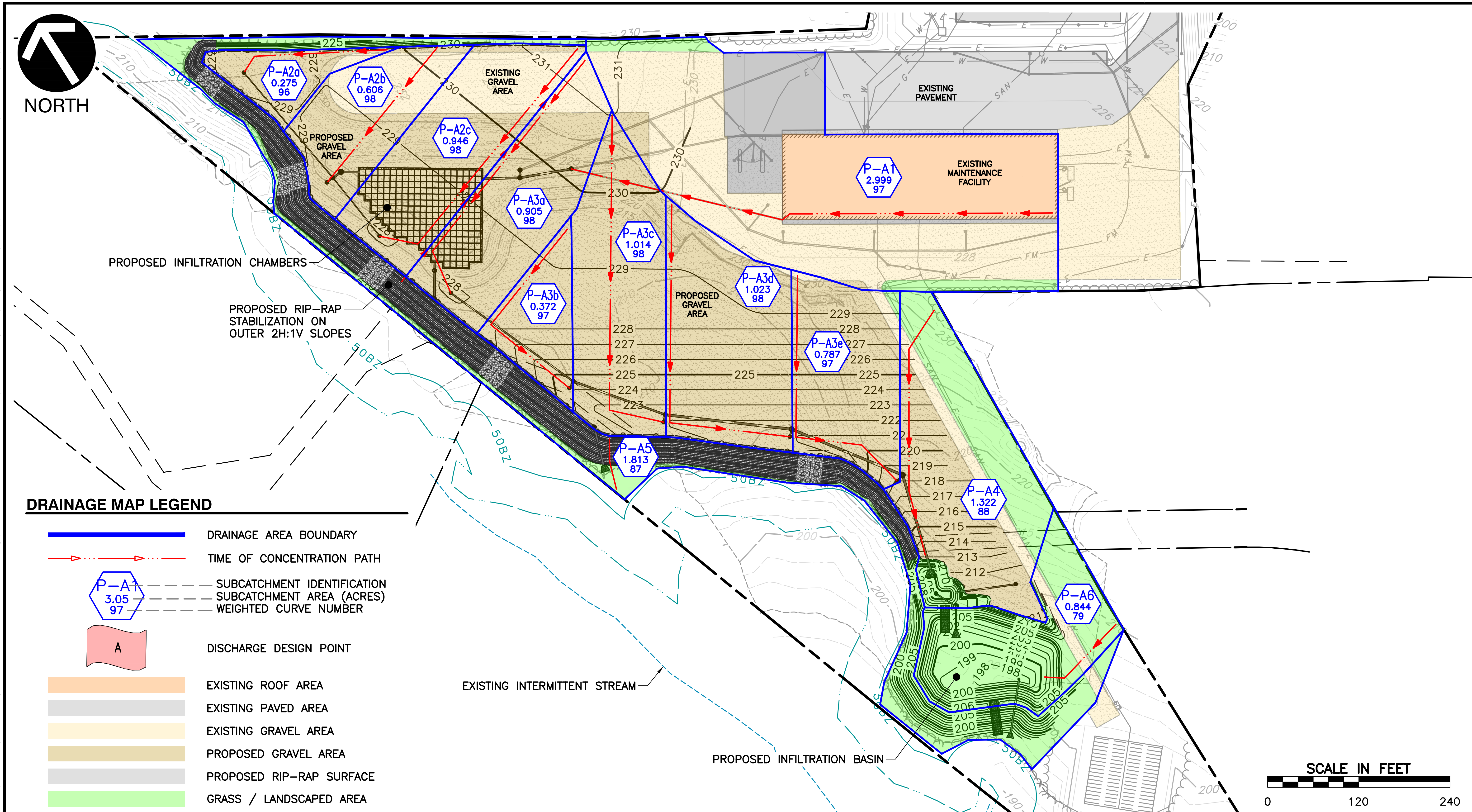
Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link A: Design Point A



APPENDIX E2

PROPOSED CONDITIONS DRAINAGE AREA MAP
AND
POST-DEVELOPMENT HYDROCAD ANALYSIS



\\cecinc.com\global\Projects\340-000\347-159\-CADD\Dwg\SW01 - Site Plans for Permitting\347159-SW01-HYD-Post-Development Drainage Map.dwg[LAYOUT2] LS:(3/10/2026 - khampton) - LP: 3/10/2026 6:59 PM

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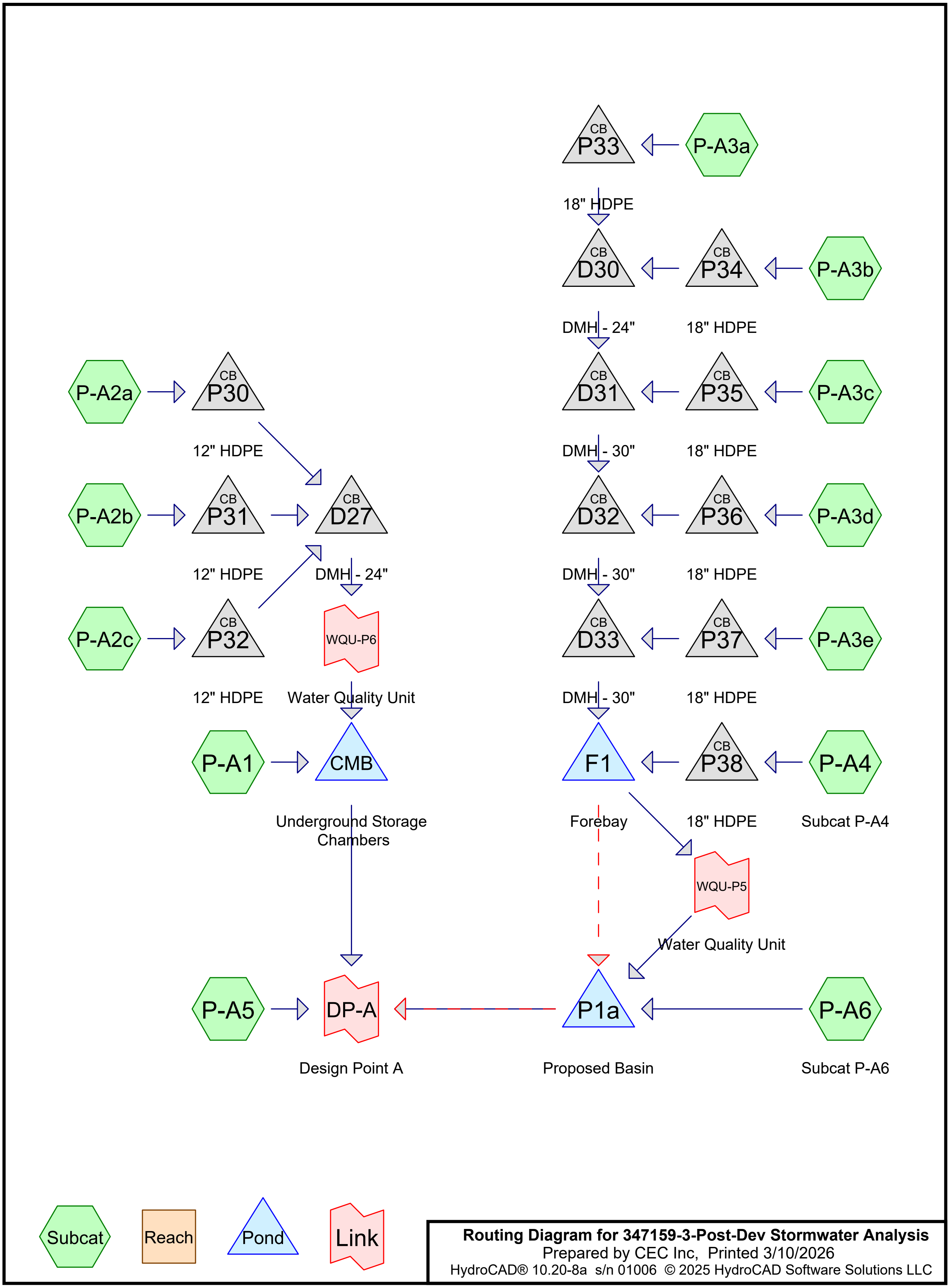
14 STERLING ROAD, BILLERICA, MA
W.L. FRENCH EXCAVATING CORPORATION

POST-DEVELOPMENT DRAINAGE MAP

DRAWN BY: KFH	CHECKED BY: DSK	APPROVED BY: DSK	FIGURE NO.:		
DATE: MARCH 2026	DWG SCALE: 1"=120'	PROJECT NO: 347-159	HYD-POST		

ENGINEERING, SURVEYING AND LANDSCAPE ARCHITECTURE IN THE STATE OF NORTH CAROLINA WILL BE PROVIDED BY CEC SURVEYING AND LANDSCAPE ARCHITECTS OF NC, PLLC. SERVICES IN PUERTO RICO WILL BE PROVIDED BY CEC ENGINEERS & CONSULTANTS, LLC. LANDSCAPE ARCHITECTURE SERVICES IN THE STATE OF OHIO WILL BE PROVIDED BY CEC LANDSCAPE ARCHITECTS, LLC.



Routing Diagram for 347159-3-Post-Dev Stormwater Analysis
Prepared by CEC Inc, Printed 3/10/2026
HydroCAD® 10.20-8a s/n 01006 © 2025 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-year 24hr	Type III 24-hr		Default	24.00	1	3.19	2
2	10-year 24hr	Type III 24-hr		Default	24.00	1	4.99	2
3	25-year 24hr	Type III 24-hr		Default	24.00	1	6.11	2
4	100-year 24hr	Type III 24-hr		Default	24.00	1	7.85	2

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.304	74	>75% Grass cover, Good, HSG C (P-A1, P-A2a, P-A2b, P-A2c, P-A3a, P-A3b, P-A3c, P-A3d, P-A3e, P-A4, P-A5, P-A6)
1.155	80	>75% Grass cover, Good, HSG D (P-A3d, P-A3e, P-A4, P-A5, P-A6)
2.234	98	EX Gravel Surface, Impervious, HSG C (P-A1, P-A2a, P-A2b, P-A2c, P-A3a, P-A3c, P-A3d, P-A3e, P-A4, P-A5, P-A6)
0.744	96	Gravel surface, HSG C (P-A5)
0.197	96	Gravel surface, HSG D (P-A5)
5.571	98	PR Gravel Surface, Impervious, HSG C (P-A1, P-A2a, P-A2b, P-A2c, P-A3a, P-A3b, P-A3c, P-A3d, P-A3e, P-A4, P-A6)
0.259	98	PR Gravel Surface, Impervious, HSG D (P-A3d, P-A3e, P-A4, P-A6)
0.507	98	Paved parking, HSG C (P-A1)
0.933	98	Roofs, HSG C (P-A1)
12.905	**94**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
11.294	HSG C	P-A1, P-A2a, P-A2b, P-A2c, P-A3a, P-A3b, P-A3c, P-A3d, P-A3e, P-A4, P-A5, P-A6
1.611	HSG D	P-A3d, P-A3e, P-A4, P-A5, P-A6
0.000	Other	
12.905		**TOTAL AREA**

Summary for Subcatchment P-A1:

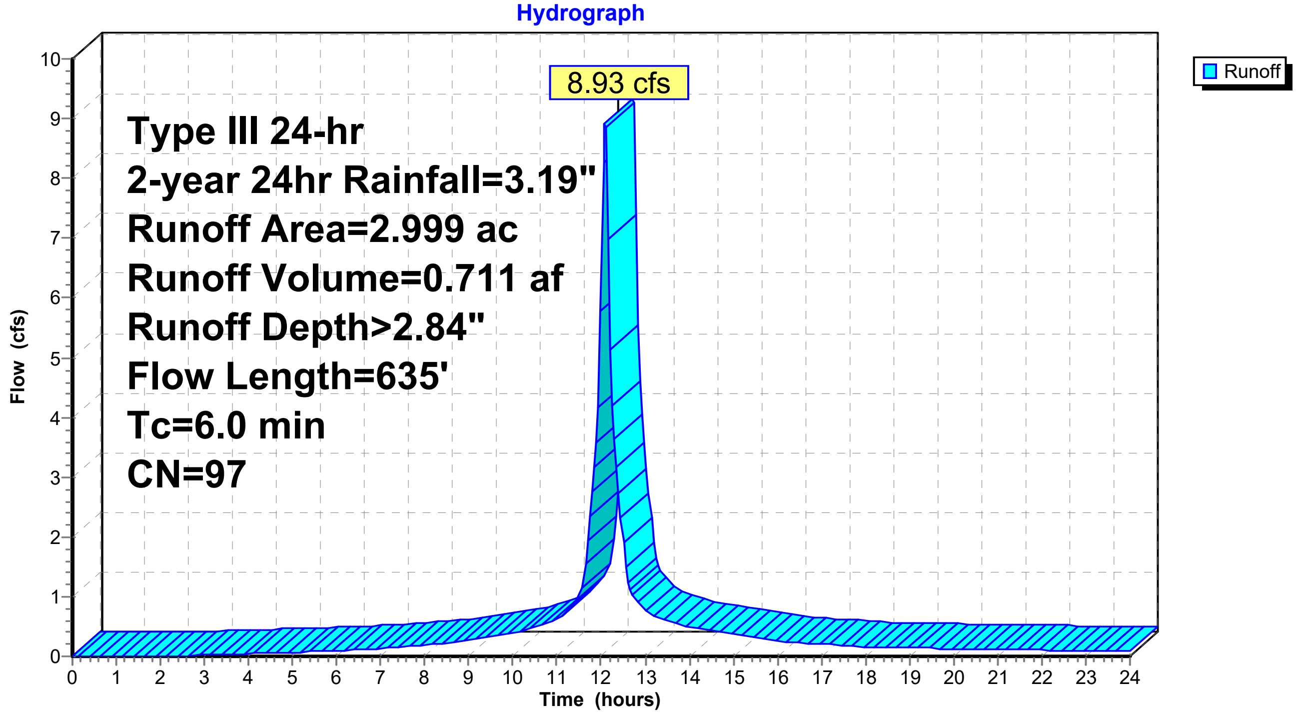
Runoff = 8.93 cfs @ 12.09 hrs, Volume= 0.711 af, Depth> 2.84"
Routed to Pond CMB : Underground Storage Chambers

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
1.360	98	EX Gravel Surface, Impervious, HSG C
0.003	98	PR Gravel Surface, Impervious, HSG C
0.043	98	PR Gravel Surface, Impervious, HSG C
0.007	98	PR Gravel Surface, Impervious, HSG C
0.933	98	Roofs, HSG C
0.050	98	Paved parking, HSG C
0.457	98	Paved parking, HSG C
0.069	74	>75% Grass cover, Good, HSG C
0.078	74	>75% Grass cover, Good, HSG C
2.999	97	Weighted Average
0.147		4.89% Pervious Area
2.852		95.11% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.19"
3.5	300	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.0	285	0.0060	4.60	8.14	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
5.7	635	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A1:



Summary for Subcatchment P-A2a:

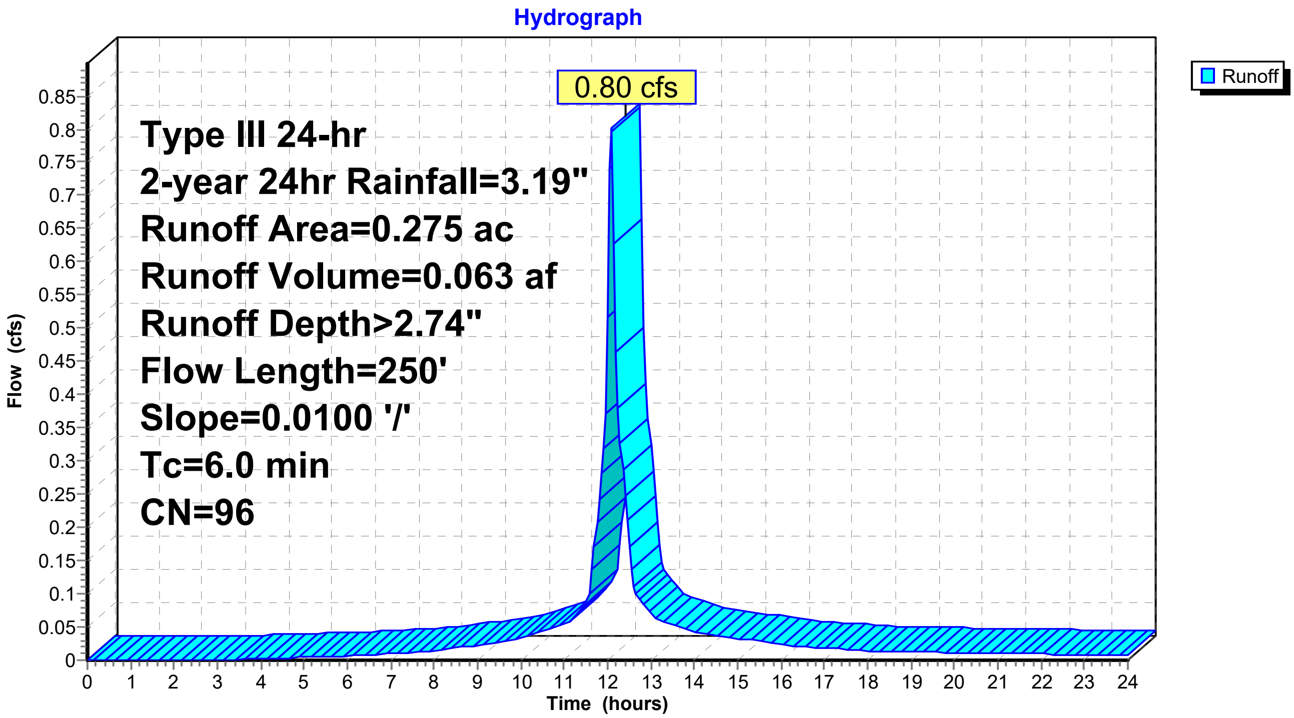
Runoff = 0.80 cfs @ 12.09 hrs, Volume= 0.063 af, Depth> 2.74"
Routed to Pond P30 : 12" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
0.021	74	>75% Grass cover, Good, HSG C
0.016	98	EX Gravel Surface, Impervious, HSG C
0.238	98	PR Gravel Surface, Impervious, HSG C
0.275	96	Weighted Average
0.021		7.62% Pervious Area
0.254		92.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
2.1	200	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.2	250	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A2a:



Summary for Subcatchment P-A2b:

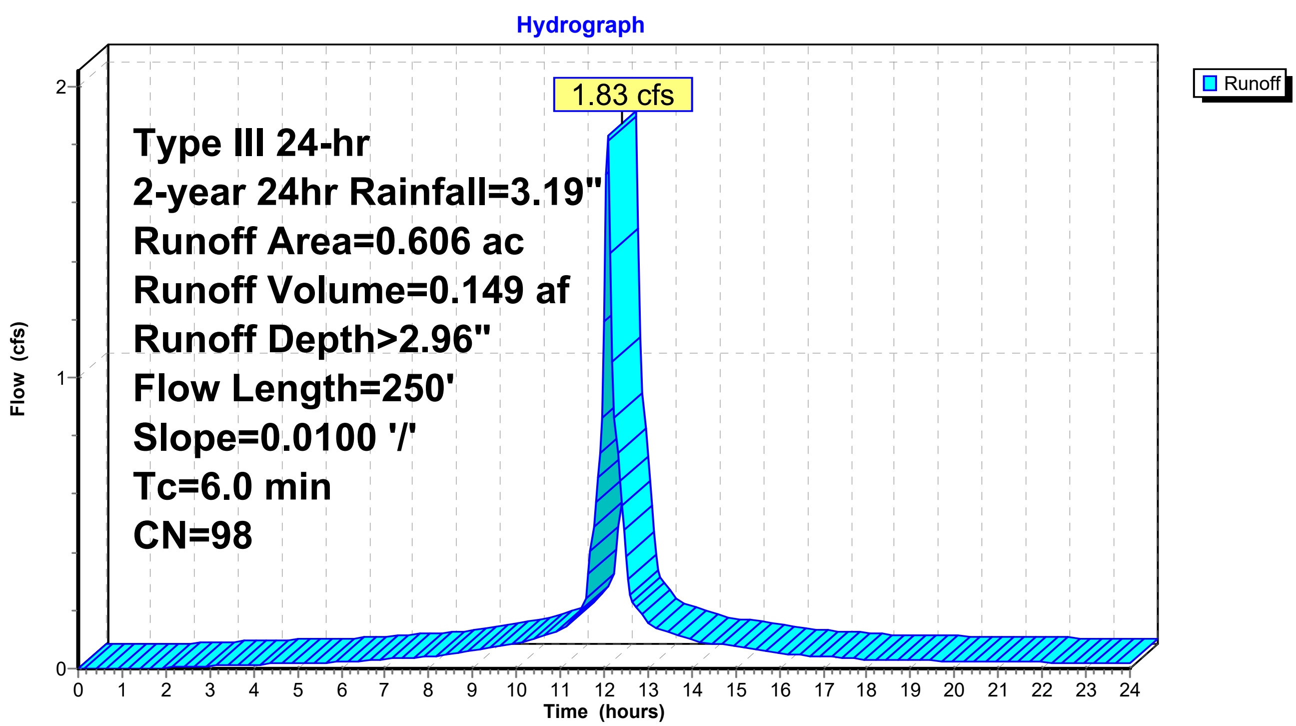
Runoff = 1.83 cfs @ 12.09 hrs, Volume= 0.149 af, Depth> 2.96"
Routed to Pond P31 : 12" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
0.330	98	PR Gravel Surface, Impervious, HSG C
0.016	98	PR Gravel Surface, Impervious, HSG C
0.247	98	EX Gravel Surface, Impervious, HSG C
0.007	74	>75% Grass cover, Good, HSG C
0.005	74	>75% Grass cover, Good, HSG C
0.606	98	Weighted Average
0.012		2.02% Pervious Area
0.594		97.98% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
2.1	200	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.2	250	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A2b:



Summary for Subcatchment P-A2c:

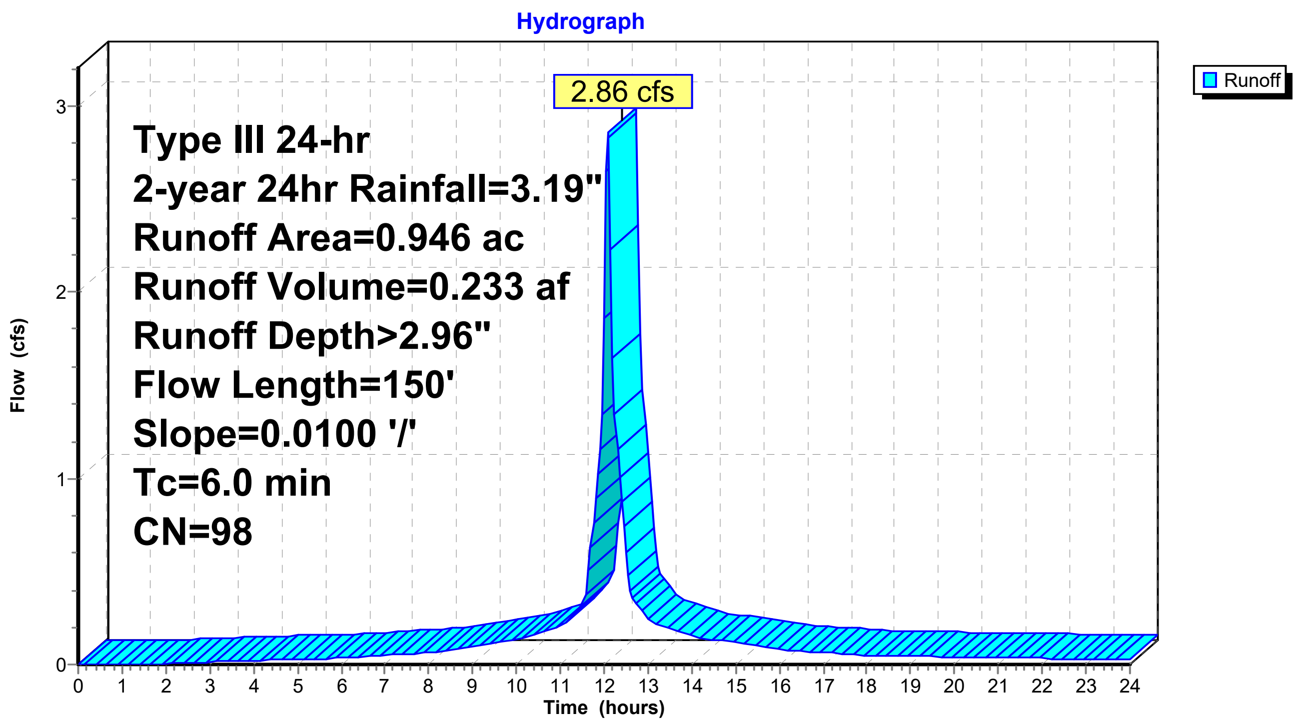
Runoff = 2.86 cfs @ 12.09 hrs, Volume= 0.233 af, Depth> 2.96"
Routed to Pond P32 : 12" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
0.284	98	EX Gravel Surface, Impervious, HSG C
0.648	98	PR Gravel Surface, Impervious, HSG C
0.006	74	>75% Grass cover, Good, HSG C
0.008	74	>75% Grass cover, Good, HSG C
0.946	98	Weighted Average
0.014		1.48% Pervious Area
0.932		98.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.0	100	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.1	150	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A2c:



Summary for Subcatchment P-A3a:

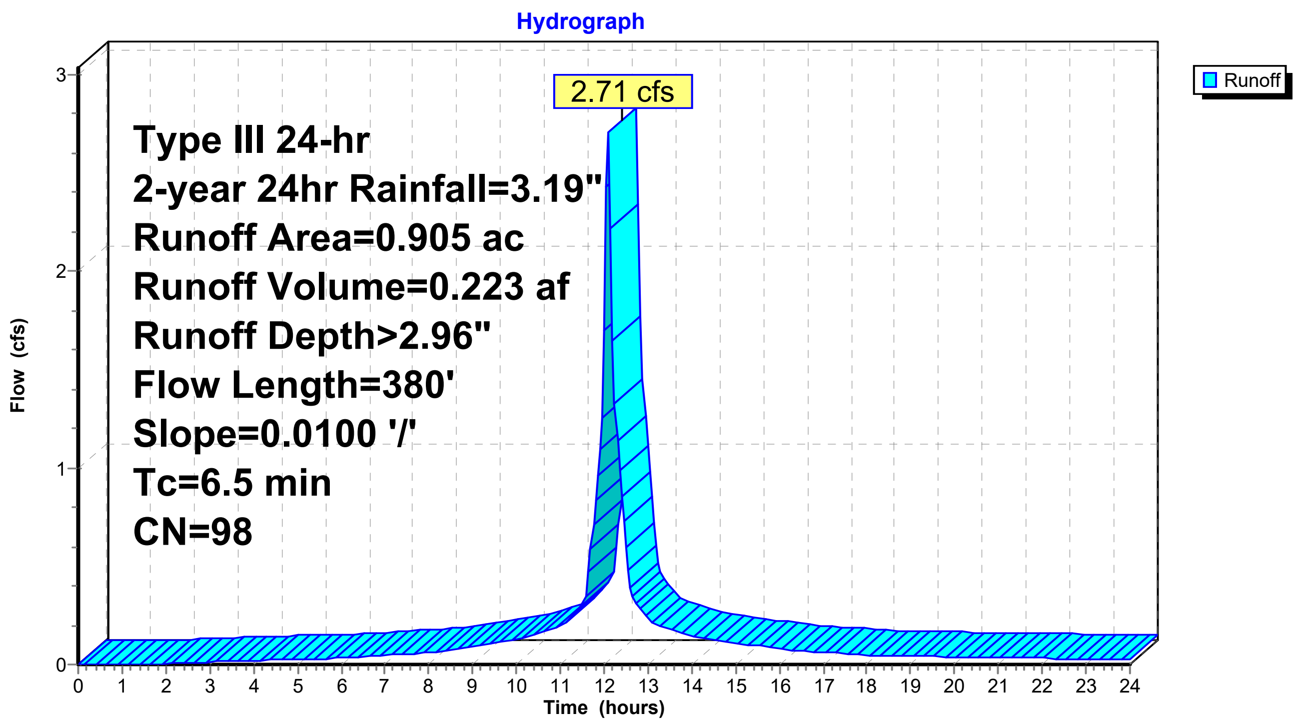
Runoff = 2.71 cfs @ 12.09 hrs, Volume= 0.223 af, Depth> 2.96"
Routed to Pond P33 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
0.805	98	PR Gravel Surface, Impervious, HSG C
0.094	98	EX Gravel Surface, Impervious, HSG C
0.006	74	>75% Grass cover, Good, HSG C
0.000	74	>75% Grass cover, Good, HSG C
0.905	98	Weighted Average
0.006		0.69% Pervious Area
0.899		99.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
3.4	330	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.5	380	Total			

Subcatchment P-A3a:



Summary for Subcatchment P-A3b:

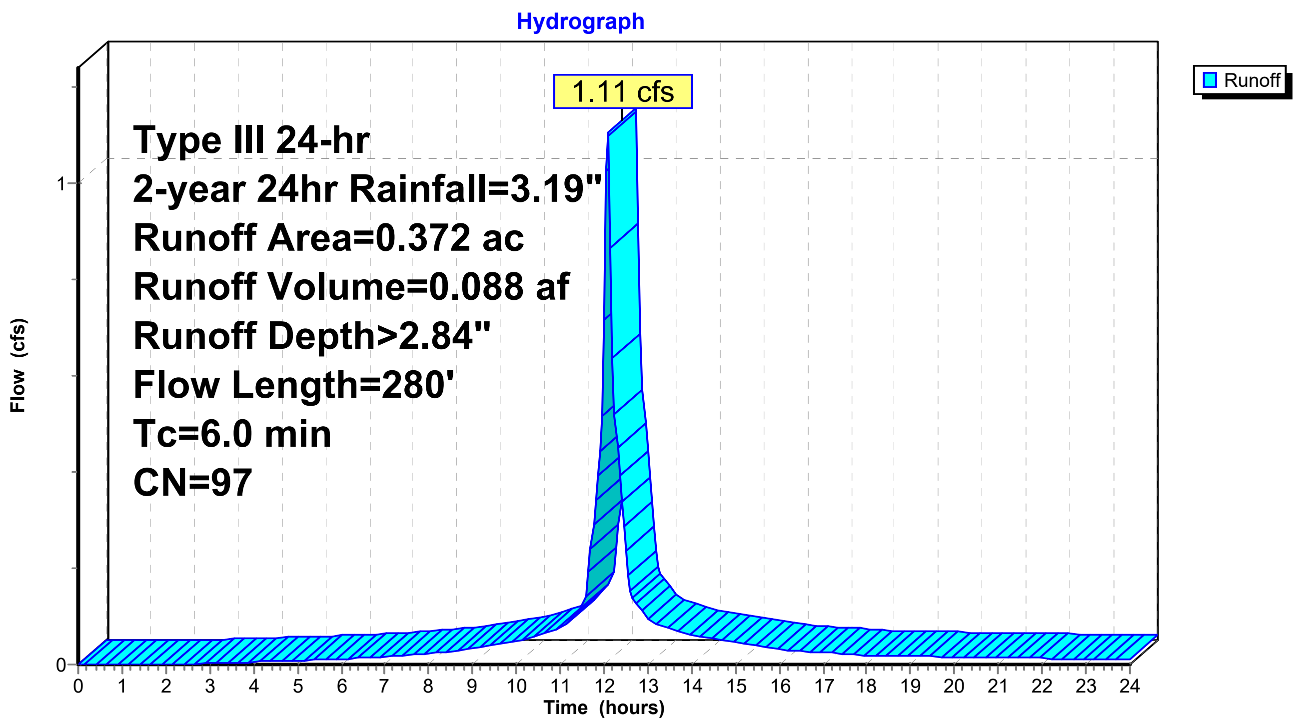
Runoff = 1.11 cfs @ 12.09 hrs, Volume= 0.088 af, Depth> 2.84"
Routed to Pond P34 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
0.008	74	>75% Grass cover, Good, HSG C
0.363	98	PR Gravel Surface, Impervious, HSG C
0.372	97	Weighted Average
0.008		2.27% Pervious Area
0.363		97.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.0	100	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	130	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.9	280	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A3b:



Summary for Subcatchment P-A3c:

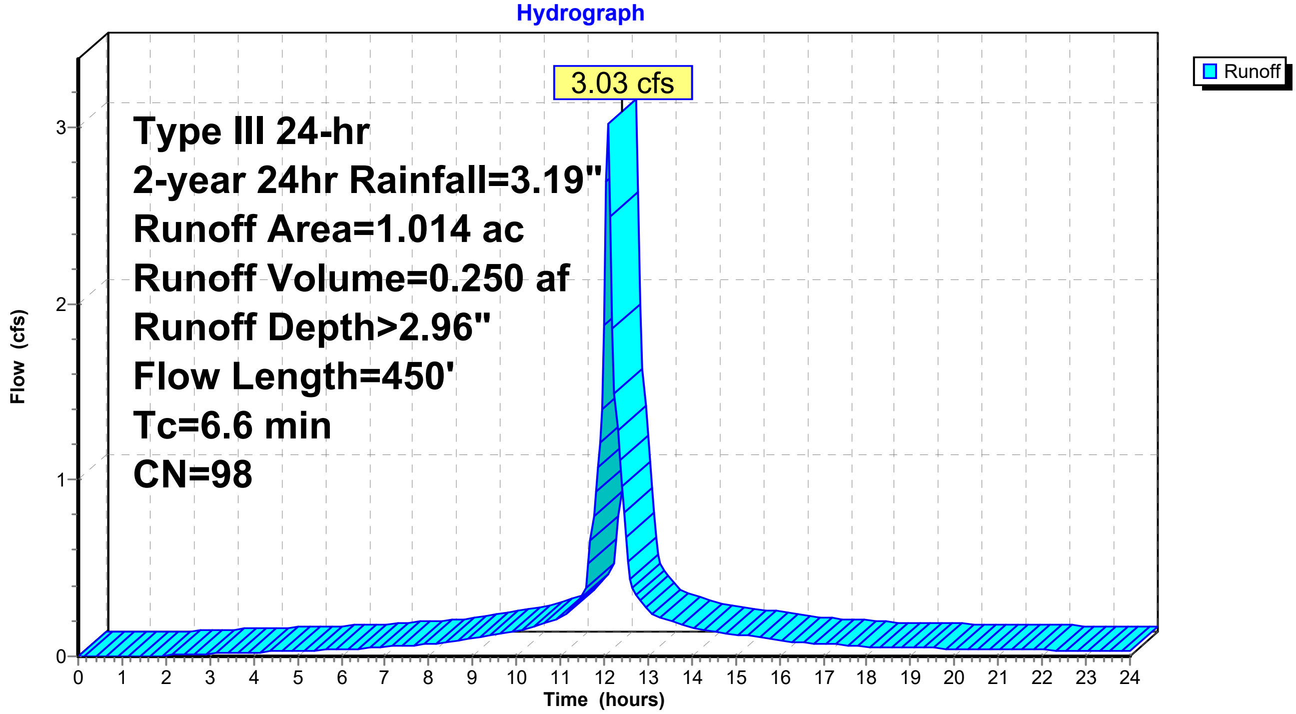
Runoff = 3.03 cfs @ 12.09 hrs, Volume= 0.250 af, Depth> 2.96"
Routed to Pond P35 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
0.007	74	>75% Grass cover, Good, HSG C
1.007	98	PR Gravel Surface, Impervious, HSG C
0.001	98	EX Gravel Surface, Impervious, HSG C
1.014	98	Weighted Average
0.007		0.70% Pervious Area
1.007		99.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
2.4	230	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.5	100	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	70	0.0150	1.97		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.6	450	Total			

Subcatchment P-A3c:



Summary for Subcatchment P-A3d:

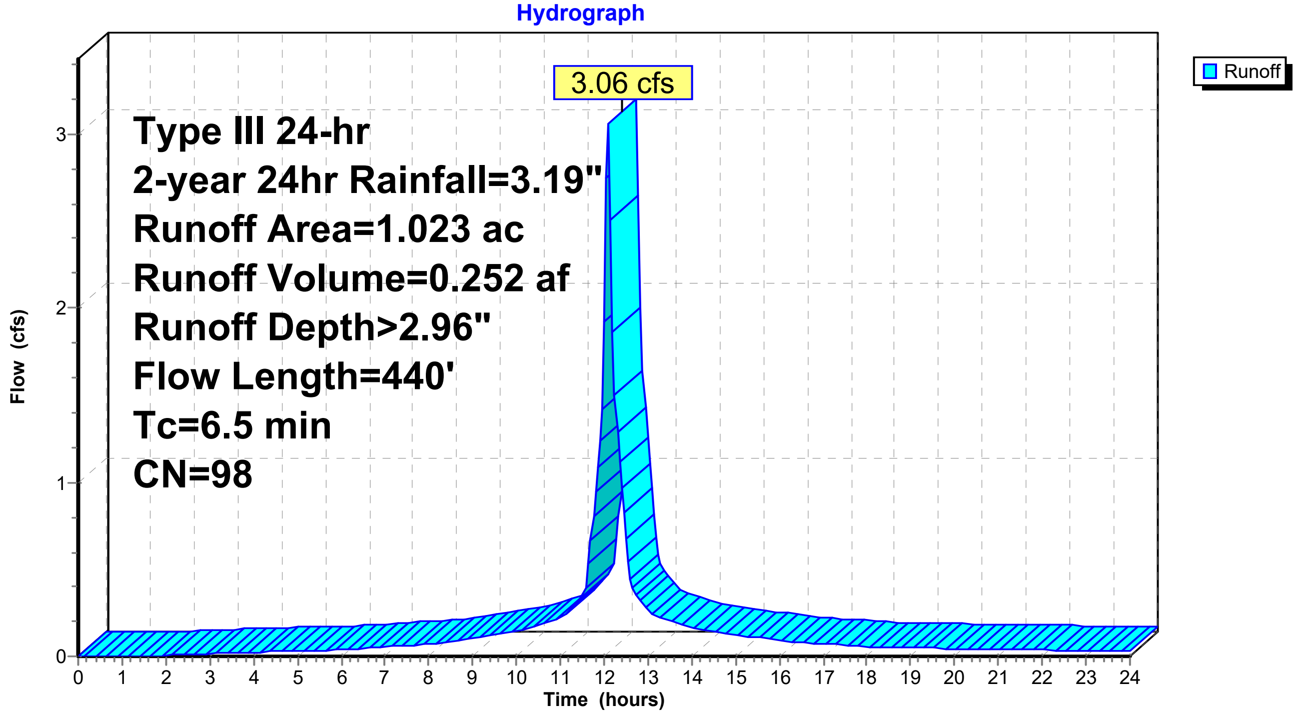
Runoff = 3.06 cfs @ 12.09 hrs, Volume= 0.252 af, Depth> 2.96"
Routed to Pond P36 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
0.004	74	>75% Grass cover, Good, HSG C
0.918	98	PR Gravel Surface, Impervious, HSG C
0.018	98	EX Gravel Surface, Impervious, HSG C
0.079	98	PR Gravel Surface, Impervious, HSG D
0.004	80	>75% Grass cover, Good, HSG D
1.023	98	Weighted Average
0.009		0.85% Pervious Area
1.015		99.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.1	110	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	120	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.7	160	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.5	440	Total			

Subcatchment P-A3d:



Summary for Subcatchment P-A3e:

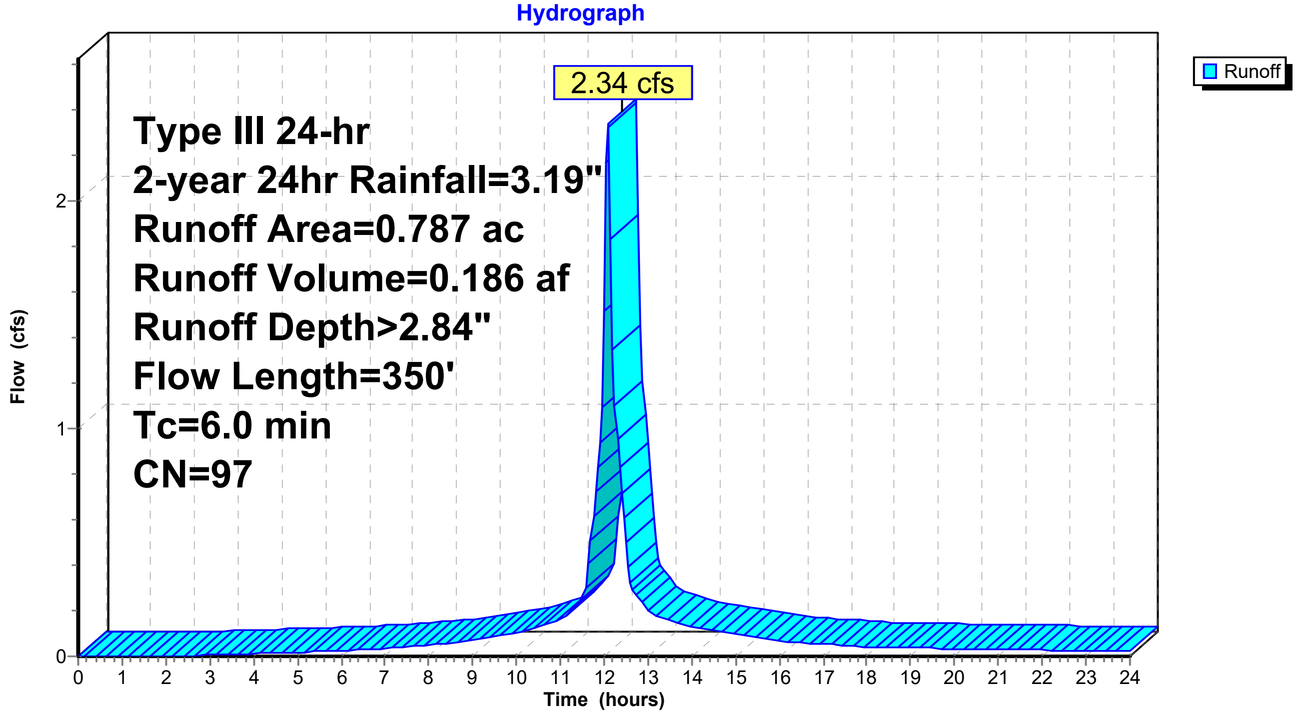
Runoff = 2.34 cfs @ 12.09 hrs, Volume= 0.186 af, Depth> 2.84"
Routed to Pond P37 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
0.031	98	EX Gravel Surface, Impervious, HSG C
0.669	98	PR Gravel Surface, Impervious, HSG C
0.012	74	>75% Grass cover, Good, HSG C
0.007	80	>75% Grass cover, Good, HSG D
0.068	98	PR Gravel Surface, Impervious, HSG D
0.787	97	Weighted Average
0.018		2.34% Pervious Area
0.768		97.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
0.7	160	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.0	140	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.8	350	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A3e:



Summary for Subcatchment P-A4: Subcat P-A4

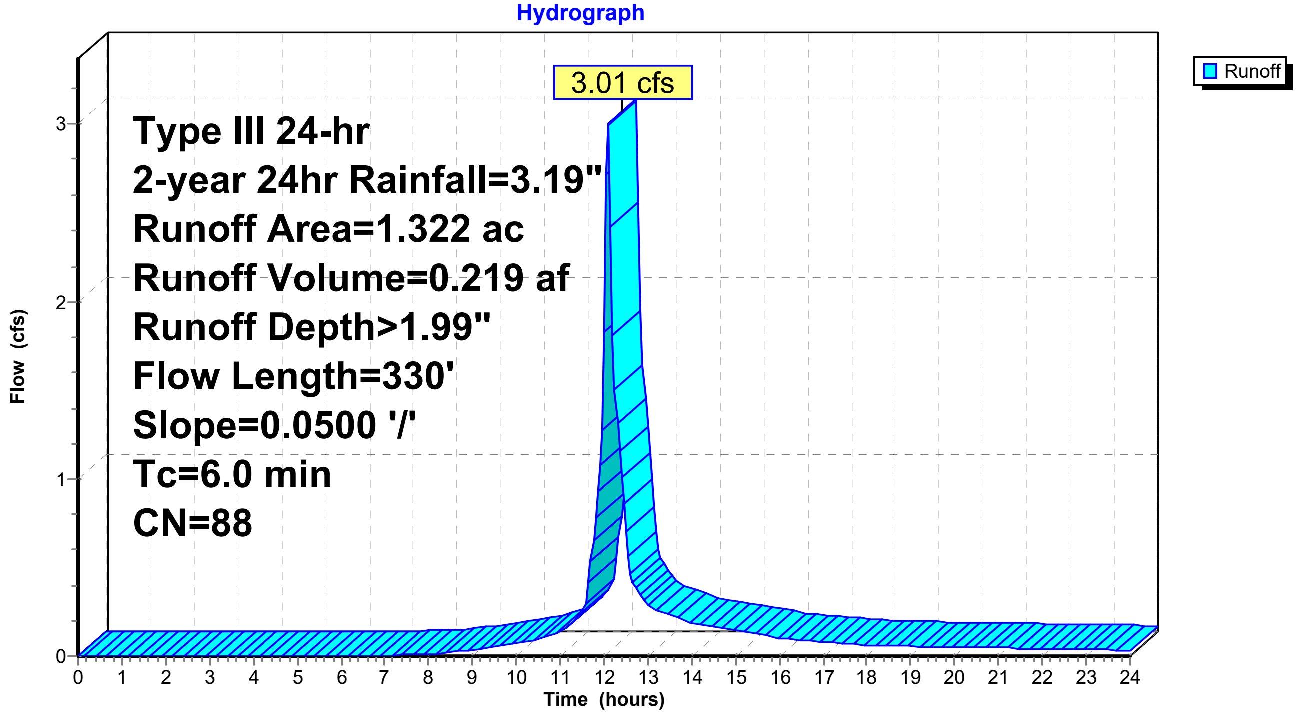
Runoff = 3.01 cfs @ 12.09 hrs, Volume= 0.219 af, Depth> 1.99"
Routed to Pond P38 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
0.123	98	EX Gravel Surface, Impervious, HSG C
0.523	98	PR Gravel Surface, Impervious, HSG C
0.403	74	>75% Grass cover, Good, HSG C
0.001	74	>75% Grass cover, Good, HSG C
0.089	80	>75% Grass cover, Good, HSG D
0.071	80	>75% Grass cover, Good, HSG D
0.112	98	PR Gravel Surface, Impervious, HSG D
1.322	88	Weighted Average
0.564		42.62% Pervious Area
0.759		57.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	50	0.0500	0.51		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.3	280	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.9	330	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A4: Subcat P-A4



Summary for Subcatchment P-A5:

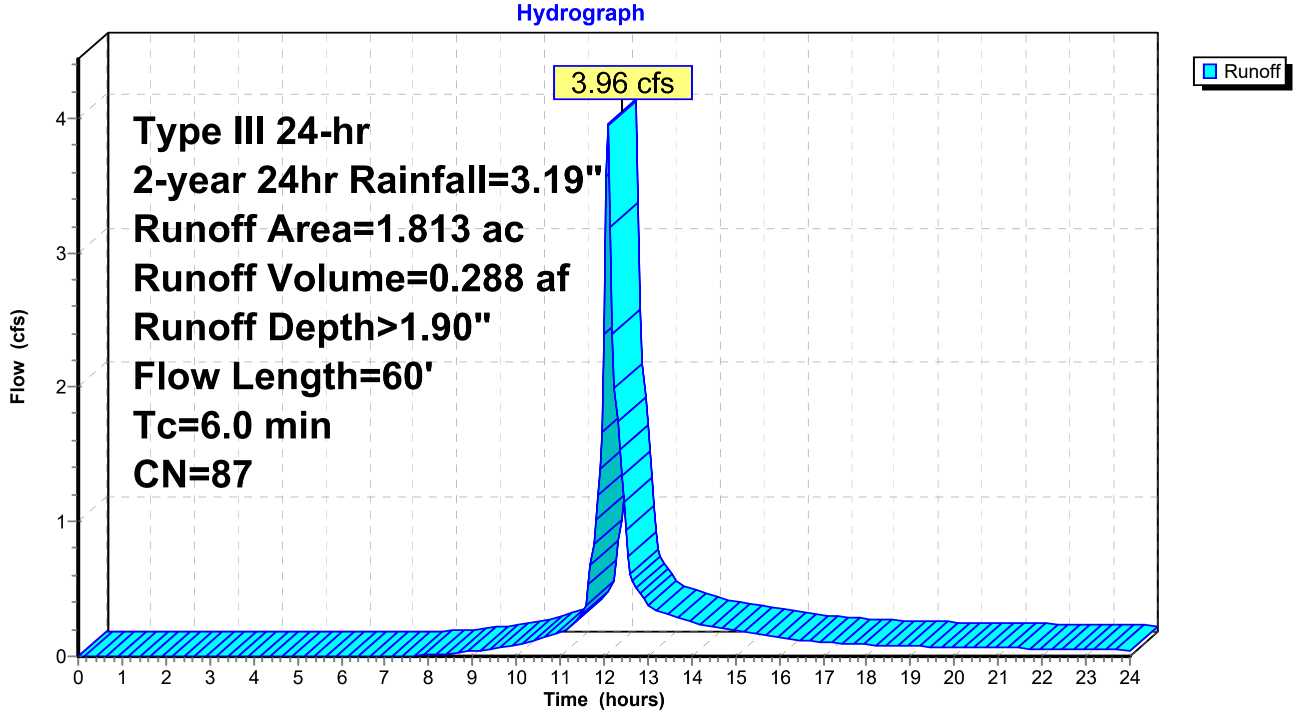
Runoff = 3.96 cfs @ 12.09 hrs, Volume= 0.288 af, Depth> 1.90"
Routed to Link DP-A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
0.011	98	EX Gravel Surface, Impervious, HSG C
0.197	96	Gravel surface, HSG D
0.000	96	Gravel surface, HSG D
0.744	96	Gravel surface, HSG C
0.414	80	>75% Grass cover, Good, HSG D
0.014	80	>75% Grass cover, Good, HSG D
0.016	80	>75% Grass cover, Good, HSG D
0.002	80	>75% Grass cover, Good, HSG D
0.010	80	>75% Grass cover, Good, HSG D
0.384	74	>75% Grass cover, Good, HSG C
0.018	74	>75% Grass cover, Good, HSG C
0.002	80	>75% Grass cover, Good, HSG D
1.813	87	Weighted Average
1.801		99.38% Pervious Area
0.011		0.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	30	0.3300	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.19"
0.5	30	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.7	60	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A5:



Summary for Subcatchment P-A6: Subcat P-A6

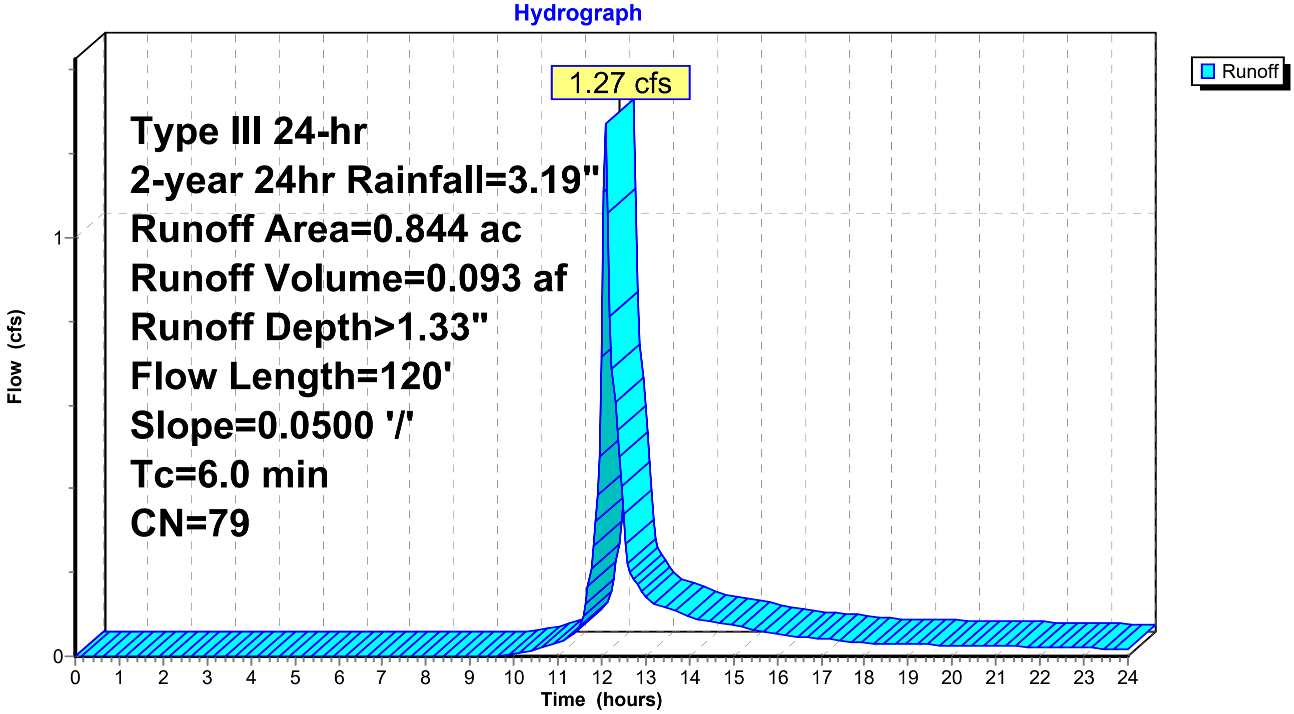
Runoff = 1.27 cfs @ 12.10 hrs, Volume= 0.093 af, Depth> 1.33"
Routed to Pond P1a : Proposed Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
0.050	98	EX Gravel Surface, Impervious, HSG C
0.000	98	PR Gravel Surface, Impervious, HSG C
0.127	74	>75% Grass cover, Good, HSG C
0.140	74	>75% Grass cover, Good, HSG C
0.425	80	>75% Grass cover, Good, HSG D
0.101	80	>75% Grass cover, Good, HSG D
0.000	98	PR Gravel Surface, Impervious, HSG D
0.844	79	Weighted Average
0.793		93.99% Pervious Area
0.051		6.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0500	0.15		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.19"
0.3	70	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.0	120	Total			

Subcatchment P-A6: Subcat P-A6



Summary for Pond CMB: Underground Storage Chambers

Inflow Area = 4.826 ac, 95.98% Impervious, Inflow Depth > 2.87" for 2-year 24hr event
Inflow = 14.43 cfs @ 12.09 hrs, Volume= 1.156 af
Outflow = 0.92 cfs @ 10.90 hrs, Volume= 1.155 af, Atten= 94%, Lag= 0.0 min
Discarded = 0.92 cfs @ 10.90 hrs, Volume= 1.155 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link DP-A : Design Point A

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 221.64' @ 13.64 hrs Surf.Area= 16,464 sf Storage= 21,072 cf
Flood Elev= 224.00' Surf.Area= 16,464 sf Storage= 54,255 cf

Plug-Flow detention time= 184.9 min calculated for 1.155 af (100% of inflow)
Center-of-Mass det. time= 184.3 min (947.2 - 762.9)

Volume	Invert	Avail.Storage	Storage Description
#1B	219.75'	6,779 cf	**196.00'W x 84.00'L x 4.92'H Field A** 80,948 cf Overall - 64,000 cf Embedded = 16,948 cf x 40.0% Voids
#2B	220.50'	47,770 cf	**retain_it upright 3.5'** x 240 Inside #1 Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf 24 Rows adjusted for 417.5 cf perimeter wall
		54,549 cf	Total Available Storage

Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	219.75'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	220.40'	**24.0" Round Culvert** L= 370.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 220.40' / 210.00' S= 0.0281 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#3	Device 2	222.75'	**6.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.92 cfs @ 10.90 hrs HW=219.80' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.92 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=219.75' (Free Discharge)
└─**2=Culvert** (Controls 0.00 cfs)
  └─**3=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond CMB: Underground Storage Chambers - Chamber Wizard Field A

Chamber Model = retain_it upright 3.5' (retain-it® upright)
Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf
Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf
24 Rows adjusted for 417.5 cf perimeter wall

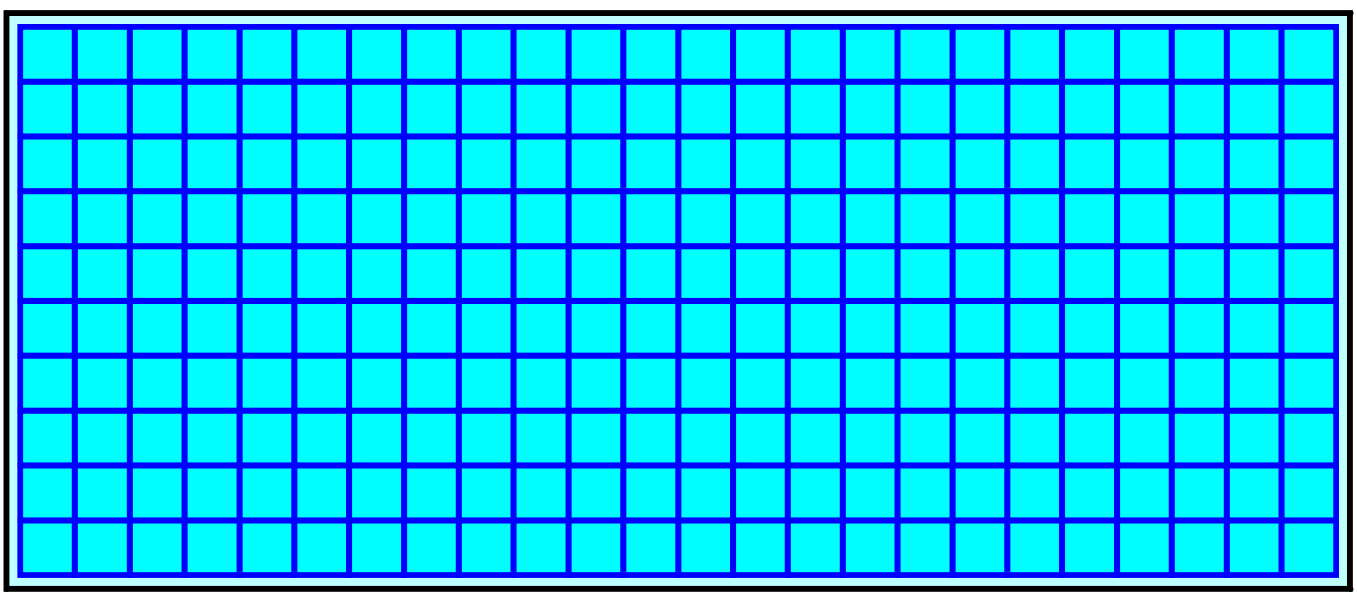
10 Chambers/Row x 8.00' Long = 80.00' Row Length +24.0" End Stone x 2 = 84.00' Base Length
24 Rows x 96.0" Wide + 24.0" Side Stone x 2 = 196.00' Base Width
9.0" Stone Base + 50.0" Chamber Height = 4.92' Field Height

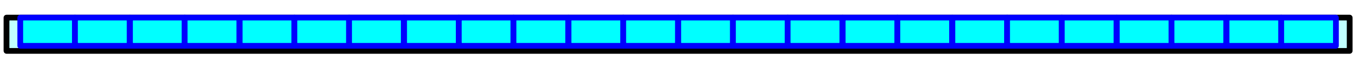
6.1 cf Sidewall x 10 x 2 + 6.1 cf Endwall x 24 x 2 = 417.5 cf Perimeter Wall
240 Chambers x 200.8 cf - 417.5 cf Perimeter wall = 47,769.8 cf Chamber Storage
240 Chambers x 266.7 cf = 64,000.0 cf Displacement

80,948.0 cf Field - 64,000.0 cf Chambers = 16,948.0 cf Stone x 40.0% Voids = 6,779.2 cf Stone Storage

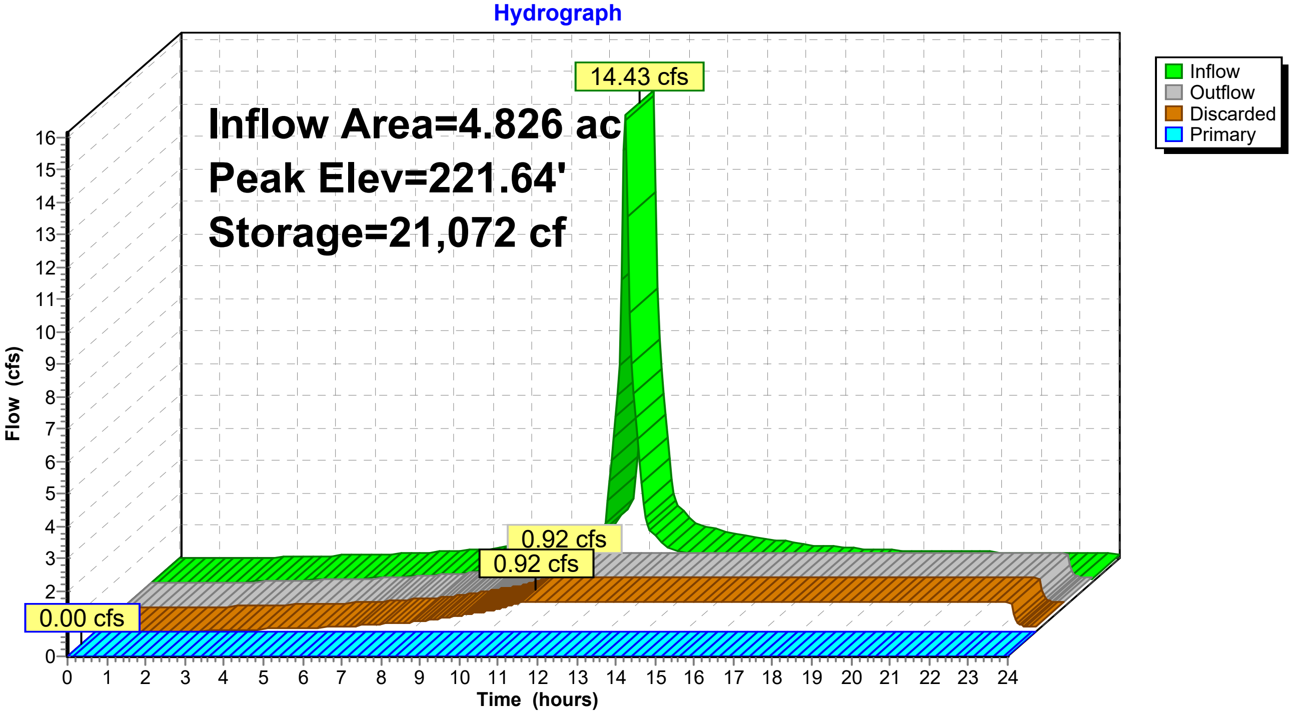
Chamber Storage + Stone Storage = 54,549.0 cf = 1.252 af
Overall Storage Efficiency = 67.4%
Overall System Size = 84.00' x 196.00' x 4.92'

240 Chambers
2,998.1 cy Field
627.7 cy Stone





Pond CMB: Underground Storage Chambers



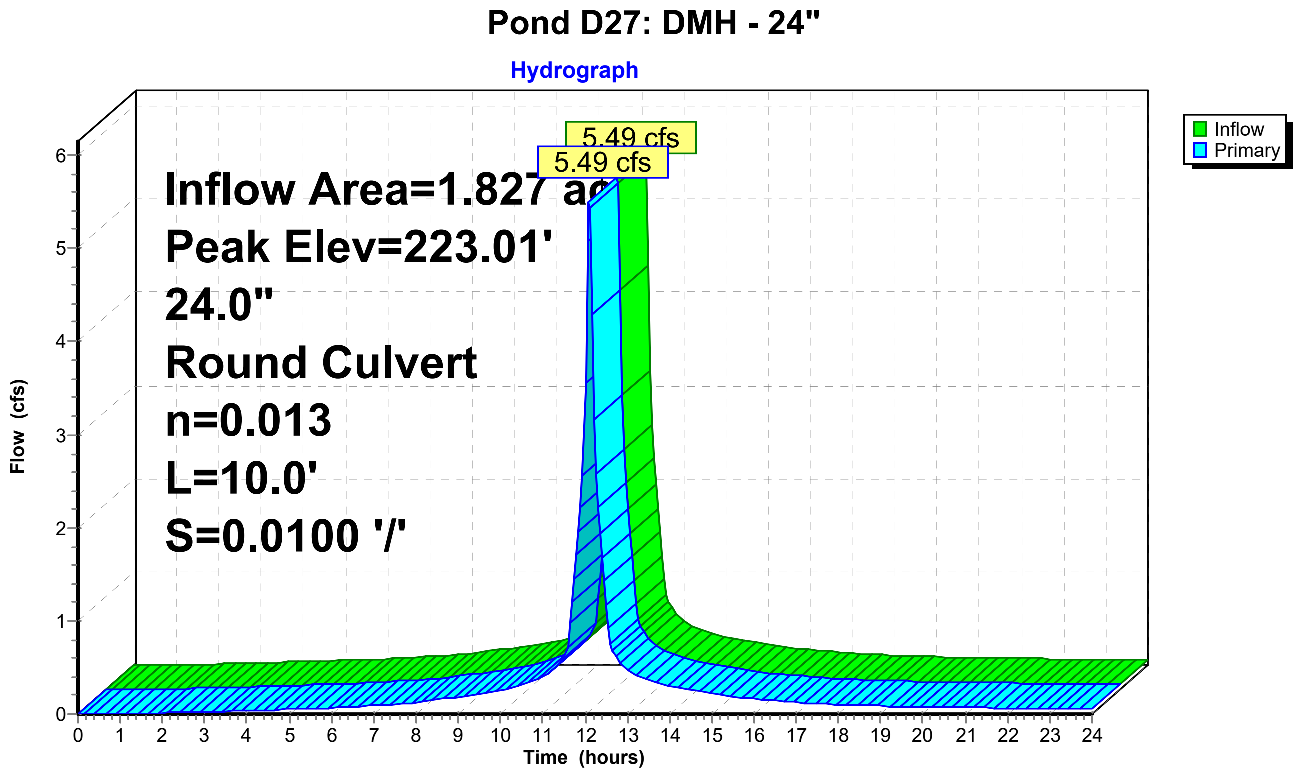
Summary for Pond D27: DMH - 24"

Inflow Area = 1.827 ac, 97.42% Impervious, Inflow Depth > 2.92" for 2-year 24hr event
Inflow = 5.49 cfs @ 12.09 hrs, Volume= 0.445 af
Outflow = 5.49 cfs @ 12.09 hrs, Volume= 0.445 af, Atten= 0%, Lag= 0.0 min
Primary = 5.49 cfs @ 12.09 hrs, Volume= 0.445 af
Routed to Link WQU-P6 : Water Quality Unit

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 223.01' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	221.80'	**24.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 221.80' / 221.70' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=5.35 cfs @ 12.09 hrs HW=222.99' (Free Discharge)
└─**1=Culvert** (Barrel Controls 5.35 cfs @ 3.95 fps)



Summary for Pond D30: DMH - 24"

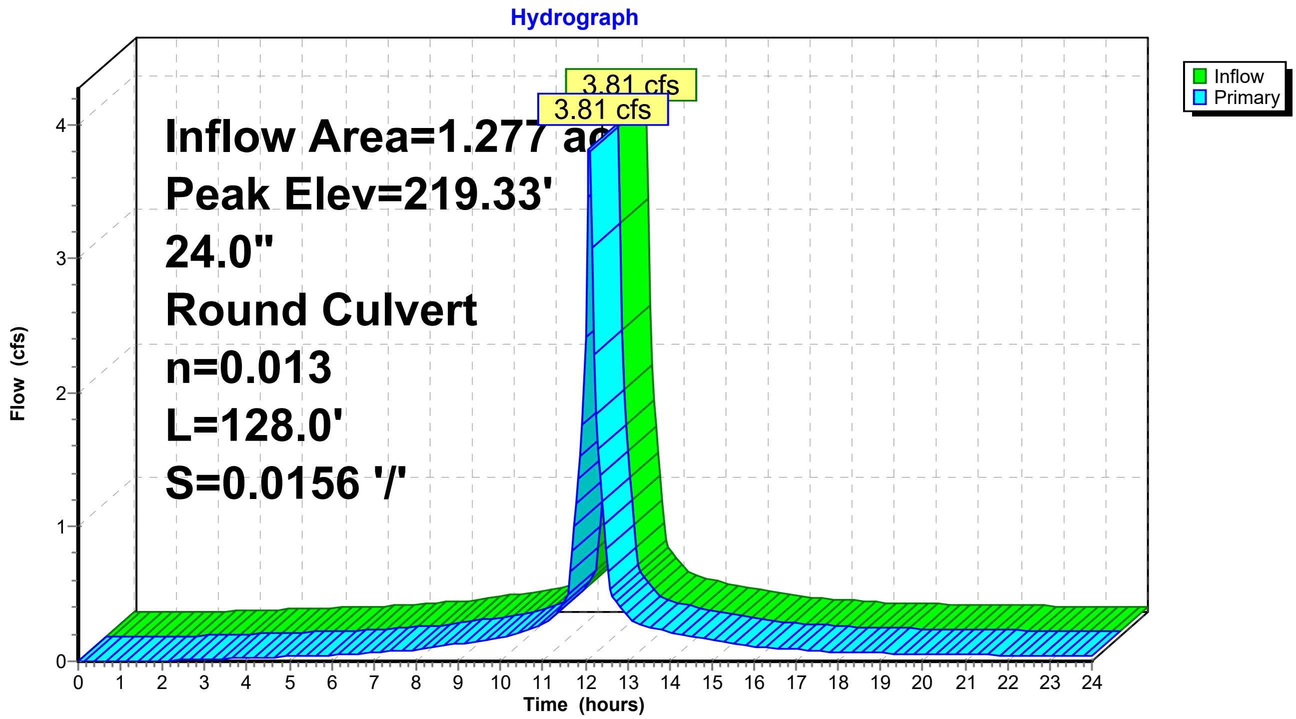
Inflow Area = 1.277 ac, 98.85% Impervious, Inflow Depth > 2.92" for 2-year 24hr event
Inflow = 3.81 cfs @ 12.09 hrs, Volume= 0.311 af
Outflow = 3.81 cfs @ 12.09 hrs, Volume= 0.311 af, Atten= 0%, Lag= 0.0 min
Primary = 3.81 cfs @ 12.09 hrs, Volume= 0.311 af
Routed to Pond D31 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 219.33' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	218.50'	**24.0" Round Culvert** L= 128.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 218.50' / 216.50' S= 0.0156 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=3.73 cfs @ 12.09 hrs HW=219.32' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 3.73 cfs @ 3.08 fps)

Pond D30: DMH - 24"



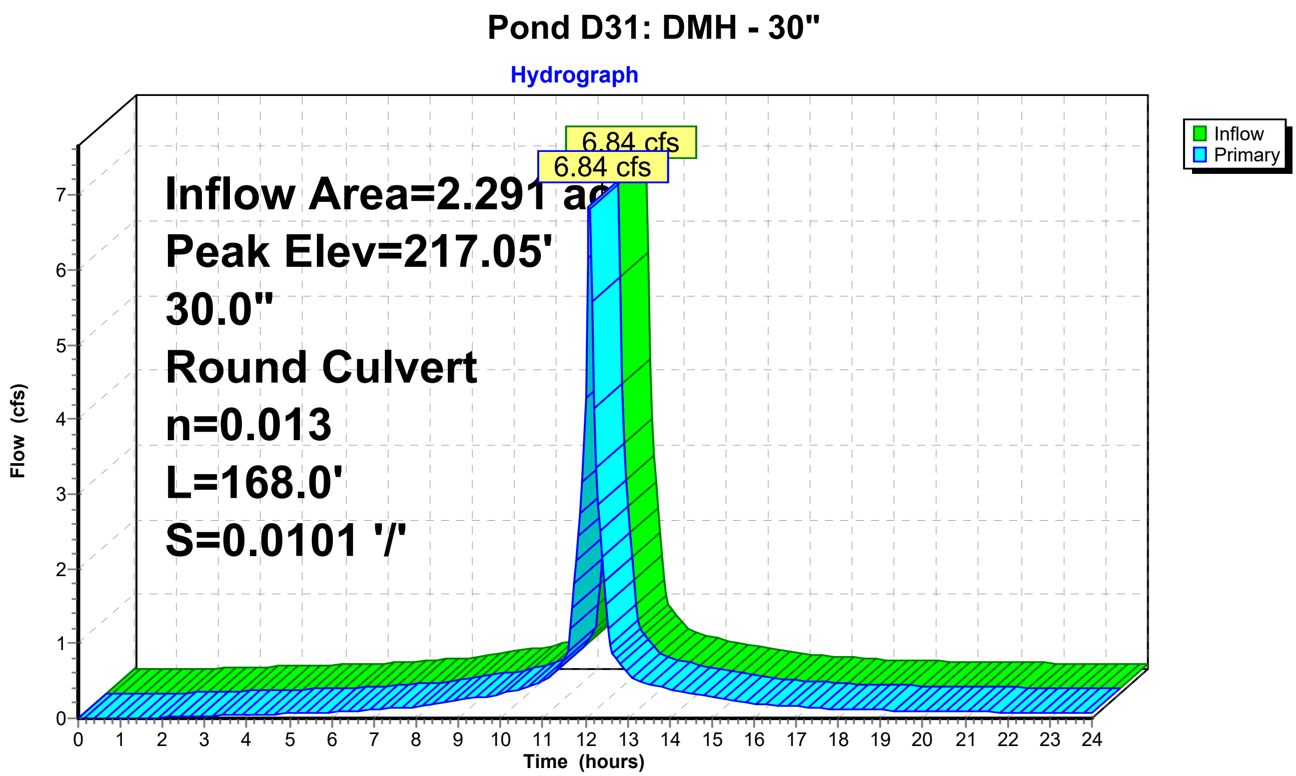
Summary for Pond D31: DMH - 30"

Inflow Area = 2.291 ac, 99.05% Impervious, Inflow Depth > 2.94" for 2-year 24hr event
Inflow = 6.84 cfs @ 12.09 hrs, Volume= 0.561 af
Outflow = 6.84 cfs @ 12.09 hrs, Volume= 0.561 af, Atten= 0%, Lag= 0.0 min
Primary = 6.84 cfs @ 12.09 hrs, Volume= 0.561 af
Routed to Pond D32 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 217.05' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	216.00'	**30.0" Round Culvert** L= 168.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 216.00' / 214.30' S= 0.0101 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf

Primary OutFlow Max=6.71 cfs @ 12.09 hrs HW=217.04' (Free Discharge)
└─**1=Culvert** (Inlet Controls 6.71 cfs @ 3.47 fps)



Summary for Pond D32: DMH - 30"

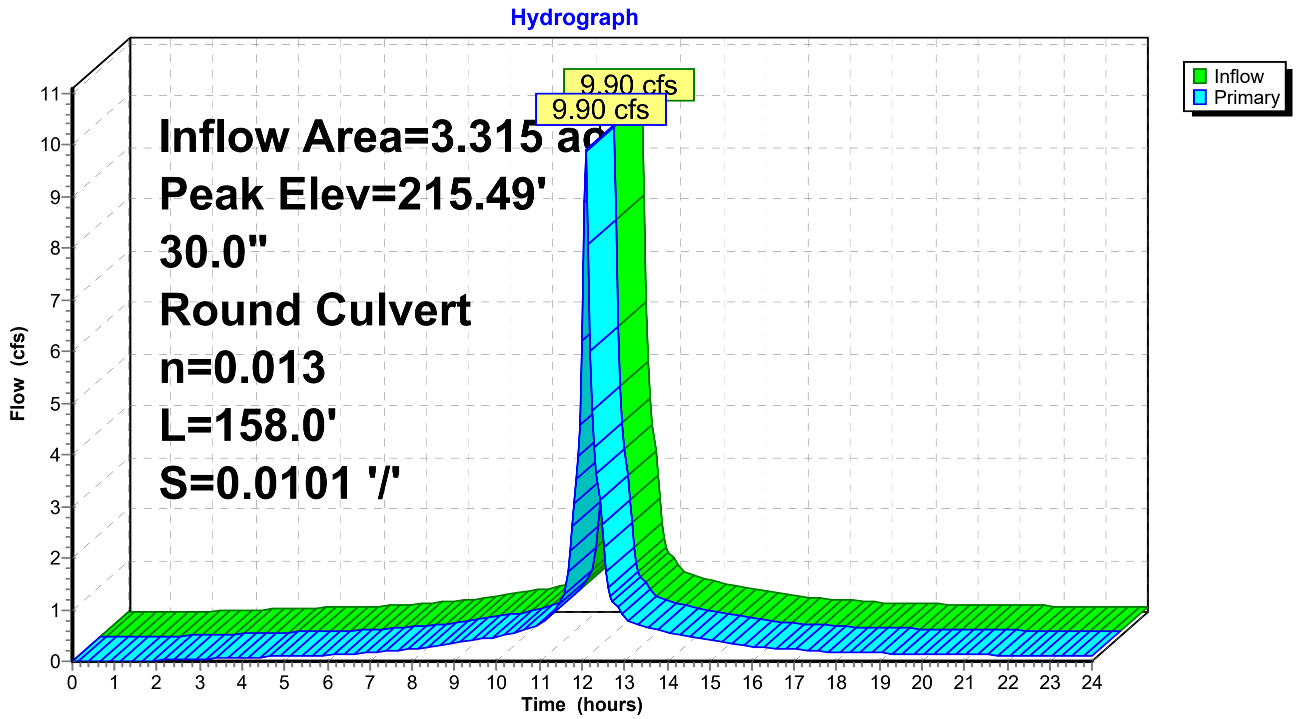
Inflow Area = 3.315 ac, 99.08% Impervious, Inflow Depth > 2.94" for 2-year 24hr event
Inflow = 9.90 cfs @ 12.09 hrs, Volume= 0.813 af
Outflow = 9.90 cfs @ 12.09 hrs, Volume= 0.813 af, Atten= 0%, Lag= 0.0 min
Primary = 9.90 cfs @ 12.09 hrs, Volume= 0.813 af
Routed to Pond D33 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 215.49' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	214.20'	**30.0" Round Culvert** L= 158.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 214.20' / 212.60' S= 0.0101 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf

Primary OutFlow Max=9.72 cfs @ 12.09 hrs HW=215.48' (Free Discharge)
1=Culvert (Inlet Controls 9.72 cfs @ 3.85 fps)

Pond D32: DMH - 30"



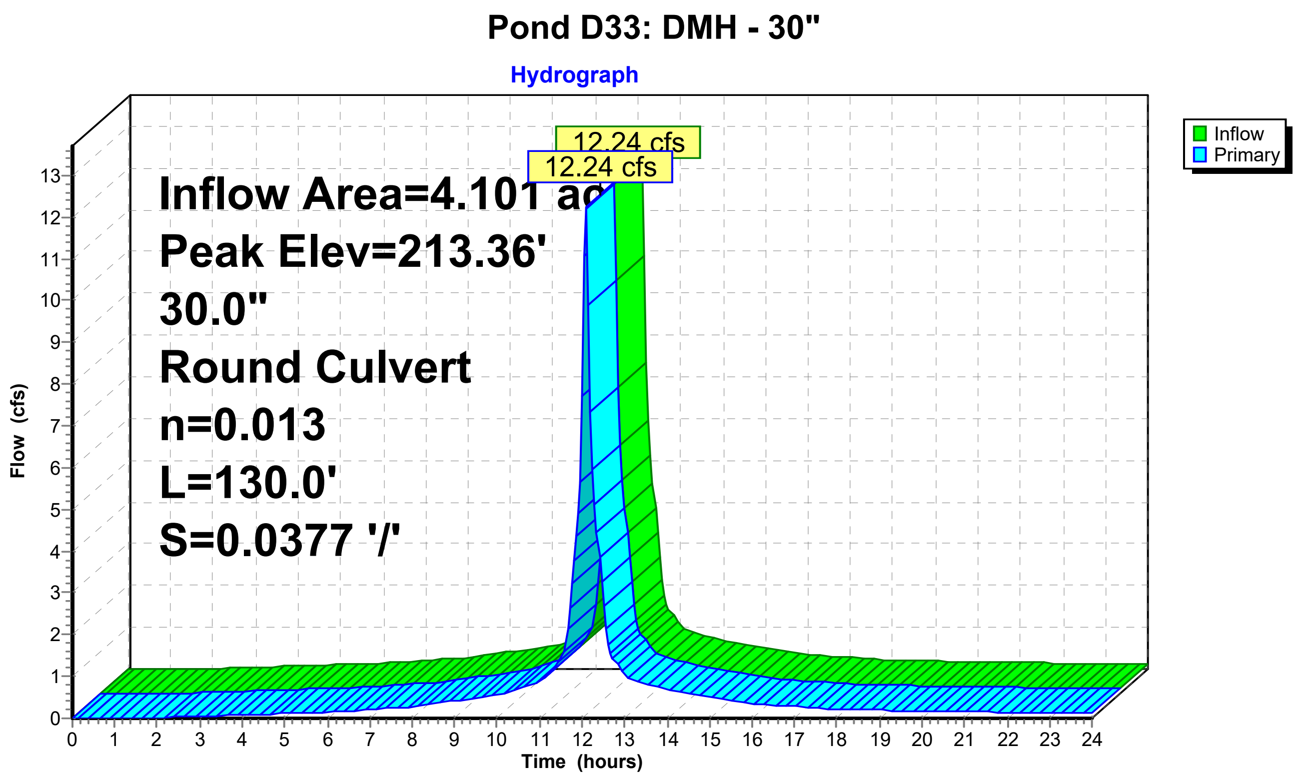
Summary for Pond D33: DMH - 30"

Inflow Area = 4.101 ac, 98.81% Impervious, Inflow Depth > 2.92" for 2-year 24hr event
Inflow = 12.24 cfs @ 12.09 hrs, Volume= 0.999 af
Outflow = 12.24 cfs @ 12.09 hrs, Volume= 0.999 af, Atten= 0%, Lag= 0.0 min
Primary = 12.24 cfs @ 12.09 hrs, Volume= 0.999 af
Routed to Pond F1 : Forebay

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 213.36' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	211.90'	**30.0" Round Culvert** L= 130.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 211.90' / 207.00' S= 0.0377 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf

Primary OutFlow Max=12.00 cfs @ 12.09 hrs HW=213.34' (Free Discharge)
└─**1=Culvert** (Inlet Controls 12.00 cfs @ 4.09 fps)



Summary for Pond F1: Forebay

Inflow Area = 5.424 ac, 88.71% Impervious, Inflow Depth > 2.70" for 2-year 24hr event
Inflow = 15.24 cfs @ 12.09 hrs, Volume= 1.218 af
Outflow = 14.40 cfs @ 12.12 hrs, Volume= 1.218 af, Atten= 6%, Lag= 1.6 min
Primary = 14.40 cfs @ 12.12 hrs, Volume= 1.218 af
Routed to Link WQU-P5 : Water Quality Unit
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond P1a : Proposed Basin

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 206.05' @ 12.12 hrs Surf.Area= 894 sf Storage= 720 cf

Plug-Flow detention time= 0.7 min calculated for 1.218 af (100% of inflow)
Center-of-Mass det. time= 0.6 min (769.6 - 769.0)

Volume	Invert	Avail.Storage	Storage Description
#1	205.00'	3,235 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

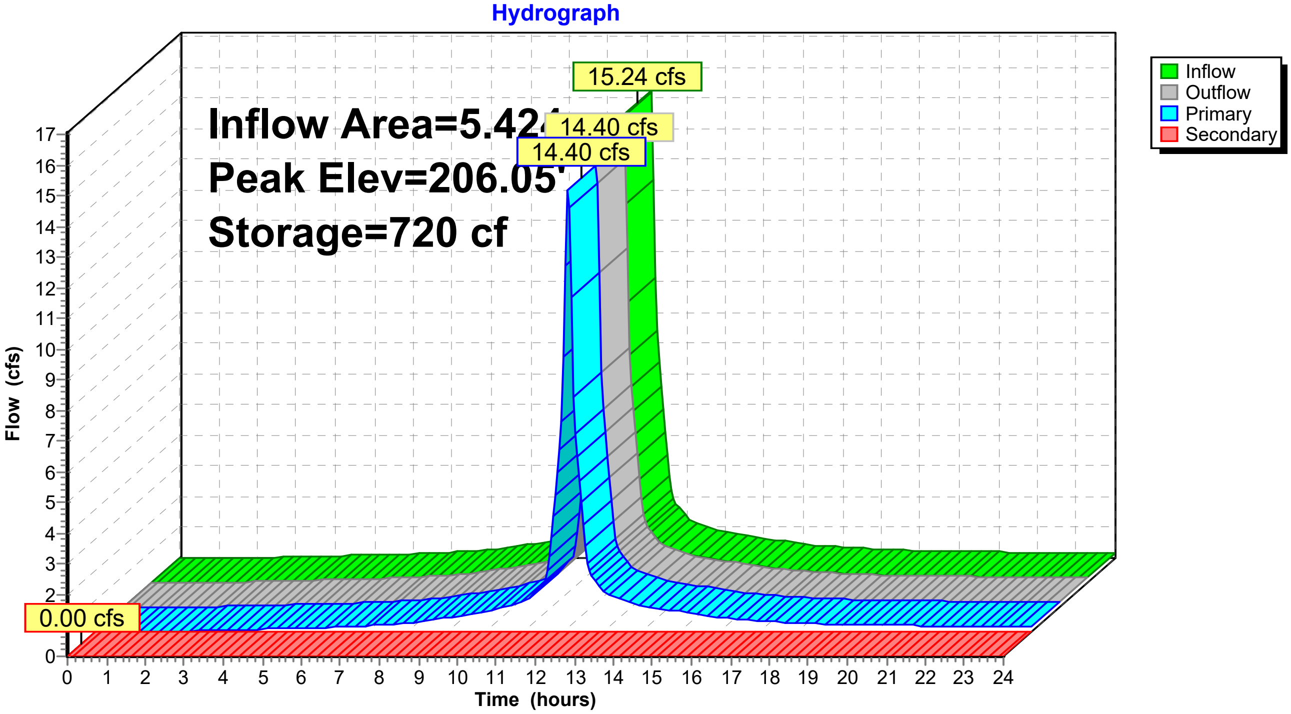
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
205.00	480	0	0
207.00	1,270	1,750	1,750
208.00	1,700	1,485	3,235

Device	Routing	Invert	Outlet Devices
#1	Primary	201.60'	**18.0" Round 18" Culvert** L= 30.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 201.60' / 201.30' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	205.00'	**1.0" x 21.0" Horiz. Double Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads
#3	Secondary	207.00'	**12.0' long + 2.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=14.09 cfs @ 12.12 hrs HW=206.01' (Free Discharge)
↑—**1=18" Culvert** (Passes 14.09 cfs of 16.27 cfs potential flow)
↑—**2=Double Grate** (Orifice Controls 14.09 cfs @ 4.83 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=205.00' (Free Discharge)
↑—**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond F1: Forebay



Summary for Pond P1a: Proposed Basin

Inflow Area = 6.267 ac, 77.58% Impervious, Inflow Depth > 2.51" for 2-year 24hr event
Inflow = 15.64 cfs @ 12.12 hrs, Volume= 1.311 af
Outflow = 1.02 cfs @ 13.87 hrs, Volume= 0.907 af, Atten= 93%, Lag= 105.1 min
Discarded = 0.71 cfs @ 13.87 hrs, Volume= 0.768 af
Primary = 0.31 cfs @ 13.87 hrs, Volume= 0.139 af
Routed to Link DP-A : Design Point A
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link DP-A : Design Point A

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 202.36' @ 13.87 hrs Surf.Area= 12,691 sf Storage= 32,020 cf

Plug-Flow detention time= 295.5 min calculated for 0.907 af (69% of inflow)
Center-of-Mass det. time= 199.5 min (974.5 - 775.0)

Volume	Invert	Avail.Storage	Storage Description
#1	198.00'	90,590 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
198.00	1,180	0	0
199.00	3,950	2,565	2,565
200.00	7,100	5,525	8,090
201.00	9,950	8,525	16,615
202.00	11,950	10,950	27,565
203.00	14,000	12,975	40,540
204.00	16,000	15,000	55,540
205.00	17,500	16,750	72,290
206.00	19,100	18,300	90,590

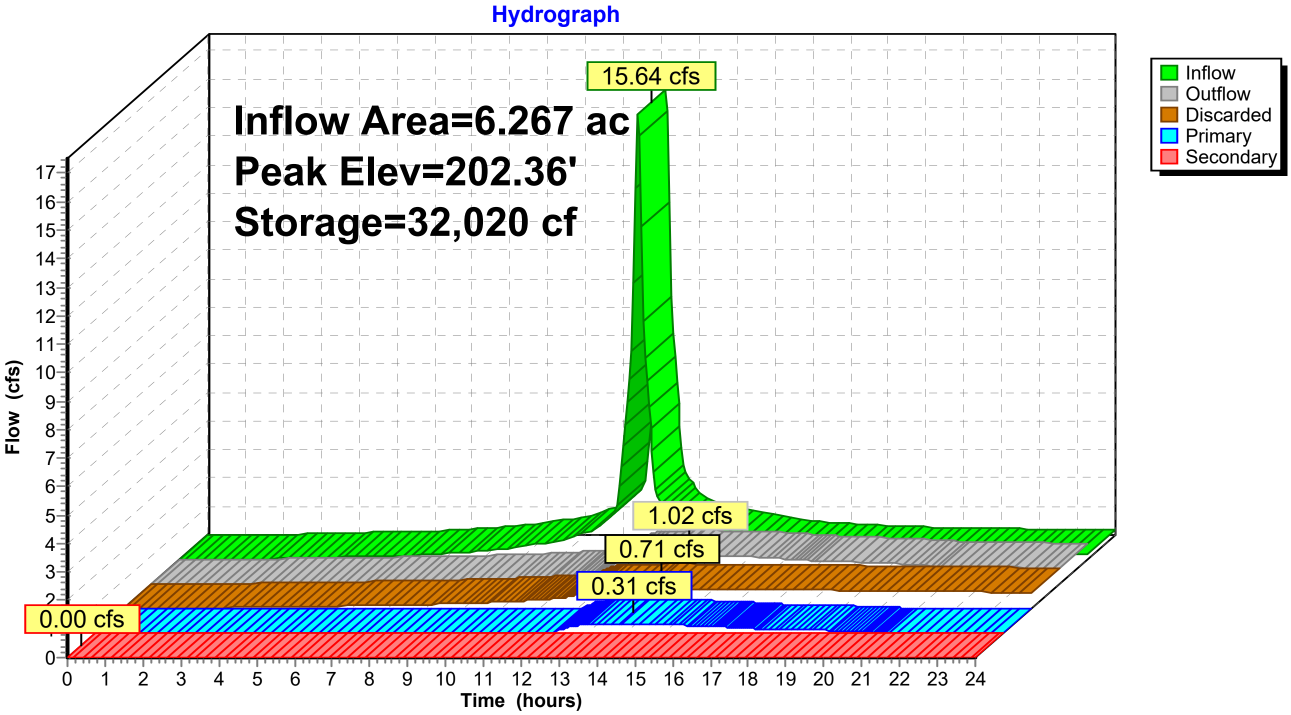
Device	Routing	Invert	Outlet Devices
#1	Secondary	205.00'	**10.0' long + 3.0 '/' SideZ x 11.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.53 2.59 2.70 2.68 2.67 2.68 2.66 2.64
#2	Primary	198.00'	**18.0" Round Culvert** L= 70.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 198.00' / 194.40' S= 0.0514 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#3	Device 2	201.50'	**1.0" Vert. Orifice/Grate X 8.00 columns** X 3 rows with 6.0" cc spacing C= 0.600 Limited to weir flow at low heads
#4	Device 2	203.00'	**18.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Discarded	198.00'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.71 cfs @ 13.87 hrs HW=202.36' (Free Discharge)
└**5=Exfiltration** (Exfiltration Controls 0.71 cfs)

Primary OutFlow Max=0.31 cfs @ 13.87 hrs HW=202.36' (Free Discharge)
└**2=Culvert** (Passes 0.31 cfs of 16.17 cfs potential flow)
 ├**3=Orifice/Grate** (Orifice Controls 0.31 cfs @ 3.54 fps)
 └**4=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=198.00' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P1a: Proposed Basin



Summary for Pond P30: 12" HDPE

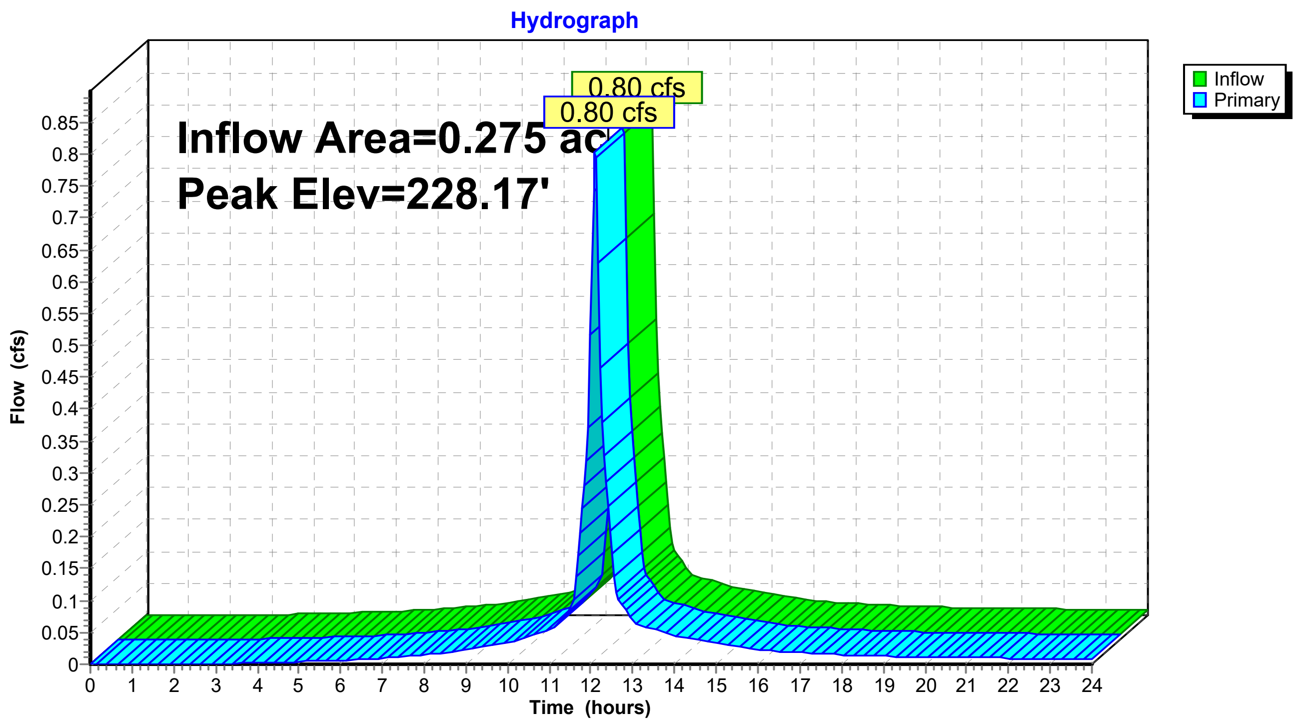
Inflow Area = 0.275 ac, 92.38% Impervious, Inflow Depth > 2.74" for 2-year 24hr event
Inflow = 0.80 cfs @ 12.09 hrs, Volume= 0.063 af
Outflow = 0.80 cfs @ 12.09 hrs, Volume= 0.063 af, Atten= 0%, Lag= 0.0 min
Primary = 0.80 cfs @ 12.09 hrs, Volume= 0.063 af
Routed to Pond D27 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 228.17' @ 12.09 hrs
Flood Elev= 228.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	224.60'	**12.0" Round Culvert** L= 180.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 224.60' / 222.80' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	228.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=0.76 cfs @ 12.09 hrs HW=228.17' (Free Discharge)
└─**1=Culvert** (Passes 0.76 cfs of 4.93 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 0.76 cfs @ 0.88 fps)

Pond P30: 12" HDPE



Summary for Pond P31: 12" HDPE

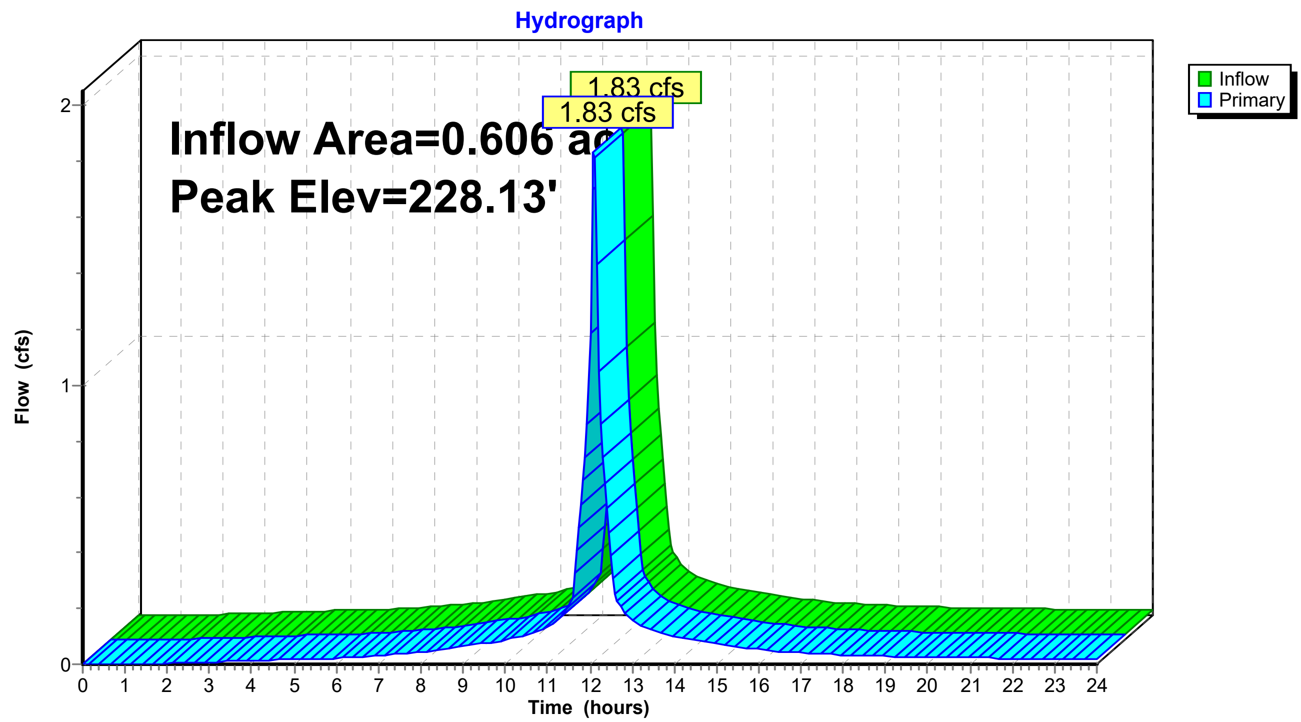
Inflow Area = 0.606 ac, 97.98% Impervious, Inflow Depth > 2.96" for 2-year 24hr event
Inflow = 1.83 cfs @ 12.09 hrs, Volume= 0.149 af
Outflow = 1.83 cfs @ 12.09 hrs, Volume= 0.149 af, Atten= 0%, Lag= 0.0 min
Primary = 1.83 cfs @ 12.09 hrs, Volume= 0.149 af
Routed to Pond D27 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 228.13' @ 12.09 hrs
Flood Elev= 223.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	223.00'	**12.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 223.00' / 222.90' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	228.00'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=1.76 cfs @ 12.09 hrs HW=228.13' (Free Discharge)
└─**1=Culvert** (Passes 1.76 cfs of 8.13 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 1.76 cfs @ 1.16 fps)

Pond P31: 12" HDPE



Summary for Pond P32: 12" HDPE

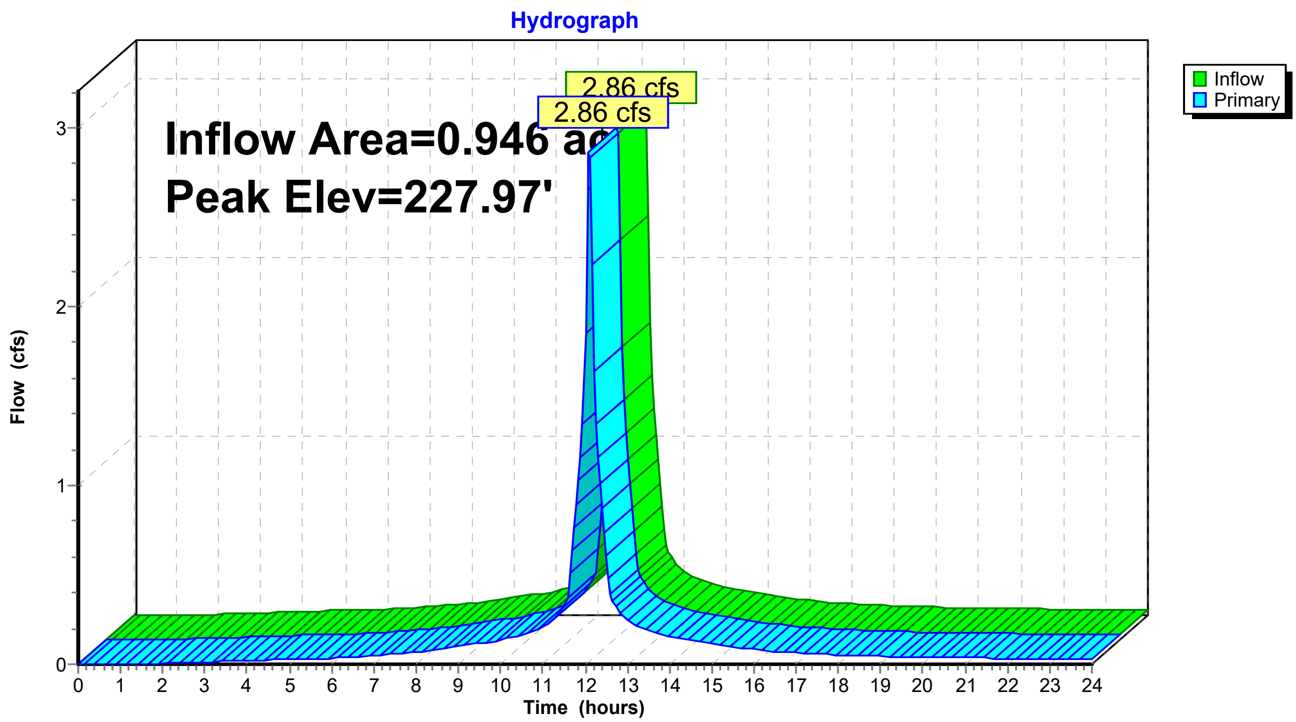
Inflow Area = 0.946 ac, 98.52% Impervious, Inflow Depth > 2.96" for 2-year 24hr event
Inflow = 2.86 cfs @ 12.09 hrs, Volume= 0.233 af
Outflow = 2.86 cfs @ 12.09 hrs, Volume= 0.233 af, Atten= 0%, Lag= 0.0 min
Primary = 2.86 cfs @ 12.09 hrs, Volume= 0.233 af
Routed to Pond D27 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 227.97' @ 12.09 hrs
Flood Elev= 228.30'

Device	Routing	Invert	Outlet Devices
#1	Primary	223.80'	**12.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 223.80' / 222.80' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	227.80'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=2.77 cfs @ 12.09 hrs HW=227.97' (Free Discharge)
└─**1=Culvert** (Passes 2.77 cfs of 5.98 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 2.77 cfs @ 1.35 fps)

Pond P32: 12" HDPE



Summary for Pond P33: 18" HDPE

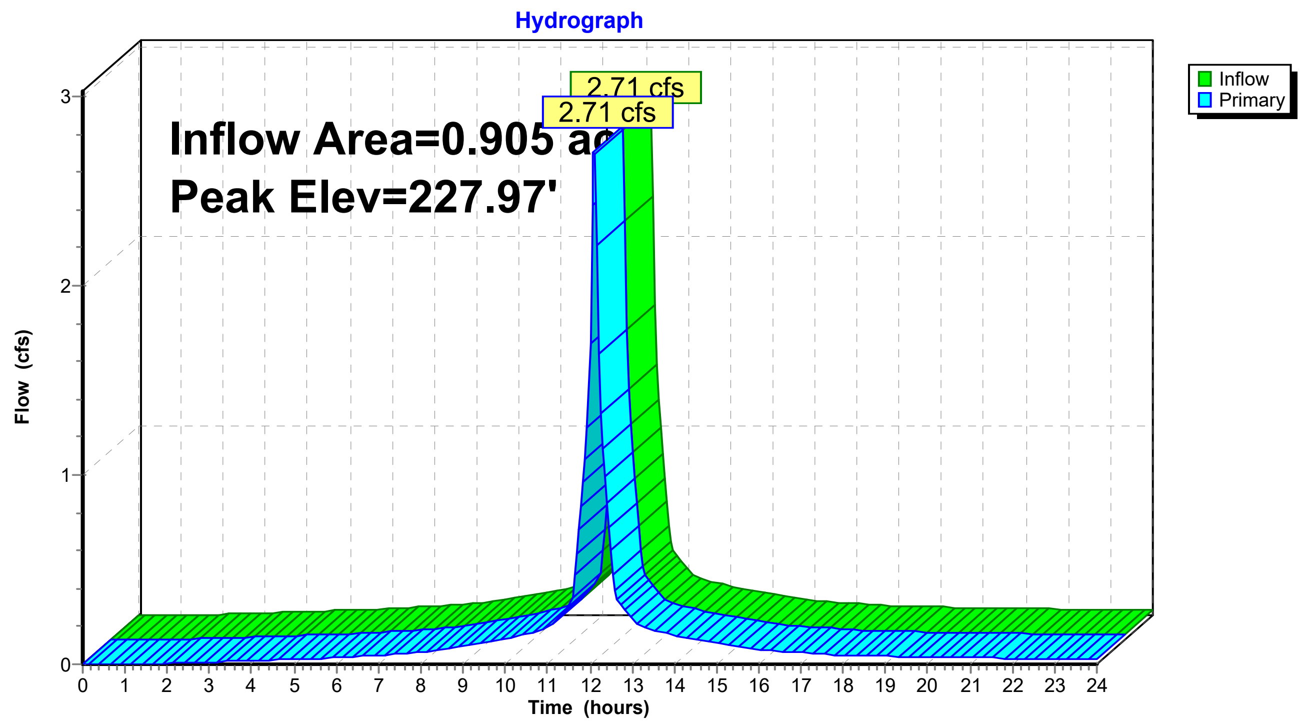
Inflow Area = 0.905 ac, 99.31% Impervious, Inflow Depth > 2.96" for 2-year 24hr event
Inflow = 2.71 cfs @ 12.09 hrs, Volume= 0.223 af
Outflow = 2.71 cfs @ 12.09 hrs, Volume= 0.223 af, Atten= 0%, Lag= 0.0 min
Primary = 2.71 cfs @ 12.09 hrs, Volume= 0.223 af
Routed to Pond D30 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 227.97' @ 12.09 hrs
Flood Elev= 228.30'

Device	Routing	Invert	Outlet Devices
#1	Primary	222.80'	**18.0" Round Culvert** L= 198.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 222.80' / 219.00' S= 0.0192 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	227.80'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=2.65 cfs @ 12.09 hrs HW=227.97' (Free Discharge)
└─**1=Culvert** (Passes 2.65 cfs of 17.12 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 2.65 cfs @ 1.33 fps)

Pond P33: 18" HDPE



Summary for Pond P34: 18" HDPE

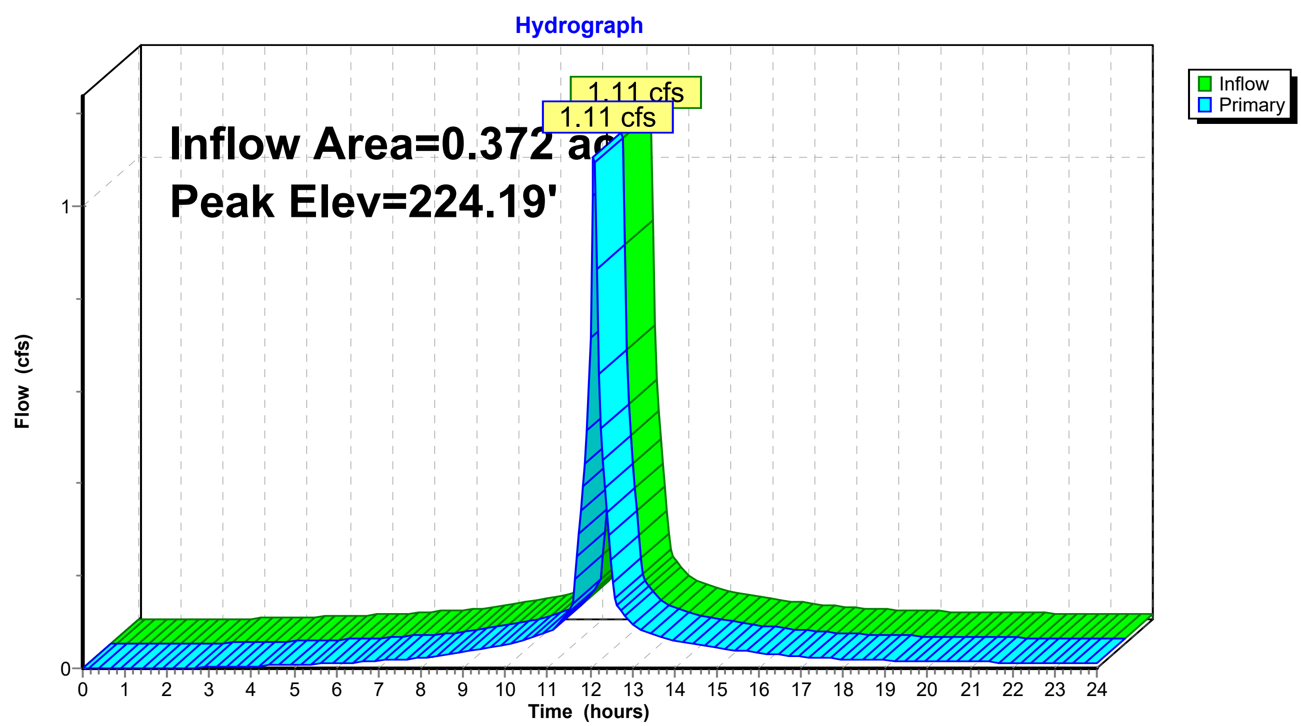
Inflow Area = 0.372 ac, 97.73% Impervious, Inflow Depth > 2.84" for 2-year 24hr event
Inflow = 1.11 cfs @ 12.09 hrs, Volume= 0.088 af
Outflow = 1.11 cfs @ 12.09 hrs, Volume= 0.088 af, Atten= 0%, Lag= 0.0 min
Primary = 1.11 cfs @ 12.09 hrs, Volume= 0.088 af
Routed to Pond D30 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 224.19' @ 12.09 hrs
Flood Elev= 224.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	219.10'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 219.10' / 219.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	224.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=1.04 cfs @ 12.09 hrs HW=224.19' (Free Discharge)
└─**1=Culvert** (Passes 1.04 cfs of 17.72 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 1.04 cfs @ 0.97 fps)

Pond P34: 18" HDPE



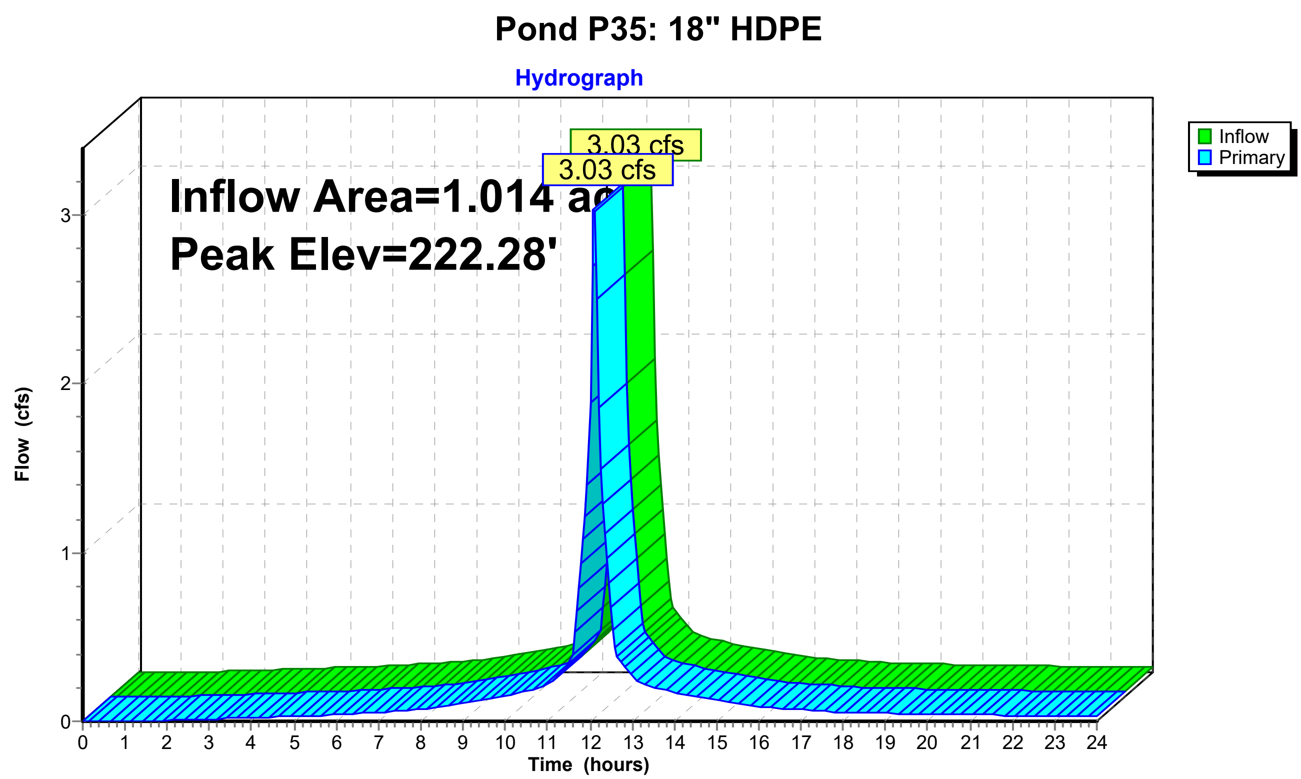
Summary for Pond P35: 18" HDPE

Inflow Area = 1.014 ac, 99.30% Impervious, Inflow Depth > 2.96" for 2-year 24hr event
Inflow = 3.03 cfs @ 12.09 hrs, Volume= 0.250 af
Outflow = 3.03 cfs @ 12.09 hrs, Volume= 0.250 af, Atten= 0%, Lag= 0.0 min
Primary = 3.03 cfs @ 12.09 hrs, Volume= 0.250 af
Routed to Pond D31 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 222.28' @ 12.09 hrs
Flood Elev= 222.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	217.10'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 217.10' / 217.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	222.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=2.97 cfs @ 12.09 hrs HW=222.28' (Free Discharge)
└**1=Culvert** (Passes 2.97 cfs of 17.91 cfs potential flow)
└**2=Orifice/Grate** (Weir Controls 2.97 cfs @ 1.38 fps)



Summary for Pond P36: 18" HDPE

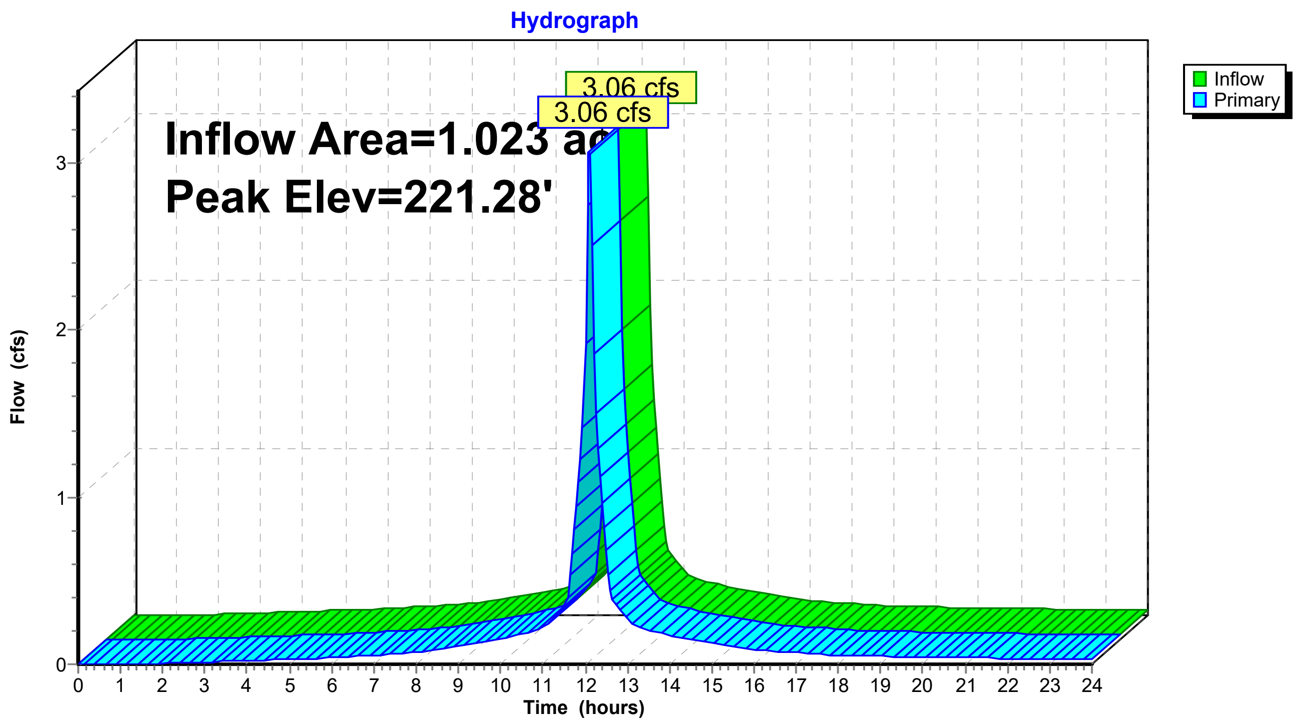
Inflow Area = 1.023 ac, 99.15% Impervious, Inflow Depth > 2.96" for 2-year 24hr event
Inflow = 3.06 cfs @ 12.09 hrs, Volume= 0.252 af
Outflow = 3.06 cfs @ 12.09 hrs, Volume= 0.252 af, Atten= 0%, Lag= 0.0 min
Primary = 3.06 cfs @ 12.09 hrs, Volume= 0.252 af
Routed to Pond D32 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 221.28' @ 12.09 hrs
Flood Elev= 221.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	216.10'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 216.10' / 216.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	221.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=2.99 cfs @ 12.09 hrs HW=221.28' (Free Discharge)
└─**1=Culvert** (Passes 2.99 cfs of 17.91 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 2.99 cfs @ 1.39 fps)

Pond P36: 18" HDPE



Summary for Pond P37: 18" HDPE

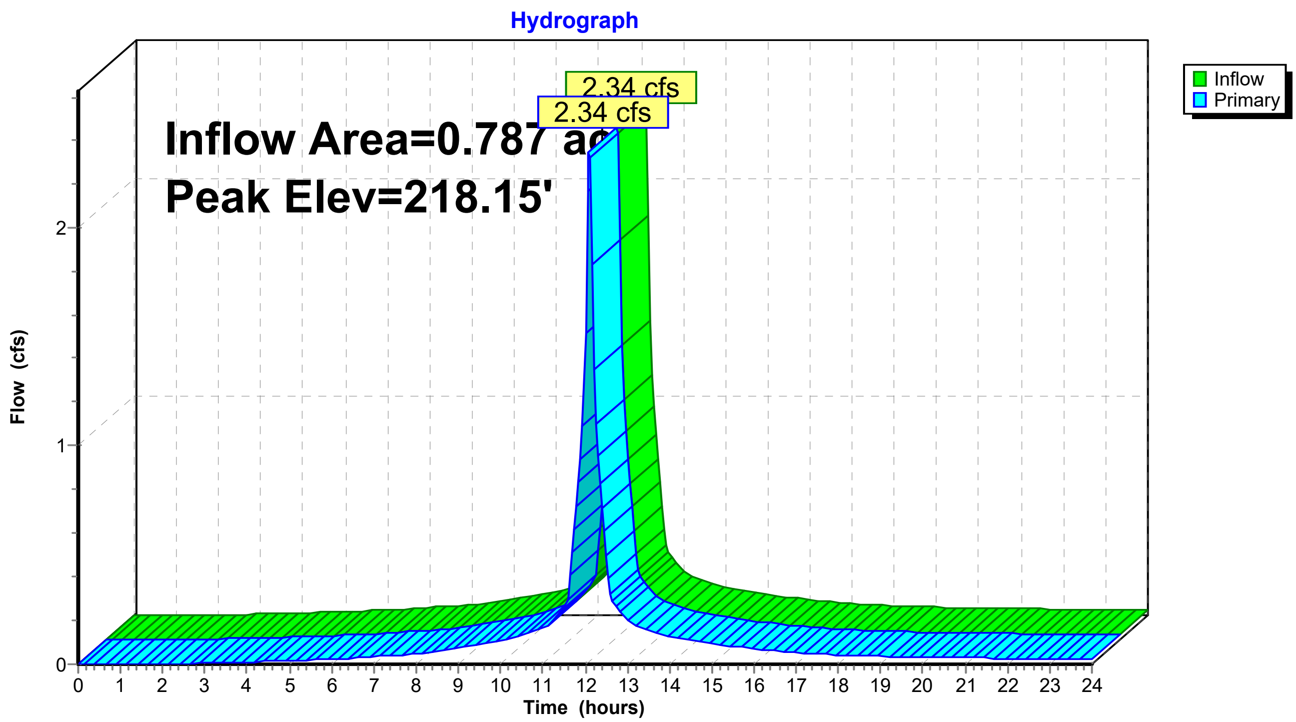
Inflow Area = 0.787 ac, 97.66% Impervious, Inflow Depth > 2.84" for 2-year 24hr event
Inflow = 2.34 cfs @ 12.09 hrs, Volume= 0.186 af
Outflow = 2.34 cfs @ 12.09 hrs, Volume= 0.186 af, Atten= 0%, Lag= 0.0 min
Primary = 2.34 cfs @ 12.09 hrs, Volume= 0.186 af
Routed to Pond D33 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 218.15' @ 12.09 hrs
Flood Elev= 218.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	213.00'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 213.00' / 212.90' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	218.00'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=2.25 cfs @ 12.09 hrs HW=218.15' (Free Discharge)
└─**1=Culvert** (Passes 2.25 cfs of 17.85 cfs potential flow)
└─**2=Orifice/Grate** (Weir Controls 2.25 cfs @ 1.26 fps)

Pond P37: 18" HDPE



Summary for Pond P38: 18" HDPE

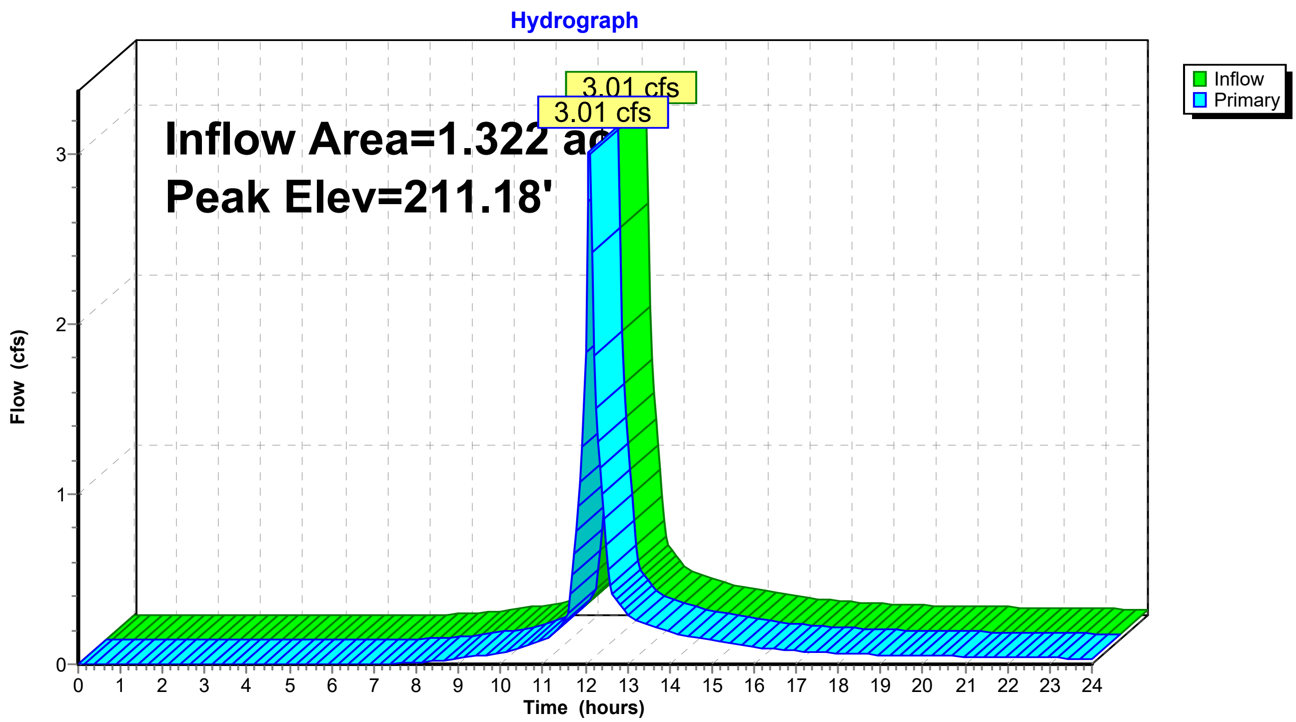
Inflow Area = 1.322 ac, 57.38% Impervious, Inflow Depth > 1.99" for 2-year 24hr event
Inflow = 3.01 cfs @ 12.09 hrs, Volume= 0.219 af
Outflow = 3.01 cfs @ 12.09 hrs, Volume= 0.219 af, Atten= 0%, Lag= 0.0 min
Primary = 3.01 cfs @ 12.09 hrs, Volume= 0.219 af
Routed to Pond F1 : Forebay

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 211.18' @ 12.09 hrs
Flood Elev= 211.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	207.80'	**18.0" Round Culvert** L= 80.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 207.80' / 207.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	211.00'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=2.94 cfs @ 12.09 hrs HW=211.18' (Free Discharge)
└─**1=Culvert** (Passes 2.94 cfs of 13.48 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 2.94 cfs @ 1.38 fps)

Pond P38: 18" HDPE

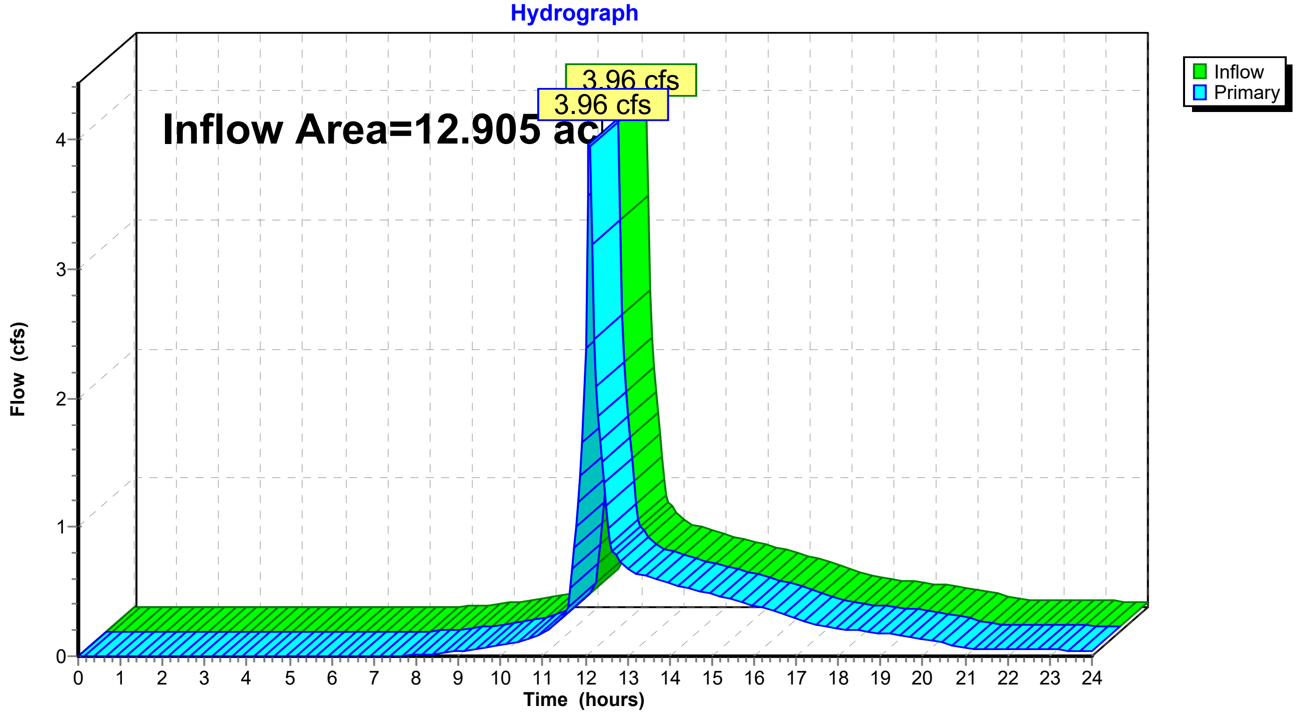


Summary for Link DP-A: Design Point A

Inflow Area = 12.905 ac, 73.65% Impervious, Inflow Depth > 0.40" for 2-year 24hr event
Inflow = 3.96 cfs @ 12.09 hrs, Volume= 0.427 af
Primary = 3.96 cfs @ 12.09 hrs, Volume= 0.427 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link DP-A: Design Point A

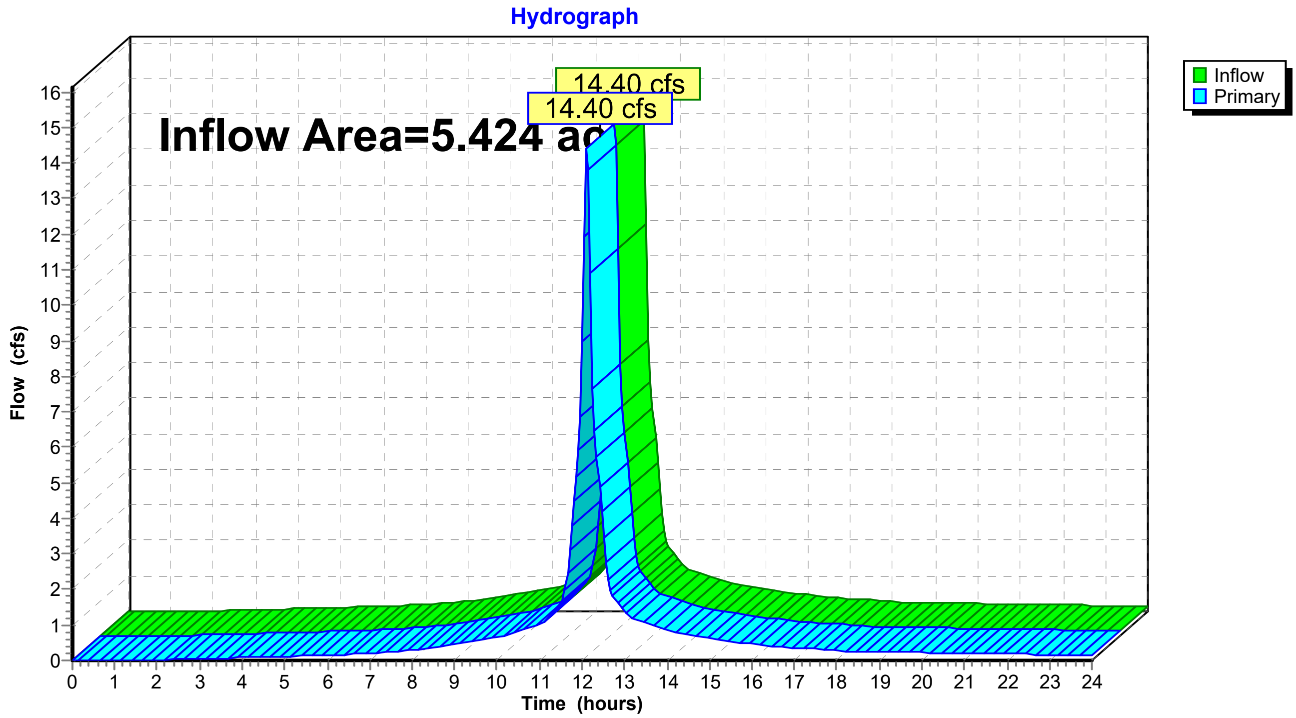


Summary for Link WQU-P5: Water Quality Unit

Inflow Area = 5.424 ac, 88.71% Impervious, Inflow Depth > 2.70" for 2-year 24hr event
Inflow = 14.40 cfs @ 12.12 hrs, Volume= 1.218 af
Primary = 14.40 cfs @ 12.12 hrs, Volume= 1.218 af, Atten= 0%, Lag= 0.0 min
Routed to Pond P1a : Proposed Basin

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link WQU-P5: Water Quality Unit

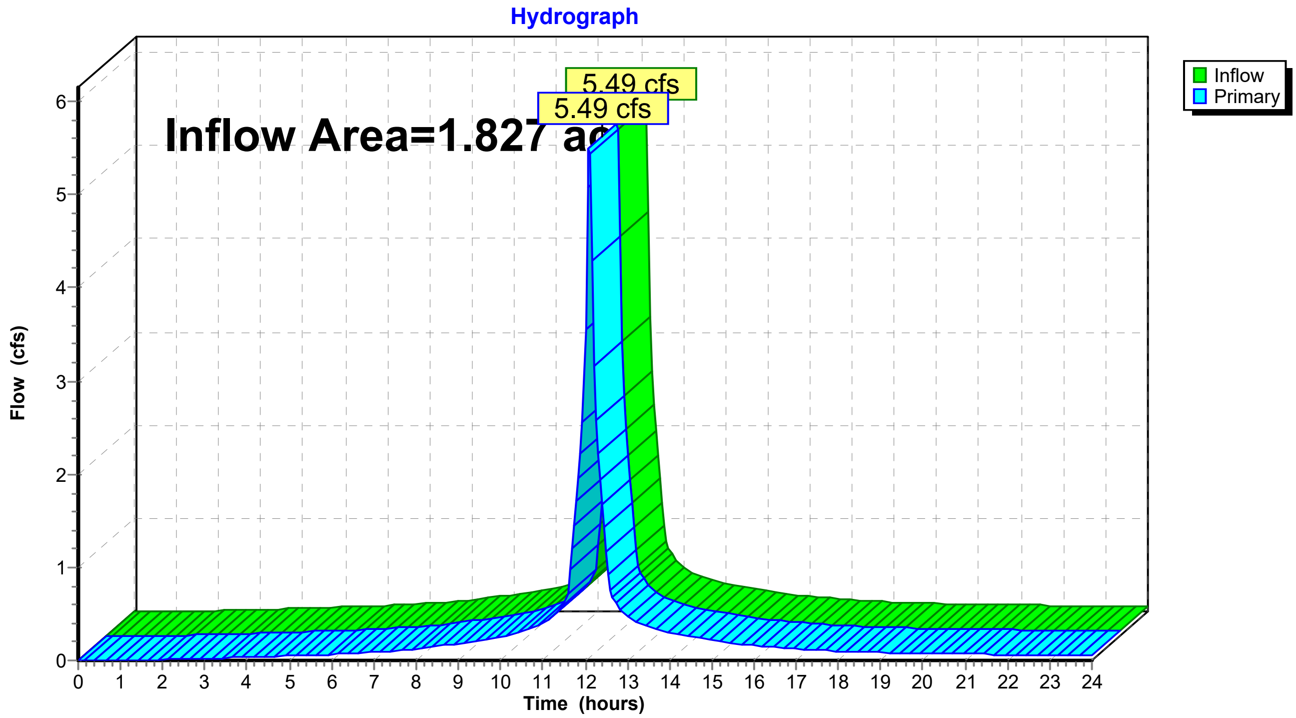


Summary for Link WQU-P6: Water Quality Unit

Inflow Area = 1.827 ac, 97.42% Impervious, Inflow Depth > 2.92" for 2-year 24hr event
Inflow = 5.49 cfs @ 12.09 hrs, Volume= 0.445 af
Primary = 5.49 cfs @ 12.09 hrs, Volume= 0.445 af, Atten= 0%, Lag= 0.0 min
Routed to Pond CMB : Underground Storage Chambers

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link WQU-P6: Water Quality Unit



Summary for Subcatchment P-A1:

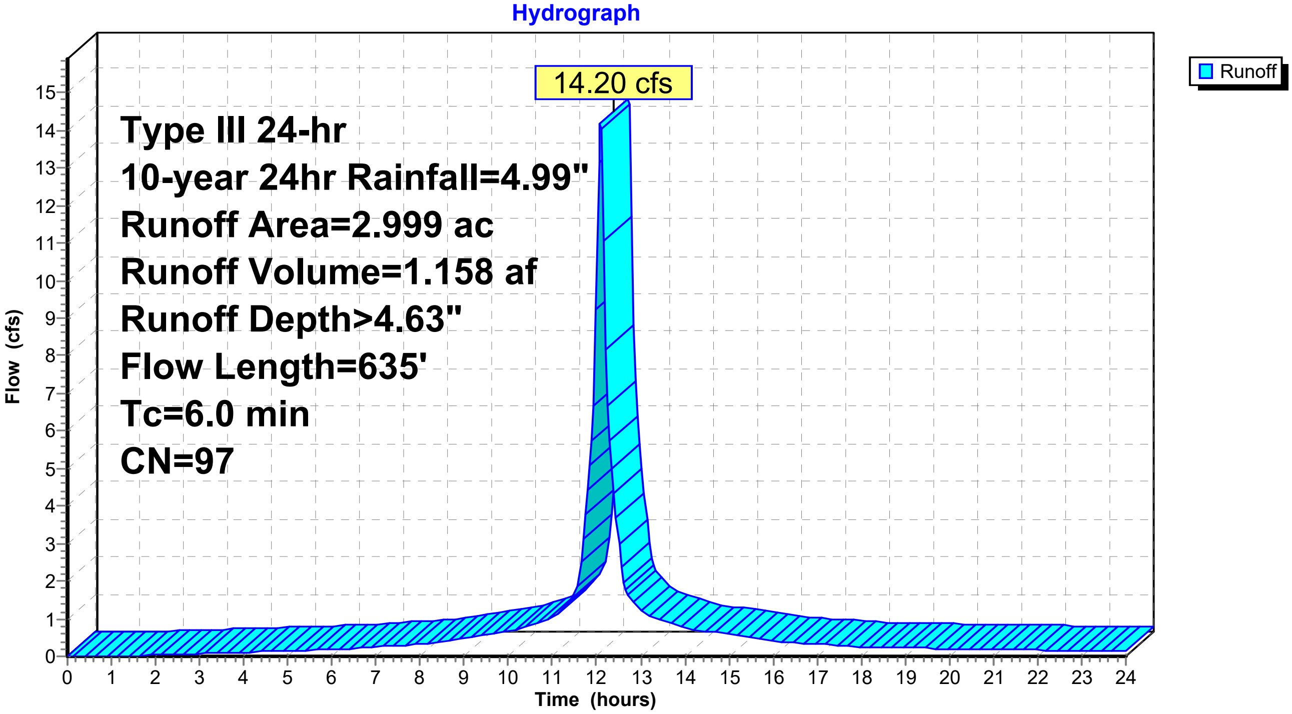
Runoff = 14.20 cfs @ 12.09 hrs, Volume= 1.158 af, Depth> 4.63"
Routed to Pond CMB : Underground Storage Chambers

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
1.360	98	EX Gravel Surface, Impervious, HSG C
0.003	98	PR Gravel Surface, Impervious, HSG C
0.043	98	PR Gravel Surface, Impervious, HSG C
0.007	98	PR Gravel Surface, Impervious, HSG C
0.933	98	Roofs, HSG C
0.050	98	Paved parking, HSG C
0.457	98	Paved parking, HSG C
0.069	74	>75% Grass cover, Good, HSG C
0.078	74	>75% Grass cover, Good, HSG C
2.999	97	Weighted Average
0.147		4.89% Pervious Area
2.852		95.11% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.19"
3.5	300	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.0	285	0.0060	4.60	8.14	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
5.7	635	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A1:



Summary for Subcatchment P-A2a:

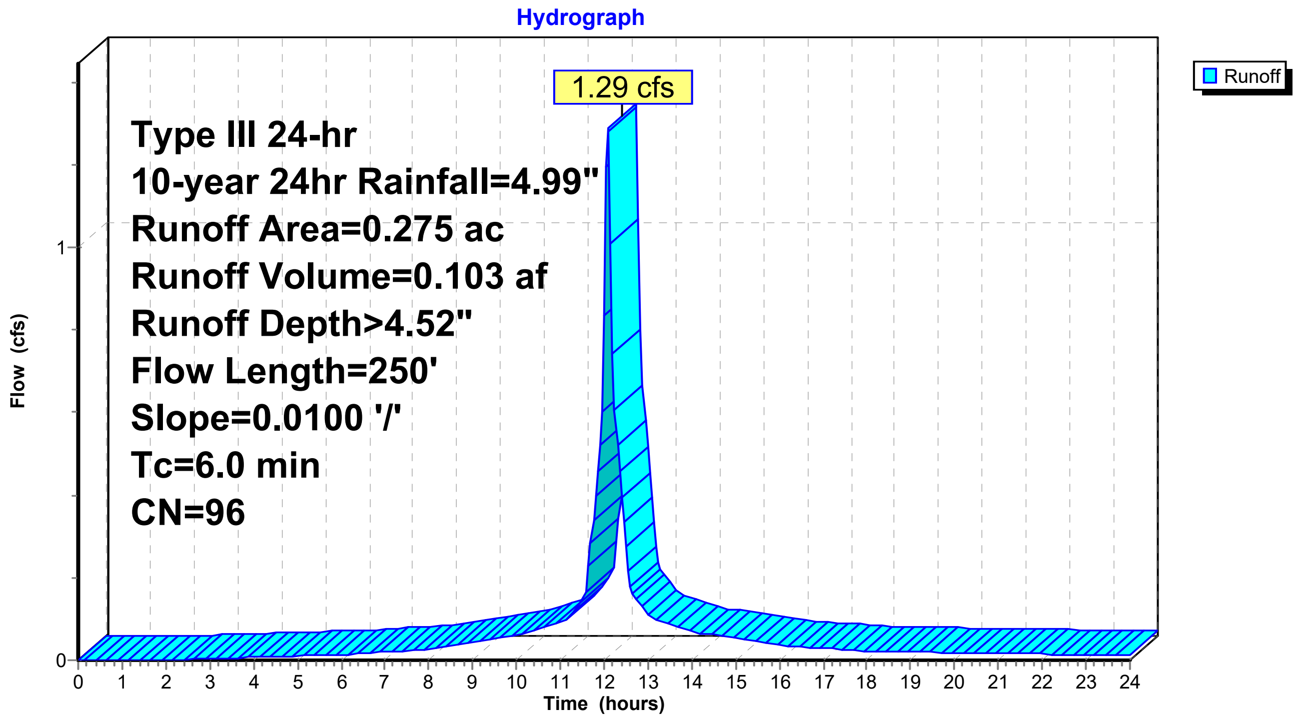
Runoff = 1.29 cfs @ 12.09 hrs, Volume= 0.103 af, Depth> 4.52"
Routed to Pond P30 : 12" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
0.021	74	>75% Grass cover, Good, HSG C
0.016	98	EX Gravel Surface, Impervious, HSG C
0.238	98	PR Gravel Surface, Impervious, HSG C
0.275	96	Weighted Average
0.021		7.62% Pervious Area
0.254		92.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
2.1	200	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.2	250	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A2a:



Summary for Subcatchment P-A2b:

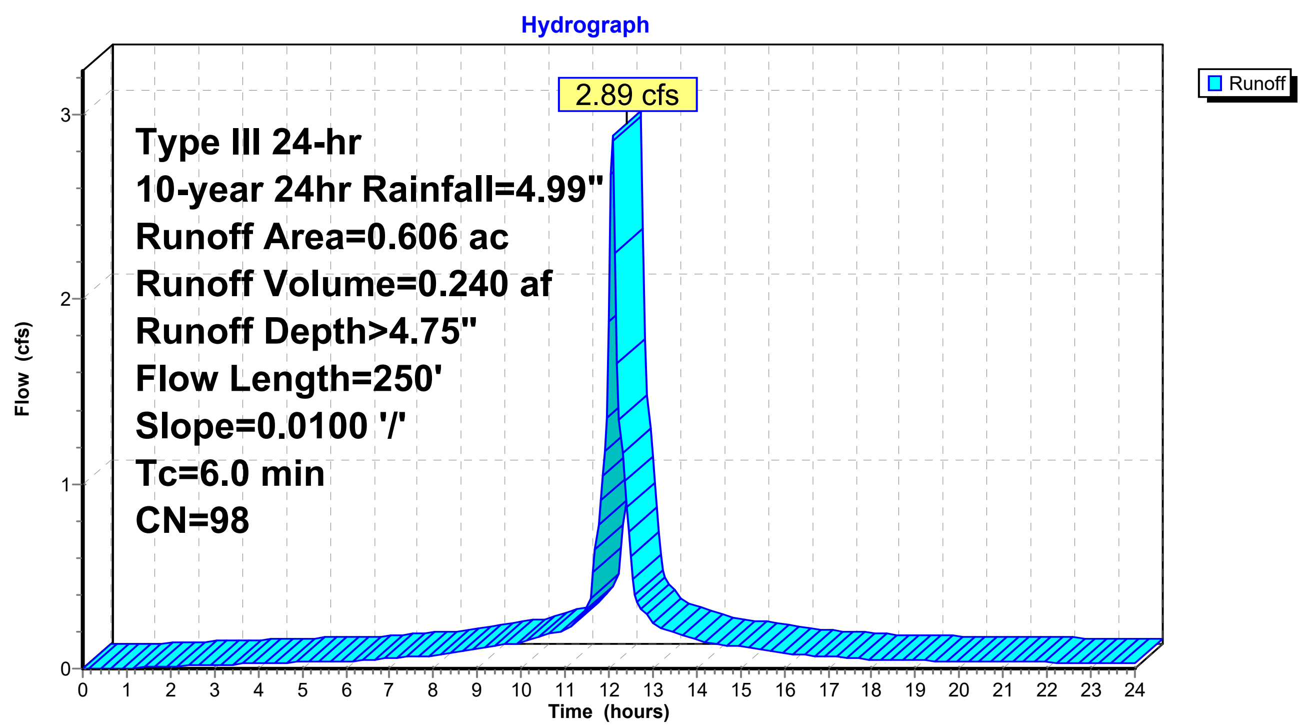
Runoff = 2.89 cfs @ 12.09 hrs, Volume= 0.240 af, Depth> 4.75"
Routed to Pond P31 : 12" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
0.330	98	PR Gravel Surface, Impervious, HSG C
0.016	98	PR Gravel Surface, Impervious, HSG C
0.247	98	EX Gravel Surface, Impervious, HSG C
0.007	74	>75% Grass cover, Good, HSG C
0.005	74	>75% Grass cover, Good, HSG C
0.606	98	Weighted Average
0.012		2.02% Pervious Area
0.594		97.98% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
2.1	200	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.2	250	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A2b:



Summary for Subcatchment P-A2c:

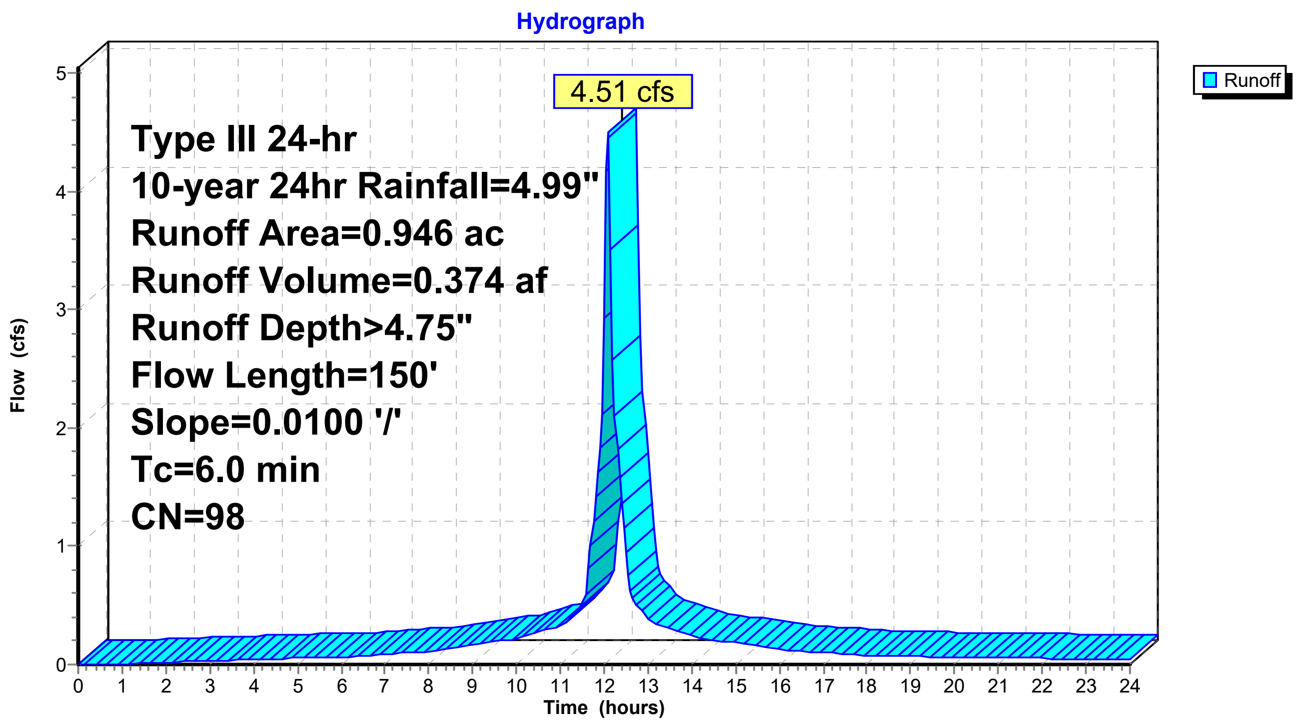
Runoff = 4.51 cfs @ 12.09 hrs, Volume= 0.374 af, Depth> 4.75"
Routed to Pond P32 : 12" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
0.284	98	EX Gravel Surface, Impervious, HSG C
0.648	98	PR Gravel Surface, Impervious, HSG C
0.006	74	>75% Grass cover, Good, HSG C
0.008	74	>75% Grass cover, Good, HSG C
0.946	98	Weighted Average
0.014		1.48% Pervious Area
0.932		98.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.0	100	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.1	150	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A2c:



Summary for Subcatchment P-A3a:

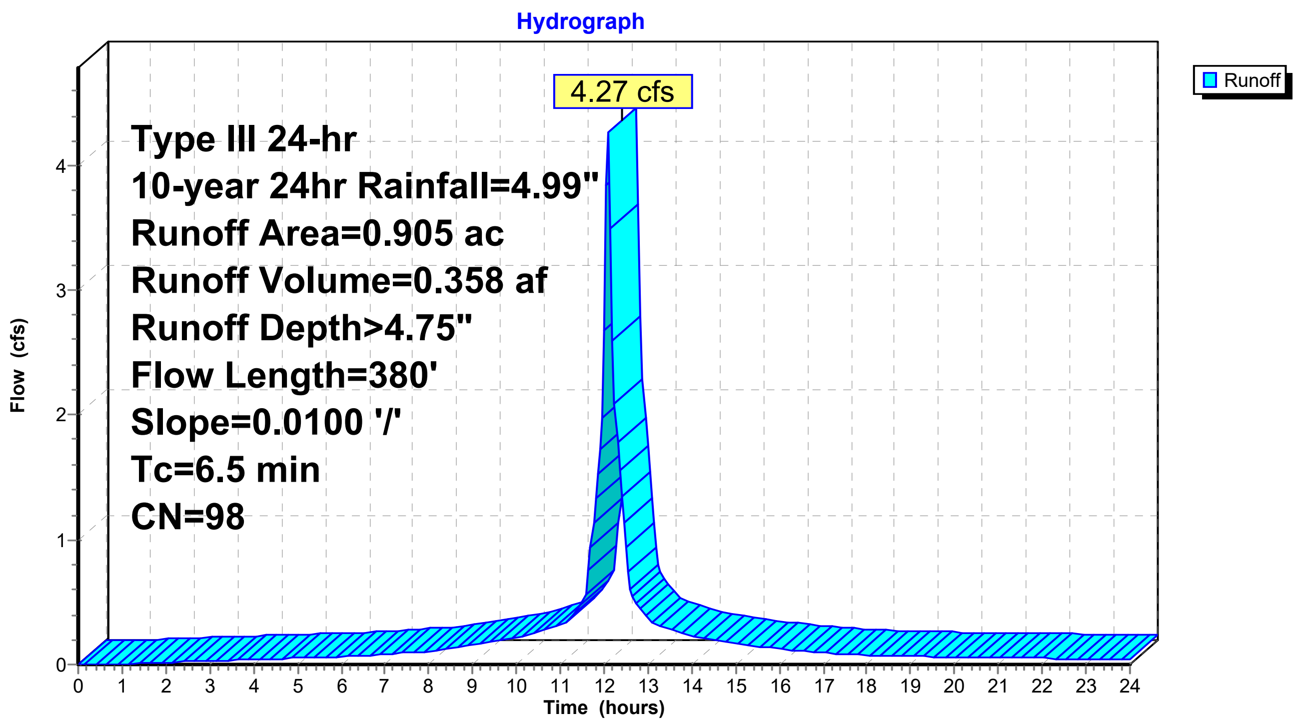
Runoff = 4.27 cfs @ 12.09 hrs, Volume= 0.358 af, Depth> 4.75"
Routed to Pond P33 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
0.805	98	PR Gravel Surface, Impervious, HSG C
0.094	98	EX Gravel Surface, Impervious, HSG C
0.006	74	>75% Grass cover, Good, HSG C
0.000	74	>75% Grass cover, Good, HSG C
0.905	98	Weighted Average
0.006		0.69% Pervious Area
0.899		99.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
3.4	330	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.5	380	Total			

Subcatchment P-A3a:



Summary for Subcatchment P-A3b:

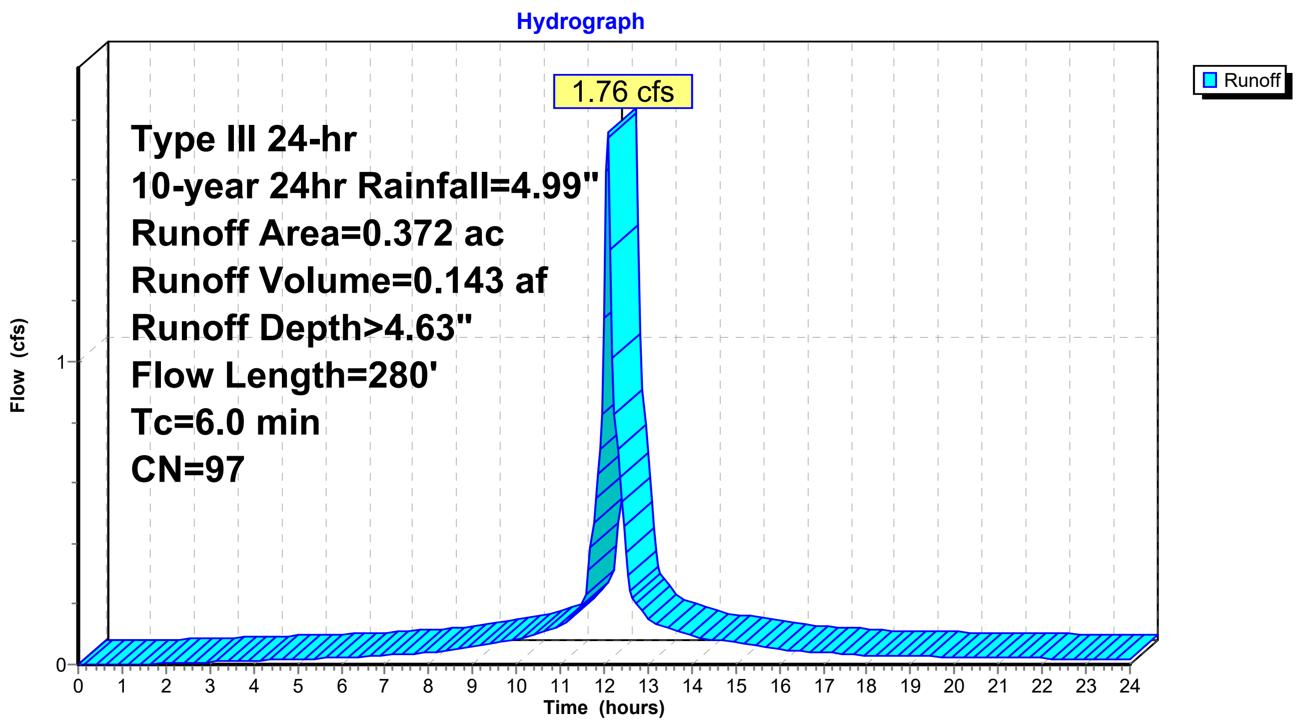
Runoff = 1.76 cfs @ 12.09 hrs, Volume= 0.143 af, Depth> 4.63"
Routed to Pond P34 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
0.008	74	>75% Grass cover, Good, HSG C
0.363	98	PR Gravel Surface, Impervious, HSG C
0.372	97	Weighted Average
0.008		2.27% Pervious Area
0.363		97.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.0	100	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	130	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.9	280	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A3b:



Summary for Subcatchment P-A3c:

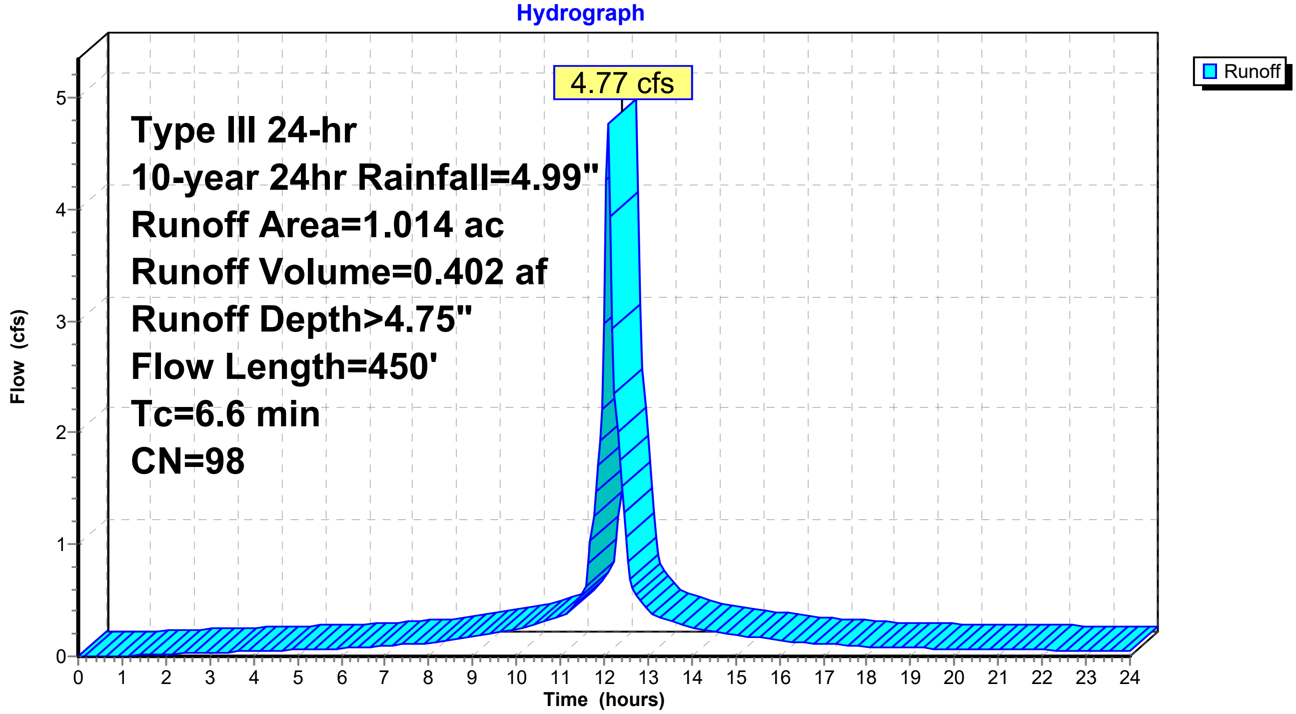
Runoff = 4.77 cfs @ 12.09 hrs, Volume= 0.402 af, Depth> 4.75"
Routed to Pond P35 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
0.007	74	>75% Grass cover, Good, HSG C
1.007	98	PR Gravel Surface, Impervious, HSG C
0.001	98	EX Gravel Surface, Impervious, HSG C
1.014	98	Weighted Average
0.007		0.70% Pervious Area
1.007		99.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
2.4	230	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.5	100	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	70	0.0150	1.97		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.6	450	Total			

Subcatchment P-A3c:



Summary for Subcatchment P-A3d:

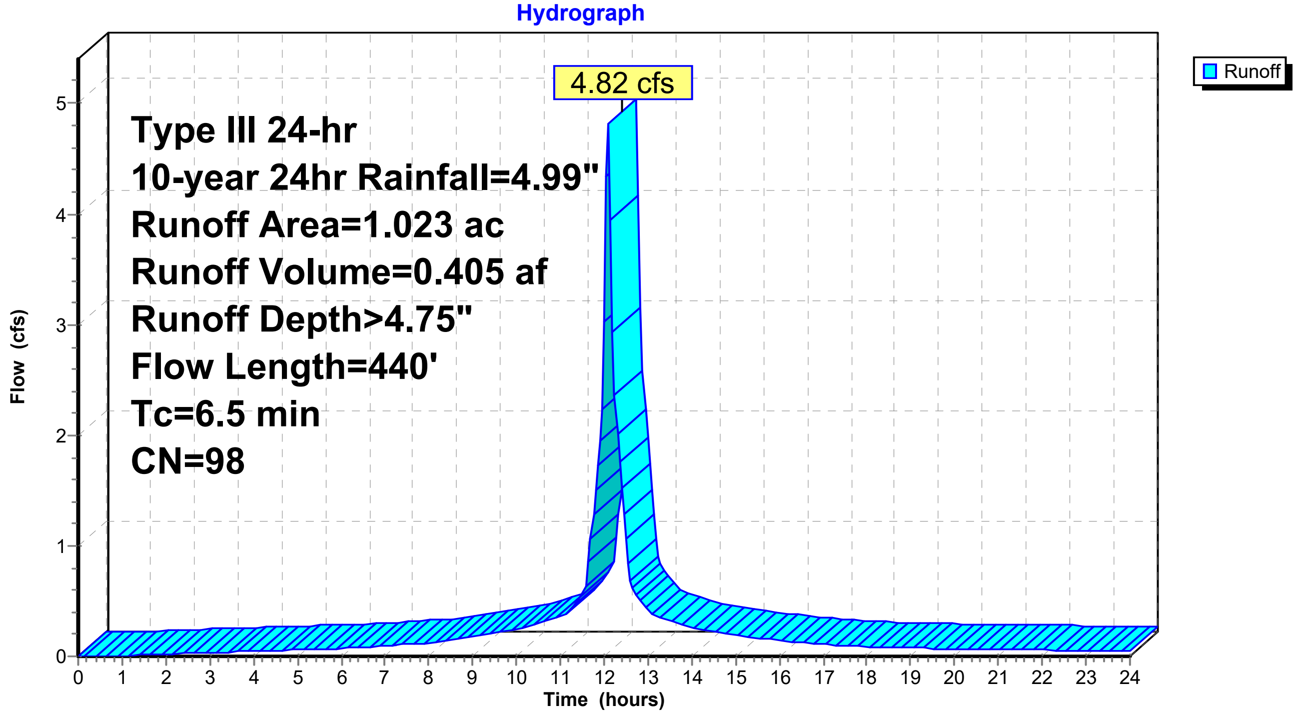
Runoff = 4.82 cfs @ 12.09 hrs, Volume= 0.405 af, Depth> 4.75"
Routed to Pond P36 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
0.004	74	>75% Grass cover, Good, HSG C
0.918	98	PR Gravel Surface, Impervious, HSG C
0.018	98	EX Gravel Surface, Impervious, HSG C
0.079	98	PR Gravel Surface, Impervious, HSG D
0.004	80	>75% Grass cover, Good, HSG D
1.023	98	Weighted Average
0.009		0.85% Pervious Area
1.015		99.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.1	110	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	120	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.7	160	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.5	440	Total			

Subcatchment P-A3d:



Summary for Subcatchment P-A3e:

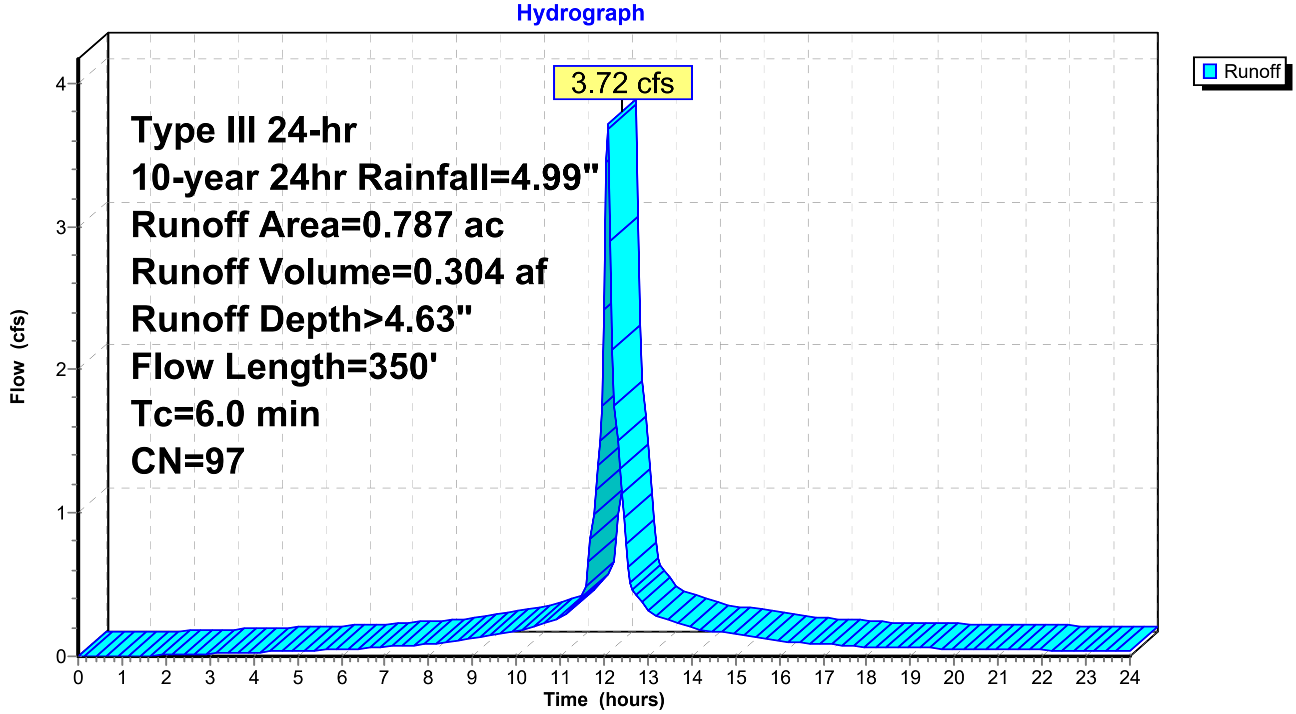
Runoff = 3.72 cfs @ 12.09 hrs, Volume= 0.304 af, Depth> 4.63"
Routed to Pond P37 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
0.031	98	EX Gravel Surface, Impervious, HSG C
0.669	98	PR Gravel Surface, Impervious, HSG C
0.012	74	>75% Grass cover, Good, HSG C
0.007	80	>75% Grass cover, Good, HSG D
0.068	98	PR Gravel Surface, Impervious, HSG D
0.787	97	Weighted Average
0.018		2.34% Pervious Area
0.768		97.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
0.7	160	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.0	140	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.8	350	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A3e:



Summary for Subcatchment P-A4: Subcat P-A4

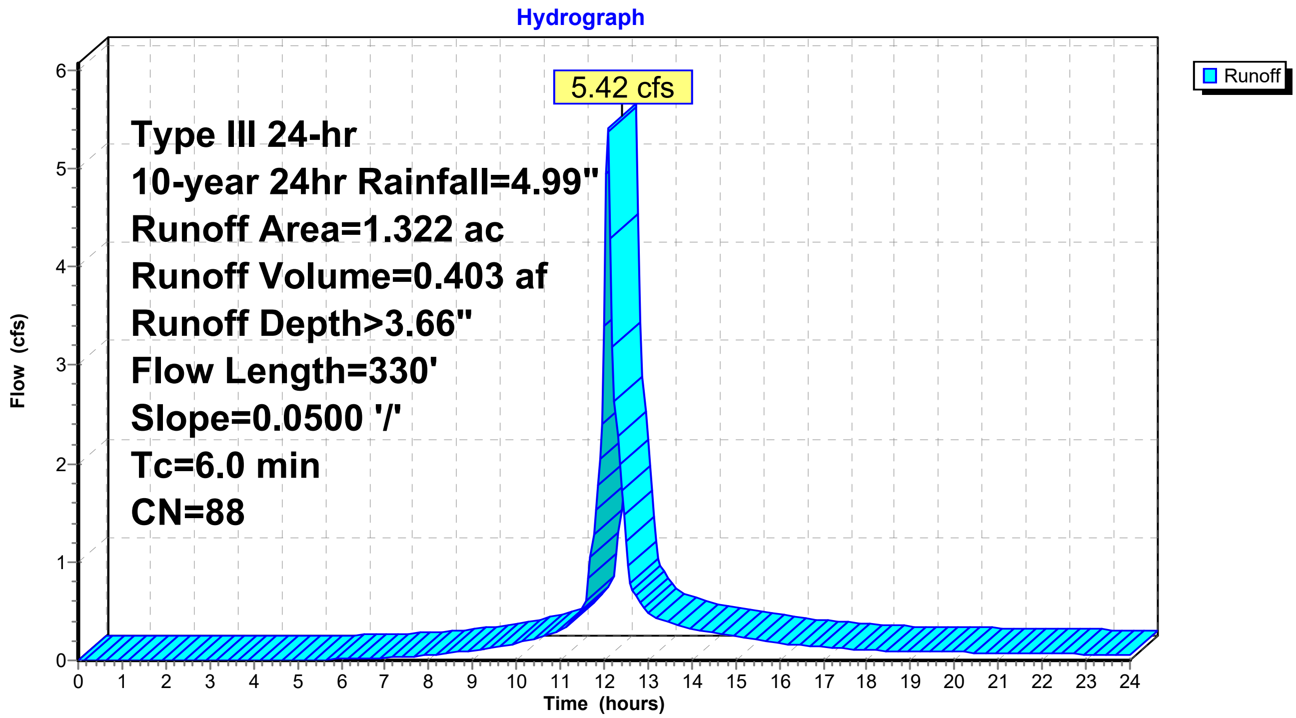
Runoff = 5.42 cfs @ 12.09 hrs, Volume= 0.403 af, Depth> 3.66"
Routed to Pond P38 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
0.123	98	EX Gravel Surface, Impervious, HSG C
0.523	98	PR Gravel Surface, Impervious, HSG C
0.403	74	>75% Grass cover, Good, HSG C
0.001	74	>75% Grass cover, Good, HSG C
0.089	80	>75% Grass cover, Good, HSG D
0.071	80	>75% Grass cover, Good, HSG D
0.112	98	PR Gravel Surface, Impervious, HSG D
1.322	88	Weighted Average
0.564		42.62% Pervious Area
0.759		57.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	50	0.0500	0.51		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.3	280	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.9	330	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A4: Subcat P-A4



Summary for Subcatchment P-A5:

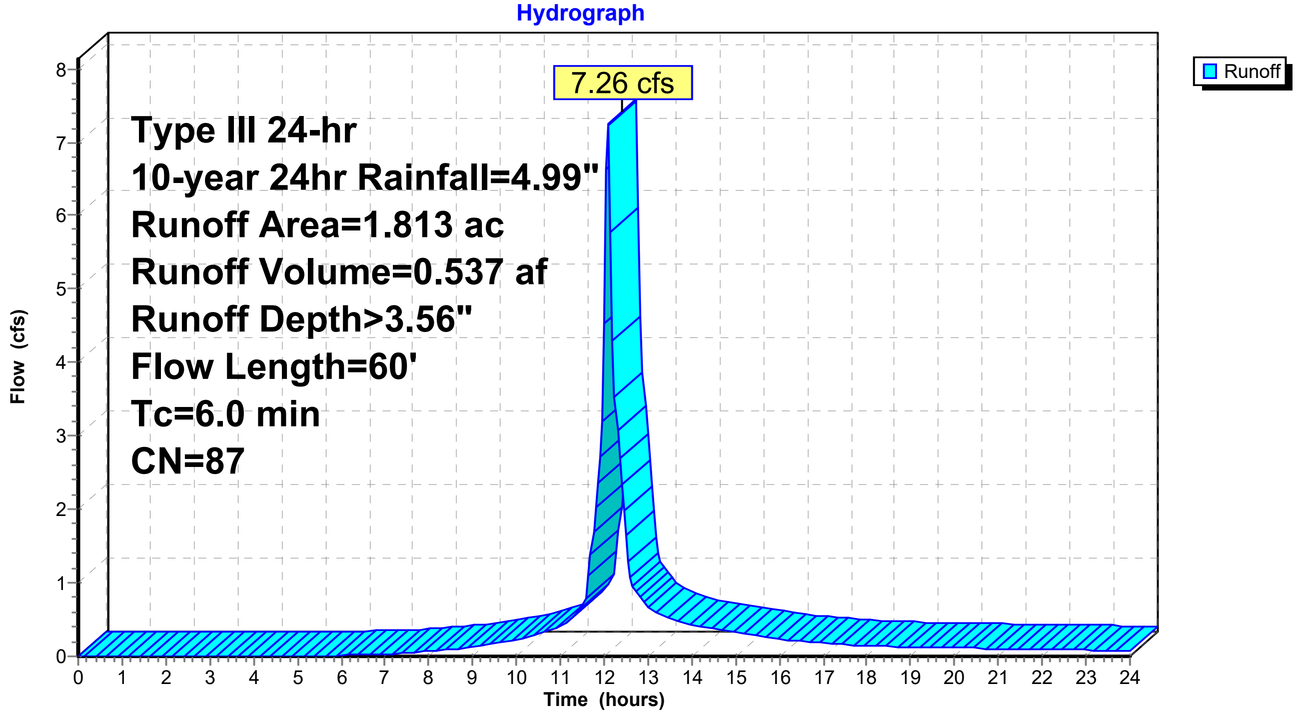
Runoff = 7.26 cfs @ 12.09 hrs, Volume= 0.537 af, Depth> 3.56"
Routed to Link DP-A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
0.011	98	EX Gravel Surface, Impervious, HSG C
0.197	96	Gravel surface, HSG D
0.000	96	Gravel surface, HSG D
0.744	96	Gravel surface, HSG C
0.414	80	>75% Grass cover, Good, HSG D
0.014	80	>75% Grass cover, Good, HSG D
0.016	80	>75% Grass cover, Good, HSG D
0.002	80	>75% Grass cover, Good, HSG D
0.010	80	>75% Grass cover, Good, HSG D
0.384	74	>75% Grass cover, Good, HSG C
0.018	74	>75% Grass cover, Good, HSG C
0.002	80	>75% Grass cover, Good, HSG D
1.813	87	Weighted Average
1.801		99.38% Pervious Area
0.011		0.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	30	0.3300	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.19"
0.5	30	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.7	60	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A5:



Summary for Subcatchment P-A6: Subcat P-A6

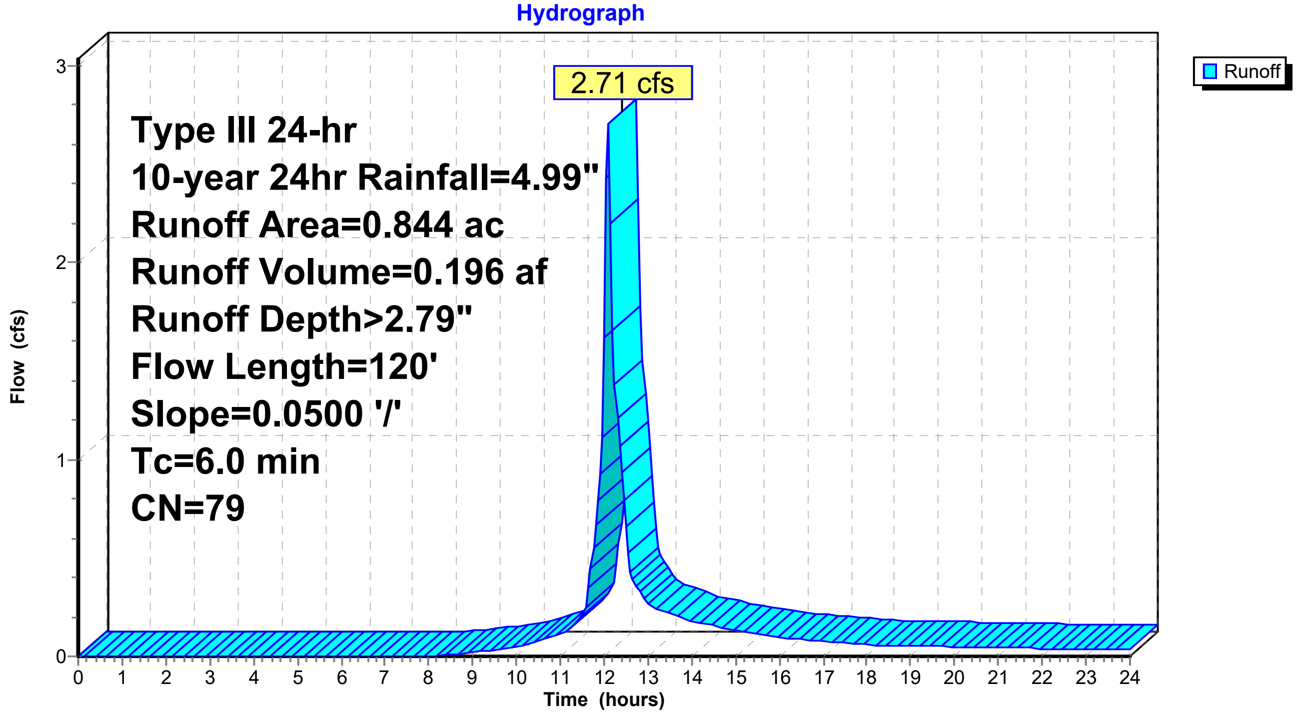
Runoff = 2.71 cfs @ 12.09 hrs, Volume= 0.196 af, Depth> 2.79"
Routed to Pond P1a : Proposed Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
0.050	98	EX Gravel Surface, Impervious, HSG C
0.000	98	PR Gravel Surface, Impervious, HSG C
0.127	74	>75% Grass cover, Good, HSG C
0.140	74	>75% Grass cover, Good, HSG C
0.425	80	>75% Grass cover, Good, HSG D
0.101	80	>75% Grass cover, Good, HSG D
0.000	98	PR Gravel Surface, Impervious, HSG D
0.844	79	Weighted Average
0.793		93.99% Pervious Area
0.051		6.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0500	0.15		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.19"
0.3	70	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.0	120	Total			

Subcatchment P-A6: Subcat P-A6



Summary for Pond CMB: Underground Storage Chambers

Inflow Area = 4.826 ac, 95.98% Impervious, Inflow Depth > 4.67" for 10-year 24hr event
Inflow = 22.88 cfs @ 12.09 hrs, Volume= 1.876 af
Outflow = 1.62 cfs @ 13.35 hrs, Volume= 1.414 af, Atten= 93%, Lag= 75.6 min
Discarded = 0.92 cfs @ 9.50 hrs, Volume= 1.316 af
Primary = 0.70 cfs @ 13.35 hrs, Volume= 0.098 af
Routed to Link DP-A : Design Point A

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 222.87' @ 13.35 hrs Surf.Area= 16,464 sf Storage= 38,315 cf
Flood Elev= 224.00' Surf.Area= 16,464 sf Storage= 54,255 cf

Plug-Flow detention time= 237.8 min calculated for 1.414 af (75% of inflow)
Center-of-Mass det. time= 152.4 min (905.6 - 753.2)

Volume	Invert	Avail.Storage	Storage Description
#1B	219.75'	6,779 cf	**196.00'W x 84.00'L x 4.92'H Field A** 80,948 cf Overall - 64,000 cf Embedded = 16,948 cf x 40.0% Voids
#2B	220.50'	47,770 cf	**retain_it upright 3.5'** x 240 Inside #1 Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf 24 Rows adjusted for 417.5 cf perimeter wall
		54,549 cf	Total Available Storage

Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	219.75'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	220.40'	**24.0" Round Culvert** L= 370.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 220.40' / 210.00' S= 0.0281 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#3	Device 2	222.75'	**6.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.92 cfs @ 9.50 hrs HW=219.80' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.92 cfs)

Primary OutFlow Max=0.69 cfs @ 13.35 hrs HW=222.87' (Free Discharge)
└─**2=Culvert** (Passes 0.69 cfs of 14.47 cfs potential flow)
  └─**3=Broad-Crested Rectangular Weir** (Weir Controls 0.69 cfs @ 0.96 fps)

Pond CMB: Underground Storage Chambers - Chamber Wizard Field A

Chamber Model = retain_it upright 3.5' (retain-it® upright)
Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf
Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf
24 Rows adjusted for 417.5 cf perimeter wall

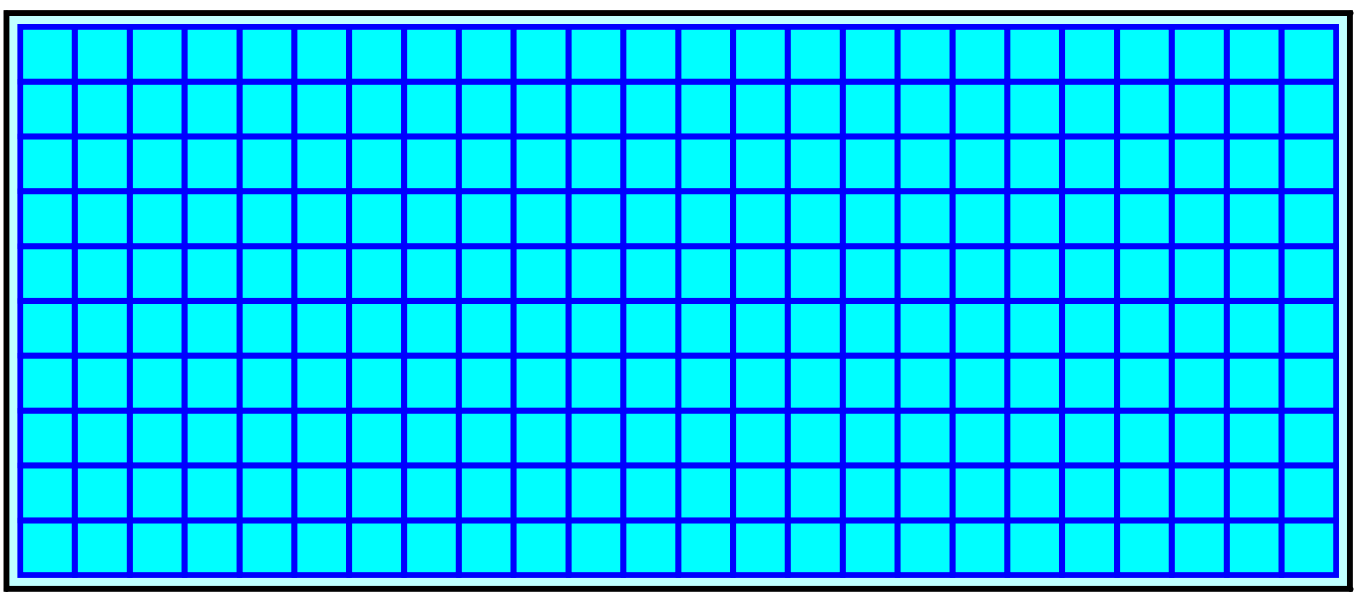
10 Chambers/Row x 8.00' Long = 80.00' Row Length +24.0" End Stone x 2 = 84.00' Base Length
24 Rows x 96.0" Wide + 24.0" Side Stone x 2 = 196.00' Base Width
9.0" Stone Base + 50.0" Chamber Height = 4.92' Field Height

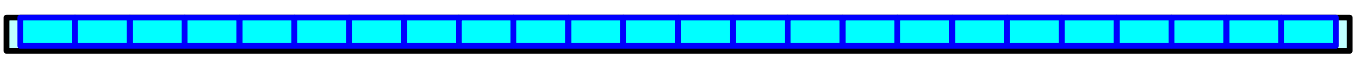
6.1 cf Sidewall x 10 x 2 + 6.1 cf Endwall x 24 x 2 = 417.5 cf Perimeter Wall
240 Chambers x 200.8 cf - 417.5 cf Perimeter wall = 47,769.8 cf Chamber Storage
240 Chambers x 266.7 cf = 64,000.0 cf Displacement

80,948.0 cf Field - 64,000.0 cf Chambers = 16,948.0 cf Stone x 40.0% Voids = 6,779.2 cf Stone Storage

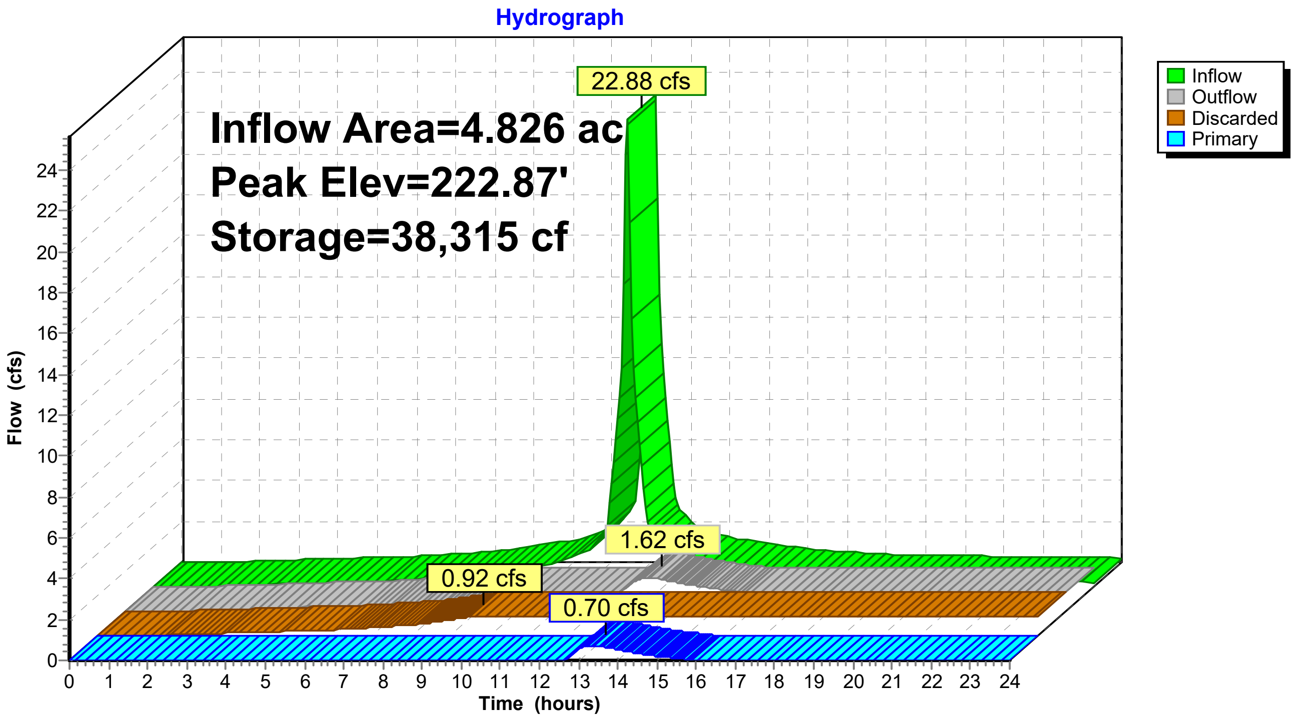
Chamber Storage + Stone Storage = 54,549.0 cf = 1.252 af
Overall Storage Efficiency = 67.4%
Overall System Size = 84.00' x 196.00' x 4.92'

240 Chambers
2,998.1 cy Field
627.7 cy Stone





Pond CMB: Underground Storage Chambers



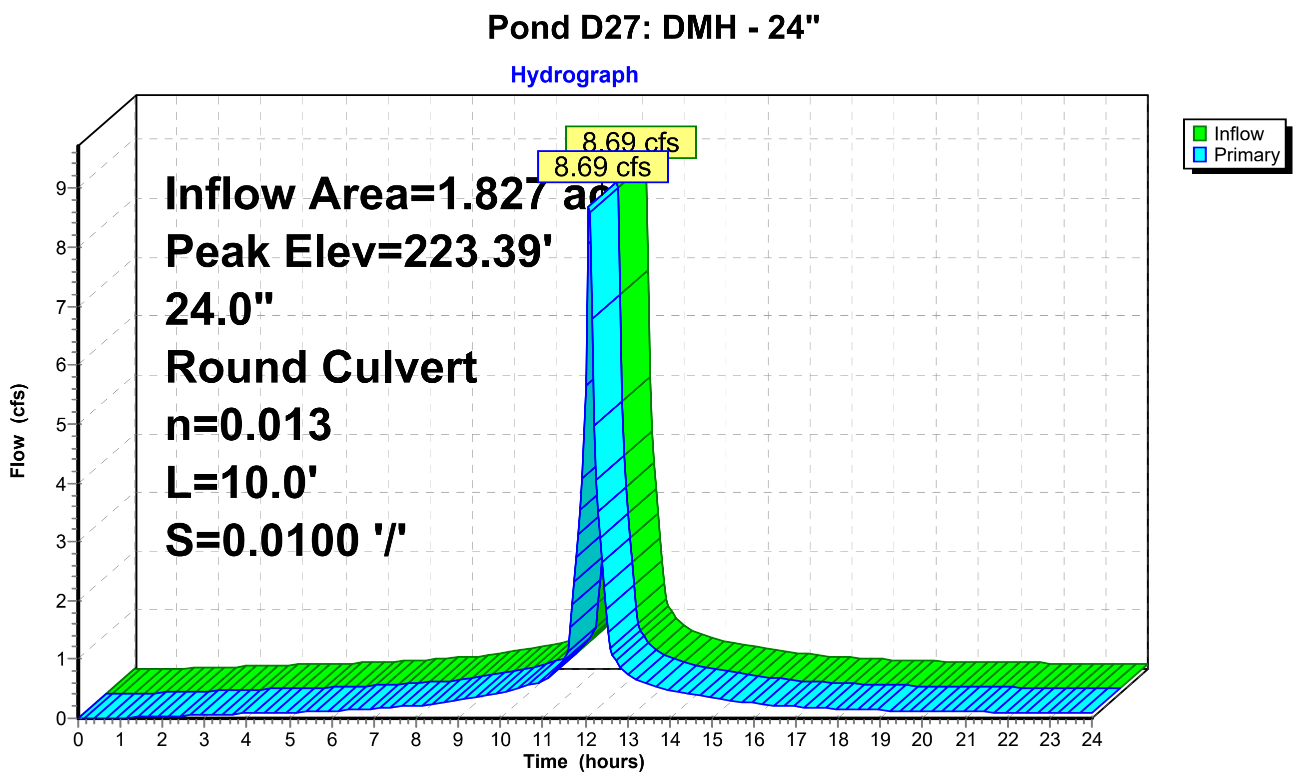
Summary for Pond D27: DMH - 24"

Inflow Area = 1.827 ac, 97.42% Impervious, Inflow Depth > 4.72" for 10-year 24hr event
Inflow = 8.69 cfs @ 12.09 hrs, Volume= 0.718 af
Outflow = 8.69 cfs @ 12.09 hrs, Volume= 0.718 af, Atten= 0%, Lag= 0.0 min
Primary = 8.69 cfs @ 12.09 hrs, Volume= 0.718 af
Routed to Link WQU-P6 : Water Quality Unit

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 223.39' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	221.80'	**24.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 221.80' / 221.70' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=8.45 cfs @ 12.09 hrs HW=223.36' (Free Discharge)
└─**1=Culvert** (Barrel Controls 8.45 cfs @ 4.43 fps)



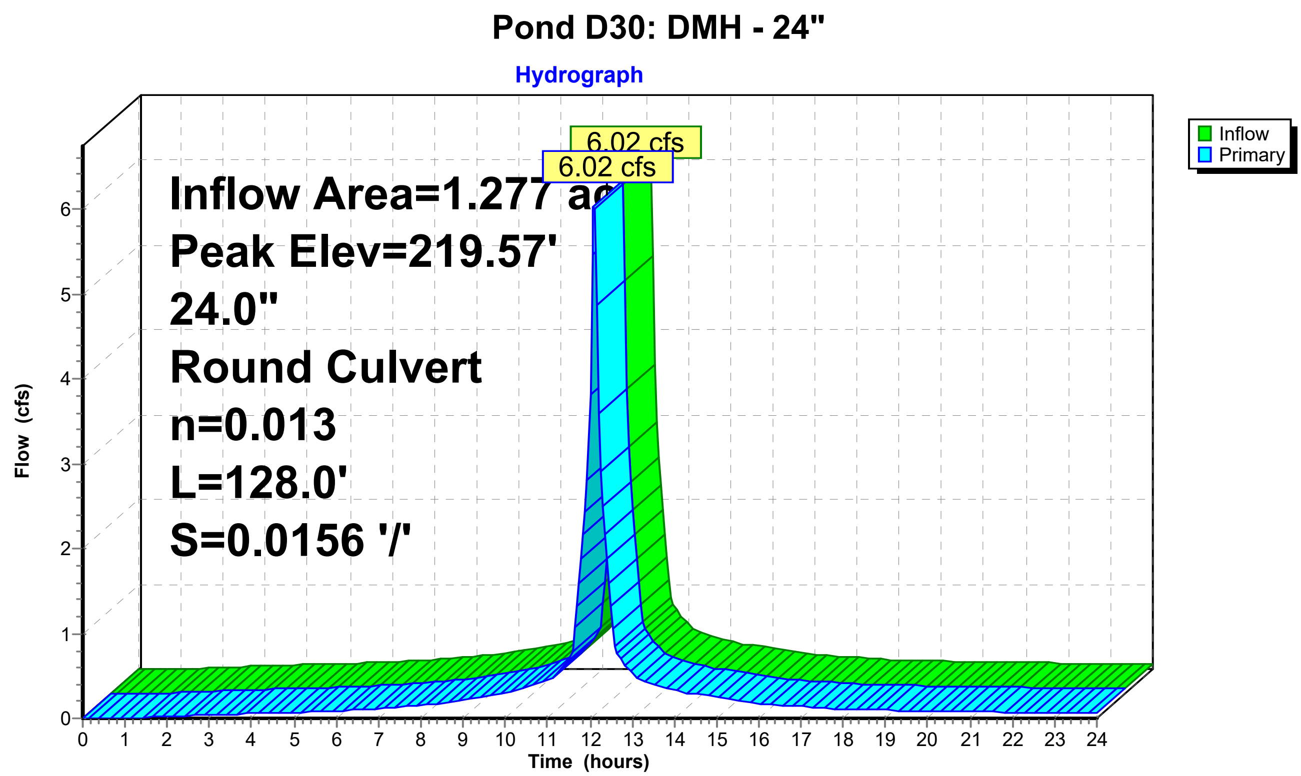
Summary for Pond D30: DMH - 24"

Inflow Area = 1.277 ac, 98.85% Impervious, Inflow Depth > 4.72" for 10-year 24hr event
Inflow = 6.02 cfs @ 12.09 hrs, Volume= 0.502 af
Outflow = 6.02 cfs @ 12.09 hrs, Volume= 0.502 af, Atten= 0%, Lag= 0.0 min
Primary = 6.02 cfs @ 12.09 hrs, Volume= 0.502 af
Routed to Pond D31 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 219.57' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	218.50'	**24.0" Round Culvert** L= 128.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 218.50' / 216.50' S= 0.0156 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=5.90 cfs @ 12.09 hrs HW=219.56' (Free Discharge)
└—**1=Culvert** (Inlet Controls 5.90 cfs @ 3.50 fps)



Summary for Pond D31: DMH - 30"

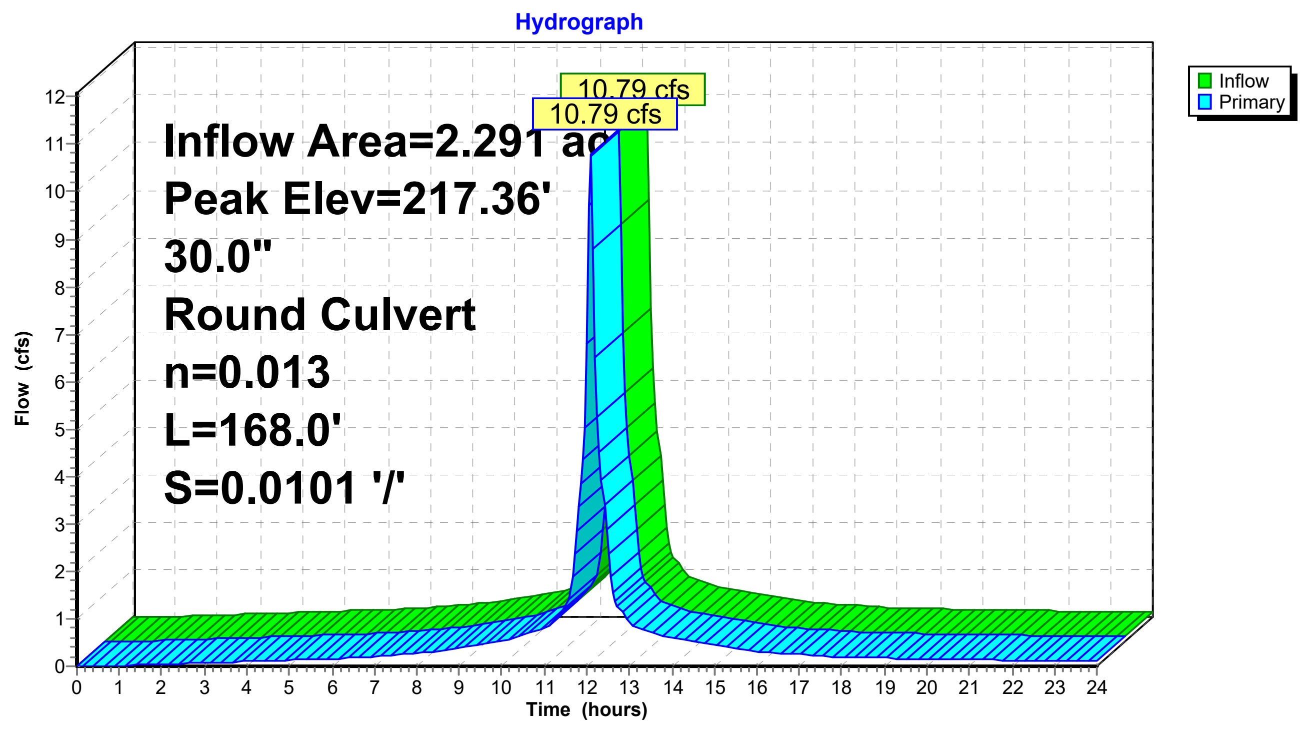
Inflow Area = 2.291 ac, 99.05% Impervious, Inflow Depth > 4.73" for 10-year 24hr event
Inflow = 10.79 cfs @ 12.09 hrs, Volume= 0.903 af
Outflow = 10.79 cfs @ 12.09 hrs, Volume= 0.903 af, Atten= 0%, Lag= 0.0 min
Primary = 10.79 cfs @ 12.09 hrs, Volume= 0.903 af
Routed to Pond D32 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 217.36' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	216.00'	**30.0" Round Culvert** L= 168.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 216.00' / 214.30' S= 0.0101 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf

Primary OutFlow Max=10.59 cfs @ 12.09 hrs HW=217.34' (Free Discharge)
1=Culvert (Inlet Controls 10.59 cfs @ 3.95 fps)

Pond D31: DMH - 30"



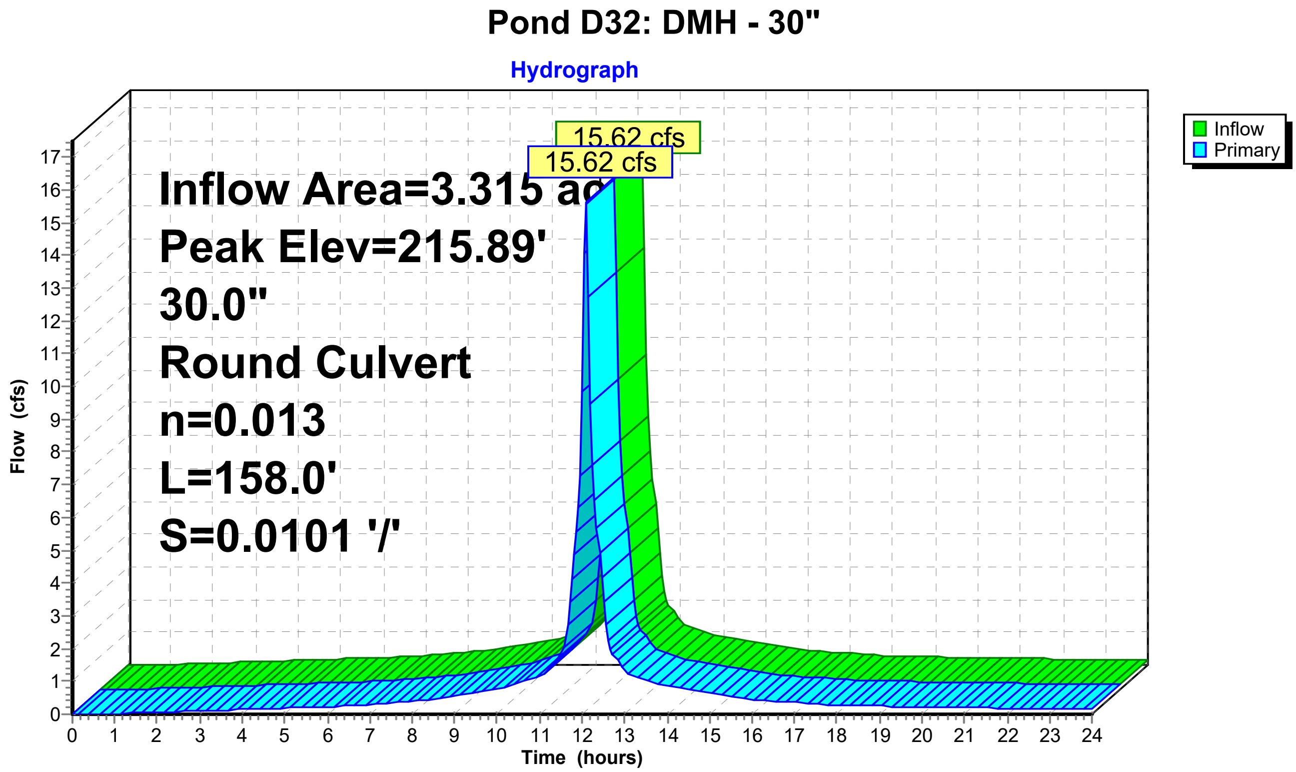
Summary for Pond D32: DMH - 30"

Inflow Area = 3.315 ac, 99.08% Impervious, Inflow Depth > 4.74" for 10-year 24hr event
Inflow = 15.62 cfs @ 12.09 hrs, Volume= 1.309 af
Outflow = 15.62 cfs @ 12.09 hrs, Volume= 1.309 af, Atten= 0%, Lag= 0.0 min
Primary = 15.62 cfs @ 12.09 hrs, Volume= 1.309 af
Routed to Pond D33 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 215.89' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	214.20'	**30.0" Round Culvert** L= 158.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 214.20' / 212.60' S= 0.0101 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf

Primary OutFlow Max=15.34 cfs @ 12.09 hrs HW=215.87' (Free Discharge)
└─**1=Culvert** (Inlet Controls 15.34 cfs @ 4.40 fps)



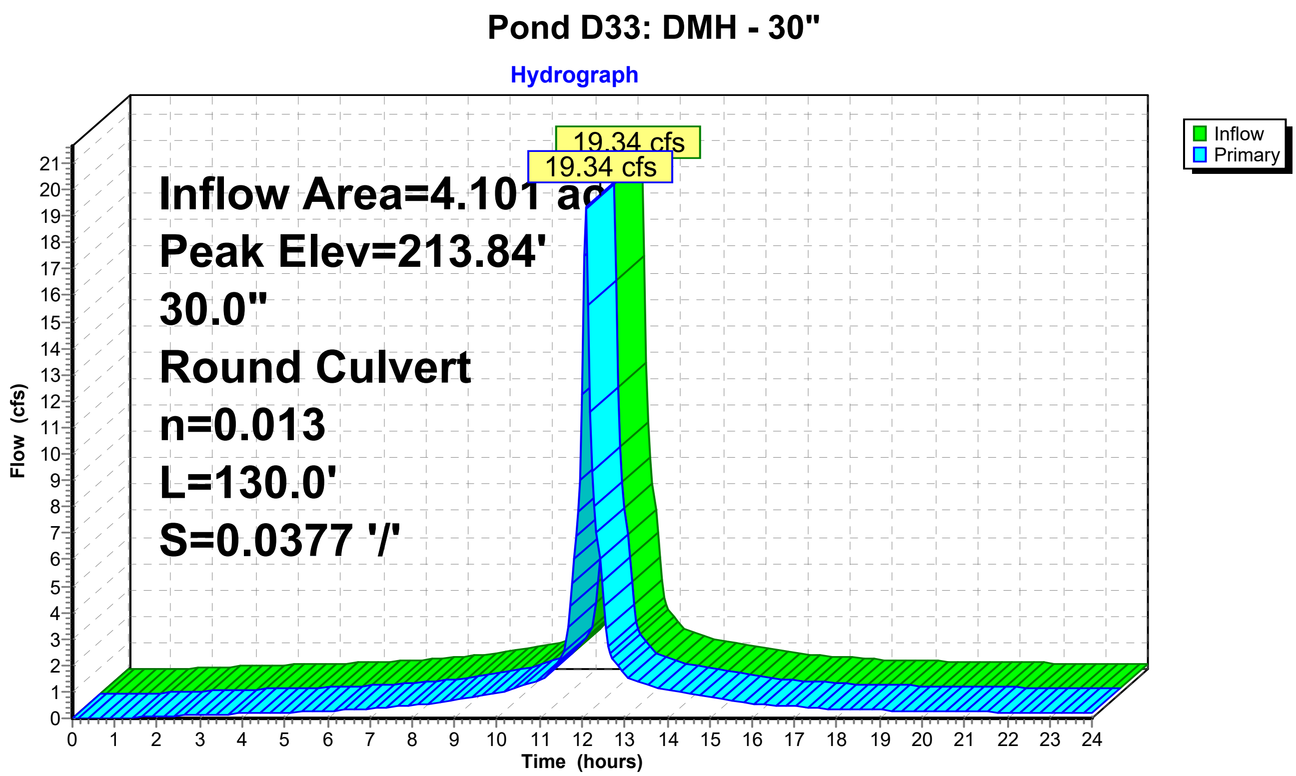
Summary for Pond D33: DMH - 30"

Inflow Area = 4.101 ac, 98.81% Impervious, Inflow Depth > 4.72" for 10-year 24hr event
Inflow = 19.34 cfs @ 12.09 hrs, Volume= 1.612 af
Outflow = 19.34 cfs @ 12.09 hrs, Volume= 1.612 af, Atten= 0%, Lag= 0.0 min
Primary = 19.34 cfs @ 12.09 hrs, Volume= 1.612 af
Routed to Pond F1 : Forebay

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 213.84' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	211.90'	**30.0" Round Culvert** L= 130.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 211.90' / 207.00' S= 0.0377 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf

Primary OutFlow Max=18.95 cfs @ 12.09 hrs HW=213.81' (Free Discharge)
└─**1=Culvert** (Inlet Controls 18.95 cfs @ 4.71 fps)



Summary for Pond F1: Forebay

Inflow Area = 5.424 ac, 88.71% Impervious, Inflow Depth > 4.46" for 10-year 24hr event
Inflow = 24.75 cfs @ 12.09 hrs, Volume= 2.015 af
Outflow = 22.75 cfs @ 12.14 hrs, Volume= 2.015 af, Atten= 8%, Lag= 2.7 min
Primary = 18.89 cfs @ 12.13 hrs, Volume= 1.989 af
Routed to Link WQU-P5 : Water Quality Unit
Secondary = 3.87 cfs @ 12.14 hrs, Volume= 0.026 af
Routed to Pond P1a : Proposed Basin

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 207.28' @ 12.13 hrs Surf.Area= 1,389 sf Storage= 2,118 cf

Plug-Flow detention time= 0.8 min calculated for 2.015 af (100% of inflow)
Center-of-Mass det. time= 0.7 min (760.3 - 759.6)

Volume	Invert	Avail.Storage	Storage Description
#1	205.00'	3,235 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

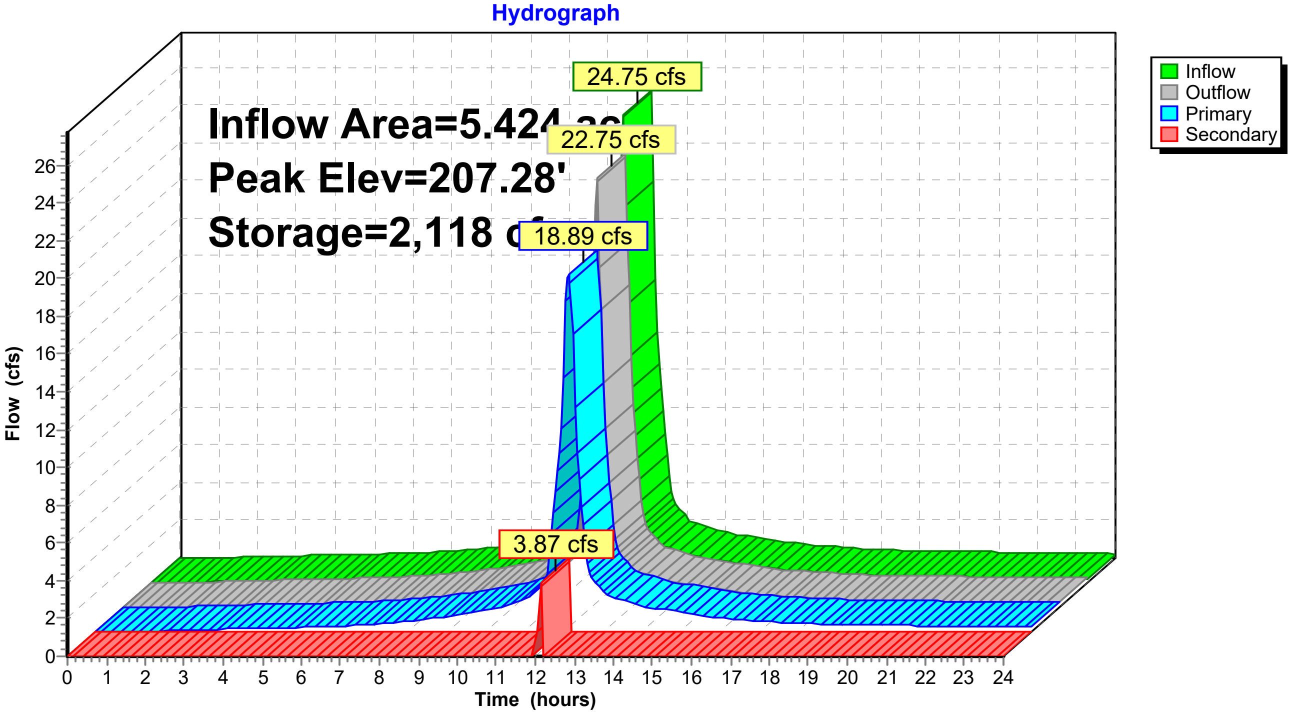
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
205.00	480	0	0
207.00	1,270	1,750	1,750
208.00	1,700	1,485	3,235

Device	Routing	Invert	Outlet Devices
#1	Primary	201.60'	**18.0" Round 18" Culvert** L= 30.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 201.60' / 201.30' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	205.00'	**1.0" x 21.0" Horiz. Double Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads
#3	Secondary	207.00'	**12.0' long + 2.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=18.78 cfs @ 12.13 hrs HW=207.22' (Free Discharge)
└─**1=18" Culvert** (Inlet Controls 18.78 cfs @ 10.63 fps)
  └─**2=Double Grate** (Passes 18.78 cfs of 20.93 cfs potential flow)

Secondary OutFlow Max=3.38 cfs @ 12.14 hrs HW=207.23' (Free Discharge)
└─**3=Broad-Crested Rectangular Weir** (Weir Controls 3.38 cfs @ 1.19 fps)

Pond F1: Forebay



Summary for Pond P1a: Proposed Basin

Inflow Area = 6.267 ac, 77.58% Impervious, Inflow Depth > 4.23" for 10-year 24hr event
Inflow = 25.12 cfs @ 12.13 hrs, Volume= 2.211 af
Outflow = 6.78 cfs @ 12.48 hrs, Volume= 1.667 af, Atten= 73%, Lag= 20.9 min
Discarded = 0.83 cfs @ 12.48 hrs, Volume= 0.913 af
Primary = 5.95 cfs @ 12.48 hrs, Volume= 0.754 af
Routed to Link DP-A : Design Point A
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link DP-A : Design Point A

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 203.48' @ 12.48 hrs Surf.Area= 14,967 sf Storage= 47,546 cf

Plug-Flow detention time= 239.6 min calculated for 1.663 af (75% of inflow)
Center-of-Mass det. time= 154.6 min (920.5 - 765.9)

Volume	Invert	Avail.Storage	Storage Description
#1	198.00'	90,590 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
198.00	1,180	0	0
199.00	3,950	2,565	2,565
200.00	7,100	5,525	8,090
201.00	9,950	8,525	16,615
202.00	11,950	10,950	27,565
203.00	14,000	12,975	40,540
204.00	16,000	15,000	55,540
205.00	17,500	16,750	72,290
206.00	19,100	18,300	90,590

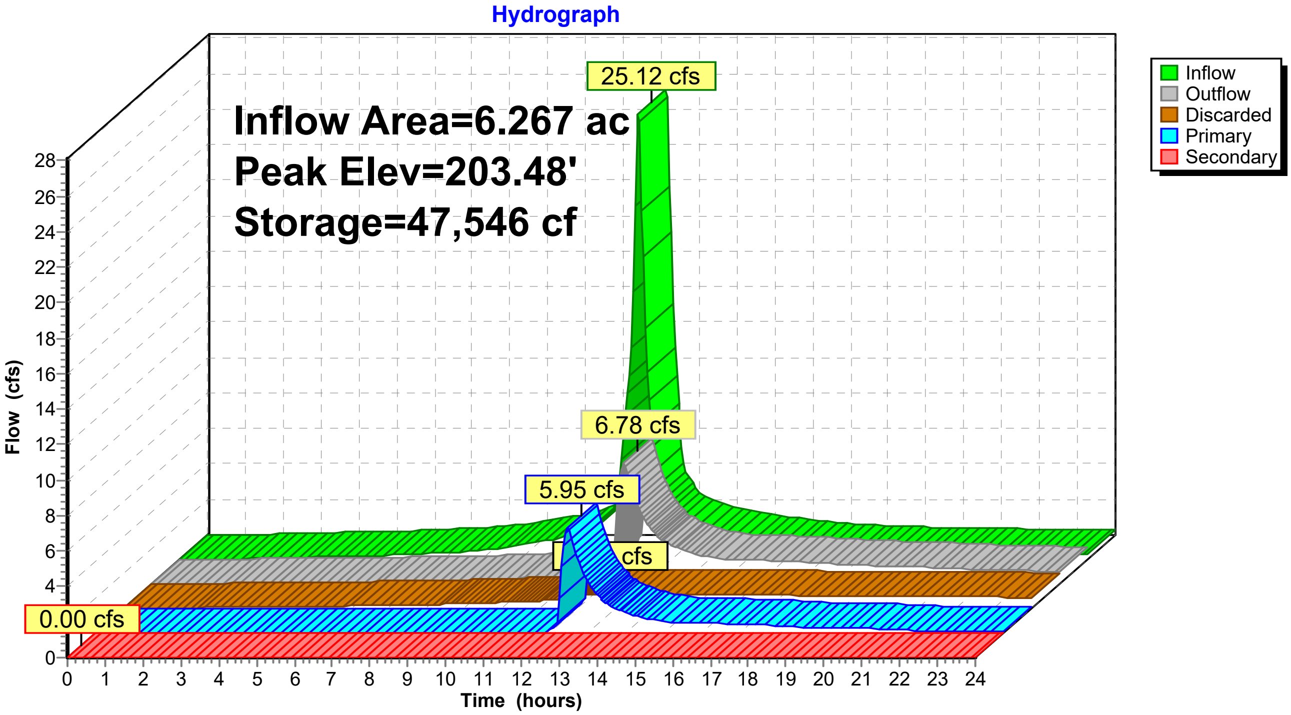
Device	Routing	Invert	Outlet Devices
#1	Secondary	205.00'	**10.0' long + 3.0 '/' SideZ x 11.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.53 2.59 2.70 2.68 2.67 2.68 2.66 2.64
#2	Primary	198.00'	**18.0" Round Culvert** L= 70.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 198.00' / 194.40' S= 0.0514 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#3	Device 2	201.50'	**1.0" Vert. Orifice/Grate X 8.00 columns** X 3 rows with 6.0" cc spacing C= 0.600 Limited to weir flow at low heads
#4	Device 2	203.00'	**18.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Discarded	198.00'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.83 cfs @ 12.48 hrs HW=203.48' (Free Discharge)
└─**5=Exfiltration** (Exfiltration Controls 0.83 cfs)

Primary OutFlow Max=5.91 cfs @ 12.48 hrs HW=203.48' (Free Discharge)
└─**2=Culvert** (Passes 5.91 cfs of 18.51 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 0.75 cfs @ 5.72 fps)
  └─**4=Orifice/Grate** (Weir Controls 5.16 cfs @ 2.27 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=198.00' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond P1a: Proposed Basin



Summary for Pond P30: 12" HDPE

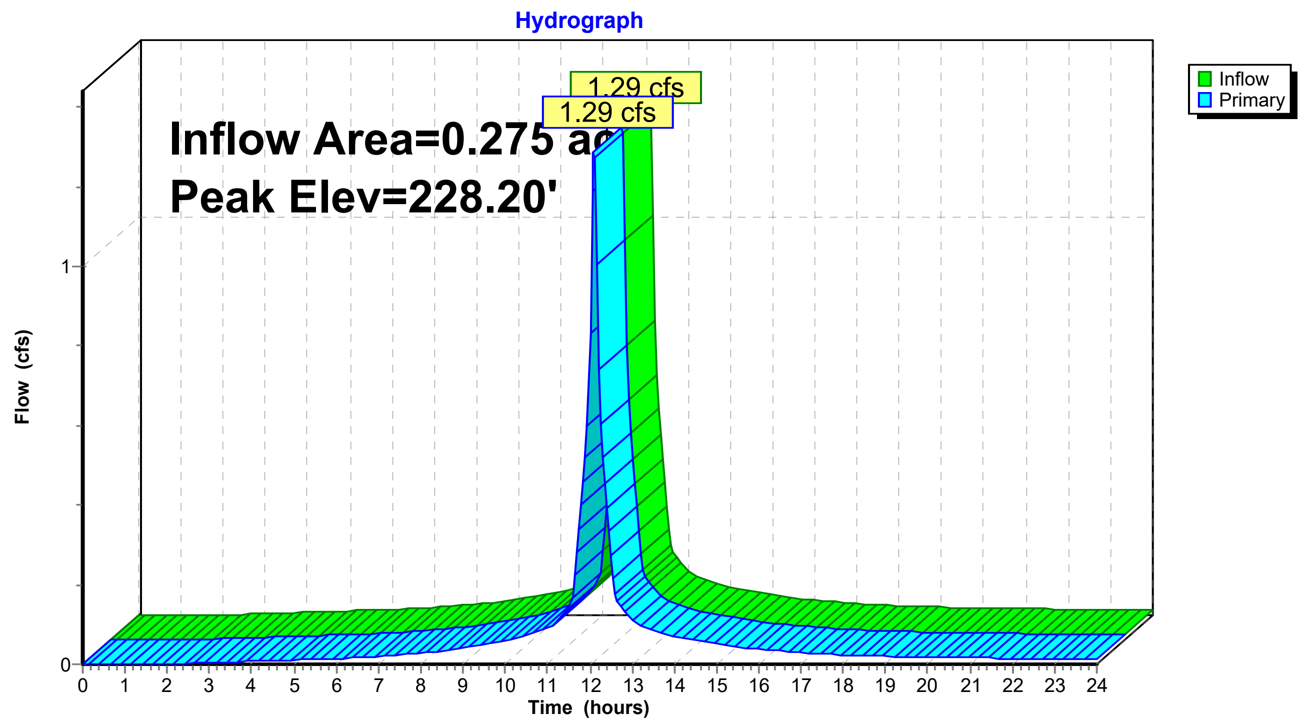
Inflow Area = 0.275 ac, 92.38% Impervious, Inflow Depth > 4.52" for 10-year 24hr event
Inflow = 1.29 cfs @ 12.09 hrs, Volume= 0.103 af
Outflow = 1.29 cfs @ 12.09 hrs, Volume= 0.103 af, Atten= 0%, Lag= 0.0 min
Primary = 1.29 cfs @ 12.09 hrs, Volume= 0.103 af
Routed to Pond D27 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 228.20' @ 12.09 hrs
Flood Elev= 228.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	224.60'	**12.0" Round Culvert** L= 180.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 224.60' / 222.80' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	228.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=1.25 cfs @ 12.09 hrs HW=228.20' (Free Discharge)
└—**1=Culvert** (Passes 1.25 cfs of 4.94 cfs potential flow)
└—**2=Orifice/Grate** (Weir Controls 1.25 cfs @ 1.04 fps)

Pond P30: 12" HDPE



Summary for Pond P31: 12" HDPE

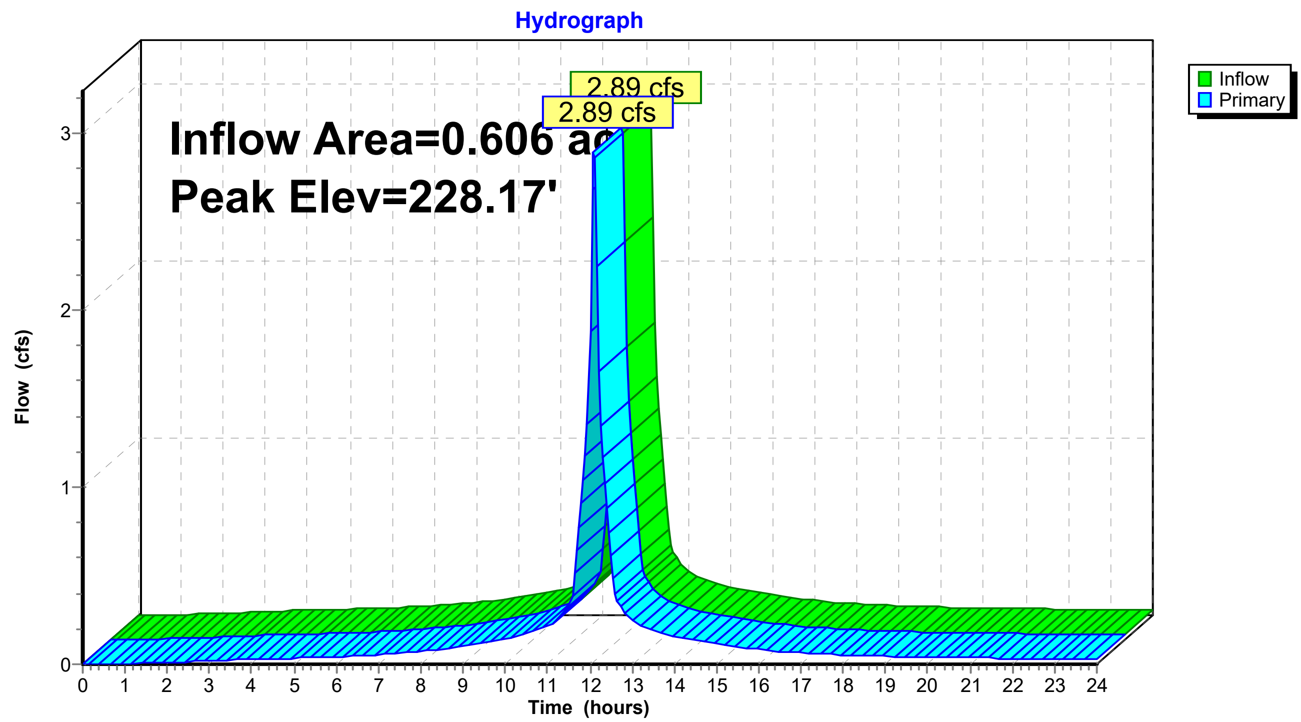
Inflow Area = 0.606 ac, 97.98% Impervious, Inflow Depth > 4.75" for 10-year 24hr event
Inflow = 2.89 cfs @ 12.09 hrs, Volume= 0.240 af
Outflow = 2.89 cfs @ 12.09 hrs, Volume= 0.240 af, Atten= 0%, Lag= 0.0 min
Primary = 2.89 cfs @ 12.09 hrs, Volume= 0.240 af
Routed to Pond D27 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 228.17' @ 12.09 hrs
Flood Elev= 223.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	223.00'	**12.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 223.00' / 222.90' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	228.00'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=2.79 cfs @ 12.09 hrs HW=228.17' (Free Discharge)
└─**1=Culvert** (Passes 2.79 cfs of 8.17 cfs potential flow)
 └─**2=Orifice/Grate** (Weir Controls 2.79 cfs @ 1.35 fps)

Pond P31: 12" HDPE



Summary for Pond P32: 12" HDPE

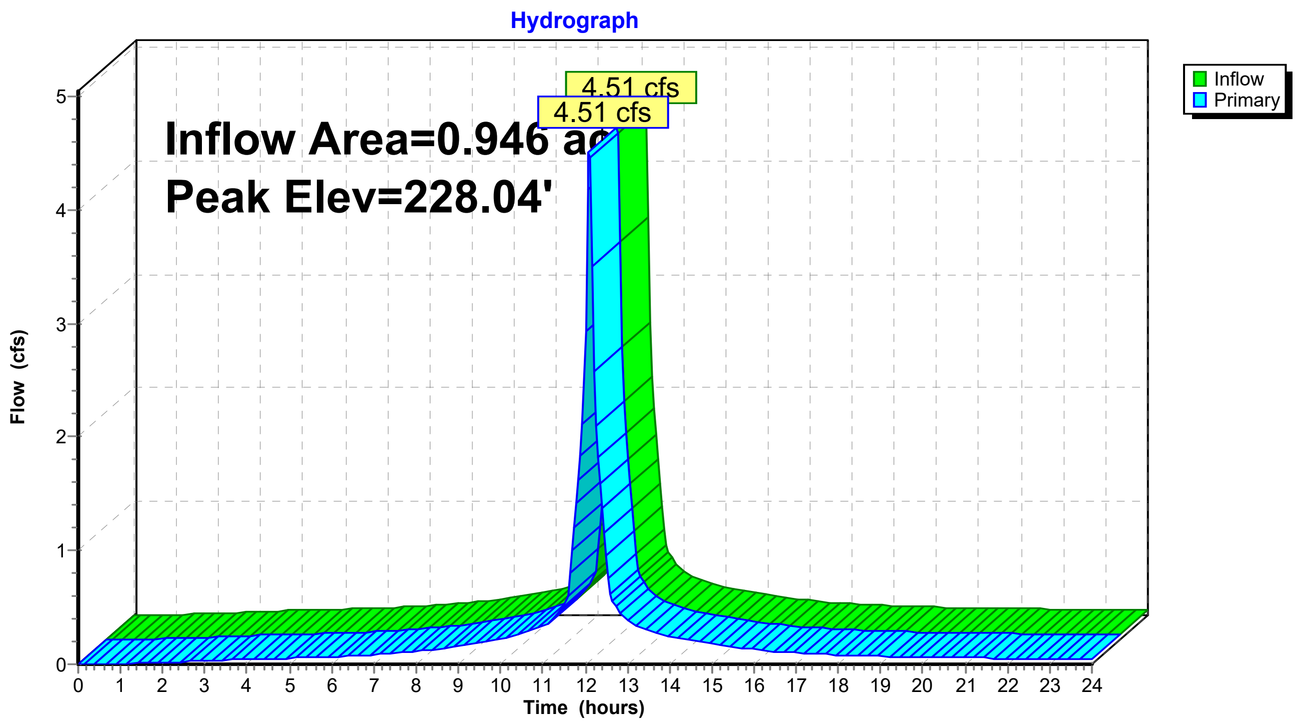
Inflow Area = 0.946 ac, 98.52% Impervious, Inflow Depth > 4.75" for 10-year 24hr event
Inflow = 4.51 cfs @ 12.09 hrs, Volume= 0.374 af
Outflow = 4.51 cfs @ 12.09 hrs, Volume= 0.374 af, Atten= 0%, Lag= 0.0 min
Primary = 4.51 cfs @ 12.09 hrs, Volume= 0.374 af
Routed to Pond D27 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 228.04' @ 12.09 hrs
Flood Elev= 228.30'

Device	Routing	Invert	Outlet Devices
#1	Primary	223.80'	**12.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 223.80' / 222.80' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	227.80'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=4.38 cfs @ 12.09 hrs HW=228.03' (Free Discharge)
└─**1=Culvert** (Passes 4.38 cfs of 6.02 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 4.38 cfs @ 1.57 fps)

Pond P32: 12" HDPE



Summary for Pond P33: 18" HDPE

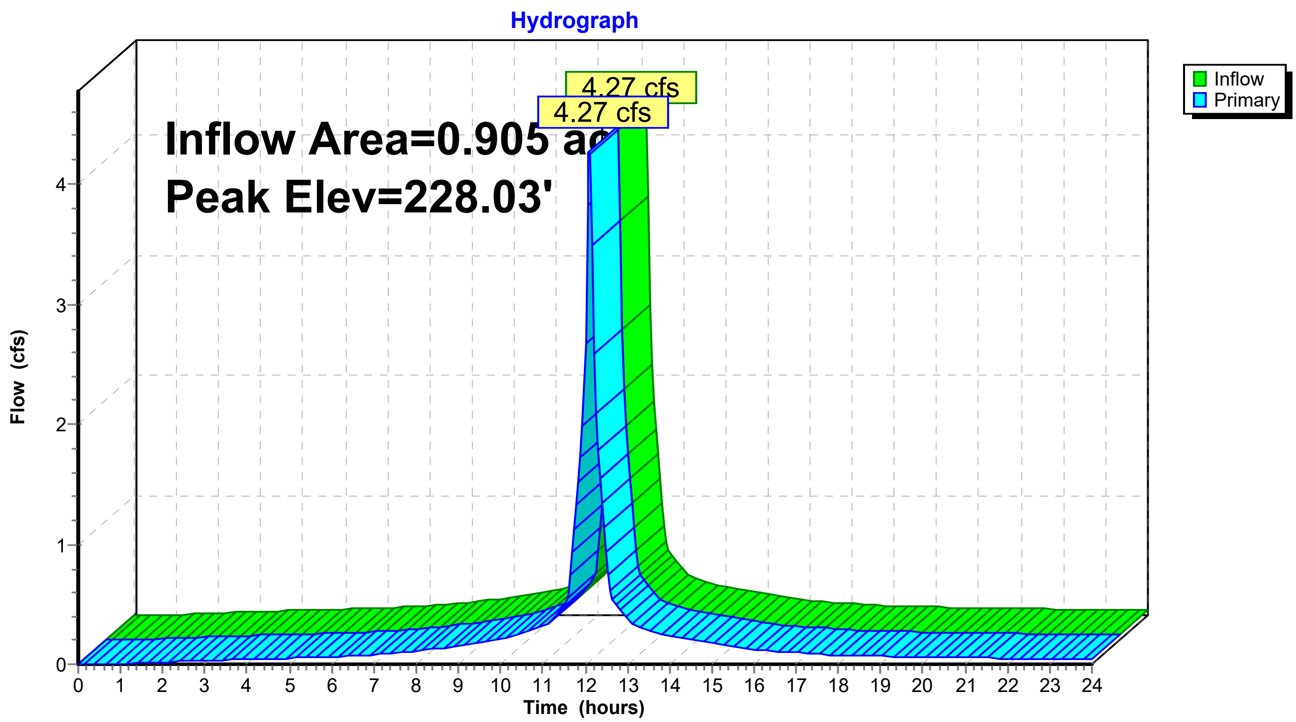
Inflow Area = 0.905 ac, 99.31% Impervious, Inflow Depth > 4.75" for 10-year 24hr event
Inflow = 4.27 cfs @ 12.09 hrs, Volume= 0.358 af
Outflow = 4.27 cfs @ 12.09 hrs, Volume= 0.358 af, Atten= 0%, Lag= 0.0 min
Primary = 4.27 cfs @ 12.09 hrs, Volume= 0.358 af
Routed to Pond D30 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 228.03' @ 12.09 hrs
Flood Elev= 228.30'

Device	Routing	Invert	Outlet Devices
#1	Primary	222.80'	**18.0" Round Culvert** L= 198.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 222.80' / 219.00' S= 0.0192 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	227.80'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=4.19 cfs @ 12.09 hrs HW=228.02' (Free Discharge)
└─**1=Culvert** (Passes 4.19 cfs of 17.19 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 4.19 cfs @ 1.55 fps)

Pond P33: 18" HDPE



Summary for Pond P34: 18" HDPE

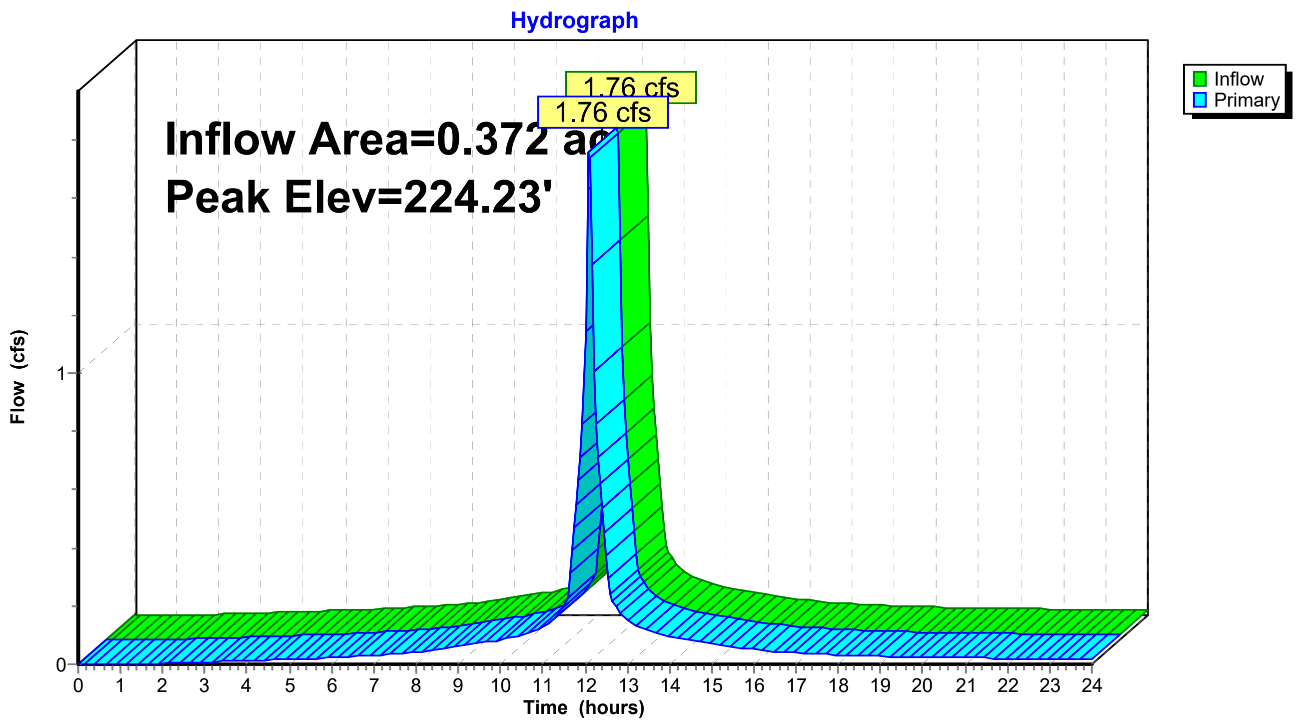
Inflow Area = 0.372 ac, 97.73% Impervious, Inflow Depth > 4.63" for 10-year 24hr event
Inflow = 1.76 cfs @ 12.09 hrs, Volume= 0.143 af
Outflow = 1.76 cfs @ 12.09 hrs, Volume= 0.143 af, Atten= 0%, Lag= 0.0 min
Primary = 1.76 cfs @ 12.09 hrs, Volume= 0.143 af
Routed to Pond D30 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 224.23' @ 12.09 hrs
Flood Elev= 224.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	219.10'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 219.10' / 219.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	224.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=1.70 cfs @ 12.09 hrs HW=224.22' (Free Discharge)
└─**1=Culvert** (Passes 1.70 cfs of 17.79 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 1.70 cfs @ 1.15 fps)

Pond P34: 18" HDPE



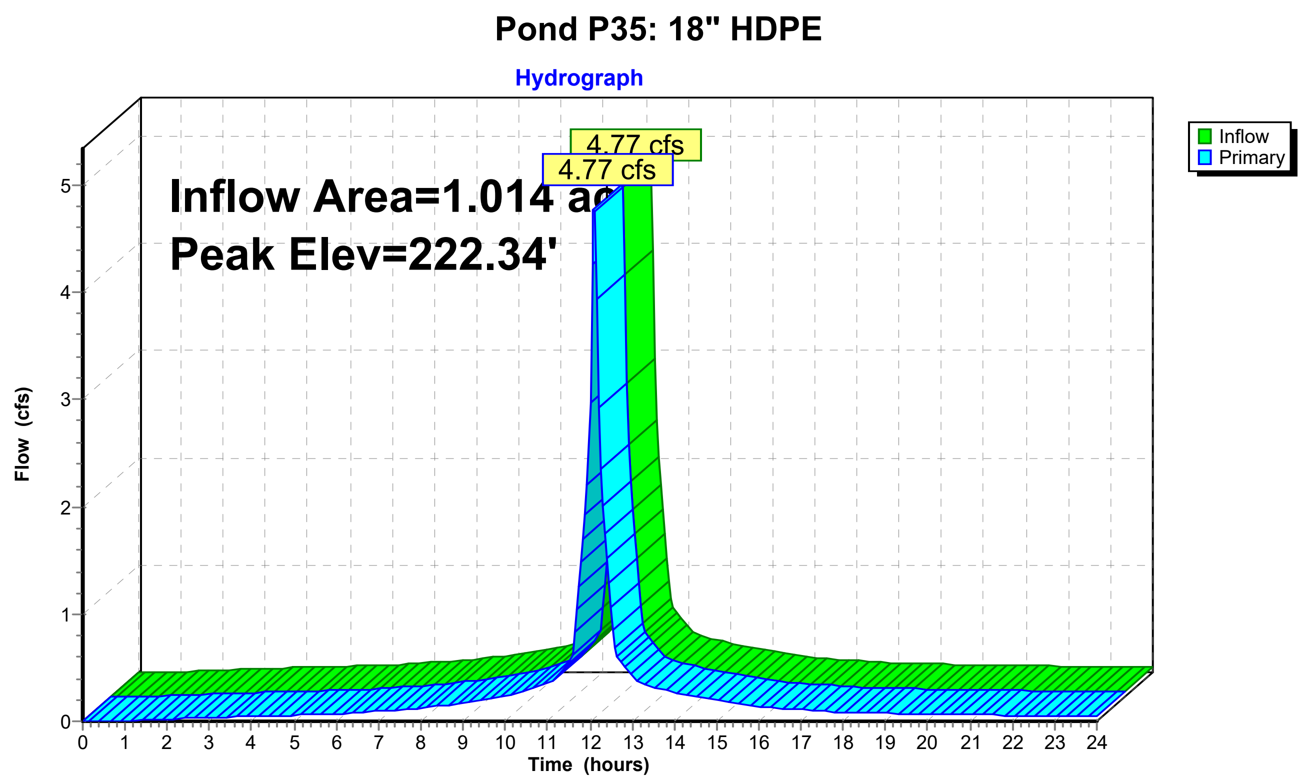
Summary for Pond P35: 18" HDPE

Inflow Area = 1.014 ac, 99.30% Impervious, Inflow Depth > 4.75" for 10-year 24hr event
Inflow = 4.77 cfs @ 12.09 hrs, Volume= 0.402 af
Outflow = 4.77 cfs @ 12.09 hrs, Volume= 0.402 af, Atten= 0%, Lag= 0.0 min
Primary = 4.77 cfs @ 12.09 hrs, Volume= 0.402 af
Routed to Pond D31 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 222.34' @ 12.09 hrs
Flood Elev= 222.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	217.10'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 217.10' / 217.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	222.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=4.68 cfs @ 12.09 hrs HW=222.34' (Free Discharge)
└─**1=Culvert** (Passes 4.68 cfs of 18.03 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 4.68 cfs @ 1.61 fps)



Summary for Pond P36: 18" HDPE

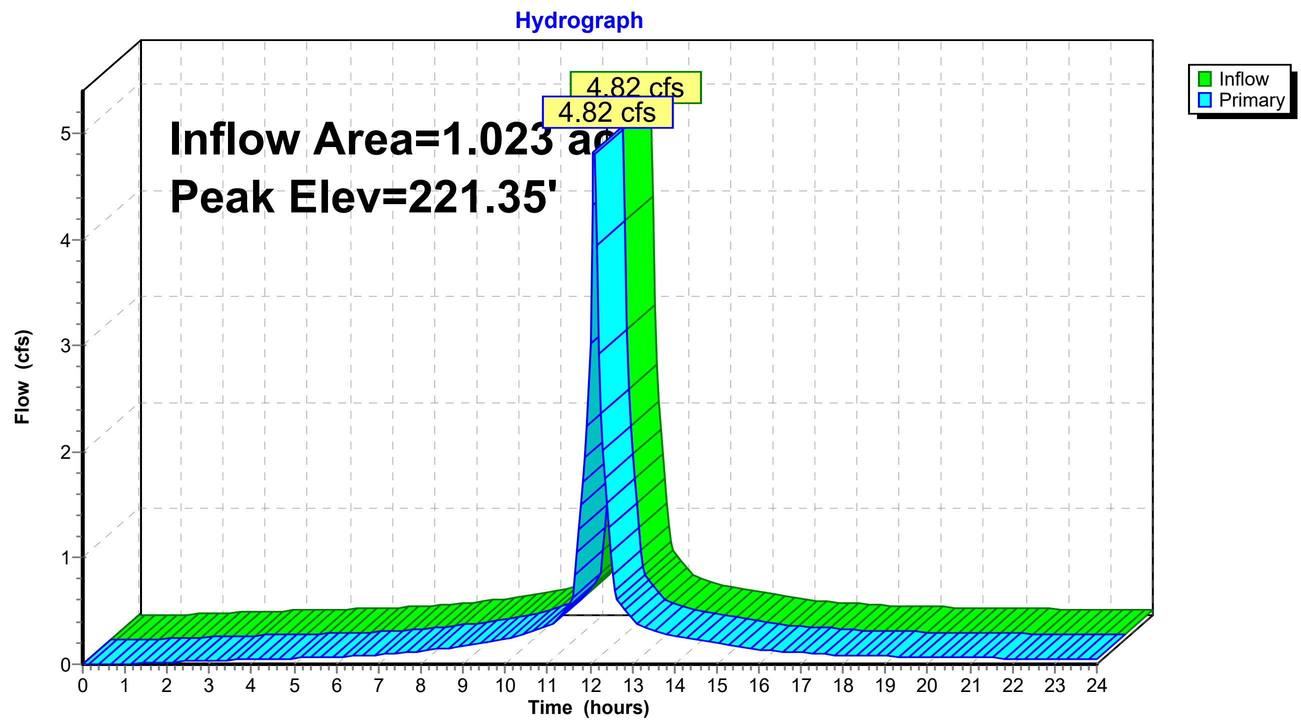
Inflow Area = 1.023 ac, 99.15% Impervious, Inflow Depth > 4.75" for 10-year 24hr event
Inflow = 4.82 cfs @ 12.09 hrs, Volume= 0.405 af
Outflow = 4.82 cfs @ 12.09 hrs, Volume= 0.405 af, Atten= 0%, Lag= 0.0 min
Primary = 4.82 cfs @ 12.09 hrs, Volume= 0.405 af
Routed to Pond D32 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 221.35' @ 12.09 hrs
Flood Elev= 221.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	216.10'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 216.10' / 216.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	221.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=4.72 cfs @ 12.09 hrs HW=221.34' (Free Discharge)
↑—**1=Culvert** (Passes 4.72 cfs of 18.04 cfs potential flow)
↑—**2=Orifice/Grate** (Weir Controls 4.72 cfs @ 1.61 fps)

Pond P36: 18" HDPE



Summary for Pond P37: 18" HDPE

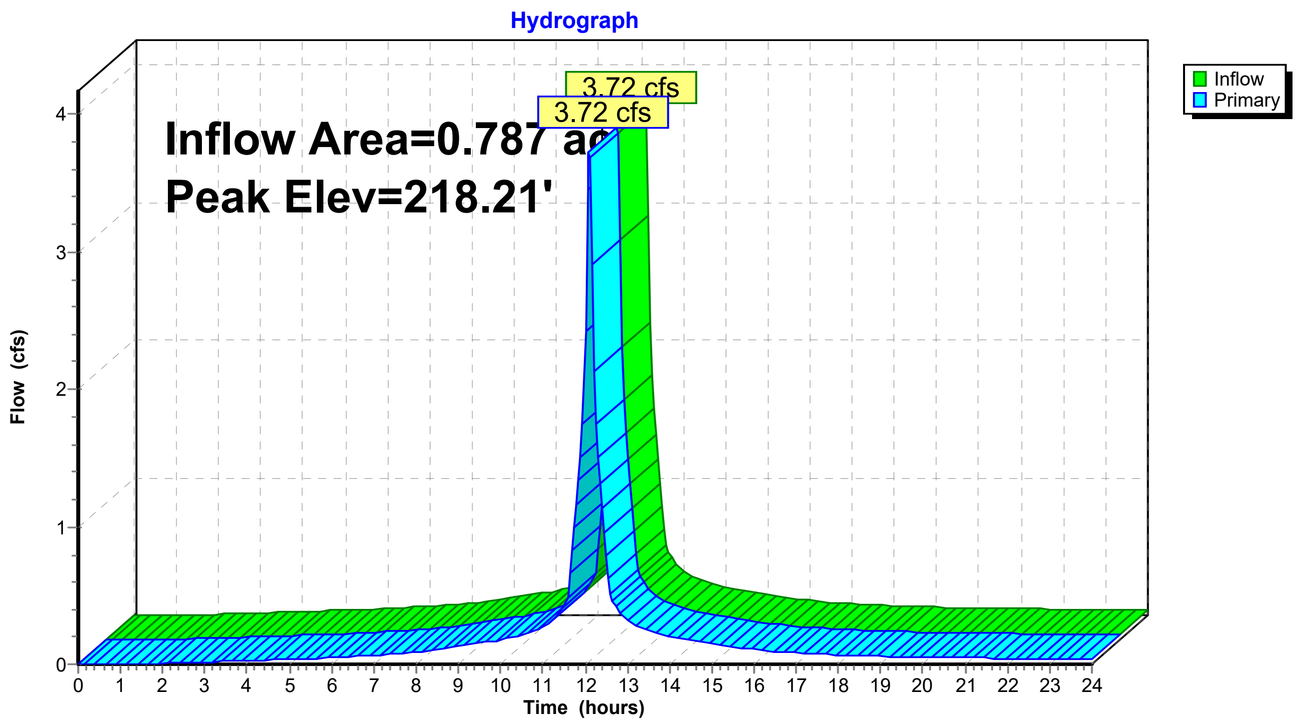
Inflow Area = 0.787 ac, 97.66% Impervious, Inflow Depth > 4.63" for 10-year 24hr event
Inflow = 3.72 cfs @ 12.09 hrs, Volume= 0.304 af
Outflow = 3.72 cfs @ 12.09 hrs, Volume= 0.304 af, Atten= 0%, Lag= 0.0 min
Primary = 3.72 cfs @ 12.09 hrs, Volume= 0.304 af
Routed to Pond D33 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 218.21' @ 12.09 hrs
Flood Elev= 218.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	213.00'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 213.00' / 212.90' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	218.00'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=3.60 cfs @ 12.09 hrs HW=218.20' (Free Discharge)
└─**1=Culvert** (Passes 3.60 cfs of 17.96 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 3.60 cfs @ 1.47 fps)

Pond P37: 18" HDPE



Summary for Pond P38: 18" HDPE

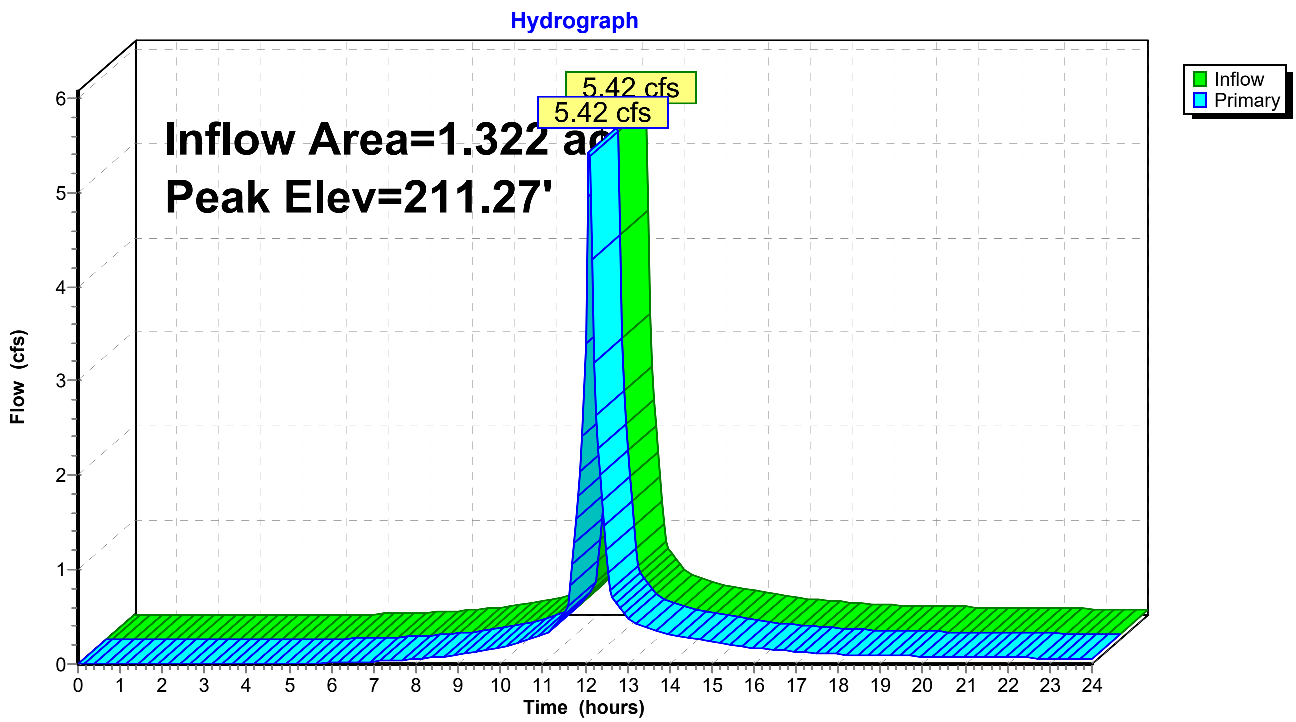
Inflow Area = 1.322 ac, 57.38% Impervious, Inflow Depth > 3.66" for 10-year 24hr event
Inflow = 5.42 cfs @ 12.09 hrs, Volume= 0.403 af
Outflow = 5.42 cfs @ 12.09 hrs, Volume= 0.403 af, Atten= 0%, Lag= 0.0 min
Primary = 5.42 cfs @ 12.09 hrs, Volume= 0.403 af
Routed to Pond F1 : Forebay

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 211.27' @ 12.09 hrs
Flood Elev= 211.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	207.80'	**18.0" Round Culvert** L= 80.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 207.80' / 207.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	211.00'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=5.28 cfs @ 12.09 hrs HW=211.26' (Free Discharge)
└─**1=Culvert** (Passes 5.28 cfs of 13.69 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 5.28 cfs @ 1.68 fps)

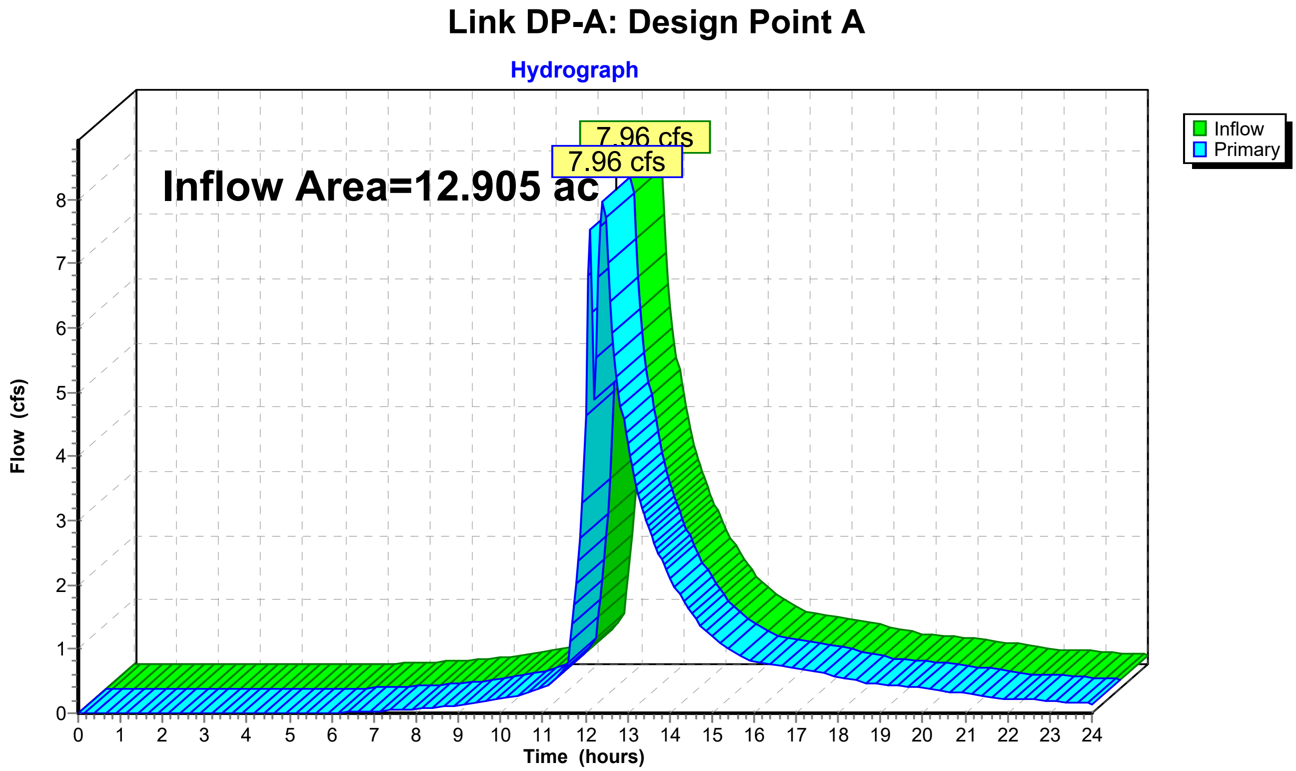
Pond P38: 18" HDPE



Summary for Link DP-A: Design Point A

Inflow Area = 12.905 ac, 73.65% Impervious, Inflow Depth > 1.29" for 10-year 24hr event
Inflow = 7.96 cfs @ 12.42 hrs, Volume= 1.388 af
Primary = 7.96 cfs @ 12.42 hrs, Volume= 1.388 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

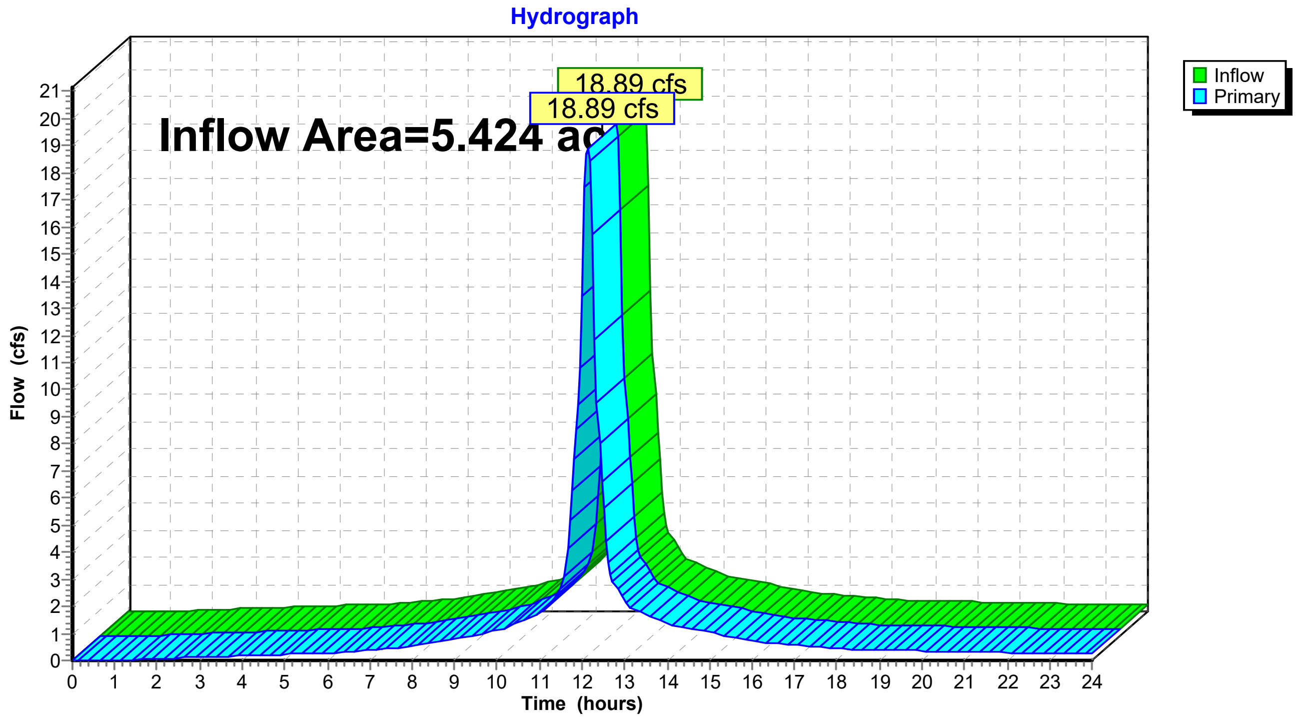


Summary for Link WQU-P5: Water Quality Unit

Inflow Area = 5.424 ac, 88.71% Impervious, Inflow Depth > 4.40" for 10-year 24hr event
Inflow = 18.89 cfs @ 12.13 hrs, Volume= 1.989 af
Primary = 18.89 cfs @ 12.13 hrs, Volume= 1.989 af, Atten= 0%, Lag= 0.0 min
Routed to Pond P1a : Proposed Basin

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

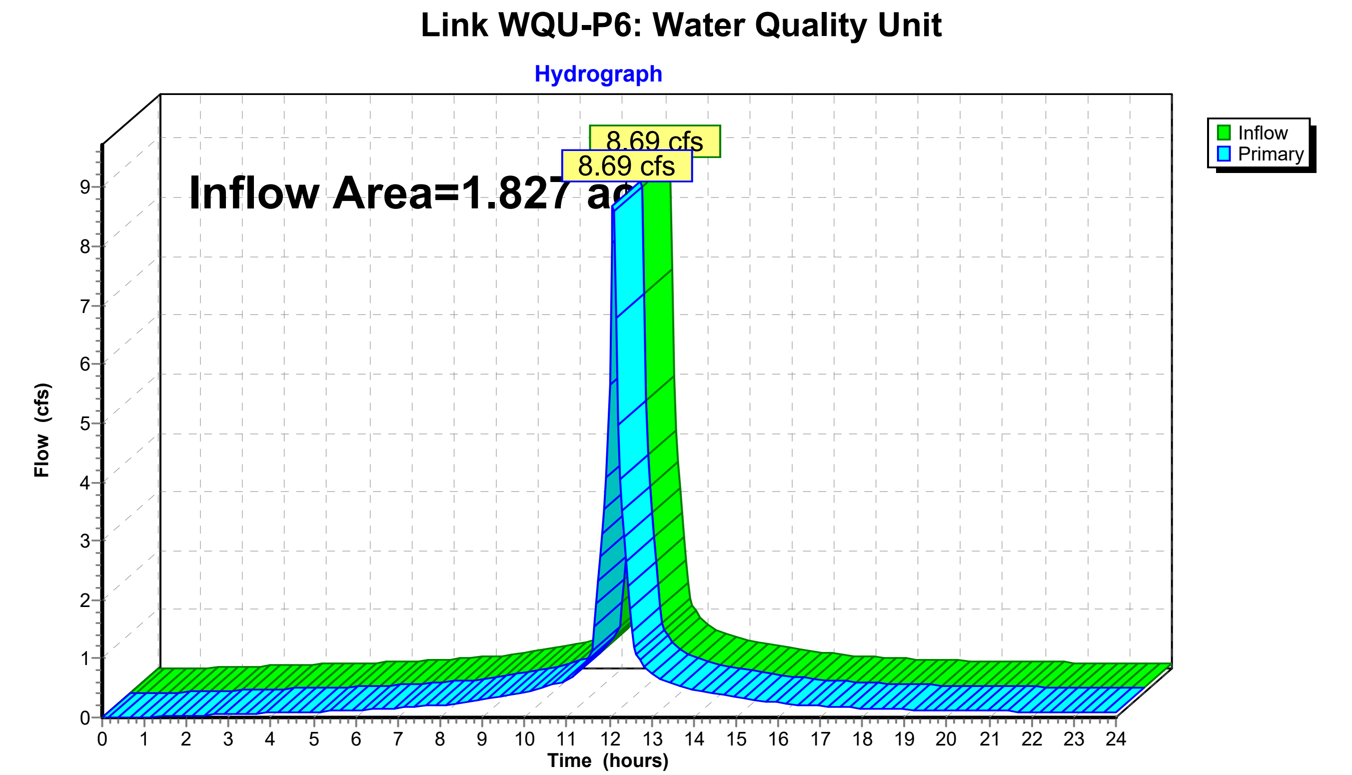
Link WQU-P5: Water Quality Unit



Summary for Link WQU-P6: Water Quality Unit

Inflow Area = 1.827 ac, 97.42% Impervious, Inflow Depth > 4.72" for 10-year 24hr event
Inflow = 8.69 cfs @ 12.09 hrs, Volume= 0.718 af
Primary = 8.69 cfs @ 12.09 hrs, Volume= 0.718 af, Atten= 0%, Lag= 0.0 min
Routed to Pond CMB : Underground Storage Chambers

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



Summary for Subcatchment P-A1:

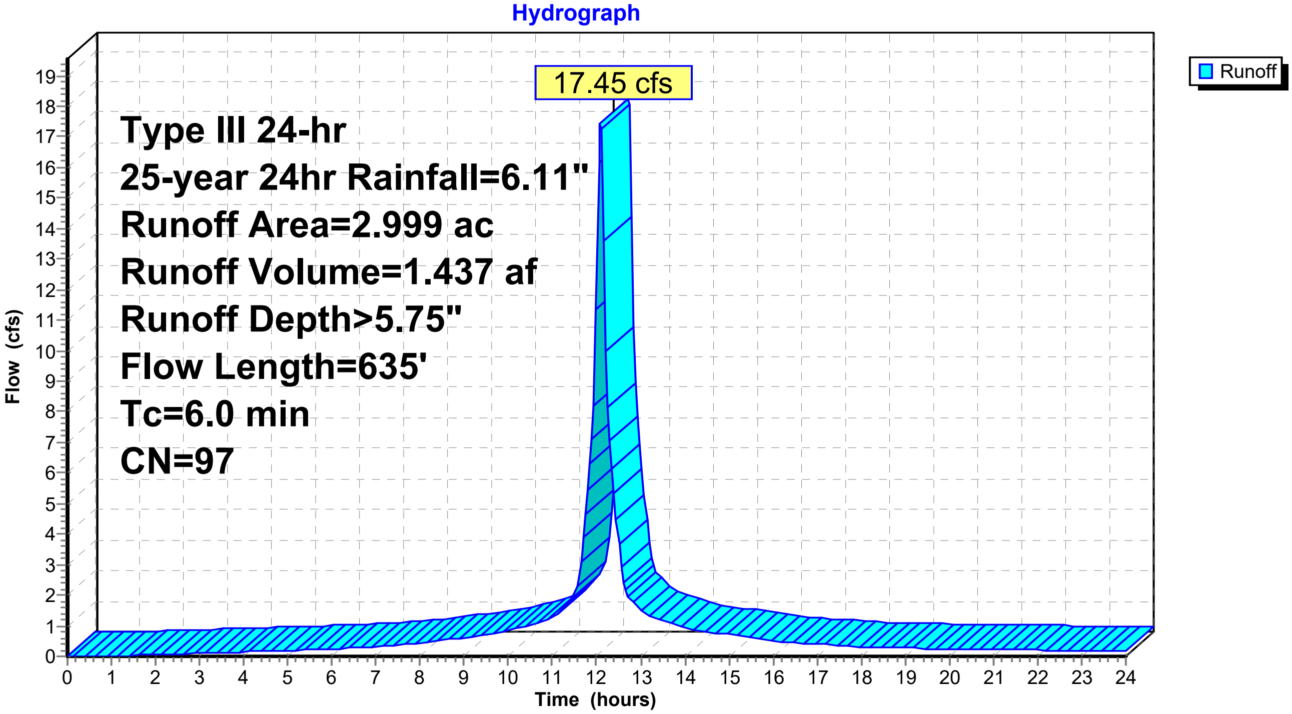
Runoff = 17.45 cfs @ 12.09 hrs, Volume= 1.437 af, Depth> 5.75"
Routed to Pond CMB : Underground Storage Chambers

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
1.360	98	EX Gravel Surface, Impervious, HSG C
0.003	98	PR Gravel Surface, Impervious, HSG C
0.043	98	PR Gravel Surface, Impervious, HSG C
0.007	98	PR Gravel Surface, Impervious, HSG C
0.933	98	Roofs, HSG C
0.050	98	Paved parking, HSG C
0.457	98	Paved parking, HSG C
0.069	74	>75% Grass cover, Good, HSG C
0.078	74	>75% Grass cover, Good, HSG C
2.999	97	Weighted Average
0.147		4.89% Pervious Area
2.852		95.11% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.19"
3.5	300	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.0	285	0.0060	4.60	8.14	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
5.7	635	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A1:



Summary for Subcatchment P-A2a:

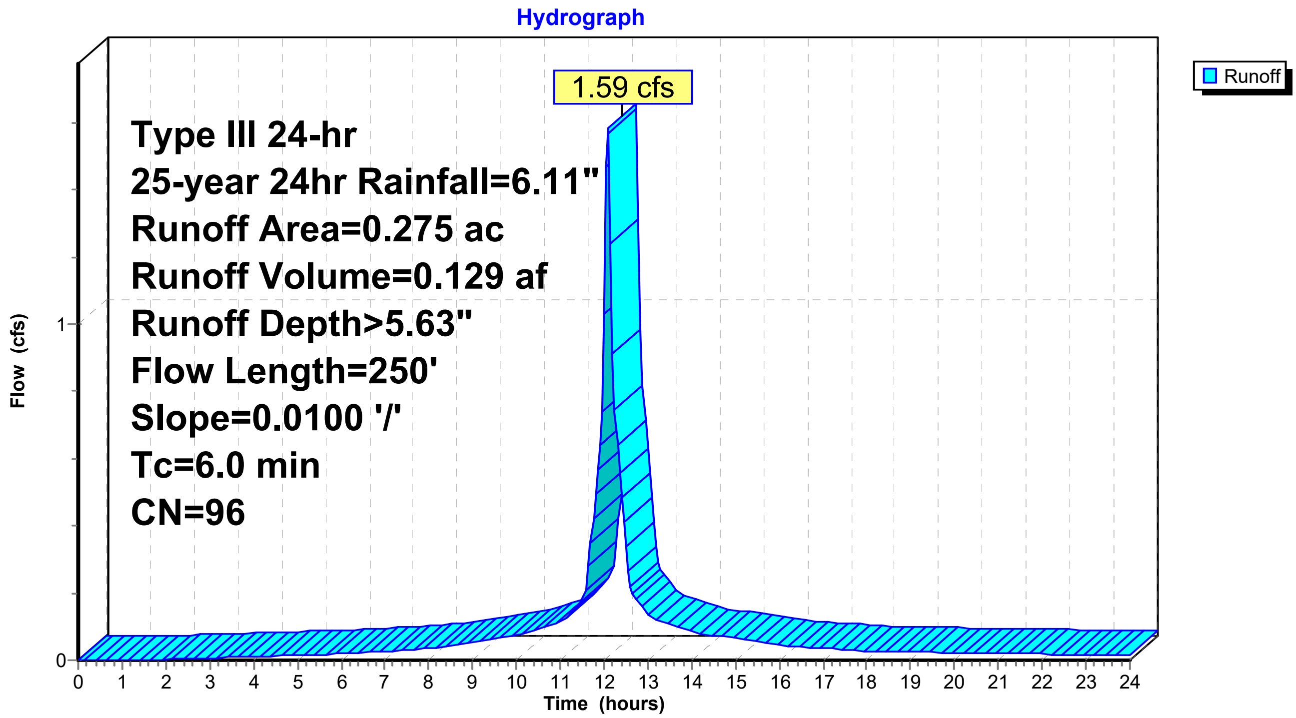
Runoff = 1.59 cfs @ 12.09 hrs, Volume= 0.129 af, Depth> 5.63"
Routed to Pond P30 : 12" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
0.021	74	>75% Grass cover, Good, HSG C
0.016	98	EX Gravel Surface, Impervious, HSG C
0.238	98	PR Gravel Surface, Impervious, HSG C
0.275	96	Weighted Average
0.021		7.62% Pervious Area
0.254		92.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
2.1	200	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.2	250	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A2a:



Summary for Subcatchment P-A2b:

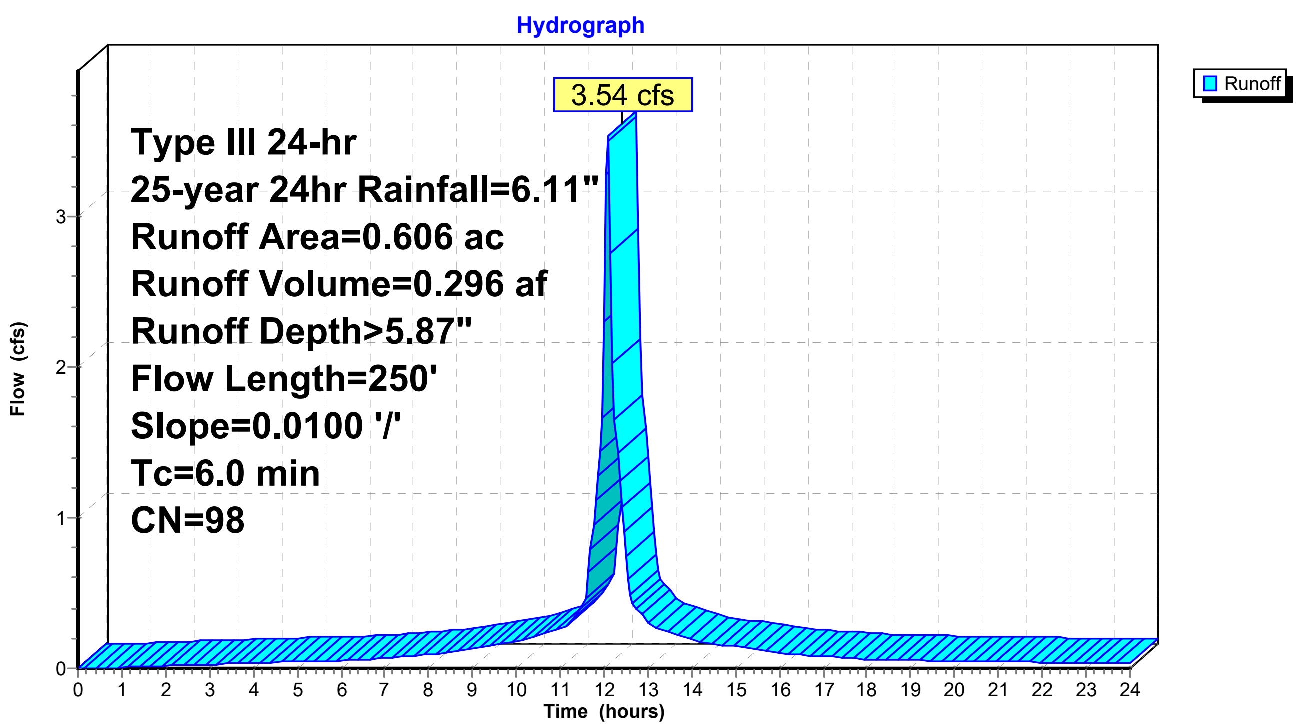
Runoff = 3.54 cfs @ 12.09 hrs, Volume= 0.296 af, Depth> 5.87"
Routed to Pond P31 : 12" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
0.330	98	PR Gravel Surface, Impervious, HSG C
0.016	98	PR Gravel Surface, Impervious, HSG C
0.247	98	EX Gravel Surface, Impervious, HSG C
0.007	74	>75% Grass cover, Good, HSG C
0.005	74	>75% Grass cover, Good, HSG C
0.606	98	Weighted Average
0.012		2.02% Pervious Area
0.594		97.98% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
2.1	200	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.2	250	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A2b:



Summary for Subcatchment P-A2c:

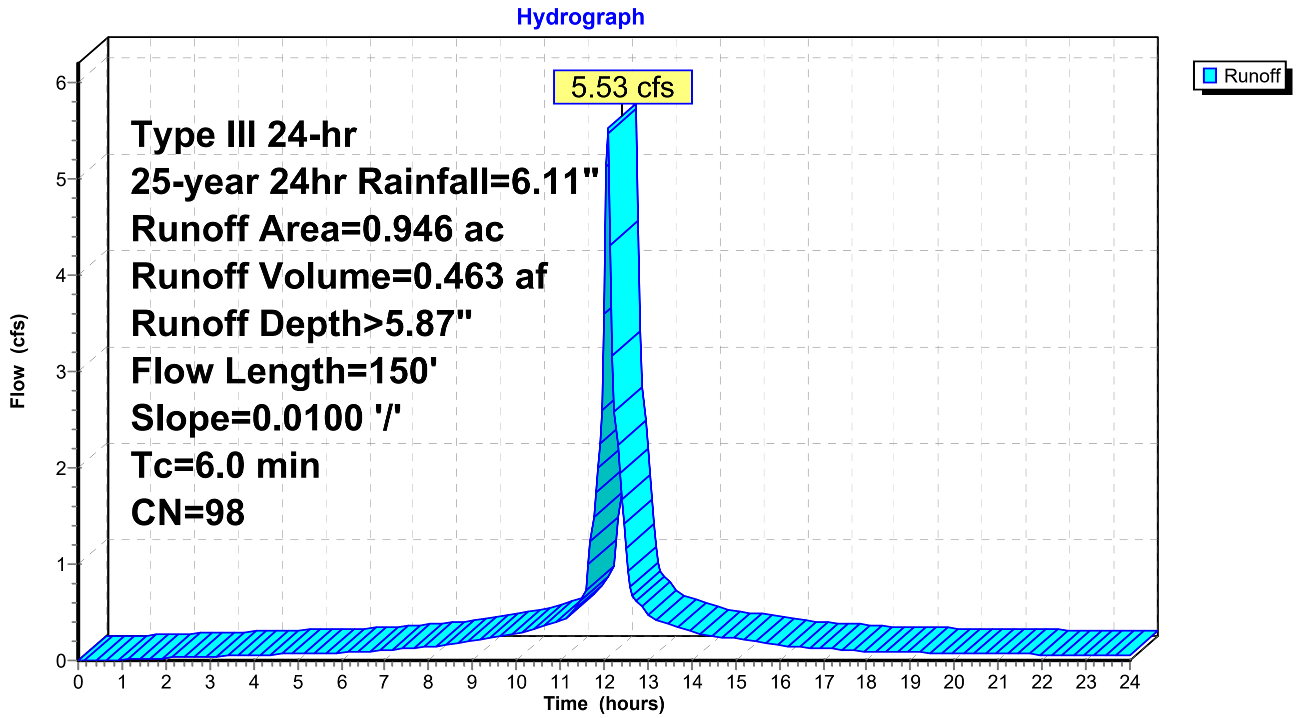
Runoff = 5.53 cfs @ 12.09 hrs, Volume= 0.463 af, Depth> 5.87"
Routed to Pond P32 : 12" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
0.284	98	EX Gravel Surface, Impervious, HSG C
0.648	98	PR Gravel Surface, Impervious, HSG C
0.006	74	>75% Grass cover, Good, HSG C
0.008	74	>75% Grass cover, Good, HSG C
0.946	98	Weighted Average
0.014		1.48% Pervious Area
0.932		98.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.0	100	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.1	150	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A2c:



Summary for Subcatchment P-A3a:

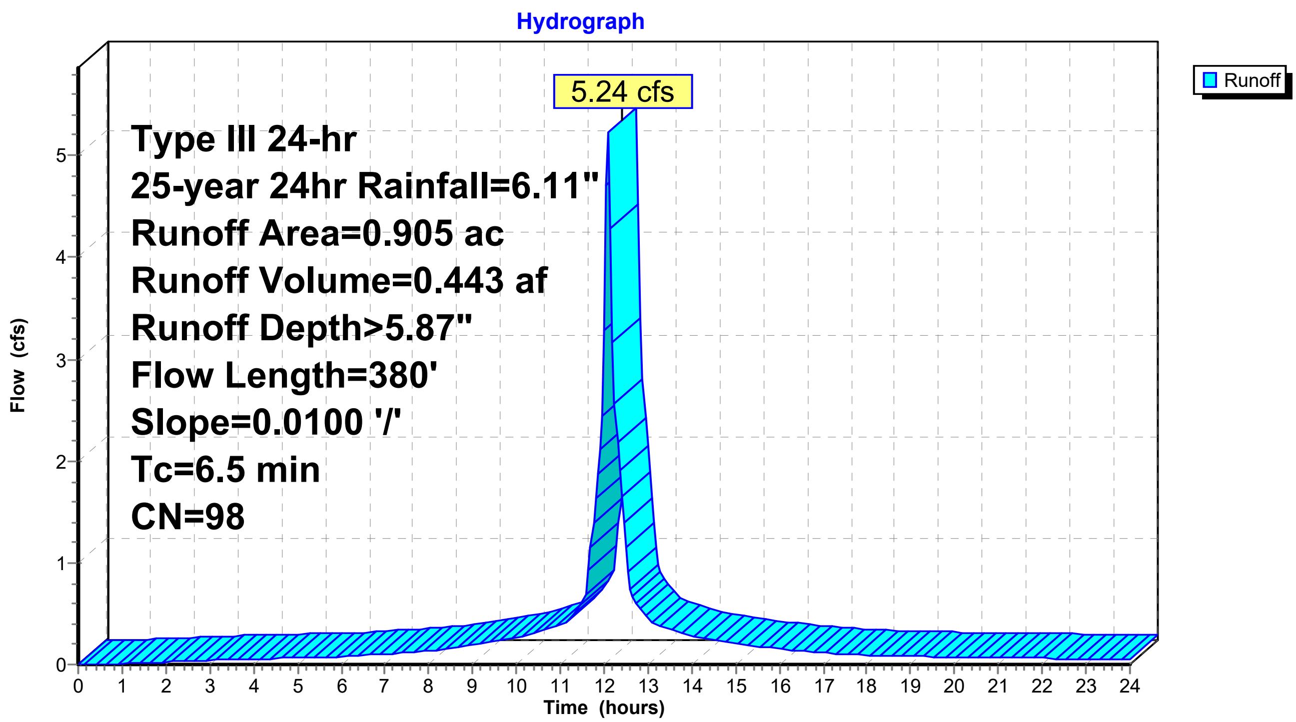
Runoff = 5.24 cfs @ 12.09 hrs, Volume= 0.443 af, Depth> 5.87"
Routed to Pond P33 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
0.805	98	PR Gravel Surface, Impervious, HSG C
0.094	98	EX Gravel Surface, Impervious, HSG C
0.006	74	>75% Grass cover, Good, HSG C
0.000	74	>75% Grass cover, Good, HSG C
0.905	98	Weighted Average
0.006		0.69% Pervious Area
0.899		99.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
3.4	330	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.5	380	Total			

Subcatchment P-A3a:



Summary for Subcatchment P-A3b:

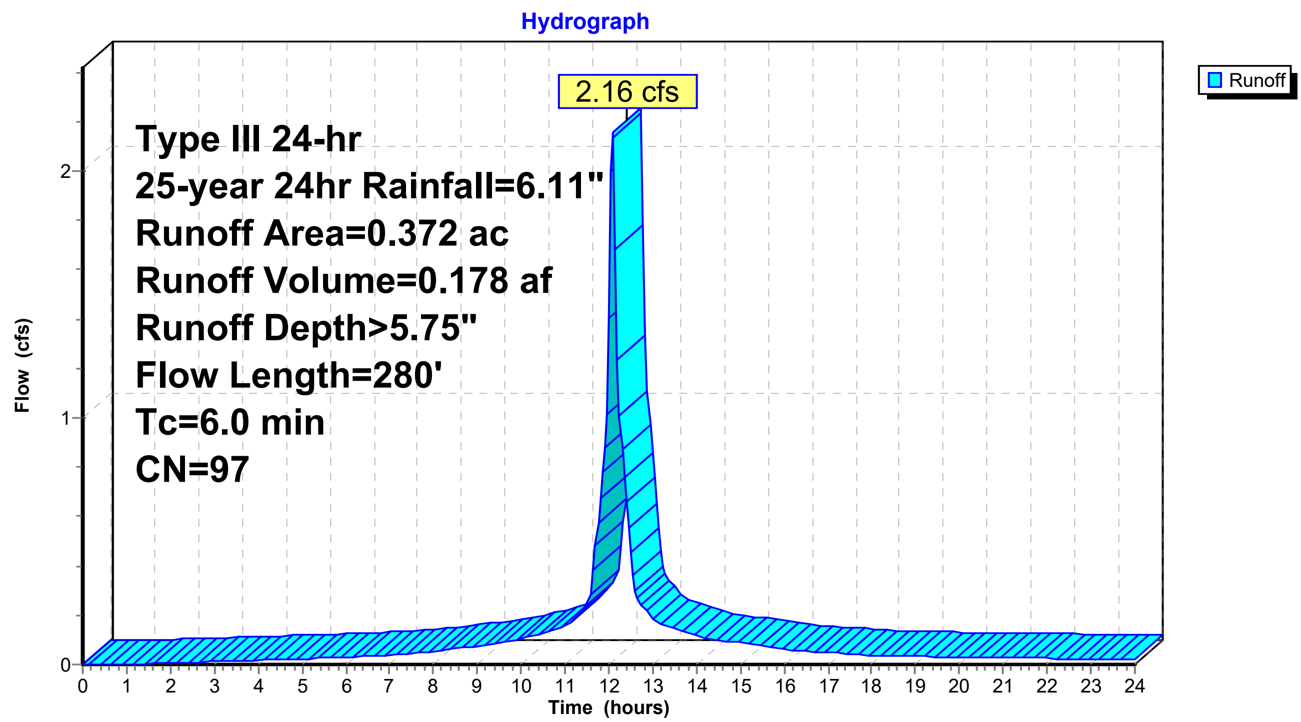
Runoff = 2.16 cfs @ 12.09 hrs, Volume= 0.178 af, Depth> 5.75"
Routed to Pond P34 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
0.008	74	>75% Grass cover, Good, HSG C
0.363	98	PR Gravel Surface, Impervious, HSG C
0.372	97	Weighted Average
0.008		2.27% Pervious Area
0.363		97.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.0	100	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	130	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.9	280	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A3b:



Summary for Subcatchment P-A3c:

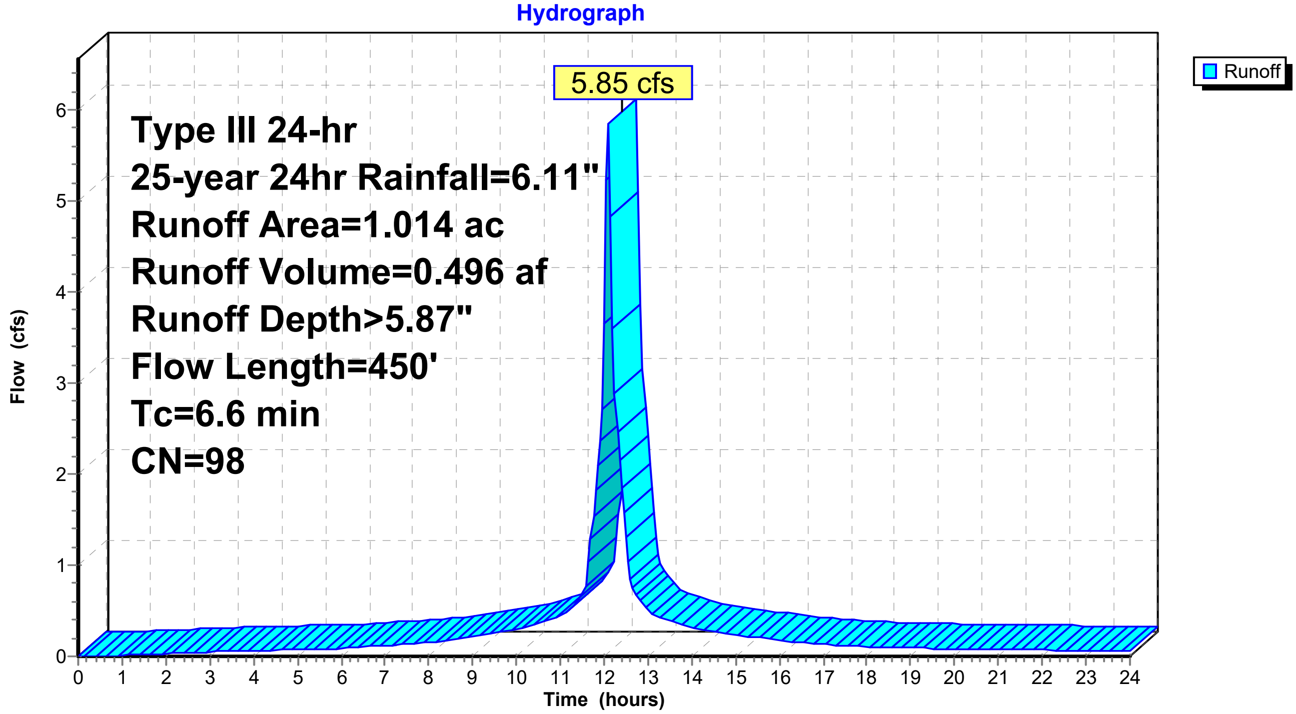
Runoff = 5.85 cfs @ 12.09 hrs, Volume= 0.496 af, Depth> 5.87"
Routed to Pond P35 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
0.007	74	>75% Grass cover, Good, HSG C
1.007	98	PR Gravel Surface, Impervious, HSG C
0.001	98	EX Gravel Surface, Impervious, HSG C
1.014	98	Weighted Average
0.007		0.70% Pervious Area
1.007		99.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
2.4	230	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.5	100	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	70	0.0150	1.97		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.6	450	Total			

Subcatchment P-A3c:



Summary for Subcatchment P-A3d:

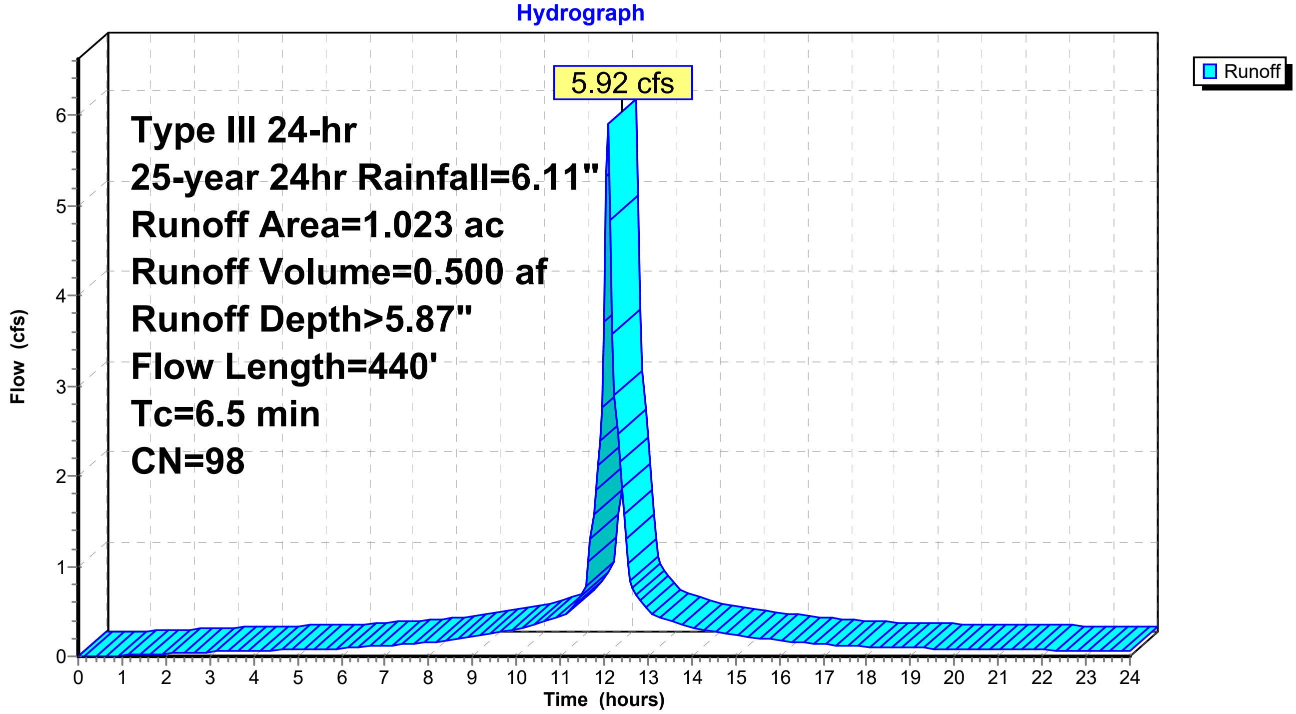
Runoff = 5.92 cfs @ 12.09 hrs, Volume= 0.500 af, Depth> 5.87"
Routed to Pond P36 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
0.004	74	>75% Grass cover, Good, HSG C
0.918	98	PR Gravel Surface, Impervious, HSG C
0.018	98	EX Gravel Surface, Impervious, HSG C
0.079	98	PR Gravel Surface, Impervious, HSG D
0.004	80	>75% Grass cover, Good, HSG D
1.023	98	Weighted Average
0.009		0.85% Pervious Area
1.015		99.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.1	110	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	120	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.7	160	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.5	440	Total			

Subcatchment P-A3d:



Summary for Subcatchment P-A3e:

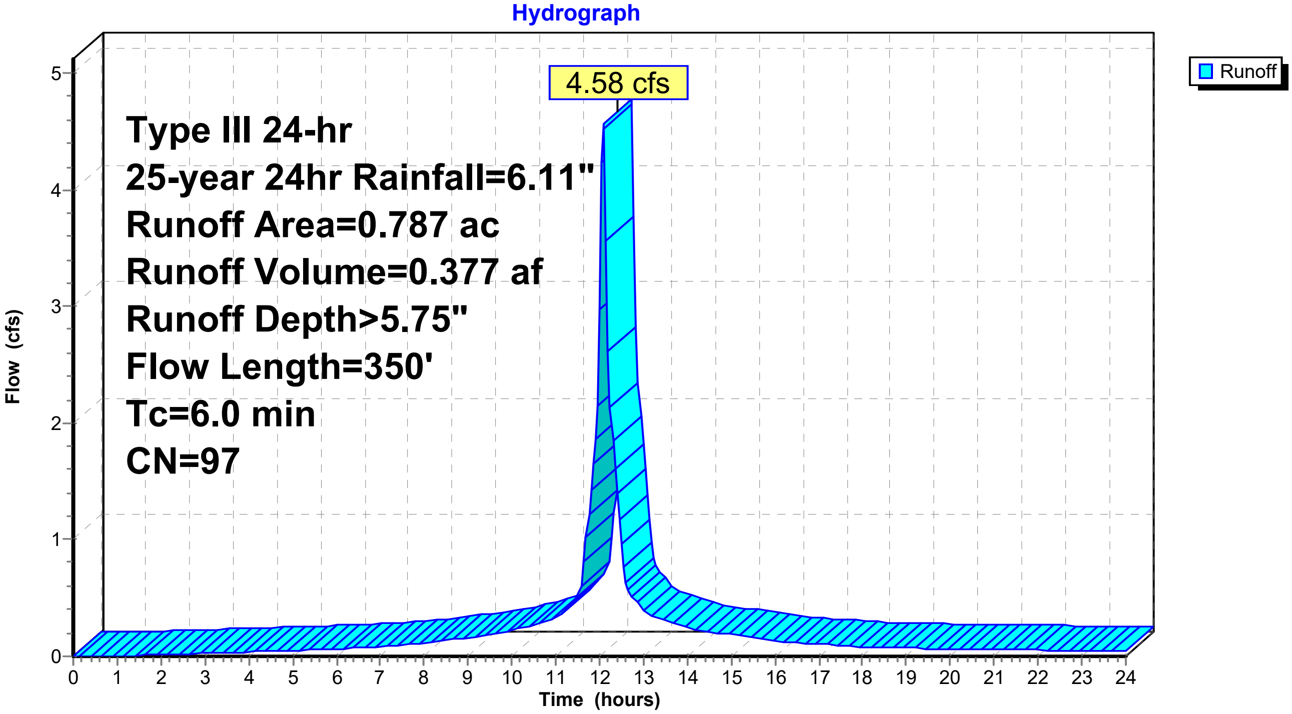
Runoff = 4.58 cfs @ 12.09 hrs, Volume= 0.377 af, Depth> 5.75"
Routed to Pond P37 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
0.031	98	EX Gravel Surface, Impervious, HSG C
0.669	98	PR Gravel Surface, Impervious, HSG C
0.012	74	>75% Grass cover, Good, HSG C
0.007	80	>75% Grass cover, Good, HSG D
0.068	98	PR Gravel Surface, Impervious, HSG D
0.787	97	Weighted Average
0.018		2.34% Pervious Area
0.768		97.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
0.7	160	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.0	140	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.8	350	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A3e:



Summary for Subcatchment P-A4: Subcat P-A4

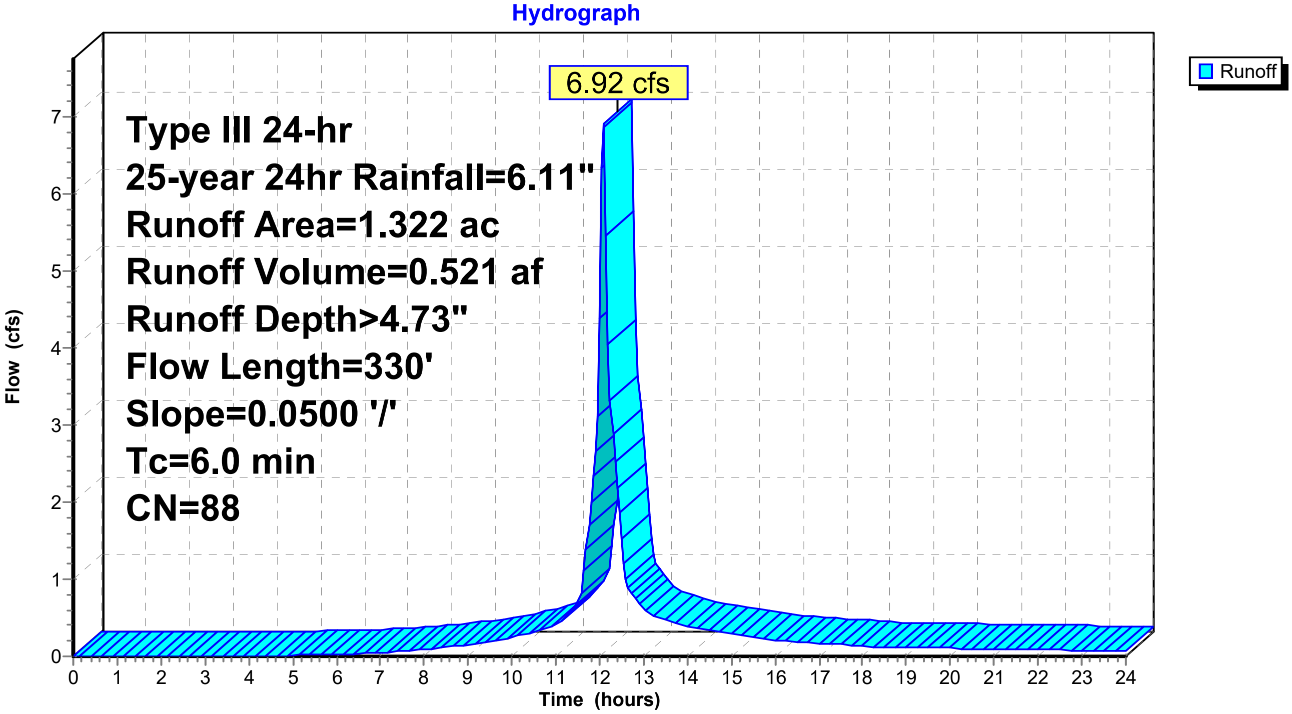
Runoff = 6.92 cfs @ 12.09 hrs, Volume= 0.521 af, Depth> 4.73"
Routed to Pond P38 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
0.123	98	EX Gravel Surface, Impervious, HSG C
0.523	98	PR Gravel Surface, Impervious, HSG C
0.403	74	>75% Grass cover, Good, HSG C
0.001	74	>75% Grass cover, Good, HSG C
0.089	80	>75% Grass cover, Good, HSG D
0.071	80	>75% Grass cover, Good, HSG D
0.112	98	PR Gravel Surface, Impervious, HSG D
1.322	88	Weighted Average
0.564		42.62% Pervious Area
0.759		57.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	50	0.0500	0.51		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.3	280	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.9	330	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A4: Subcat P-A4



Summary for Subcatchment P-A5:

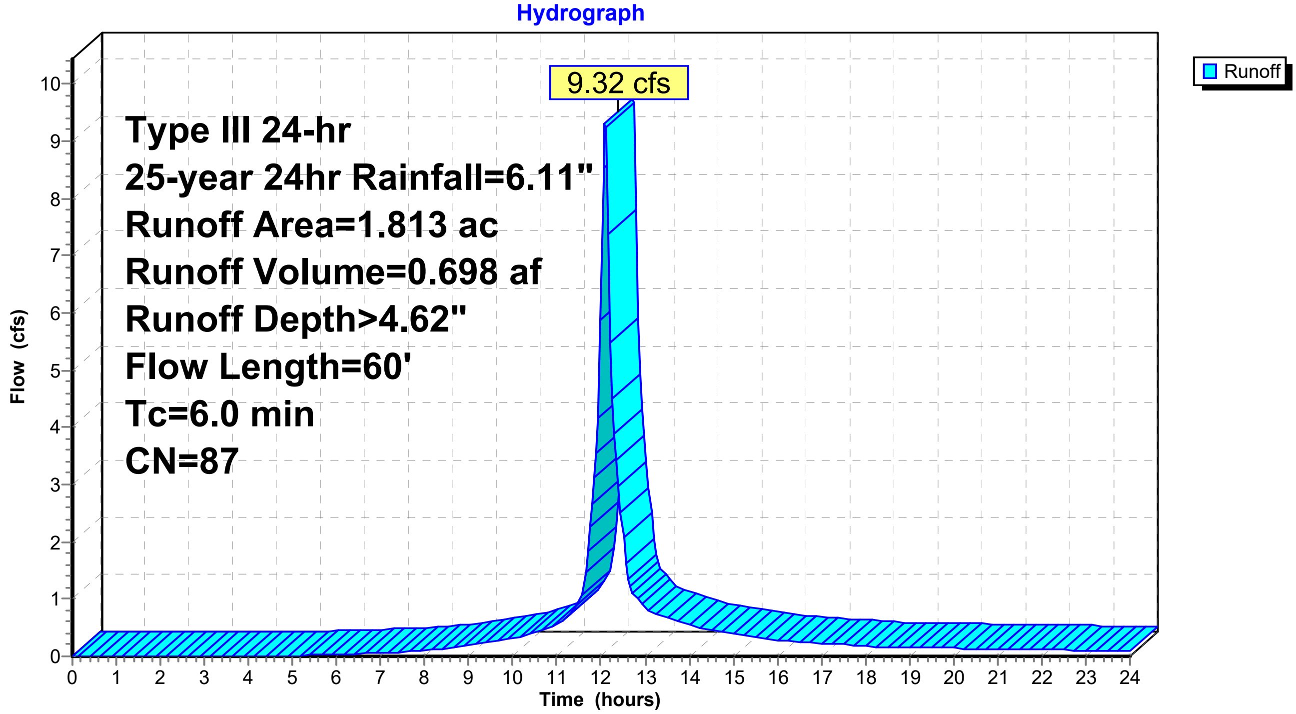
Runoff = 9.32 cfs @ 12.09 hrs, Volume= 0.698 af, Depth> 4.62"
Routed to Link DP-A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
0.011	98	EX Gravel Surface, Impervious, HSG C
0.197	96	Gravel surface, HSG D
0.000	96	Gravel surface, HSG D
0.744	96	Gravel surface, HSG C
0.414	80	>75% Grass cover, Good, HSG D
0.014	80	>75% Grass cover, Good, HSG D
0.016	80	>75% Grass cover, Good, HSG D
0.002	80	>75% Grass cover, Good, HSG D
0.010	80	>75% Grass cover, Good, HSG D
0.384	74	>75% Grass cover, Good, HSG C
0.018	74	>75% Grass cover, Good, HSG C
0.002	80	>75% Grass cover, Good, HSG D
1.813	87	Weighted Average
1.801		99.38% Pervious Area
0.011		0.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	30	0.3300	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.19"
0.5	30	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.7	60	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A5:



Summary for Subcatchment P-A6: Subcat P-A6

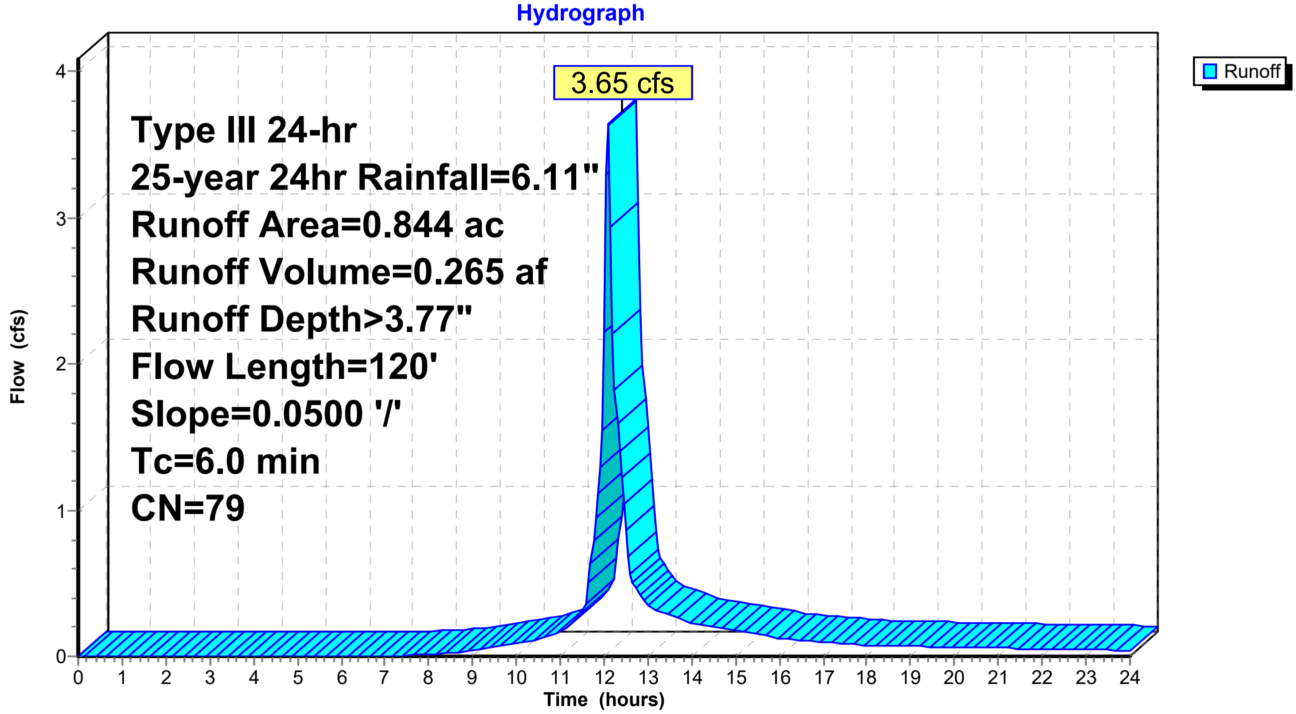
Runoff = 3.65 cfs @ 12.09 hrs, Volume= 0.265 af, Depth> 3.77"
Routed to Pond P1a : Proposed Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
0.050	98	EX Gravel Surface, Impervious, HSG C
0.000	98	PR Gravel Surface, Impervious, HSG C
0.127	74	>75% Grass cover, Good, HSG C
0.140	74	>75% Grass cover, Good, HSG C
0.425	80	>75% Grass cover, Good, HSG D
0.101	80	>75% Grass cover, Good, HSG D
0.000	98	PR Gravel Surface, Impervious, HSG D
0.844	79	Weighted Average
0.793		93.99% Pervious Area
0.051		6.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0500	0.15		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.19"
0.3	70	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.0	120	Total			

Subcatchment P-A6: Subcat P-A6



Summary for Pond CMB: Underground Storage Chambers

Inflow Area = 4.826 ac, 95.98% Impervious, Inflow Depth > 5.78" for 25-year 24hr event
Inflow = 28.12 cfs @ 12.09 hrs, Volume= 2.325 af
Outflow = 5.97 cfs @ 12.50 hrs, Volume= 1.801 af, Atten= 79%, Lag= 24.9 min
Discarded = 0.92 cfs @ 8.85 hrs, Volume= 1.376 af
Primary = 5.05 cfs @ 12.50 hrs, Volume= 0.425 af
Routed to Link DP-A : Design Point A

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 223.18' @ 12.50 hrs Surf.Area= 16,464 sf Storage= 42,751 cf
Flood Elev= 224.00' Surf.Area= 16,464 sf Storage= 54,255 cf

Plug-Flow detention time= 198.1 min calculated for 1.801 af (77% of inflow)
Center-of-Mass det. time= 116.2 min (865.7 - 749.5)

Volume	Invert	Avail.Storage	Storage Description
#1B	219.75'	6,779 cf	**196.00'W x 84.00'L x 4.92'H Field A** 80,948 cf Overall - 64,000 cf Embedded = 16,948 cf x 40.0% Voids
#2B	220.50'	47,770 cf	**retain_it upright 3.5'** x 240 Inside #1 Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf 24 Rows adjusted for 417.5 cf perimeter wall
		54,549 cf	Total Available Storage

Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	219.75'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	220.40'	**24.0" Round Culvert** L= 370.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 220.40' / 210.00' S= 0.0281 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#3	Device 2	222.75'	**6.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.92 cfs @ 8.85 hrs HW=219.80' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.92 cfs)

Primary OutFlow Max=5.04 cfs @ 12.50 hrs HW=223.18' (Free Discharge)
└─**2=Culvert** (Passes 5.04 cfs of 15.95 cfs potential flow)
  └─**3=Broad-Crested Rectangular Weir** (Weir Controls 5.04 cfs @ 1.94 fps)

Pond CMB: Underground Storage Chambers - Chamber Wizard Field A

Chamber Model = retain_it upright 3.5' (retain-it® upright)
Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf
Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf
24 Rows adjusted for 417.5 cf perimeter wall

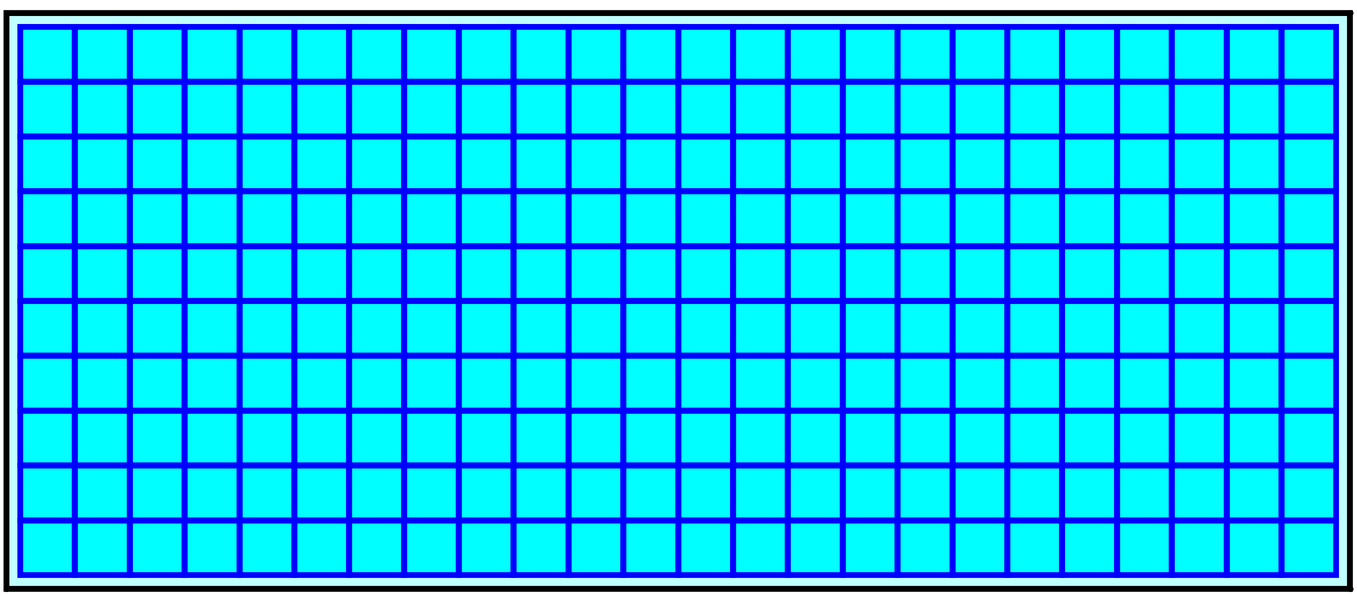
10 Chambers/Row x 8.00' Long = 80.00' Row Length +24.0" End Stone x 2 = 84.00' Base Length
24 Rows x 96.0" Wide + 24.0" Side Stone x 2 = 196.00' Base Width
9.0" Stone Base + 50.0" Chamber Height = 4.92' Field Height

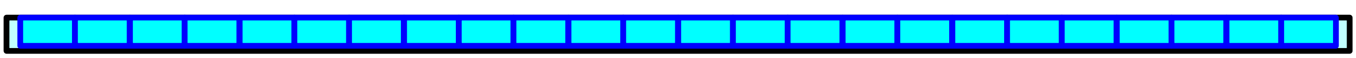
6.1 cf Sidewall x 10 x 2 + 6.1 cf Endwall x 24 x 2 = 417.5 cf Perimeter Wall
240 Chambers x 200.8 cf - 417.5 cf Perimeter wall = 47,769.8 cf Chamber Storage
240 Chambers x 266.7 cf = 64,000.0 cf Displacement

80,948.0 cf Field - 64,000.0 cf Chambers = 16,948.0 cf Stone x 40.0% Voids = 6,779.2 cf Stone Storage

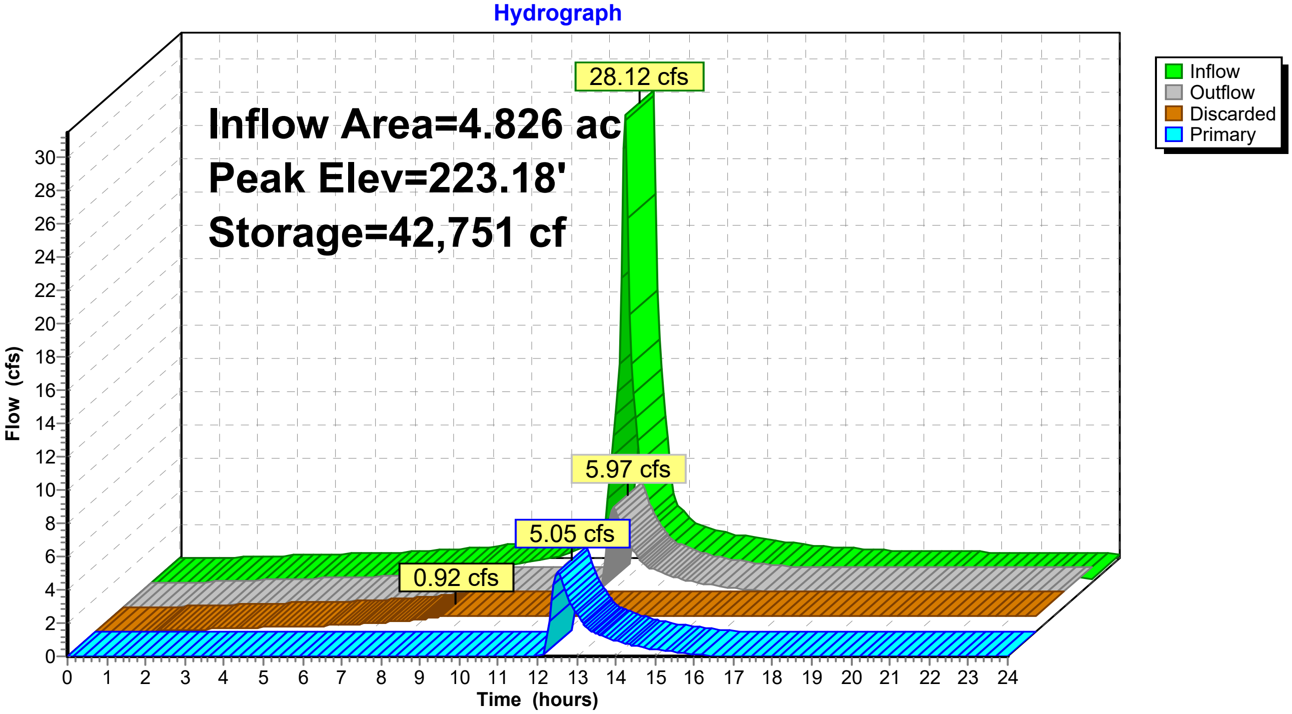
Chamber Storage + Stone Storage = 54,549.0 cf = 1.252 af
Overall Storage Efficiency = 67.4%
Overall System Size = 84.00' x 196.00' x 4.92'

240 Chambers
2,998.1 cy Field
627.7 cy Stone





Pond CMB: Underground Storage Chambers



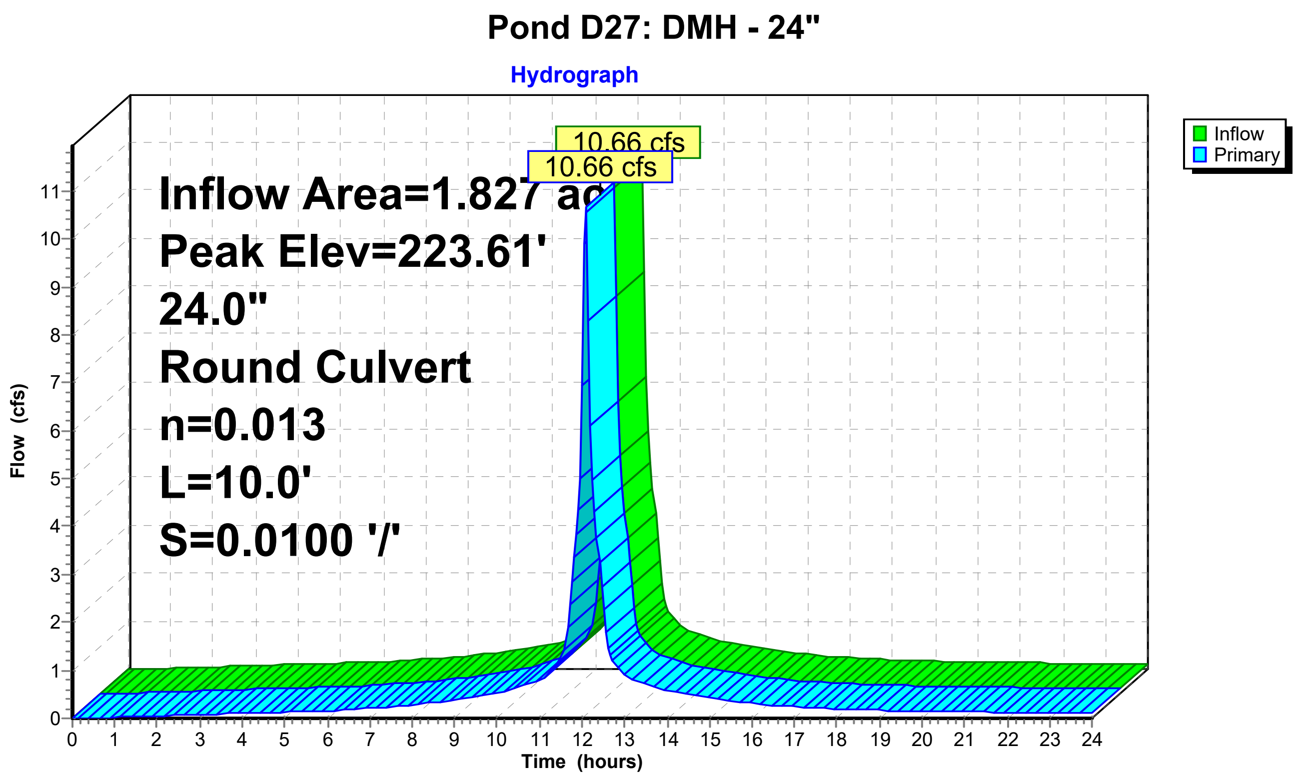
Summary for Pond D27: DMH - 24"

Inflow Area = 1.827 ac, 97.42% Impervious, Inflow Depth > 5.83" for 25-year 24hr event
Inflow = 10.66 cfs @ 12.09 hrs, Volume= 0.888 af
Outflow = 10.66 cfs @ 12.09 hrs, Volume= 0.888 af, Atten= 0%, Lag= 0.0 min
Primary = 10.66 cfs @ 12.09 hrs, Volume= 0.888 af
Routed to Link WQU-P6 : Water Quality Unit

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 223.61' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	221.80'	**24.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 221.80' / 221.70' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=10.37 cfs @ 12.09 hrs HW=223.57' (Free Discharge)
└─**1=Culvert** (Barrel Controls 10.37 cfs @ 4.67 fps)



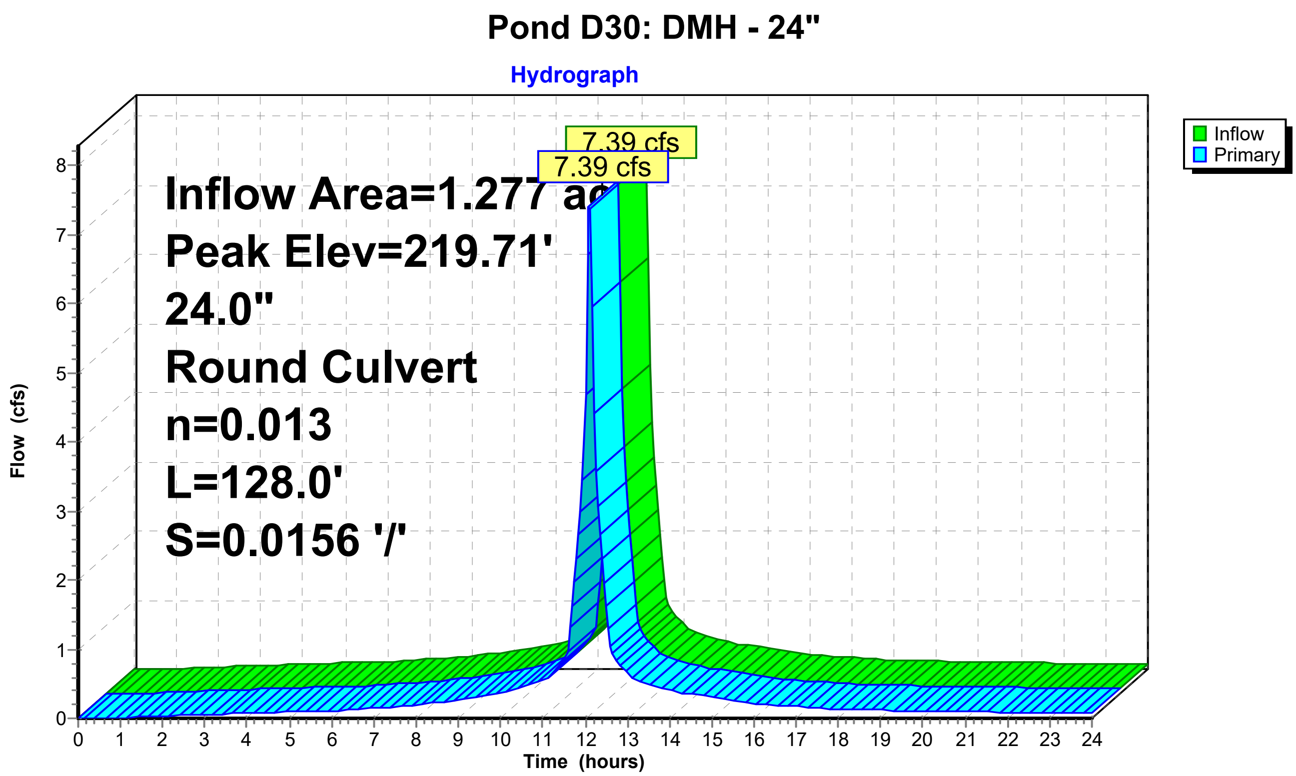
Summary for Pond D30: DMH - 24"

Inflow Area = 1.277 ac, 98.85% Impervious, Inflow Depth > 5.83" for 25-year 24hr event
Inflow = 7.39 cfs @ 12.09 hrs, Volume= 0.621 af
Outflow = 7.39 cfs @ 12.09 hrs, Volume= 0.621 af, Atten= 0%, Lag= 0.0 min
Primary = 7.39 cfs @ 12.09 hrs, Volume= 0.621 af
Routed to Pond D31 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 219.71' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	218.50'	**24.0" Round Culvert** L= 128.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 218.50' / 216.50' S= 0.0156 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=7.24 cfs @ 12.09 hrs HW=219.69' (Free Discharge)
└─**1=Culvert** (Inlet Controls 7.24 cfs @ 3.71 fps)



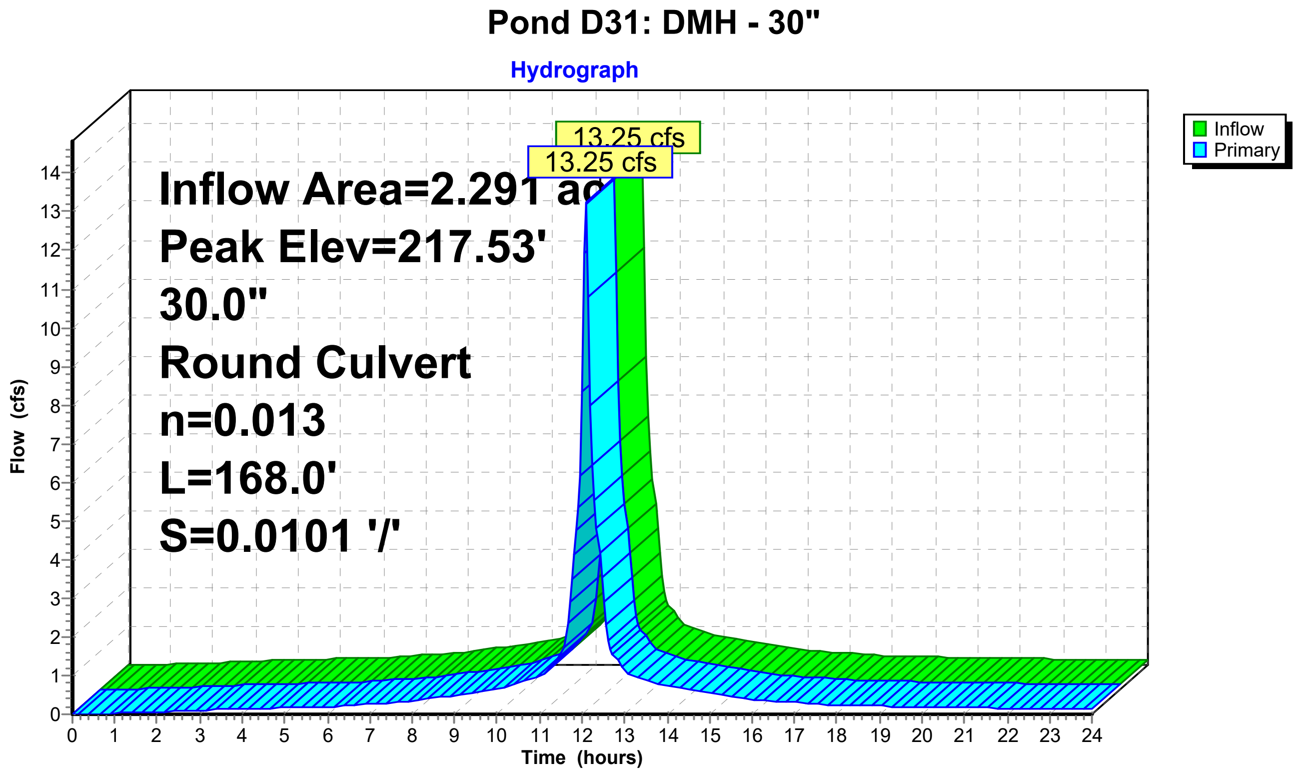
Summary for Pond D31: DMH - 30"

Inflow Area = 2.291 ac, 99.05% Impervious, Inflow Depth > 5.85" for 25-year 24hr event
Inflow = 13.25 cfs @ 12.09 hrs, Volume= 1.117 af
Outflow = 13.25 cfs @ 12.09 hrs, Volume= 1.117 af, Atten= 0%, Lag= 0.0 min
Primary = 13.25 cfs @ 12.09 hrs, Volume= 1.117 af
Routed to Pond D32 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 217.53' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	216.00'	**30.0" Round Culvert** L= 168.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 216.00' / 214.30' S= 0.0101 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf

Primary OutFlow Max=13.00 cfs @ 12.09 hrs HW=217.51' (Free Discharge)
↑**1=Culvert** (Inlet Controls 13.00 cfs @ 4.19 fps)



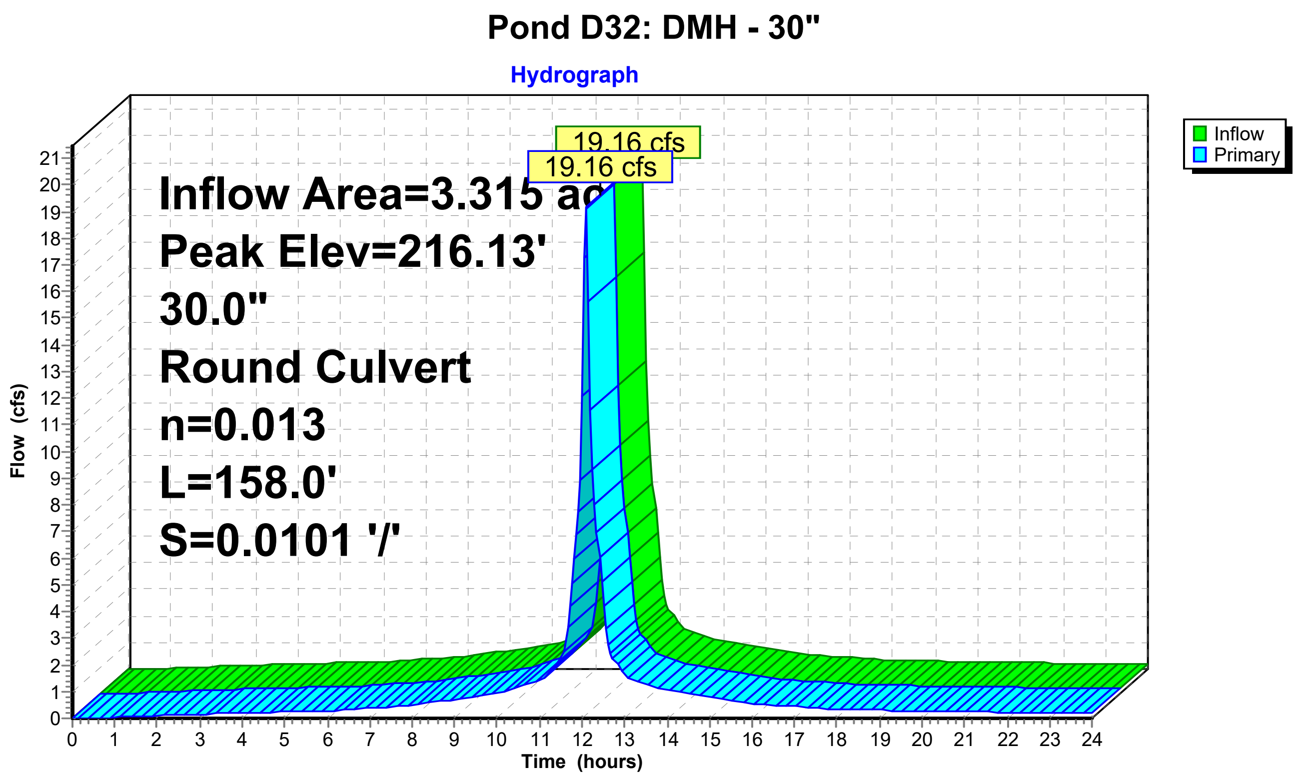
Summary for Pond D32: DMH - 30"

Inflow Area = 3.315 ac, 99.08% Impervious, Inflow Depth > 5.85" for 25-year 24hr event
Inflow = 19.16 cfs @ 12.09 hrs, Volume= 1.617 af
Outflow = 19.16 cfs @ 12.09 hrs, Volume= 1.617 af, Atten= 0%, Lag= 0.0 min
Primary = 19.16 cfs @ 12.09 hrs, Volume= 1.617 af
Routed to Pond D33 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 216.13' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	214.20'	**30.0" Round Culvert** L= 158.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 214.20' / 212.60' S= 0.0101 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf

Primary OutFlow Max=18.82 cfs @ 12.09 hrs HW=216.10' (Free Discharge)
└─**1=Culvert** (Inlet Controls 18.82 cfs @ 4.70 fps)



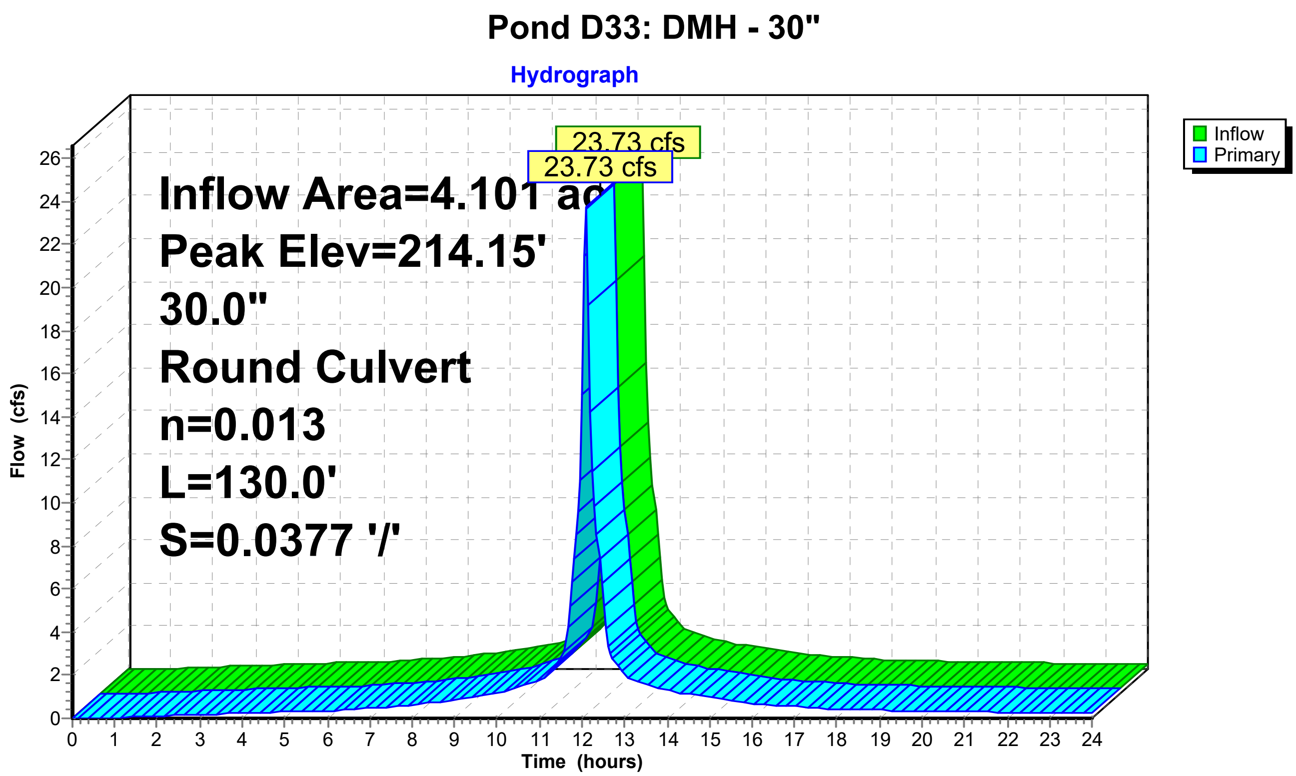
Summary for Pond D33: DMH - 30"

Inflow Area = 4.101 ac, 98.81% Impervious, Inflow Depth > 5.83" for 25-year 24hr event
Inflow = 23.73 cfs @ 12.09 hrs, Volume= 1.994 af
Outflow = 23.73 cfs @ 12.09 hrs, Volume= 1.994 af, Atten= 0%, Lag= 0.0 min
Primary = 23.73 cfs @ 12.09 hrs, Volume= 1.994 af
Routed to Pond F1 : Forebay

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 214.15' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	211.90'	**30.0" Round Culvert** L= 130.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 211.90' / 207.00' S= 0.0377 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf

Primary OutFlow Max=23.27 cfs @ 12.09 hrs HW=214.11' (Free Discharge)
1=Culvert (Inlet Controls 23.27 cfs @ 5.06 fps)



Summary for Pond F1: Forebay

Inflow Area = 5.424 ac, 88.71% Impervious, Inflow Depth > 5.56" for 25-year 24hr event
Inflow = 30.65 cfs @ 12.09 hrs, Volume= 2.515 af
Outflow = 32.31 cfs @ 12.11 hrs, Volume= 2.515 af, Atten= 0%, Lag= 1.0 min
Primary = 19.37 cfs @ 12.11 hrs, Volume= 2.420 af
Routed to Link WQU-P5 : Water Quality Unit
Secondary = 12.95 cfs @ 12.11 hrs, Volume= 0.095 af
Routed to Pond P1a : Proposed Basin

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 207.53' @ 12.11 hrs Surf.Area= 1,498 sf Storage= 2,485 cf

Plug-Flow detention time= 0.8 min calculated for 2.515 af (100% of inflow)
Center-of-Mass det. time= 0.7 min (756.5 - 755.8)

Volume	Invert	Avail.Storage	Storage Description
#1	205.00'	3,235 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

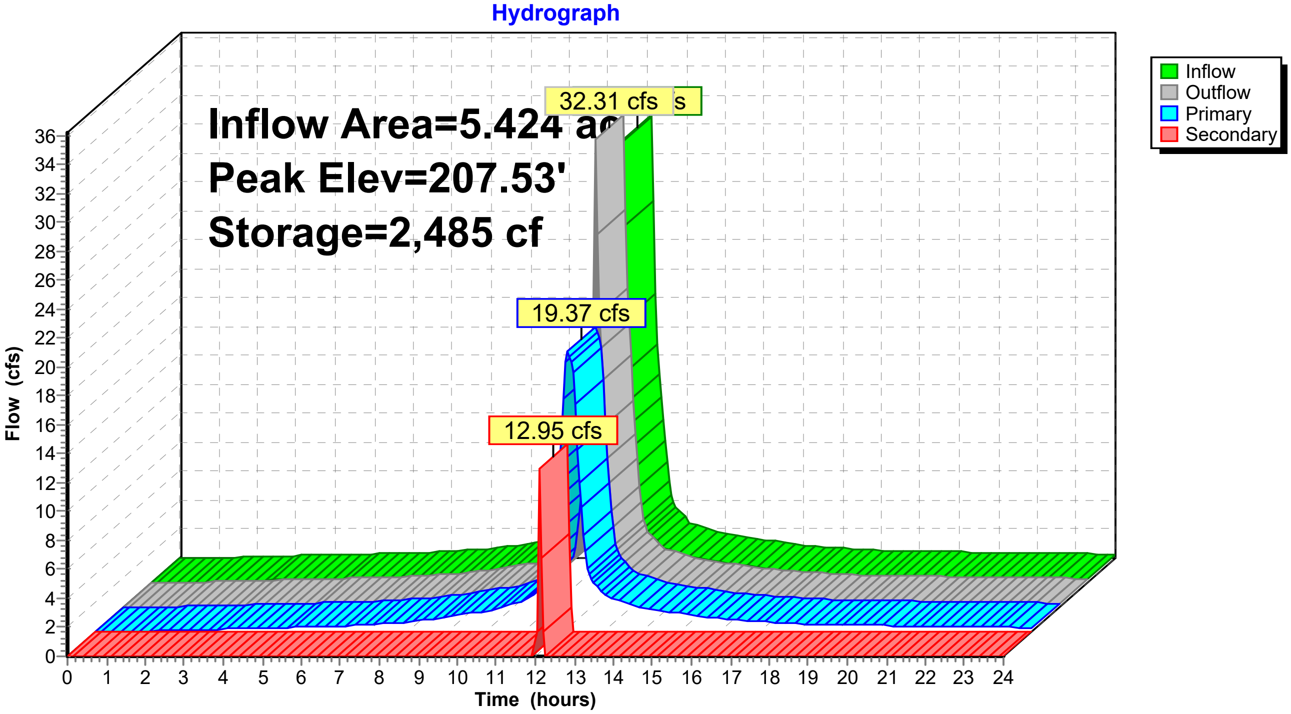
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
205.00	480	0	0
207.00	1,270	1,750	1,750
208.00	1,700	1,485	3,235

Device	Routing	Invert	Outlet Devices
#1	Primary	201.60'	**18.0" Round 18" Culvert** L= 30.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 201.60' / 201.30' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	205.00'	**1.0" x 21.0" Horiz. Double Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads
#3	Secondary	207.00'	**12.0' long + 2.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=19.29 cfs @ 12.11 hrs HW=207.49' (Free Discharge)
└─**1=18" Culvert** (Inlet Controls 19.29 cfs @ 10.91 fps)
  └─**2=Double Grate** (Passes 19.29 cfs of 22.15 cfs potential flow)

Secondary OutFlow Max=11.76 cfs @ 12.11 hrs HW=207.50' (Free Discharge)
└─**3=Broad-Crested Rectangular Weir** (Weir Controls 11.76 cfs @ 1.82 fps)

Pond F1: Forebay



Summary for Pond P1a: Proposed Basin

Inflow Area = 6.267 ac, 77.58% Impervious, Inflow Depth > 5.32" for 25-year 24hr event
Inflow = 35.91 cfs @ 12.11 hrs, Volume= 2.780 af
Outflow = 10.32 cfs @ 12.43 hrs, Volume= 2.191 af, Atten= 71%, Lag= 19.5 min
Discarded = 0.89 cfs @ 12.43 hrs, Volume= 0.966 af
Primary = 9.43 cfs @ 12.43 hrs, Volume= 1.225 af
Routed to Link DP-A : Design Point A
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link DP-A : Design Point A

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 204.01' @ 12.43 hrs Surf.Area= 16,014 sf Storage= 55,694 cf

Plug-Flow detention time= 206.6 min calculated for 2.191 af (79% of inflow)
Center-of-Mass det. time= 127.3 min (889.3 - 762.1)

Volume	Invert	Avail.Storage	Storage Description
#1	198.00'	90,590 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
198.00	1,180	0	0
199.00	3,950	2,565	2,565
200.00	7,100	5,525	8,090
201.00	9,950	8,525	16,615
202.00	11,950	10,950	27,565
203.00	14,000	12,975	40,540
204.00	16,000	15,000	55,540
205.00	17,500	16,750	72,290
206.00	19,100	18,300	90,590

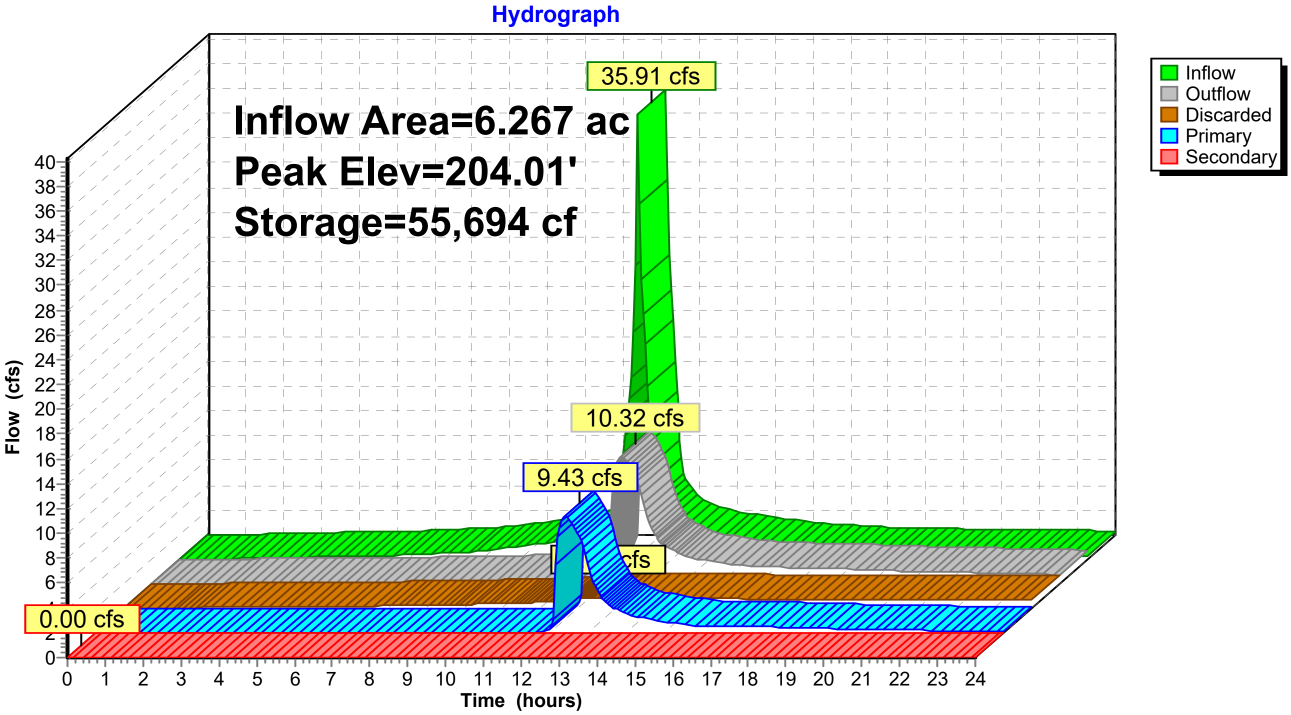
Device	Routing	Invert	Outlet Devices
#1	Secondary	205.00'	**10.0' long + 3.0 '/' SideZ x 11.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.53 2.59 2.70 2.68 2.67 2.68 2.66 2.64
#2	Primary	198.00'	**18.0" Round Culvert** L= 70.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 198.00' / 194.40' S= 0.0514 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#3	Device 2	201.50'	**1.0" Vert. Orifice/Grate X 8.00 columns** X 3 rows with 6.0" cc spacing C= 0.600 Limited to weir flow at low heads
#4	Device 2	203.00'	**18.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Discarded	198.00'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.89 cfs @ 12.43 hrs HW=204.01' (Free Discharge)
└─**5=Exfiltration** (Exfiltration Controls 0.89 cfs)

Primary OutFlow Max=9.42 cfs @ 12.43 hrs HW=204.01' (Free Discharge)
└─**2=Culvert** (Passes 9.42 cfs of 19.51 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 0.88 cfs @ 6.71 fps)
  └─**4=Orifice/Grate** (Orifice Controls 8.54 cfs @ 4.83 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=198.00' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond P1a: Proposed Basin



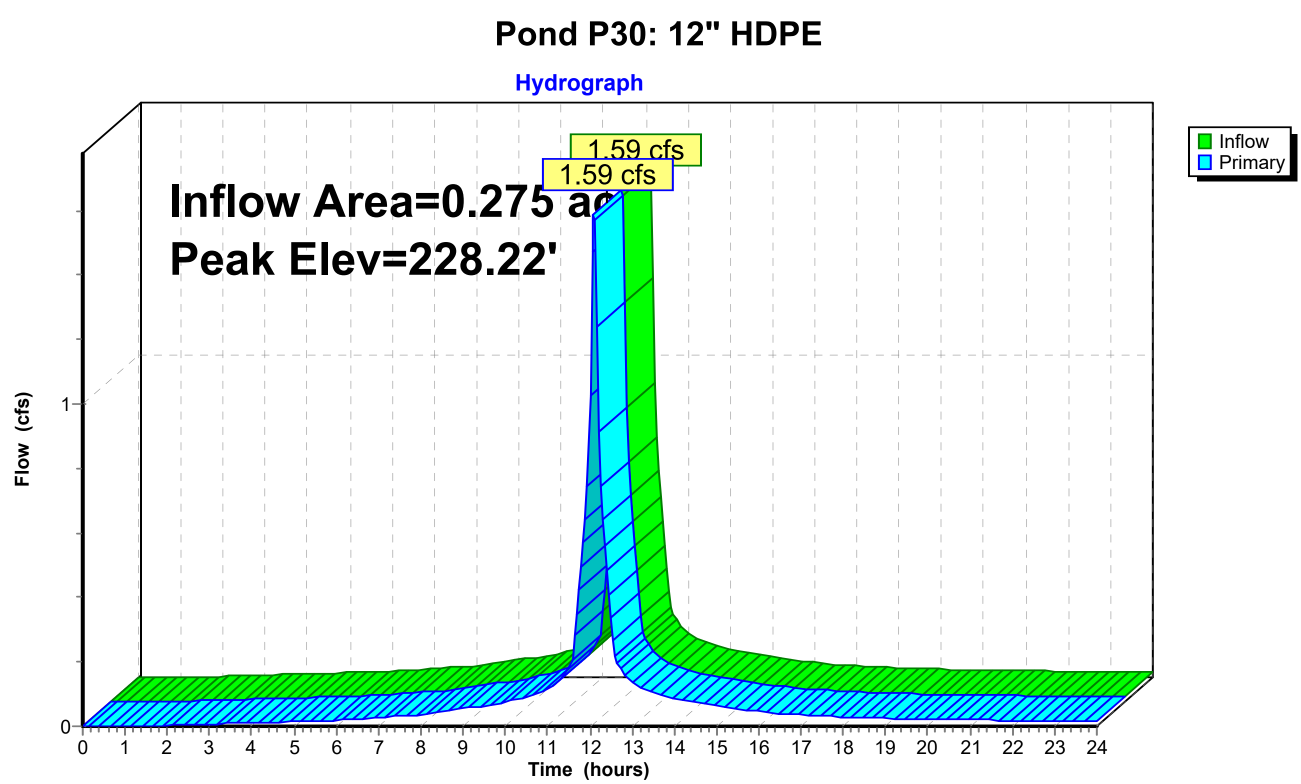
Summary for Pond P30: 12" HDPE

Inflow Area = 0.275 ac, 92.38% Impervious, Inflow Depth > 5.63" for 25-year 24hr event
Inflow = 1.59 cfs @ 12.09 hrs, Volume= 0.129 af
Outflow = 1.59 cfs @ 12.09 hrs, Volume= 0.129 af, Atten= 0%, Lag= 0.0 min
Primary = 1.59 cfs @ 12.09 hrs, Volume= 0.129 af
Routed to Pond D27 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 228.22' @ 12.09 hrs
Flood Elev= 228.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	224.60'	**12.0" Round Culvert** L= 180.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 224.60' / 222.80' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	228.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=1.53 cfs @ 12.09 hrs HW=228.21' (Free Discharge)
└─**1=Culvert** (Passes 1.53 cfs of 4.95 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 1.53 cfs @ 1.11 fps)



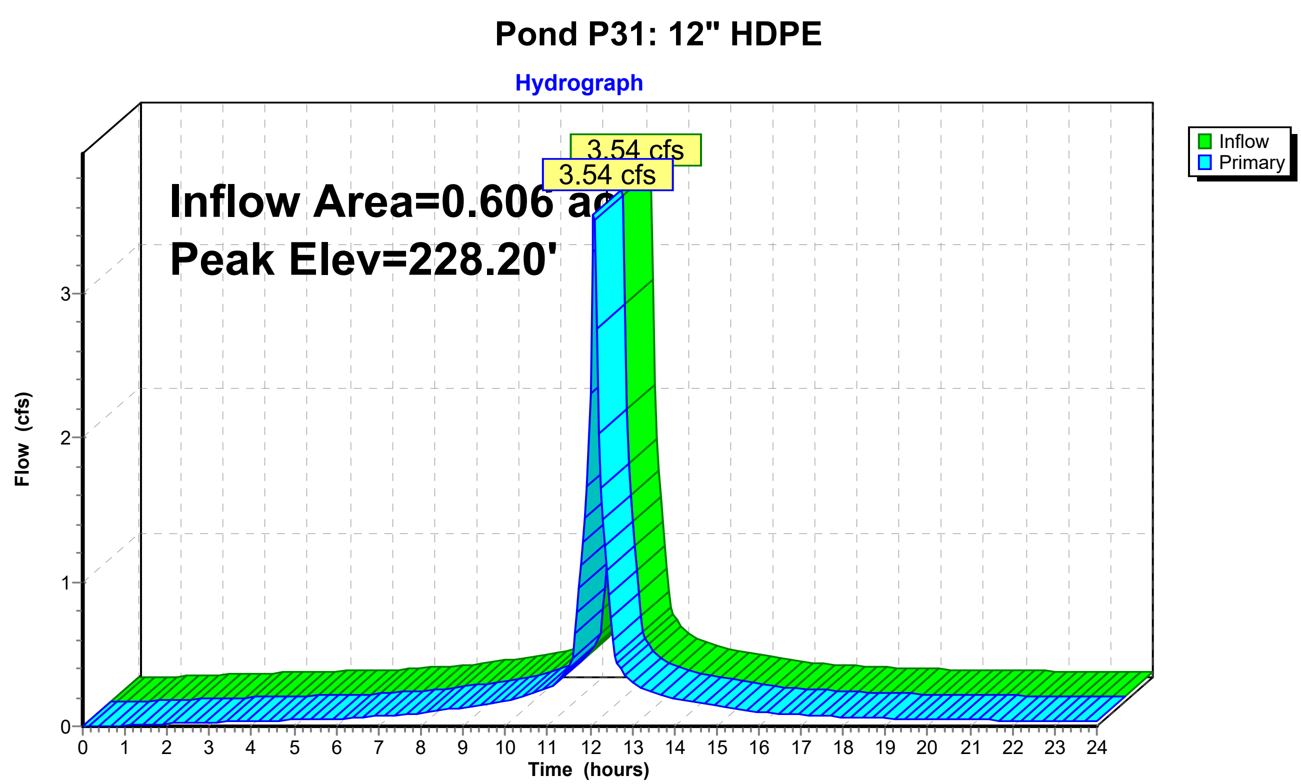
Summary for Pond P31: 12" HDPE

Inflow Area = 0.606 ac, 97.98% Impervious, Inflow Depth > 5.87" for 25-year 24hr event
Inflow = 3.54 cfs @ 12.09 hrs, Volume= 0.296 af
Outflow = 3.54 cfs @ 12.09 hrs, Volume= 0.296 af, Atten= 0%, Lag= 0.0 min
Primary = 3.54 cfs @ 12.09 hrs, Volume= 0.296 af
Routed to Pond D27 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 228.20' @ 12.09 hrs
Flood Elev= 223.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	223.00'	**12.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 223.00' / 222.90' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	228.00'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=3.44 cfs @ 12.09 hrs HW=228.20' (Free Discharge)
└─**1=Culvert** (Passes 3.44 cfs of 8.20 cfs potential flow)
└─**2=Orifice/Grate** (Weir Controls 3.44 cfs @ 1.45 fps)



Summary for Pond P32: 12" HDPE

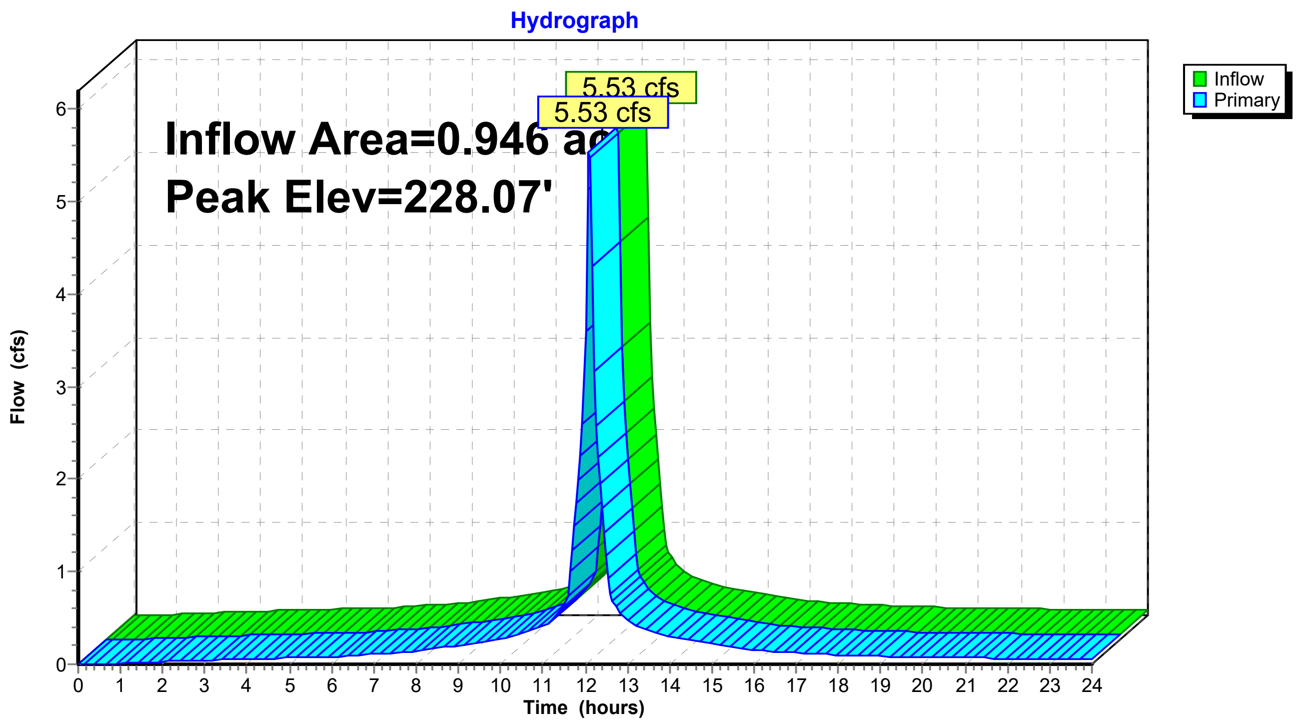
Inflow Area = 0.946 ac, 98.52% Impervious, Inflow Depth > 5.87" for 25-year 24hr event
Inflow = 5.53 cfs @ 12.09 hrs, Volume= 0.463 af
Outflow = 5.53 cfs @ 12.09 hrs, Volume= 0.463 af, Atten= 0%, Lag= 0.0 min
Primary = 5.53 cfs @ 12.09 hrs, Volume= 0.463 af
Routed to Pond D27 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 228.07' @ 12.09 hrs
Flood Elev= 228.30'

Device	Routing	Invert	Outlet Devices
#1	Primary	223.80'	**12.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 223.80' / 222.80' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	227.80'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=5.37 cfs @ 12.09 hrs HW=228.07' (Free Discharge)
└─**1=Culvert** (Passes 5.37 cfs of 6.04 cfs potential flow)
└─**2=Orifice/Grate** (Weir Controls 5.37 cfs @ 1.69 fps)

Pond P32: 12" HDPE



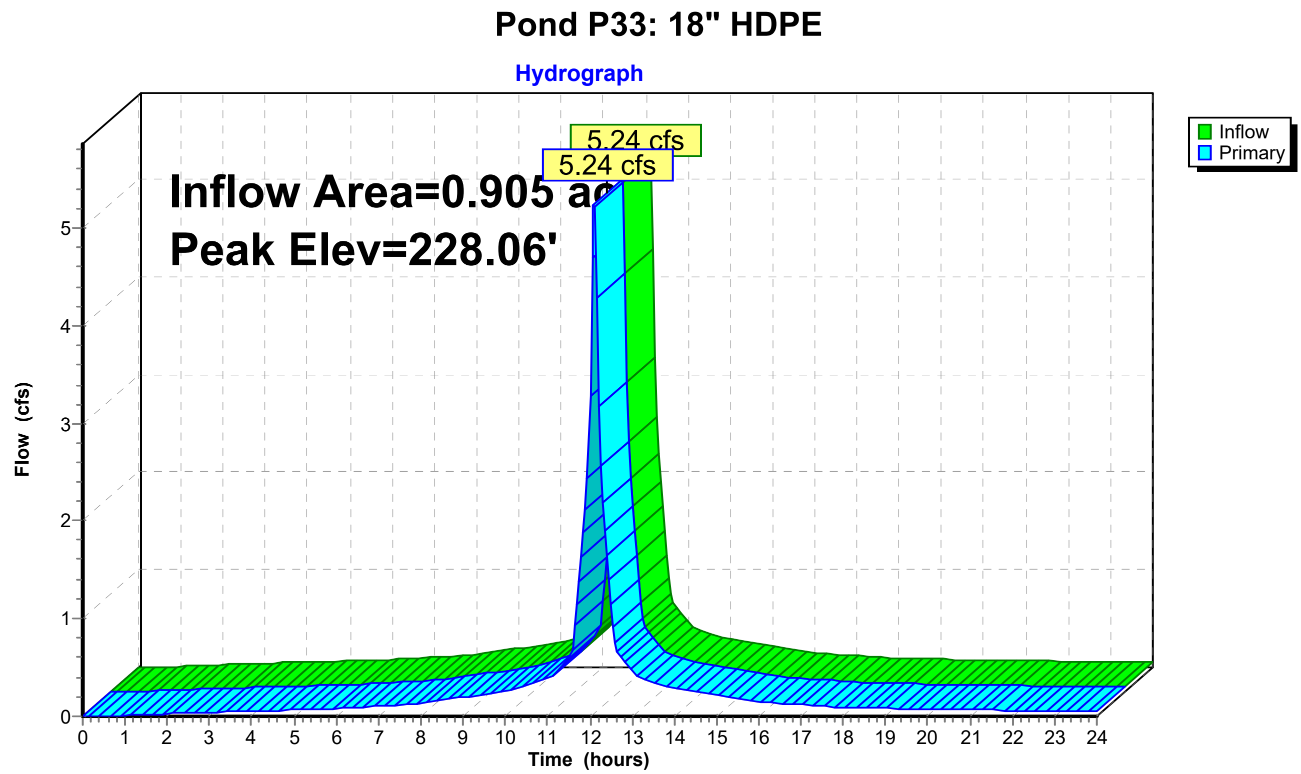
Summary for Pond P33: 18" HDPE

Inflow Area = 0.905 ac, 99.31% Impervious, Inflow Depth > 5.87" for 25-year 24hr event
Inflow = 5.24 cfs @ 12.09 hrs, Volume= 0.443 af
Outflow = 5.24 cfs @ 12.09 hrs, Volume= 0.443 af, Atten= 0%, Lag= 0.0 min
Primary = 5.24 cfs @ 12.09 hrs, Volume= 0.443 af
Routed to Pond D30 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 228.06' @ 12.09 hrs
Flood Elev= 228.30'

Device	Routing	Invert	Outlet Devices
#1	Primary	222.80'	**18.0" Round Culvert** L= 198.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 222.80' / 219.00' S= 0.0192 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	227.80'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=5.12 cfs @ 12.09 hrs HW=228.06' (Free Discharge)
└─**1=Culvert** (Passes 5.12 cfs of 17.23 cfs potential flow)
└─**2=Orifice/Grate** (Weir Controls 5.12 cfs @ 1.66 fps)



Summary for Pond P34: 18" HDPE

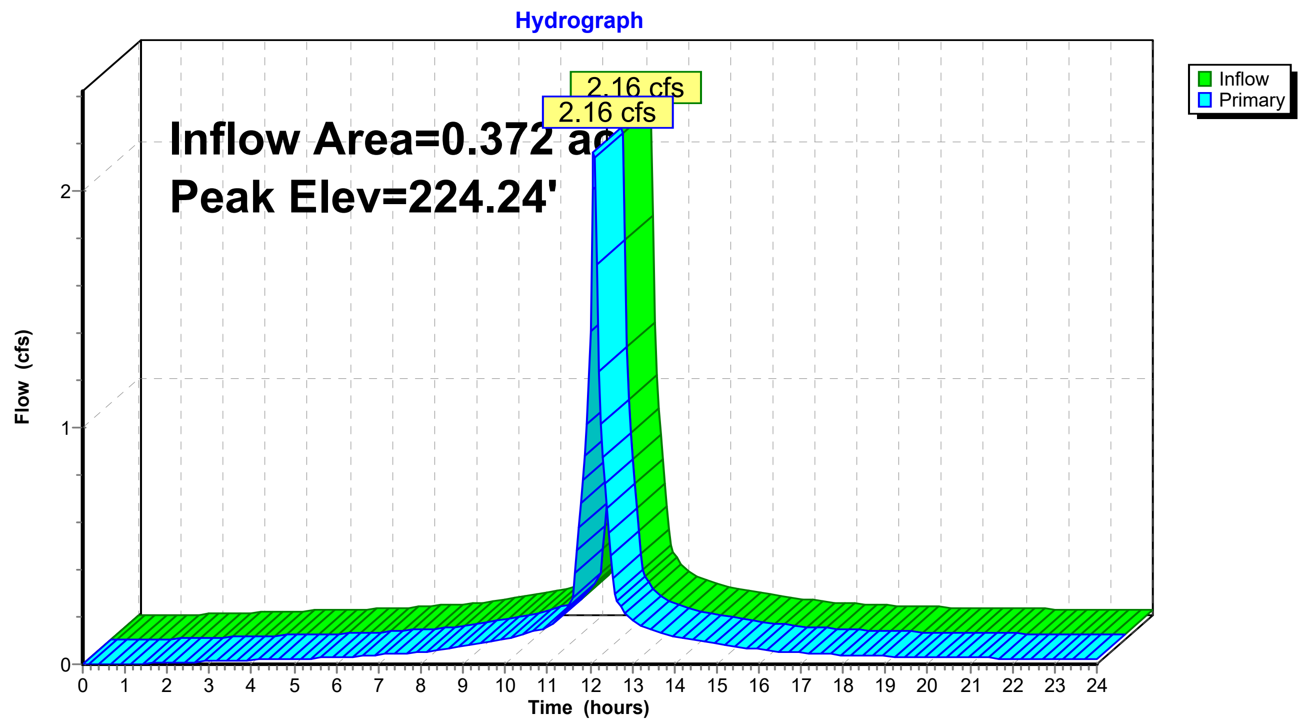
Inflow Area = 0.372 ac, 97.73% Impervious, Inflow Depth > 5.75" for 25-year 24hr event
Inflow = 2.16 cfs @ 12.09 hrs, Volume= 0.178 af
Outflow = 2.16 cfs @ 12.09 hrs, Volume= 0.178 af, Atten= 0%, Lag= 0.0 min
Primary = 2.16 cfs @ 12.09 hrs, Volume= 0.178 af
Routed to Pond D30 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 224.24' @ 12.09 hrs
Flood Elev= 224.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	219.10'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 219.10' / 219.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	224.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=2.07 cfs @ 12.09 hrs HW=224.24' (Free Discharge)
└─**1=Culvert** (Passes 2.07 cfs of 17.83 cfs potential flow)
 └─**2=Orifice/Grate** (Weir Controls 2.07 cfs @ 1.23 fps)

Pond P34: 18" HDPE



Summary for Pond P35: 18" HDPE

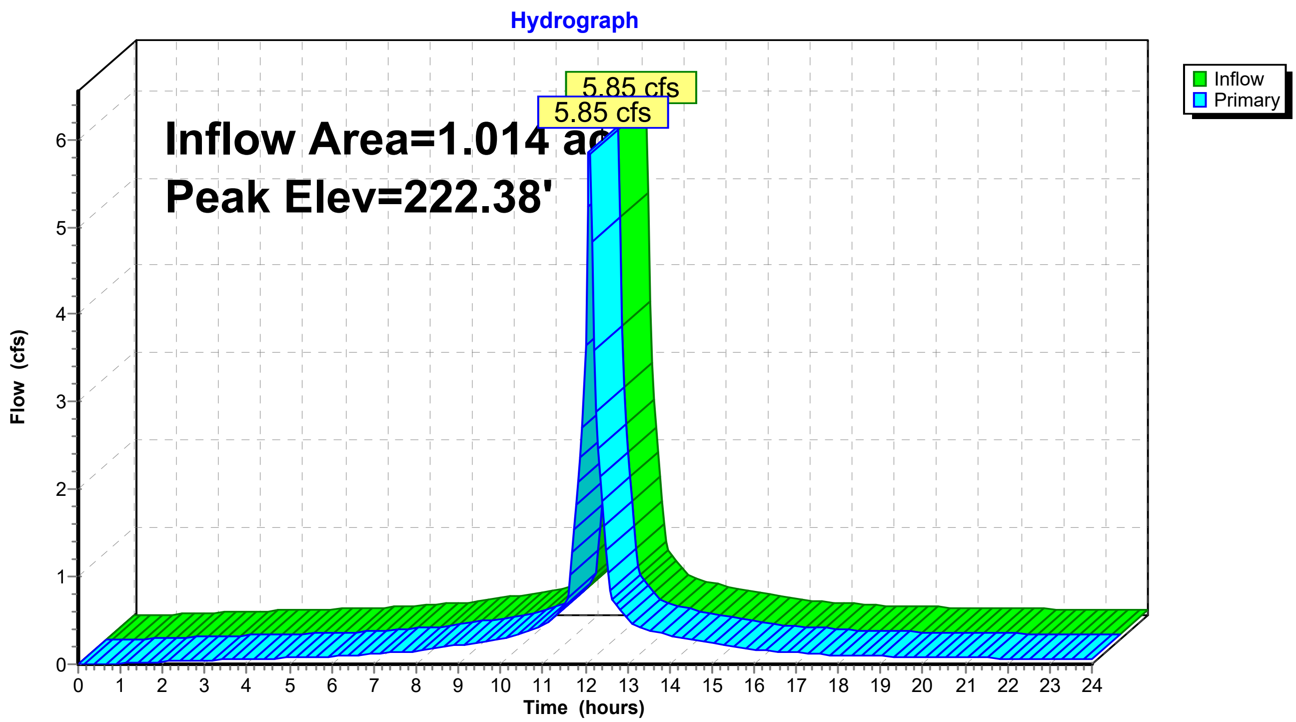
Inflow Area = 1.014 ac, 99.30% Impervious, Inflow Depth > 5.87" for 25-year 24hr event
Inflow = 5.85 cfs @ 12.09 hrs, Volume= 0.496 af
Outflow = 5.85 cfs @ 12.09 hrs, Volume= 0.496 af, Atten= 0%, Lag= 0.0 min
Primary = 5.85 cfs @ 12.09 hrs, Volume= 0.496 af
Routed to Pond D31 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 222.38' @ 12.09 hrs
Flood Elev= 222.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	217.10'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 217.10' / 217.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	222.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=5.76 cfs @ 12.09 hrs HW=222.38' (Free Discharge)
└─**1=Culvert** (Passes 5.76 cfs of 18.11 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 5.76 cfs @ 1.73 fps)

Pond P35: 18" HDPE



Summary for Pond P36: 18" HDPE

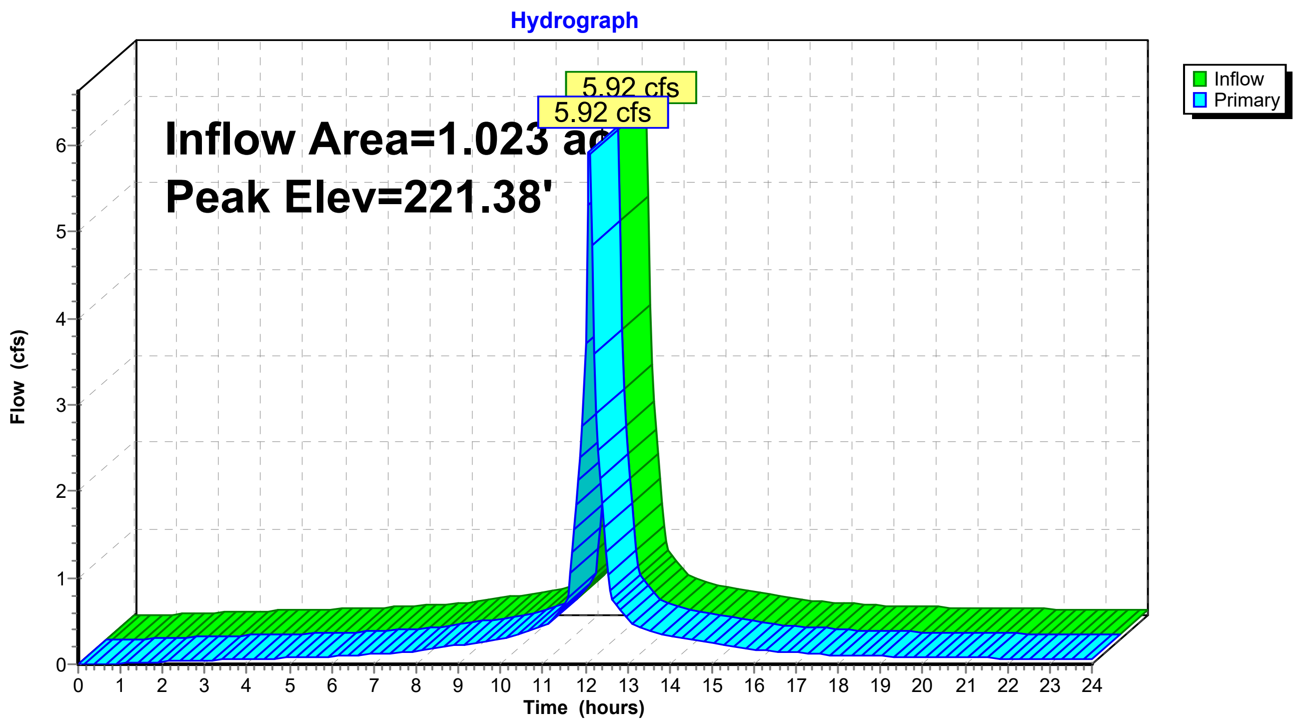
Inflow Area = 1.023 ac, 99.15% Impervious, Inflow Depth > 5.87" for 25-year 24hr event
Inflow = 5.92 cfs @ 12.09 hrs, Volume= 0.500 af
Outflow = 5.92 cfs @ 12.09 hrs, Volume= 0.500 af, Atten= 0%, Lag= 0.0 min
Primary = 5.92 cfs @ 12.09 hrs, Volume= 0.500 af
Routed to Pond D32 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 221.38' @ 12.09 hrs
Flood Elev= 221.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	216.10'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 216.10' / 216.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	221.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=5.81 cfs @ 12.09 hrs HW=221.38' (Free Discharge)
└─**1=Culvert** (Passes 5.81 cfs of 18.11 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 5.81 cfs @ 1.73 fps)

Pond P36: 18" HDPE



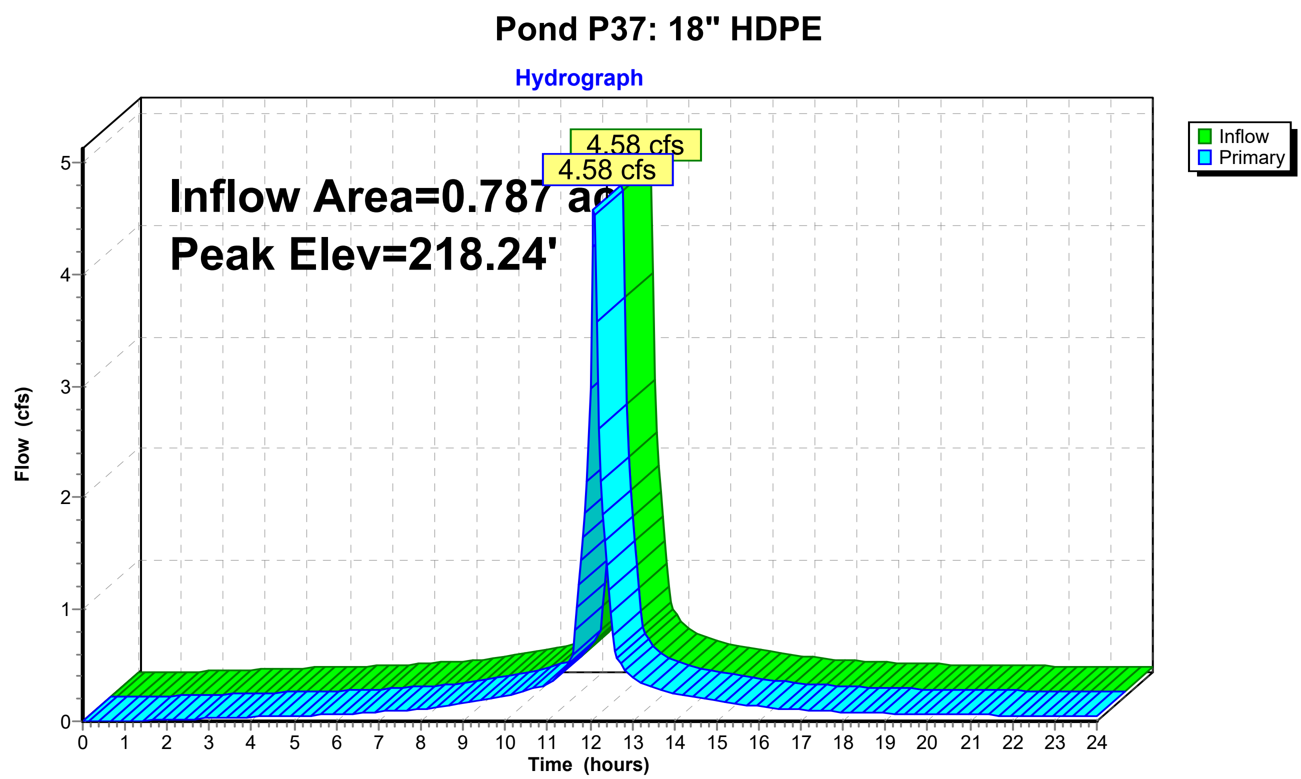
Summary for Pond P37: 18" HDPE

Inflow Area = 0.787 ac, 97.66% Impervious, Inflow Depth > 5.75" for 25-year 24hr event
Inflow = 4.58 cfs @ 12.09 hrs, Volume= 0.377 af
Outflow = 4.58 cfs @ 12.09 hrs, Volume= 0.377 af, Atten= 0%, Lag= 0.0 min
Primary = 4.58 cfs @ 12.09 hrs, Volume= 0.377 af
Routed to Pond D33 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 218.24' @ 12.09 hrs
Flood Elev= 218.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	213.00'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 213.00' / 212.90' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	218.00'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=4.44 cfs @ 12.09 hrs HW=218.23' (Free Discharge)
└─**1=Culvert** (Passes 4.44 cfs of 18.02 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 4.44 cfs @ 1.58 fps)



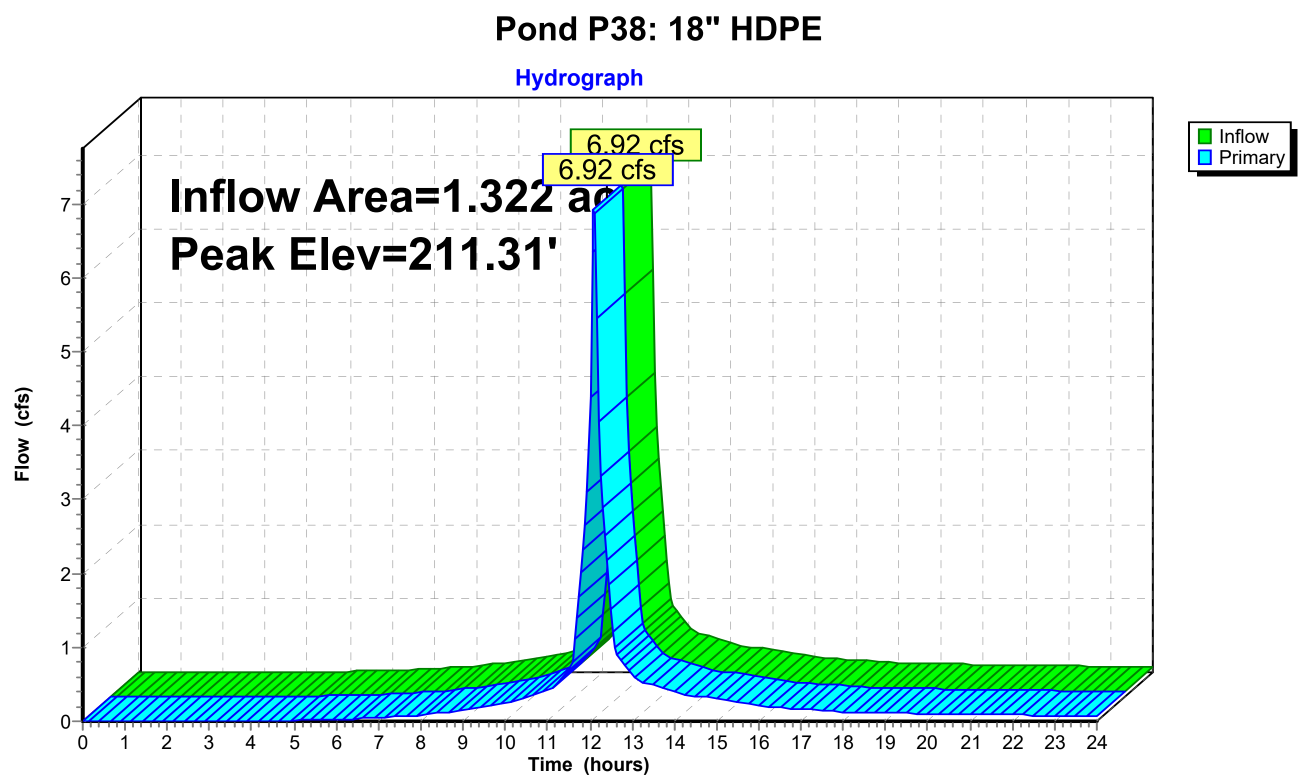
Summary for Pond P38: 18" HDPE

Inflow Area = 1.322 ac, 57.38% Impervious, Inflow Depth > 4.73" for 25-year 24hr event
Inflow = 6.92 cfs @ 12.09 hrs, Volume= 0.521 af
Outflow = 6.92 cfs @ 12.09 hrs, Volume= 0.521 af, Atten= 0%, Lag= 0.0 min
Primary = 6.92 cfs @ 12.09 hrs, Volume= 0.521 af
Routed to Pond F1 : Forebay

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 211.31' @ 12.09 hrs
Flood Elev= 211.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	207.80'	**18.0" Round Culvert** L= 80.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 207.80' / 207.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	211.00'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

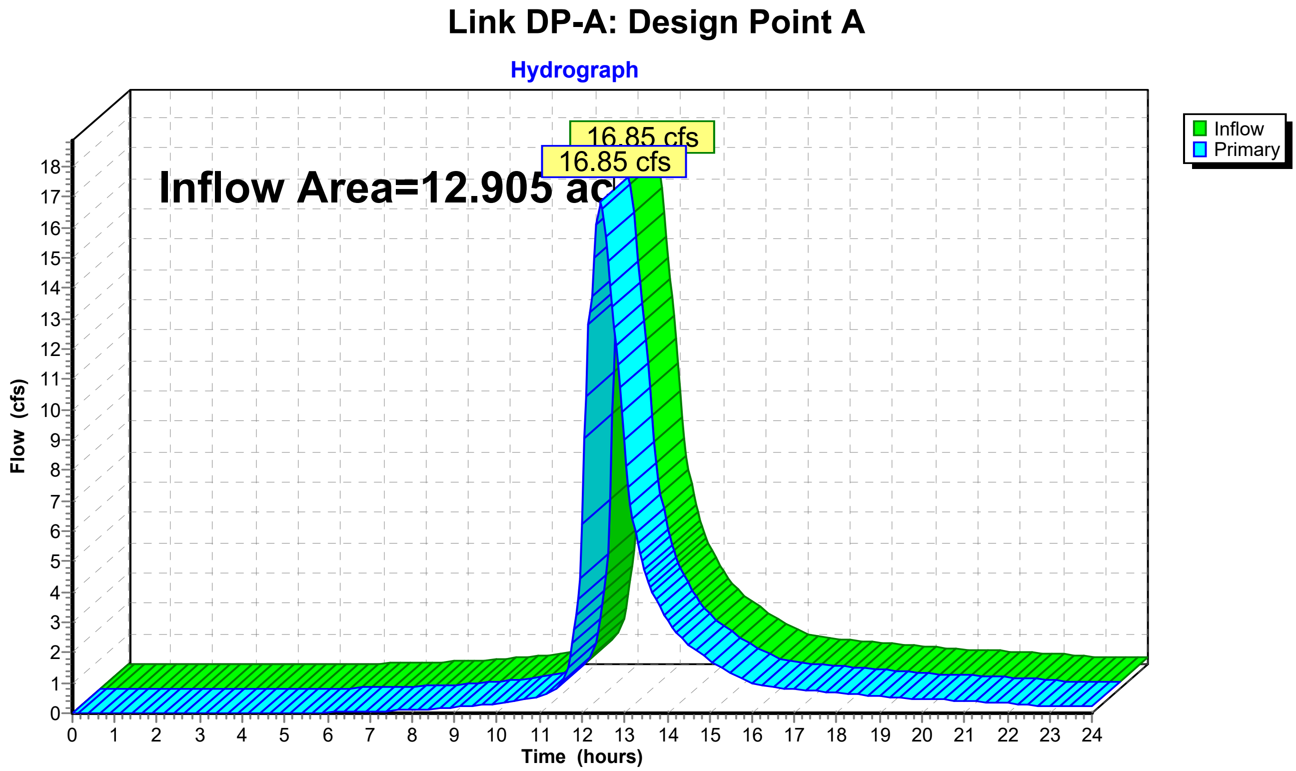
Primary OutFlow Max=6.74 cfs @ 12.09 hrs HW=211.31' (Free Discharge)
└─**1=Culvert** (Passes 6.74 cfs of 13.81 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 6.74 cfs @ 1.82 fps)



Summary for Link DP-A: Design Point A

Inflow Area = 12.905 ac, 73.65% Impervious, Inflow Depth > 2.18" for 25-year 24hr event
Inflow = 16.85 cfs @ 12.44 hrs, Volume= 2.348 af
Primary = 16.85 cfs @ 12.44 hrs, Volume= 2.348 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

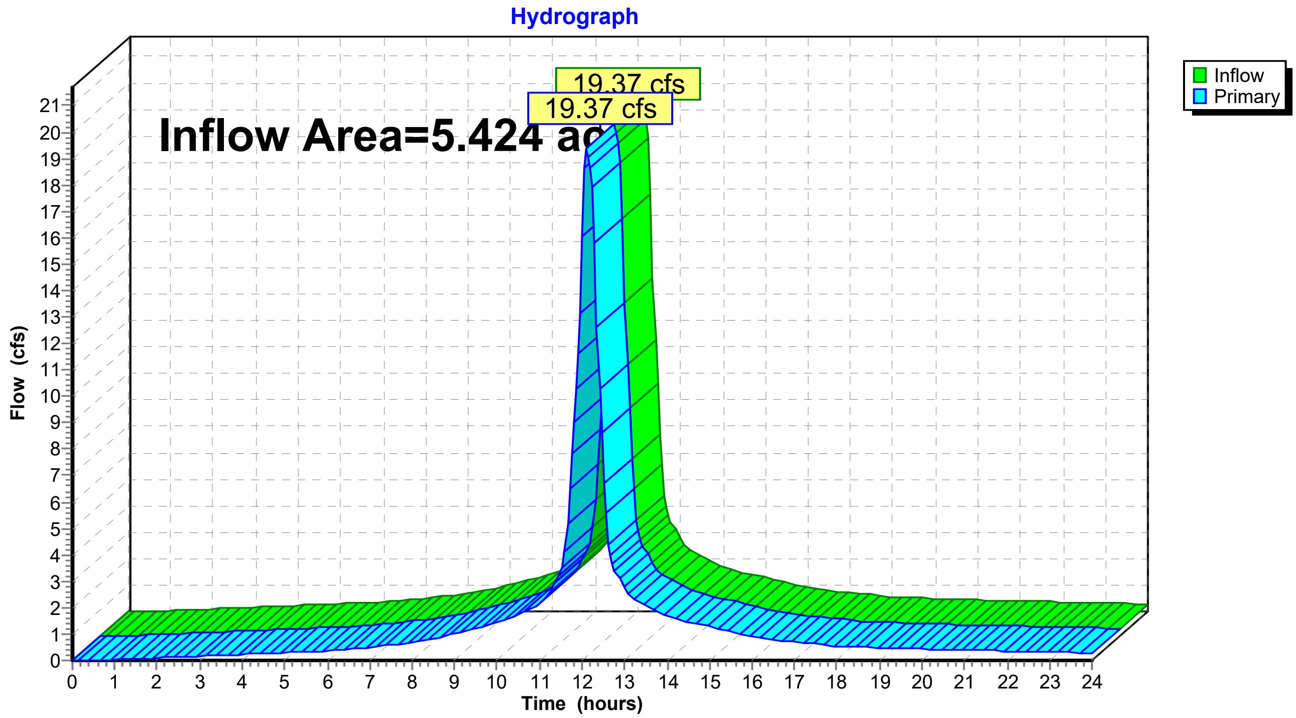


Summary for Link WQU-P5: Water Quality Unit

Inflow Area = 5.424 ac, 88.71% Impervious, Inflow Depth > 5.35" for 25-year 24hr event
Inflow = 19.37 cfs @ 12.11 hrs, Volume= 2.420 af
Primary = 19.37 cfs @ 12.11 hrs, Volume= 2.420 af, Atten= 0%, Lag= 0.0 min
Routed to Pond P1a : Proposed Basin

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

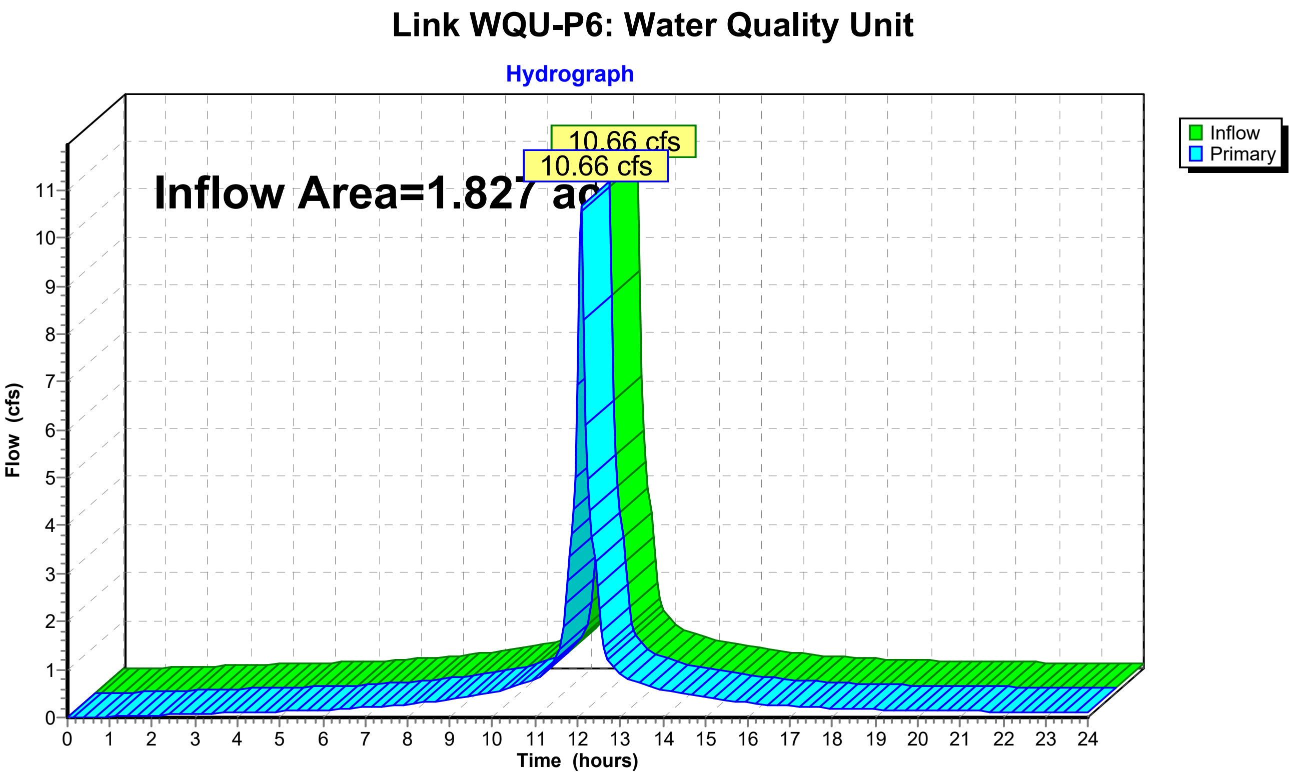
Link WQU-P5: Water Quality Unit



Summary for Link WQU-P6: Water Quality Unit

Inflow Area = 1.827 ac, 97.42% Impervious, Inflow Depth > 5.83" for 25-year 24hr event
Inflow = 10.66 cfs @ 12.09 hrs, Volume= 0.888 af
Primary = 10.66 cfs @ 12.09 hrs, Volume= 0.888 af, Atten= 0%, Lag= 0.0 min
Routed to Pond CMB : Underground Storage Chambers

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



Summary for Subcatchment P-A1:

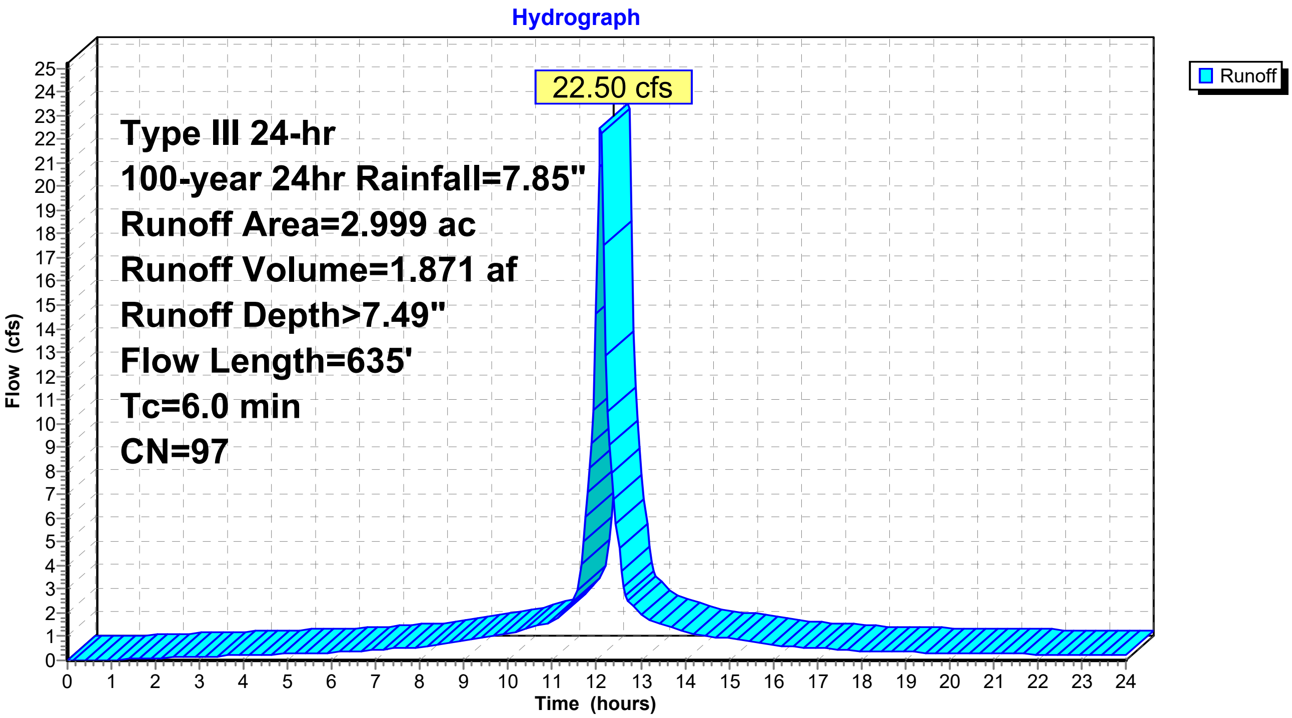
Runoff = 22.50 cfs @ 12.09 hrs, Volume= 1.871 af, Depth> 7.49"
Routed to Pond CMB : Underground Storage Chambers

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
1.360	98	EX Gravel Surface, Impervious, HSG C
0.003	98	PR Gravel Surface, Impervious, HSG C
0.043	98	PR Gravel Surface, Impervious, HSG C
0.007	98	PR Gravel Surface, Impervious, HSG C
0.933	98	Roofs, HSG C
0.050	98	Paved parking, HSG C
0.457	98	Paved parking, HSG C
0.069	74	>75% Grass cover, Good, HSG C
0.078	74	>75% Grass cover, Good, HSG C
2.999	97	Weighted Average
0.147		4.89% Pervious Area
2.852		95.11% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.19"
3.5	300	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.0	285	0.0060	4.60	8.14	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
5.7	635	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A1:



Summary for Subcatchment P-A2a:

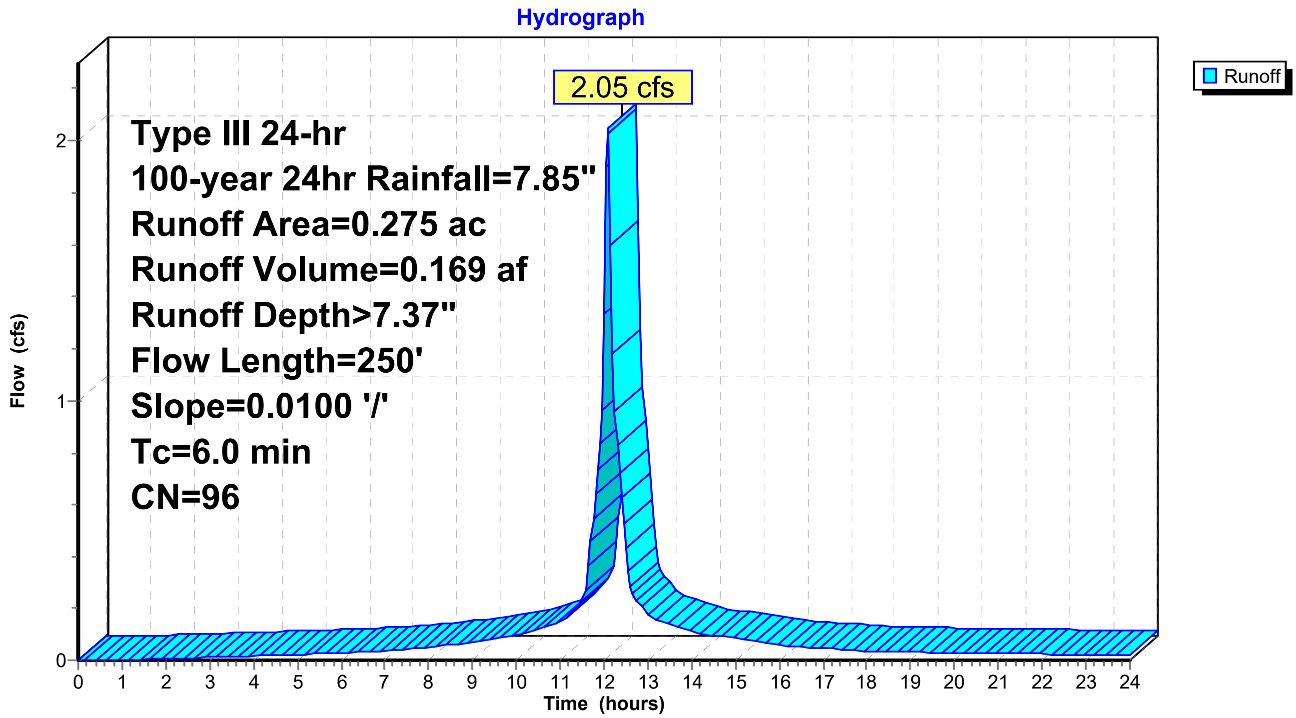
Runoff = 2.05 cfs @ 12.09 hrs, Volume= 0.169 af, Depth> 7.37"
Routed to Pond P30 : 12" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
0.021	74	>75% Grass cover, Good, HSG C
0.016	98	EX Gravel Surface, Impervious, HSG C
0.238	98	PR Gravel Surface, Impervious, HSG C
0.275	96	Weighted Average
0.021		7.62% Pervious Area
0.254		92.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
2.1	200	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.2	250	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A2a:



Summary for Subcatchment P-A2b:

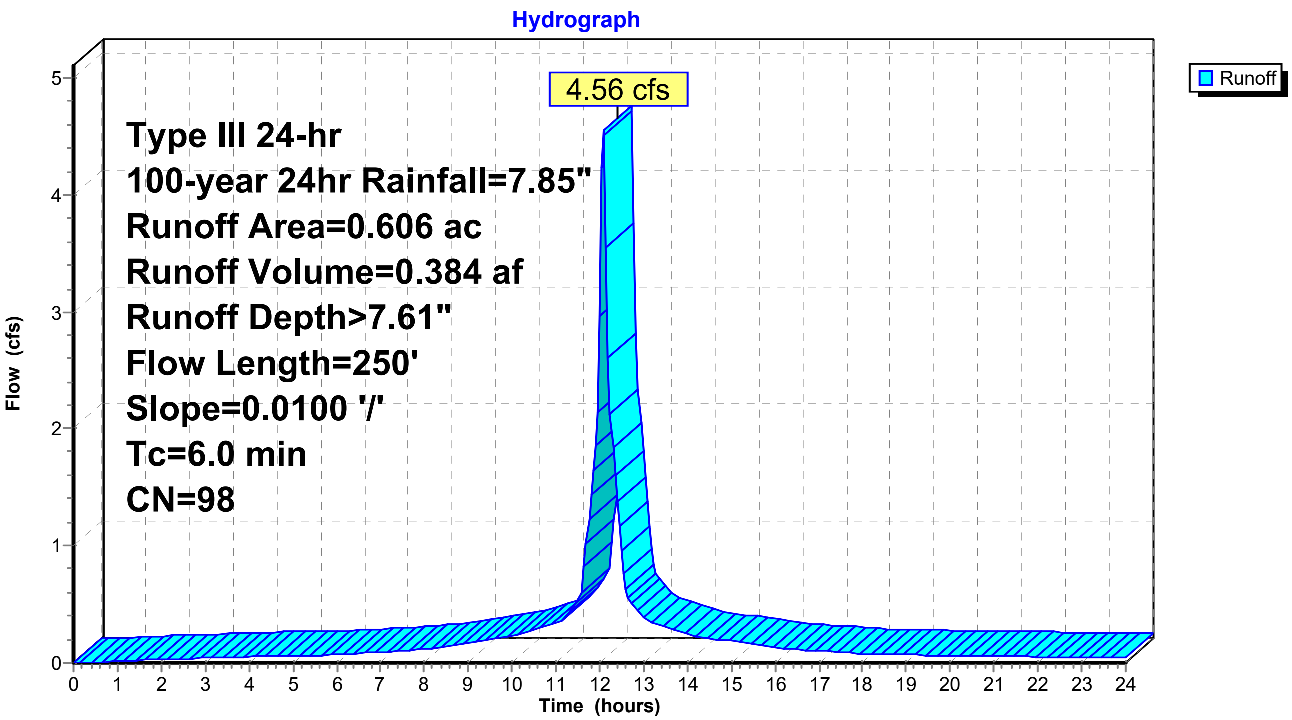
Runoff = 4.56 cfs @ 12.09 hrs, Volume= 0.384 af, Depth> 7.61"
Routed to Pond P31 : 12" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
0.330	98	PR Gravel Surface, Impervious, HSG C
0.016	98	PR Gravel Surface, Impervious, HSG C
0.247	98	EX Gravel Surface, Impervious, HSG C
0.007	74	>75% Grass cover, Good, HSG C
0.005	74	>75% Grass cover, Good, HSG C
0.606	98	Weighted Average
0.012		2.02% Pervious Area
0.594		97.98% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
2.1	200	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
5.2	250	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A2b:



Summary for Subcatchment P-A2c:

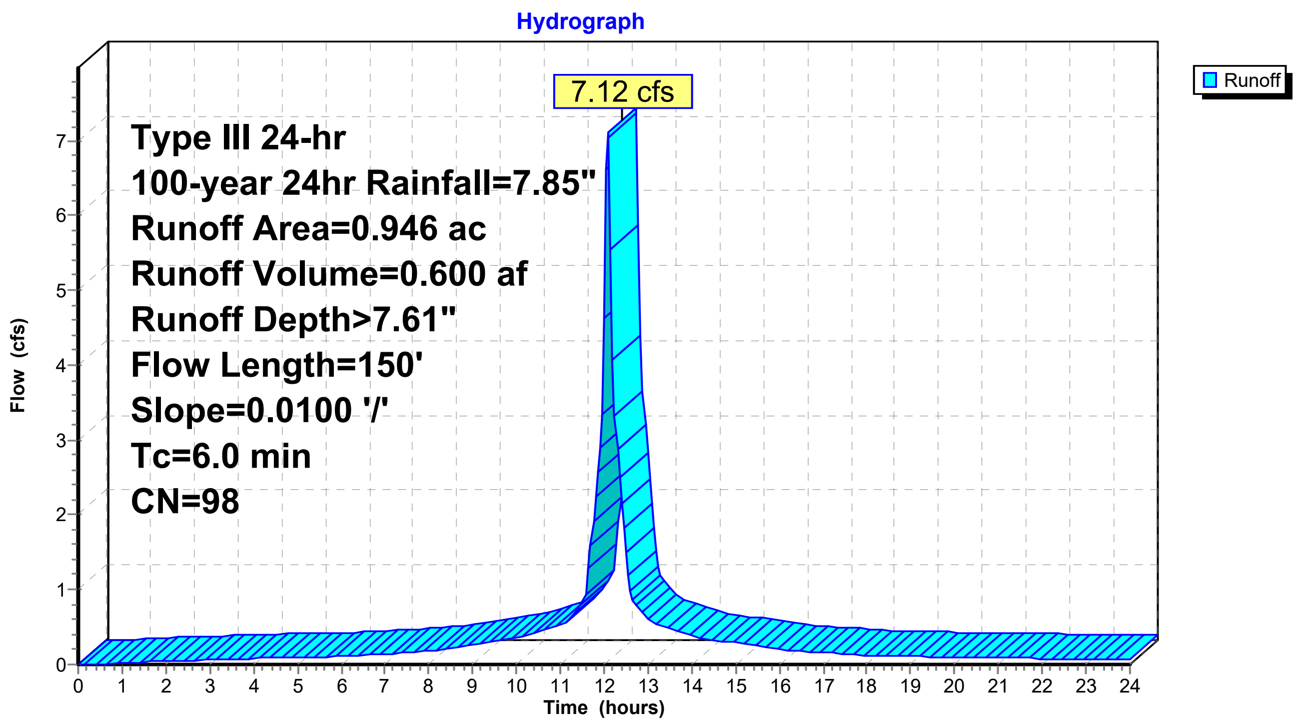
Runoff = 7.12 cfs @ 12.09 hrs, Volume= 0.600 af, Depth> 7.61"
Routed to Pond P32 : 12" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
0.284	98	EX Gravel Surface, Impervious, HSG C
0.648	98	PR Gravel Surface, Impervious, HSG C
0.006	74	>75% Grass cover, Good, HSG C
0.008	74	>75% Grass cover, Good, HSG C
0.946	98	Weighted Average
0.014		1.48% Pervious Area
0.932		98.52% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.0	100	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.1	150	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A2c:



Summary for Subcatchment P-A3a:

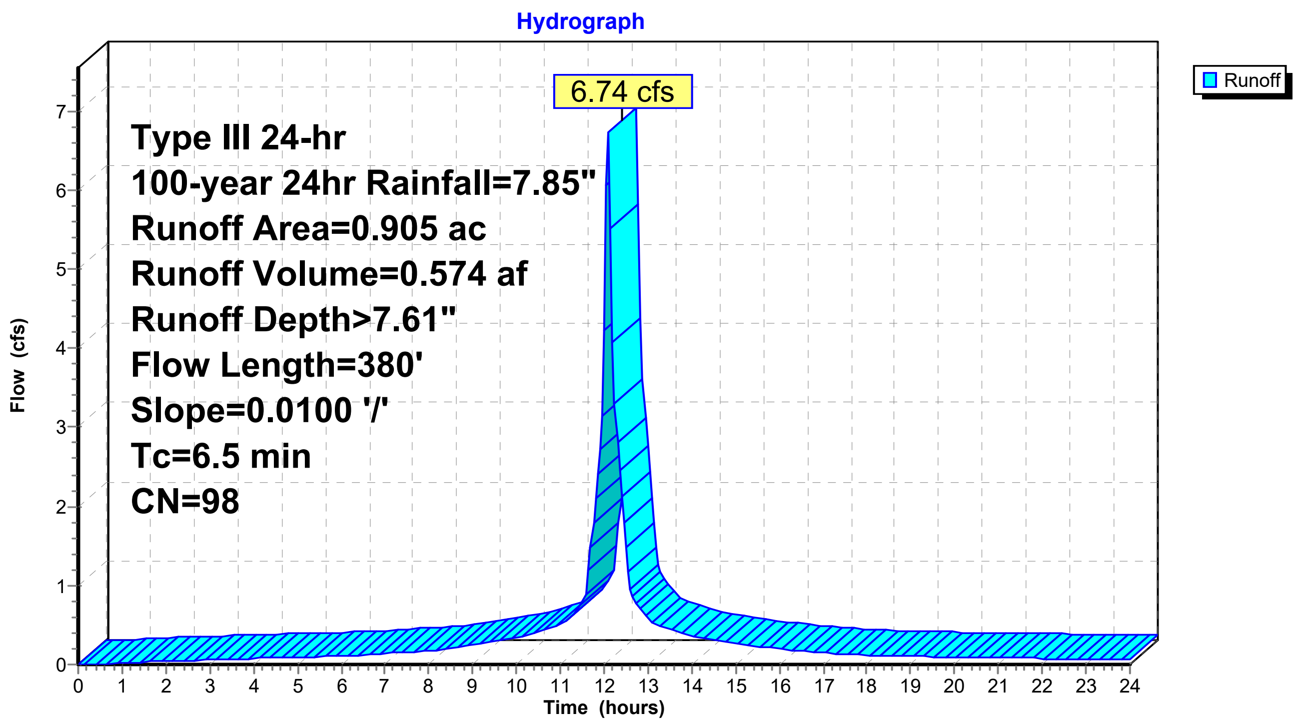
Runoff = 6.74 cfs @ 12.09 hrs, Volume= 0.574 af, Depth> 7.61"
Routed to Pond P33 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
0.805	98	PR Gravel Surface, Impervious, HSG C
0.094	98	EX Gravel Surface, Impervious, HSG C
0.006	74	>75% Grass cover, Good, HSG C
0.000	74	>75% Grass cover, Good, HSG C
0.905	98	Weighted Average
0.006		0.69% Pervious Area
0.899		99.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
3.4	330	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.5	380	Total			

Subcatchment P-A3a:



Summary for Subcatchment P-A3b:

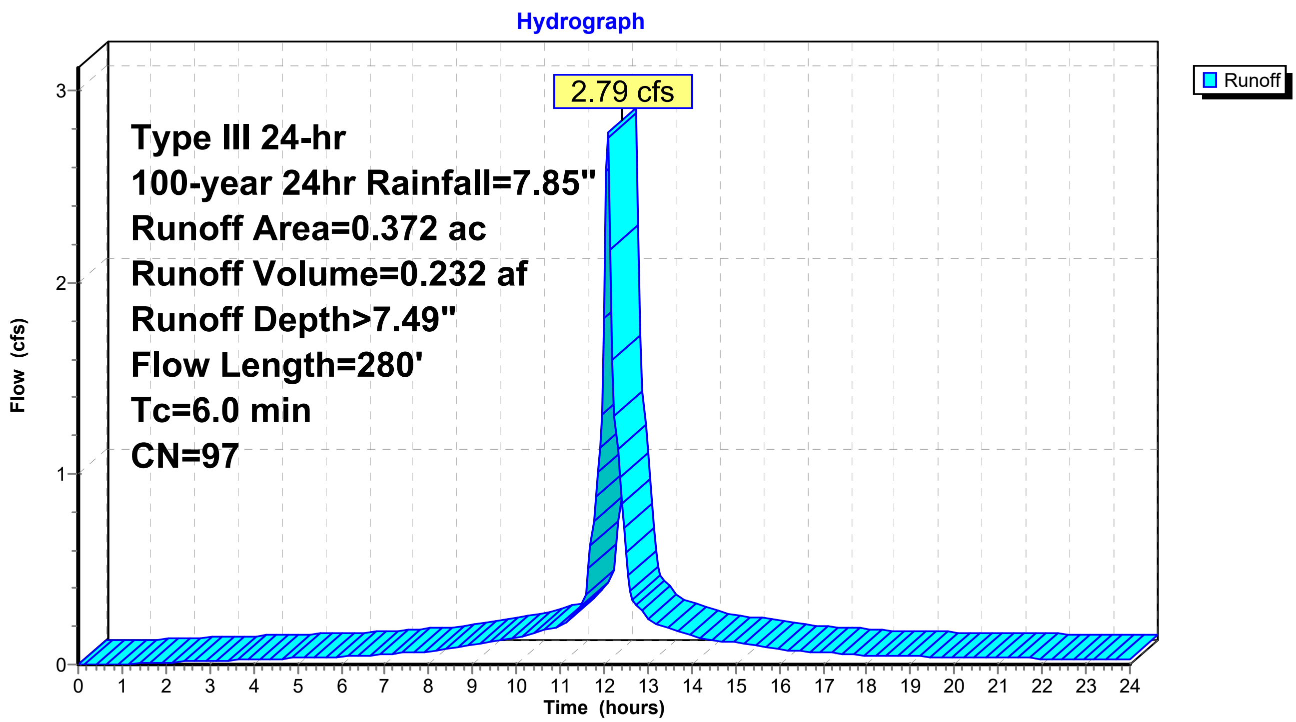
Runoff = 2.79 cfs @ 12.09 hrs, Volume= 0.232 af, Depth> 7.49"
Routed to Pond P34 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
0.008	74	>75% Grass cover, Good, HSG C
0.363	98	PR Gravel Surface, Impervious, HSG C
0.372	97	Weighted Average
0.008		2.27% Pervious Area
0.363		97.73% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.0	100	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	130	0.0300	2.79		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.9	280	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A3b:



Summary for Subcatchment P-A3c:

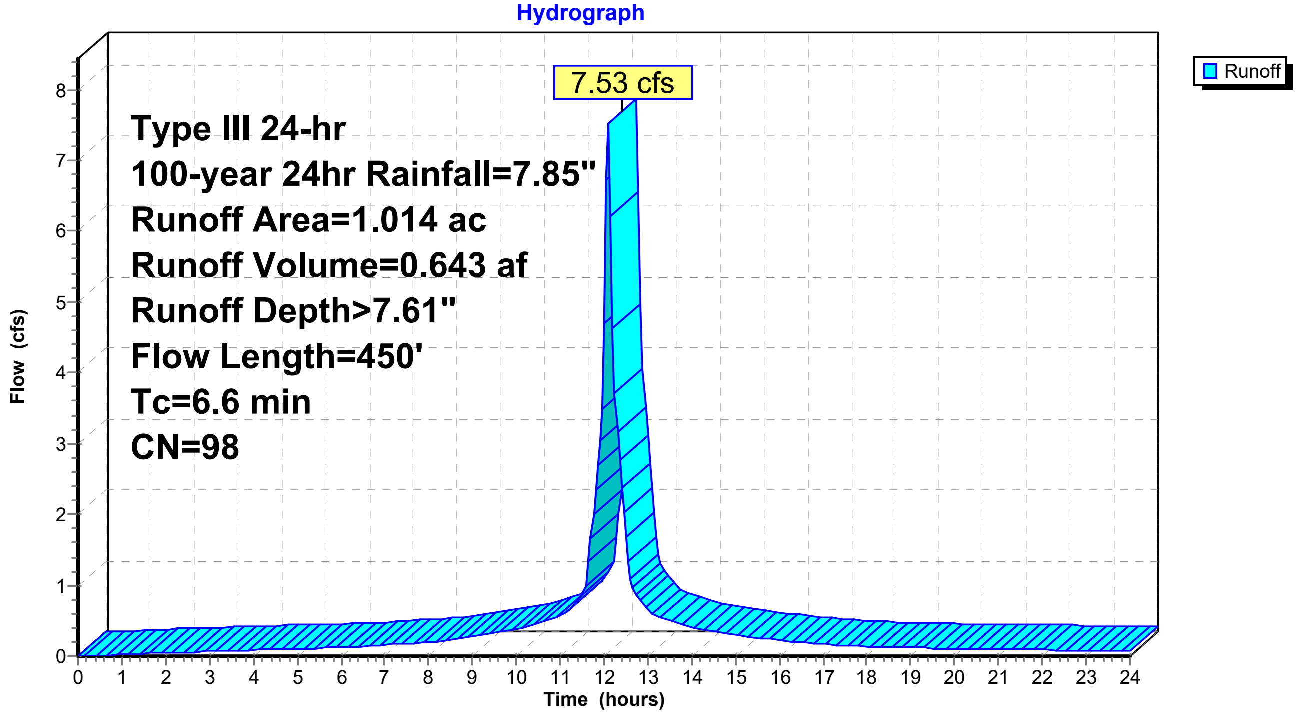
Runoff = 7.53 cfs @ 12.09 hrs, Volume= 0.643 af, Depth> 7.61"
Routed to Pond P35 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
0.007	74	>75% Grass cover, Good, HSG C
1.007	98	PR Gravel Surface, Impervious, HSG C
0.001	98	EX Gravel Surface, Impervious, HSG C
1.014	98	Weighted Average
0.007		0.70% Pervious Area
1.007		99.30% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
2.4	230	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.5	100	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	70	0.0150	1.97		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.6	450	Total			

Subcatchment P-A3c:



Summary for Subcatchment P-A3d:

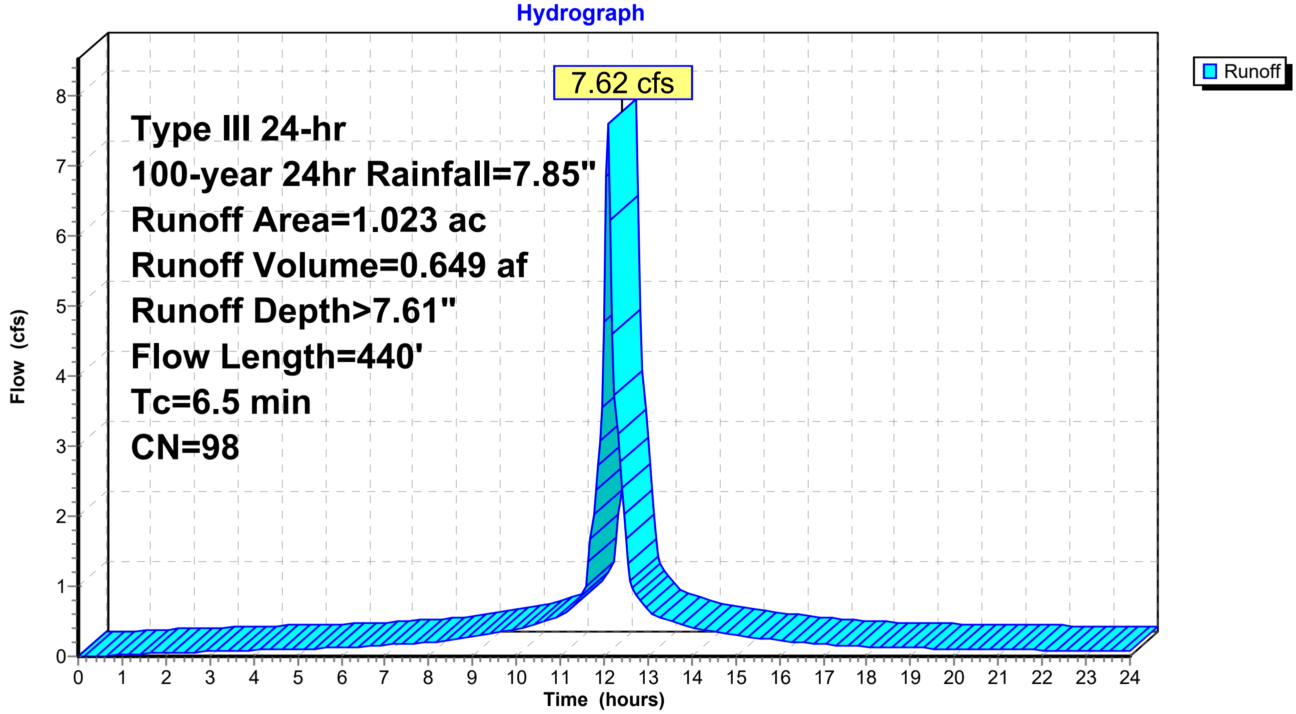
Runoff = 7.62 cfs @ 12.09 hrs, Volume= 0.649 af, Depth> 7.61"
Routed to Pond P36 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
0.004	74	>75% Grass cover, Good, HSG C
0.918	98	PR Gravel Surface, Impervious, HSG C
0.018	98	EX Gravel Surface, Impervious, HSG C
0.079	98	PR Gravel Surface, Impervious, HSG D
0.004	80	>75% Grass cover, Good, HSG D
1.023	98	Weighted Average
0.009		0.85% Pervious Area
1.015		99.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.1	110	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	120	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.7	160	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.5	440	Total			

Subcatchment P-A3d:



Summary for Subcatchment P-A3e:

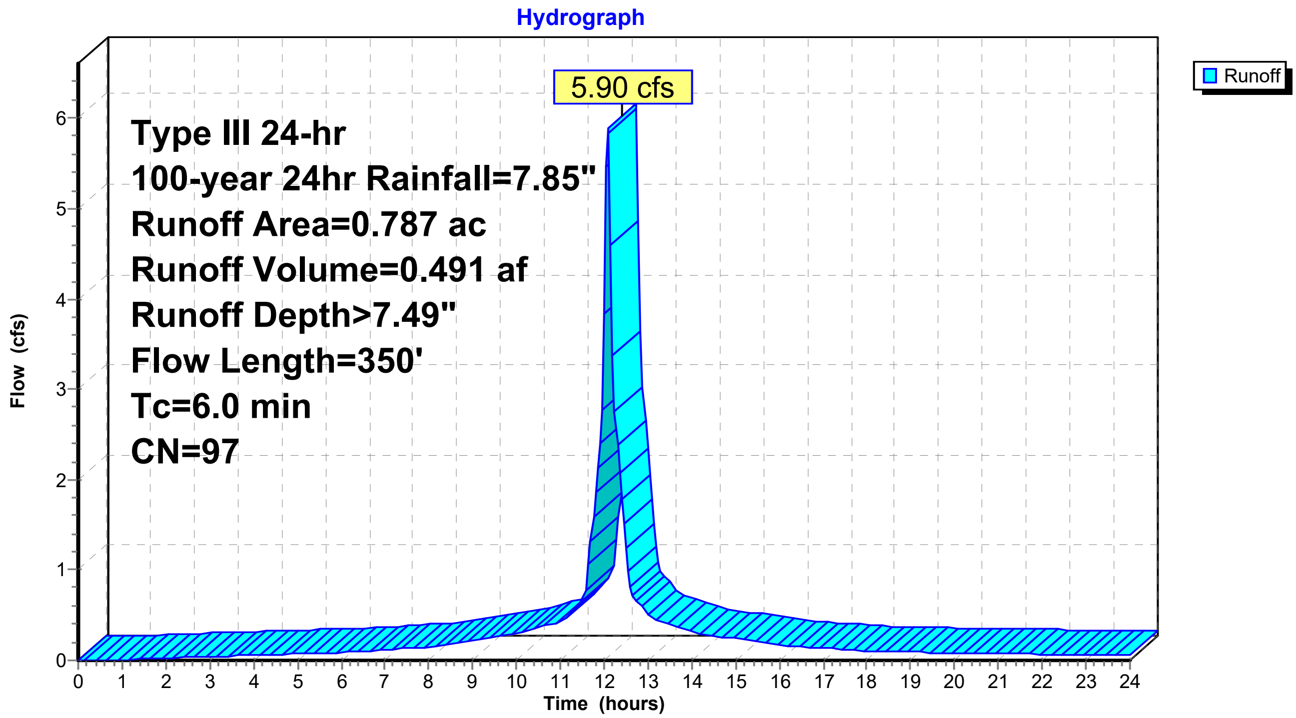
Runoff = 5.90 cfs @ 12.09 hrs, Volume= 0.491 af, Depth> 7.49"
Routed to Pond P37 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
0.031	98	EX Gravel Surface, Impervious, HSG C
0.669	98	PR Gravel Surface, Impervious, HSG C
0.012	74	>75% Grass cover, Good, HSG C
0.007	80	>75% Grass cover, Good, HSG D
0.068	98	PR Gravel Surface, Impervious, HSG D
0.787	97	Weighted Average
0.018		2.34% Pervious Area
0.768		97.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.1	50	0.0100	0.27		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
0.7	160	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.0	140	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
4.8	350	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A3e:



Summary for Subcatchment P-A4: Subcat P-A4

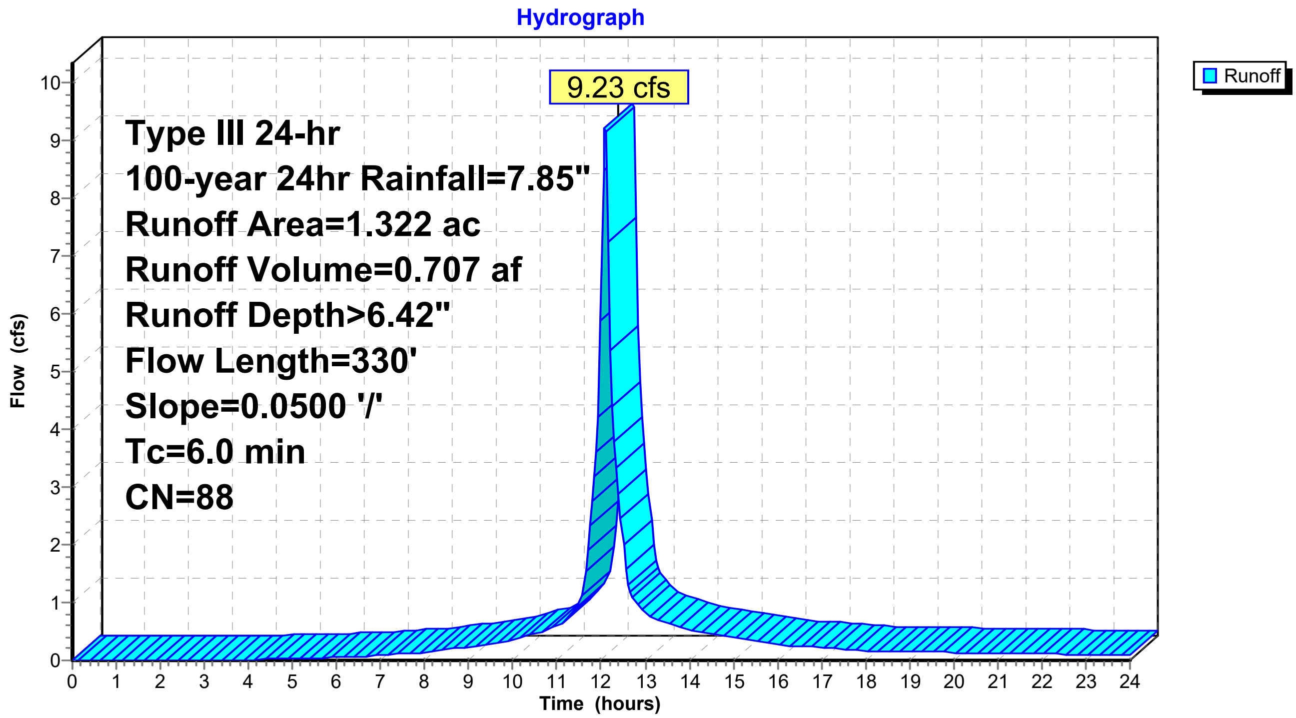
Runoff = 9.23 cfs @ 12.09 hrs, Volume= 0.707 af, Depth> 6.42"
Routed to Pond P38 : 18" HDPE

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
0.123	98	EX Gravel Surface, Impervious, HSG C
0.523	98	PR Gravel Surface, Impervious, HSG C
0.403	74	>75% Grass cover, Good, HSG C
0.001	74	>75% Grass cover, Good, HSG C
0.089	80	>75% Grass cover, Good, HSG D
0.071	80	>75% Grass cover, Good, HSG D
0.112	98	PR Gravel Surface, Impervious, HSG D
1.322	88	Weighted Average
0.564		42.62% Pervious Area
0.759		57.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	50	0.0500	0.51		**Sheet Flow,** Fallow n= 0.050 P2= 3.19"
1.3	280	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.9	330	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A4: Subcat P-A4



Summary for Subcatchment P-A5:

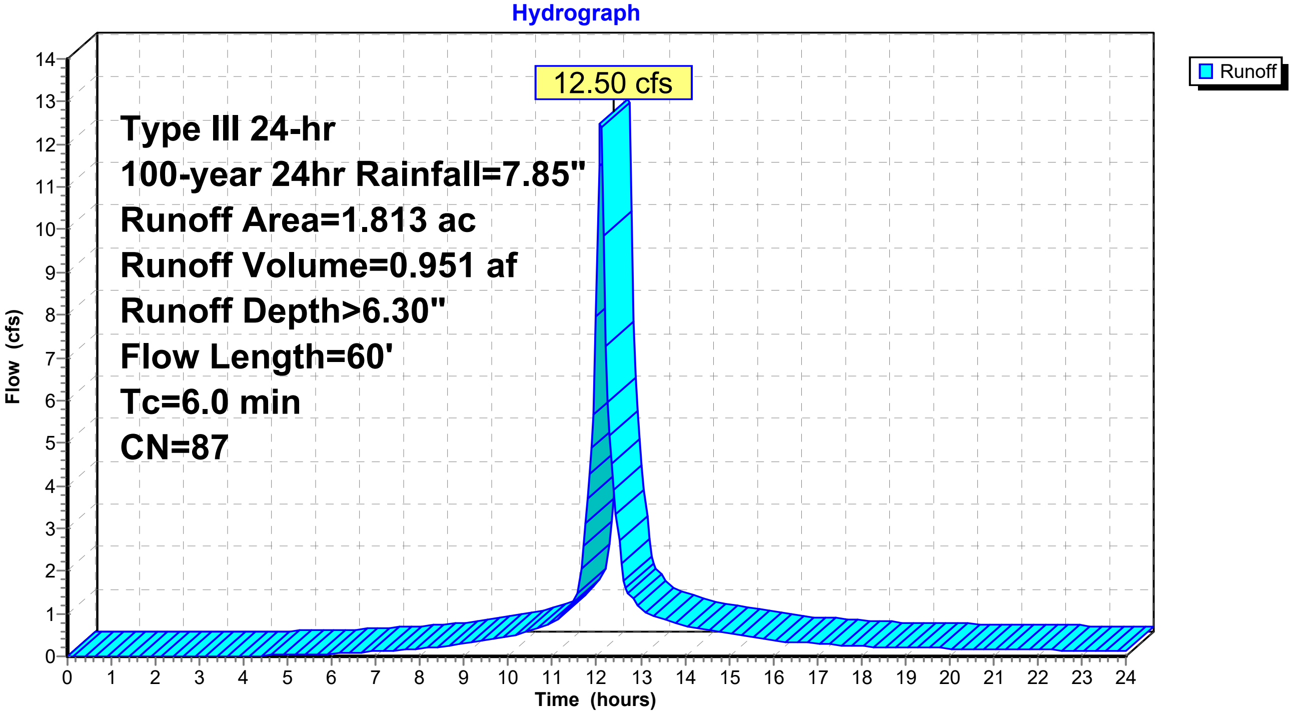
Runoff = 12.50 cfs @ 12.09 hrs, Volume= 0.951 af, Depth> 6.30"
Routed to Link DP-A : Design Point A

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
0.011	98	EX Gravel Surface, Impervious, HSG C
0.197	96	Gravel surface, HSG D
0.000	96	Gravel surface, HSG D
0.744	96	Gravel surface, HSG C
0.414	80	>75% Grass cover, Good, HSG D
0.014	80	>75% Grass cover, Good, HSG D
0.016	80	>75% Grass cover, Good, HSG D
0.002	80	>75% Grass cover, Good, HSG D
0.010	80	>75% Grass cover, Good, HSG D
0.384	74	>75% Grass cover, Good, HSG C
0.018	74	>75% Grass cover, Good, HSG C
0.002	80	>75% Grass cover, Good, HSG D
1.813	87	Weighted Average
1.801		99.38% Pervious Area
0.011		0.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	30	0.3300	0.41		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.19"
0.5	30	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
1.7	60	Total, Increased to minimum Tc = 6.0 min			

Subcatchment P-A5:



Summary for Subcatchment P-A6: Subcat P-A6

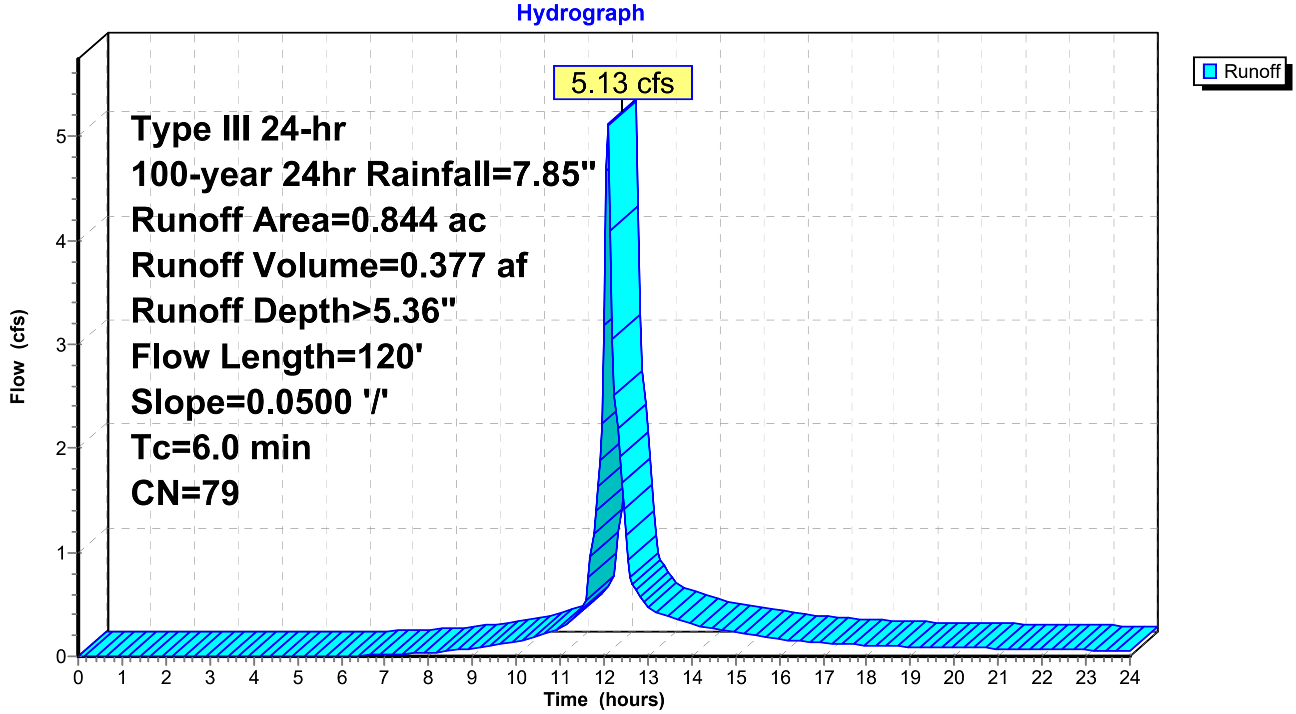
Runoff = 5.13 cfs @ 12.09 hrs, Volume= 0.377 af, Depth> 5.36"
Routed to Pond P1a : Proposed Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-year 24hr Rainfall=7.85"

Area (ac)	CN	Description
0.050	98	EX Gravel Surface, Impervious, HSG C
0.000	98	PR Gravel Surface, Impervious, HSG C
0.127	74	>75% Grass cover, Good, HSG C
0.140	74	>75% Grass cover, Good, HSG C
0.425	80	>75% Grass cover, Good, HSG D
0.101	80	>75% Grass cover, Good, HSG D
0.000	98	PR Gravel Surface, Impervious, HSG D
0.844	79	Weighted Average
0.793		93.99% Pervious Area
0.051		6.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0500	0.15		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.19"
0.3	70	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.0	120	Total			

Subcatchment P-A6: Subcat P-A6



Summary for Pond CMB: Underground Storage Chambers

Inflow Area = 4.826 ac, 95.98% Impervious, Inflow Depth > 7.52" for 100-year 24hr event
Inflow = 36.23 cfs @ 12.09 hrs, Volume= 3.023 af
Outflow = 15.39 cfs @ 12.29 hrs, Volume= 2.420 af, Atten= 58%, Lag= 12.0 min
Discarded = 0.92 cfs @ 8.15 hrs, Volume= 1.455 af
Primary = 14.47 cfs @ 12.29 hrs, Volume= 0.965 af
Routed to Link DP-A : Design Point A

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 223.56' @ 12.29 hrs Surf.Area= 16,464 sf Storage= 48,085 cf
Flood Elev= 224.00' Surf.Area= 16,464 sf Storage= 54,255 cf

Plug-Flow detention time= 158.9 min calculated for 2.420 af (80% of inflow)
Center-of-Mass det. time= 81.9 min (827.3 - 745.4)

Volume	Invert	Avail.Storage	Storage Description
#1B	219.75'	6,779 cf	**196.00'W x 84.00'L x 4.92'H Field A** 80,948 cf Overall - 64,000 cf Embedded = 16,948 cf x 40.0% Voids
#2B	220.50'	47,770 cf	**retain_it upright 3.5'** x 240 Inside #1 Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf 24 Rows adjusted for 417.5 cf perimeter wall
		54,549 cf	Total Available Storage

Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	219.75'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	220.40'	**24.0" Round Culvert** L= 370.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 220.40' / 210.00' S= 0.0281 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf
#3	Device 2	222.75'	**6.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Discarded OutFlow Max=0.92 cfs @ 8.15 hrs HW=219.80' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.92 cfs)

Primary OutFlow Max=14.43 cfs @ 12.29 hrs HW=223.56' (Free Discharge)
└─**2=Culvert** (Passes 14.43 cfs of 17.55 cfs potential flow)
  └─**3=Broad-Crested Rectangular Weir** (Weir Controls 14.43 cfs @ 2.97 fps)

Pond CMB: Underground Storage Chambers - Chamber Wizard Field A

Chamber Model = retain_it upright 3.5' (retain-it® upright)
Inside= 84.0"W x 42.0"H => 25.10 sf x 8.00'L = 200.8 cf
Outside= 96.0"W x 50.0"H => 33.33 sf x 8.00'L = 266.7 cf
24 Rows adjusted for 417.5 cf perimeter wall

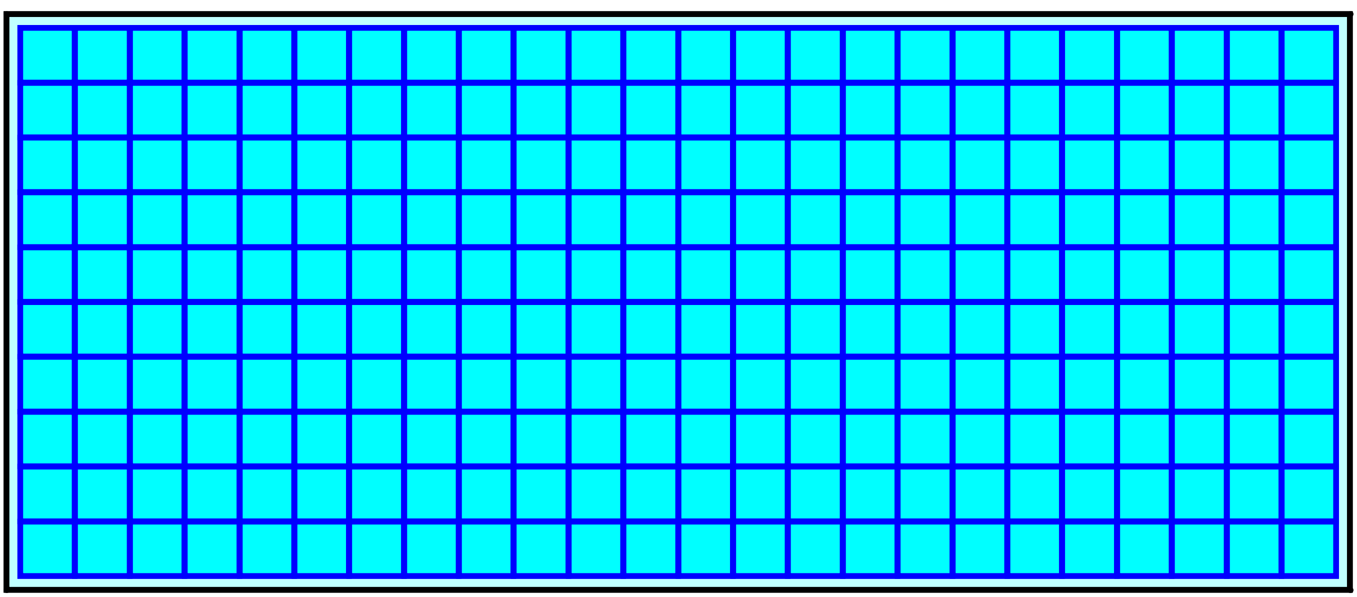
10 Chambers/Row x 8.00' Long = 80.00' Row Length +24.0" End Stone x 2 = 84.00' Base Length
24 Rows x 96.0" Wide + 24.0" Side Stone x 2 = 196.00' Base Width
9.0" Stone Base + 50.0" Chamber Height = 4.92' Field Height

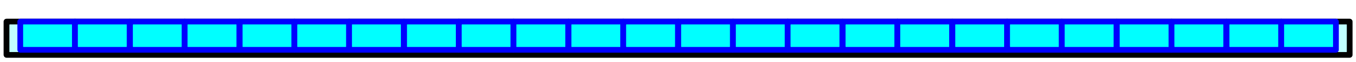
6.1 cf Sidewall x 10 x 2 + 6.1 cf Endwall x 24 x 2 = 417.5 cf Perimeter Wall
240 Chambers x 200.8 cf - 417.5 cf Perimeter wall = 47,769.8 cf Chamber Storage
240 Chambers x 266.7 cf = 64,000.0 cf Displacement

80,948.0 cf Field - 64,000.0 cf Chambers = 16,948.0 cf Stone x 40.0% Voids = 6,779.2 cf Stone Storage

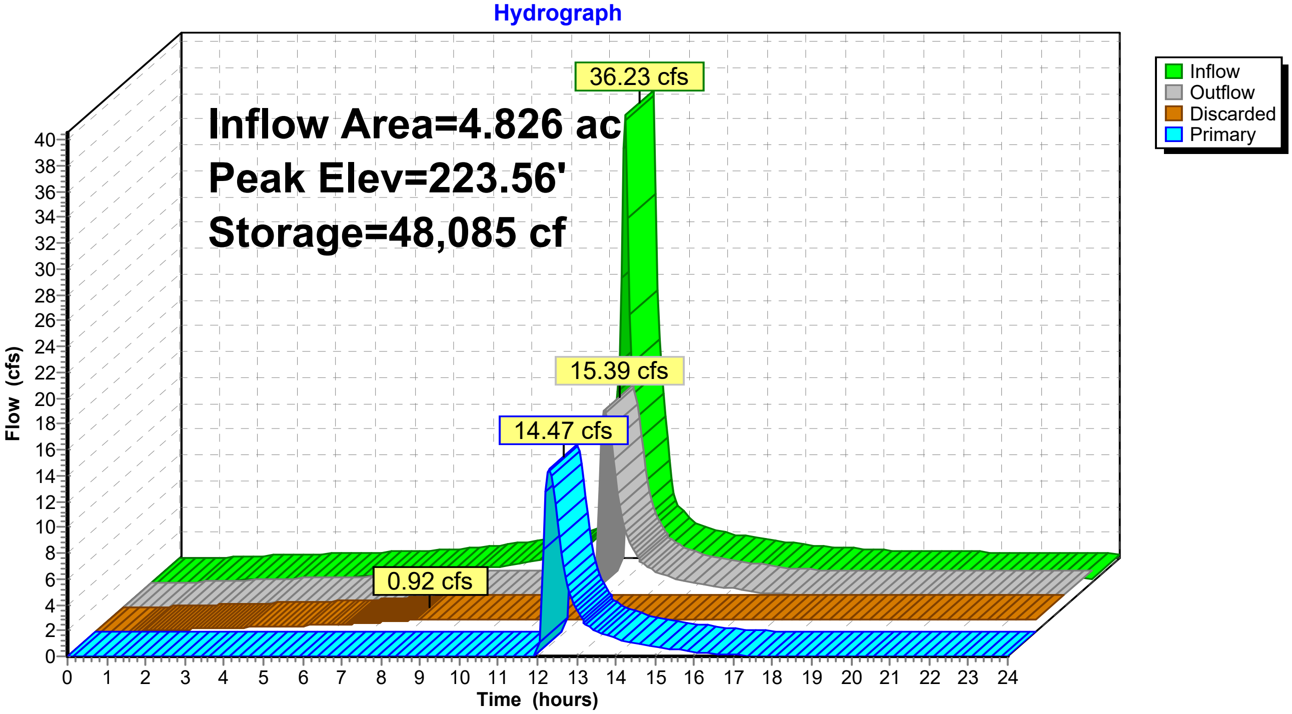
Chamber Storage + Stone Storage = 54,549.0 cf = 1.252 af
Overall Storage Efficiency = 67.4%
Overall System Size = 84.00' x 196.00' x 4.92'

240 Chambers
2,998.1 cy Field
627.7 cy Stone





Pond CMB: Underground Storage Chambers



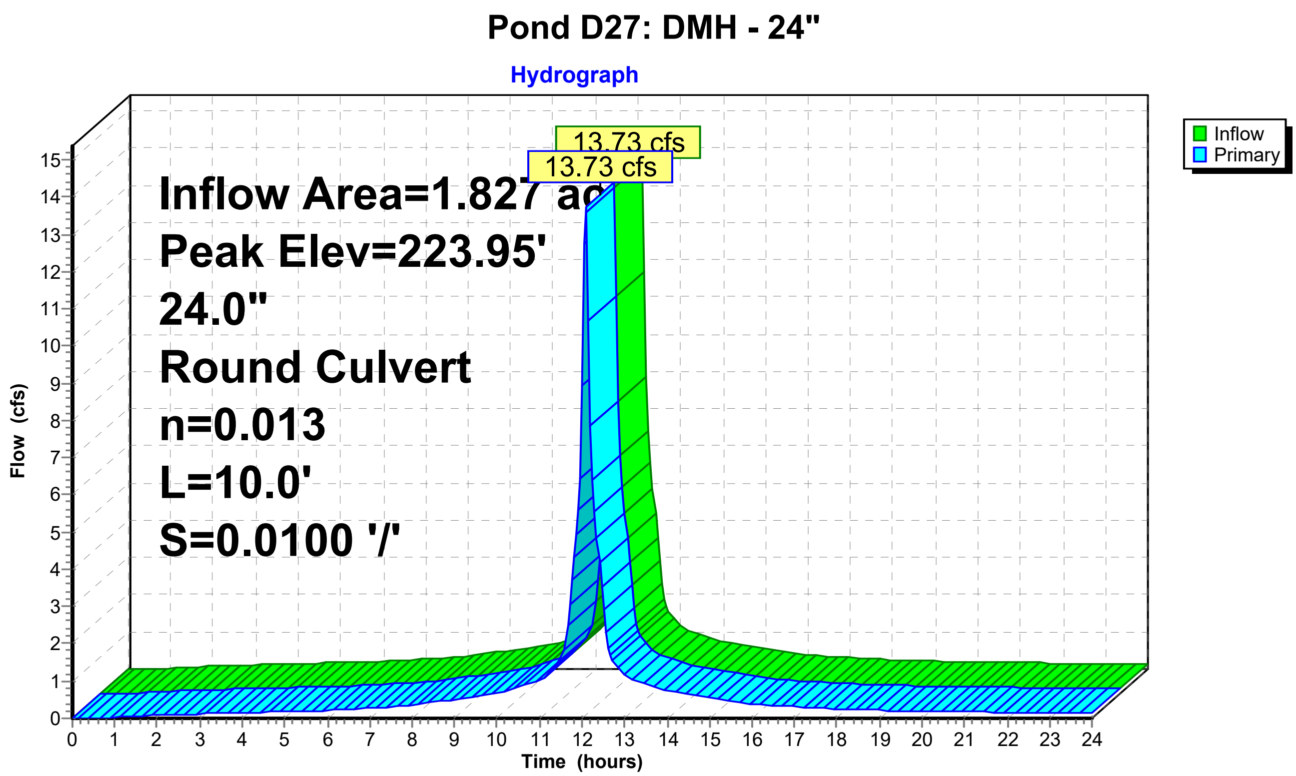
Summary for Pond D27: DMH - 24"

Inflow Area = 1.827 ac, 97.42% Impervious, Inflow Depth > 7.57" for 100-year 24hr event
Inflow = 13.73 cfs @ 12.09 hrs, Volume= 1.152 af
Outflow = 13.73 cfs @ 12.09 hrs, Volume= 1.152 af, Atten= 0%, Lag= 0.0 min
Primary = 13.73 cfs @ 12.09 hrs, Volume= 1.152 af
Routed to Link WQU-P6 : Water Quality Unit

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 223.95' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	221.80'	**24.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 221.80' / 221.70' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=13.36 cfs @ 12.09 hrs HW=223.90' (Free Discharge)
└—**1=Culvert** (Barrel Controls 13.36 cfs @ 5.03 fps)



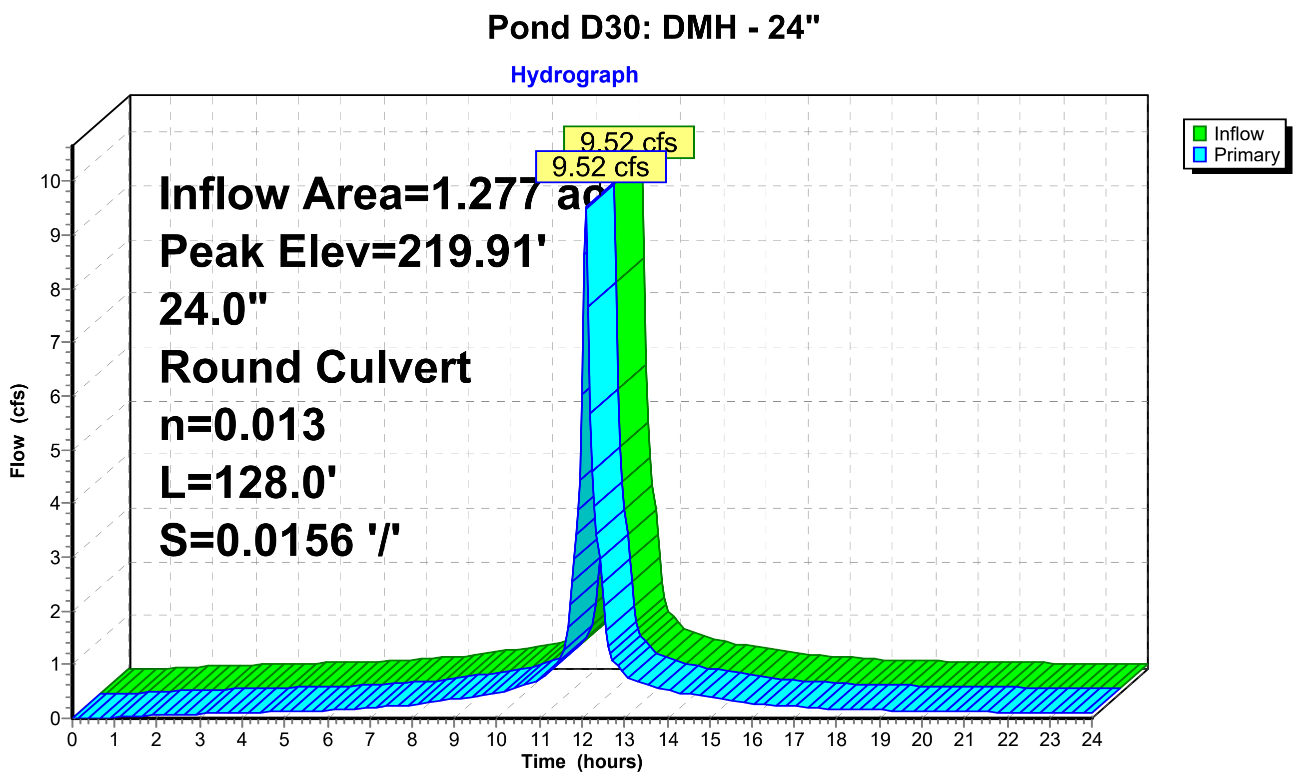
Summary for Pond D30: DMH - 24"

Inflow Area = 1.277 ac, 98.85% Impervious, Inflow Depth > 7.57" for 100-year 24hr event
Inflow = 9.52 cfs @ 12.09 hrs, Volume= 0.806 af
Outflow = 9.52 cfs @ 12.09 hrs, Volume= 0.806 af, Atten= 0%, Lag= 0.0 min
Primary = 9.52 cfs @ 12.09 hrs, Volume= 0.806 af
Routed to Pond D31 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 219.91' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	218.50'	**24.0" Round Culvert** L= 128.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 218.50' / 216.50' S= 0.0156 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=9.32 cfs @ 12.09 hrs HW=219.89' (Free Discharge)
└**1=Culvert** (Inlet Controls 9.32 cfs @ 4.01 fps)



Summary for Pond D31: DMH - 30"

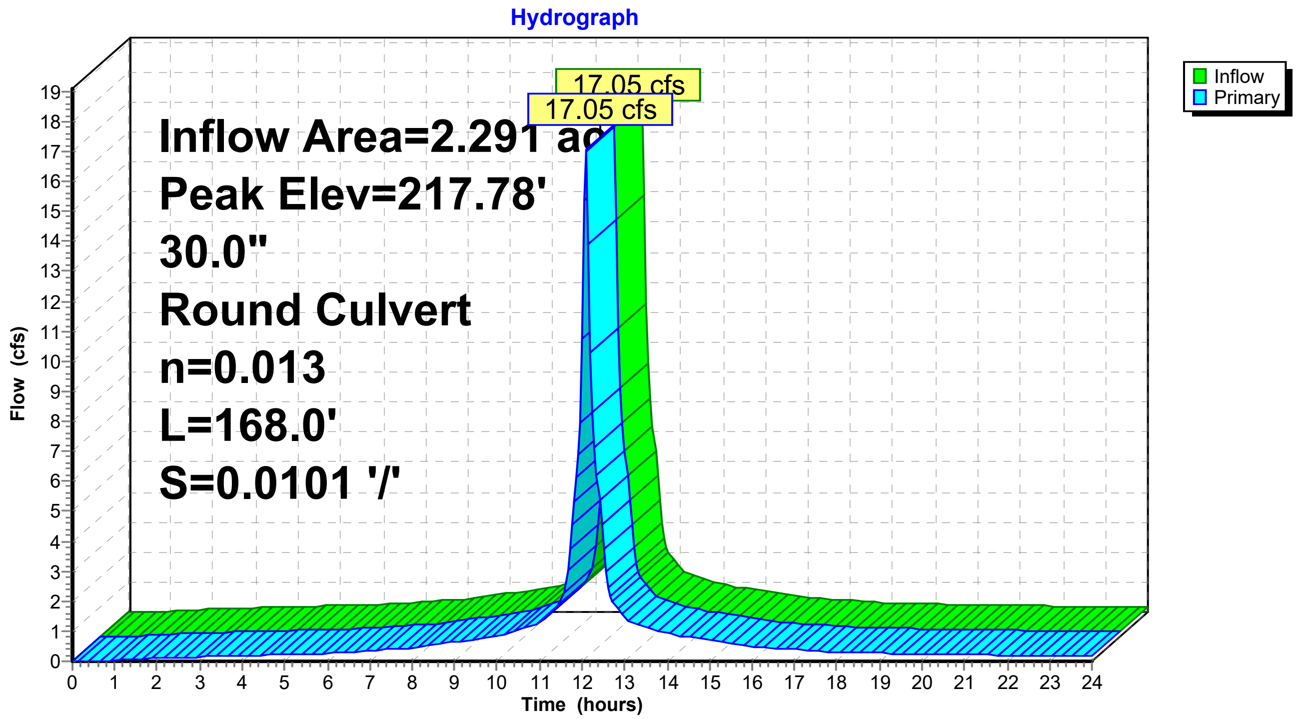
Inflow Area = 2.291 ac, 99.05% Impervious, Inflow Depth > 7.59" for 100-year 24hr event
Inflow = 17.05 cfs @ 12.09 hrs, Volume= 1.448 af
Outflow = 17.05 cfs @ 12.09 hrs, Volume= 1.448 af, Atten= 0%, Lag= 0.0 min
Primary = 17.05 cfs @ 12.09 hrs, Volume= 1.448 af
Routed to Pond D32 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 217.78' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	216.00'	**30.0" Round Culvert** L= 168.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 216.00' / 214.30' S= 0.0101 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf

Primary OutFlow Max=16.74 cfs @ 12.09 hrs HW=217.76' (Free Discharge)
1=Culvert (Inlet Controls 16.74 cfs @ 4.52 fps)

Pond D31: DMH - 30"



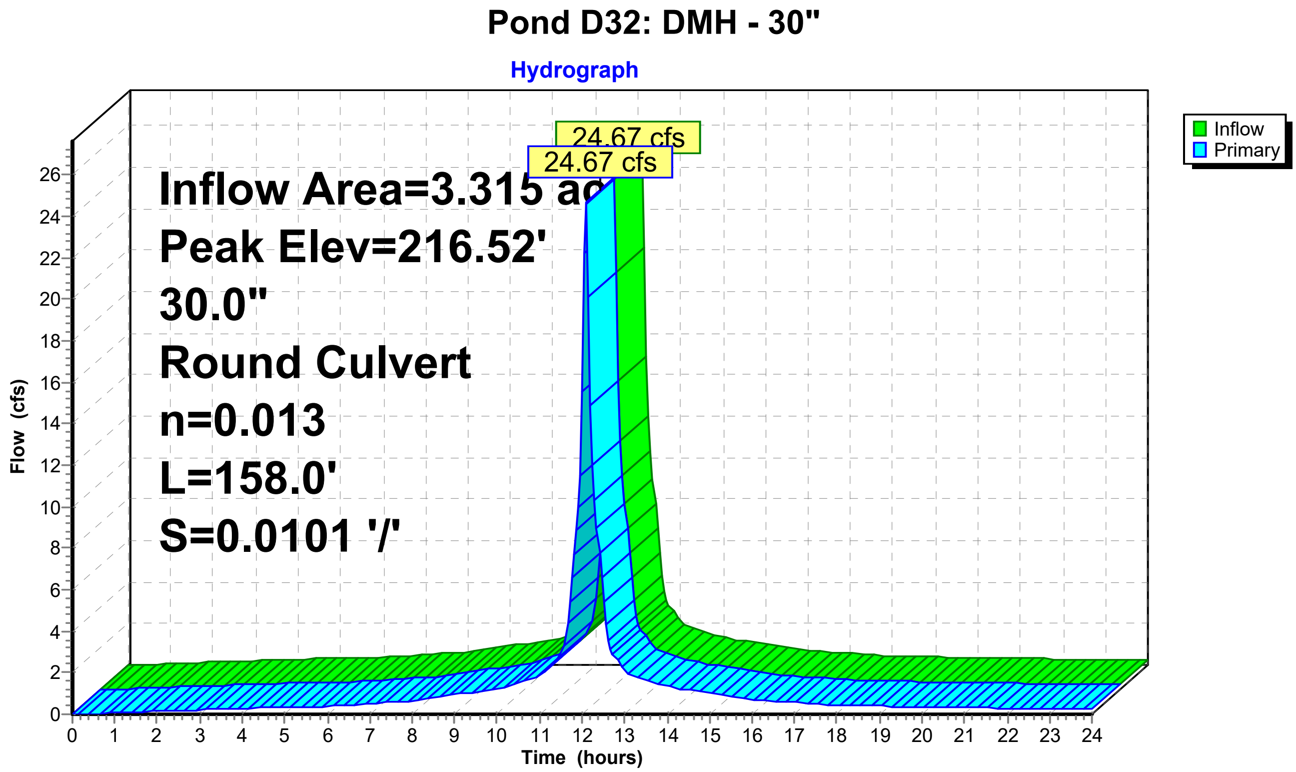
Summary for Pond D32: DMH - 30"

Inflow Area = 3.315 ac, 99.08% Impervious, Inflow Depth > 7.59" for 100-year 24hr event
Inflow = 24.67 cfs @ 12.09 hrs, Volume= 2.097 af
Outflow = 24.67 cfs @ 12.09 hrs, Volume= 2.097 af, Atten= 0%, Lag= 0.0 min
Primary = 24.67 cfs @ 12.09 hrs, Volume= 2.097 af
Routed to Pond D33 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 216.52' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	214.20'	**30.0" Round Culvert** L= 158.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 214.20' / 212.60' S= 0.0101 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf

Primary OutFlow Max=24.24 cfs @ 12.09 hrs HW=216.49' (Free Discharge)
1=Culvert (Inlet Controls 24.24 cfs @ 5.15 fps)



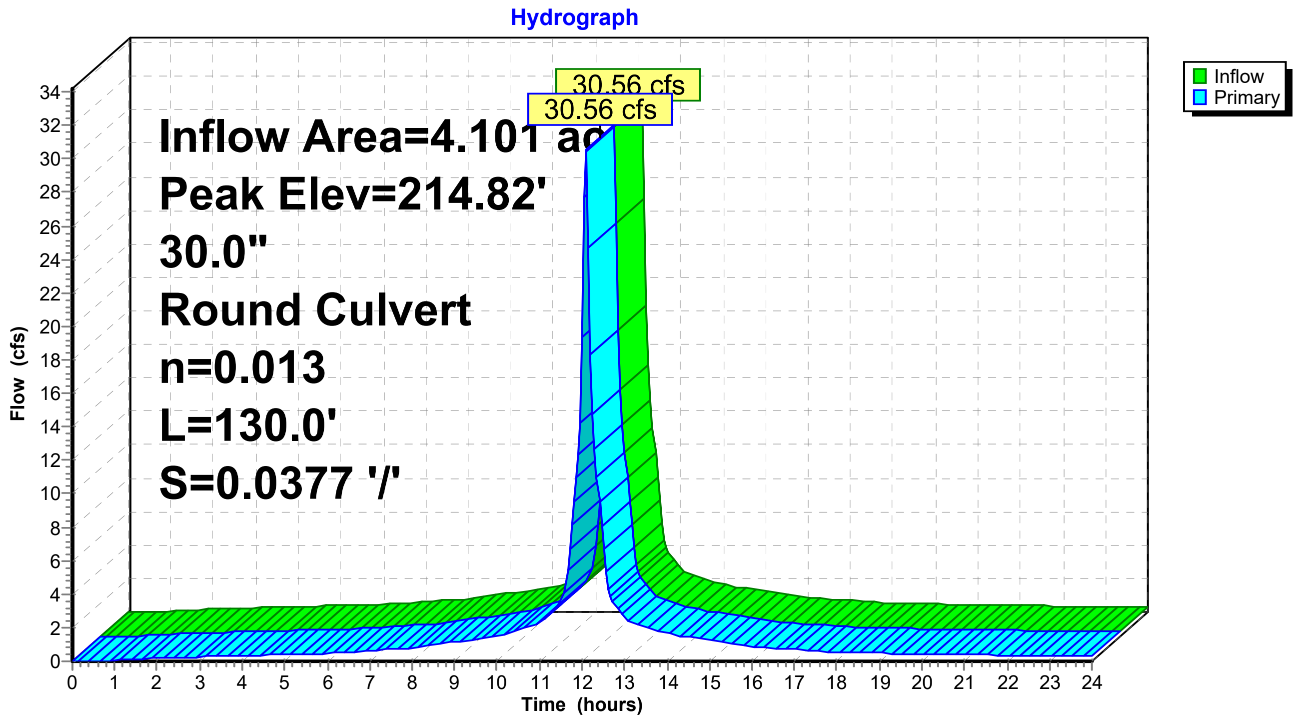
Summary for Pond D33: DMH - 30"

Inflow Area = 4.101 ac, 98.81% Impervious, Inflow Depth > 7.57" for 100-year 24hr event
Inflow = 30.56 cfs @ 12.09 hrs, Volume= 2.588 af
Outflow = 30.56 cfs @ 12.09 hrs, Volume= 2.588 af, Atten= 0%, Lag= 0.0 min
Primary = 30.56 cfs @ 12.09 hrs, Volume= 2.588 af
Routed to Pond F1 : Forebay

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 214.82' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	211.90'	**30.0" Round Culvert** L= 130.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 211.90' / 207.00' S= 0.0377 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 4.91 sf

Primary OutFlow Max=29.96 cfs @ 12.09 hrs HW=214.76' (Free Discharge)
└─**1=Culvert** (Inlet Controls 29.96 cfs @ 6.10 fps)



Summary for Pond F1: Forebay

Inflow Area = 5.424 ac, 88.71% Impervious, Inflow Depth > 7.29" for 100-year 24hr event
Inflow = 39.78 cfs @ 12.09 hrs, Volume= 3.295 af
Outflow = 39.45 cfs @ 12.10 hrs, Volume= 3.294 af, Atten= 1%, Lag= 0.5 min
Primary = 19.64 cfs @ 12.10 hrs, Volume= 3.055 af
Routed to Link WQU-P5 : Water Quality Unit
Secondary = 19.80 cfs @ 12.10 hrs, Volume= 0.239 af
Routed to Pond P1a : Proposed Basin

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 207.68' @ 12.10 hrs Surf.Area= 1,563 sf Storage= 2,714 cf

Plug-Flow detention time= 0.8 min calculated for 3.294 af (100% of inflow)
Center-of-Mass det. time= 0.7 min (752.2 - 751.4)

Volume	Invert	Avail.Storage	Storage Description
#1	205.00'	3,235 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

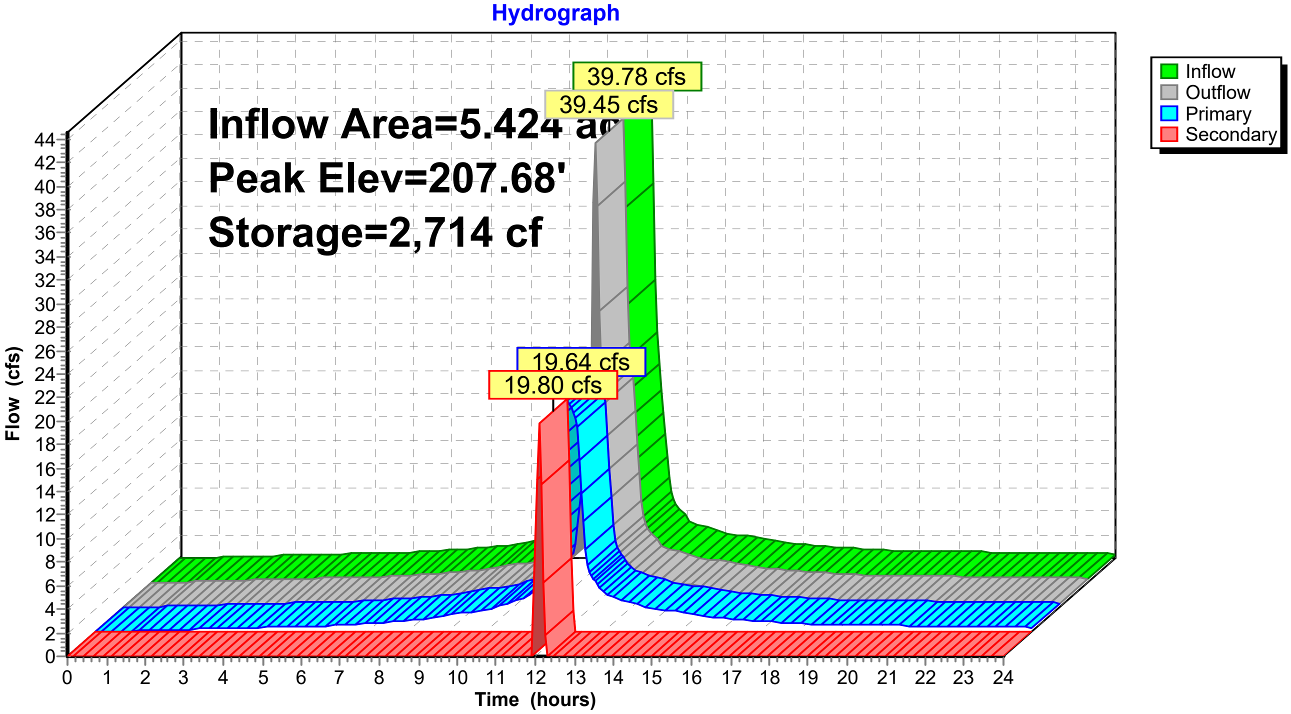
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
205.00	480	0	0
207.00	1,270	1,750	1,750
208.00	1,700	1,485	3,235

Device	Routing	Invert	Outlet Devices
#1	Primary	201.60'	**18.0" Round 18" Culvert** L= 30.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 201.60' / 201.30' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	205.00'	**1.0" x 21.0" Horiz. Double Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads
#3	Secondary	207.00'	**12.0' long + 2.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=19.64 cfs @ 12.10 hrs HW=207.68' (Free Discharge)
└─**1=18" Culvert** (Inlet Controls 19.64 cfs @ 11.11 fps)
  └─**2=Double Grate** (Passes 19.64 cfs of 22.98 cfs potential flow)

Secondary OutFlow Max=19.70 cfs @ 12.10 hrs HW=207.68' (Free Discharge)
└─**3=Broad-Crested Rectangular Weir** (Weir Controls 19.70 cfs @ 2.18 fps)

Pond F1: Forebay



Summary for Pond P1a: Proposed Basin

Inflow Area = 6.267 ac, 77.58% Impervious, Inflow Depth > 7.03" for 100-year 24hr event
Inflow = 44.56 cfs @ 12.10 hrs, Volume= 3.672 af
Outflow = 13.76 cfs @ 12.44 hrs, Volume= 3.024 af, Atten= 69%, Lag= 20.7 min
Discarded = 0.97 cfs @ 12.44 hrs, Volume= 1.040 af
Primary = 12.79 cfs @ 12.44 hrs, Volume= 1.984 af
Routed to Link DP-A : Design Point A
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Link DP-A : Design Point A

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 204.90' @ 12.44 hrs Surf.Area= 17,350 sf Storage= 70,544 cf

Plug-Flow detention time= 177.7 min calculated for 3.018 af (82% of inflow)
Center-of-Mass det. time= 106.9 min (864.6 - 757.6)

Volume	Invert	Avail.Storage	Storage Description
#1	198.00'	90,590 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
198.00	1,180	0	0
199.00	3,950	2,565	2,565
200.00	7,100	5,525	8,090
201.00	9,950	8,525	16,615
202.00	11,950	10,950	27,565
203.00	14,000	12,975	40,540
204.00	16,000	15,000	55,540
205.00	17,500	16,750	72,290
206.00	19,100	18,300	90,590

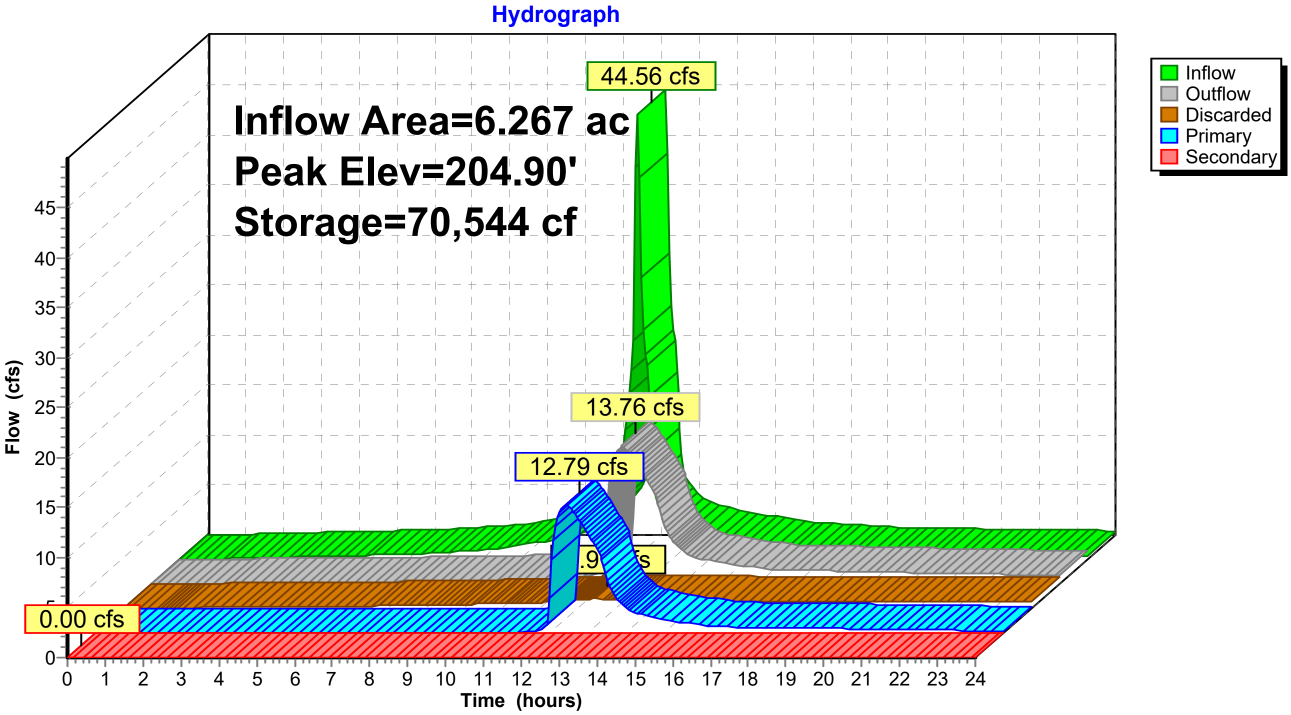
Device	Routing	Invert	Outlet Devices
#1	Secondary	205.00'	**10.0' long + 3.0 '/' SideZ x 11.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.53 2.59 2.70 2.68 2.67 2.68 2.66 2.64
#2	Primary	198.00'	**18.0" Round Culvert** L= 70.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 198.00' / 194.40' S= 0.0514 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#3	Device 2	201.50'	**1.0" Vert. Orifice/Grate X 8.00 columns** X 3 rows with 6.0" cc spacing C= 0.600 Limited to weir flow at low heads
#4	Device 2	203.00'	**18.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Discarded	198.00'	**2.410 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.97 cfs @ 12.44 hrs HW=204.90' (Free Discharge)
└─**5=Exfiltration** (Exfiltration Controls 0.97 cfs)

Primary OutFlow Max=12.79 cfs @ 12.44 hrs HW=204.90' (Free Discharge)
└─**2=Culvert** (Passes 12.79 cfs of 21.10 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 1.06 cfs @ 8.12 fps)
  └─**4=Orifice/Grate** (Orifice Controls 11.72 cfs @ 6.63 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=198.00' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir**(Controls 0.00 cfs)

Pond P1a: Proposed Basin



Summary for Pond P30: 12" HDPE

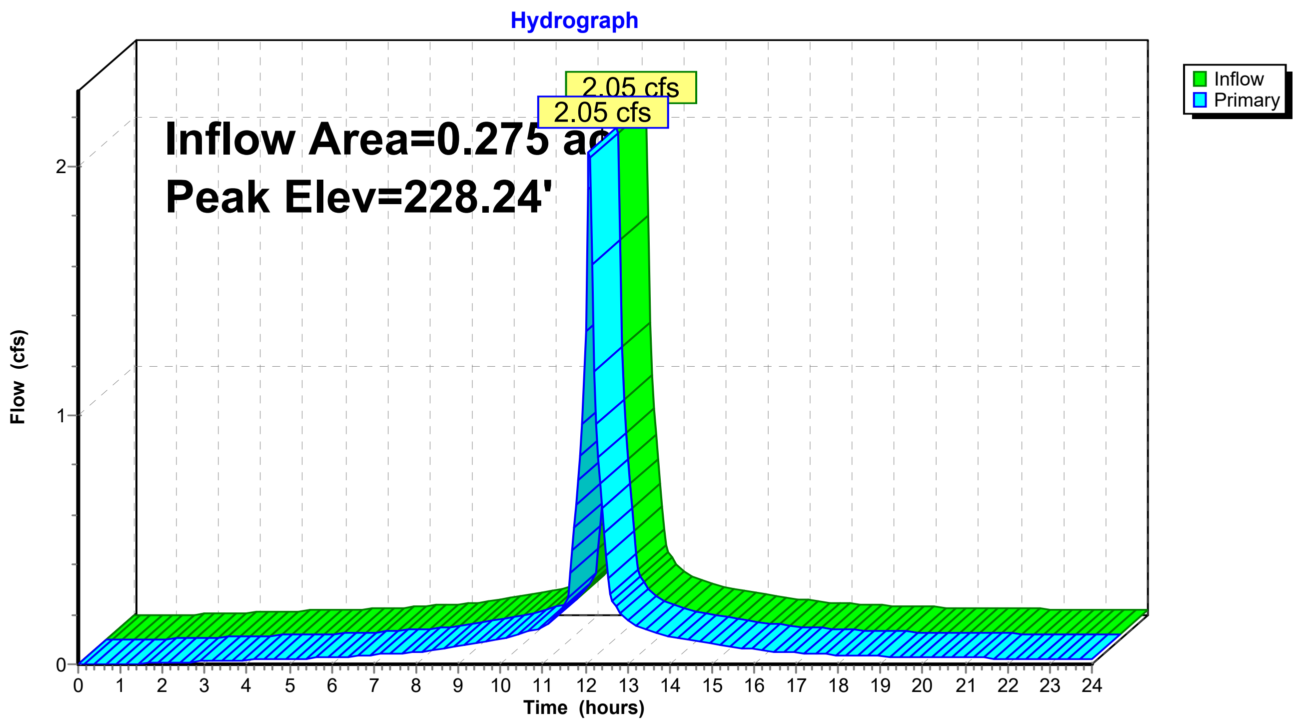
Inflow Area = 0.275 ac, 92.38% Impervious, Inflow Depth > 7.37" for 100-year 24hr event
Inflow = 2.05 cfs @ 12.09 hrs, Volume= 0.169 af
Outflow = 2.05 cfs @ 12.09 hrs, Volume= 0.169 af, Atten= 0%, Lag= 0.0 min
Primary = 2.05 cfs @ 12.09 hrs, Volume= 0.169 af
Routed to Pond D27 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 228.24' @ 12.09 hrs
Flood Elev= 228.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	224.60'	**12.0" Round Culvert** L= 180.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 224.60' / 222.80' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	228.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=1.99 cfs @ 12.09 hrs HW=228.24' (Free Discharge)
└─**1=Culvert** (Passes 1.99 cfs of 4.96 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 1.99 cfs @ 1.21 fps)

Pond P30: 12" HDPE



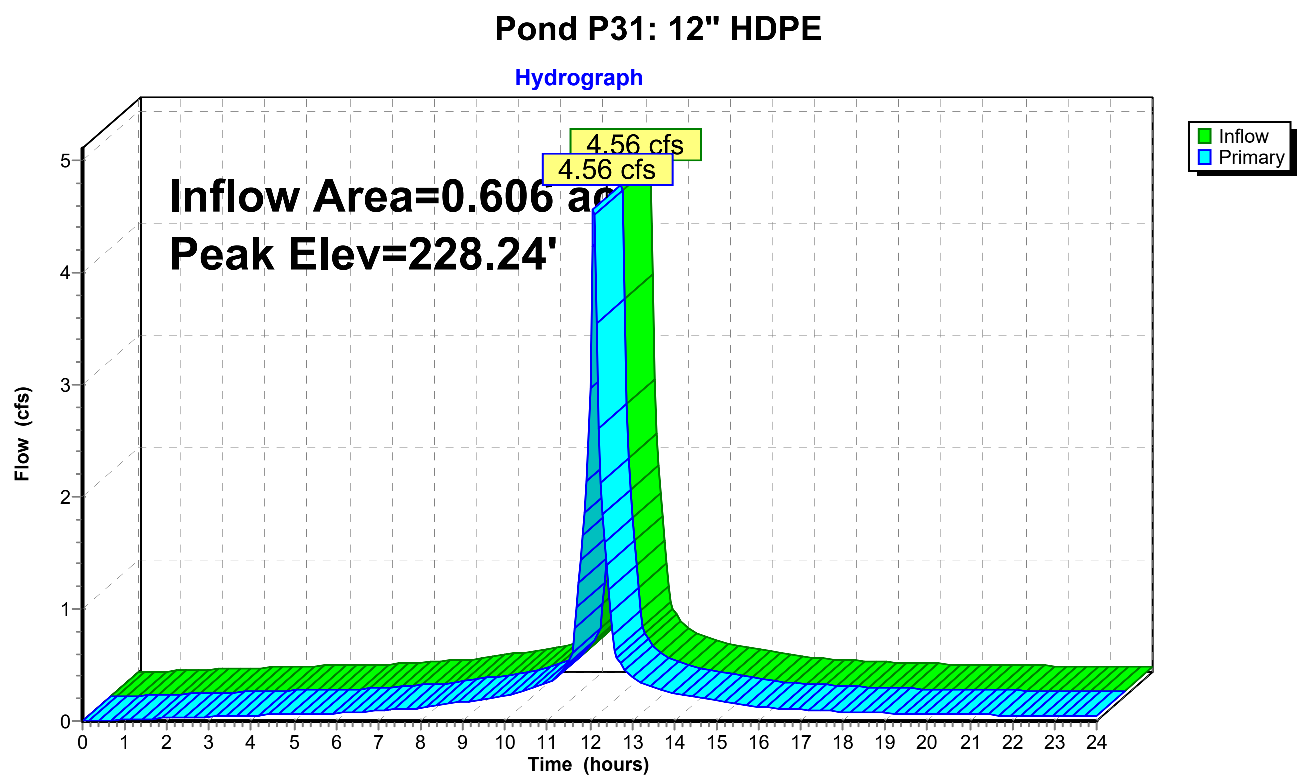
Summary for Pond P31: 12" HDPE

Inflow Area = 0.606 ac, 97.98% Impervious, Inflow Depth > 7.61" for 100-year 24hr event
Inflow = 4.56 cfs @ 12.09 hrs, Volume= 0.384 af
Outflow = 4.56 cfs @ 12.09 hrs, Volume= 0.384 af, Atten= 0%, Lag= 0.0 min
Primary = 4.56 cfs @ 12.09 hrs, Volume= 0.384 af
Routed to Pond D27 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 228.24' @ 12.09 hrs
Flood Elev= 223.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	223.00'	**12.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 223.00' / 222.90' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	228.00'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=4.42 cfs @ 12.09 hrs HW=228.23' (Free Discharge)
└─**1=Culvert** (Passes 4.42 cfs of 8.23 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 4.42 cfs @ 1.58 fps)



Summary for Pond P32: 12" HDPE

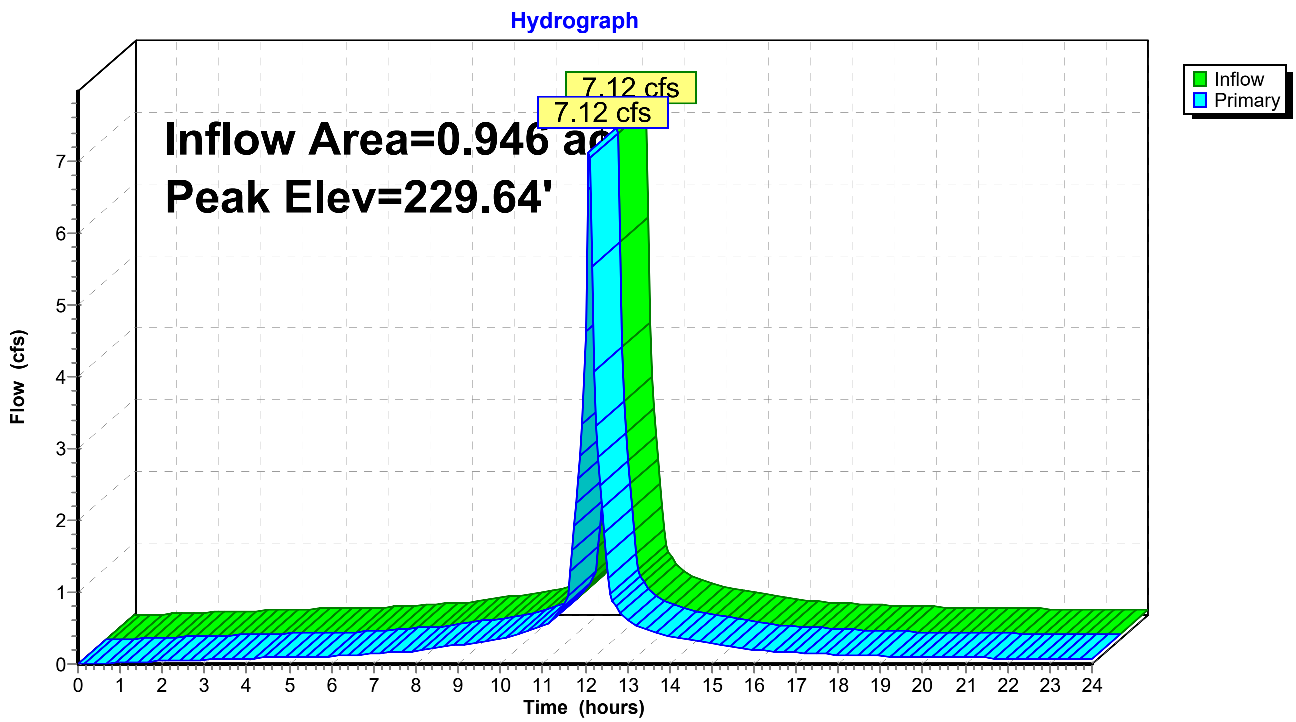
Inflow Area = 0.946 ac, 98.52% Impervious, Inflow Depth > 7.61" for 100-year 24hr event
Inflow = 7.12 cfs @ 12.09 hrs, Volume= 0.600 af
Outflow = 7.12 cfs @ 12.09 hrs, Volume= 0.600 af, Atten= 0%, Lag= 0.0 min
Primary = 7.12 cfs @ 12.09 hrs, Volume= 0.600 af
Routed to Pond D27 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 229.64' @ 12.09 hrs
Flood Elev= 228.30'

Device	Routing	Invert	Outlet Devices
#1	Primary	223.80'	**12.0" Round Culvert** L= 100.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 223.80' / 222.80' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	227.80'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=6.93 cfs @ 12.09 hrs HW=229.41' (Free Discharge)
└─**1=Culvert** (Barrel Controls 6.93 cfs @ 8.82 fps)
└─**2=Orifice/Grate** (Passes 6.93 cfs of 17.79 cfs potential flow)

Pond P32: 12" HDPE



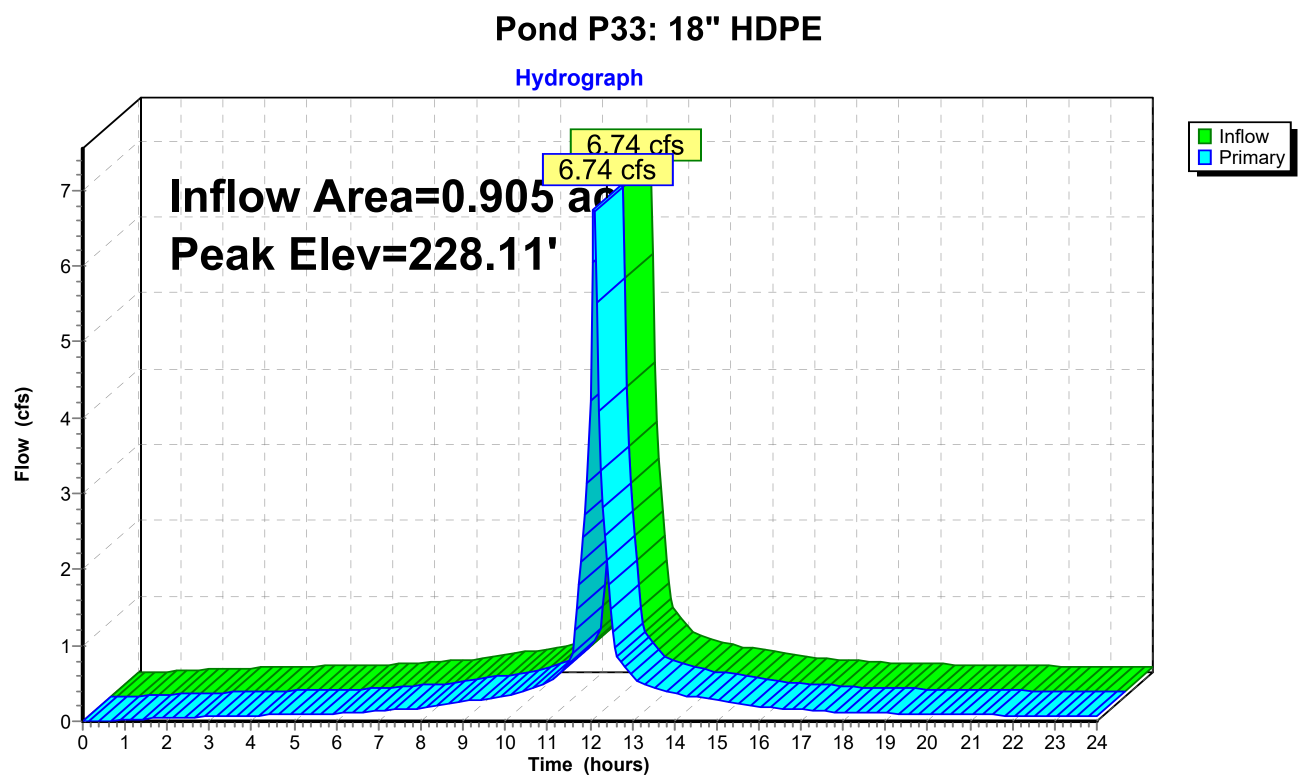
Summary for Pond P33: 18" HDPE

Inflow Area = 0.905 ac, 99.31% Impervious, Inflow Depth > 7.61" for 100-year 24hr event
Inflow = 6.74 cfs @ 12.09 hrs, Volume= 0.574 af
Outflow = 6.74 cfs @ 12.09 hrs, Volume= 0.574 af, Atten= 0%, Lag= 0.0 min
Primary = 6.74 cfs @ 12.09 hrs, Volume= 0.574 af
Routed to Pond D30 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 228.11' @ 12.09 hrs
Flood Elev= 228.30'

Device	Routing	Invert	Outlet Devices
#1	Primary	222.80'	**18.0" Round Culvert** L= 198.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 222.80' / 219.00' S= 0.0192 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	227.80'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=6.60 cfs @ 12.09 hrs HW=228.10' (Free Discharge)
└─**1=Culvert** (Passes 6.60 cfs of 17.28 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 6.60 cfs @ 1.80 fps)



Summary for Pond P34: 18" HDPE

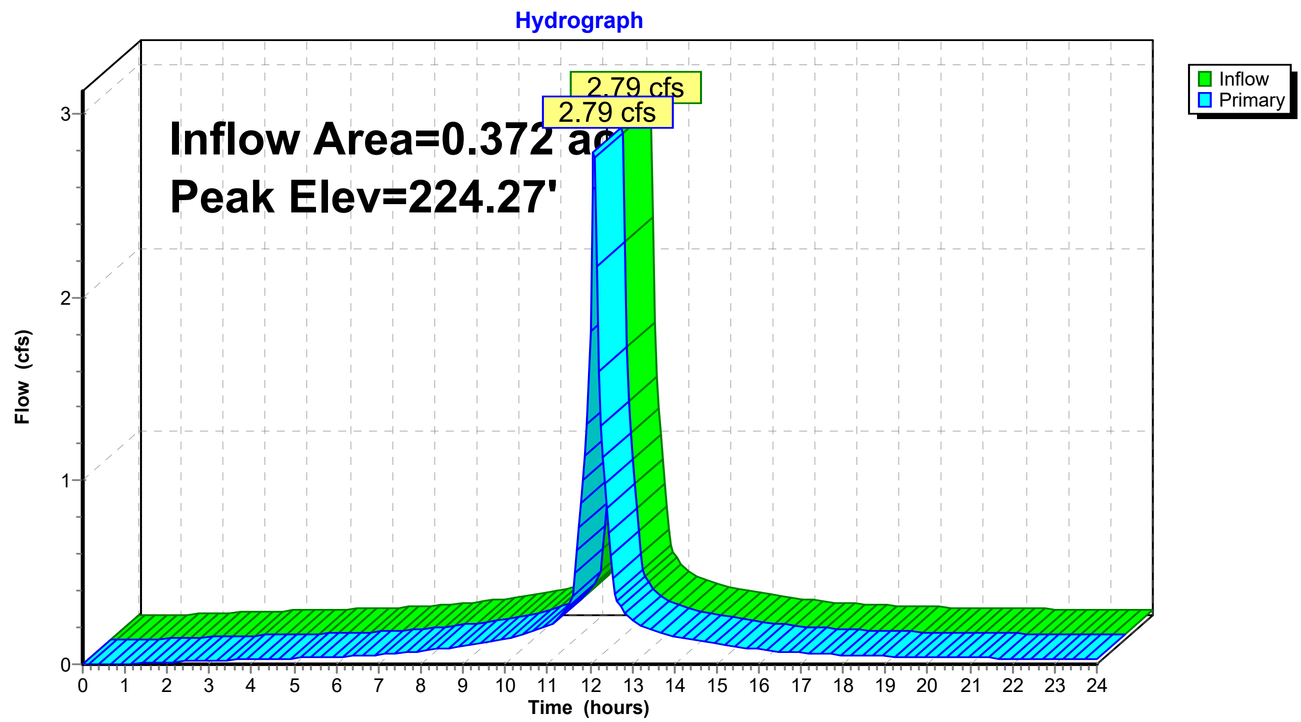
Inflow Area = 0.372 ac, 97.73% Impervious, Inflow Depth > 7.49" for 100-year 24hr event
Inflow = 2.79 cfs @ 12.09 hrs, Volume= 0.232 af
Outflow = 2.79 cfs @ 12.09 hrs, Volume= 0.232 af, Atten= 0%, Lag= 0.0 min
Primary = 2.79 cfs @ 12.09 hrs, Volume= 0.232 af
Routed to Pond D30 : DMH - 24"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 224.27' @ 12.09 hrs
Flood Elev= 224.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	219.10'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 219.10' / 219.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	224.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=2.71 cfs @ 12.09 hrs HW=224.27' (Free Discharge)
└─**1=Culvert** (Passes 2.71 cfs of 17.89 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 2.71 cfs @ 1.34 fps)

Pond P34: 18" HDPE



Summary for Pond P35: 18" HDPE

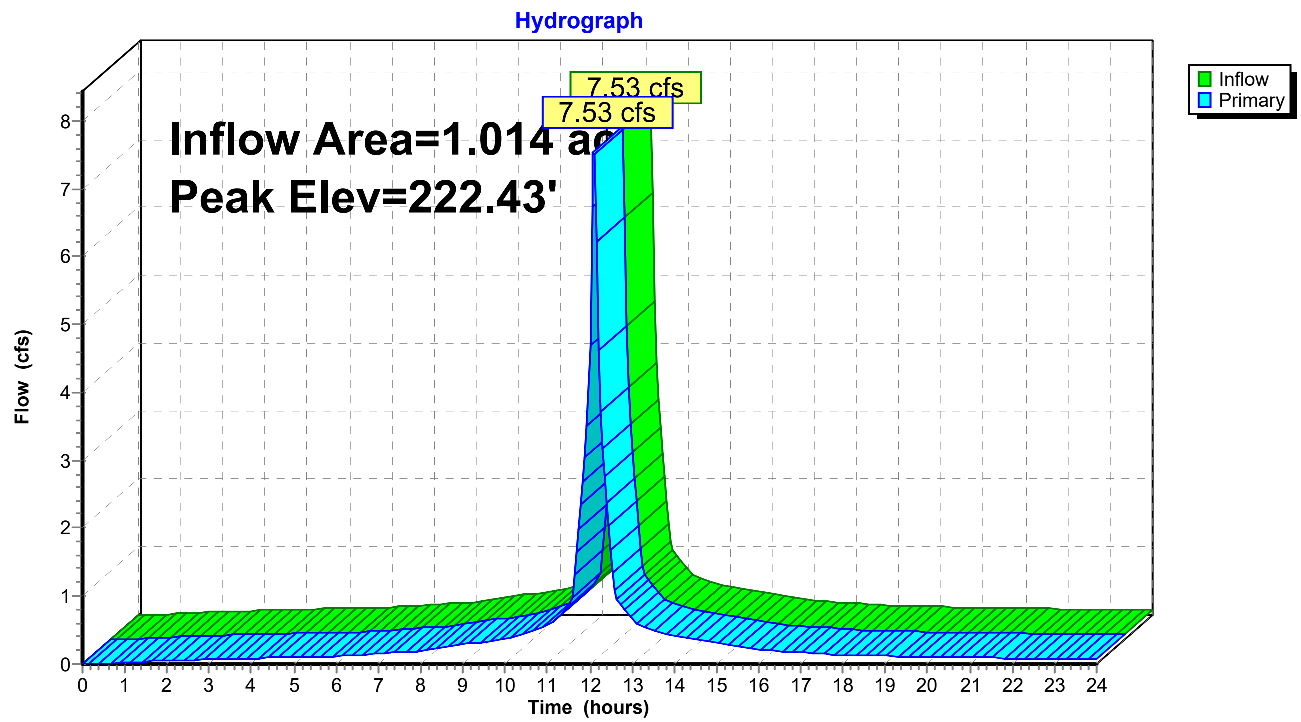
Inflow Area = 1.014 ac, 99.30% Impervious, Inflow Depth > 7.61" for 100-year 24hr event
Inflow = 7.53 cfs @ 12.09 hrs, Volume= 0.643 af
Outflow = 7.53 cfs @ 12.09 hrs, Volume= 0.643 af, Atten= 0%, Lag= 0.0 min
Primary = 7.53 cfs @ 12.09 hrs, Volume= 0.643 af
Routed to Pond D31 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 222.43' @ 12.09 hrs
Flood Elev= 222.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	217.10'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 217.10' / 217.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	222.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=7.41 cfs @ 12.09 hrs HW=222.43' (Free Discharge)
└─**1=Culvert** (Passes 7.41 cfs of 18.21 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 7.41 cfs @ 1.88 fps)

Pond P35: 18" HDPE



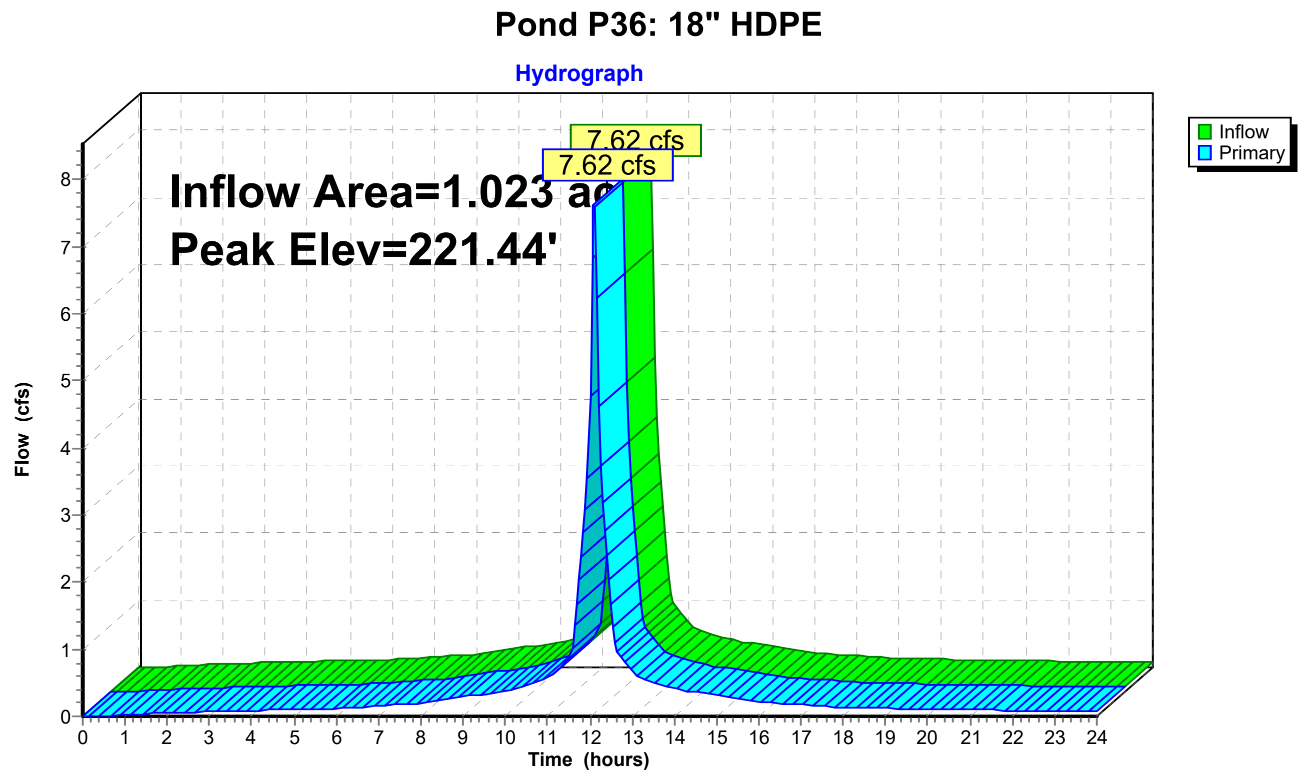
Summary for Pond P36: 18" HDPE

Inflow Area = 1.023 ac, 99.15% Impervious, Inflow Depth > 7.61" for 100-year 24hr event
Inflow = 7.62 cfs @ 12.09 hrs, Volume= 0.649 af
Outflow = 7.62 cfs @ 12.09 hrs, Volume= 0.649 af, Atten= 0%, Lag= 0.0 min
Primary = 7.62 cfs @ 12.09 hrs, Volume= 0.649 af
Routed to Pond D32 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 221.44' @ 12.09 hrs
Flood Elev= 221.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	216.10'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 216.10' / 216.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	221.10'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=7.48 cfs @ 12.09 hrs HW=221.43' (Free Discharge)
└─**1=Culvert** (Passes 7.48 cfs of 18.21 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 7.48 cfs @ 1.88 fps)



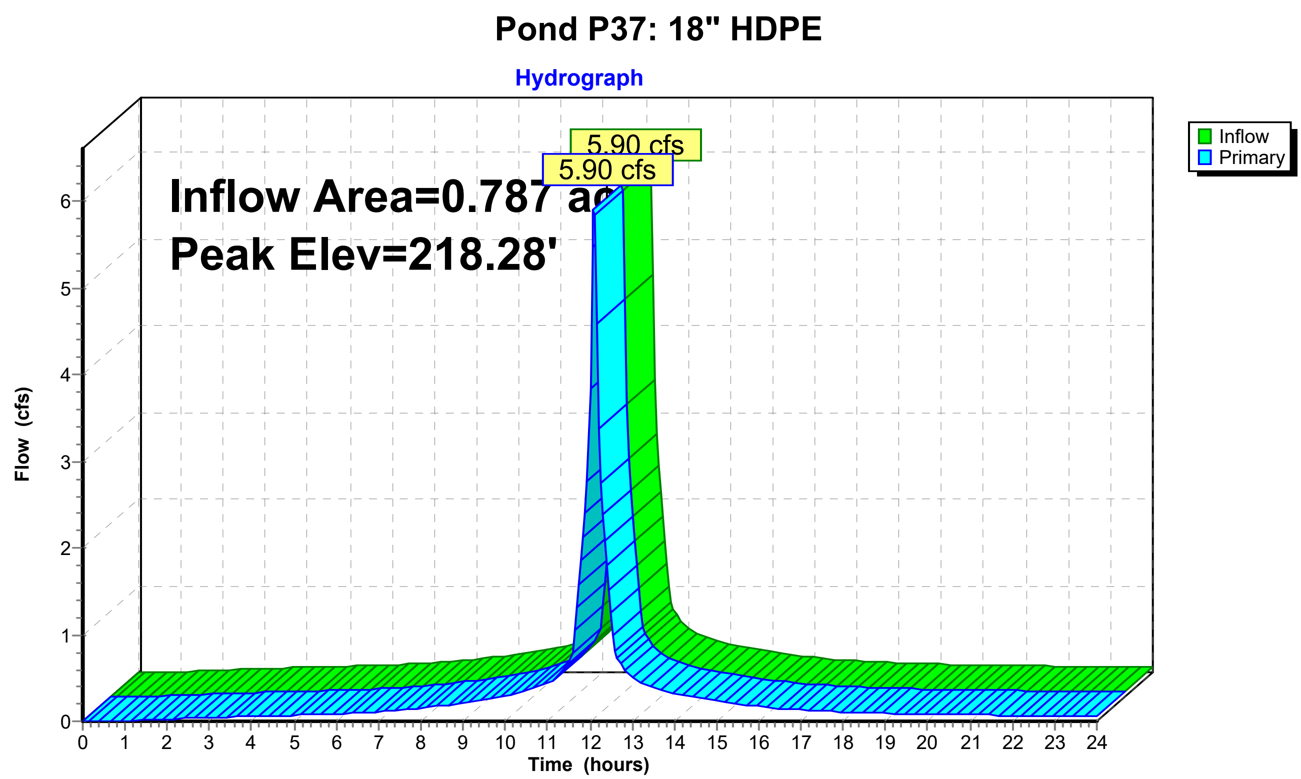
Summary for Pond P37: 18" HDPE

Inflow Area = 0.787 ac, 97.66% Impervious, Inflow Depth > 7.49" for 100-year 24hr event
Inflow = 5.90 cfs @ 12.09 hrs, Volume= 0.491 af
Outflow = 5.90 cfs @ 12.09 hrs, Volume= 0.491 af, Atten= 0%, Lag= 0.0 min
Primary = 5.90 cfs @ 12.09 hrs, Volume= 0.491 af
Routed to Pond D33 : DMH - 30"

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 218.28' @ 12.09 hrs
Flood Elev= 218.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	213.00'	**18.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 213.00' / 212.90' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	218.00'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=5.74 cfs @ 12.09 hrs HW=218.28' (Free Discharge)
└─**1=Culvert** (Passes 5.74 cfs of 18.10 cfs potential flow)
  └─**2=Orifice/Grate** (Weir Controls 5.74 cfs @ 1.72 fps)



Summary for Pond P38: 18" HDPE

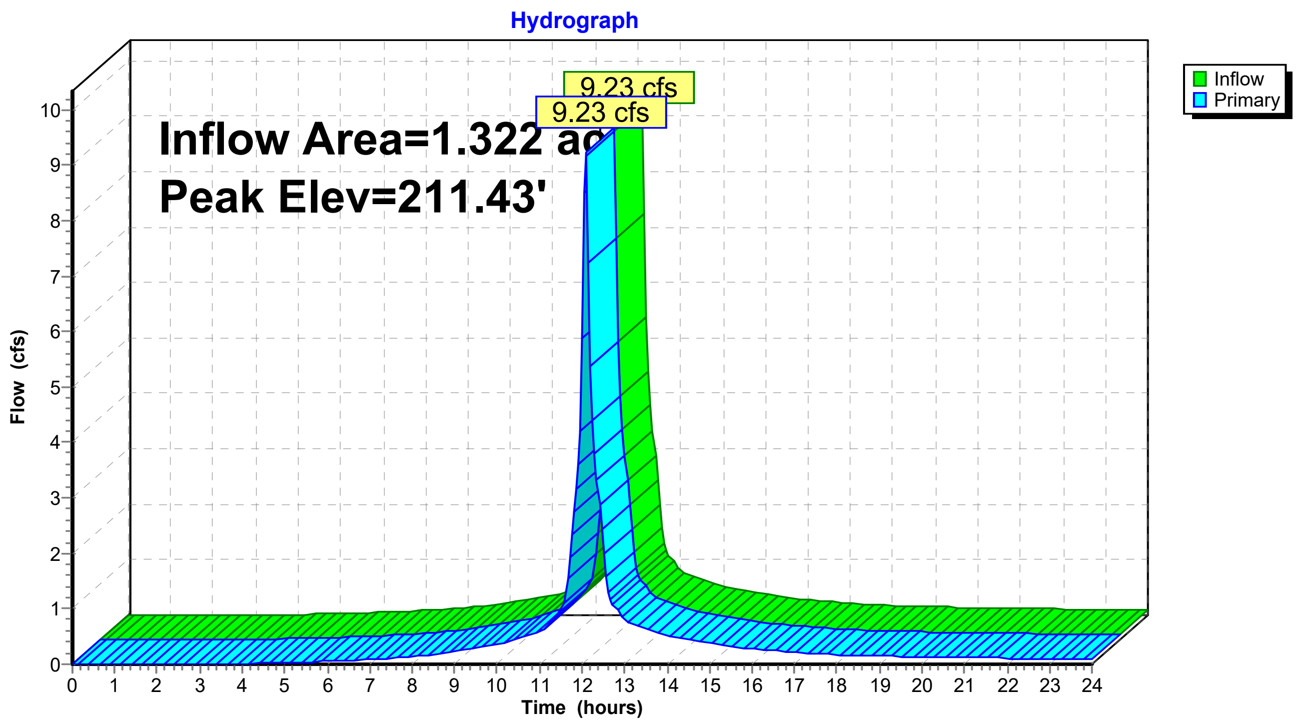
Inflow Area = 1.322 ac, 57.38% Impervious, Inflow Depth > 6.42" for 100-year 24hr event
Inflow = 9.23 cfs @ 12.09 hrs, Volume= 0.707 af
Outflow = 9.23 cfs @ 12.09 hrs, Volume= 0.707 af, Atten= 0%, Lag= 0.0 min
Primary = 9.23 cfs @ 12.09 hrs, Volume= 0.707 af
Routed to Pond F1 : Forebay

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 211.43' @ 12.09 hrs
Flood Elev= 211.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	207.80'	**18.0" Round Culvert** L= 80.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 207.80' / 207.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	211.00'	**1.0" x 21.0" Horiz. Orifice/Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads

Primary OutFlow Max=9.02 cfs @ 12.09 hrs HW=211.41' (Free Discharge)
└─**1=Culvert** (Passes 9.02 cfs of 14.06 cfs potential flow)
  └─**2=Orifice/Grate** (Orifice Controls 9.02 cfs @ 3.09 fps)

Pond P38: 18" HDPE

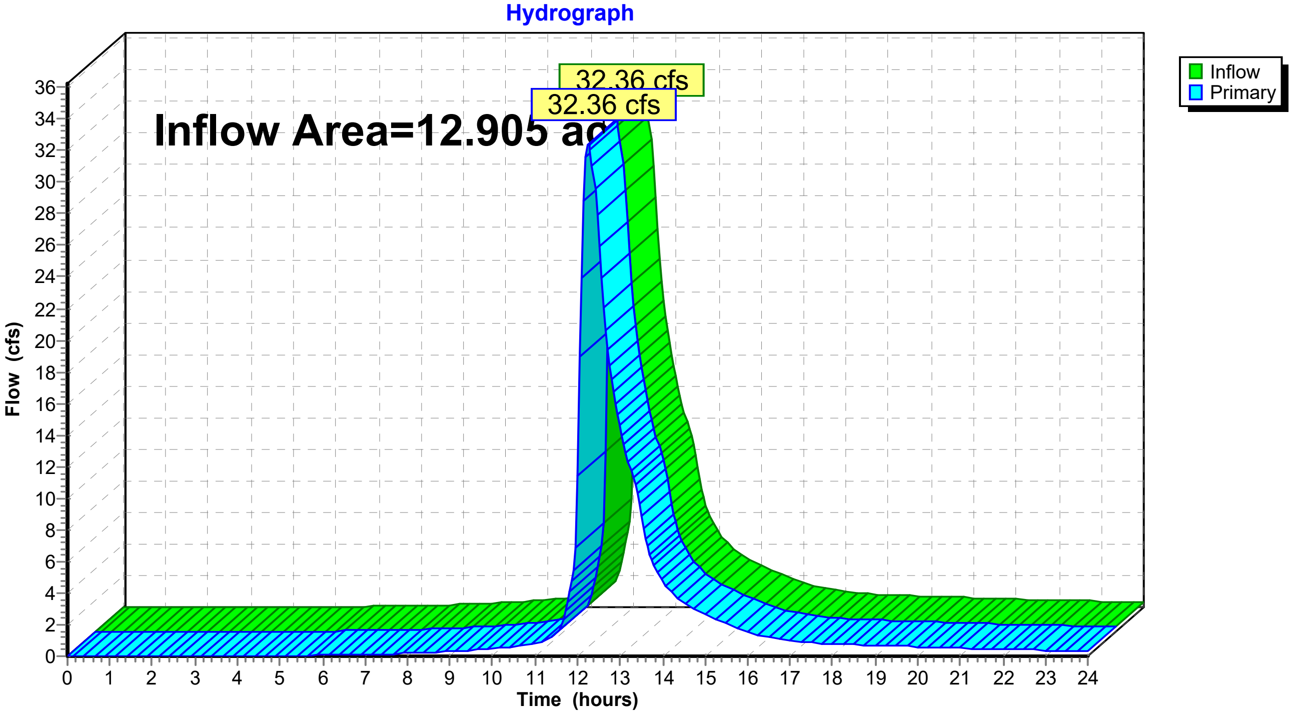


Summary for Link DP-A: Design Point A

Inflow Area =	12.905 ac, 73.65% Impervious,	Inflow Depth > 3.63"	for 100-year 24hr event	
Inflow =	32.36 cfs @	12.26 hrs, Volume=	3.900 af	
Primary =	32.36 cfs @	12.26 hrs, Volume=	3.900 af,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link DP-A: Design Point A

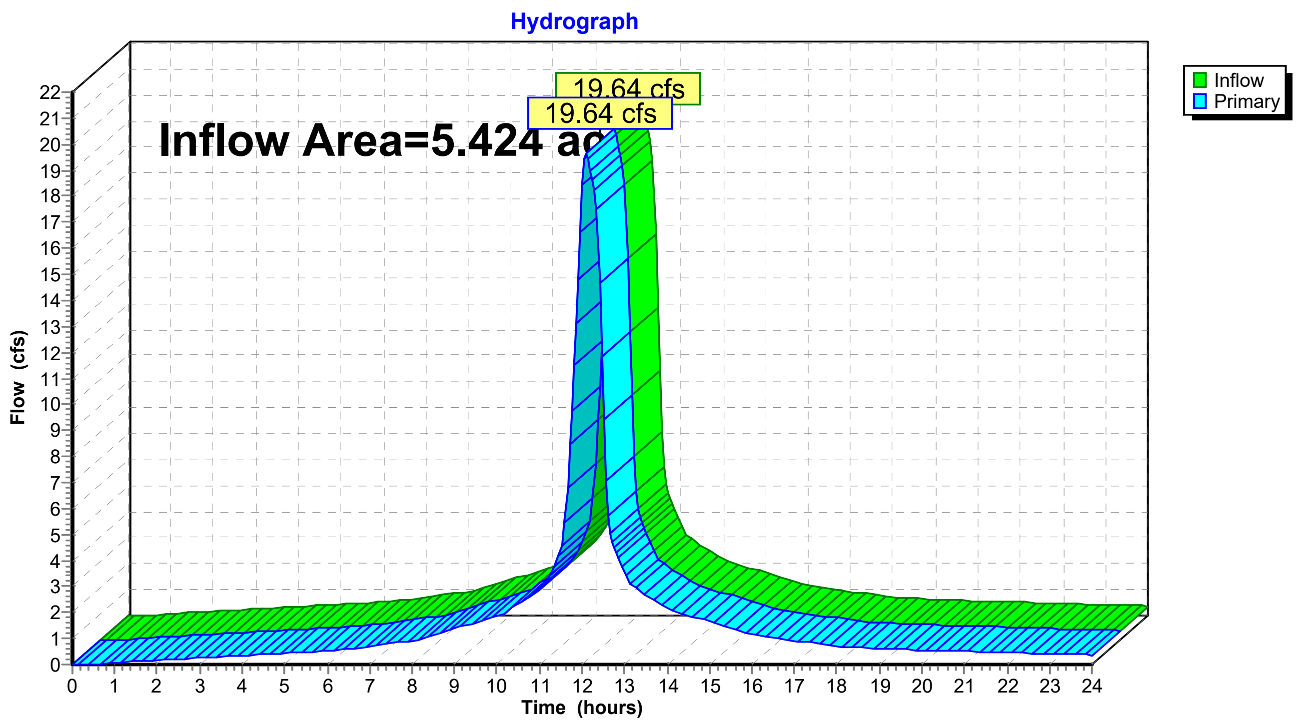


Summary for Link WQU-P5: Water Quality Unit

Inflow Area = 5.424 ac, 88.71% Impervious, Inflow Depth > 6.76" for 100-year 24hr event
Inflow = 19.64 cfs @ 12.10 hrs, Volume= 3.055 af
Primary = 19.64 cfs @ 12.10 hrs, Volume= 3.055 af, Atten= 0%, Lag= 0.0 min
Routed to Pond P1a : Proposed Basin

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

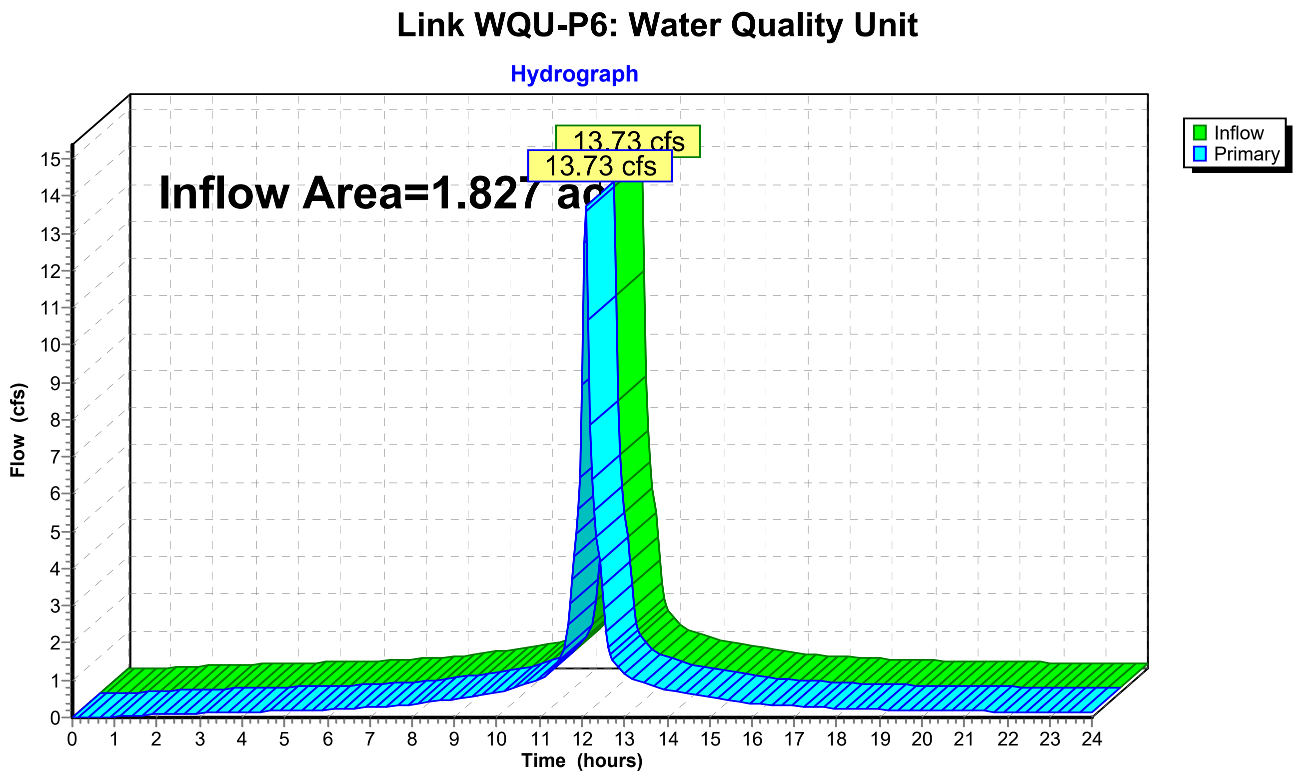
Link WQU-P5: Water Quality Unit



Summary for Link WQU-P6: Water Quality Unit

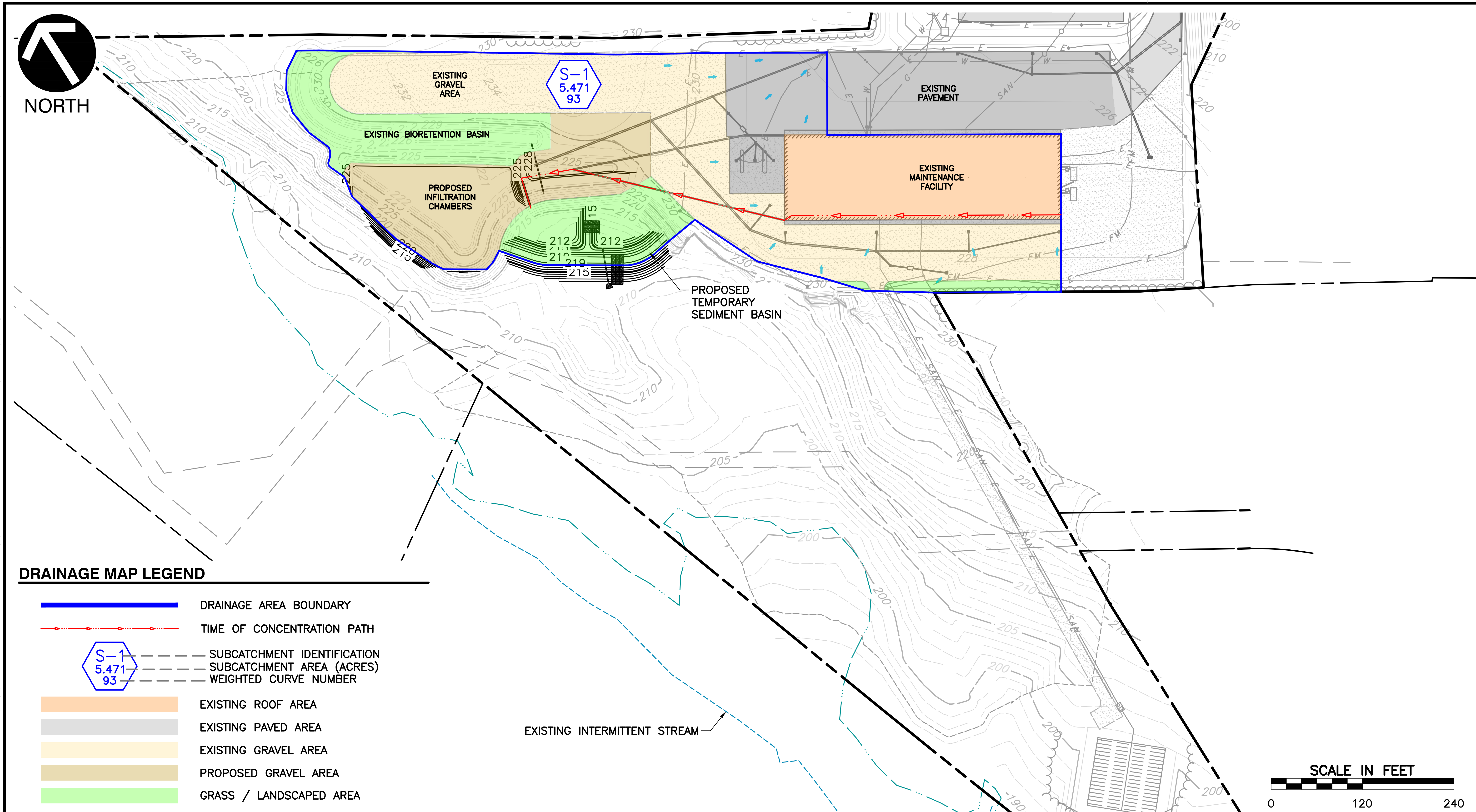
Inflow Area = 1.827 ac, 97.42% Impervious, Inflow Depth > 7.57" for 100-year 24hr event
Inflow = 13.73 cfs @ 12.09 hrs, Volume= 1.152 af
Primary = 13.73 cfs @ 12.09 hrs, Volume= 1.152 af, Atten= 0%, Lag= 0.0 min
Routed to Pond CMB : Underground Storage Chambers

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



APPENDIX E3

INTERIM CONDITIONS DRAINAGE AREA MAP
AND
INTERIM CONDITIONS HYDROCAD ANALYSIS



DRAINAGE MAP LEGEND

- DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION PATH
- S-1 — SUBCATCHMENT IDENTIFICATION
- 5.471 — SUBCATCHMENT AREA (ACRES)
- 93 — WEIGHTED CURVE NUMBER
- EXISTING ROOF AREA
- EXISTING PAVED AREA
- EXISTING GRAVEL AREA
- PROPOSED GRAVEL AREA
- GRASS / LANDSCAPED AREA

CEC
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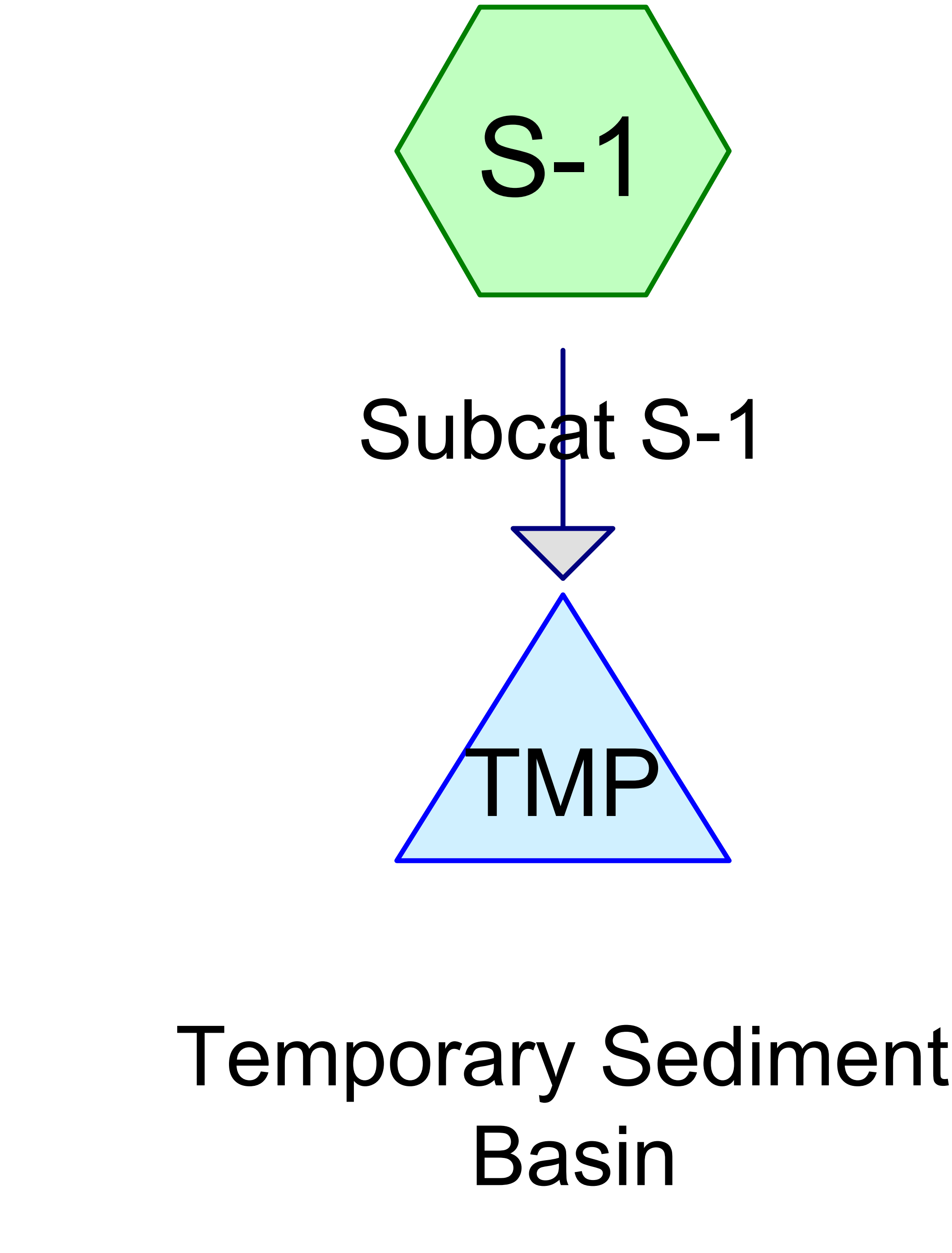
SITE DEVELOPMENT PERMITTING
14 STERLING ROAD, BILLERICA, MA
STERLING ROAD, LLC

INTERIM CONDITIONS DRAINAGE MAP

DRAWN BY: KFH	CHECKED BY: DSK	APPROVED BY: DSK	FIGURE NO.: HYD-INT
DATE: MARCH 2026	DWG SCALE: 1"=120'	PROJECT NO: 347-159	

ENGINEERING, SURVEYING AND LANDSCAPE ARCHITECTURE IN THE STATE OF NORTH CAROLINA WILL BE PROVIDED BY CEC SURVEYING AND LANDSCAPE ARCHITECTS OF NC, PLLC. SERVICES IN PUERTO RICO WILL BE PROVIDED BY CEC ENGINEERS & CONSULTANTS, LLC. LANDSCAPE ARCHITECTURE SERVICES IN THE STATE OF OHIO WILL BE PROVIDED BY CEC LANDSCAPE ARCHITECTS, LLC.



Routing Diagram for 347159-2-INTERIM Stormwater Analysis
Prepared by CEC Inc, Printed 3/10/2026

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-year 24hr	Type III 24-hr		Default	24.00	1	3.19	2
2	10-year 24hr	Type III 24-hr		Default	24.00	1	4.99	2
3	25-year 24hr	Type III 24-hr		Default	24.00	1	6.11	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.112	74	>75% Grass cover, Good, HSG C (S-1)
1.988	98	EX Gravel Surface, Impervious, HSG C (S-1)
0.930	98	PR Gravel Surface, Impervious, HSG C (S-1)
0.507	98	Paved parking, HSG C (S-1)
0.933	98	Roofs, HSG C (S-1)
5.471	**93**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
5.471	HSG C	S-1
0.000	HSG D	
0.000	Other	
5.471		**TOTAL AREA**

Summary for Subcatchment S-1: Subcat S-1

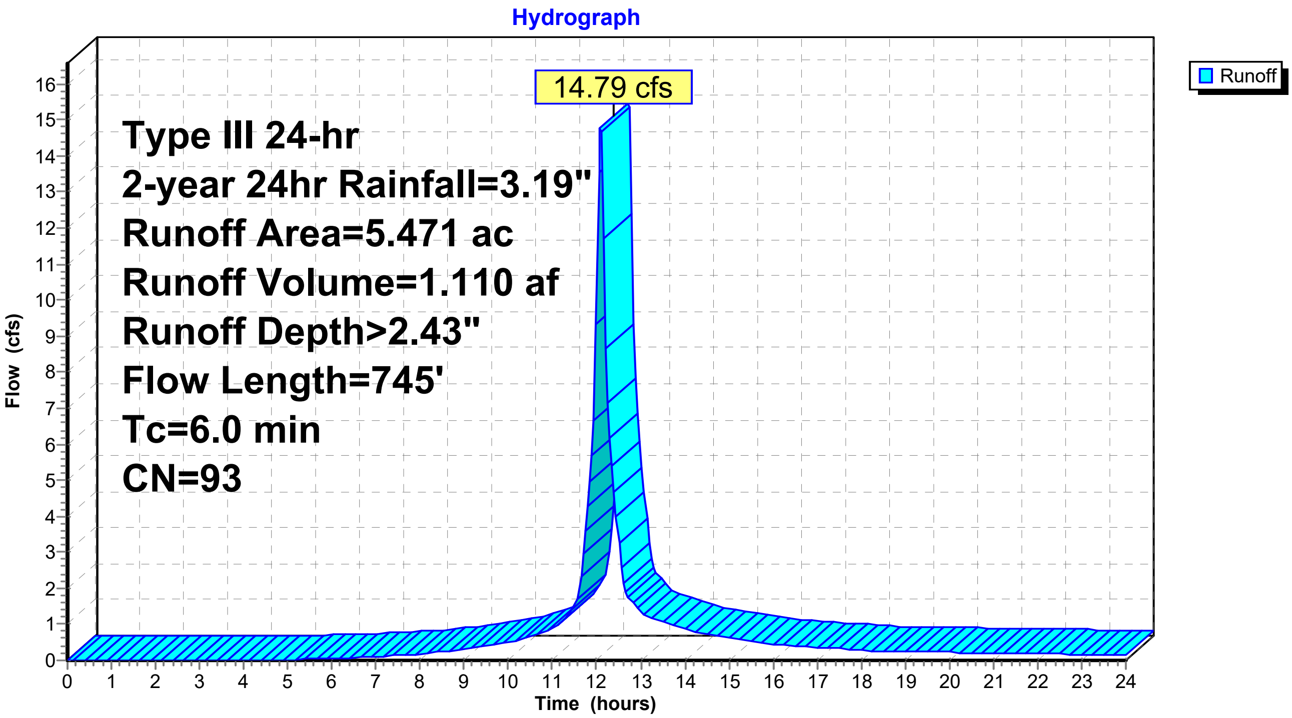
Runoff = 14.79 cfs @ 12.09 hrs, Volume= 1.110 af, Depth> 2.43"
Routed to Pond TMP : Temporary Sediment Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-year 24hr Rainfall=3.19"

Area (ac)	CN	Description
1.112	74	>75% Grass cover, Good, HSG C
1.988	98	EX Gravel Surface, Impervious, HSG C
0.930	98	PR Gravel Surface, Impervious, HSG C
0.507	98	Paved parking, HSG C
0.933	98	Roofs, HSG C
5.471	93	Weighted Average
1.112		20.33% Pervious Area
4.359		79.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.19"
3.5	300	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.1	395	0.0110	6.23	11.02	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
5.8	745	Total, Increased to minimum Tc = 6.0 min			

Subcatchment S-1: Subcat S-1



Summary for Pond TMP: Temporary Sediment Basin

Inflow Area = 5.471 ac, 79.67% Impervious, Inflow Depth > 2.43" for 2-year 24hr event
Inflow = 14.79 cfs @ 12.09 hrs, Volume= 1.110 af
Outflow = 3.56 cfs @ 12.48 hrs, Volume= 1.069 af, Atten= 76%, Lag= 23.6 min
Primary = 3.56 cfs @ 12.48 hrs, Volume= 1.069 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 216.26' @ 12.48 hrs Surf.Area= 8,750 sf Storage= 21,106 cf

Plug-Flow detention time= 158.7 min calculated for 1.069 af (96% of inflow)
Center-of-Mass det. time= 137.6 min (929.9 - 792.3)

Volume	Invert	Avail.Storage	Storage Description
#1	212.00'	50,700 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

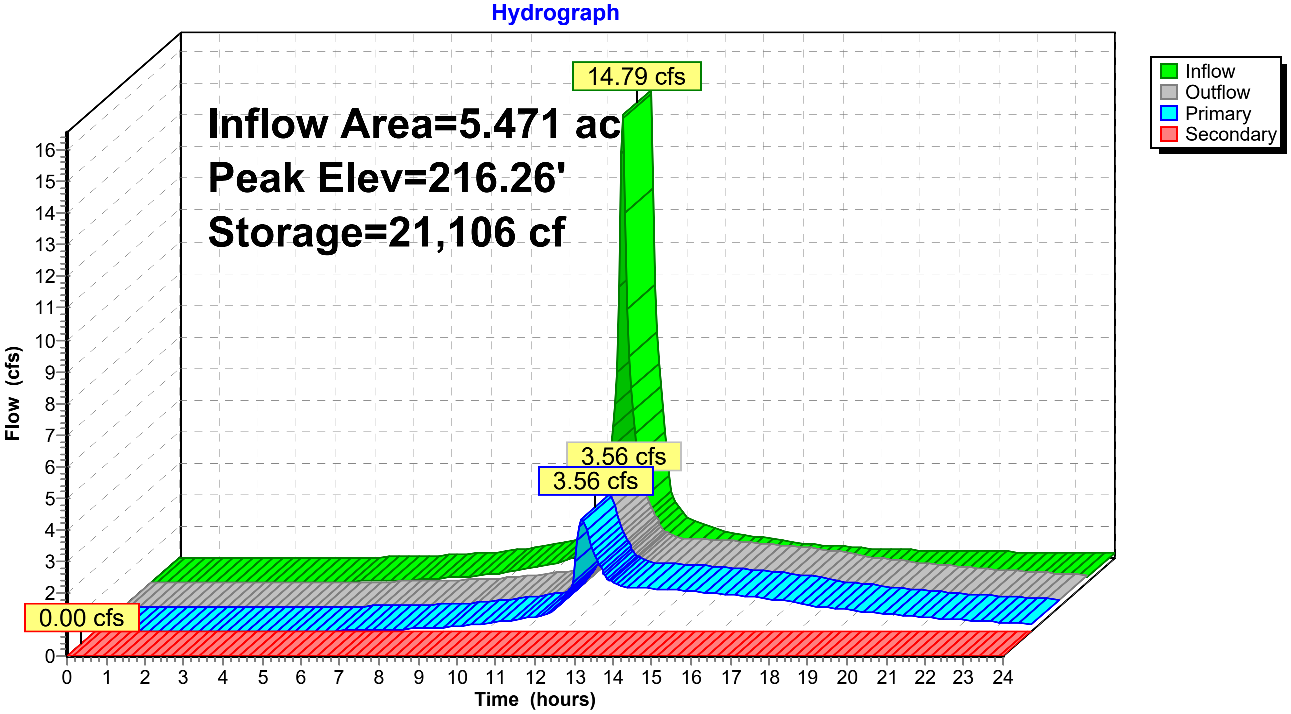
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
212.00	1,000	0	0
213.00	2,600	1,800	1,800
214.00	5,000	3,800	5,600
215.00	6,600	5,800	11,400
217.00	10,000	16,600	28,000
219.00	12,700	22,700	50,700

Device	Routing	Invert	Outlet Devices
#1	Secondary	218.00'	**10.0' long + 3.0 '/' SideZ x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#2	Primary	211.00'	**18.0" Round Culvert** L= 60.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 211.00' / 210.40' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#3	Device 2	212.00'	**0.5" Vert. Orifice/Grate X 16.00 columns** X 8 rows with 4.0" cc spacing C= 0.600 Limited to weir flow at low heads
#4	Device 2	216.00'	**18.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=3.54 cfs @ 12.48 hrs HW=216.26' (Free Discharge)
↑—**2=Culvert** (Passes 3.54 cfs of 18.08 cfs potential flow)
  ↑—**3=Orifice/Grate** (Orifice Controls 1.46 cfs @ 8.38 fps)
  └—**4=Orifice/Grate** (Weir Controls 2.08 cfs @ 1.68 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=212.00' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond TMP: Temporary Sediment Basin



Summary for Subcatchment S-1: Subcat S-1

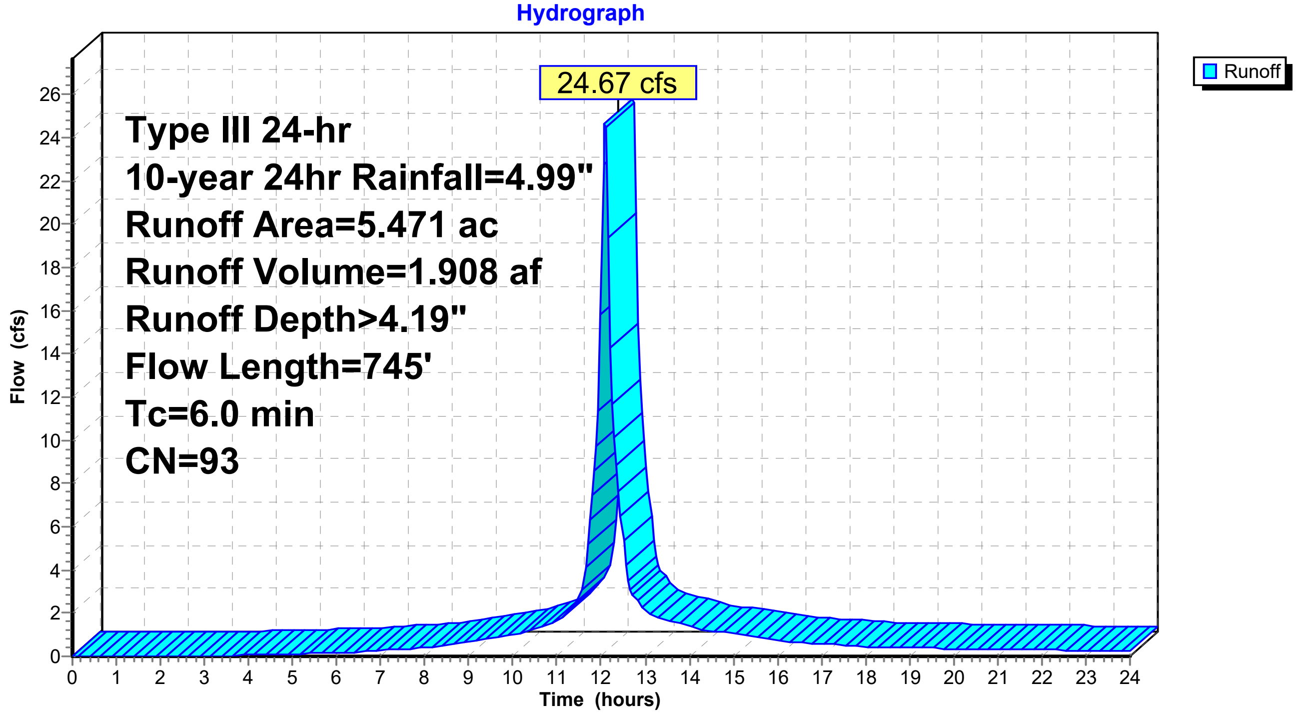
Runoff = 24.67 cfs @ 12.09 hrs, Volume= 1.908 af, Depth> 4.19"
Routed to Pond TMP : Temporary Sediment Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-year 24hr Rainfall=4.99"

Area (ac)	CN	Description
1.112	74	>75% Grass cover, Good, HSG C
1.988	98	EX Gravel Surface, Impervious, HSG C
0.930	98	PR Gravel Surface, Impervious, HSG C
0.507	98	Paved parking, HSG C
0.933	98	Roofs, HSG C
5.471	93	Weighted Average
1.112		20.33% Pervious Area
4.359		79.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.19"
3.5	300	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.1	395	0.0110	6.23	11.02	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
5.8	745	Total, Increased to minimum Tc = 6.0 min			

Subcatchment S-1: Subcat S-1



Summary for Pond TMP: Temporary Sediment Basin

Inflow Area = 5.471 ac, 79.67% Impervious, Inflow Depth > 4.19" for 10-year 24hr event
Inflow = 24.67 cfs @ 12.09 hrs, Volume= 1.908 af
Outflow = 10.54 cfs @ 12.29 hrs, Volume= 1.836 af, Atten= 57%, Lag= 12.1 min
Primary = 10.54 cfs @ 12.29 hrs, Volume= 1.836 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 217.09' @ 12.29 hrs Surf.Area= 10,122 sf Storage= 28,911 cf

Plug-Flow detention time= 125.0 min calculated for 1.836 af (96% of inflow)
Center-of-Mass det. time= 102.8 min (880.7 - 777.9)

Volume	Invert	Avail.Storage	Storage Description
#1	212.00'	50,700 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

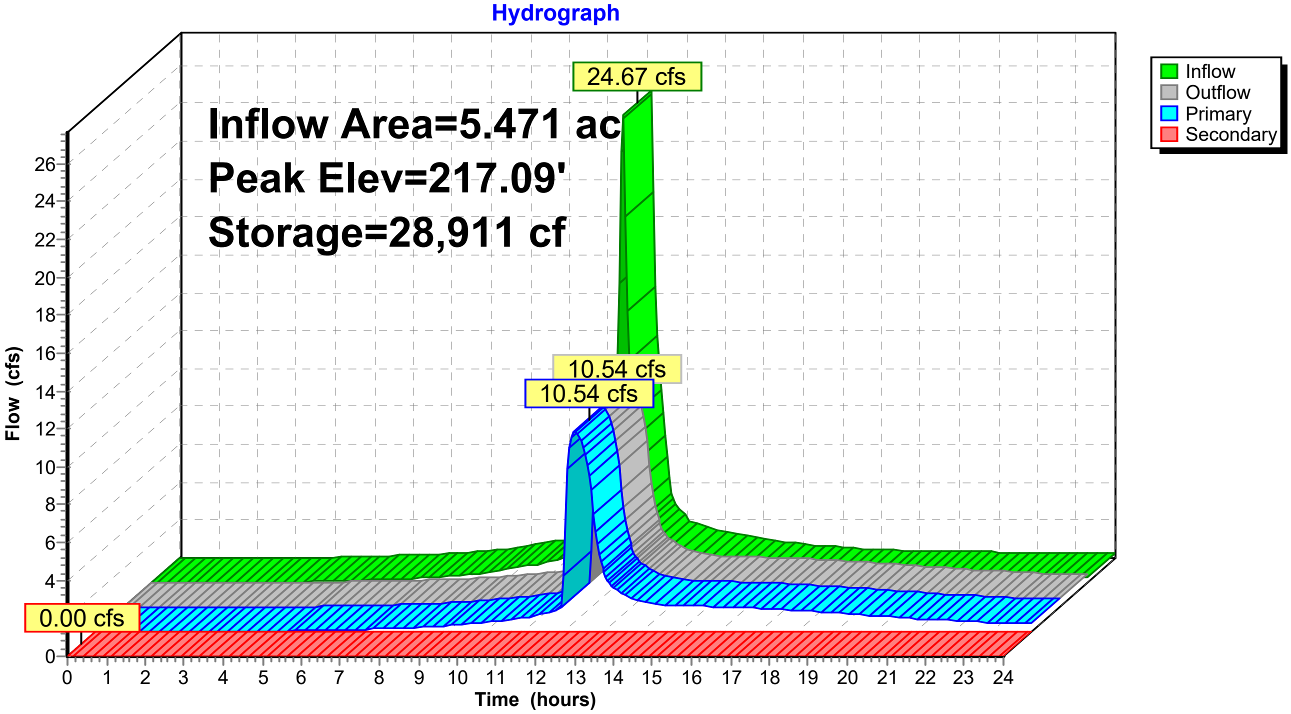
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
212.00	1,000	0	0
213.00	2,600	1,800	1,800
214.00	5,000	3,800	5,600
215.00	6,600	5,800	11,400
217.00	10,000	16,600	28,000
219.00	12,700	22,700	50,700

Device	Routing	Invert	Outlet Devices
#1	Secondary	218.00'	**10.0' long + 3.0 '/' SideZ x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#2	Primary	211.00'	**18.0" Round Culvert** L= 60.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 211.00' / 210.40' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#3	Device 2	212.00'	**0.5" Vert. Orifice/Grate X 16.00 columns** X 8 rows with 4.0" cc spacing C= 0.600 Limited to weir flow at low heads
#4	Device 2	216.00'	**18.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=10.53 cfs @ 12.29 hrs HW=217.09' (Free Discharge)
└─**2=Culvert** (Passes 10.53 cfs of 19.66 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 1.65 cfs @ 9.46 fps)
  └─**4=Orifice/Grate** (Orifice Controls 8.88 cfs @ 5.02 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=212.00' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond TMP: Temporary Sediment Basin



Summary for Subcatchment S-1: Subcat S-1

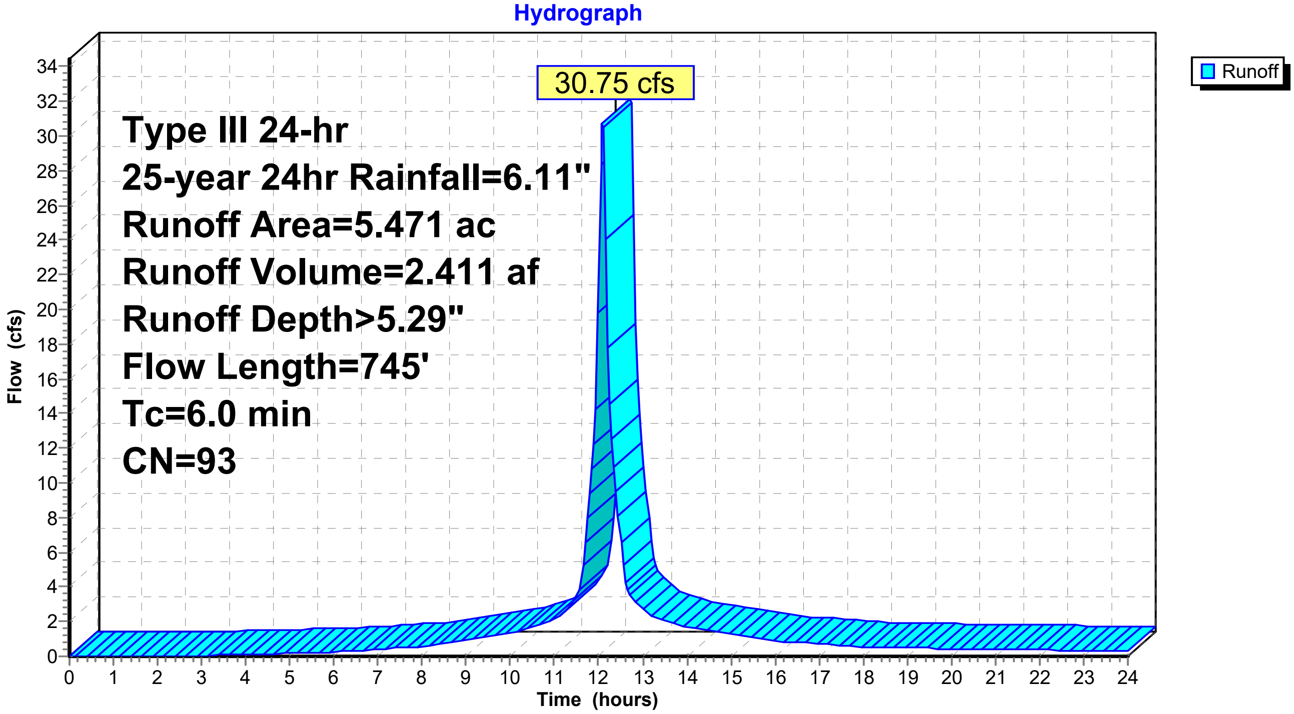
Runoff = 30.75 cfs @ 12.09 hrs, Volume= 2.411 af, Depth> 5.29"
Routed to Pond TMP : Temporary Sediment Basin

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25-year 24hr Rainfall=6.11"

Area (ac)	CN	Description
1.112	74	>75% Grass cover, Good, HSG C
1.988	98	EX Gravel Surface, Impervious, HSG C
0.930	98	PR Gravel Surface, Impervious, HSG C
0.507	98	Paved parking, HSG C
0.933	98	Roofs, HSG C
5.471	93	Weighted Average
1.112		20.33% Pervious Area
4.359		79.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.2	50	0.0050	0.69		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.19"
3.5	300	0.0050	1.44		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.1	395	0.0110	6.23	11.02	**Pipe Channel,** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.013 Corrugated PE, smooth interior
5.8	745	Total, Increased to minimum Tc = 6.0 min			

Subcatchment S-1: Subcat S-1



Summary for Pond TMP: Temporary Sediment Basin

Inflow Area = 5.471 ac, 79.67% Impervious, Inflow Depth > 5.29" for 25-year 24hr event
Inflow = 30.75 cfs @ 12.09 hrs, Volume= 2.411 af
Outflow = 12.78 cfs @ 12.30 hrs, Volume= 2.317 af, Atten= 58%, Lag= 12.6 min
Primary = 12.78 cfs @ 12.30 hrs, Volume= 2.317 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 217.67' @ 12.30 hrs Surf.Area= 10,907 sf Storage= 35,026 cf

Plug-Flow detention time= 114.1 min calculated for 2.313 af (96% of inflow)
Center-of-Mass det. time= 91.5 min (863.6 - 772.0)

Volume	Invert	Avail.Storage	Storage Description
#1	212.00'	50,700 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

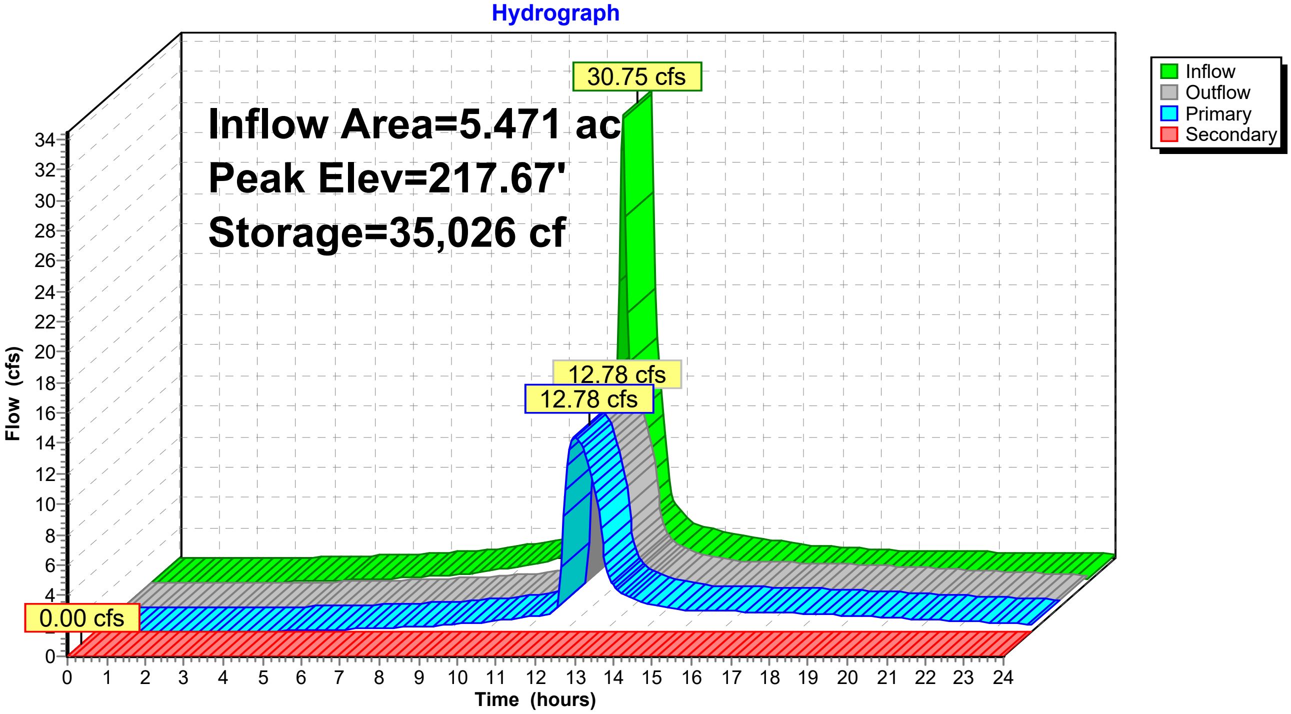
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
212.00	1,000	0	0
213.00	2,600	1,800	1,800
214.00	5,000	3,800	5,600
215.00	6,600	5,800	11,400
217.00	10,000	16,600	28,000
219.00	12,700	22,700	50,700

Device	Routing	Invert	Outlet Devices
#1	Secondary	218.00'	**10.0' long + 3.0 '/' SideZ x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#2	Primary	211.00'	**18.0" Round Culvert** L= 60.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 211.00' / 210.40' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#3	Device 2	212.00'	**0.5" Vert. Orifice/Grate X 16.00 columns** X 8 rows with 4.0" cc spacing C= 0.600 Limited to weir flow at low heads
#4	Device 2	216.00'	**18.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=12.77 cfs @ 12.30 hrs HW=217.67' (Free Discharge)
└─**2=Culvert** (Passes 12.77 cfs of 20.70 cfs potential flow)
  ├─**3=Orifice/Grate** (Orifice Controls 1.77 cfs @ 10.16 fps)
  └─**4=Orifice/Grate** (Orifice Controls 11.00 cfs @ 6.22 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=212.00' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond TMP: Temporary Sediment Basin



APPENDIX F

SUPPORTING CALCULATIONS

F1 - Atlas Rainfall Data
F2 - Water Quality Calculations
F3 - Groundwater Recharge Calculations
F4 - TSS Removal Calculation Worksheets
F5 - Culvert Outlet RipRap Apron Sizing Calculations
F6 - Contech Water Quality Unit Sizing Test Results
F7 - Illicit Discharge Statement

APPENDIX F1

Atlas Rainfall Data

NOAA Atlas 14, Volume 10, Version 3
Location name: North Billerica, Massachusetts, USA*
Latitude: 42.568°, Longitude: -71.3056°
Elevation: 201 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

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	0.316 (0.252-0.392)	0.378 (0.301-0.470)	0.480 (0.380-0.598)	0.565 (0.446-0.709)	0.682 (0.519-0.890)	0.770 (0.573-1.02)	0.863 (0.621-1.19)	0.969 (0.656-1.36)	1.12 (0.729-1.62)	1.25 (0.791-1.84)
10-min	0.447 (0.356-0.555)	0.536 (0.427-0.666)	0.681 (0.540-0.849)	0.801 (0.631-1.00)	0.967 (0.735-1.26)	1.09 (0.812-1.45)	1.22 (0.880-1.68)	1.37 (0.930-1.92)	1.59 (1.03-2.30)	1.77 (1.12-2.61)
15-min	0.526 (0.419-0.653)	0.630 (0.502-0.784)	0.800 (0.635-0.998)	0.942 (0.743-1.18)	1.14 (0.865-1.48)	1.28 (0.954-1.71)	1.44 (1.04-1.98)	1.61 (1.09-2.26)	1.87 (1.22-2.70)	2.08 (1.32-3.07)
30-min	0.720 (0.574-0.894)	0.863 (0.687-1.07)	1.10 (0.871-1.37)	1.29 (1.02-1.62)	1.56 (1.19-2.04)	1.76 (1.31-2.35)	1.98 (1.42-2.72)	2.22 (1.50-3.11)	2.58 (1.67-3.72)	2.87 (1.82-4.23)
60-min	0.913 (0.728-1.13)	1.10 (0.873-1.36)	1.40 (1.11-1.74)	1.64 (1.30-2.06)	1.99 (1.51-2.59)	2.24 (1.67-2.99)	2.51 (1.81-3.47)	2.82 (1.92-3.96)	3.28 (2.13-4.74)	3.66 (2.32-5.39)
2-hr	1.16 (0.932-1.43)	1.41 (1.13-1.74)	1.82 (1.46-2.26)	2.16 (1.72-2.69)	2.63 (2.02-3.43)	2.98 (2.24-3.96)	3.35 (2.45-4.64)	3.81 (2.59-5.32)	4.52 (2.94-6.50)	5.13 (3.26-7.50)
3-hr	1.34 (1.08-1.64)	1.63 (1.32-2.01)	2.12 (1.70-2.61)	2.52 (2.01-3.13)	3.08 (2.38-4.00)	3.49 (2.64-4.63)	3.93 (2.89-5.44)	4.49 (3.06-6.24)	5.36 (3.50-7.68)	6.12 (3.89-8.92)
6-hr	1.71 (1.39-2.08)	2.09 (1.70-2.55)	2.72 (2.20-3.33)	3.24 (2.61-3.99)	3.96 (3.08-5.12)	4.49 (3.42-5.93)	5.07 (3.75-6.98)	5.80 (3.97-8.00)	6.95 (4.55-9.88)	7.95 (5.07-11.5)
12-hr	2.16 (1.77-2.62)	2.65 (2.17-3.21)	3.44 (2.80-4.18)	4.09 (3.32-5.00)	5.00 (3.91-6.40)	5.66 (4.33-7.41)	6.39 (4.74-8.71)	7.29 (5.01-9.98)	8.69 (5.71-12.3)	9.90 (6.34-14.2)
24-hr	2.59 (2.14-3.11)	3.19 (2.63-3.84)	4.17 (3.43-5.04)	4.99 (4.07-6.05)	6.11 (4.82-7.78)	6.94 (5.35-9.03)	7.85 (5.86-10.6)	8.98 (6.20-12.2)	10.7 (7.08-15.1)	12.3 (7.88-17.5)
2-day	2.93 (2.44-3.49)	3.66 (3.05-4.37)	4.86 (4.03-5.82)	5.86 (4.82-7.05)	7.23 (5.74-9.15)	8.23 (6.39-10.7)	9.34 (7.05-12.6)	10.8 (7.45-14.5)	13.0 (8.61-18.1)	15.0 (9.66-21.3)
3-day	3.20 (2.68-3.80)	3.99 (3.34-4.74)	5.28 (4.39-6.29)	6.34 (5.24-7.60)	7.81 (6.23-9.85)	8.88 (6.93-11.5)	10.1 (7.63-13.6)	11.6 (8.06-15.6)	14.1 (9.31-19.5)	16.2 (10.5-22.9)
4-day	3.47 (2.91-4.11)	4.28 (3.59-5.07)	5.61 (4.68-6.67)	6.71 (5.56-8.02)	8.22 (6.58-10.3)	9.33 (7.30-12.0)	10.6 (8.01-14.2)	12.1 (8.45-16.3)	14.7 (9.73-20.3)	16.9 (10.9-23.8)
7-day	4.20 (3.56-4.95)	5.05 (4.26-5.95)	6.43 (5.41-7.60)	7.58 (6.32-9.00)	9.16 (7.36-11.4)	10.3 (8.10-13.2)	11.6 (8.81-15.4)	13.2 (9.23-17.6)	15.8 (10.5-21.7)	18.0 (11.7-25.2)
10-day	4.88 (4.14-5.72)	5.75 (4.88-6.75)	7.17 (6.06-8.44)	8.35 (7.00-9.88)	9.98 (8.04-12.3)	11.2 (8.78-14.1)	12.5 (9.48-16.4)	14.1 (9.88-18.7)	16.6 (11.1-22.7)	18.8 (12.2-26.2)
20-day	6.83 (5.85-7.95)	7.78 (6.66-9.07)	9.34 (7.95-10.9)	10.6 (8.98-12.5)	12.4 (10.0-15.1)	13.7 (10.8-17.1)	15.1 (11.4-19.5)	16.7 (11.8-22.0)	19.0 (12.7-25.7)	20.8 (13.5-28.8)
30-day	8.45 (7.27-9.79)	9.47 (8.14-11.0)	11.1 (9.53-13.0)	12.5 (10.6-14.6)	14.4 (11.7-17.5)	15.9 (12.5-19.6)	17.4 (13.1-22.0)	18.9 (13.4-24.7)	21.0 (14.1-28.3)	22.6 (14.7-31.1)
45-day	10.5 (9.08-12.1)	11.6 (10.0-13.4)	13.4 (11.5-15.5)	14.9 (12.7-17.3)	16.9 (13.8-20.4)	18.6 (14.6-22.7)	20.1 (15.1-25.3)	21.6 (15.4-28.2)	23.6 (15.9-31.7)	24.9 (16.3-34.3)
60-day	12.2 (10.6-14.1)	13.4 (11.6-15.4)	15.3 (13.2-17.7)	16.9 (14.5-19.6)	19.1 (15.6-22.8)	20.8 (16.4-25.3)	22.4 (16.9-28.0)	23.9 (17.1-31.0)	25.8 (17.5-34.6)	27.1 (17.7-37.1)

[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.

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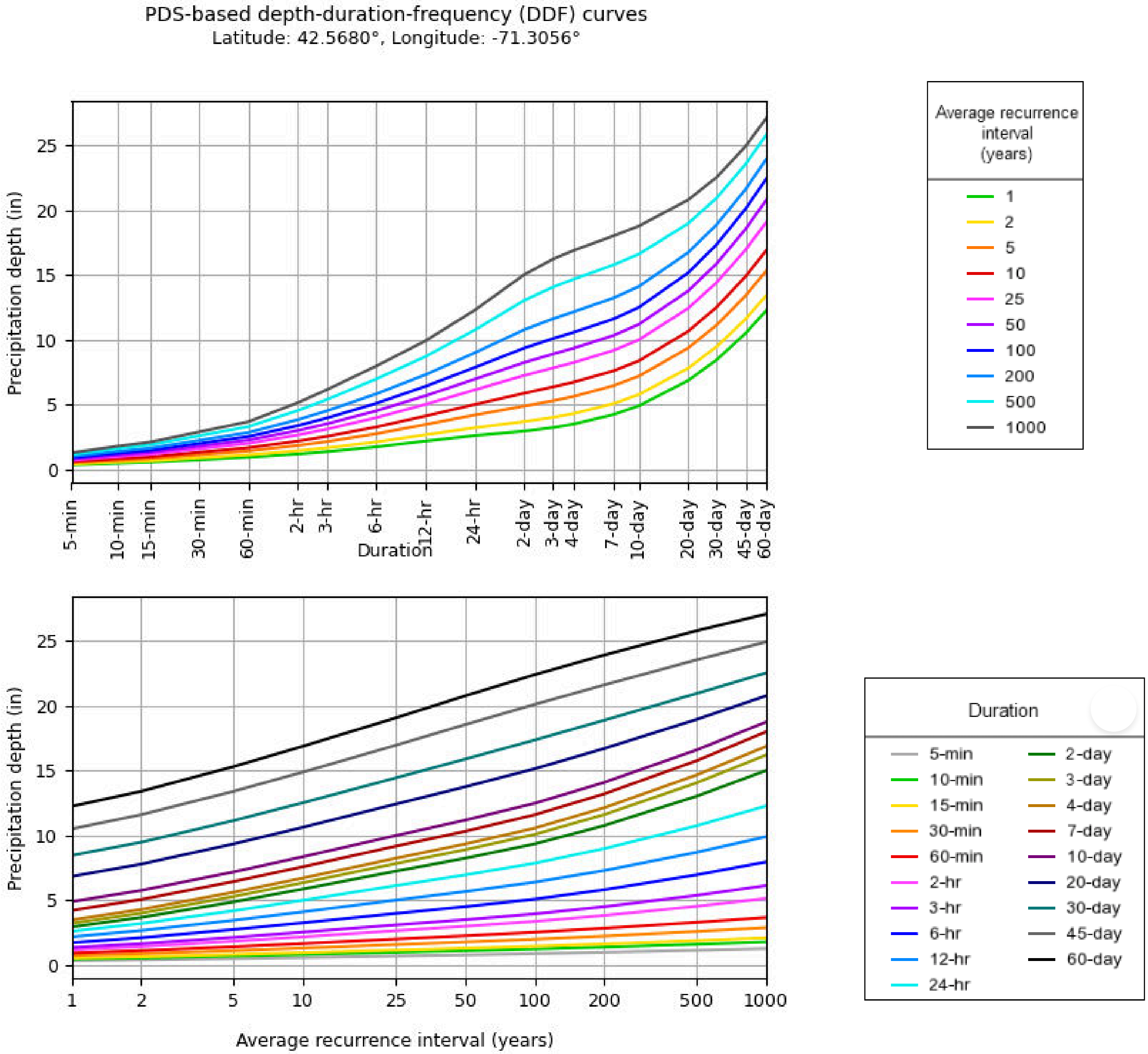
PF graphical



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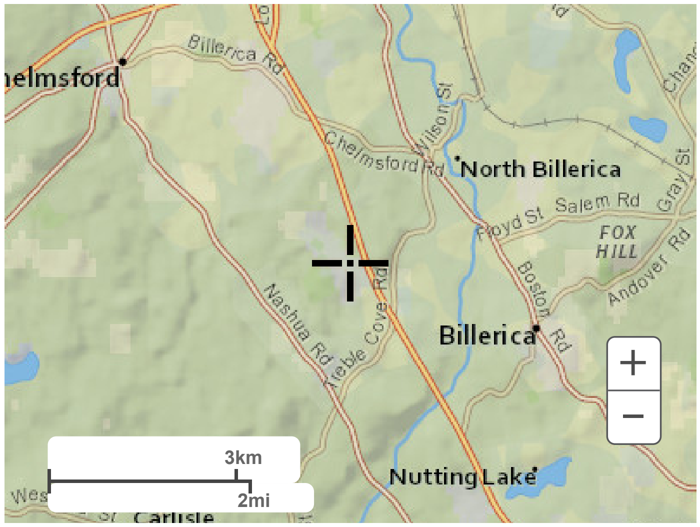
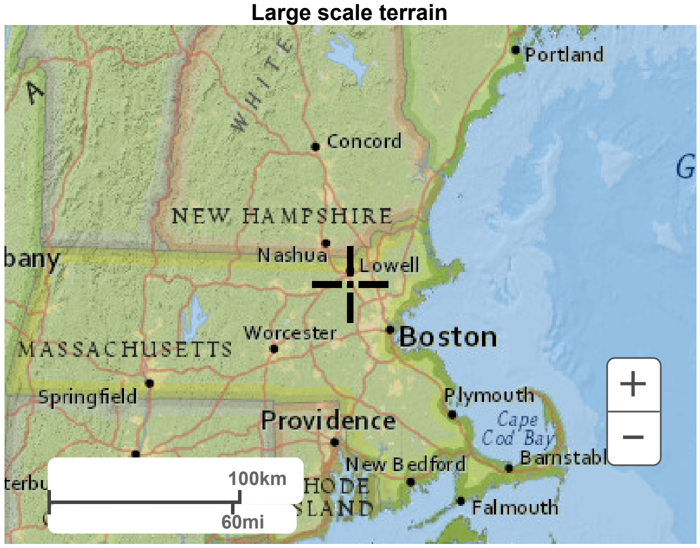
Maps & aerials

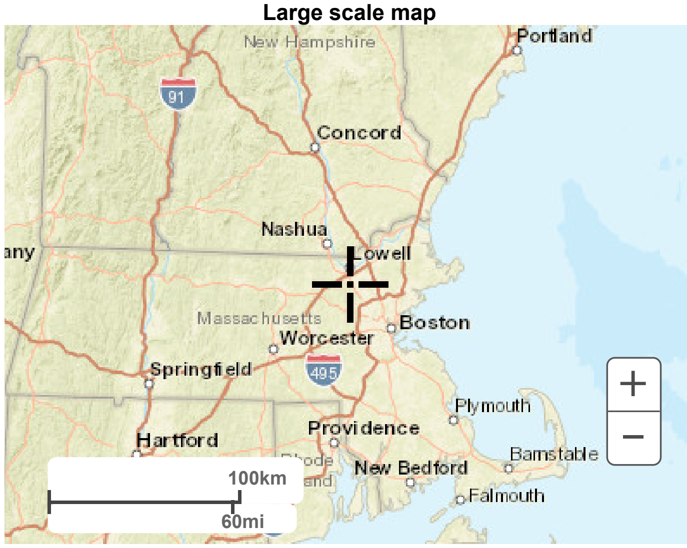
Small scale terrain



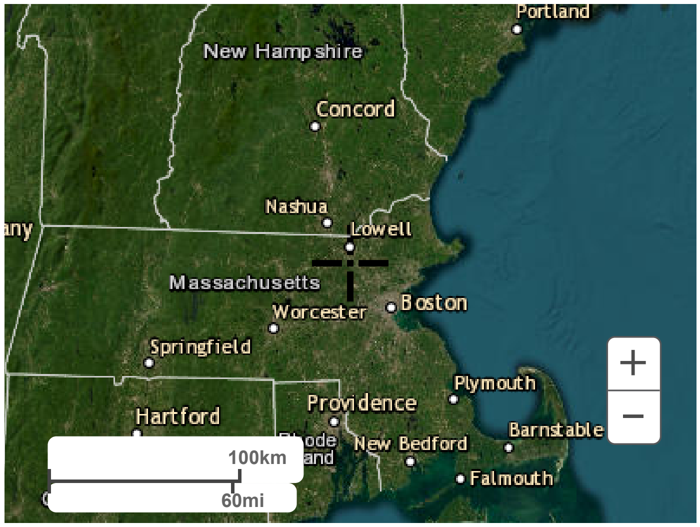
Large scale terrain



Large scale map



Large scale aerial



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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

APPENDIX F2

Water Quality Calculations

Water Quality Volume Flow Rate Calculations

Project Name:	Site Development Permitting	Date:	Mar. 2026
Project Location:	14 Sterling Road, Billerica, MA	Calculated By:	KFH
Project Number:	347-159	Checked By:	DSK

Structure Name: WQU-P5 Description: Contech Cascade CS-6
Subcatchment: P-A3a through P-A3e, PA-4

Total Drainage Area: 5.424 ac

% Impervious: 88.71%
Total Impervious Area: 4.812 ac
**Refer to HydroCAD Report*

Runoff Depth to be Treated: 1.0 inches

Required Water Quality Volume:	**17,466**	**cf**
	0.401	ac ft

FLOW RATE CONVERSION*

Q = (qu)(A)(WQV)

Where:

Q = flow rate associated with the depth of runoff, in cfs
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area, in square miles
WQV = water quality volume in watershed inches

Given:

1-acre = 0.0015625 mi^2
6 minute = 0.01 hours
qu (**1**-inch) = **774** csm/in

Calculation:

qu= **774**
A= 4.81 ac
WQV= 1.0 in

Required Water Quality Flow Rate:	**5.82**	**cfs****

Proposed sediment forebay attenuates equivalent water quality flow rate for 0.401 ac-ft of flow to **5.22 cfs, refer to attached HydroCAD output.

Contech WQU Device CS-6 will provide a min. of 80% TSS Removal Efficiency below 5.6 cfs (See Attached Documentation)

(Based on Manufacturer's sizing. See attached documentation.)

* Flow rate conversion based on the Massachusetts Department of Environmental Protection Wetlands Program - Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Practices

Water Quality Volume Flow Rate Calculations

Project Name:	Site Development Permitting	Date:	Mar. 2026
Project Location:	14 Sterling Road, Billerica, MA	Calculated By:	KFH
Project Number:	347-159	Checked By:	DSK

Structure Name: WQU-P6 Description: Contech Cascade CS-5
Subcatchment: P-A2a through P-A2c

Total Drainage Area: 1.827 ac

% Impervious: 97.42%
Total Impervious Area: 1.780 ac
**Refer to HydroCAD Report*

Runoff Depth to be Treated: 1.0 inches

Required Water Quality Volume:	**6,461**	**cf**
	0.148	ac ft

FLOW RATE CONVERSION

Q = (qu)(A)(WQV)

Where:

Q = flow rate associated with the depth of runoff, in cfs
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area, in square miles
WQV = water quality volume in watershed inches

Given:

1-acre = 0.0015625 mi^2
6 minute = 0.01 hours
qu (**1**-inch) = **774** csm/in

Calculation:

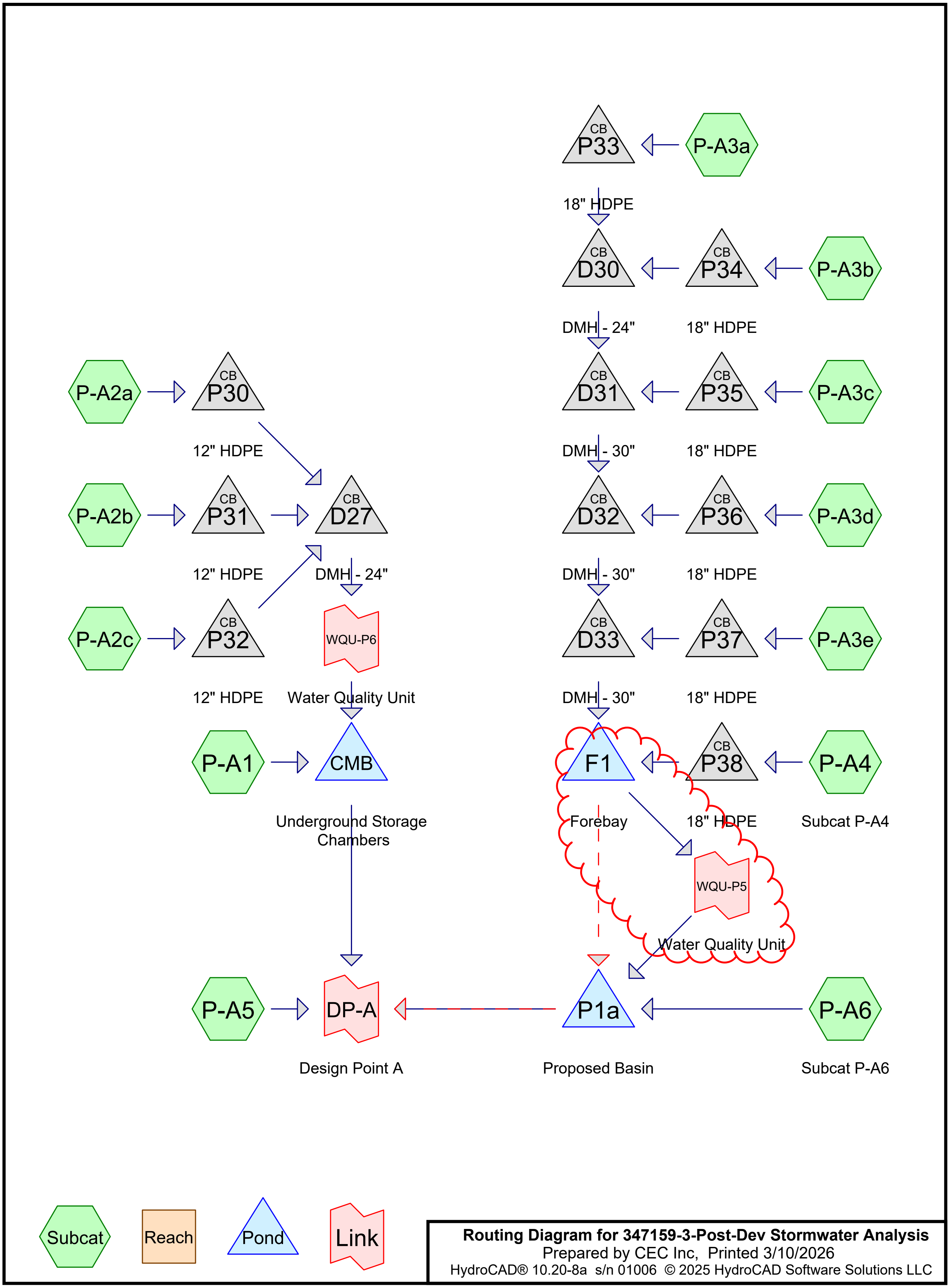
qu= **774**
A= 1.78 ac
WQV= 1.0 in

Required Water Quality Flow Rate:	**2.15**	**cfs**

Contech WQU Device CS-5 will provide a min. of 80% TSS Removal Efficiency below 3.5 cfs (See Attached Documentation)

(Based on Manufacturer's sizing. See attached documentation.)

* Flow rate conversion based on the Massachusetts Department of Environmental Protection Wetlands Program - Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Practices



Routing Diagram for 347159-3-Post-Dev Stormwater Analysis
Prepared by CEC Inc, Printed 3/10/2026
HydroCAD® 10.20-8a s/n 01006 © 2025 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	1" WQ Volume	Type III 24-hr		Default	24.00	1	1.28	2

Refer to Post-Development HydroCAD Model Output located in Appendix E for a complete report which includes the proposed conditions areas, soil listing, subcatchments, etc.

Summary for Pond F1: Forebay

Inflow Area = 5.424 ac, 88.71% Impervious, Inflow Depth > 0.89" for 1" WQ Volume event
Inflow = 5.21 cfs @ 12.09 hrs, Volume= 0.402 af
Outflow = 5.22 cfs @ 12.10 hrs, Volume= 0.401 af, Atten= 0%, Lag= 0.3 min
Primary = 5.22 cfs @ 12.10 hrs, Volume= 0.401 af
Routed to Link WQU-P5 : Water Quality Unit
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond P1a : Proposed Basin

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 205.26' @ 12.10 hrs Surf.Area= 583 sf Storage= 138 cf

Plug-Flow detention time= 0.8 min calculated for 0.401 af (100% of inflow)
Center-of-Mass det. time= 0.7 min (793.1 - 792.4)

Volume	Invert	Avail.Storage	Storage Description
#1	205.00'	3,235 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

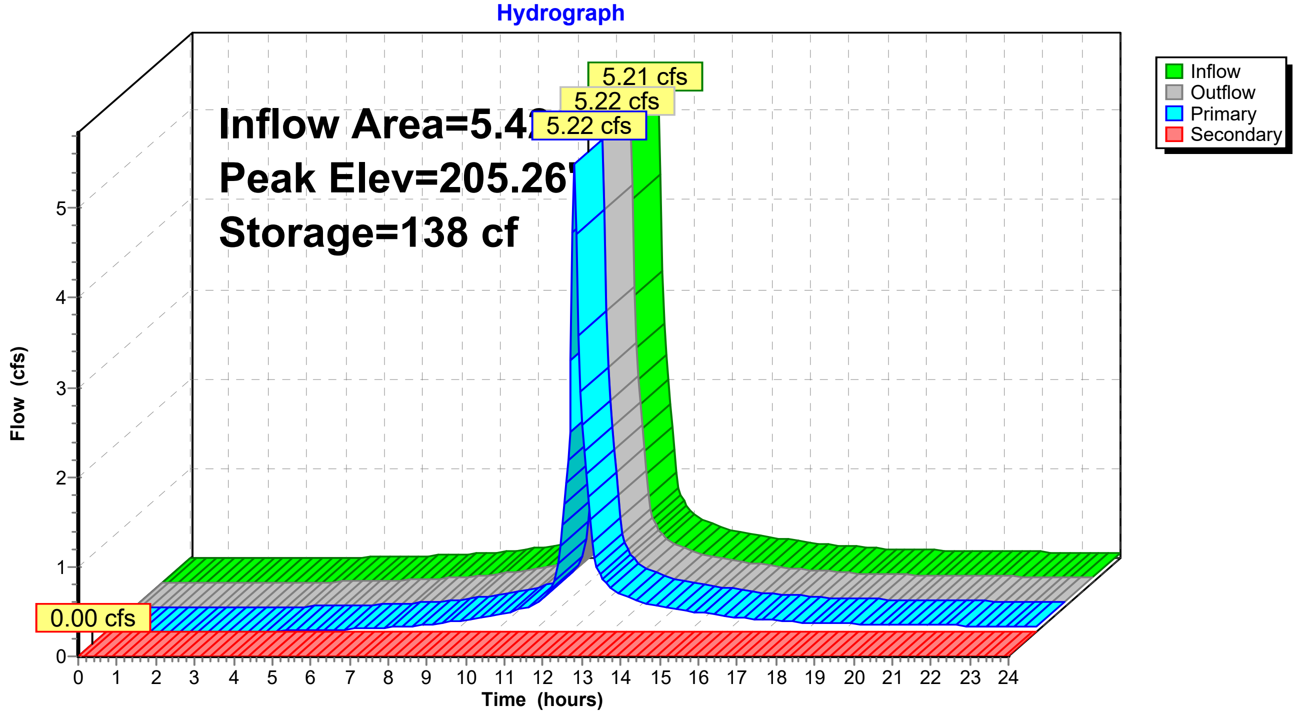
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
205.00	480	0	0
207.00	1,270	1,750	1,750
208.00	1,700	1,485	3,235

Device	Routing	Invert	Outlet Devices
#1	Primary	201.60'	**18.0" Round 18" Culvert** L= 30.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 201.60' / 201.30' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf
#2	Device 1	205.00'	**1.0" x 21.0" Horiz. Double Grate X 10.00 columns** X 2 rows C= 0.600 in 24.0" x 48.0" Grate (36% open area) Limited to weir flow at low heads
#3	Secondary	207.00'	**12.0' long + 2.0 '/' SideZ x 10.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.49 2.56 2.70 2.69 2.68 2.69 2.67 2.64

Primary OutFlow Max=5.21 cfs @ 12.10 hrs HW=205.26' (Free Discharge)
↑—**1=18" Culvert** (Passes 5.21 cfs of 14.52 cfs potential flow)
↑—**2=Double Grate** (Weir Controls 5.21 cfs @ 1.67 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=205.00' (Free Discharge)
↑—**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond F1: Forebay

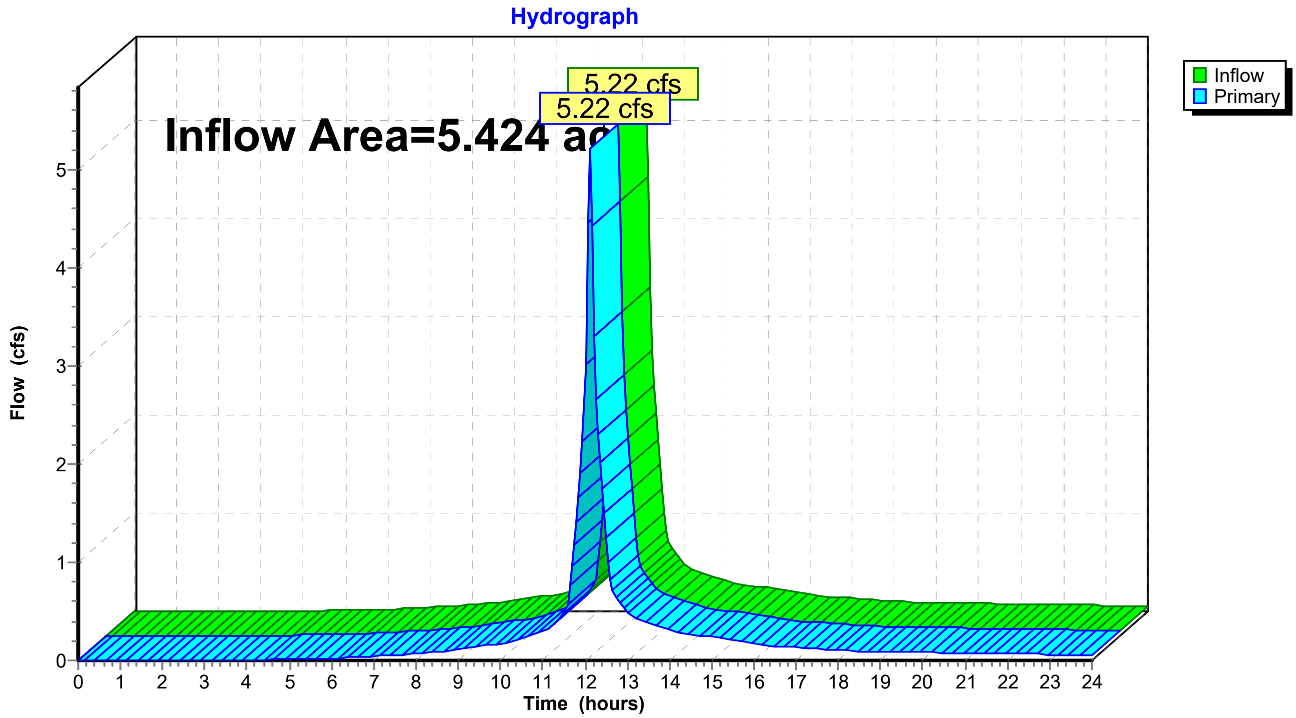


Summary for Link WQU-P5: Water Quality Unit

Inflow Area = 5.424 ac, 88.71% Impervious, Inflow Depth > 0.89" for 1" WQ Volume event
Inflow = 5.22 cfs @ 12.10 hrs, Volume= 0.401 af
Primary = 5.22 cfs @ 12.10 hrs, Volume= 0.401 af, Atten= 0%, Lag= 0.0 min
Routed to Pond P1a : Proposed Basin

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Link WQU-P5: Water Quality Unit



APPENDIX F3

Groundwater Recharge Calculations

Groundwater Recharge Calculations

Project Name:	W.L. French Site Development Permitting	Date:	Mar. 2026
Project Location:	14 Sterling Road, Billerica, MA	Calculated By:	KFH
Project Number:	347-159	Checked By:	DSK

OVERALL SITE RECHARGE

Existing Conditions Impervious Area

Hydraulic Soil Group	Area (sq ft)	Area (acres)	Recharge Depth (in)	Volume (cu ft)
A	0	0.00	0.60	0
B	0	0.00	0.35	0
C	160,100	3.68	0.25	3,336
D	0	0.00	0.10	0
TOTAL	**160,100**	**3.68**		**3,336**

Proposed Conditions Impervious Area

Hydraulic Soil Group	Area (sq ft)	Area (acres)	Recharge Depth (in)	Volume (cu ft)
A	0	0.00	0.60	0
B	0	0.00	0.35	0
C	435,200	9.99	0.25	9,067
D	19,900	0.46	0.10	166
TOTAL	**455,100**	**10.45**		**9,233**

Net Required Recharge Volume: 5,897 cu ft

Capture Area Adjustment

* Impervious Area to Recharge Facility:	4.63	ac
Total Site Impervious Area:	10.45	ac
** Impervious Ratio:	2.26	

* (includes portions of the existing pavement and the maintenance facility roof area)

** (Total Site Impervious / Impervious Area to Recharge Facility)

Adjusted Required Recharge Volume: 13,303 cu ft

Groundwater Recharge Calculations

Project Name:	W.L. French Site Development Permitting	Date:	Mar. 2026
Project Location:	14 Sterling Road, Billerica, MA	Calculated By:	KFH
Project Number:	347-159	Checked By:	DSK

Stormwater BMP: Underground Chambers (node CMB)   Description: Retain-It 3.5' Chambers

Provided Recharge Volume

Bottom of Stone:	219.75	ft
Overflow Outlet Elevation:	222.75	ft
*** Volume Provided:	36,642	cu ft

*** (See attached HydroCAD output)

Total Provided Recharge Volume:	**36,642**	**cu ft**

72-hour Drawdown Calculation

Provided Recharge Volume:	36,642	cu ft
Saturated Hydraulic Conductivity:	2.41	in / hr
Bottom Area:	16,464	sq ft
Drawdown Time:	**11.1**	**hours**

(Rawls Rate for Loamy Sand was used)

APPENDIX F4

TSS Removal Calculation Worksheets

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

TSS Removal Calculation Worksheet

Location: Infiltration Basin P1

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
Contech Water Quality Unit	**0.80**	**0.75**	**0.60**	**0.15**
Infiltration Basin	**0.80**	**0.15**	**0.12**	**0.03**

Total TSS Removal = 97%

Project: **14 Sterling Road, Billerica, MA**
Prepared By: **KFH**
Date: **March 2026**

*Equals remaining load from previous BMP (E) which enters the BMP

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

TSS Removal Calculation Worksheet

Location: Underground Infiltration Chambers

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
Contech Water Quality Unit	**0.80**	**0.75**	**0.60**	**0.15**
Subsurface Infiltration Structure	**0.80**	**0.15**	**0.12**	**0.03**

Total TSS Removal = 97%

Project: **14 Sterling Road, Billerica, MA**
Prepared By: **KFH**
Date: **March 2026**

*Equals remaining load from previous BMP (E) which enters the BMP

APPENDIX F5

Culvert Outlet RipRap Apron Sizing Calculations

Project Name: Site Development Permitting **Date:** Mar. 2026
Project Location: 14 Sterling Road, Billerica, MA **Calculated By:** KFH
Project Number: 347-159 **Checked By:** DSK

CULVERT OUTLET RIP-RAP APRON SIZING CALCULATION

References: USDA Soil Conservation Service, Minnesota Technical Note #3, "Loose Riprap Protection," July 1989.

Objective: Determine the minimum culvert outlet apron dimensions and riprap gradation (D_{50}) based on stormwater discharge and tailwater conditions.

Methodology:

Step 1: Determine Equivalent Single Culvert Diameter (as required)
(if there is only one culvert, skip to Step 2)

When multiple culverts are present, the outlet protection must be sized adequately for all culverts. To account for multiple culverts, a dimensionless Discharge Intensity (D.I.) value, which relates the shape of the culvert to the potential development of scour, should be calculated for each culvert. The total D.I. value is equal to the individual culvert D.I. values and represents an equivalent single culvert diameter. The equivalent single culvert diameter is used to determine the required minimum riprap D50.

Common parameters for round culverts used in equation 3.8 are displayed in Table 3-1 below for reference.

$$D.I. = \frac{Q}{A(gR)^{0.5}}$$ Equation 3.8

Where,
- D.I. = discharge intensity (dimensionless)
- A = area of flow, ft^2
- Q = discharge, ft^3/s (obtained from HydroCAD Analysis)
- g = gravitational constant, 32.2 $ft./s^2$
- R = hydraulic radius of culvert, ft.

Table 3-1. Parameters for Round Conduits

Diameter (inches)	Area (sq ft)	Perimeter (feet)	Hydraulic Radius	$A(gR)^{0.5}$
12	0.785	3.142	0.25	2.23
15	1.227	3.927	0.3125	3.89
18	1.767	4.712	0.375	6.14
24	3.142	6.28	0.5	12.61
30	4.909	7.85	0.625	22.02
36	7.069	9.425	0.75	34.74
42	9.621	11.00	0.875	51.068
48	12.566	12.56	1.0	71.306
54	15.904	14.14	1.125	95.721
60	19.635	15.708	1.25	124.57

Step 2: Determine tailwater condition

Tailwater depth is defined as the liquid depth immediately downstream of a structure. In the case of culverts, the tailwater depth determines whether a culvert is unsubmerged or submerged. Equation 10.4 below is limited to a tailwater depth between 0.4D and 1.0D of the culvert(s). Submerged conditions and appropriate equations are described in more detail in Step 5.

Step 3: Calculate riprap D_{50}

$$D_{50} = 0.2D\left(\frac{Q}{\sqrt{g} * D^{2.5}}\right)^{4/3}\left(\frac{D}{TW}\right) \qquad \text{Equation 10.4}$$

Where,

D_{50} = riprap size, ft.

Q = discharge, ft^3/s (obtained from HydroCAD Analysis)

D = culvert diameter (circular), ft.

TW = tailwater depth, ft. (obtained from HydroCAD Analysis)

g = gravitational constant, 32.2 $ft./s^2$

Note:
1. Equation 10.4 assumes that the riprap specific gravity is 2.65. If the actual specific gravity differs from this assumed value, the D_{50} should be adjusted accordingly to the actual specific gravity.
2. If the tailwater depth is unknown, assume a tailwater depth equal to 0.4D.

Step 4: Determine riprap class

The riprap class chosen from the table below shall be greater than the minimum required D_{50} calculated from Equation 10.4.

Table 10.1. Example Riprap Classes and Apron Dimensions

Class	D_{50} (mm)	D_{50} (in)	Apron Length[1]	Apron Depth
1	125	5	4D	$3.5D_{50}$
2	150	6	4D	$3.3D_{50}$
3	250	10	5D	$2.4D_{50}$
4	350	14	6D	$2.2D_{50}$
5	500	20	7D	$2.0D_{50}$
6	550	22	8D	$2.0D_{50}$

[1]D is the culvert rise.

Note:
1. Riprap class is only used to determine empirical relationships between depth of riprap and apron length and a D_{50} of riprap and apron depth. Additional design calculations may be needed to confirm riprap stability based on project specific criteria.
2. For design consistency, a minimum riprap D_{50} of 6 inches will be used for all aprons regardless of riprap class determination based on Table 10.1

Step 5: Determine apron length and depth based on riprap class

Table 10.1 provides apron length as a function of the culvert diameter and the depth (i.e. thickness of stone layer) as a function of the D_{50}.

If the culvert is in an unsubmerged condition, 0.4D<TW<1.0D, the riprap gradation and apron dimension determination is complete.

If the culvert is in a submerged condition, TW>1.0D, the riprap gradation requires further evaluated as described in steps 7 and 8 below to determine if it is sufficient to avoid downstream scour.

Step 6: Determine if beaching is likely to occur

Beaching, the relocation of eroded materials, may occur when there is scour of apron material at the outlet of the culvert. The potential for this to occur is evaluated with Equation 3.9 below and should be evaluated under all tailwater conditions.

$$\frac{Q}{(gD^5)^{0.5}} \leq 1 + \frac{25 * D_{50}}{D} \qquad \text{Equation 3.9}$$

Step 7: Use Figure 10.3 to determine the average velocity at the end of the rip-rap apron

For tailwater conditions above the acceptable range for Equation 10.4 (TW > 1.0D), Figure 10.3 is used to determine the velocity downstream of the culvert. The average velocity, V_{ave}, is obtained from a separate calculation while the apron length is determined as described in Step 5 above.

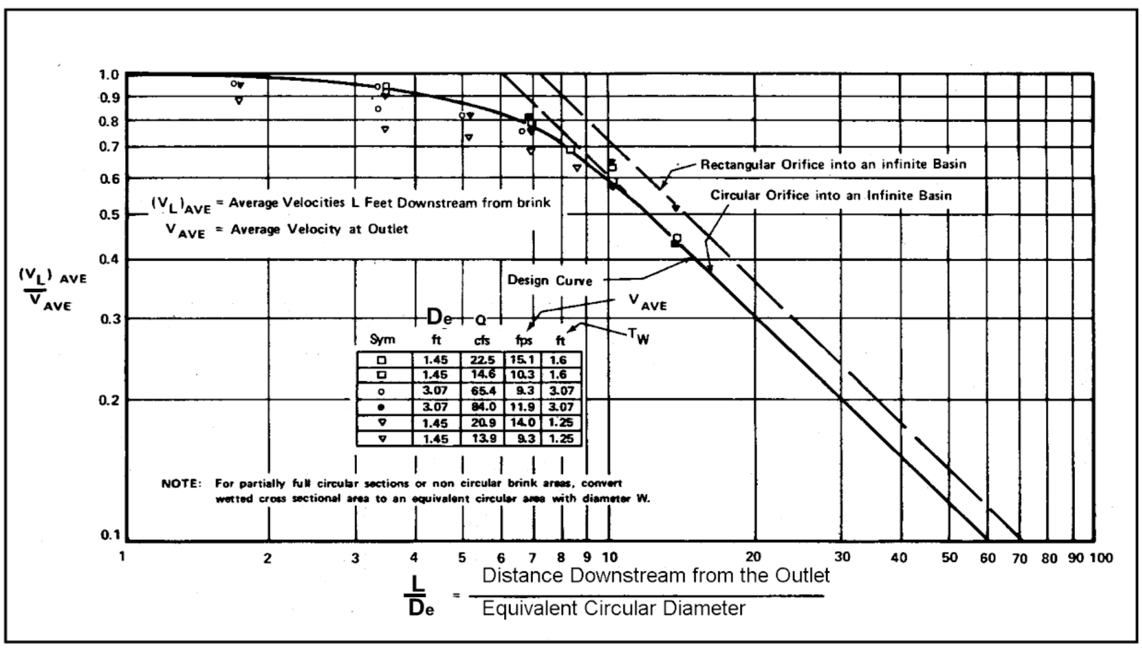


Figure 10.3. Distribution of Centerline Velocity for Flow from Submerged Outlets

Step 8: Calculate D_{50} based on velocity at the end of the riprap apron

Under tailwater conditions greater than 1.0D, it is appropriate to estimate the attenuation of the flow velocity downstream of the culvert outlet using Figure 10.3 as described in Step 7. This procedure can be used to confirm the minimum required riprap D50 after flow attenuation at a distance, L, downstream from the culvert discharge is adequately sized, based on Equation 10.6.

The specified riprap gradation shall be the larger D50 determined by comparing values from Equations 10.4 and 10.6 to prevent downstream scour.

$$D_{50} = \frac{0.692}{S-1}\left(\frac{V^2}{2g}\right) \qquad \text{Equation 10.6}$$

Where

- S = riprap specific gravity
- V = velocity at the end of the riprap apron ft./s = $(V_L)_{AVE}$
- g = gravitational acceleration

Project Name: Site Development Permitting
Project Location: 14 Sterling Road, Billerica, MA
Project Number: 347-159
Date: Mar. 2026
Calculated By: KFH
Checked By: DSK

RIP-RAP APRON SIZING CALCULATION
Temporary Outlet Protection #T1
(Sediment Basin Outlet Culvert)

Step 1: Determine Equivalent Single Culvert Diameter
(Not applicable)

Step 2: Determine tailwater condition

TW = 0.6 ft. (TW is unknown, therefore it is assumed to equal 0.4 D)
D = 1.50 ft.

TW < D thus the culvert is in unsubmerged conditions

Step 3: Calculate riprap D_{50}

$$D_{50} = 0.2D\left(\frac{Q}{\sqrt{g}*D^{2.5}}\right)^{4/3}\left(\frac{D}{TW}\right)$$

Given,
Q = 12.78 ft^3/s From HydroCAD Analysis for 24-hour, 25-year storm event
D = 1.50 ft = W_O (circular)
TW = 0.60 ft
g = 32.2 ft/s^2

D_{50} = **0.57** ft = **6.9** inches = **10** inches (round up to nearest rip-rap class)
(min. 6" rip-rap used for design purposes)

Steps 4&5: Determine riprap class and corresponding apron dimensions
(Minimum Class 2, D_{50} of 6" used)

Table 10.1: RipRap Classes and Apron Dimensions

Class	D_{50} (mm)	D_{50} (in)	Apron Length[1]	Apron Depth
1	125	5	4D	$3.5D_{50}$
2	150	6	4D	$3.3D_{50}$
3	250	10	5D	$2.4D_{50}$
4	350	14	6D	$2.2D_{50}$
5	500	20	7D	$2.0D_{50}$
6	550	22	8D	$2.0D_{50}$

[1]D is the culvert rise.

Riprap Class = **3**

Apron Length = **8** ft

Apron Depth = **24** inches

Apron Width = **3D**
(at culvert outlet) = **4.5** ft

Apron Width = **3D + (2/3)L**
(at apron end) = **10** ft

Step 6: Determine if beaching is likely to occur

$$\frac{Q}{(gD^5)^{0.5}} \leq 1 + \frac{25 * D_{50}}{D}$$

0.82 ≤ **14.89** **Beaching not likely to occur**

Project Name: Site Development Permitting **Date:** Mar. 2026
Project Location: 14 Sterling Road, Billerica, MA **Calculated By:** KFH
Project Number: 347-159 **Checked By:** DSK

RIP-RAP APRON SIZING CALCULATION
Outlet Protection #1
(Pond 1 / OCS-1 Outlet Culvert)

Step 1: Determine Equivalent Single Culvert Diameter
(Not applicable)

Step 2: Determine tailwater condition

TW = 0.6 ft. (TW is unknown, therefore it is assumed to equal 0.4 D)
D = 1.50 ft.

TW < D thus the culvert is in unsubmerged conditions

Step 3: Calculate riprap D_{50}

$$D_{50} = 0.2D\left(\frac{Q}{\sqrt{g} * D^{2.5}}\right)^{4/3}\left(\frac{D}{TW}\right)$$

Given,

Q = 9.43 ft^3/s From HydroCAD Analysis for 24-hour, 25-year storm event
D = 1.50 ft = W_O (circular)
TW = 0.60 ft
g = 32.2 ft/s^2

D_{50} = **0.38** ft = **4.6** inches = **6** inches (round up to nearest rip-rap class)
(min. 6" rip-rap used for design purposes)

Steps 4&5: Determine riprap class and corresponding apron dimensions
(Minimum Class 2, D_{50} of 6" used)

Table 10.1: RipRap Classes and Apron Dimensions

Class	D_{50} (mm)	D_{50} (in)	Apron Length[1]	Apron Depth
1	125	5	4D	$3.5D_{50}$
2	150	6	4D	$3.3D_{50}$
3	250	10	5D	$2.4D_{50}$
4	350	14	6D	$2.2D_{50}$
5	500	20	7D	$2.0D_{50}$
6	550	22	8D	$2.0D_{50}$

[1]D is the culvert rise.

Riprap Class = **2**

Apron Length = **6** ft

Apron Depth = **20** inches

Apron Width (at culvert outlet) = **3D** = **4.5** ft

Apron Width (at apron end) = **3D + (2/3)L** = **9** ft

Step 6: Determine if beaching is likely to occur

$$\frac{Q}{(gD^5)^{0.5}} \leq 1 + \frac{25 * D_{50}}{D}$$

0.60 ≤ **9.33** **Beaching not likely to occur**

Project Name: Site Development Permitting
Project Location: 14 Sterling Road, Billerica, MA
Project Number: 347-159

Date: Mar. 2026
Calculated By: KFH
Checked By: DSK

RIP-RAP APRON SIZING CALCULATION
Outlet Protection #2
(WQU-P5 Outlet Culvert)

Step 1: Determine Equivalent Single Culvert Diameter
(Not applicable)

Step 2: Determine tailwater condition

TW = 0.6 ft. (TW is unknown, therefore it is assumed to equal 0.4 D)
D = 1.50 ft.

TW < D thus the culvert is in unsubmerged conditions

Step 3: Calculate riprap D_{50}

$$D_{50} = 0.2D\left(\frac{Q}{\sqrt{g}*D^{2.5}}\right)^{4/3}\left(\frac{D}{TW}\right)$$

Given,
Q = 19.37 ft^3/s From HydroCAD Analysis for 24-hour, 25-year storm event
D = 1.50 ft = W_O (circular)
TW = 0.60 ft
g = 32.2 ft/s^2

D_{50} = 1.00 ft = 12.0 inches = 14 inches (round up to nearest rip-rap class)
(min. 6" rip-rap used for design purposes)

Steps 4&5: Determine riprap class and corresponding apron dimensions
(Minimum Class 2, D_{50} of 6" used)

Table 10.1: RipRap Classes and Apron Dimensions

Class	D_{50} (mm)	D_{50} (in)	Apron Length[1]	Apron Depth
1	125	5	4D	$3.5D_{50}$
2	150	6	4D	$3.3D_{50}$
3	250	10	5D	$2.4D_{50}$
4	350	14	6D	$2.2D_{50}$
5	500	20	7D	$2.0D_{50}$
6	550	22	8D	$2.0D_{50}$

[1]D is the culvert rise.

Riprap Class = 4

Apron Length = 9 ft

Apron Depth = 31 inches

Apron Width (at culvert outlet) = **3D** = 4.5 ft

Apron Width (at apron end) = **3D + (2/3)L** = 11 ft

Step 6: Determine if beaching is likely to occur

$$\frac{Q}{(gD^5)^{0.5}} \leq 1 + \frac{25 * D_{50}}{D}$$

1.24 ≤ 20.44 **Beaching not likely to occur**

Project Name: Site Development Permitting
Project Location: 14 Sterling Road, Billerica, MA
Project Number: 347-159

Date: Mar. 2026
Calculated By: KFH
Checked By: DSK

RIP-RAP APRON SIZING CALCULATION
Outlet Protection #3
(DMH-P33 Outlet Culvert)

Step 1: Determine Equivalent Single Culvert Diameter
(Not applicable)

Step 2: Determine tailwater condition

TW = 1.0 ft. (TW is unknown, therefore it is assumed to equal 0.4 D)
D = 2.50 ft.

TW < D thus the culvert is in unsubmerged conditions

Step 3: Calculate riprap D_{50}

$$D_{50} = 0.2D\left(\frac{Q}{\sqrt{g} * D^{2.5}}\right)^{4/3}\left(\frac{D}{TW}\right)$$

Given,
Q = 23.73 ft^3/s From HydroCAD Analysis for 24-hour, 25-year storm event
D = 2.50 ft = W_O (circular)
TW = 1.00 ft
g = 32.2 ft/s^2

D_{50} = 0.40 ft = 4.8 inches = 6 inches (round up to nearest rip-rap class)
(min. 6" rip-rap used for design purposes)

Steps 4&5: Determine riprap class and corresponding apron dimensions
(Minimum Class 2, D_{50} of 6" used)

Table 10.1: RipRap Classes and Apron Dimensions

Class	D_{50} (mm)	D_{50} (in)	Apron Length[1]	Apron Depth
1	125	5	4D	$3.5D_{50}$
2	150	6	4D	$3.3D_{50}$
3	250	10	5D	$2.4D_{50}$
4	350	14	6D	$2.2D_{50}$
5	500	20	7D	$2.0D_{50}$
6	550	22	8D	$2.0D_{50}$

[1]D is the culvert rise.

Riprap Class = 2

Apron Length = 10 ft

Apron Depth = 20 inches

Apron Width (at culvert outlet) = **3D** = 7.5 ft

Apron Width (at apron end) = **3D + (2/3)L** = 15 ft

Step 6: Determine if beaching is likely to occur

$$\frac{Q}{(gD^5)^{0.5}} \leq 1 + \frac{25 * D_{50}}{D}$$

0.42 ≤ 6.00 **Beaching not likely to occur**

Civil & Environmental Consultants, Inc.

Project Name: Site Development Permitting
Project Location: 14 Sterling Road, Billerica, MA
Project Number: 347-159

Date: Mar. 2026
Calculated By: KFH
Checked By: DSK

RIP-RAP APRON SIZING CALCULATION
Outlet Protection #4
(OCS-2 Outlet Culvert)

Step 1: Determine Equivalent Single Culvert Diameter
(Not applicable)

Step 2: Determine tailwater condition

TW = 0.8 ft. (TW is unknown, therefore it is assumed to equal 0.4 D)
D = 2.00 ft.

TW < D thus the culvert is in unsubmerged conditions

Step 3: Calculate riprap D_{50}

$$D_{50} = 0.2D \left(\frac{Q}{\sqrt{g} * D^{2.5}}\right)^{4/3} \left(\frac{D}{TW}\right)$$

Given,

Q = 5.05 ft^3/s From HydroCAD Analysis for 24-hour, 100-year storm event
D = 2.00 ft = W_O (circular)
TW = 0.80 ft
g = 32.2 ft/s^2

D_{50} = **0.08** ft = **1.0** inches = **6** inches (round up to nearest rip-rap class)
(min. 6" rip-rap used for design purposes)

Steps 4&5: Determine riprap class and corresponding apron dimensions
(Minimum Class 2, D_{50} of 6" used)

Table 10.1: RipRap Classes and Apron Dimensions

Class	D_{50} (mm)	D_{50} (in)	Apron Length[1]	Apron Depth
1	125	5	4D	$3.5D_{50}$
2	150	6	4D	$3.3D_{50}$
3	250	10	5D	$2.4D_{50}$
4	350	14	6D	$2.2D_{50}$
5	500	20	7D	$2.0D_{50}$
6	550	22	8D	$2.0D_{50}$

[1]D is the culvert rise.

Riprap Class = **2**

Apron Length = **8** ft

Apron Depth = **20** inches

Apron Width = **3D**
(at culvert outlet) = **6** ft

Apron Width = **3D + (2/3)L**
(at apron end) = **12** ft

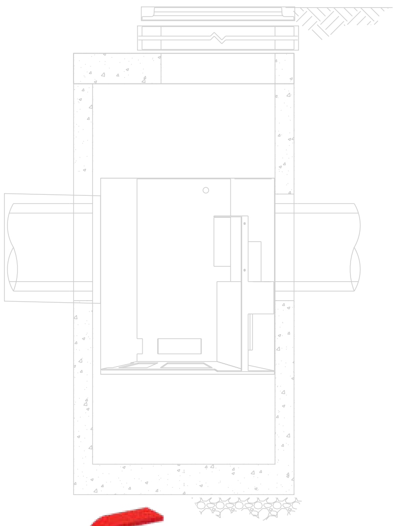
Step 6: Determine if beaching is likely to occur

$$\frac{Q}{(gD^5)^{0.5}} \leq 1 + \frac{25 * D_{50}}{D}$$

0.16 ≤ **7.25** **Beaching not likely to occur**

APPENDIX F6

Contech Water Quality Unit Sizing Test Results



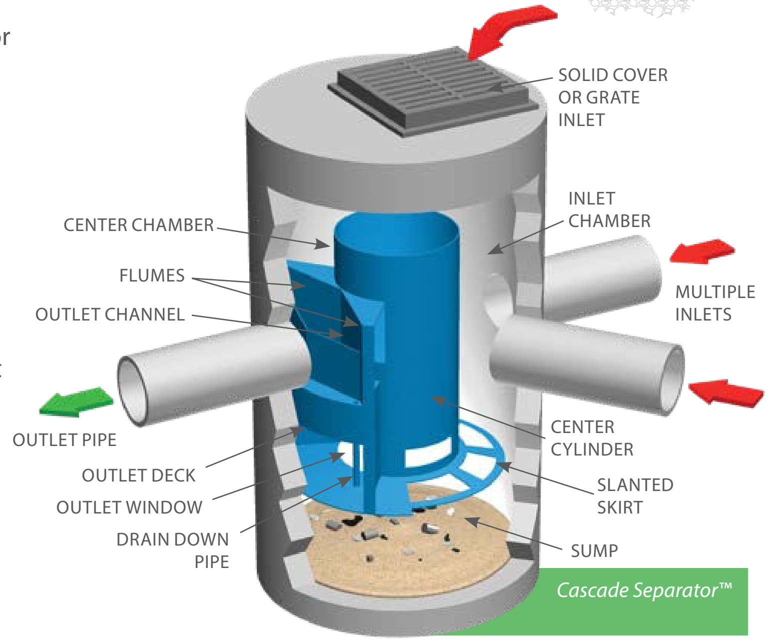
The Cascade Separator® System

(See next page for treatment / sizing documentation)

Advanced Sediment Capture Technology ...

The Cascade Separator® is the newest innovation in stormwater treatment from Contech. The Cascade Separator was developed by Contech's stormwater experts using advanced modeling tools and Contech's industry leading stormwater laboratory.

This innovative hydrodynamic separator excels at sediment capture and retention while also removing hydrocarbons, trash, and debris from stormwater runoff. What makes the Cascade Separator unique is the use of opposing vortices that enhance particle settling and a unique skirt design that allows for sediment transport into the sump while reducing turbulence and resuspension of previously captured material. These two factors allow the Cascade Separator to treat high flow rates in a small footprint, resulting in an efficient and economical solution for any site.



FEATURE	BENEFIT
Unique skirt design & opposing vortices	Superior TSS removal; reduced system size and costs
Inlet area accepts wide range of inlet pipe angles	Design and installation flexibility
Accepts multiple inlet pipes*	Eliminates the need for separate junction structure
Grate inlet option*	Eliminates the need for a separate grate inlet structure
Internal bypass	Eliminates the need for a separate bypass structure
Clear access to sump and stored pollutants	Fast, easy maintenance

** NJDEP testing based on Cascade Separator with one inlet pipe and no grate inlet*

Learn More:
www.ContechES.com/cascade

SELECT CASCADE APPROVALS

- New Jersey Department of Environmental Protection Certification (NJDEP)

CASCADE MAINTENANCE

Cascade provides unobstructed access to stored pollutants, making it easy to maintain using a vacuum truck, with no requirement to enter the unit.

Product Flow Rates

CASCADE

	Model	Treatment Rate (cfs)	Sediment Capacity[1] (CF)
	CS-3	1.02	11
	CS-4	2.00	19
WQU-P6	CS-5	3.50	29
WQU-P5	CS-6	5.60	42
	CS-8	12.00	75
	CS-10	18.00	118

SCICLONEX

Model	Treatment Rate[3] (cfs)	Sediment Capacity[1] (CF)
SCX-4	2.22	25.2
SCX-5	3.88	39.2
SCX-6	6.22	56.6
SCX-8	13.32	100.6
SCX-10	19.98	157.0

CDS

Model	Treatment Rate[2] (cfs)	Sediment Capacity[1] (CF)
1515-3	1.00	14
2015-4	1.40	25
2015-5	1.40	39
2015-6	1.40	57
2020-5	2.20	39
2020-6	2.20	57
2025-5	3.20	39
2025-6	3.20	57
3020-6	3.90	57
3025-6	5.00	57
3030-6	5.70	57
3035-6	6.50	57
4030-8	7.50	151
4040-8	9.50	151

STORMCEPTOR STC

Model	Treatment Rate (cfs)	Sediment Capacity[1] (CF)
STC 450i	0.40	46
STC 900	0.89	89
STC 2400	1.58	205
STC 4800	2.47	543
STC 7200	3.56	839
STC 11000	4.94	1086
STC 16000	7.12	1677

1 *Additional sediment storage capacity available – Check with your local representative for information.*

2 *Treatment Capacity is based on laboratory testing using OK-110 (average D50 particle size of approximately 100 microns) and a 2400 micron screen.*

3 *Based on MADEP sizing criteria requiring treating 100% of the Water Quality Flow before bypass and achieving 80% Net Annual TSS Removal.*

STORMWATER SOLUTIONS

PIPE SOLUTIONS

STRUCTURES SOLUTIONS

CONTECH ENGINEERED SOLUTIONS

Get social with us:

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APPENDIX F7

Illicit Discharge Statement

ILLICIT DISCHARGE COMPLIANCE STATEMENT

I VERIFY THAT NO ILLICIT DISCHARGES EXIST FOR THE PROPOSED SITE DEVELOPMENT PROJECT LOCATED AT 14 STERLING ROAD IN BILLERICA MASSACHUSETTS. THROUGH THE IMPLEMENTATION OF THE *CONSTRUCTION PERIOD POLLUTION PREVENTION AND SEDIMENTATION AND EROSION CONTROL PLAN* AS WELL AS THE *OPERATION AND MAINTENANCE PLAN*, MEASURES ARE SET FORTH TO PREVENT ILLICIT DISCHARGES FROM ENTERING THE STORMWATER MANAGEMENT DRAINAGE SYSTEM.

[signature]	David S. Kelley	
SIGNATURE	**PRINT NAME**	**DATE**

PRINCIPAL	Civil and Environmental Consultants, Inc.
TITLE	**COMPANY**

SIGNATURE	**PRINT NAME**	**DATE**

TITLE	**COMPANY**

NOTE: THIS CERTIFICATION MUST BE SIGNED BEFORE STORMWATER IS CONVEYED TO THE PROPOSED STORMWATER DRAINAGE SYSTEM IN ACCORDANCE WITH STANDARD 10 OF THE MASSACHUSETTS STORMWATER MANAGEMENT STANDARDS.