Stormwater Management Report

Definitive Site Plan

Reactory Drive – Lot 3B
Worcester, Massachusetts

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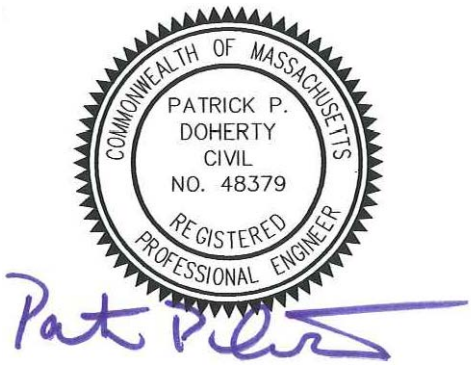

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Project Summary

The Project Site is a parcel of land located at the former Worcester State Hospital campus in Worcester, MA which has recently been subdivided and will become a Bio-manufacturing Park known as The Reactory. According to the City Assessing office, the project site is a portion of Map 57 Block 004 Lot B1 and has an address of 305 Belmont Street. The subject lot's address will be Lot 3B Hospital Drive upon completion of construction of the subdivision roadway and acceptance of the street by the City as a public way.

The Site is approximately 6.35 acres and is bounded to the west by Hospital Drive which will become a City public way. To the north is a lot within the subdivision which contains the former "Hale Building". Private access easements Goldsberry Drive and Clocktower Drive bound the property to the south and east. Uses within the vicinity of the site are other biopharmaceutical and institutional uses. The property is located in the BG-3.0 Zoning district. The site is currently vacant excepting a paved parking area. Structures including a greenhouse / maintenance building and several residential cottages occupied the site but were razed as part of the subdivision and redevelopment process.

The proposed development will consist of construction of a two-story , 95,000 gross square foot, multi-nodal, cell or gene therapy manufacturing facility. Site improvements including driveways, parking areas, loading and service area will also be constructed on site in support of the proposed use.

The subdivision, including this property, has been reviewed under the Massachusetts Environmental Policy Act (MEPA). A Certificate on the ENF has been issued by the Secretary of Energy and Environmental Affairs indicating that an Environmental Impact Statement is not required and that the project's environmental impacts will be avoided, minimized or mitigated to the extent practicable. Development of this site is consistent with information presented to MEPA during its review.

The project site does not contain any Bordering Vegetated Wetlands (BVW) systems or other resources regulated by the Wetlands protection act. The site does not contain any areas within flood zone or habitat for rare or endangered species.

Development of the property does not propose impacts to regulated resource areas but does propose work within 100-feet of stormwater inlets that connect to the City of Worcester street drainage system and will require submission of the Notice of

Intent to the City of Worcester Conservation Commission in accordance with the City of Worcester Wetlands Protection Ordinance.

The site has been designed to meet requirement of the City of Worcester Wetlands Protection Ordinance and complies with Massachusetts Stormwater Handbook. Stormwater calculations utilize NOAA Atlas 14 rainfall depths as required by the City regulations. The stormwater management system will meet the objectives of the Massachusetts Stormwater Handbook and Regulations by inclusion of stormwater Best Management Practices (BMP's) such as source reduction, deep sump hooded catch basins, proprietary water quality units, underground recharge and detention chamber system with isolator row. These BMP's will reduce total suspended solids from stormwater discharges and approximate annual groundwater recharge. Additionally the BMP's will attenuate stormwater discharge so that there will be no increase in peak discharge rates between the pre- and post-development conditions. Details of the proposed stormwater management system can be found in the following sections of the report.

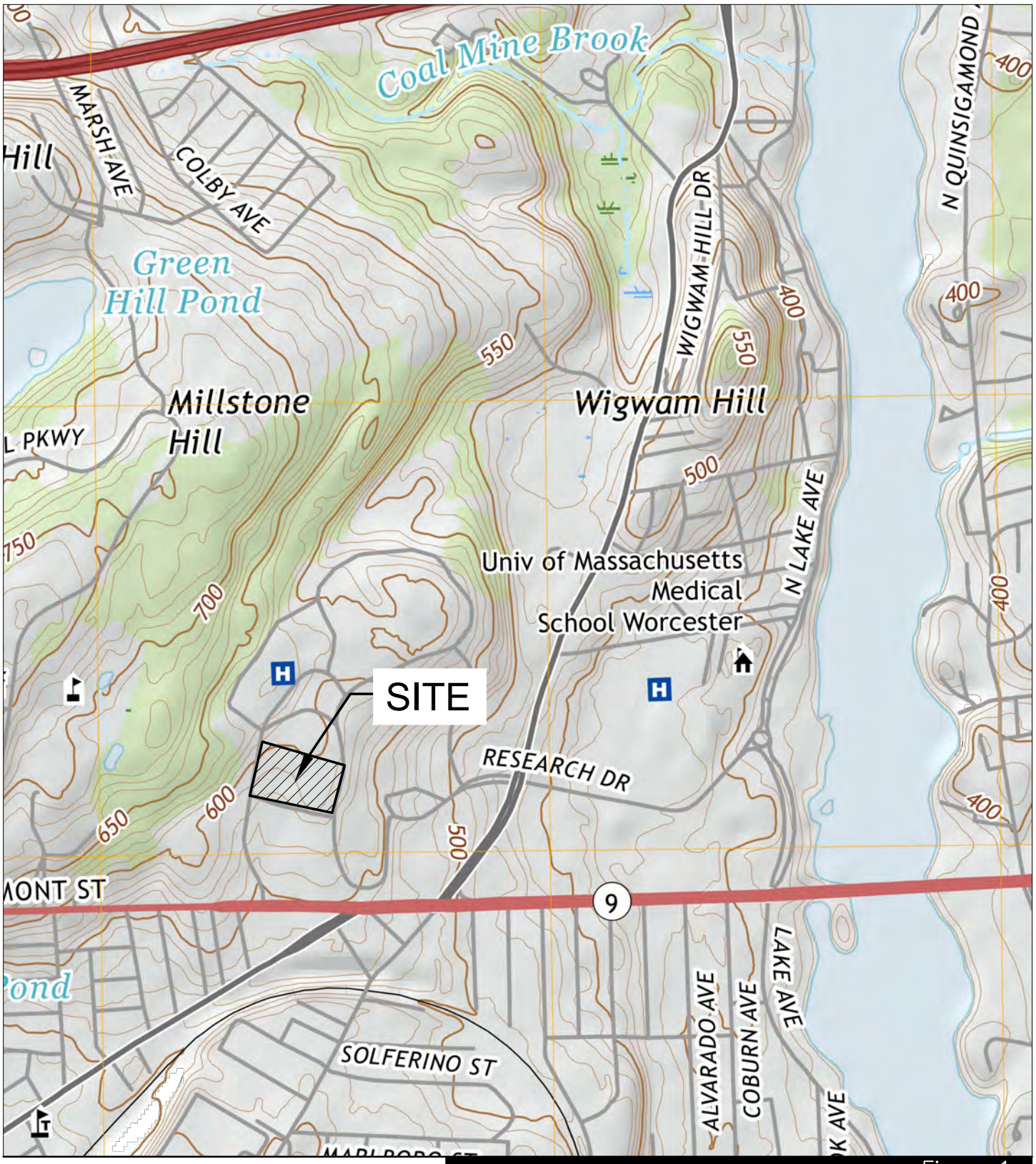

Figure 1

Site Location Map
Lot 3B Hospital Dr
Worcester, MA

0 500 1000 Feet

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Existing Conditions

Summary

The Project Site is a parcel of land located at the former Worcester State Hospital campus in Worcester, MA which has recently been subdivided and will become a Bio-manufacturing Park known as The Reactory. According to the City Assessing office, the project site is a portion of Map 57 Block 004 Lot B1 and has an address of 305 Belmont Street. The subject lot's address will be Lot 3B Hospital Drive upon completion of construction of the subdivision roadway and acceptance of the street by the City as a public way.

The Site is approximately 6.35 acres and is bounded to the west by Hospital Drive which will become a City public way. To the north is a lot within the subdivision which contains the former "Hale Building". Private access easements Goldsberry Drive and Clocktower Drive bound the property to the south and east. Uses within the vicinity of the site are other biopharmaceutical and institutional uses. The property is located in the BG-3.0 Zoning district. The site is currently vacant excepting a paved parking area. Structures including a greenhouse / maintenance building and several residential cottages occupied the site but were razed as part of the subdivision and redevelopment process. Prior to demolition activities approximately 2.35 acres of the site were covered with impervious surfaces.

The parcel slopes from north to the south and east with a grades averaging approximately twelve (12%) percent. Stormwater Runoff from the site flows off site into the subsurface drainage systems with private roadways Goldsberry Drive and Clocktower Drive. The roadway drainage systems flow in southerly direction and connect to the drainage system within Belmont Street which flows in an easterly direction.

The project parcel is part of the Blackstone River watershed. Based upon a review of FEMA mapping there are no areas mapped as flood plain on or within the vicinity of the site.

The project site is not located within an area designated as Priority or Estimated Habitat of Rare Species by the Natural Heritage & Endangered Species Program (NHESP) 2017 Maps. No Certified or Potential Vernal Pools are located in this area of the City. The closest Area of Critical Environmental Concern (ACEC), the Miscoe,

Warren and Whitehall Watersheds ACEC, is approximately 6 miles southeast east of the project site.

Based upon a review of the NRCS Soil maps, soils located on site are classified as Paxton fine sandy loam (Hydrologic Group C), and Woodbridge Fine Sandy Loam (Hydrologic Soil Group C).

Hydrologic Information

For the existing conditions hydrologic analysis, the site was divided into 2 drainage areas that contribute flow to a design points where peak discharge rate was evaluated (see Figure 2). The design points chosen are the Goldsberry Drive drainage system and the Clocktower Drive drainage system were site stormwater runoff flows prior to discharge off site.

Drainage Area EX1 – Consists of areas of the site contributes stormwater flow to the Goldsberry Drive drainage system.

Drainage Area EX2 – Consists of areas of the site contributes stormwater flow to the Clocktower Drive drainage system.

Table 1 summarizes the key hydrologic parameters for each drainage area used in the existing conditions analysis.

Table 1
Existing Conditions Hydrologic Data

(Drainage Area #)	Discharge Location	Design Point	Impervious Area (acres)	Area (acres)	Curve Number	Time of Concentration (min)
EX1	*Goldsberry Drainage*	*DP1*	*2.03*	*4.40*	*85*	*5.0*
EX2	*Clocktower Drainage*	*DP2*	*0.32*	*1.75*	*78*	*11.1*

Proposed Conditions

Summary

The project, which will include the construction of a two story biomanufacturing use building with approximately 95,000 square feet of leasable area and associated parking and service areas, was designed to comply fully with the Massachusetts Stormwater Management Policy and the City of Worcester Zoning and Conservation Commission Regulations. Existing drainage and grading patterns were maintained to the maximum extent possible. Low impact development stormwater management techniques have been incorporated into the design. These practices are focused at decentralizing stormwater management at the site and incorporating smaller stormwater management techniques into the design that will reduce peak runoff rates, maximizing groundwater recharge and improve water quality.

Impervious areas of the site under proposed conditions consist of roof area, parking and service areas, concrete sidewalks, gathering areas and utility pads. The total impervious surface coverage will be approximately 3.50 acres or 55% percent of the site. This represents an increase of impervious coverage compared to existing conditions of 1.15 acres. An analysis has been performed to confirm that post development peak stormwater runoff rates will not exceed predevelopment rates due to this increase in impervious coverage. Additionally, recharge to ground water will approximate pre-development conditions by recharging parking lot and roof runoff.

Areas of the site are considered Land Uses with Higher Potential Pollution Loading (LUHPPL). These areas include the loading / service area of the building as it will require a NPDES multisector general permit. Other areas of the site are not considered LUHPPL. Discharge from LUHPPL requires specific Stormwater BMP's, a water quality volume of 1-inch times impervious surface and requires removal of more than 44% total suspended solids prior to infiltration practices.

Under proposed conditions, storm water runoff will be renovated through use of Stormwater Best Management Practices (BMPs) that are approved for use for LUHPPL, Pretreatment devices, and infiltration practices. Source control will include covering dumpsters and regular sweeping of paved surfaces. Pretreatment BMP's include deep sump hooded catch basins and proprietary stormwater treatment devices. Infiltration devices include subsurface chamber systems.

The proprietary stormwater quality units proposed are "Barracuda" hydrodynamic separator units manufactured by Baysavers Technologies which have been certified by NJCAT to provide 50 percent TSS removal rate at the published water quality flow rates.

Details of the stormwater water management system features are as follows:

Water Quantity and Quality Control

Site Layout

The site has been designed to minimize impacts by concentrating the development in previous disturbed areas of the site.

Source Control

A comprehensive source control program will be implemented at the site, which includes regular pavement sweeping, catch basin cleaning, and maintenance of service and lawn areas. Trash will be managed by the use of a fully enclosed compactors which are loaded from within the building. Other waste items will be stored within the building and loaded into waste hauling vehicles from a loading dock.

Snow Management

Snow storage areas are shown on the project site plans. No snow will be placed in stormwater management components or wetland resource areas. As much as possible snow will be allowed to melt toward pavement where debris and sand may be deposited and swept up for disposal and snow melt will enter the stormwater management system where it will receive proper treatment.

Spill Prevention

Spill prevention is achieved with the proper storage and handling of hazardous materials. During construction, this is addressed in the Stormwater Pollution Prevention Plan (SWPPP) for Construction Activities to be prepared and implemented by the Site Contractor.

Catch Basins with Sumps and Oil/debris Traps

Catch basins at the site are to be constructed with sumps (minimum 4-feet) and oil/debris traps to prevent the discharge of sediments and floating contaminants.

Catch basins will be inspected four times per year and cleaned when deposits reach a depth of two feet.

Barracuda Water Quality Units

Proprietary hydrodynamic particle separator water quality units have oil/debris traps to prevent the discharge of sediments and floating contaminants. Units will be inspected four times per year and cleaned when deposits reach a depth of twenty (20) inches.

Subsurface Chamber Detention Basins

An underground stormwater detention system will control post development peak runoff rates by utilizing an outlet control device. This system will incorporate an "isolator row" wrapped in geotextile filter fabric to renovate and remove TSS prior to discharge.

Hydrologic Information

For the proposed conditions, hydrologic analysis, the site was divided into six (6) drainage areas (see Figure 3). These areas discharge to the design point where peak discharge rate were evaluated for both existing and proposed conditions.

Drainage Subarea PR1A– Consists of areas of the parking lot on the west side of the building.

Drainage Subarea PR1B– Consists of the roof area of the building.

Drainage Subarea PR1C– Consists of areas of the loading / service area on the west side of the building.

Drainage Subarea PR1D– Consists of areas south of the building.

Drainage Subarea PR2– Consists of areas north of the building that contributed runoff to Clocktower Drive.

Drainage Subarea PR3– Consists of areas east and south of the loading area that contribute runoff to Clocktower Drive.

Table 2 summarizes the key hydrologic parameters for each drainage area used in the proposed conditions analyses.

Table 2
Proposed Conditions Hydrologic Data

Drainage Area #	Treatment BMP	Design Point	Impervious Area (Acres)	Total Area (acres)	Curve Number	Time of Concentration (min)
DA PR1A	*Infiltration (UG 1)*	*DP1*	*1.07*	*1.49*	*91*	*5.0*
DA PR1B	*N/A roof area only*	*DP1*	*1.88*	*1.88*	*98*	*5.0*
DA PR1C	*Barracuda WQU, Isolator Row (UG 3)*	*DP1*	*0.46*	*0.62*	*92*	*5.0*
DA PR1D	*N/A Landscape areas*	*DP1*	*0.30*	*0.87*	*82*	*5.0*
DA PR2	*N/A*	*DP2*	*0.02*	*0.97*	*75*	*11.4*
DA PR3	*N/A*	*DP2*	*0.13*	*0.33*	*84*	*5.0*

The site complies fully with the total suspended solids removal requirements of the Stormwater Management Policy and EPA general permit. The calculated TSS removal rates for discharges from the site are shown on the Worksheets included in Appendix E.

Analysis Summary

Hydrologic Analysis

The rainfall-runoff response of the Site under existing and proposed conditions was evaluated for storm events with recurrence intervals of 2, 10, 25 and 100-years. Rainfall depths used for this analysis were based on NOAA ATLAS 14, Volume 10 Version 3; they were 3.19, 4.92, 6.00, and 7.66-inches respectively. Runoff coefficients for the pre- and post-development conditions, as previously shown in Tables 1 and 2 respectively, were determined using NRCS Technical Release 55 (TR-55) methodology as provided in HydroCAD.

Drainage areas used in the analyses were described in previous sections and shown on Figures 2 and 3. The HydroCAD model is based on the NRCS Technical Release 20 (TR-20) Model for Project Formulation Hydrology. Detailed printouts of the HydroCAD analyses are included in Appendix D. Table 3 presents a summary of the existing and proposed conditions peak discharge rates.

Table 3
Peak Discharge Rates (cfs*)

Design Point	2-year	10-year	25-year	100-year
Design Point DP1:				
Existing	9.4	17.5	22.6	30.5
Proposed	9.0	16.7	21.2	29.6
Design Point DP2:				
Existing	2.1	17.5	6.2	8.8
Proposed	1.5	3.2	4.3	6.1

* Expressed in cubic feet per second

The results of the analysis indicate that there is no increase in peak discharge rates at the design points between the pre- and post-development conditions

Hydraulic Analysis

The closed drainage system was designed for the 10-year storm event.

Drainage pipes were sized using Manning's Equation for full-flow capacity and the Rational Method. Pipe sizing calculations are included in Appendix E of this report.

Water Quality / TSS Reduction

TSS Reduction Calculations are included in Appendix E of this report. Methodologies utilized to perform the calculation were based upon the Massachusetts Stormwater Handbook

Table 4
TSS Removal Calculations

Drainage Area #	Impervious Area (Acres)	Treatment Train TSS Removal (%)
DA PR1A	*1.07*	*93%*
DA PR1C	*0.46*	*81%*
DA PR2,3	*0.05*	*0%*
Weighted Average		*90%*

The site complies fully with TSS reduction targets of Mass Stormwater Manual and EPA general permit.

Groundwater Recharge

Groundwater Recharge Calculations are included in Appendix E of this report. Methodologies utilized to perform the calculation were based upon the Massachusetts Stormwater Handbook

Table 5
Required Groundwater Recharge Calculations

Soil Hyd Group	Impervious Area (Acres)	Required Recharge (in)	Recharge Volume (cf)
A	*0.00*	*0.60*	*0*
B	*0.00*	*0.35*	*0*
C	*3.50*	*0.25*	*3176*
D	*0.00*	*0.10*	*0*
Required Recharge			*3.176 cf*

Subarea PR1c does not flow to an infiltration BMB

Adjusted Recharge requirement is 119% of required volume or 3,768 cf

Table 6
Provided Groundwater Recharge Calculations

Infiltration BMP	Totals Storage Volume (cf)	Credited Recharge Volume (cf) *
Recharge Basin UG-1	*7,779 cf*	*2,213 cf*
Recharge Basin UG-2	*3,950 cf*	*1,768 cf*
Totals		*3,981 cf*

* Credited Recharge Volume is a conservative estimate of recharge volume and is calculated as available storage below outlet invert. Actual recharge realized will be higher than shown as the static method was utilized to determine potential recharge. No recharge credit is not taken for potential infiltration during a storm event.

Stormwater Management Regulations

The purpose of the Stormwater Management Plan (the Plan) is to provide long-term protection of natural resources in and around the Site. This is achieved by implementing water quality and quantity control measures designed to decrease the amount of pollutants discharged from the Site, increase the quality of stormwater recharged on the Site, and control discharge rates.

The following sections describe the regulations pertinent to stormwater management and the specific components of the Plan to be implemented.

Stormwater Regulations and Permitting

The following stormwater related regulations and guidelines apply to the proposed site development:

- Massachusetts State Stormwater Management Performance Standards and Guidelines, Department of Environmental Protection and Office of Coastal Zone Management (DEP/CZM, 2008).

- Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Stormwater Permit for Construction Activities disturbing greater than one acre (EPA, Federal Register, December 8, 1999 and amendments)

Compliance with these regulations is described in the following sections.

Stormwater Management Standards and Guidelines

The methods for compliance with the ten stormwater performance standards developed by the MA DEP are summarized below.

Standard 1: (Untreated discharges)

No new stormwater conveyances (e.g., outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.
Same rule applies for new developments and redevelopments.

- ***What BMPs are proposed to ensure that all new discharges associated with the discharge are adequately treated?***
  Response: Source control such as regular pavement sweeping, and covering dumpsters will be implemented. Hooded- Deep Sump catch basins and proprietary water quality treatment units will be used as pretreatment devices. underground chamber recharge/detention basins will be used as final treatment devices.

- ***What BMPs are proposed to ensure that no new discharges cause erosion in wetlands or waters of the Commonwealth?***
  Response: There will be no point discharges from the proposed site to any wetlands or waters of the Commonwealth.

- ***Will the proposed discharge comply with all applicable requirements of the Massachusetts Clean Waters Act and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00?***
  Response: Yes.

- ***What BMPs have been considered to prevent erosion from existing stormwater discharges?***
  Response: N/A

Standard 2: Peak rate control and flood prevention

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 land subject to coastal storm flowage.

- ***Does the redevelopment design meet Standard 2, comparing post-development to pre-development conditions?***
  Response: Yes, the redevelopment design fully complies with Standard 2. There will be no increase in peak discharge rates from the pre-development to the post-development conditions for the 2, 10, and 100-year storm events. See Table 3 in Section 4 and supporting calculations in Appendix D.

Standard 3: (Recharge to Ground water)

Loss of annual recharge to ground water shall be eliminated or minimized through the use of infiltration measures, including environmentally sensitive site design, low impact development techniques, best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from the pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

- ***Does the redevelopment design meet Standard 3, comparing post-development to pre-development conditions?***
  Response: Yes, the project will include recharge systems so that post development recharge will be in excess of predevelopment rates.

- ***If not, the applicant shall document an analysis of alternative approaches for meeting the Standard?***

Response: N/A

- ***What soil types are present on the site? Is the site is comprised solely of C and D soils and bedrock at the land surface?***
  Response: The site is comprised of hydrologic group C soils.

- ***Does the project include sites where recharge is proposed at or adjacent to an area classified as contaminated, sites where contamination has been capped in place, sites that have an Activity and Use Limitation (AUL) that precludes inducing runoff to the groundwater, pursuant to MGL Chapter 21E and the Massachusetts Contingency Plan 310 CMR 40.0000; sites that are the location of a solid waste landfill as defined in 310 CMR 19.000; or sites where groundwater from the recharge location flows directly toward a solid waste landfill or 21E site?***
  Response: No.

- ***Is the stormwater runoff from a land use with a higher potential pollutant load?***
  Response: The loading / service area is LUHPPL if the proposed use requires a NPDES multi-sector general permit.

- ***Is the discharge to the ground located within the Zone II or Interim Wellhead Protection Area of a public water supply?***
  Response: No

- ***Does the site have an infiltration rate greater than 2.4 inches per hour?***
  Response: No.

<u>Standard 4: (80% TSS Removal)</u>

Stormwater management systems must be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This standard is met when:
a. Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan and thereafter are implemented and maintained;
b. Stormwater BMPs are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and
c. Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.

- ***Has the proponent developed a long-term pollution plan that fully meets the requirements of Standard 4?***
  Response: The long-term pollution plan is to be included in the SWPPP (Stormwater Pollution Prevention Plan) by the site contractor and owner in accordance with the Environmental Protection Agency's (EPA's) National Pollutant Discharge Elimination System (NPDES) General Permit Program for Stormwater Discharges from Construction Sites. The SWPPP is not included in this report. However, standard recommended components of the Stormwater Pollution Prevention Plan for construction phases of the development to be prepared and implemented by the site contractor are described in Appendix F and Appendix G.

- ***Does the pollution prevention plan include the following source control measures?***
  - ***Street sweeping***
  - ***Proper management of snow, salt, sand and other deicing chemicals***
  - ***Proper management of fertilizers, herbicides and pesticides***
  - ***Stabilization of existing eroding surfaces***

  Response: Yes, all the aforementioned source control measures will be included in the SWPPP.

- ***Does the redevelopment design provide for treatment of all runoff from existing (as well as new) impervious areas to achieve 80% TSS removal? If 80% TSS removal is not achieved, has the stormwater management system been designed to remove TSS to the maximum extent practicable?***

  Response: Yes, the site has been designed to remove more than 80% TSS from all impervious areas.

- ***Have the proposed stormwater BMPs been properly sized to capture the prescribed runoff volume?***
  - ***One inch rule applies for discharge***
    - ***within a Zone II or Interim Wellhead Protection Area,***
    - ***near or to another critical area,***
    - ***from a land use with a higher potential pollutant load***
    - ***to the ground where the infiltration rate is greater than 2.4 inches per hour***

  Response: Yes, the one- inch rule for calculating water quality volume applies in areas considered LUHPPL. Water quality volume calculations are included in Appendix E.

- ***Has adequate pretreatment been proposed?***
  - ***44% TSS Removal Pretreatment Requirement applies if:***

- ***Stormwater runoff is from a land use with a higher potential pollutant load***
- ***Stormwater is discharged***
  - ***To the ground within the Zone II or Interim Wellhead Protection Area of a Public Water Supply***
  - ***To the ground with an infiltration rate greater than 2.4 inches per hour***
  - ***Near or to an Outstanding Resource Water, Special Resource Water, Cold-Water Fishery, Shellfish Growing Area, or Bathing Beach.***

Response: yes

<u>Standard 5 (Higher Potential Pollutant Loads (HPPL)</u>

For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention, all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt and stormwater runoff, the proponent shall use the specific stormwater BMPs determined by the Department to be suitable for such use as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26-53, and the regulations promulgated thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.

Pollution Prevention

- ***Has the proponent considered any of the following operational source control measures?***
  - ***Formation of a pollution prevention team,***
  - ***Good housekeeping practices,***
  - ***Preventive maintenance procedures,***
  - ***Spill prevention and clean up,***
  - ***Employee training, and***
  - ***Regular inspection of pollutant sources.***

  Response: Yes the tenant will properly train all employees for property pollution prevention.

- ***Has the proponent considered implementation of any of the following operational changes to reduce the quantity of pollutants on site?***
  - ***Process changes,***
  - ***Raw material changes,***
  - ***Product changes, or***
  - ***Recycling.***

  Response: TBD

- ***Has the proponent considered making capital improvements to protect the land uses with higher potential pollutant loads from exposure to rain, snow, snow melt, and stormwater runoff?***
  - ***Enclosing and/or covering pollutant sources (e.g. placing pollutant sources within a building or other enclosure, placing a roof over storage and working areas, placing tarps under pollutant source)***
  - ***Installing a containment system with an emergency shutoff to contain spills?***
  - ***Physically segregating the pollutant source to prevent run-on of uncontaminated stormwater?***

  Response: Waste products will be stored within the building prior to hauling or loaded into enclosed compactors from areas within the building.

Treatment

- ***If applicable, compliance with the treatment and pretreatment requirements of Standard 5 only to the Maximum Extent Practicable by directing the stormwater runoff from land uses with higher potential pollutant loads to appropriate stormwater BMPs.***
  - ***Are the BMPs selected capable of removing the pollutants associated with the higher potential pollutant load land ("LUHPPL") use?***

  Response: Yes

  - ***Is the land use likely to generate stormwater with high concentrations of oil and grease? If so has an oil grit separator, sand filter, filtering bioretention area or equivalent been proposed for pretreatment?***

  Response: Yes

- ***What specific measures have been considered to offset the anticipated impacts of land uses with higher potential pollutant loads?***

  Response: Waste products will be stored within the building prior to hauling or loaded into enclosed compactors from areas within the building.

- ***If the development proposal is a brownfield project, the applicant shall demonstrate how the stormwater management measures have been designed to prevent mobilization or remobilization of soil and groundwater contamination. (See Brownfield section)***
  Response: The proposal is not a brownfield project.

Other Requirements

- ***Does the discharge comply with all applicable requirements of the Massachusetts Clean Waters Act, 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00?***
  Response: Yes.

Standard 6 (Critical Areas)

Stormwater discharges to a Zone II or Interim Wellhead Protection Area of a public water supply and stormwater discharges near or any other critical area require the use of the specific source control and pollution prevention measures and the specific stormwater best management practices determined by the Department to be suitable for managing discharges to such area, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters or Special Resource Waters shall be set back from the receiving water and receive the highest and best practical method of treatment. A "stormwater discharge," as defined in 314 CMR 3.04(2)(a)1. or (b), to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of the public water supply.

Response: The proposed project will discharge near ORW. The discharge locations have been set back from ORW. 93% TSS will be removed prior to discharge and rip rap velocity dissipaters will be constructed at each discharge point.

Standard 7: Redevelopment

A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural stormwater best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

Response: The project is not a redevelopment project.

Standard 8: (Erosion, Sediment Control)

A plan to control construction-related impacts, including erosion sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan), must be developed and implemented.

- ***Has the proponent submitted a construction period erosion, sedimentation and pollution prevention plan that meets the requirements of Standard 8?***
  Response: Yes, the recommended erosion and sedimentation control practices are included in Appendix F and will be finalized as part of the Notice of Intent process. A maintenance checklist recommended for evaluating erosion control BMPs is also included.

Standard 9: (Operation and Maintenance)

A long-term operation and maintenance plan must be developed and implemented to ensure that stormwater management systems function as designed.

- ***Has the proponent submitted a long-term Operation and Maintenance plan that meets the requirements of Standard 9?***
  Response: The recommended practices for operating and maintaining long term stormwater BMPs is included in Appendix G. A recommended checklist for maintenance inspections and follow up is also included.

Standard 10 (Illicit Discharges)

All illicit discharges to the stormwater management system are prohibited.

- ***Are there any known or suspected illicit discharges to the stormwater management system at the redevelopment project site?***
  Response: There are no known illicit discharges to the stormwater management system at the site.

- ***Has an illicit connection detection program been implemented using visual screening, dye or smoke testing?***
  Response: All existing utilities on the site will be removed during construction. No illicit discharges are proposed in our plans to be implemented by the contractor.

- ***Have an Illicit Discharge Compliance Statement and associated site map been submitted verifying that there are no illicit discharges to the stormwater management system at the site?***
  Response: To the best of our information, knowledge, and belief there are no existing or proposed illicit discharges at the site. If any do exist, none would remain after the project is developed.

The Stormwater Management Policy issued by the DEP states that the "use of the standards should prevent or minimize adverse environmental impacts due to unmanaged stormwater while limiting undue costs and recognizing site constraints."
The Stormwater Management Policy issued by the DEP states that the "use of the standards should prevent or minimize adverse environmental impacts due to unmanaged stormwater while limiting undue costs and recognizing site constraints."

Federal NPDES Construction-Related General Stormwater Permits

The proposed project will result in the disturbance of more than one acre of land and thus requires the preparation and implementation of a Stormwater Pollution Prevention Plan (SWPPP) by the **site contractor** and **owner** in accordance with the Environmental Protection Agency's (EPA's) National Pollutant Discharge Elimination System (NPDES) General Permit Program for Stormwater Discharges from Construction Sites. The SWPPP is not included in this report. However, standard recommended components of the Stormwater Pollution Prevention Plan for construction phases of the development to be prepared and implemented by the site contractor are described in Appendix F.

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

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.

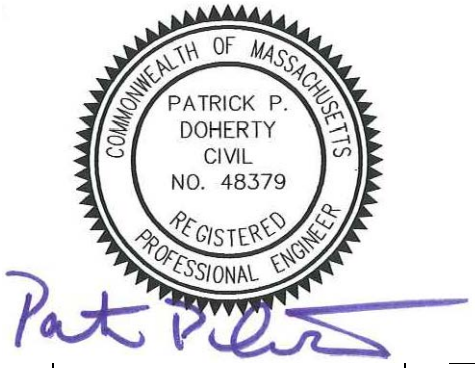
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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



Patrick P. Doherty, PE 9/3/20

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 for Stormwater Report

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:

- ☒ 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
- ☐ Other (describe): _____

Standard 1: No New Untreated Discharges

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

Checklist for Stormwater Report

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 for Stormwater Report

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 for Stormwater Report

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

☐ 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.

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

Checklist for Stormwater Report

Checklist (continued)

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

☐ 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.

☐ 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.

☐ 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 for 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 A:
Existing/Proposed Conditions Plans

MIDPOINT
ENGINEERING + CONSULTING

37 SUTTON ROAD
WEBSTER, MA 01570
(508) 721-1900
pdoherty@midpointengineering.com

LEGEND

- DESIGN POINT
- POND
- DRAINAGE AREA DESIGNATION
- DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION FLOW LINE
- SOIL BOUNDARY

NRCS SOIL CLASSIFICATIONS

- 102C — CHATFIELD–HOLLIS ROCK OUTCROP COMPLEX, HYDROLOGIC SOIL GROUP B
- 305B — PAXTON FINE SANDY LOAM HYDROLOGIC SOIL GROUP C
- 310A — WOODBRIDGE FINE SANDY LOAM HYDROLOGIC SOIL GROUP C
- IMPERVIOUS COVERAGE

0 30 60 Feet

Figure 2

Existing Conditions Drainage Areas

MIDPOINT
ENGINEERING + CONSULTING

37 SUTTON ROAD
WEBSTER, MA 01570
(508) 721-1900
pdoherty@midpointengineering.com

LEGEND

- DESIGN POINT
- POND
- DRAINAGE AREA DESIGNATION
- DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION FLOW LINE
- SOIL BOUNDARY

NRCS SOIL CLASSIFICATIONS

- 102C — CHATFIELD–HOLLIS ROCK OUTCROP COMPLEX, HYDROLOGIC SOIL GROUP B
- 305B — PAXTON FINE SANDY LOAM HYDROLOGIC SOIL GROUP C
- 310A — WOODBRIDGE FINE SANDY LOAM HYDROLOGIC SOIL GROUP C

IMPERVIOUS COVERAGE

0 30 60 Feet

Figure 3

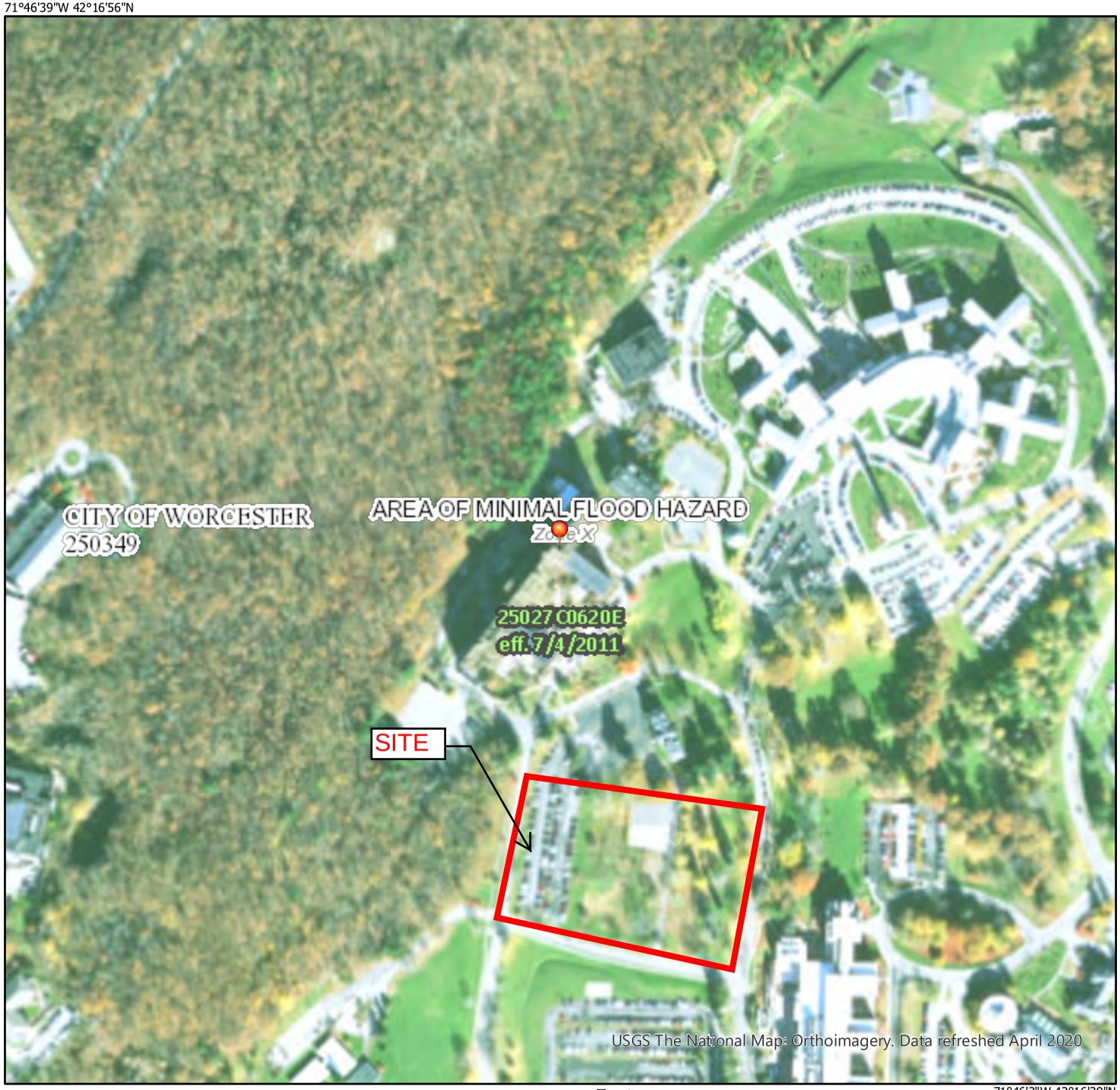
Proposed Conditions Drainage Areas

Appendix B: Floodplain Information

National Flood Hazard Layer FIRMette

FEMA

71°46'39"W 42°16'56"N



71°46'2"W 42°16'29"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

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.

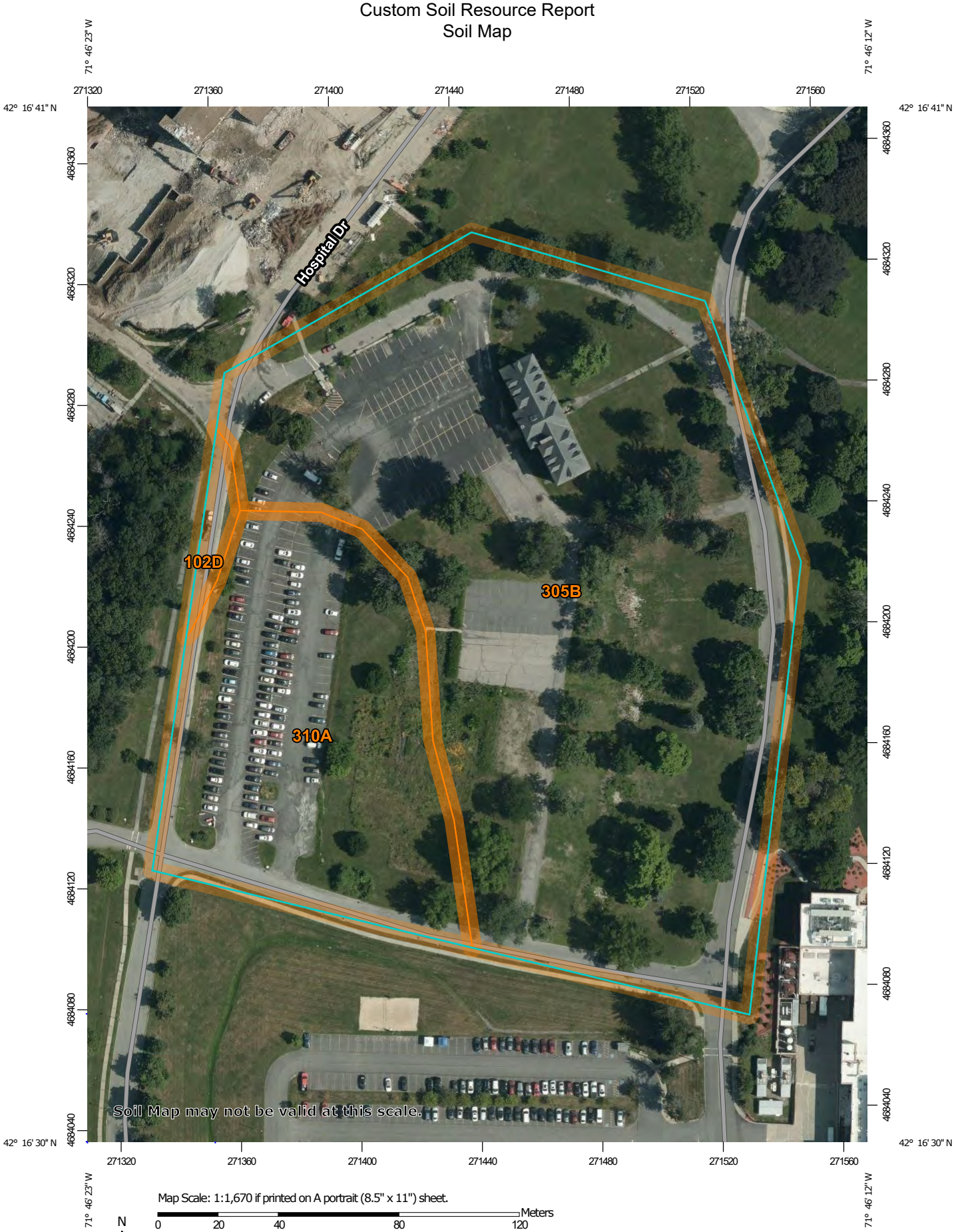
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 9/2/2020 at 5:15 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.

Appendix C:
NRCS Soil Survey Information

Custom Soil Resource Report
Soil Map



Map Scale: 1:1,670 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

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

Engineering Properties–Worcester County, Massachusetts, Northeastern Part														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
102D—Chatfield-Hollis-Rock outcrop complex, 15 to 35 percent slopes														
Chatfield, extremely stony	35	B	0-1	Moderately decomposed plant material, highly decomposed plant material, slightly decomposed plant material	PT	A-8	0- 0- 0	0- 0- 0	—	—	—	—	—	—
			1-2	Fine sandy loam, very gravelly sandy loam, loam, very fine sandy loam, silt loam, gravelly fine sandy loam, cobbly fine sandy loam, very gravelly loam, stony loam, gravelly sandy loam, cobbly loam, gravelly loam, stony fine sandy loam, highly organic fine sandy loam	GC-GM, GM, SC-SM, SM, GW-GM, GW-GC, GP-GM, GP-GC, SW-SM, SW-SC, SP-SM, SP-SC	A-1-a, A-2-4, A-4, A-1-b, A-2-5, A-5	0- 0- 7	0- 0- 29	56-95-95	27-88-88	21-75-80	11-43-48	0-42 -80	NP-4 -8

Engineering Properties–Worcester County, Massachusetts, Northeastern Part														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
			2-30	Loam, very fine sandy loam, silt loam, gravelly loam, cobbly fine sandy loam, stony loam, fine sandy loam, gravelly fine sandy loam, gravelly sandy loam, cobbly loam, stony fine sandy loam	CL-ML, GM, ML, SM, GC, GC-GM, SC, SC-SM, CL	A-2-7, A-1-b, A-2-4, A-4, A-2-5, A-2-6, A-5, A-6, A-7-5	0- 0- 7	0- 8- 29	70-82-94	40-74-92	32-63-89	18-38-57	0-22 -41	NP-6 -11

Engineering Properties–Worcester County, Massachusetts, Northeastern Part														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
			30-40	Bedrock	—	—	—	—	—	—	—	—	—	—
Hollis, extremely stony	30	D	0-2	Slightly decomposed plant material, moderately decomposed plant material, highly decomposed plant material	PT	A-8	0- 0- 0	0- 0- 0	—	—	—	—	—	—
			2-7	Very gravelly sandy loam, loam, gravelly fine sandy loam, cobbly fine sandy loam, very gravelly loam, stony loam, fine sandy loam, gravelly sandy loam, cobbly loam, gravelly loam, stony fine sandy loam, gravelly highly organic fine sandy loam	SM, GM, GC-GM, SC-SM	A-2-5, A-4, A-1-a, A-1-b, A-2-4, A-5	0- 0- 16	0- 5- 34	40-83-88	33-72-88	26-61-80	14-35-48	0-42 -80	NP-4 -8
			7-16	Very gravelly sandy loam, loam, gravelly fine sandy loam, cobbly fine sandy loam, very gravelly loam, stony loam, fine sandy loam, gravelly sandy loam, cobbly loam, gravelly loam, stony fine sandy loam	SM, GM, GC, GC-GM, SC, SC-SM, CL-ML, CL, ML	A-2, A-2-6, A-4, A-2-5, A-1-b, A-2-4, A-5, A-2-7, A-6, A-7-5	0- 0- 14	0- 7- 29	47-84-91	41-75-91	33-65-87	19-39-56	0-22 -41	NP-6 -11
			16-26	Bedrock	—	—	—	—	—	—	—	—	—	—

Engineering Properties–Worcester County, Massachusetts, Northeastern Part														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
Rock outcrop	20	D	0-79	Bedrock	—	—	—	—	—	—	—	—	—	—
305B—Paxton fine sandy loam, 3 to 8 percent slopes														
Paxton	80	C	0-8	Fine sandy loam, loam, gravelly sandy loam, gravelly fine sandy loam	SM, SC-SM	A-1, A-7, A-4	0- 0- 22	0- 0- 22	47-89-89	44-89-89	34-75-85	18-43-55	0-29 -41	NP-3 -11
			8-15	Fine sandy loam, loam, gravelly sandy loam	CL-ML, GM, CL, ML, SM	A-2, A-1, A-6, A-4	0- 0- 7	0- 0- 14	52-91-91	50-91-91	38-76-87	20-44-57	0-21 -32	NP-3 -11
			15-26	Fine sandy loam, loam, gravelly sandy loam	CL-ML, ML, SM, GM, CL	A-2, A-1, A-6, A-4	0- 0- 6	0- 0- 13	56-85-92	55-85-92	41-71-88	22-41-57	0-19 -29	NP-3 -11
			26-65	Gravelly sandy loam, gravelly fine sandy loam, fine sandy loam, loam, gravelly coarse sandy loam	CL-ML, SM, ML, GM, CL	A-1, A-6, A-4, A-2-4	0- 0- 6	0- 0- 12	61-70-94	59-69-93	45-58-90	24-34-58	0-18 -28	NP-3 -11

Engineering Properties–Worcester County, Massachusetts, Northeastern Part														
Map unit symbol and soil name	Pct. of map unit	Hydrologic group	Depth	USDA texture	Classification		Pct Fragments		Percentage passing sieve number—				Liquid limit	Plasticity index
					Unified	AASHTO	>10 inches	3-10 inches	4	10	40	200		
			In				*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*	*L-R-H*
310A—Woodbridge fine sandy loam, 0 to 3 percent slopes														
Woodbridge	85	C/D	0-7	Fine sandy loam, sandy loam, loam, gravelly fine sandy loam	GM, CL-ML, SC, ML, GC, SC-SM, GC-GM, SM, CL, OL, OH	A-5, A-4, A-2-4, A-2-5	0- 0- 3	0- 0- 3	69-90-100	67-90-100	52-76-94	28-44-59	0-30 -60	NP-5 -10
			7-18	Fine sandy loam, sandy loam, gravelly fine sandy loam, loam	GC-GM, CL, GM, ML, GC, SC, CL-ML, SM, SC-SM	A-6, A-2-6, A-1-b, A-2-4, A-4	0- 0- 5	0- 0- 14	54-84-100	52-83-100	40-70-94	22-41-59	0-20 -34	NP-6 -11
			18-30	Gravelly fine sandy loam, fine sandy loam, loam, sandy loam	SC, GC, GC-GM, CL, CL-ML, GM, ML, SM, SC-SM	A-2-4, A-4, A-6, A-2-6, A-1-b	0- 0- 5	0- 0- 14	54-84-100	52-83-100	40-70-94	22-41-59	0-20 -30	NP-7 -11
			30-65	Gravelly fine sandy loam, fine sandy loam, sandy loam, loam	GM, CL-ML, SC, GC, CL, GC-GM, ML, SM, SC-SM	A-4, A-1-b, A-2-4, A-2-6, A-6	0- 0- 6	0- 0- 12	60-69-100	58-68-100	45-57-94	24-33-59	0-18 -27	NP-7 -11

LEGEND

B-1 BORING LOCATION (APPROX.)

B-6 BORING/WELL LOCATION (APPROX.)

REFERENCE

THIS PLAN IS BASED UPON A MARCH 24, 2017 CONCEPT MASTER PLAN BY BOHLER ENGINEERING.

WHITESTONE ASSOCIATES, INC.

Environmental & Geotechnical Engineers & Consultants

352 TURNPIKE ROAD, SUITE 320, SOUTHBOROUGH, MA 01772

508.485.0755 WHITESTONEASSOC.COM

DRAWING TITLE:
BORING LOCATION PLAN

CLIENT:
WORCESTER BUSINESS DEVELOPMENT CORPORATION

PROJECT:
PROPOSED BIOMANUFACTURING CAMPUS
305 BELMONT STREET
CITY & COUNTY OF WORCESTER, MA

PROJECT #: GM1714433.000	
DESIGNED BY: GR	PROJ. MGR.: JL
DATE: 4/20/17	FIGURE: 1
SCALE: 1" = 200'	

N:\Job Folders\2017\1714433GM\Drawings and Plans\GM1714433.000 BLP.dwg

WHITESTONE ASSOCIATES, INC.

RECORD OF SUBSURFACE EXPLORATION

Boring No.: B-4

Project:	Proposed Biomanufacturing Campus	**WAI Project No.:**	GM1714433.000
Location:	305 Belmont Street, Worcester, Worcester County, Massachussetts	**Client:**	Worcester Business Develop. Corp.

Surface Elevation:	± NS feet above msl	**Date Started:**	4/13/2017		**Water Depth (feet bgs)**	**Elevation (feet msl)**	**Cave-In Depth (feet bgs)** / **Elevation (feet msl)**
Termination Depth:	20.9 feet bgs	**Date Completed:**	4/13/2017				
Proposed Location:	Building D	**Logged By:**	JL	**During:**	19.0	--	
Drill / Test Method:	HSA / SPT	**Contractor:**	GQ	**At Completion:**	--	--	**At Completion:** -- / --
		Equipment:	Mobile B-57	**24 Hours:**	--	--	**24 Hours:** -- / --

SAMPLE INFORMATION						DEPTH	STRATA	DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)			
						0.0	TS	8" Topsoil	
0 - 2	S-1		2 - 3 - 3 - 3	15	6		FILL	Brown, Loose, Medium to Fine Sand, Some Silt, Trace Gravel (FILL)	
2 - 4	S-2		5 - 4 - 5 - 4	4	9			As Above (FILL)	
						5.0			
5 - 7	S-3		2 - 7 - 12 - 18	10	19			As Above (FILL)	
							GLACIAL TILL	Brown, Medium Dense to Dense, Coarse to Fine Sand, Some Silt, Little Gravel (SM)	
7 - 9	S-4		40 - 18 - 17 - 18	16	35			Brown, Dense, Medium to Fine Sand, little Silt, Trace Gravel (SM)	
						10.0			
10 - 12	S-5		10 - 15 - 17 - 20	12	32			Brown, Dense, Fine Sand, Some Silt (SM)	
						15.0			
15 - 17	S-6		15 - 15 - 16 - 19	10	31			As Above (SM)	
						20.0			
20 - 20.9	S-7		10 - 50/4"	12				As Above, Trace Gravel (SM)	
								Boring Log B-4 Auger Refusal on Probable Bedrock, Exploration Terminated at a Depth of 20.9 Feet Below Ground Surface.	
						25.0			

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

WHITESTONE ASSOCIATES, INC.

RECORD OF SUBSURFACE EXPLORATION

Boring No.: B-5

Project:	Proposed Biomanufacturing Campus	**WAI Project No.:**	GM1714433.000
Location:	305 Belmont Street, Worcester, Worcester County, Massachussetts	**Client:**	Worcester Business Develop. Corp.

Surface Elevation:	± NS feet above msl	**Date Started:**	4/13/2017		**Water Depth (feet bgs)** | **Elevation (feet msl)**		**Cave-In Depth (feet bgs)** | **Elevation (feet msl)**
Termination Depth:	22.0 feet bgs	**Date Completed:**	4/13/2017				
Proposed Location:	Building D	**Logged By:**	JL	**During:**	19.0 | --		
Drill / Test Method:	HSA / SPT	**Contractor:**	GQ	**At Completion:**	-- | --	**At Completion:**	-- | --
		Equipment:	Mobile B-57	**24 Hours:**	-- | --	**24 Hours:**	-- | --

SAMPLE INFORMATION						DEPTH	STRATA		DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)				
						0.0	TS		6" Topsoil	
0 - 2	S-1		1 - 2 - 3 - 3	11	5		FILL		Brown, Loose, Medium to Fine Sand, Some Silt, Trace Gravel (FILL)	
2 - 4	S-2		1 - 2 - 1 - 2	1	3				As Above (FILL)	
						5.0	GLACIAL TILL			
5 - 7	S-3		4 - 5 - 8 - 11	10	13				Brown, Medium Dense, Medium to Fine Sand, Some Silt, Trace Gravel (SM)	
7 - 9	S-4		11 - 12 - 18 - 24	5	30				Brown, Medium Dense to Dense, Coarse to Fine Sand, Little Silt, Little Gravel (SM)	
						10.0				
10 - 12	S-5		10 - 15 - 20 - 22	14	35				As Above, Dense, Some Silt (SM)	
						15.0				
15 - 16.3	S-6		12 - 25 - 50/4"	10	50				Brown, Dense to Very Dense, Medium to Fine Sand, Some Silt, Trace Gravel (SM)	
						20.0				
20 - 22	S-7		14 - 14 - 20 - 26	10	34				As Above, Dense (SM)	
						25.0			Boring Log B-5 Terminated at a Depth of 22.0 Feet Below Ground Surface.	

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

WHITESTONE ASSOCIATES, INC.

RECORD OF SUBSURFACE EXPLORATION

Boring No.: B-10

Project:	Proposed Biomanufacturing Campus	**WAI Project No.:**	GM1714433.000
Location:	305 Belmont Street, Worcester, Worcester County, Massachussetts	**Client:**	Worcester Business Develop. Corp.

Surface Elevation:	± NS feet above msl	**Date Started:**	4/18/2017	**Water Depth | Elevation (feet bgs) | (feet msl)**		**Cave-In Depth | Elevation (feet bgs) | (feet msl)**	
Termination Depth:	22.0 feet bgs	**Date Completed:**	4/18/2017				
Proposed Location:	Building D	**Logged By:**	DC	**During:**	-- | --		
Drill / Test Method:	HSA / SPT	**Contractor:**	GQ	**At Completion:**	-- | --	**At Completion:**	-- | --
		Equipment:	Mobile B-57	**24 Hours:**	-- | --	**24 Hours:**	-- | --

SAMPLE INFORMATION						DEPTH	STRATA		DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)				
						0.0	TS		5" Topsoil	
0 - 2	S-1		1 - 2 - 5 - 4	12	7		FILL		Brown, Loose, Medium to Fine Sand, Some Silt, Some Gravel (FILL)	
2 - 4	S-2		2 - 1 - 1 - 2	12	2				As Above, Very Loose, Little Gravel (FILL)	
						5.0				
5 - 7	S-3		4 - 6 - 11 - 13	22	17				As Above, Loose to Medium Dense (FILL)	
							GLACIAL TILL		Brown, Medium Dense, Medium to Fine Sand, Some Silt, Little Gravel (SM)	
7 - 9	S-4		21 - 24 - 24 - 26	18	48				As Above (SM)	
						10.0				
10 - 12	S-5		11 - 18 - 27 - 50	-	45				No Recovery	
						15.0				
15 - 16.4	S-6		27 - 42 - 62/5"	16	84				As Above, Very Dense (SM)	
						20.0				
20 - 22	S-7		16 - 32 - 29 - 33	21	61				As Above (SM)	
									Boring Log B-10 Terminated at a Depth of 22.0 Feet Below Ground Surface.	
						25.0				

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

WHITESTONE ASSOCIATES, INC.

RECORD OF SUBSURFACE EXPLORATION

Boring No.: B-11

Project:	Proposed Biomanufacturing Campus	**WAI Project No.:**	GM1714433.000
Location:	305 Belmont Street, Worcester, Worcester County, Massachussetts	**Client:**	Worcester Business Develop. Corp.

Surface Elevation:	± NS feet above msl	**Date Started:**	4/19/2017	**Water Depth (feet bgs) | Elevation (feet msl)**	**Cave-In Depth (feet bgs) | Elevation (feet msl)**
Termination Depth:	15.0 feet bgs	**Date Completed:**	4/19/2017		
Proposed Location:	Building D	**Logged By:**	JL	**During:** -- | --	
Drill / Test Method:	HSA / SPT	**Contractor:**	GQ	**At Completion:** -- | --	**At Completion:** -- | --
		Equipment:	Mobile B-57	**24 Hours:** -- | --	**24 Hours:** -- | --

SAMPLE INFORMATION						DEPTH	STRATA	DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)			
						0.0			
							PAVEMENT	3" Asphalt	
0.5 - 2.5	S-1		6 - 5 - 3 - 3	3	8		FILL	Brown, Loose, Medium to Fine Sand, Some Silt, Little Gravel, Cobbles (FILL)	
2.5 - 4.5	S-2		2 - 3 - 6 - 23	3	9			As Above (FILL)	
						5.0	GLACIAL TILL		
5 - 7	S-3		8 - 12 - 20 - 22	17	32			Brown, Dense, Coarse to Fine Sand, Some Silt, and Gravel (SM)	
7 - 9	S-4		15 - 20 - 40 - 40	12	60			Brown, Very Dense, Medium to Fine Sand, Some Silt, Little Gravel (SM)	
						10.0			
10 - 12	S-5		7 - 9 - 13 - 14	10	22			As Above, Medium Dense (SM)	
15 - 15	S-6		50/0"	0	-	15.0		Cobbles at 14.5 Feet	
								Boring Log B-11 Auger Refusal on Probable Bedrock, Exploration Terminated at a Depth of 15.0 Feet Below Ground Surface.	
						20.0			
						25.0			

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

WHITESTONE ASSOCIATES, INC.

RECORD OF SUBSURFACE EXPLORATION

Boring No.: B-12

Project:	Proposed Biomanufacturing Campus	**WAI Project No.:**	GM1714433.000
Location:	305 Belmont Street, Worcester, Worcester County, Massachussetts	**Client:**	Worcester Business Develop. Corp.

Surface Elevation:	± NS feet above msl	**Date Started:**	4/19/2017	**Water Depth | Elevation (feet bgs) | (feet msl)**		**Cave-In Depth | Elevation (feet bgs) | (feet msl)**	
Termination Depth:	20.8 feet bgs	**Date Completed:**	4/19/2017				
Proposed Location:	Building D	**Logged By:**	JL	**During:**	-- | --		
Drill / Test Method:	HSA / SPT	**Contractor:**	GQ	**At Completion:**	-- | --	**At Completion:**	-- | --
		Equipment:	Mobile B-57	**24 Hours:**	-- | --	**24 Hours:**	-- | --

SAMPLE INFORMATION						DEPTH	STRATA		DESCRIPTION OF MATERIALS (Classification)	REMARKS
Depth (feet)	No	Type	Blows Per 6"	Rec. (in.)	N	(feet)				
						0.0				
							PAVEMENT		3" Asphalt	
0.5 - 2.5	S-1		6 - 6 - 4 - 4	10	10		FILL		Brown, Loose to Medium Dense, Medium to Fine Sand, Some Silt, Little Gravel (FILL)	
2.5 - 4.5	S-2		7 - 10 - 10 - 20	14	20		GLACIAL TILL		Gray/Brown, Medium Dense, Medium to Fine Sand, Some Silt, Trace Gravel (SM)	
						5.0				
5 - 7	S-3		3 - 4 - 8 - 8	20	12				As Above (SM)	
7 - 9	S-4		28 - 15 - 17 - 17	16	32				As Above (SM)	
						10.0				
10 - 12	S-5		10 - 12 - 25 - 35	18	37				As Above (SM)	
						15.0			Cobbles Below 15 Feet	
15 - 16	S-6		13 - 50	8	-				As Above (SM)	
						20.0				
20 - 20.8	S-7		37 - 50/4"	6	-				As Above (SM)	
						25.0			Boring Log B-12 Terminated at a Depth of 20.8 Feet Below Ground Surface.	

NOTES: bgs = below ground surface, msl = mean sea level, NA = Not Applicable, NE = Not Encountered, NS = Not Surveyed, P = Perched

Appendix D: Hydrologic Analysis

NOAA Atlas 14, Volume 10, Version 3
Location name: Worcester, Massachusetts, USA*
Latitude: 42.2785°, Longitude: -71.7724°
Elevation: 622.95 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	0.343 (0.272-0.427)	0.403 (0.320-0.503)	0.502 (0.396-0.629)	0.584 (0.458-0.736)	0.697 (0.527-0.919)	0.783 (0.578-1.06)	0.871 (0.622-1.22)	0.966 (0.655-1.40)	1.10 (0.714-1.65)	1.20 (0.762-1.85)
10-min	0.486 (0.385-0.605)	0.572 (0.453-0.713)	0.712 (0.562-0.891)	0.828 (0.649-1.04)	0.987 (0.747-1.30)	1.11 (0.819-1.50)	1.23 (0.881-1.73)	1.37 (0.927-1.98)	1.56 (1.01-2.34)	1.71 (1.08-2.63)
15-min	0.572 (0.453-0.712)	0.672 (0.533-0.839)	0.837 (0.661-1.05)	0.974 (0.764-1.23)	1.16 (0.879-1.53)	1.31 (0.964-1.76)	1.45 (1.04-2.03)	1.61 (1.09-2.33)	1.83 (1.19-2.75)	2.01 (1.27-3.09)
30-min	0.774 (0.614-0.964)	0.911 (0.722-1.14)	1.14 (0.896-1.42)	1.32 (1.04-1.67)	1.58 (1.19-2.08)	1.77 (1.31-2.39)	1.97 (1.41-2.76)	2.19 (1.48-3.17)	2.49 (1.62-3.74)	2.73 (1.73-4.20)
60-min	0.976 (0.774-1.22)	1.15 (0.911-1.43)	1.43 (1.13-1.80)	1.67 (1.31-2.10)	1.99 (1.51-2.63)	2.24 (1.66-3.02)	2.49 (1.78-3.49)	2.77 (1.88-4.01)	3.15 (2.05-4.73)	3.45 (2.18-5.31)
2-hr	1.23 (0.982-1.52)	1.46 (1.17-1.81)	1.84 (1.46-2.29)	2.16 (1.70-2.70)	2.59 (1.97-3.41)	2.91 (2.17-3.93)	3.26 (2.35-4.58)	3.65 (2.48-5.26)	4.23 (2.76-6.33)	4.71 (2.99-7.20)
3-hr	1.41 (1.13-1.74)	1.68 (1.35-2.08)	2.13 (1.70-2.64)	2.50 (1.98-3.12)	3.01 (2.31-3.96)	3.39 (2.54-4.57)	3.80 (2.76-5.35)	4.28 (2.92-6.15)	5.00 (3.27-7.45)	5.61 (3.57-8.54)
6-hr	1.77 (1.42-2.17)	2.13 (1.71-2.61)	2.72 (2.18-3.35)	3.21 (2.56-3.98)	3.89 (3.00-5.08)	4.39 (3.31-5.89)	4.93 (3.61-6.91)	5.58 (3.81-7.96)	6.57 (4.30-9.72)	7.40 (4.72-11.2)
12-hr	2.20 (1.78-2.68)	2.67 (2.16-3.25)	3.43 (2.77-4.20)	4.07 (3.26-5.01)	4.94 (3.83-6.42)	5.59 (4.24-7.45)	6.29 (4.63-8.76)	7.13 (4.89-10.1)	8.40 (5.52-12.4)	9.48 (6.06-14.2)
24-hr	2.61 (2.13-3.16)	3.19 (2.60-3.86)	4.13 (3.36-5.03)	4.92 (3.97-6.02)	6.00 (4.68-7.75)	6.80 (5.18-9.01)	7.66 (5.67-10.6)	8.71 (5.99-12.3)	10.3 (6.78-15.0)	11.6 (7.48-17.4)
2-day	2.96 (2.43-3.56)	3.63 (2.99-4.38)	4.74 (3.88-5.73)	5.66 (4.60-6.88)	6.92 (5.43-8.90)	7.85 (6.03-10.4)	8.87 (6.61-12.3)	10.1 (6.99-14.2)	12.0 (7.96-17.5)	13.7 (8.83-20.3)
3-day	3.21 (2.65-3.85)	3.94 (3.25-4.73)	5.13 (4.21-6.18)	6.12 (4.99-7.42)	7.48 (5.89-9.58)	8.48 (6.53-11.1)	9.57 (7.16-13.2)	10.9 (7.57-15.2)	13.0 (8.62-18.8)	14.8 (9.56-21.9)
4-day	3.44 (2.85-4.12)	4.21 (3.48-5.04)	5.46 (4.49-6.56)	6.49 (5.31-7.85)	7.92 (6.25-10.1)	8.97 (6.92-11.8)	10.1 (7.57-13.9)	11.5 (8.00-16.0)	13.7 (9.09-19.8)	15.6 (10.1-23.0)
7-day	4.11 (3.42-4.89)	4.94 (4.11-5.88)	6.29 (5.21-7.52)	7.42 (6.10-8.92)	8.97 (7.11-11.4)	10.1 (7.83-13.1)	11.4 (8.51-15.4)	12.8 (8.95-17.7)	15.1 (10.1-21.7)	17.0 (11.0-25.0)
10-day	4.77 (3.99-5.66)	5.64 (4.70-6.69)	7.05 (5.86-8.40)	8.22 (6.79-9.86)	9.84 (7.81-12.4)	11.0 (8.56-14.3)	12.3 (9.23-16.6)	13.8 (9.67-19.0)	16.1 (10.7-23.0)	18.0 (11.6-26.2)
20-day	6.81 (5.73-8.03)	7.73 (6.50-9.12)	9.23 (7.72-10.9)	10.5 (8.71-12.5)	12.2 (9.72-15.2)	13.5 (10.5-17.2)	14.8 (11.1-19.6)	16.3 (11.4-22.2)	18.2 (12.2-25.8)	19.8 (12.9-28.7)
30-day	8.52 (7.20-10.0)	9.47 (7.99-11.1)	11.0 (9.26-13.0)	12.3 (10.3-14.6)	14.1 (11.2-17.4)	15.4 (12.0-19.5)	16.8 (12.5-21.9)	18.2 (12.8-24.6)	19.9 (13.4-28.1)	21.2 (13.8-30.6)
45-day	10.6 (9.03-12.4)	11.6 (9.85-13.6)	13.2 (11.2-15.6)	14.6 (12.2-17.2)	16.4 (13.2-20.1)	17.9 (13.9-22.3)	19.3 (14.3-24.8)	20.5 (14.5-27.7)	22.1 (14.9-30.9)	23.1 (15.1-33.2)
60-day	12.4 (10.6-14.5)	13.4 (11.4-15.7)	15.1 (12.8-17.7)	16.5 (13.8-19.4)	18.4 (14.8-22.4)	19.9 (15.5-24.8)	21.3 (15.8-27.3)	22.5 (16.0-30.3)	24.0 (16.2-33.5)	24.9 (16.3-35.6)

[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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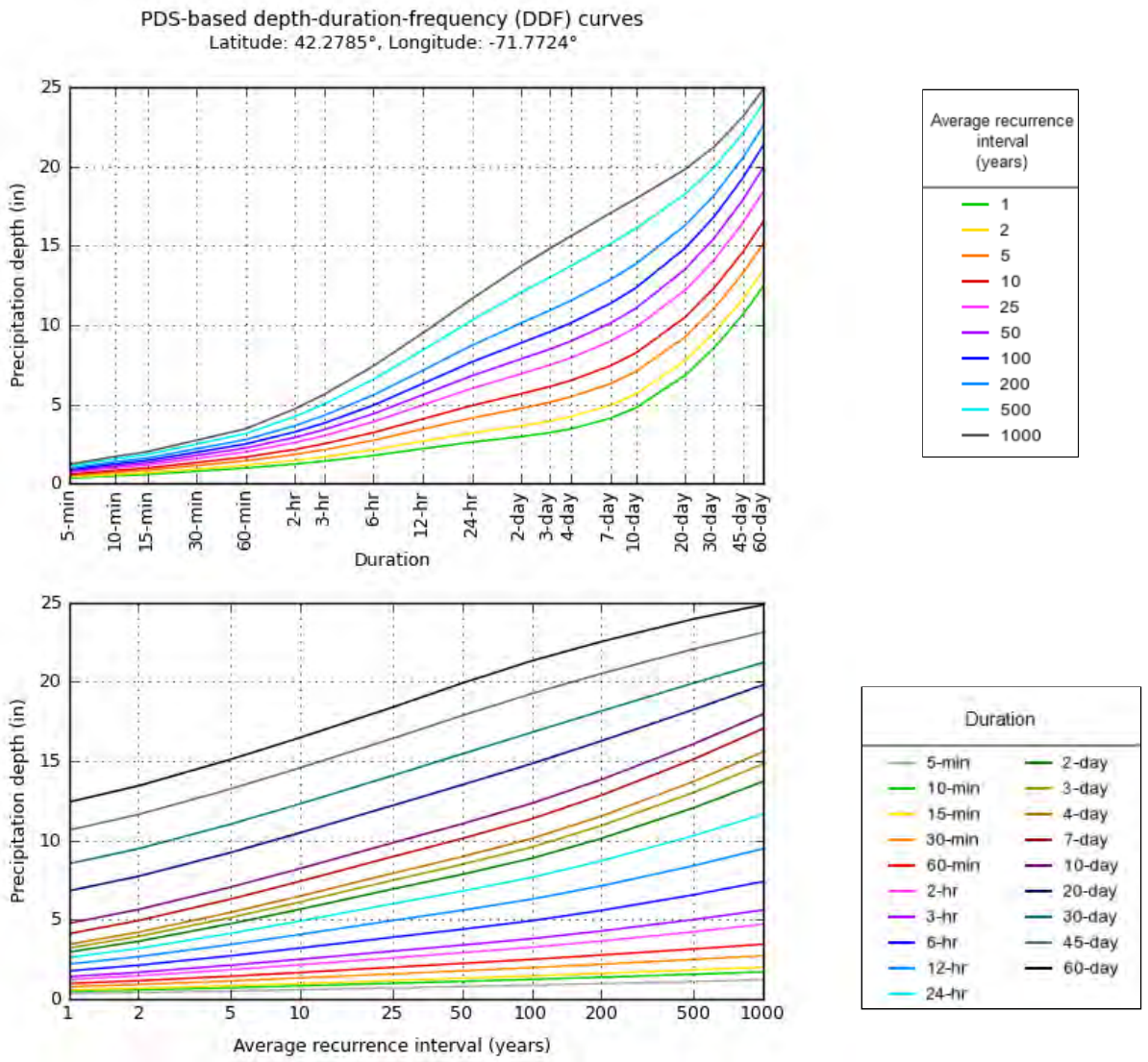
PF graphical



NOAA Atlas 14, Volume 10, Version 3

Created (GMT): Fri Aug 14 19:17:07 2020

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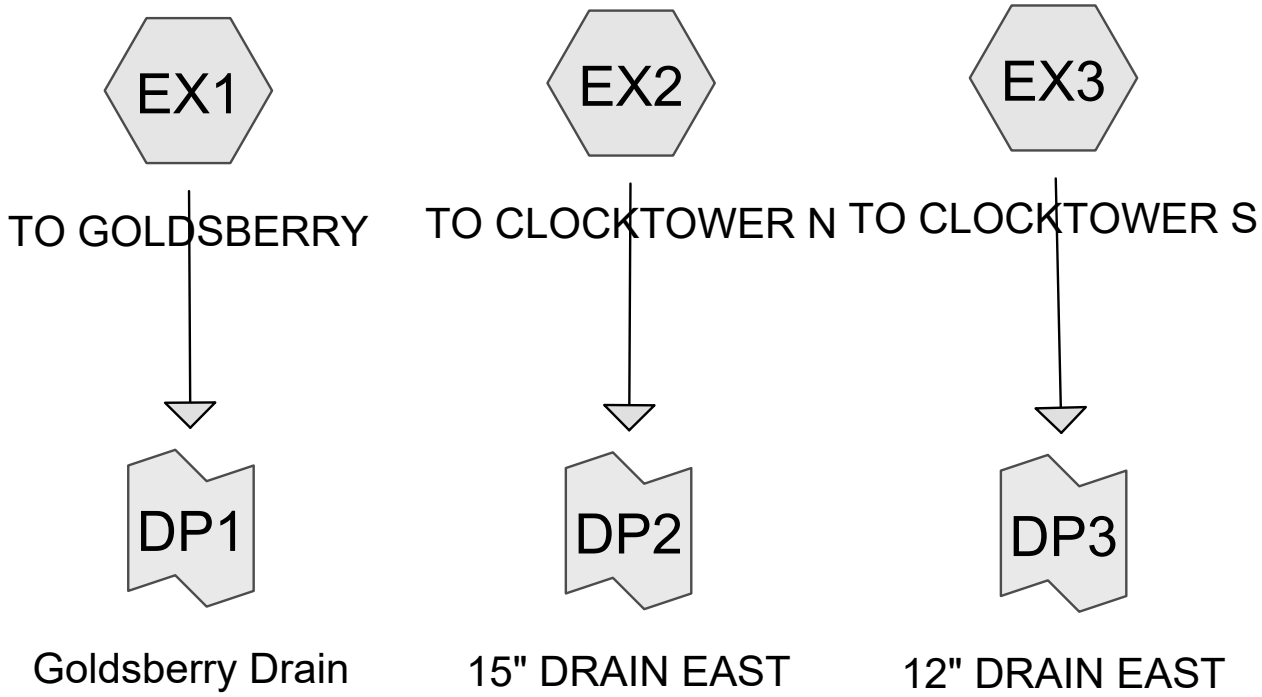
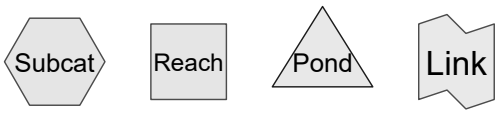
Maps & aerials

Small scale terrain

Large scale terrain

HydroCAD Analysis: Existing Conditions





Drainage Diagram for Lot D Existing
Prepared by MidPoint Engineering & Consulting, Printed 9/2/2020
HydroCAD® 9.10 s/n 07107 © 2011 HydroCAD Software Solutions LLC

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX1: TO GOLDSBERRY Runoff Area=191,839 sf 45.99% Impervious Runoff Depth>1.75"
Flow Length=630' Tc=5.0 min CN=85 Runoff=9.37 cfs 0.641 af

Subcatchment EX2: TO CLOCKTOWER N Runoff Area=33,206 sf 15.46% Impervious Runoff Depth>1.26"
Flow Length=308' Slope=0.0400 '/' Tc=11.1 min CN=78 Runoff=0.93 cfs 0.080 af

Subcatchment EX3: TO CLOCKTOWER S Runoff Area=43,068 sf 19.95% Impervious Runoff Depth>1.33"
Flow Length=230' Slope=0.0500 '/' Tc=9.8 min CN=79 Runoff=1.33 cfs 0.109 af

Link DP1: Goldsberry Drain Inflow=9.37 cfs 0.641 af
Primary=9.37 cfs 0.641 af

Link DP2: 15" DRAIN EAST Inflow=0.93 cfs 0.080 af
Primary=0.93 cfs 0.080 af

Link DP3: 12" DRAIN EAST Inflow=1.33 cfs 0.109 af
Primary=1.33 cfs 0.109 af

Total Runoff Area = 6.155 ac Runoff Volume = 0.831 af Average Runoff Depth = 1.62"
61.98% Pervious = 3.815 ac 38.02% Impervious = 2.340 ac

Summary for Subcatchment EX1: TO GOLDSBERRY

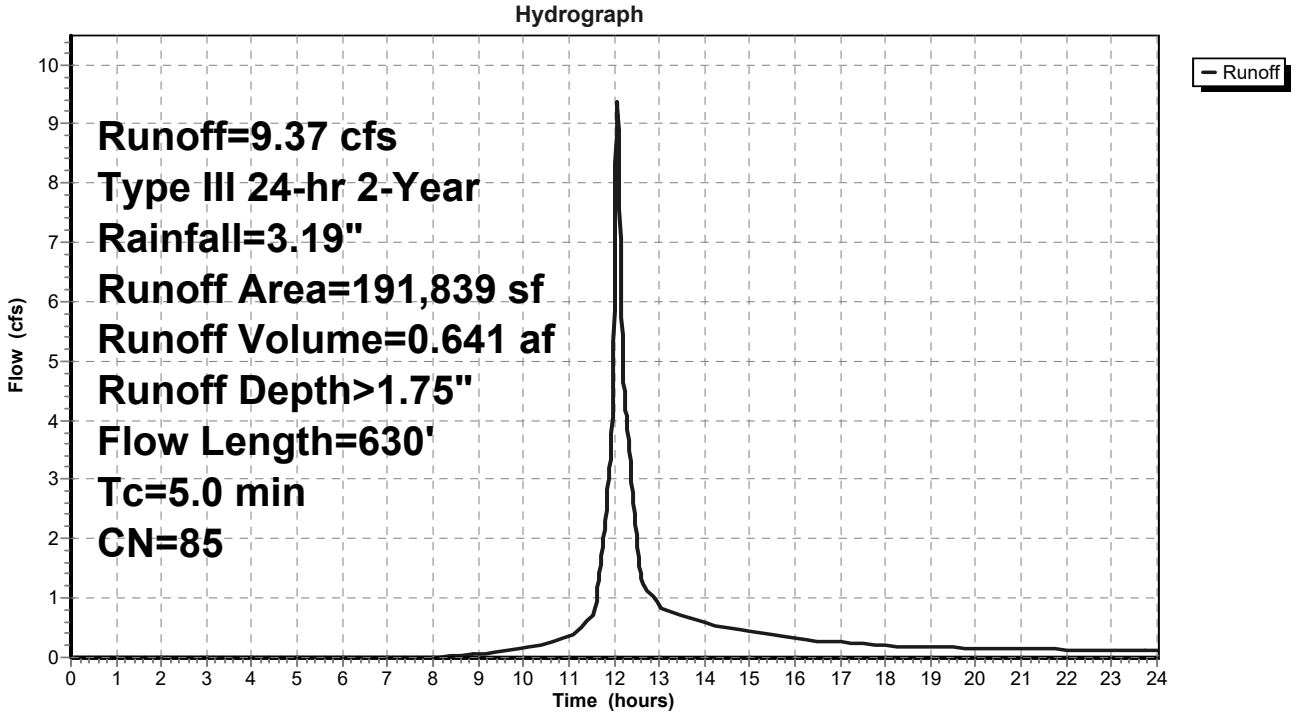
Runoff = 9.37 cfs @ 12.08 hrs, Volume= 0.641 af, Depth> 1.75"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.19"

Area (sf)	CN	Description
88,220	98	Paved parking, HSG C
103,619	74	>75% Grass cover, Good, HSG C
191,839	85	Weighted Average
103,619		54.01% Pervious Area
88,220		45.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	150	0.0300	1.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
2.2	480	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.4					**Direct Entry, adjustment**
5.0	630	Total			

Subcatchment EX1: TO GOLDSBERRY



Summary for Subcatchment EX2: TO CLOCKTOWER N

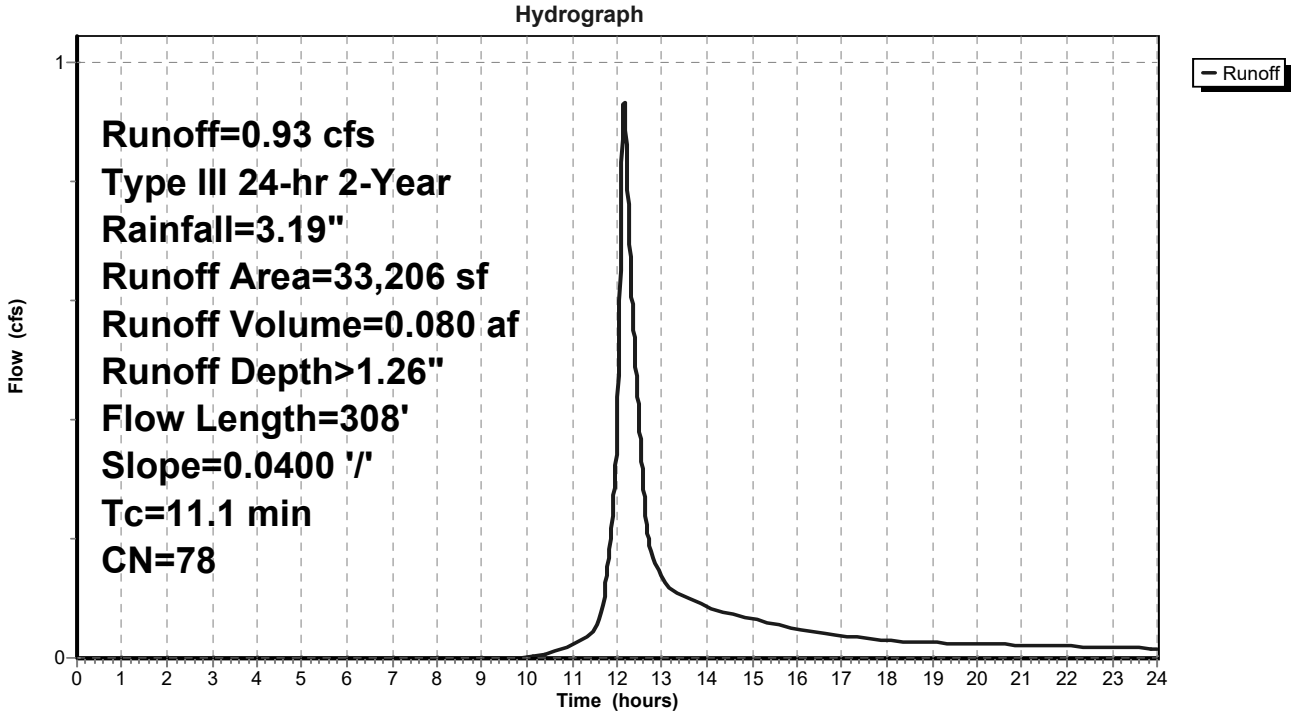
Runoff = 0.93 cfs @ 12.16 hrs, Volume= 0.080 af, Depth> 1.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.19"

Area (sf)	CN	Description
5,133	98	Paved parking, HSG C
28,073	74	>75% Grass cover, Good, HSG C
33,206	78	Weighted Average
28,073		84.54% Pervious Area
5,133		15.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.3	150	0.0400	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
0.8	158	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
11.1	308	Total			

Subcatchment EX2: TO CLOCKTOWER N



Summary for Subcatchment EX3: TO CLOCKTOWER S

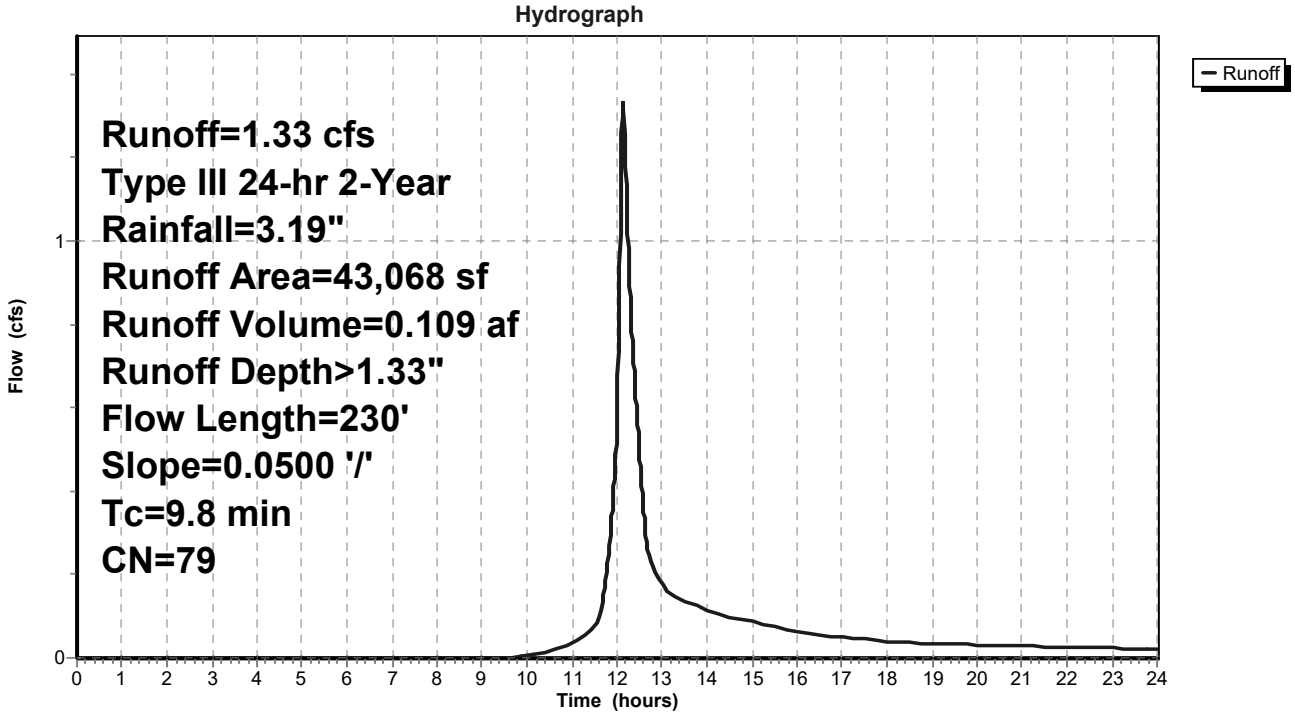
Runoff = 1.33 cfs @ 12.14 hrs, Volume= 0.109 af, Depth> 1.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.19"

Area (sf)	CN	Description
8,590	98	Paved parking, HSG C
34,478	74	>75% Grass cover, Good, HSG C
43,068	79	Weighted Average
34,478		80.05% Pervious Area
8,590		19.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	150	0.0500	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
0.4	80	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.8	230	Total			

Subcatchment EX3: TO CLOCKTOWER S

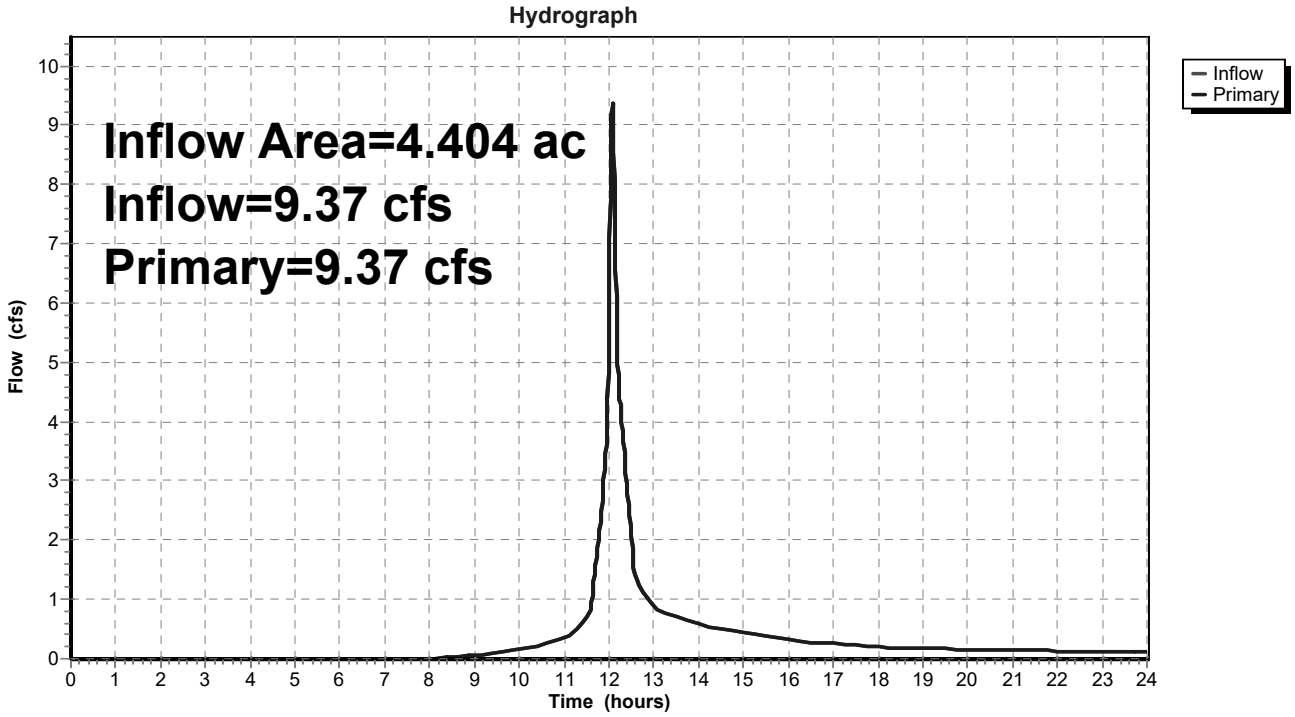


Summary for Link DP1: Goldsberry Drain

Inflow Area = 4.404 ac, 45.99% Impervious, Inflow Depth > 1.75" for 2-Year event
Inflow = 9.37 cfs @ 12.08 hrs, Volume= 0.641 af
Primary = 9.37 cfs @ 12.08 hrs, Volume= 0.641 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP1: Goldsberry Drain

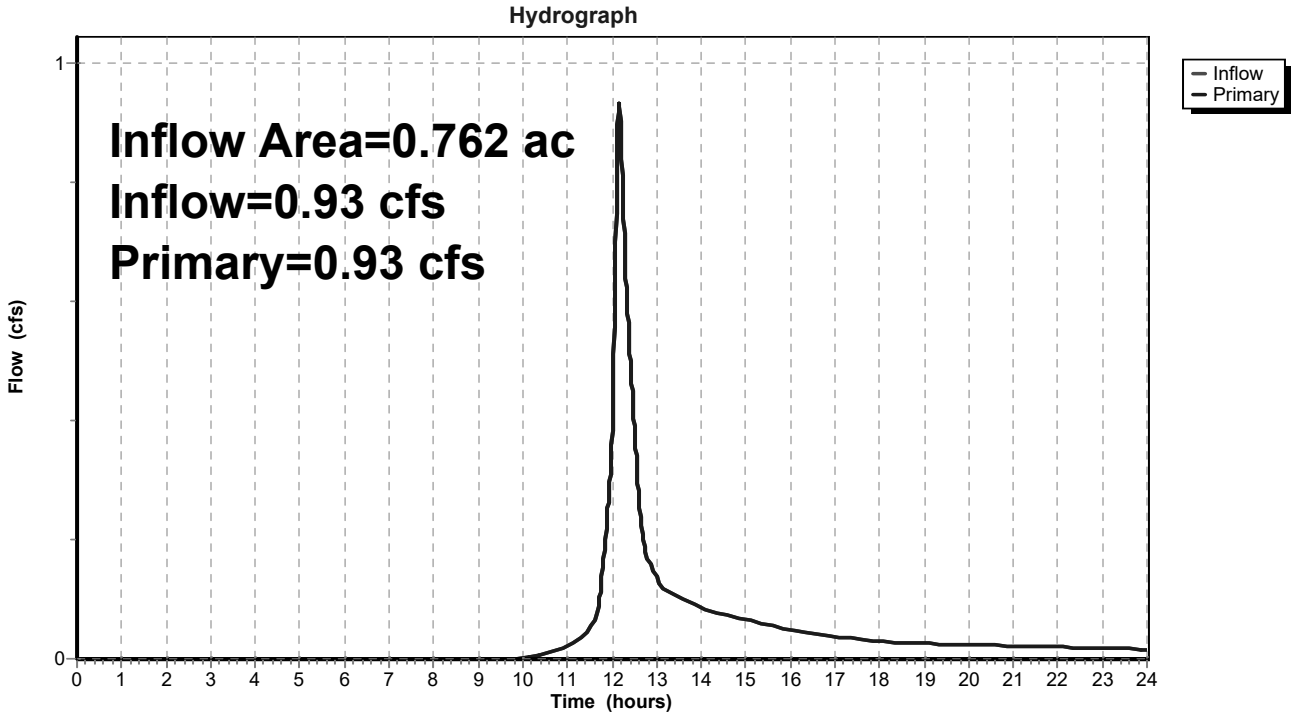


Summary for Link DP2: 15" DRAIN EAST

Inflow Area = 0.762 ac, 15.46% Impervious, Inflow Depth > 1.26" for 2-Year event
Inflow = 0.93 cfs @ 12.16 hrs, Volume= 0.080 af
Primary = 0.93 cfs @ 12.16 hrs, Volume= 0.080 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP2: 15" DRAIN EAST

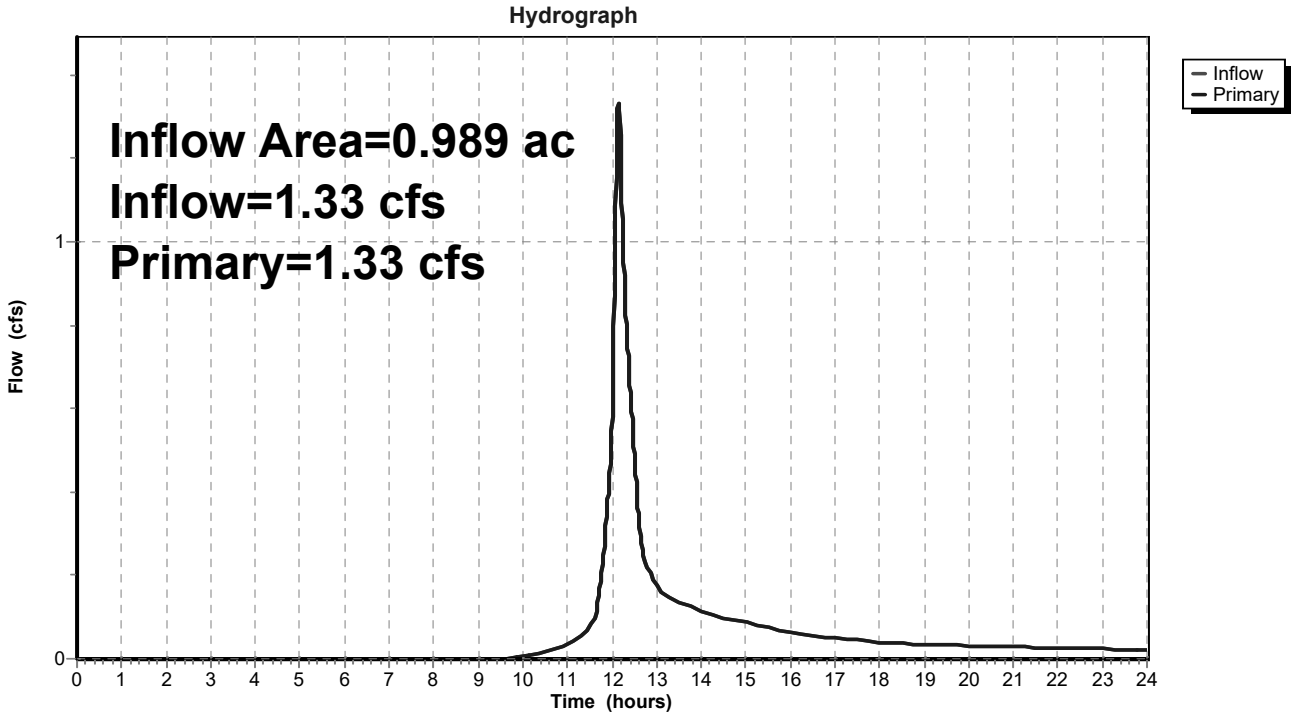


Summary for Link DP3: 12" DRAIN EAST

Inflow Area = 0.989 ac, 19.95% Impervious, Inflow Depth > 1.33" for 2-Year event
Inflow = 1.33 cfs @ 12.14 hrs, Volume= 0.109 af
Primary = 1.33 cfs @ 12.14 hrs, Volume= 0.109 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP3: 12" DRAIN EAST



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX1: TO GOLDSBERRY Runoff Area=191,839 sf 45.99% Impervious Runoff Depth>3.29"
Flow Length=630' Tc=5.0 min CN=85 Runoff=17.46 cfs 1.208 af

Subcatchment EX2: TO CLOCKTOWER N Runoff Area=33,206 sf 15.46% Impervious Runoff Depth>2.64"
Flow Length=308' Slope=0.0400 '/' Tc=11.1 min CN=78 Runoff=2.00 cfs 0.168 af

Subcatchment EX3: TO CLOCKTOWER S Runoff Area=43,068 sf 19.95% Impervious Runoff Depth>2.73"
Flow Length=230' Slope=0.0500 '/' Tc=9.8 min CN=79 Runoff=2.79 cfs 0.225 af

Link DP1: Goldsberry Drain Inflow=17.46 cfs 1.208 af
Primary=17.46 cfs 1.208 af

Link DP2: 15" DRAIN EAST Inflow=2.00 cfs 0.168 af
Primary=2.00 cfs 0.168 af

Link DP3: 12" DRAIN EAST Inflow=2.79 cfs 0.225 af
Primary=2.79 cfs 0.225 af

Total Runoff Area = 6.155 ac Runoff Volume = 1.600 af Average Runoff Depth = 3.12"
61.98% Pervious = 3.815 ac 38.02% Impervious = 2.340 ac

Summary for Subcatchment EX1: TO GOLDSBERRY

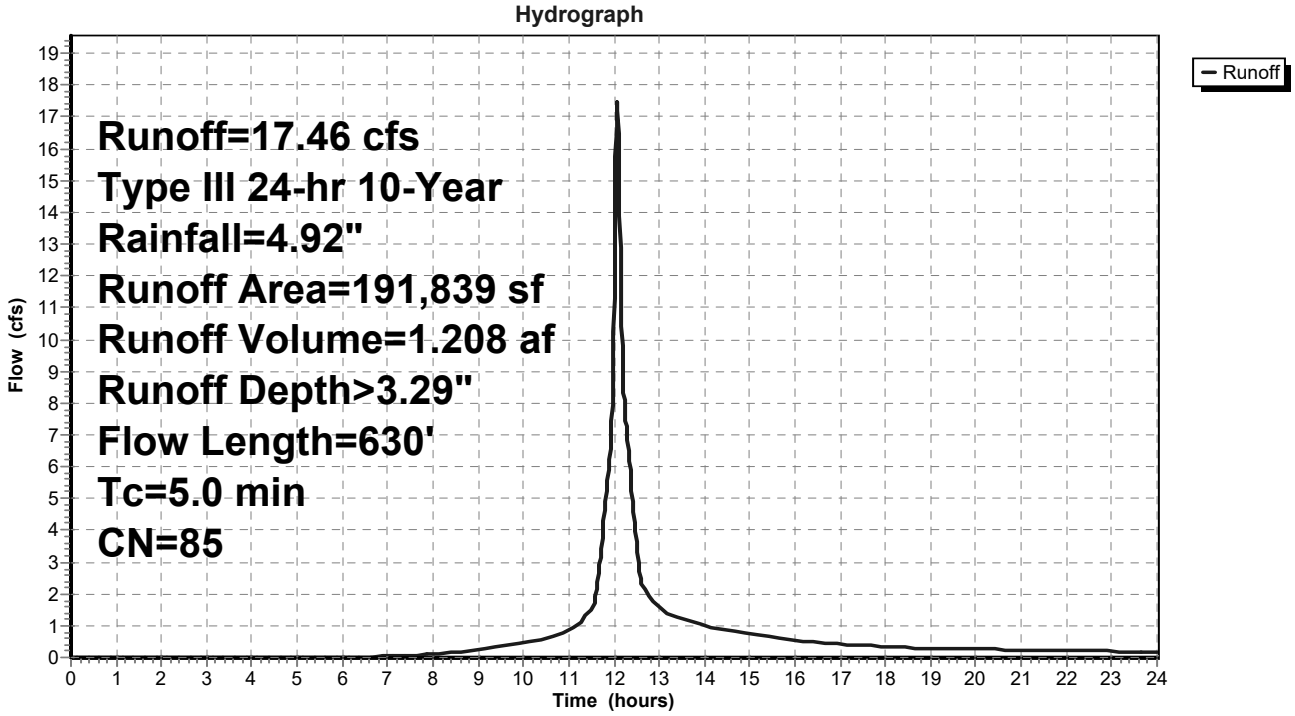
Runoff = 17.46 cfs @ 12.07 hrs, Volume= 1.208 af, Depth> 3.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.92"

Area (sf)	CN	Description
88,220	98	Paved parking, HSG C
103,619	74	>75% Grass cover, Good, HSG C
191,839	85	Weighted Average
103,619		54.01% Pervious Area
88,220		45.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	150	0.0300	1.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
2.2	480	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.4					**Direct Entry, adjustment**
5.0	630	Total			

Subcatchment EX1: TO GOLDSBERRY



Summary for Subcatchment EX2: TO CLOCKTOWER N

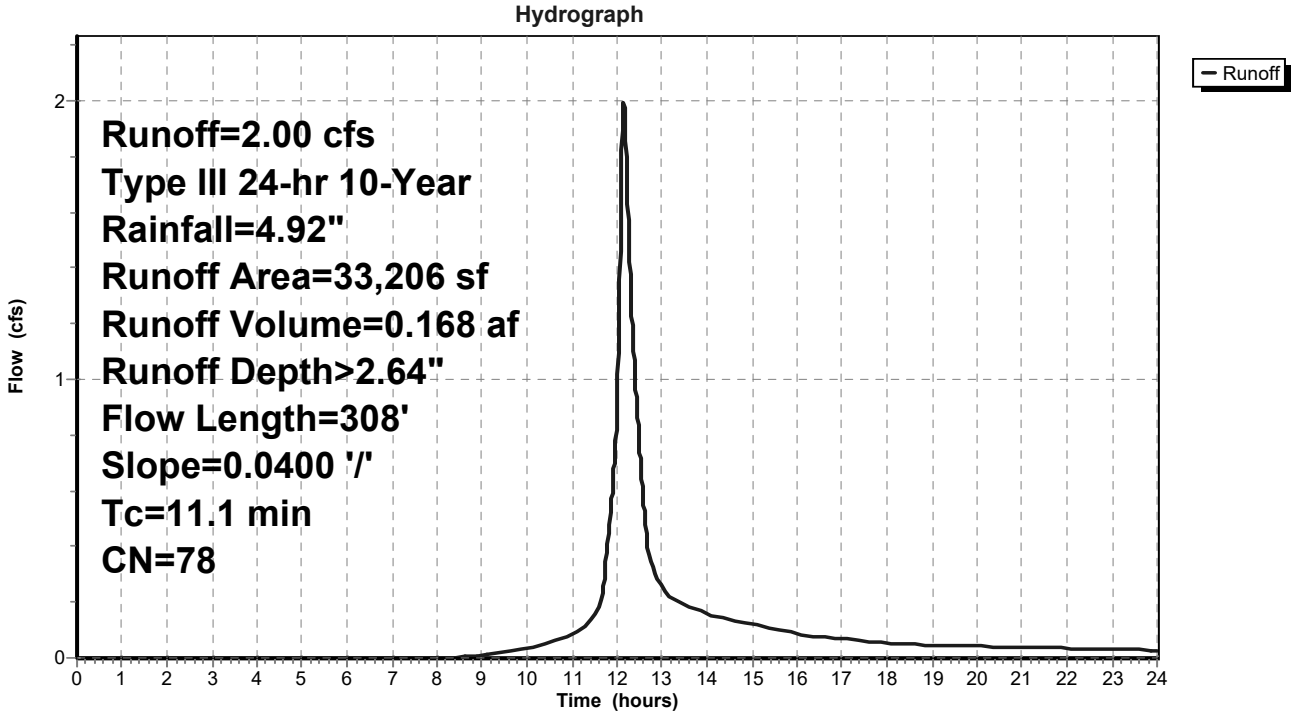
Runoff = 2.00 cfs @ 12.15 hrs, Volume= 0.168 af, Depth> 2.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.92"

Area (sf)	CN	Description
5,133	98	Paved parking, HSG C
28,073	74	>75% Grass cover, Good, HSG C
33,206	78	Weighted Average
28,073		84.54% Pervious Area
5,133		15.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.3	150	0.0400	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
0.8	158	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
11.1	308	Total			

Subcatchment EX2: TO CLOCKTOWER N



Summary for Subcatchment EX3: TO CLOCKTOWER S

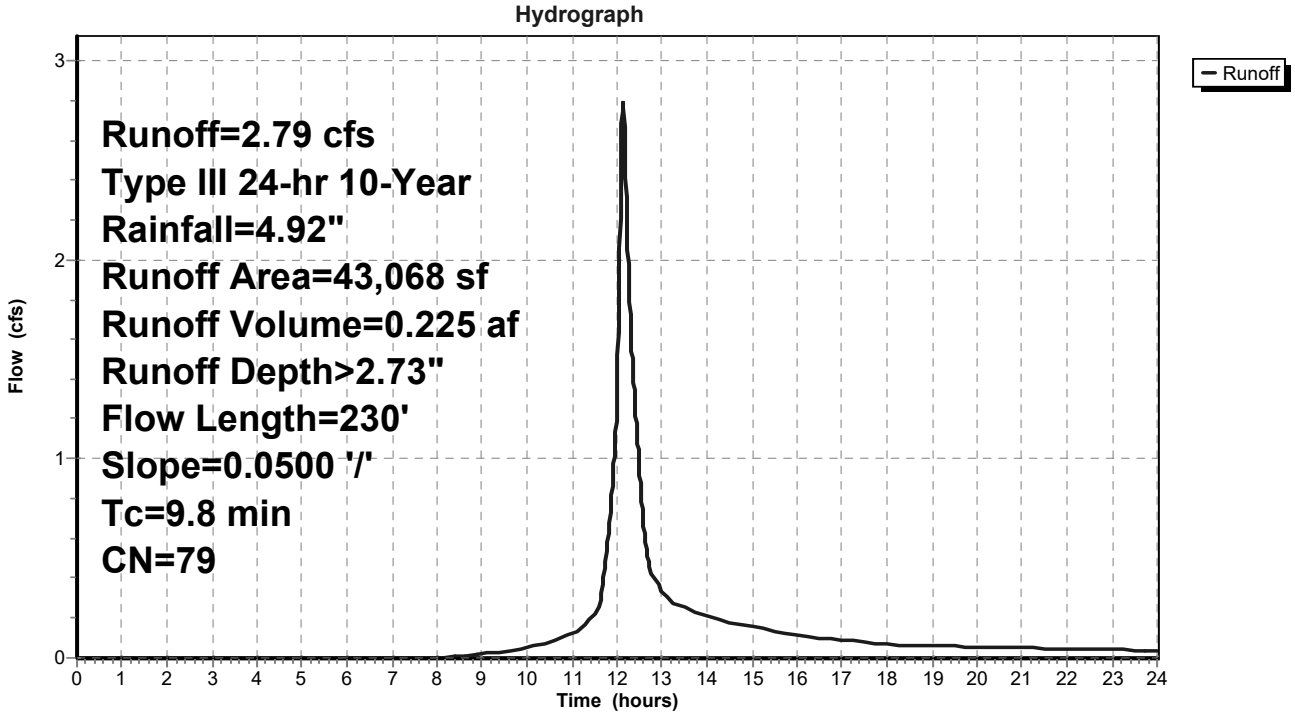
Runoff = 2.79 cfs @ 12.14 hrs, Volume= 0.225 af, Depth> 2.73"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.92"

Area (sf)	CN	Description
8,590	98	Paved parking, HSG C
34,478	74	>75% Grass cover, Good, HSG C
43,068	79	Weighted Average
34,478		80.05% Pervious Area
8,590		19.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	150	0.0500	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
0.4	80	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.8	230	Total			

Subcatchment EX3: TO CLOCKTOWER S

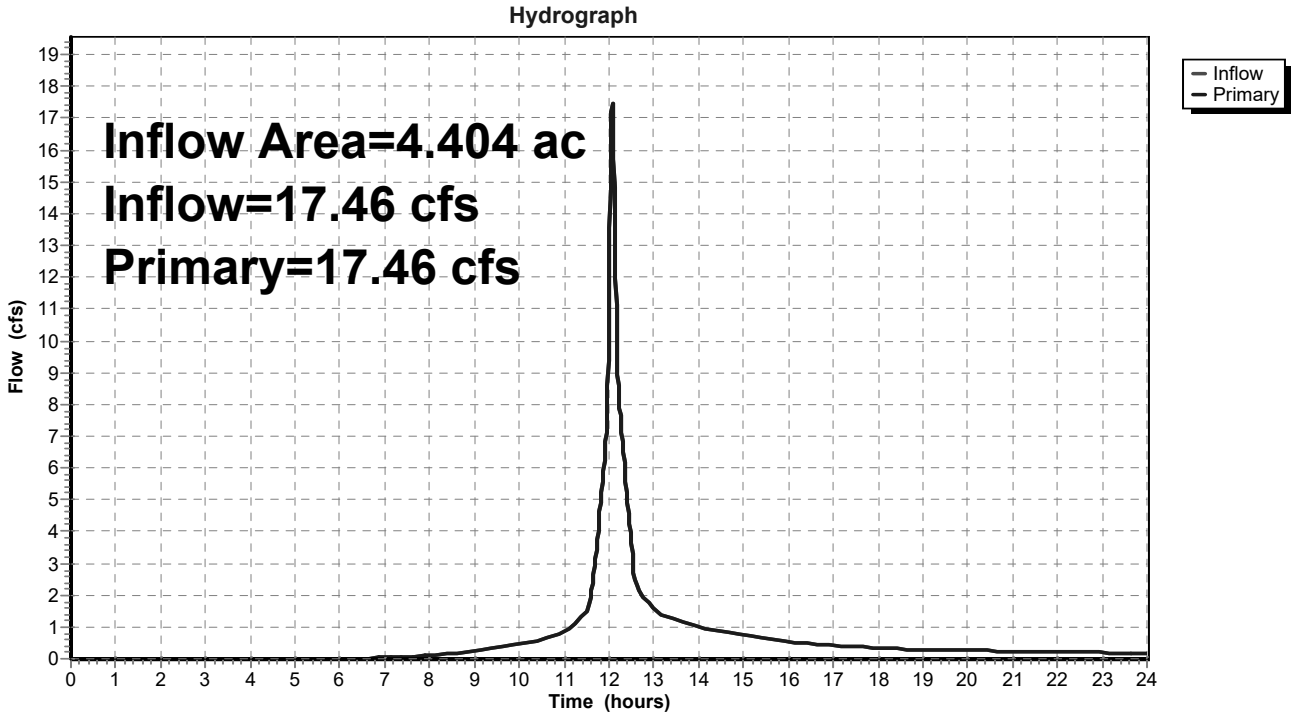


Summary for Link DP1: Goldsberry Drain

Inflow Area = 4.404 ac, 45.99% Impervious, Inflow Depth > 3.29" for 10-Year event
Inflow = 17.46 cfs @ 12.07 hrs, Volume= 1.208 af
Primary = 17.46 cfs @ 12.07 hrs, Volume= 1.208 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP1: Goldsberry Drain

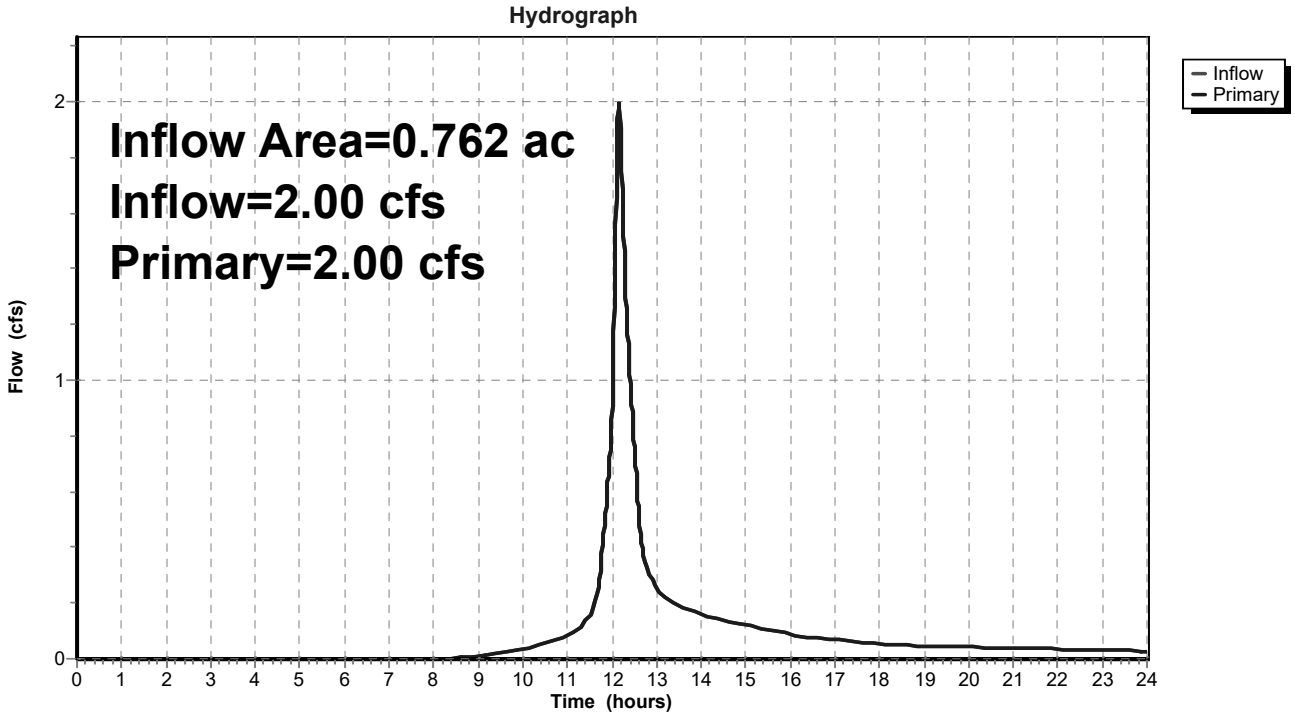


Summary for Link DP2: 15" DRAIN EAST

Inflow Area = 0.762 ac, 15.46% Impervious, Inflow Depth > 2.64" for 10-Year event
Inflow = 2.00 cfs @ 12.15 hrs, Volume= 0.168 af
Primary = 2.00 cfs @ 12.15 hrs, Volume= 0.168 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP2: 15" DRAIN EAST

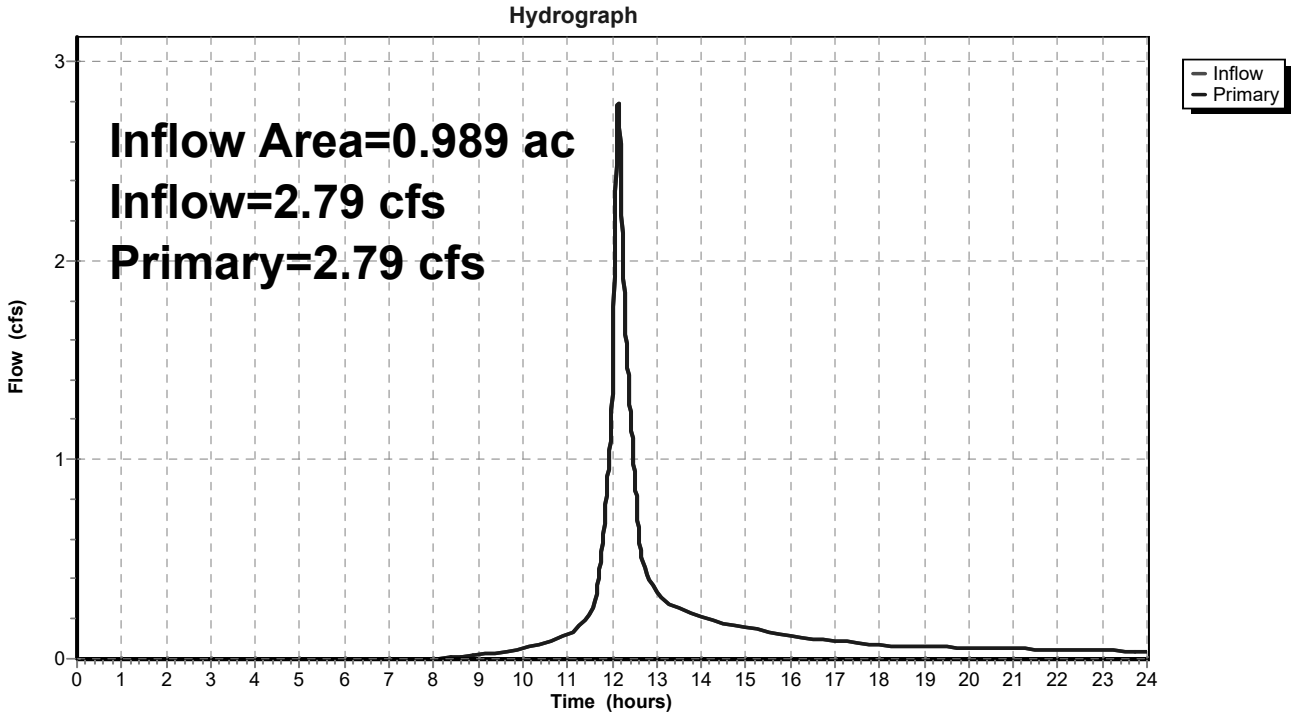


Summary for Link DP3: 12" DRAIN EAST

Inflow Area = 0.989 ac, 19.95% Impervious, Inflow Depth > 2.73" for 10-Year event
Inflow = 2.79 cfs @ 12.14 hrs, Volume= 0.225 af
Primary = 2.79 cfs @ 12.14 hrs, Volume= 0.225 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP3: 12" DRAIN EAST



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX1: TO GOLDSBERRY Runoff Area=191,839 sf 45.99% Impervious Runoff Depth>4.30"
Flow Length=630' Tc=5.0 min CN=85 Runoff=22.59 cfs 1.578 af

Subcatchment EX2: TO CLOCKTOWER N Runoff Area=33,206 sf 15.46% Impervious Runoff Depth>3.57"
Flow Length=308' Slope=0.0400 '/' Tc=11.1 min CN=78 Runoff=2.70 cfs 0.227 af

Subcatchment EX3: TO CLOCKTOWER S Runoff Area=43,068 sf 19.95% Impervious Runoff Depth>3.67"
Flow Length=230' Slope=0.0500 '/' Tc=9.8 min CN=79 Runoff=3.75 cfs 0.303 af

Link DP1: Goldsberry Drain Inflow=22.59 cfs 1.578 af
Primary=22.59 cfs 1.578 af

Link DP2: 15" DRAIN EAST Inflow=2.70 cfs 0.227 af
Primary=2.70 cfs 0.227 af

Link DP3: 12" DRAIN EAST Inflow=3.75 cfs 0.303 af
Primary=3.75 cfs 0.303 af

Total Runoff Area = 6.155 ac Runoff Volume = 2.107 af Average Runoff Depth = 4.11"
61.98% Pervious = 3.815 ac 38.02% Impervious = 2.340 ac

Summary for Subcatchment EX1: TO GOLDSBERRY

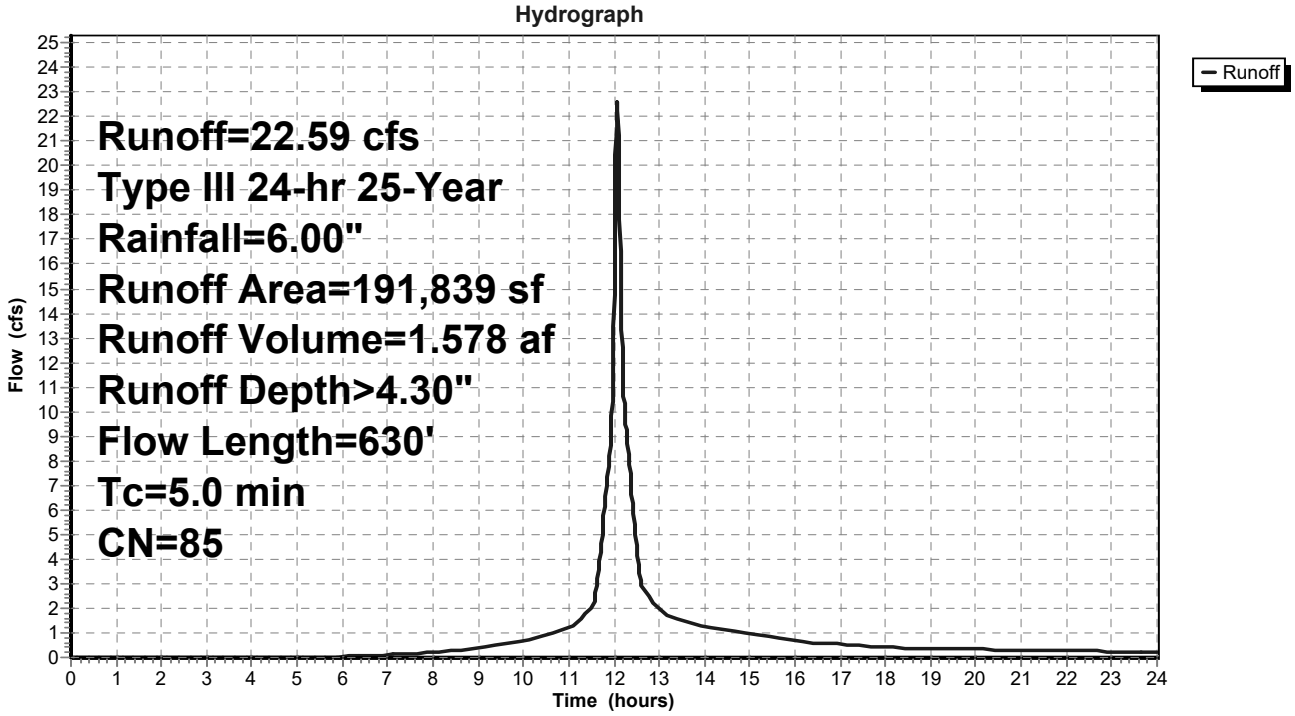
Runoff = 22.59 cfs @ 12.07 hrs, Volume= 1.578 af, Depth> 4.30"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.00"

Area (sf)	CN	Description
88,220	98	Paved parking, HSG C
103,619	74	>75% Grass cover, Good, HSG C
191,839	85	Weighted Average
103,619		54.01% Pervious Area
88,220		45.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	150	0.0300	1.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
2.2	480	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.4					**Direct Entry, adjustment**
5.0	630	Total			

Subcatchment EX1: TO GOLDSBERRY



Summary for Subcatchment EX2: TO CLOCKTOWER N

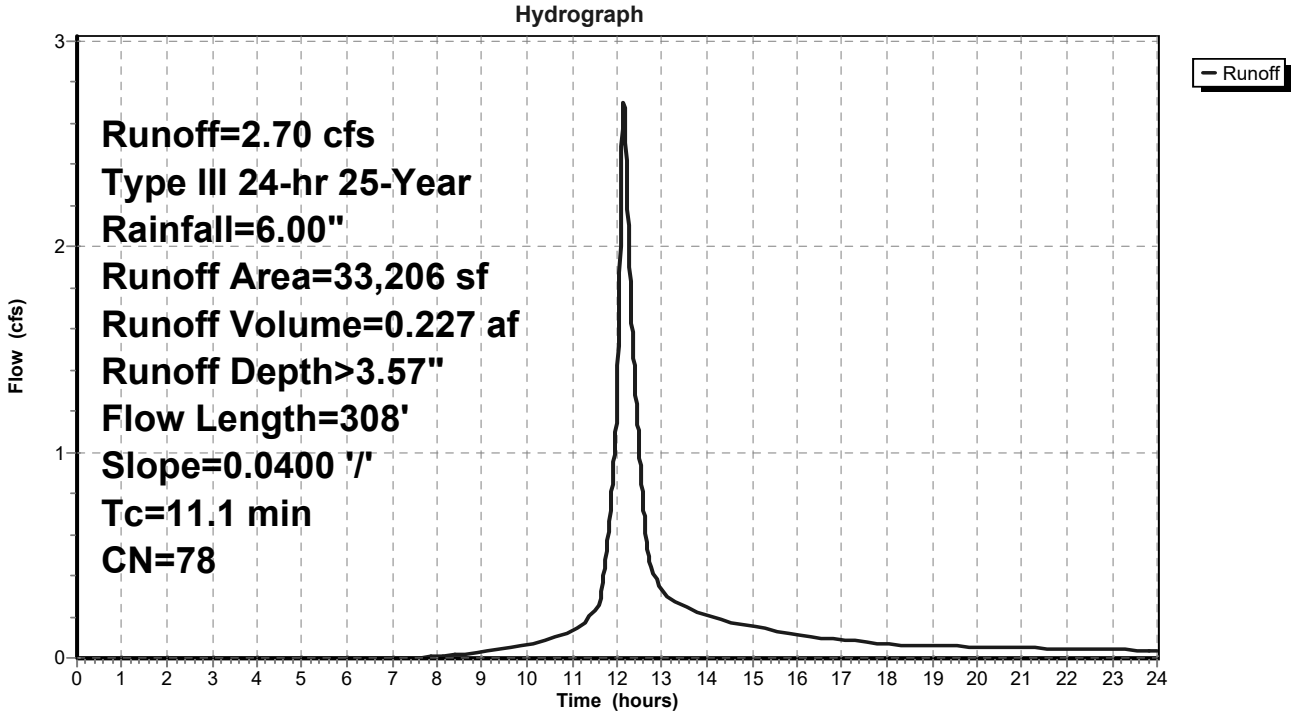
Runoff = 2.70 cfs @ 12.15 hrs, Volume= 0.227 af, Depth> 3.57"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.00"

Area (sf)	CN	Description
5,133	98	Paved parking, HSG C
28,073	74	>75% Grass cover, Good, HSG C
33,206	78	Weighted Average
28,073		84.54% Pervious Area
5,133		15.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.3	150	0.0400	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
0.8	158	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
11.1	308	Total			

Subcatchment EX2: TO CLOCKTOWER N



Summary for Subcatchment EX3: TO CLOCKTOWER S

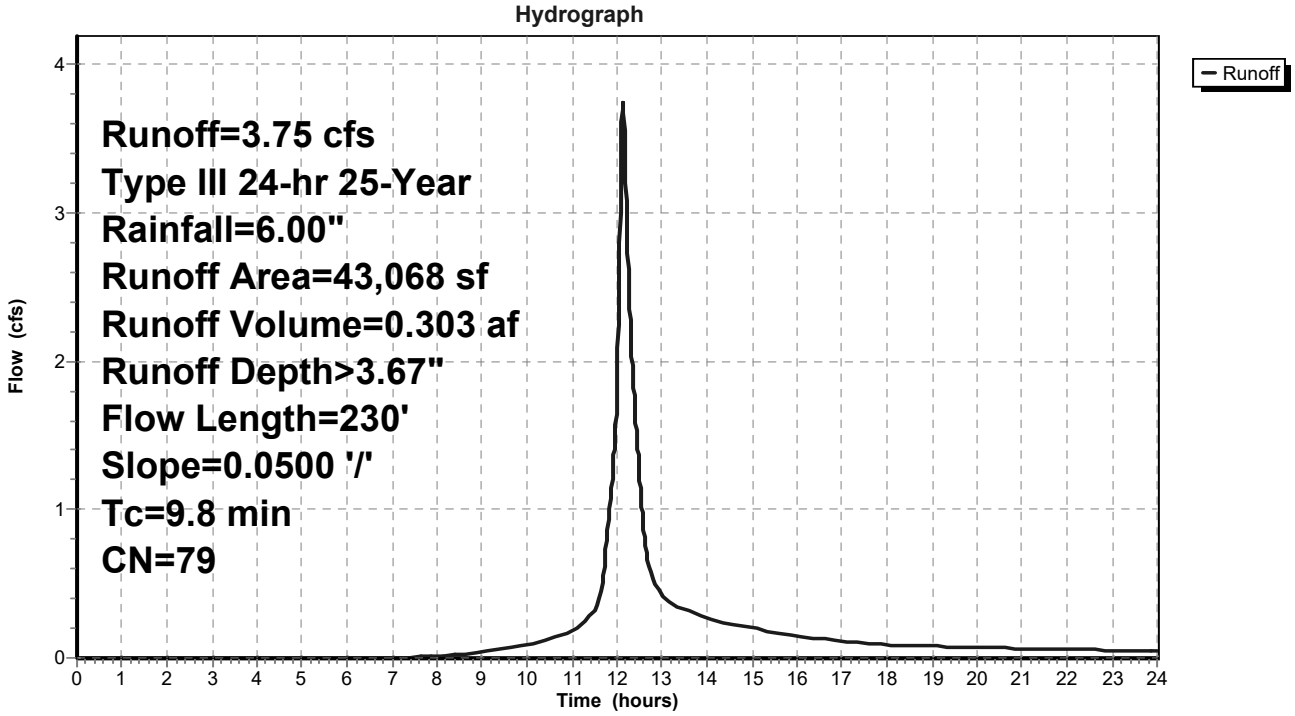
Runoff = 3.75 cfs @ 12.14 hrs, Volume= 0.303 af, Depth> 3.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.00"

Area (sf)	CN	Description
8,590	98	Paved parking, HSG C
34,478	74	>75% Grass cover, Good, HSG C
43,068	79	Weighted Average
34,478		80.05% Pervious Area
8,590		19.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	150	0.0500	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
0.4	80	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.8	230	Total			

Subcatchment EX3: TO CLOCKTOWER S

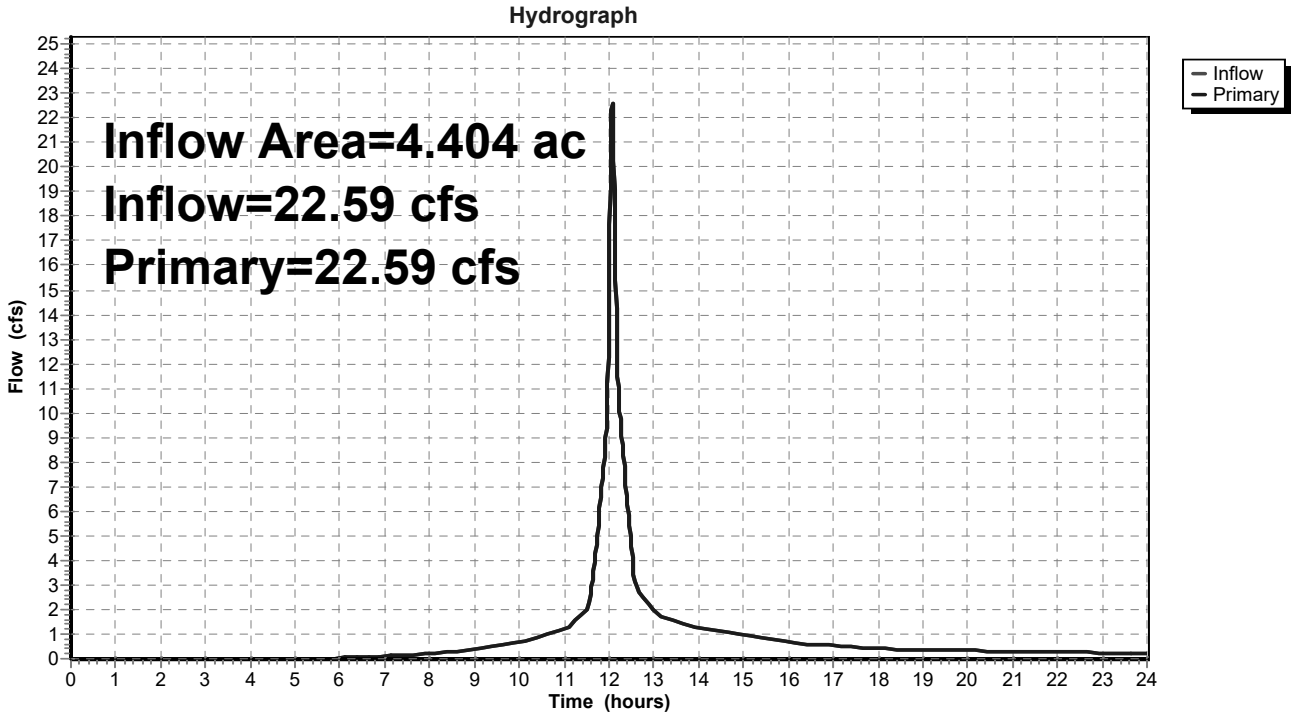


Summary for Link DP1: Goldsberry Drain

Inflow Area = 4.404 ac, 45.99% Impervious, Inflow Depth > 4.30" for 25-Year event
Inflow = 22.59 cfs @ 12.07 hrs, Volume= 1.578 af
Primary = 22.59 cfs @ 12.07 hrs, Volume= 1.578 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP1: Goldsberry Drain

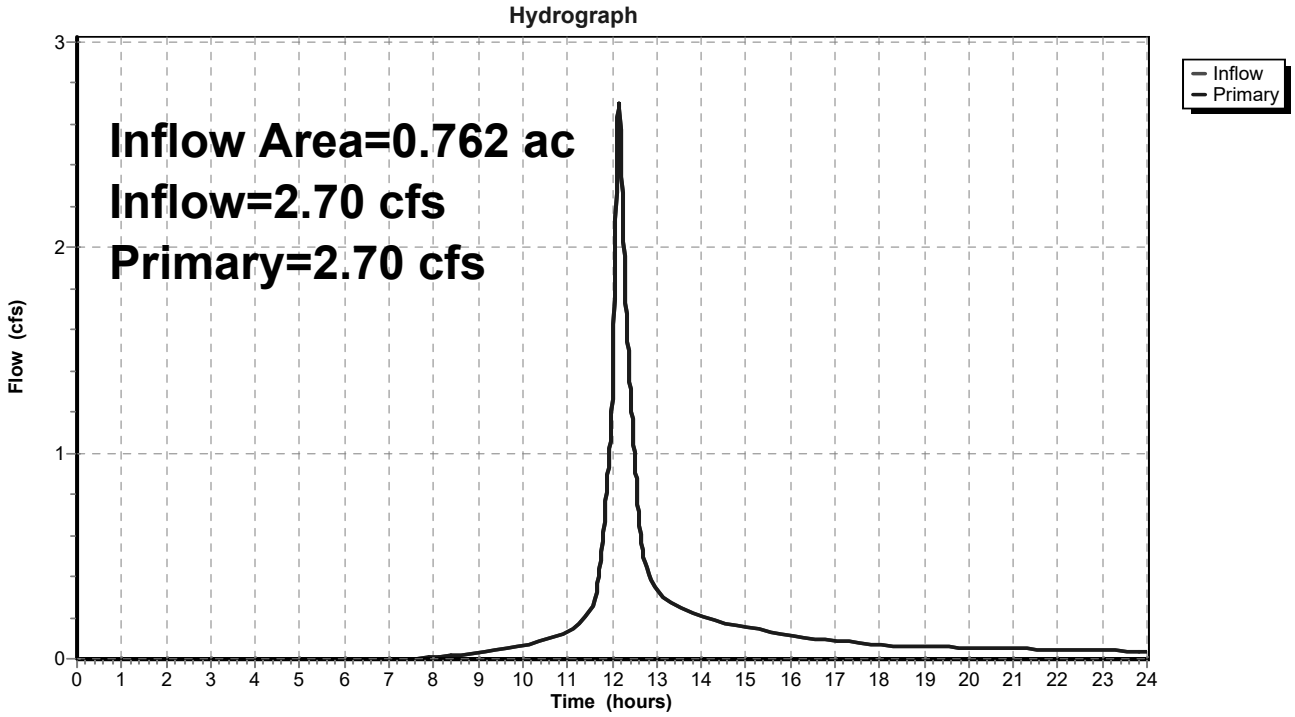


Summary for Link DP2: 15" DRAIN EAST

Inflow Area = 0.762 ac, 15.46% Impervious, Inflow Depth > 3.57" for 25-Year event
Inflow = 2.70 cfs @ 12.15 hrs, Volume= 0.227 af
Primary = 2.70 cfs @ 12.15 hrs, Volume= 0.227 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP2: 15" DRAIN EAST

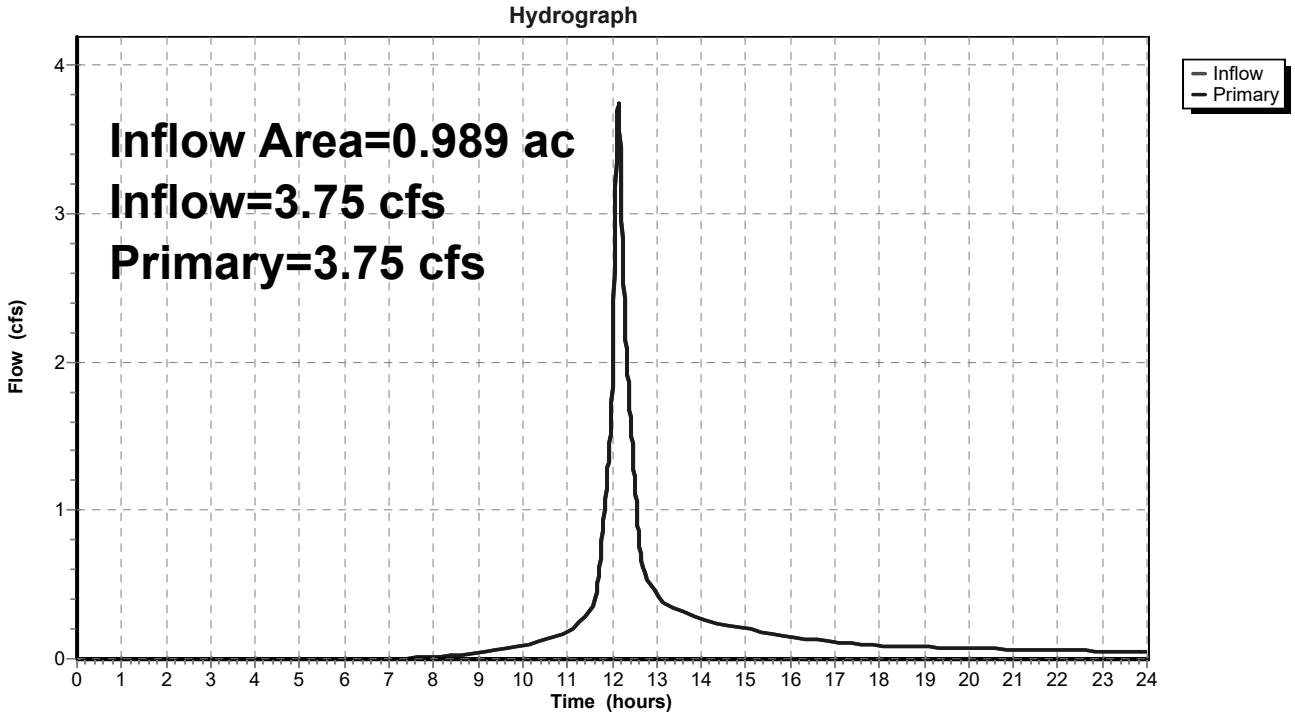


Summary for Link DP3: 12" DRAIN EAST

Inflow Area = 0.989 ac, 19.95% Impervious, Inflow Depth > 3.67" for 25-Year event
Inflow = 3.75 cfs @ 12.14 hrs, Volume= 0.303 af
Primary = 3.75 cfs @ 12.14 hrs, Volume= 0.303 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP3: 12" DRAIN EAST



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX1: TO GOLDSBERRY Runoff Area=191,839 sf 45.99% Impervious Runoff Depth>5.88"
Flow Length=630' Tc=5.0 min CN=85 Runoff=30.45 cfs 2.158 af

Subcatchment EX2: TO CLOCKTOWER N Runoff Area=33,206 sf 15.46% Impervious Runoff Depth>5.07"
Flow Length=308' Slope=0.0400 '/' Tc=11.1 min CN=78 Runoff=3.81 cfs 0.322 af

Subcatchment EX3: TO CLOCKTOWER S Runoff Area=43,068 sf 19.95% Impervious Runoff Depth>5.18"
Flow Length=230' Slope=0.0500 '/' Tc=9.8 min CN=79 Runoff=5.24 cfs 0.427 af

Link DP1: Goldsberry Drain Inflow=30.45 cfs 2.158 af
Primary=30.45 cfs 2.158 af

Link DP2: 15" DRAIN EAST Inflow=3.81 cfs 0.322 af
Primary=3.81 cfs 0.322 af

Link DP3: 12" DRAIN EAST Inflow=5.24 cfs 0.427 af
Primary=5.24 cfs 0.427 af

Total Runoff Area = 6.155 ac Runoff Volume = 2.907 af Average Runoff Depth = 5.67"
61.98% Pervious = 3.815 ac 38.02% Impervious = 2.340 ac

Summary for Subcatchment EX1: TO GOLDSBERRY

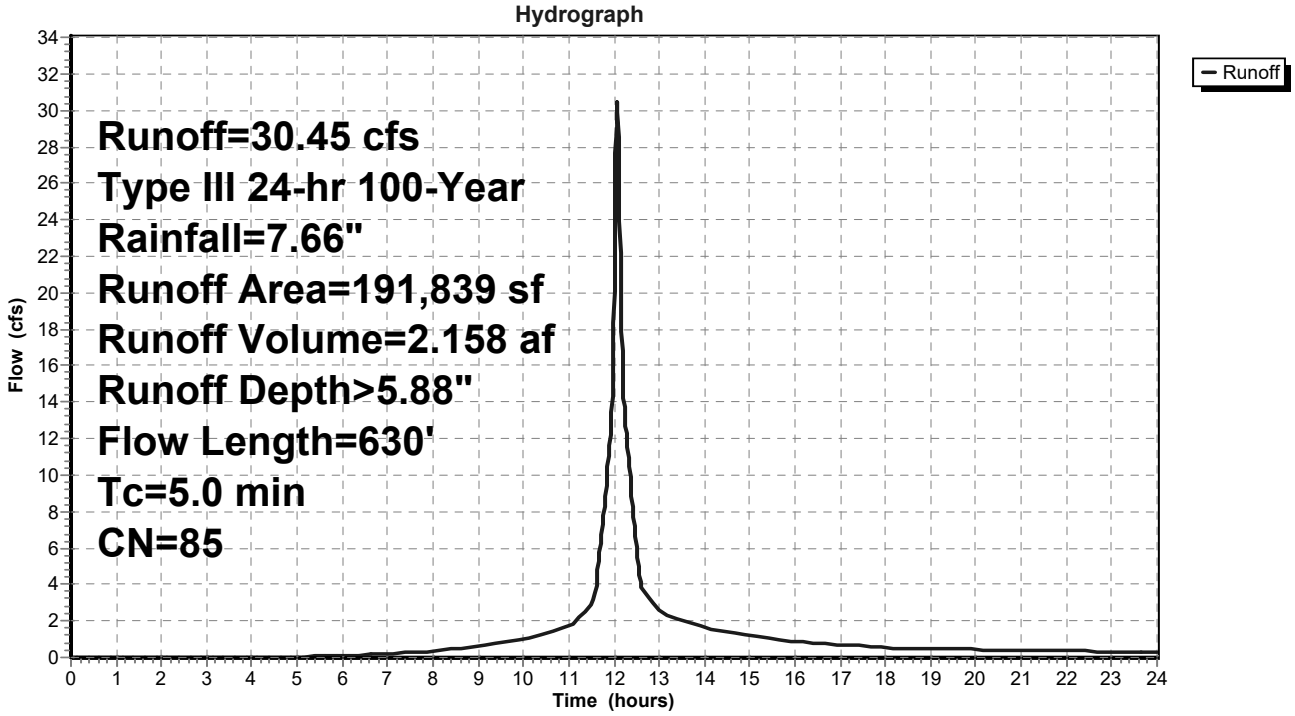
Runoff = 30.45 cfs @ 12.07 hrs, Volume= 2.158 af, Depth> 5.88"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.66"

Area (sf)	CN	Description
88,220	98	Paved parking, HSG C
103,619	74	>75% Grass cover, Good, HSG C
191,839	85	Weighted Average
103,619		54.01% Pervious Area
88,220		45.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	150	0.0300	1.75		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
2.2	480	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.4					**Direct Entry, adjustment**
5.0	630	Total			

Subcatchment EX1: TO GOLDSBERRY



Summary for Subcatchment EX2: TO CLOCKTOWER N

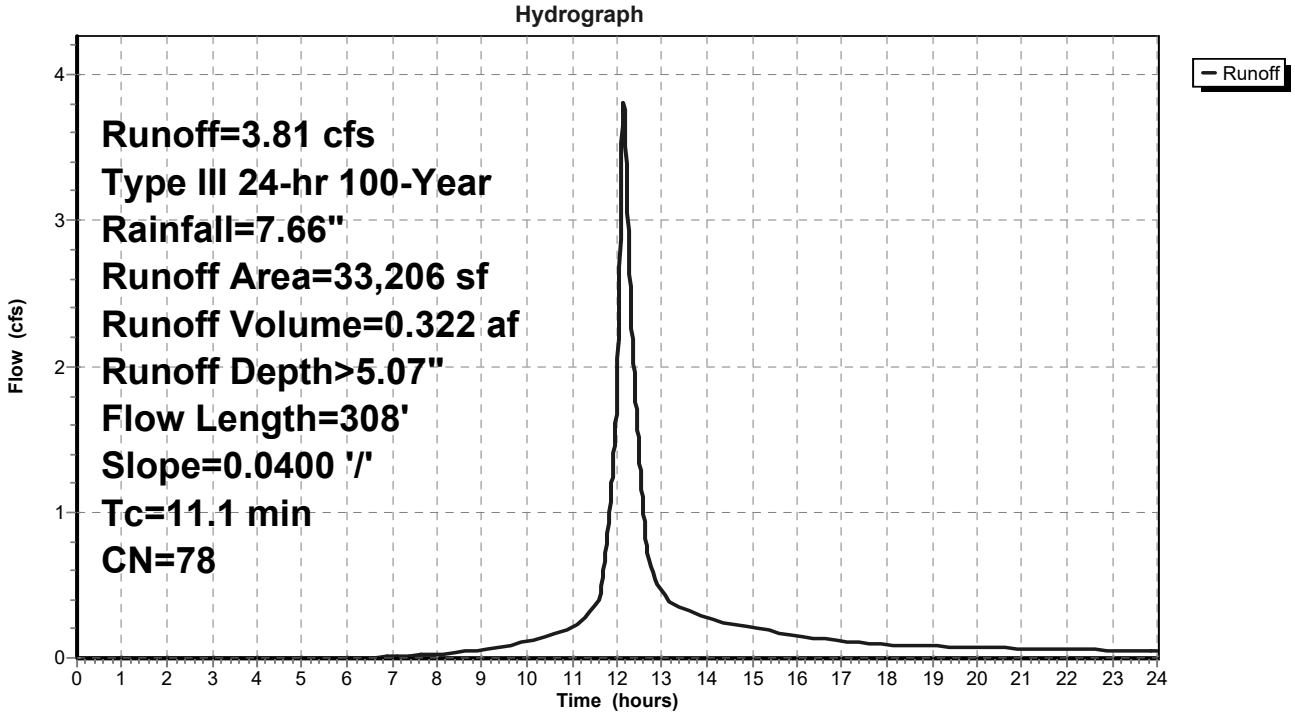
Runoff = 3.81 cfs @ 12.15 hrs, Volume= 0.322 af, Depth> 5.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.66"

Area (sf)	CN	Description
5,133	98	Paved parking, HSG C
28,073	74	>75% Grass cover, Good, HSG C
33,206	78	Weighted Average
28,073		84.54% Pervious Area
5,133		15.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.3	150	0.0400	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
0.8	158	0.0400	3.22		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
11.1	308	Total			

Subcatchment EX2: TO CLOCKTOWER N



Summary for Subcatchment EX3: TO CLOCKTOWER S

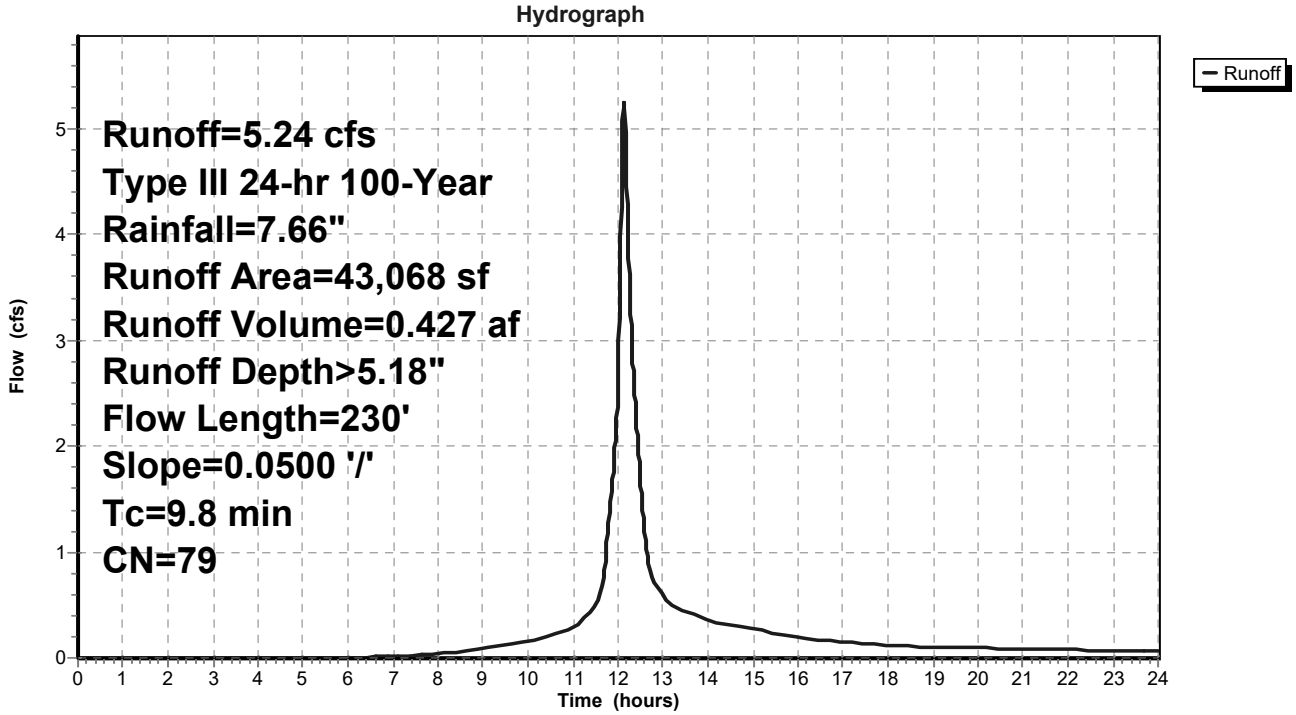
Runoff = 5.24 cfs @ 12.14 hrs, Volume= 0.427 af, Depth> 5.18"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.66"

Area (sf)	CN	Description
8,590	98	Paved parking, HSG C
34,478	74	>75% Grass cover, Good, HSG C
43,068	79	Weighted Average
34,478		80.05% Pervious Area
8,590		19.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	150	0.0500	0.27		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
0.4	80	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
9.8	230	Total			

Subcatchment EX3: TO CLOCKTOWER S

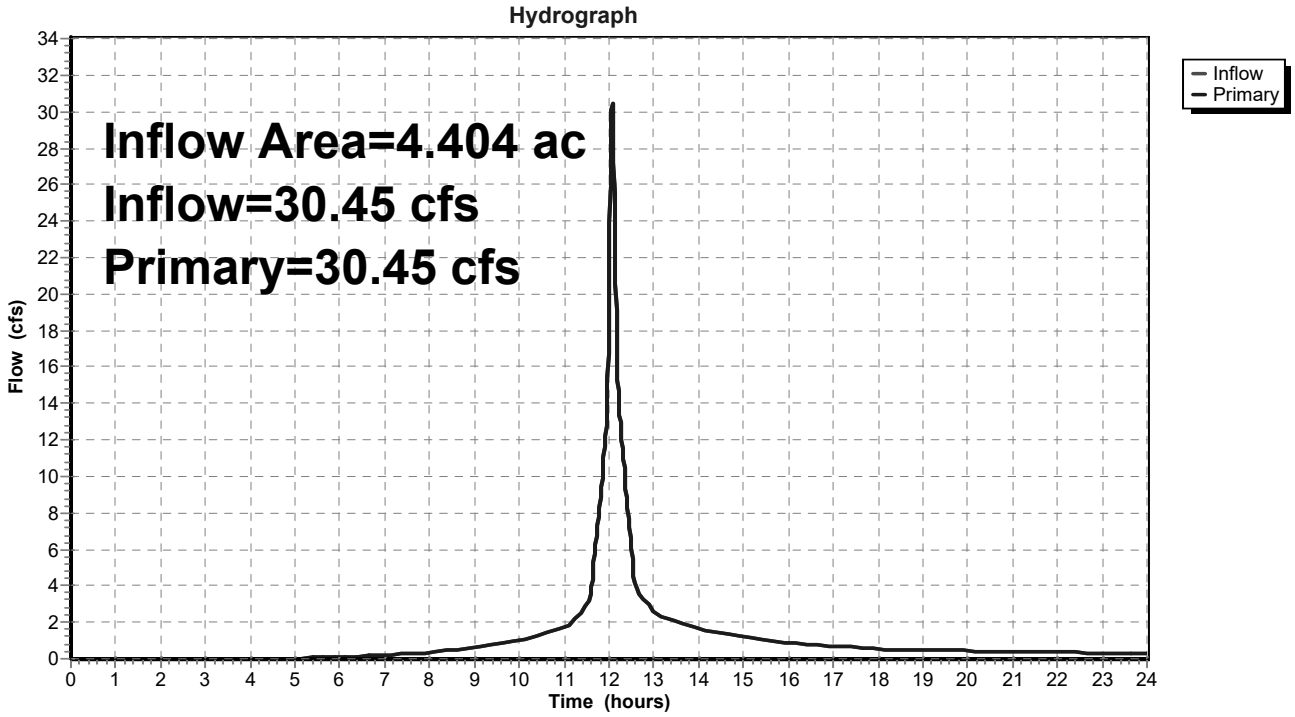


Summary for Link DP1: Goldsberry Drain

Inflow Area = 4.404 ac, 45.99% Impervious, Inflow Depth > 5.88" for 100-Year event
Inflow = 30.45 cfs @ 12.07 hrs, Volume= 2.158 af
Primary = 30.45 cfs @ 12.07 hrs, Volume= 2.158 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP1: Goldsberry Drain

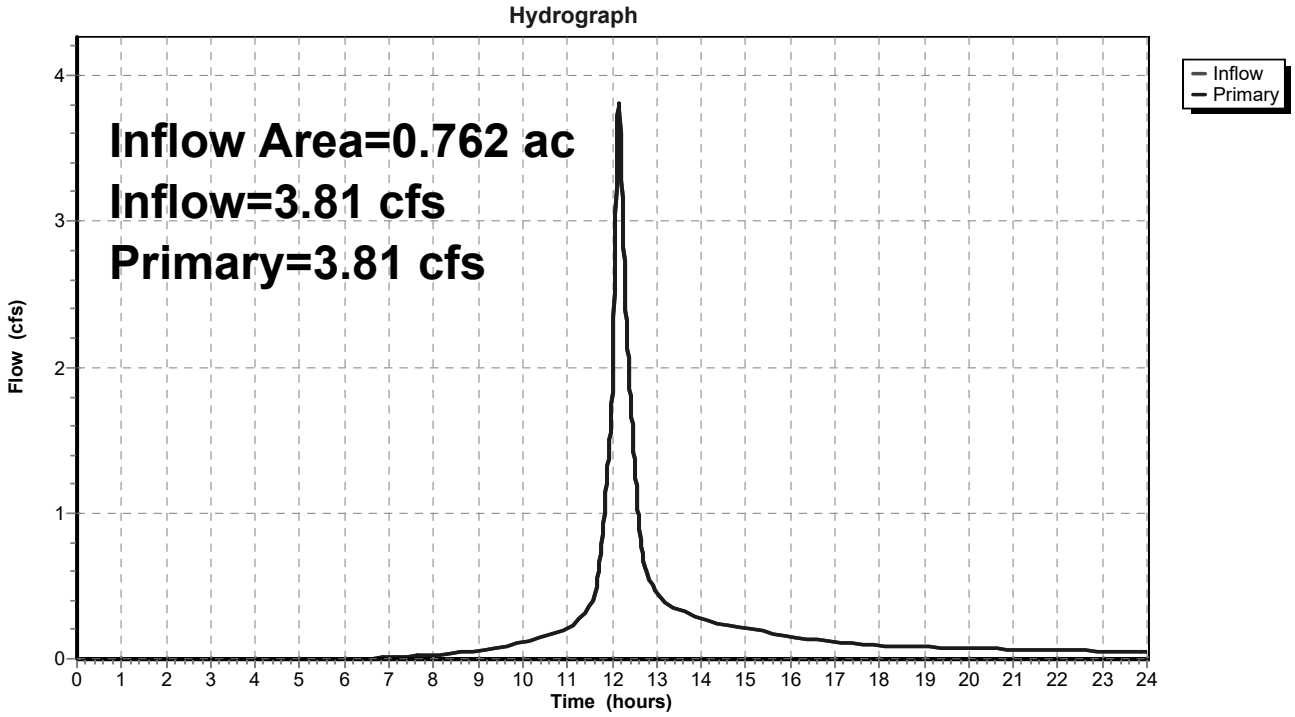


Summary for Link DP2: 15" DRAIN EAST

Inflow Area = 0.762 ac, 15.46% Impervious, Inflow Depth > 5.07" for 100-Year event
Inflow = 3.81 cfs @ 12.15 hrs, Volume= 0.322 af
Primary = 3.81 cfs @ 12.15 hrs, Volume= 0.322 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP2: 15" DRAIN EAST

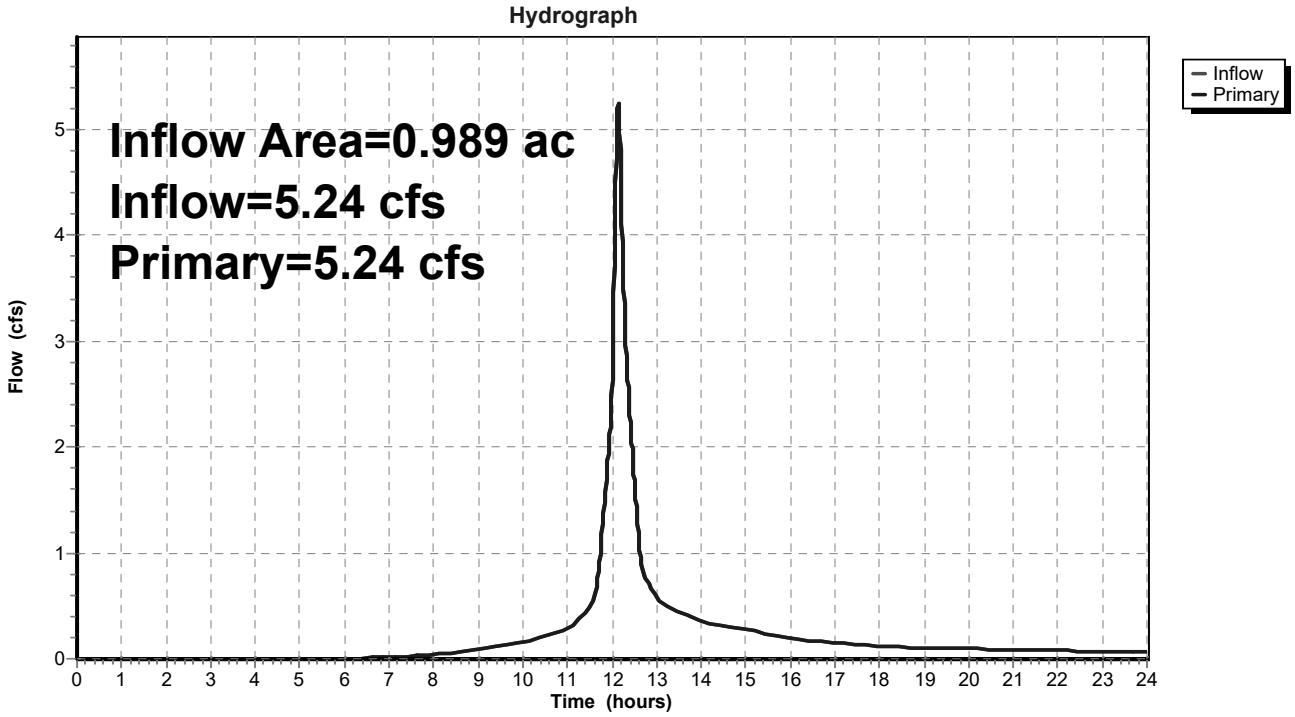


Summary for Link DP3: 12" DRAIN EAST

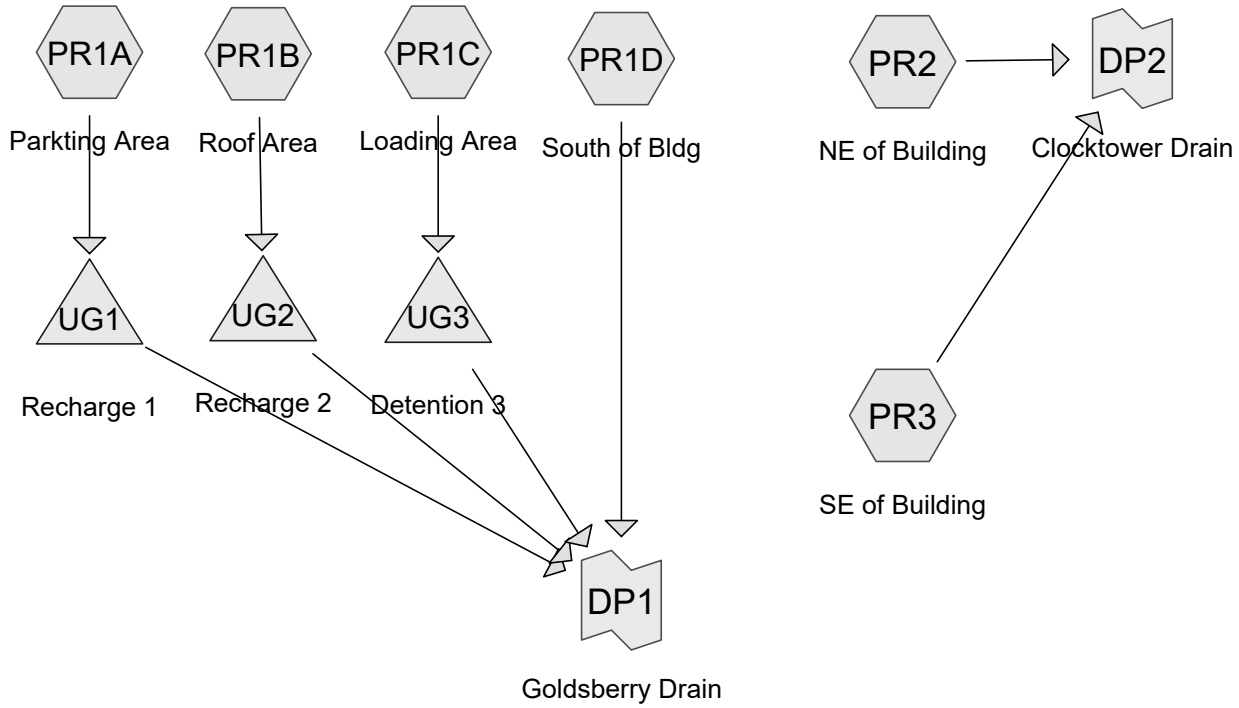
Inflow Area = 0.989 ac, 19.95% Impervious, Inflow Depth > 5.18" for 100-Year event
Inflow = 5.24 cfs @ 12.14 hrs, Volume= 0.427 af
Primary = 5.24 cfs @ 12.14 hrs, Volume= 0.427 af, Atten= 0%, Lag= 0.0 min

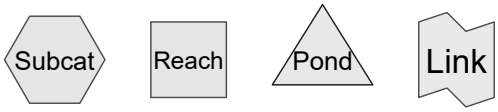
Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP3: 12" DRAIN EAST



HydroCAD Analysis: Proposed Conditions





Drainage Diagram for Lot 3B Hospital Drive Proposed
Prepared by MidPoint Engineering & Consulting, Printed 9/2/2020
HydroCAD® 9.10 s/n 07107 © 2011 HydroCAD Software Solutions LLC

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR1A: Parkting Area Runoff Area=64,777 sf 71.84% Impervious Runoff Depth>2.25"
Tc=5.0 min CN=91 Runoff=4.00 cfs 0.278 af

Subcatchment PR1B: Roof Area Runoff Area=81,874 sf 100.00% Impervious Runoff Depth>2.96"
Tc=5.0 min CN=98 Runoff=6.03 cfs 0.463 af

Subcatchment PR1C: Loading Area Runoff Area=26,937 sf 74.77% Impervious Runoff Depth>2.34"
Tc=5.0 min CN=92 Runoff=1.72 cfs 0.121 af

Subcatchment PR1D: South of Bldg Runoff Area=37,900 sf 33.98% Impervious Runoff Depth>1.53"
Tc=5.0 min CN=82 Runoff=1.61 cfs 0.111 af

Subcatchment PR2: NE of Building Runoff Area=42,363 sf 2.25% Impervious Runoff Depth>1.08"
Tc=11.4 min CN=75 Runoff=0.99 cfs 0.088 af

Subcatchment PR3: SE of Building Runoff Area=14,225 sf 40.19% Impervious Runoff Depth>1.67"
Tc=5.0 min CN=84 Runoff=0.66 cfs 0.046 af

Pond UG1: Recharge 1 Peak Elev=590.93' Storage=4,795 cf Inflow=4.00 cfs 0.278 af
Outflow=1.72 cfs 0.221 af

Pond UG2: Recharge 2 Peak Elev=579.40' Storage=2,811 cf Inflow=6.03 cfs 0.463 af
18.0" Round Culvert n=0.013 L=45.0' S=0.1356 '/' Outflow=5.64 cfs 0.420 af

Pond UG3: Detention 3 Peak Elev=584.67' Storage=1,089 cf Inflow=1.72 cfs 0.121 af
Outflow=0.75 cfs 0.120 af

Link DP1: Goldsberry Drain Inflow=8.97 cfs 0.872 af
Primary=8.97 cfs 0.872 af

Link DP2: Clocktower Drain Inflow=1.47 cfs 0.133 af
Primary=1.47 cfs 0.133 af

Total Runoff Area = 6.154 ac Runoff Volume = 1.106 af Average Runoff Depth = 2.16"
37.29% Pervious = 2.295 ac 62.71% Impervious = 3.859 ac

Summary for Subcatchment PR1A: Parkting Area

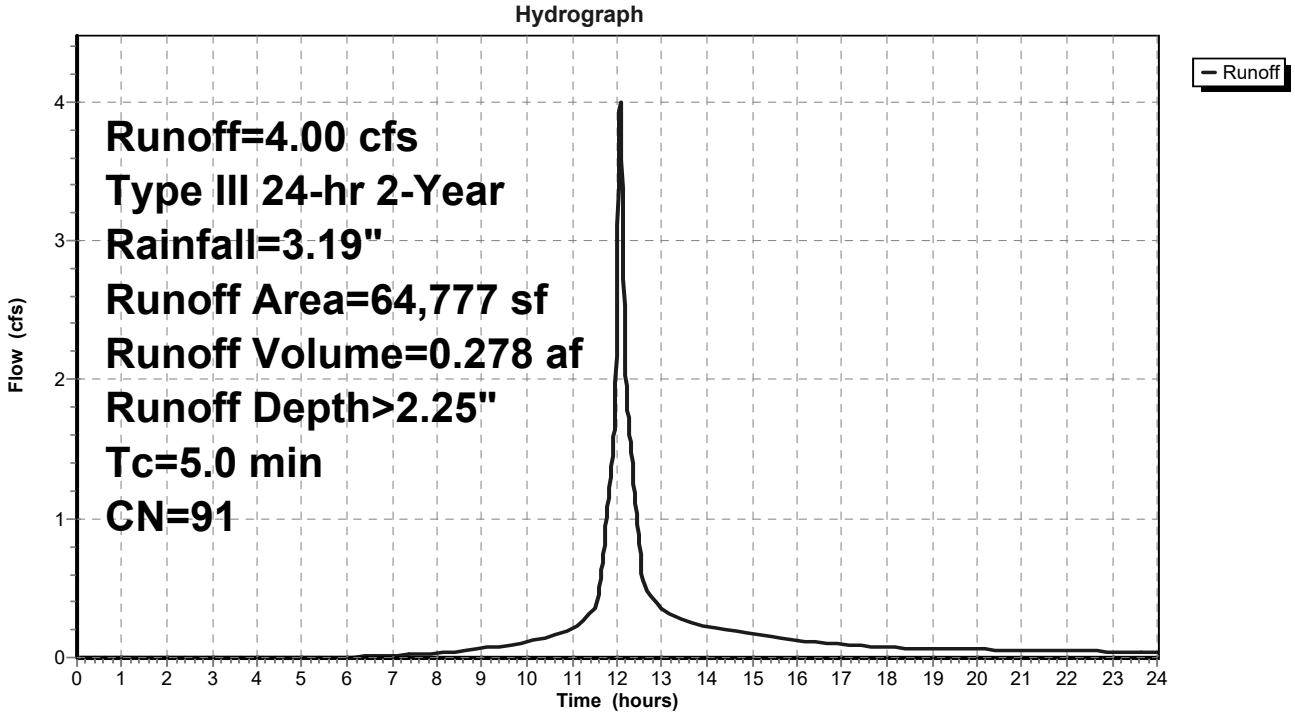
Runoff = 4.00 cfs @ 12.07 hrs, Volume= 0.278 af, Depth> 2.25"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.19"

Area (sf)	CN	Description
46,538	98	Paved parking, HSG C
18,239	74	>75% Grass cover, Good, HSG C
64,777	91	Weighted Average
18,239		28.16% Pervious Area
46,538		71.84% Impervious Area

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

Subcatchment PR1A: Parkting Area



Summary for Subcatchment PR1B: Roof Area

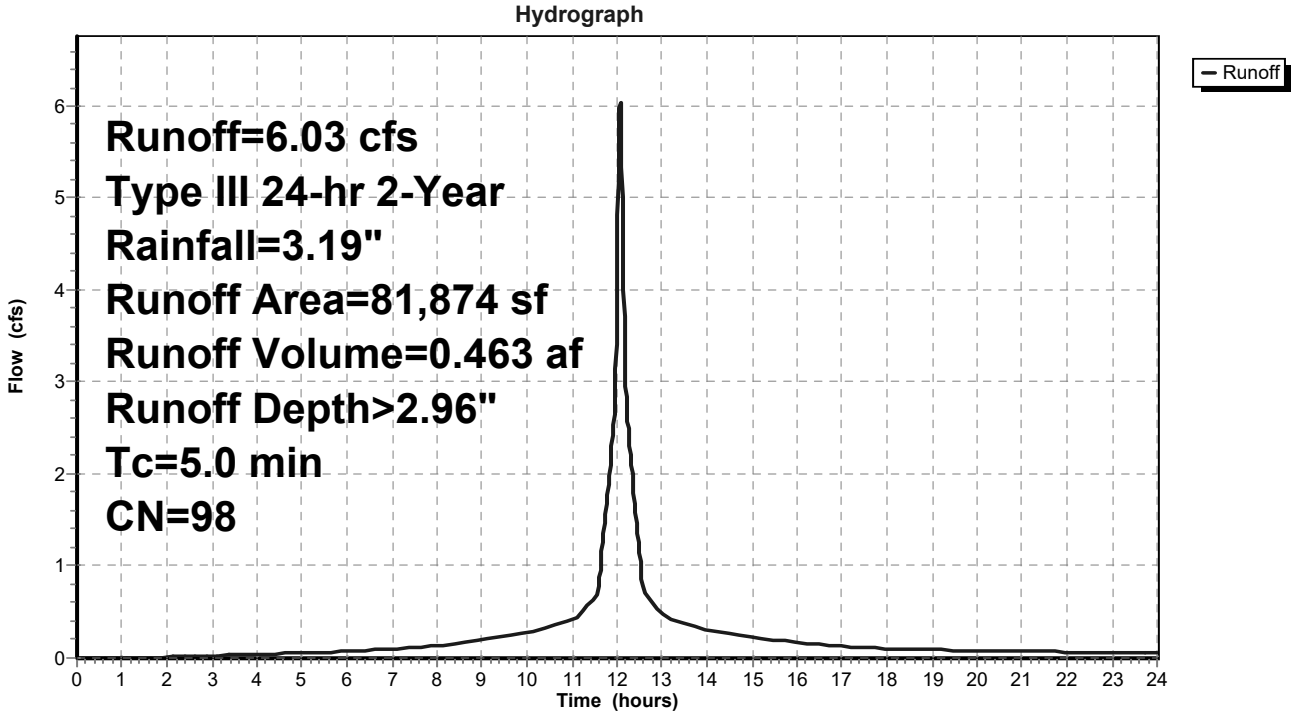
Runoff = 6.03 cfs @ 12.07 hrs, Volume= 0.463 af, Depth> 2.96"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.19"

Area (sf)	CN	Description
81,874	98	Roofs, HSG C
81,874		100.00% Impervious Area

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

Subcatchment PR1B: Roof Area



Summary for Subcatchment PR1C: Loading Area

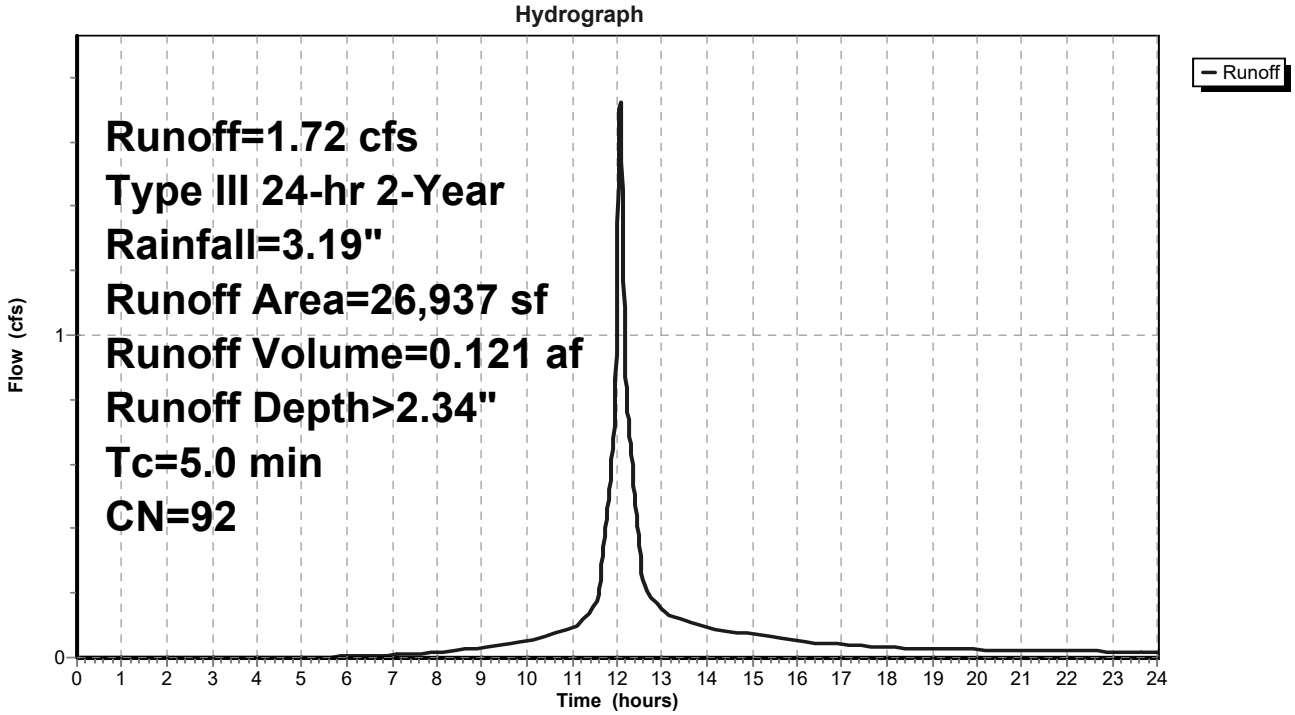
Runoff = 1.72 cfs @ 12.07 hrs, Volume= 0.121 af, Depth> 2.34"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.19"

Area (sf)	CN	Description
20,142	98	Paved parking, HSG C
6,795	74	>75% Grass cover, Good, HSG C
26,937	92	Weighted Average
6,795		25.23% Pervious Area
20,142		74.77% Impervious Area

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

Subcatchment PR1C: Loading Area



Summary for Subcatchment PR1D: South of Bldg

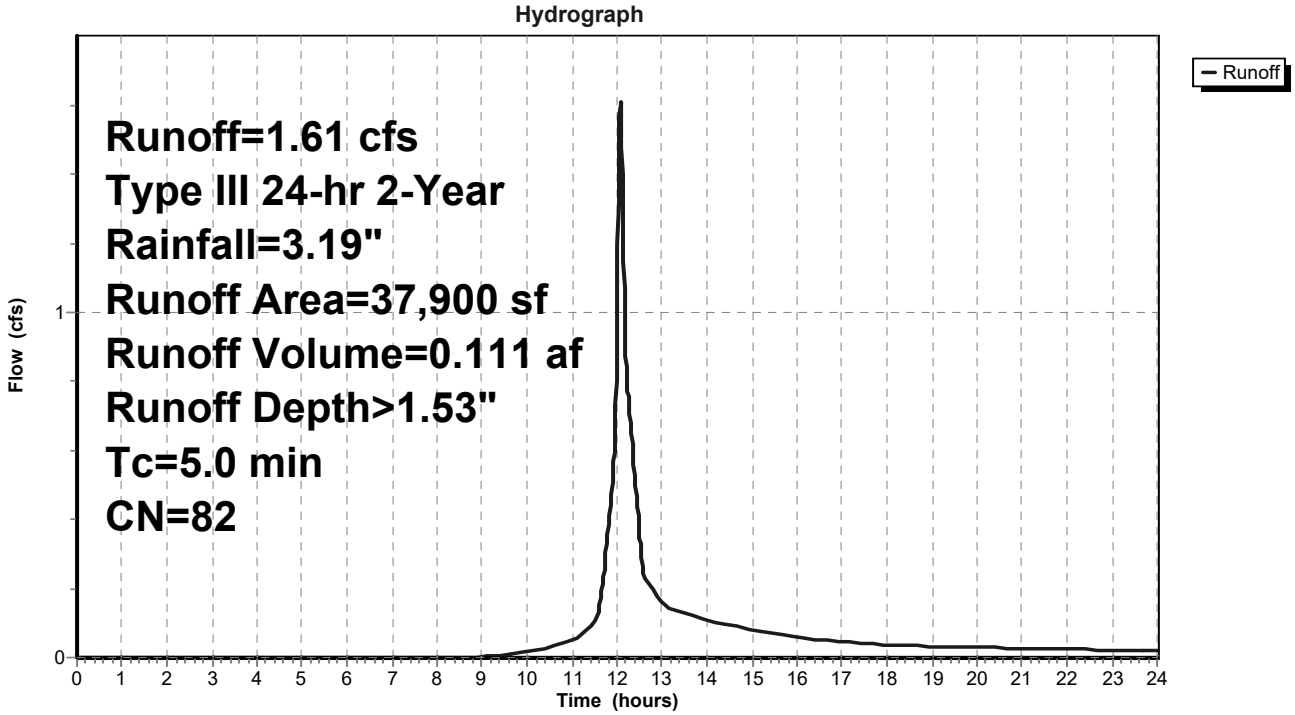
Runoff = 1.61 cfs @ 12.08 hrs, Volume= 0.111 af, Depth> 1.53"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.19"

Area (sf)	CN	Description
12,880	98	Paved parking, HSG C
25,020	74	>75% Grass cover, Good, HSG C
37,900	82	Weighted Average
25,020		66.02% Pervious Area
12,880		33.98% Impervious Area

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

Subcatchment PR1D: South of Bldg



Summary for Subcatchment PR2: NE of Building

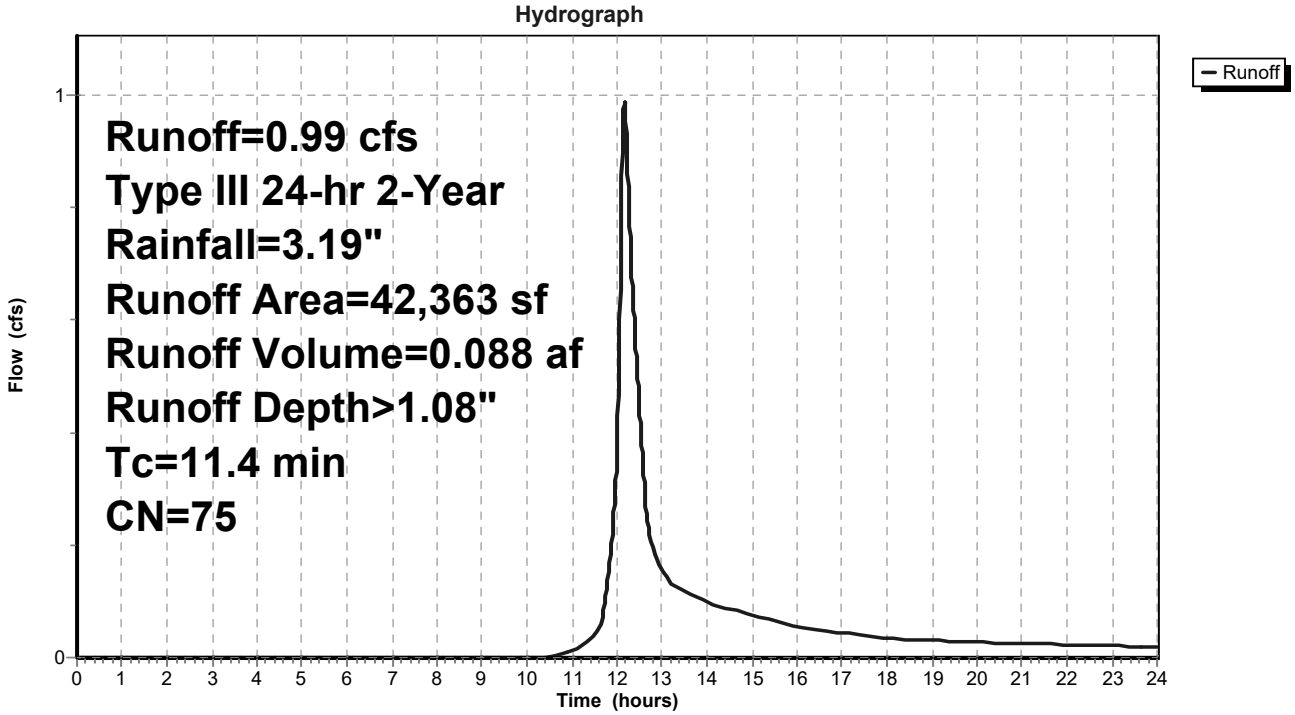
Runoff = 0.99 cfs @ 12.17 hrs, Volume= 0.088 af, Depth> 1.08"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.19"

Area (sf)	CN	Description
954	98	Paved parking, HSG C
41,409	74	>75% Grass cover, Good, HSG C
42,363	75	Weighted Average
41,409		97.75% Pervious Area
954		2.25% Impervious Area

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

Subcatchment PR2: NE of Building



Summary for Subcatchment PR3: SE of Building

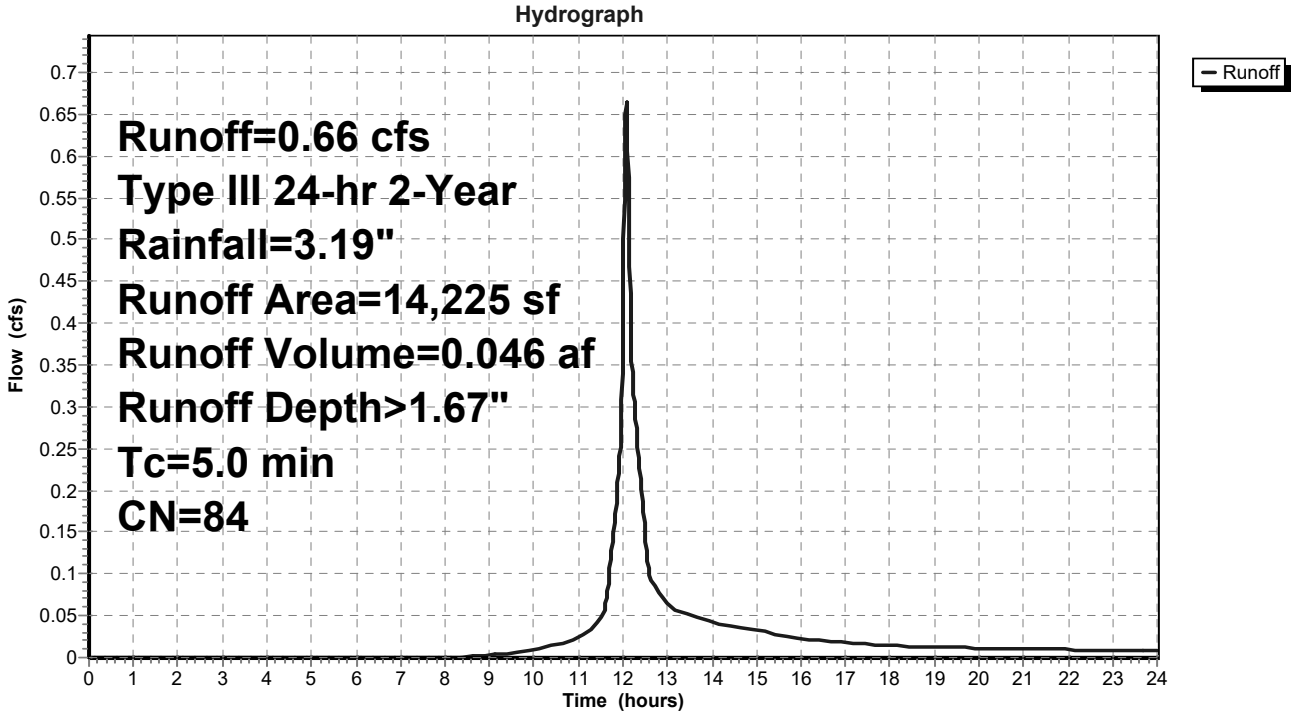
Runoff = 0.66 cfs @ 12.08 hrs, Volume= 0.046 af, Depth> 1.67"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.19"

Area (sf)	CN	Description
5,717	98	Paved parking, HSG C
8,508	74	>75% Grass cover, Good, HSG C
14,225	84	Weighted Average
8,508		59.81% Pervious Area
5,717		40.19% Impervious Area

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

Subcatchment PR3: SE of Building



Summary for Pond UG1: Recharge 1

Inflow Area = 1.487 ac, 71.84% Impervious, Inflow Depth > 2.25" for 2-Year event
Inflow = 4.00 cfs @ 12.07 hrs, Volume= 0.278 af
Outflow = 1.72 cfs @ 12.25 hrs, Volume= 0.221 af, Atten= 57%, Lag= 10.9 min
Primary = 1.72 cfs @ 12.25 hrs, Volume= 0.221 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 590.93' @ 12.25 hrs Surf.Area= 3,587 sf Storage= 4,795 cf

Plug-Flow detention time= 144.1 min calculated for 0.221 af (79% of inflow)
Center-of-Mass det. time= 67.2 min (868.4 - 801.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	589.00'	3,184 cf	**49.00'W x 73.20'L x 3.50'H Field A** 12,554 cf Overall - 4,594 cf Embedded = 7,960 cf x 40.0% Voids
#2A	589.50'	4,594 cf	**ADS_StormTech SC-740 +Cap** x 100 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap
#3	592.00'	10,225 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		18,003 cf	Total Available Storage

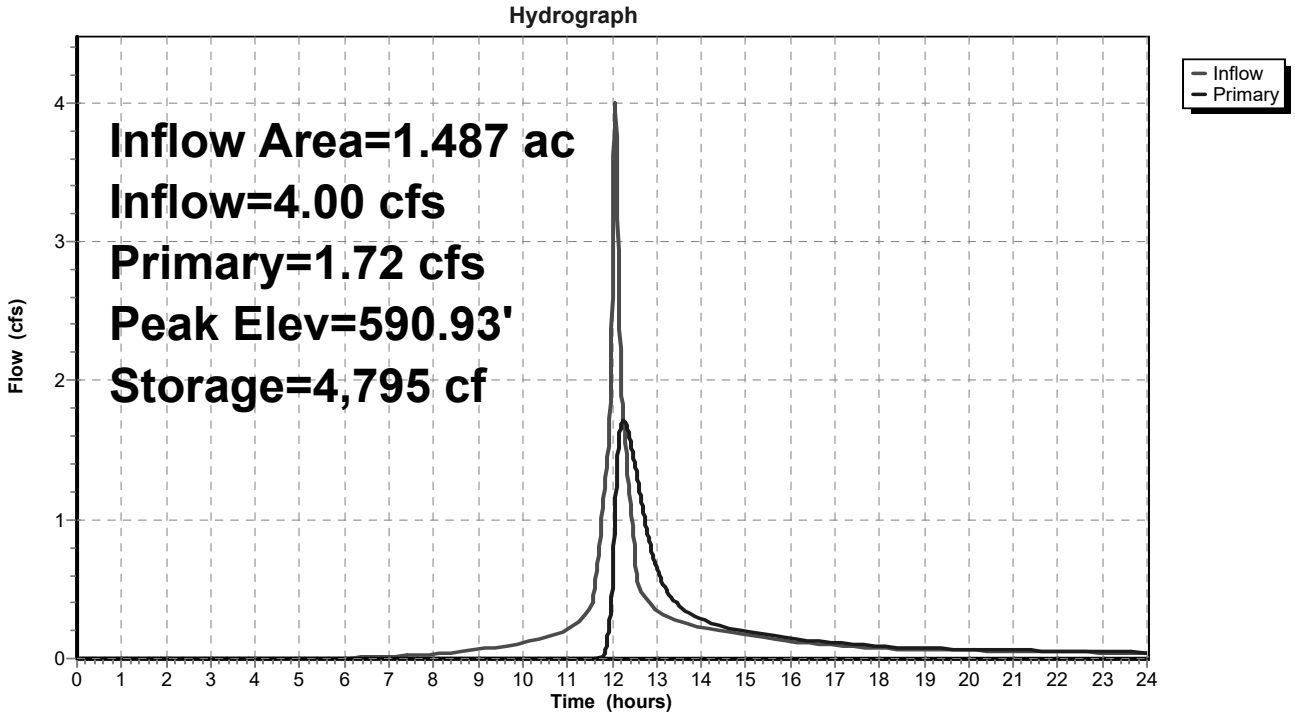
Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
592.00	100	0	0
592.50	100	50	50
593.00	100	50	100
594.00	100	100	200
594.50	10,000	2,525	2,725
595.00	20,000	7,500	10,225

Device	Routing	Invert	Outlet Devices
#1	Primary	590.00'	**9.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	590.75'	**12.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	592.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.0' Crest Height

Primary OutFlow Max=1.71 cfs @ 12.25 hrs HW=590.93' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 1.58 cfs @ 3.58 fps)
- **2=Orifice/Grate** (Orifice Controls 0.13 cfs @ 1.43 fps)
- **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond UG1: Recharge 1



Summary for Pond UG2: Recharge 2

Inflow Area = 1.880 ac,100.00% Impervious, Inflow Depth > 2.96" for 2-Year event
Inflow = 6.03 cfs @ 12.07 hrs, Volume= 0.463 af
Outflow = 5.64 cfs @ 12.10 hrs, Volume= 0.420 af, Atten= 7%, Lag= 1.7 min
Primary = 5.64 cfs @ 12.10 hrs, Volume= 0.420 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 579.40' @ 12.10 hrs Surf.Area= 1,187 sf Storage= 2,811 cf

Plug-Flow detention time= 87.6 min calculated for 0.420 af (91% of inflow)
Center-of-Mass det. time= 41.3 min (796.3 - 755.1)

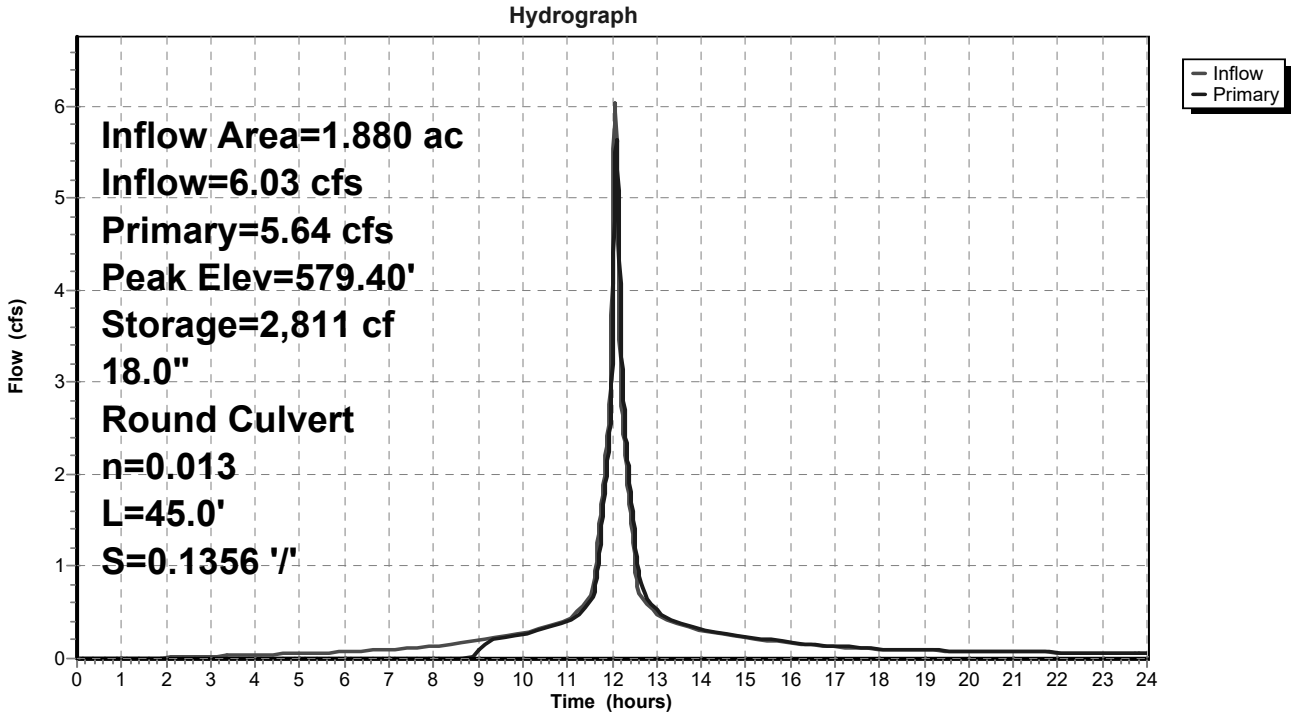
Volume	Invert	Avail.Storage	Storage Description
#1A	576.00'	1,689 cf	**22.75'W x 52.19'L x 5.50'H Field A** 6,530 cf Overall - 2,309 cf Embedded = 4,221 cf x 40.0% Voids
#2A	576.75'	2,309 cf	**ADS_StormTech MC-3500 d +Cap** x 21 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
		3,998 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	578.20'	**18.0" Round Culvert** L= 45.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 578.20' / 572.10' S= 0.1356 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=5.63 cfs @ 12.10 hrs HW=579.40' (Free Discharge)
└**1=Culvert** (Inlet Controls 5.63 cfs @ 3.73 fps)

Pond UG2: Recharge 2



Summary for Pond UG3: Detention 3

Inflow Area = 0.618 ac, 74.77% Impervious, Inflow Depth > 2.34" for 2-Year event
Inflow = 1.72 cfs @ 12.07 hrs, Volume= 0.121 af
Outflow = 0.75 cfs @ 12.24 hrs, Volume= 0.120 af, Atten= 56%, Lag= 10.3 min
Primary = 0.75 cfs @ 12.24 hrs, Volume= 0.120 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 584.67' @ 12.24 hrs Surf.Area= 1,024 sf Storage= 1,089 cf

Plug-Flow detention time= 21.9 min calculated for 0.120 af (99% of inflow)
Center-of-Mass det. time= 18.0 min (814.5 - 796.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	583.00'	1,462 cf	**22.75'W x 45.02'L x 5.50'H Field A** 5,633 cf Overall - 1,979 cf Embedded = 3,654 cf x 40.0% Voids
#2A	583.75'	1,979 cf	**ADS_StormTech MC-3500 c +Cap** x 18 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
#3	587.50'	5,100 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		8,541 cf	Total Available Storage

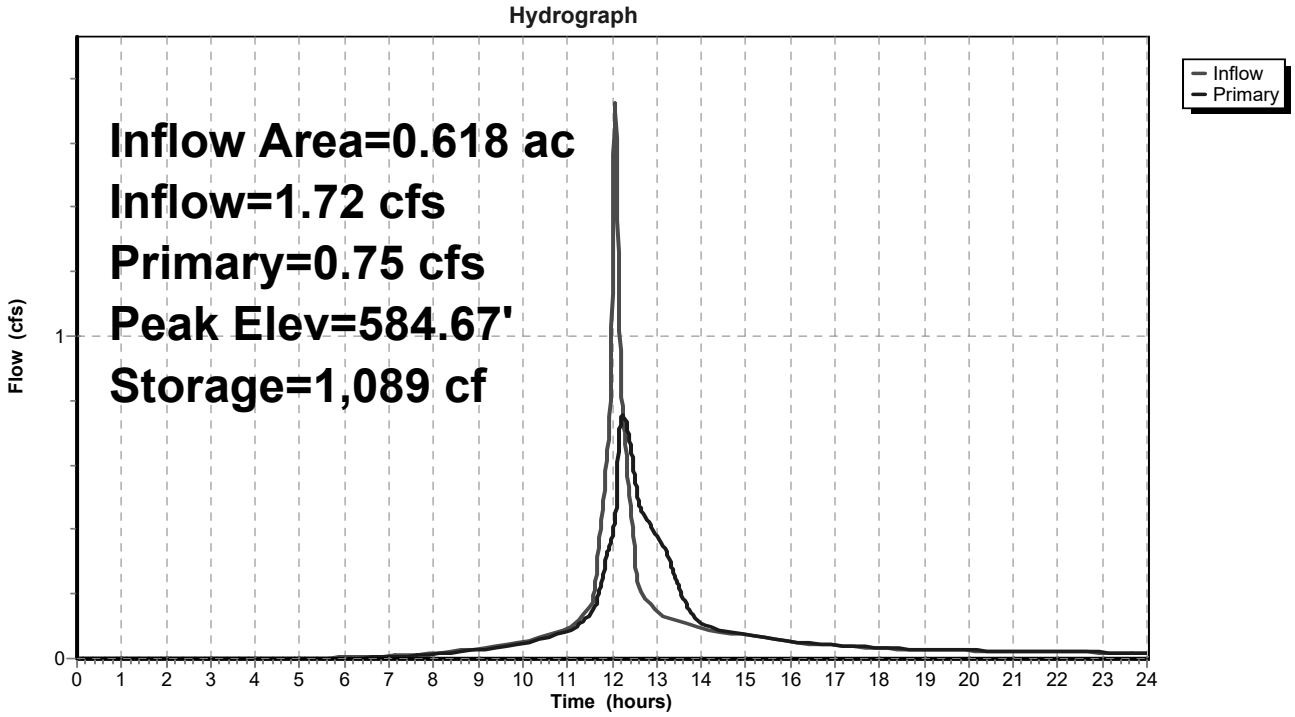
Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
587.50	100	0	0
587.80	100	30	30
588.00	100	20	50
589.00	10,000	5,050	5,100

Device	Routing	Invert	Outlet Devices
#1	Primary	583.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	584.33'	**5.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	587.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.0' Crest Height

Primary OutFlow Max=0.75 cfs @ 12.24 hrs HW=584.67' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.52 cfs @ 5.91 fps)
- **2=Orifice/Grate** (Orifice Controls 0.24 cfs @ 1.99 fps)
- **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond UG3: Detention 3

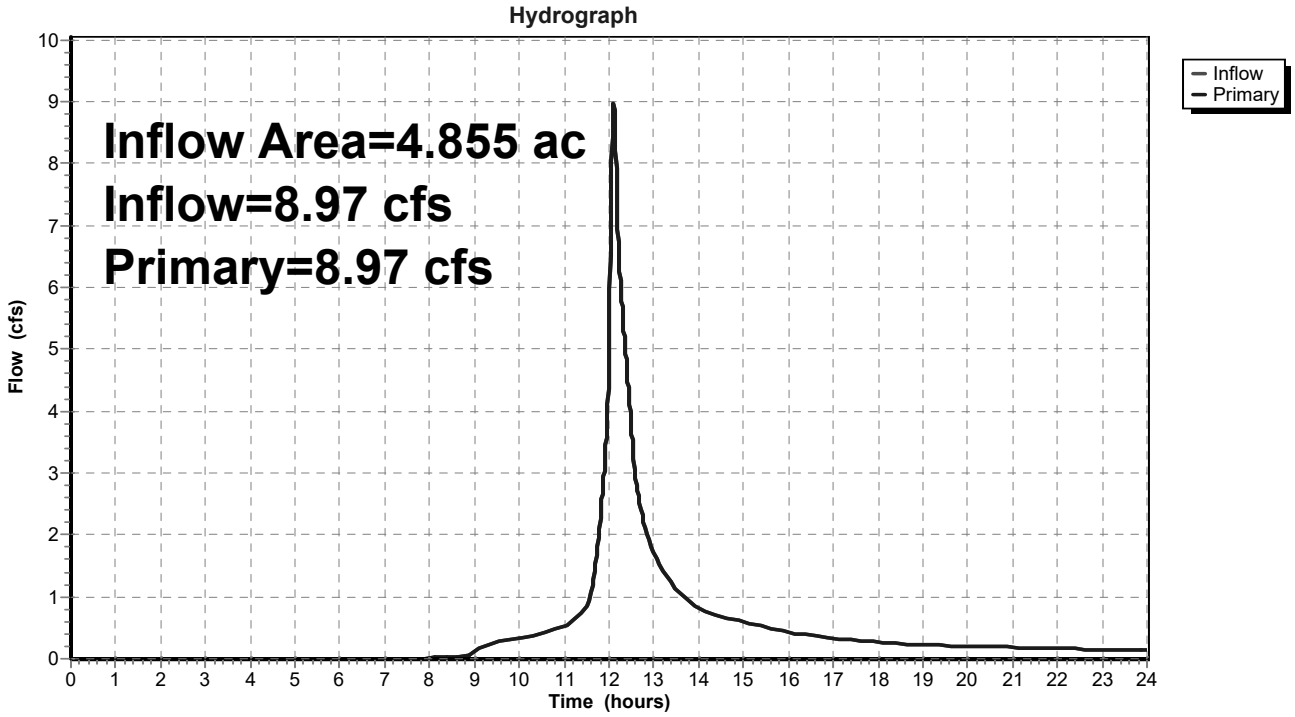


Summary for Link DP1: Goldsberry Drain

Inflow Area = 4.855 ac, 76.33% Impervious, Inflow Depth > 2.15" for 2-Year event
Inflow = 8.97 cfs @ 12.10 hrs, Volume= 0.872 af
Primary = 8.97 cfs @ 12.10 hrs, Volume= 0.872 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP1: Goldsberry Drain

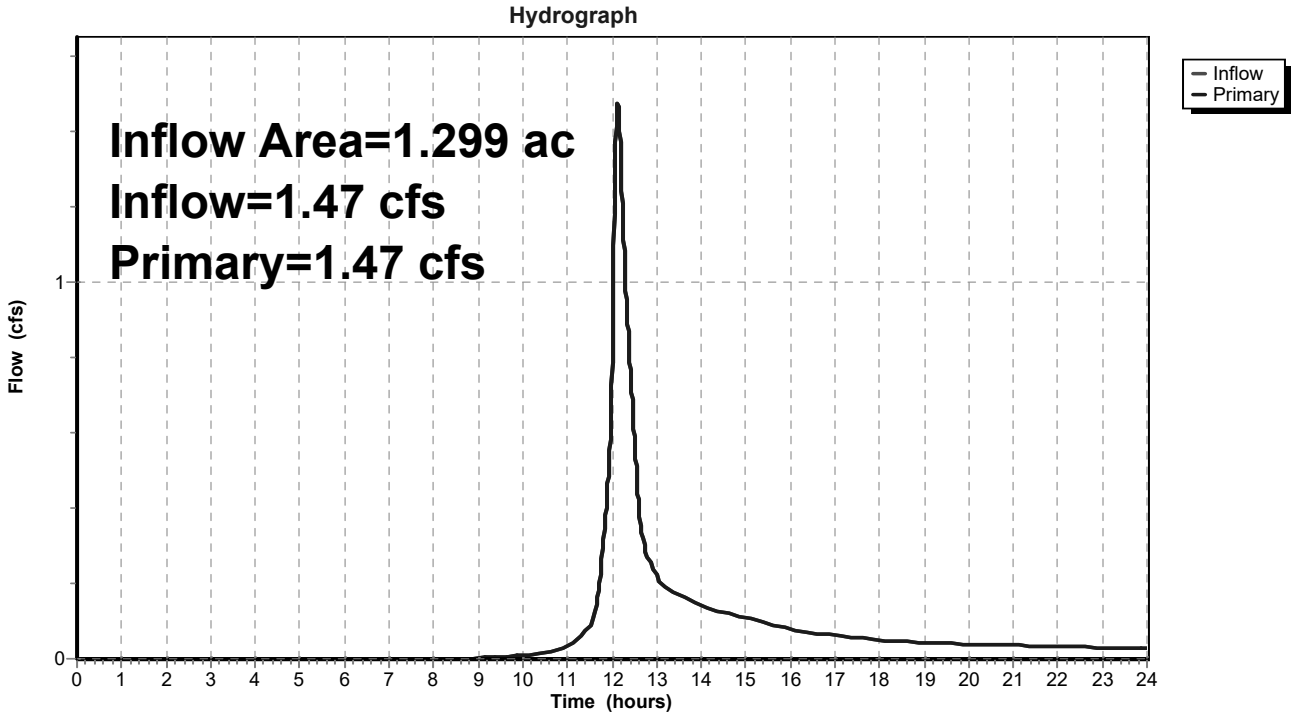


Summary for Link DP2: Clocktower Drain

Inflow Area = 1.299 ac, 11.79% Impervious, Inflow Depth > 1.23" for 2-Year event
Inflow = 1.47 cfs @ 12.12 hrs, Volume= 0.133 af
Primary = 1.47 cfs @ 12.12 hrs, Volume= 0.133 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP2: Clocktower Drain



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR1A: Parkting Area Runoff Area=64,777 sf 71.84% Impervious Runoff Depth>3.90"
Tc=5.0 min CN=91 Runoff=6.76 cfs 0.483 af

Subcatchment PR1B: Roof Area Runoff Area=81,874 sf 100.00% Impervious Runoff Depth>4.68"
Tc=5.0 min CN=98 Runoff=9.37 cfs 0.733 af

Subcatchment PR1C: Loading Area Runoff Area=26,937 sf 74.77% Impervious Runoff Depth>4.01"
Tc=5.0 min CN=92 Runoff=2.86 cfs 0.207 af

Subcatchment PR1D: South of Bldg Runoff Area=37,900 sf 33.98% Impervious Runoff Depth>3.00"
Tc=5.0 min CN=82 Runoff=3.17 cfs 0.218 af

Subcatchment PR2: NE of Building Runoff Area=42,363 sf 2.25% Impervious Runoff Depth>2.38"
Tc=11.4 min CN=75 Runoff=2.26 cfs 0.193 af

Subcatchment PR3: SE of Building Runoff Area=14,225 sf 40.19% Impervious Runoff Depth>3.19"
Tc=5.0 min CN=84 Runoff=1.26 cfs 0.087 af

Pond UG1: Recharge 1 Peak Elev=591.56' Storage=6,295 cf Inflow=6.76 cfs 0.483 af
Outflow=4.40 cfs 0.424 af

Pond UG2: Recharge 2 Peak Elev=579.96' Storage=3,227 cf Inflow=9.37 cfs 0.733 af
18.0" Round Culvert n=0.013 L=45.0' S=0.1356 '/' Outflow=8.56 cfs 0.690 af

Pond UG3: Detention 3 Peak Elev=585.58' Storage=1,820 cf Inflow=2.86 cfs 0.207 af
Outflow=1.32 cfs 0.206 af

Link DP1: Goldsberry Drain Inflow=16.68 cfs 1.537 af
Primary=16.68 cfs 1.537 af

Link DP2: Clocktower Drain Inflow=3.19 cfs 0.280 af
Primary=3.19 cfs 0.280 af

Total Runoff Area = 6.154 ac Runoff Volume = 1.921 af Average Runoff Depth = 3.75"
37.29% Pervious = 2.295 ac 62.71% Impervious = 3.859 ac

Summary for Subcatchment PR1A: Parkting Area

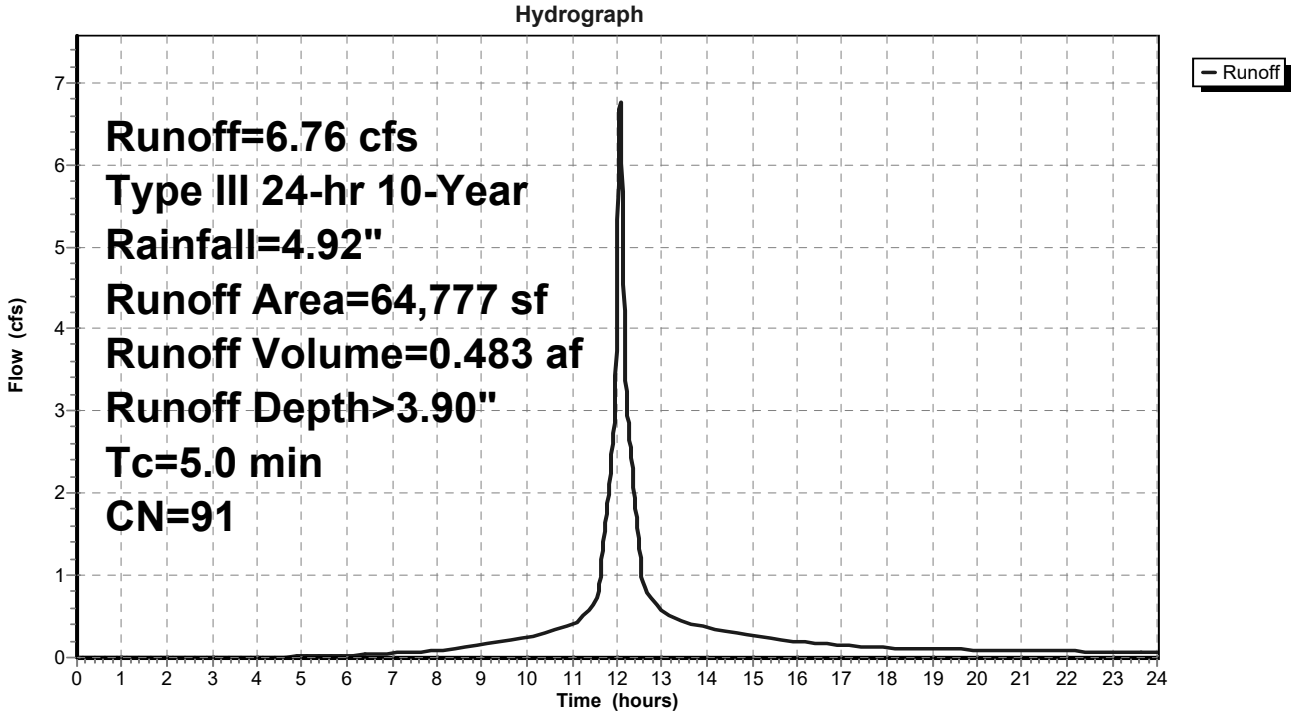
Runoff = 6.76 cfs @ 12.07 hrs, Volume= 0.483 af, Depth> 3.90"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.92"

Area (sf)	CN	Description
46,538	98	Paved parking, HSG C
18,239	74	>75% Grass cover, Good, HSG C
64,777	91	Weighted Average
18,239		28.16% Pervious Area
46,538		71.84% Impervious Area

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

Subcatchment PR1A: Parkting Area



Summary for Subcatchment PR1B: Roof Area

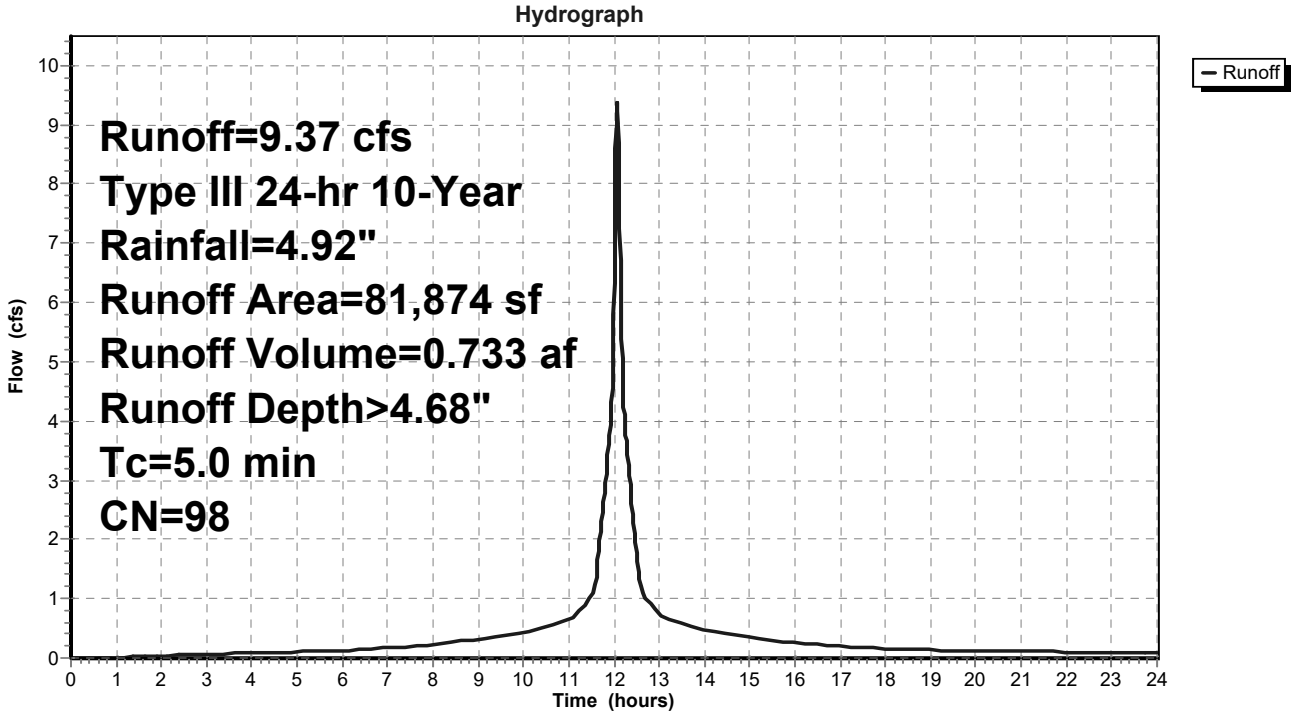
Runoff = 9.37 cfs @ 12.07 hrs, Volume= 0.733 af, Depth> 4.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.92"

Area (sf)	CN	Description
81,874	98	Roofs, HSG C
81,874		100.00% Impervious Area

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

Subcatchment PR1B: Roof Area



Summary for Subcatchment PR1C: Loading Area

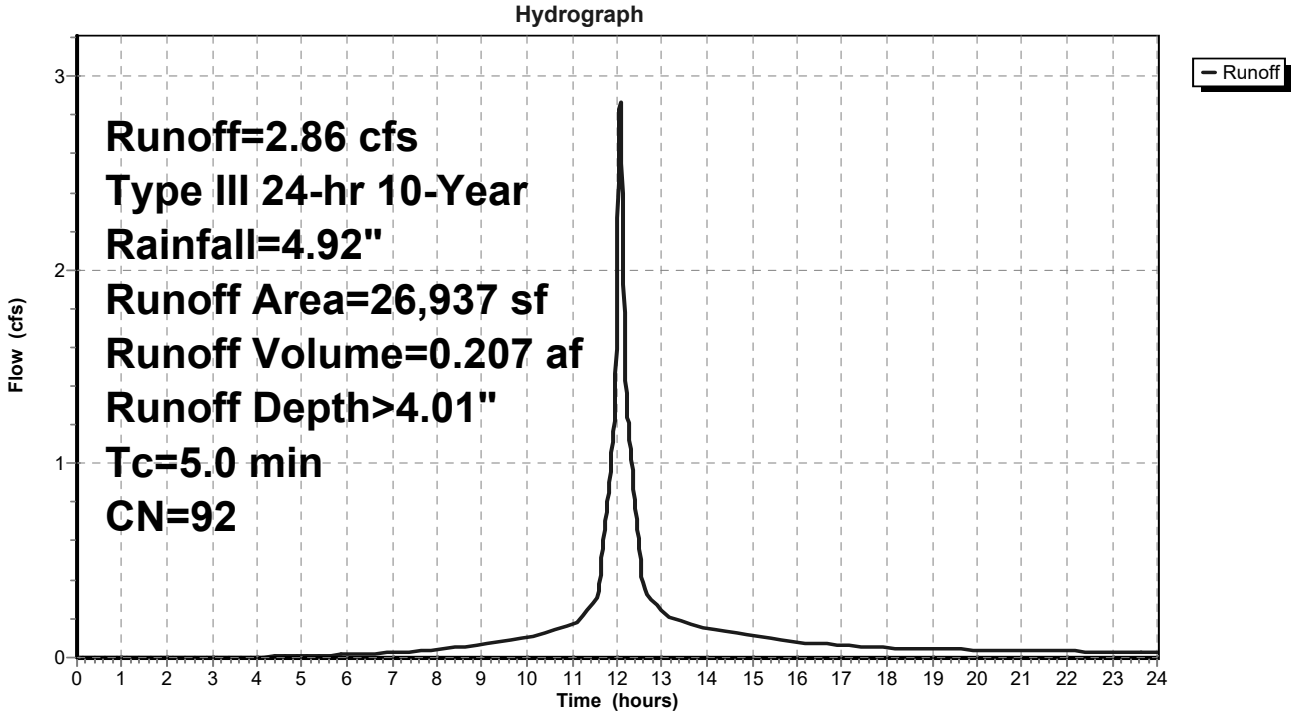
Runoff = 2.86 cfs @ 12.07 hrs, Volume= 0.207 af, Depth> 4.01"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.92"

Area (sf)	CN	Description
20,142	98	Paved parking, HSG C
6,795	74	>75% Grass cover, Good, HSG C
26,937	92	Weighted Average
6,795		25.23% Pervious Area
20,142		74.77% Impervious Area

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

Subcatchment PR1C: Loading Area



Summary for Subcatchment PR1D: South of Bldg

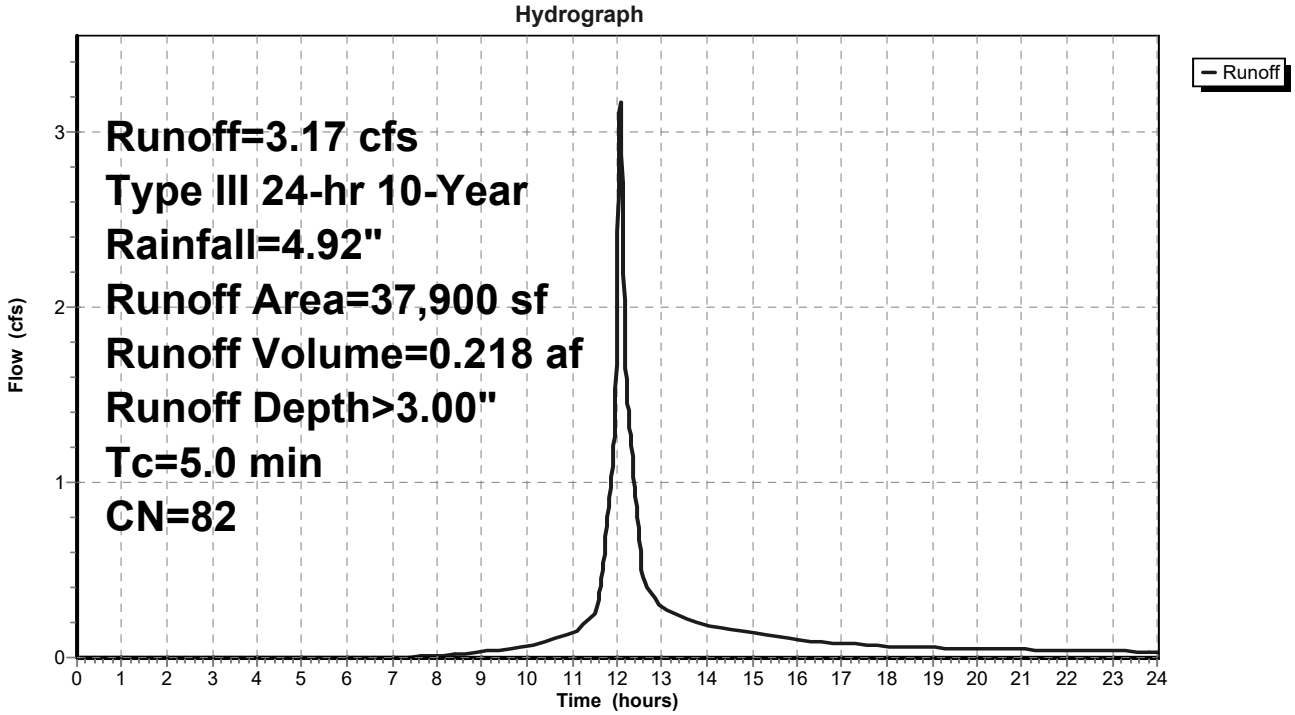
Runoff = 3.17 cfs @ 12.07 hrs, Volume= 0.218 af, Depth> 3.00"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.92"

Area (sf)	CN	Description
12,880	98	Paved parking, HSG C
25,020	74	>75% Grass cover, Good, HSG C
37,900	82	Weighted Average
25,020		66.02% Pervious Area
12,880		33.98% Impervious Area

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

Subcatchment PR1D: South of Bldg



Summary for Subcatchment PR2: NE of Building

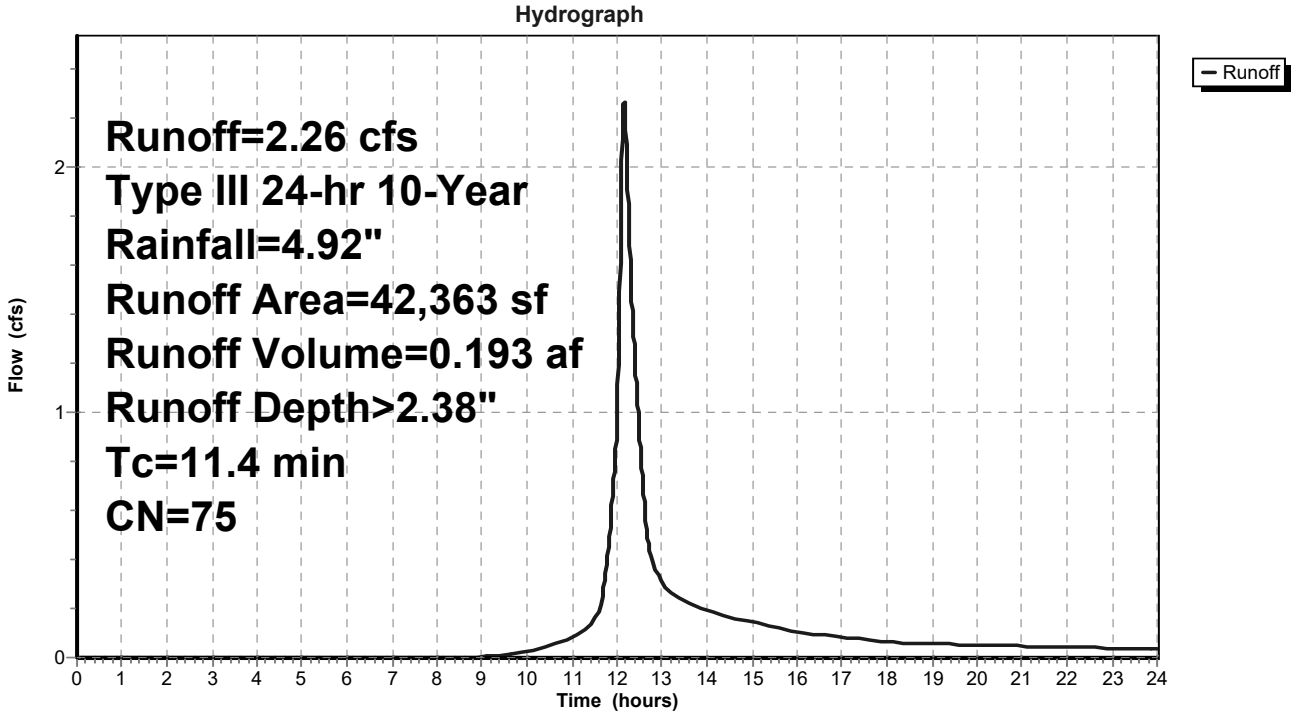
Runoff = 2.26 cfs @ 12.16 hrs, Volume= 0.193 af, Depth> 2.38"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.92"

Area (sf)	CN	Description
954	98	Paved parking, HSG C
41,409	74	>75% Grass cover, Good, HSG C
42,363	75	Weighted Average
41,409		97.75% Pervious Area
954		2.25% Impervious Area

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

Subcatchment PR2: NE of Building



Summary for Subcatchment PR3: SE of Building

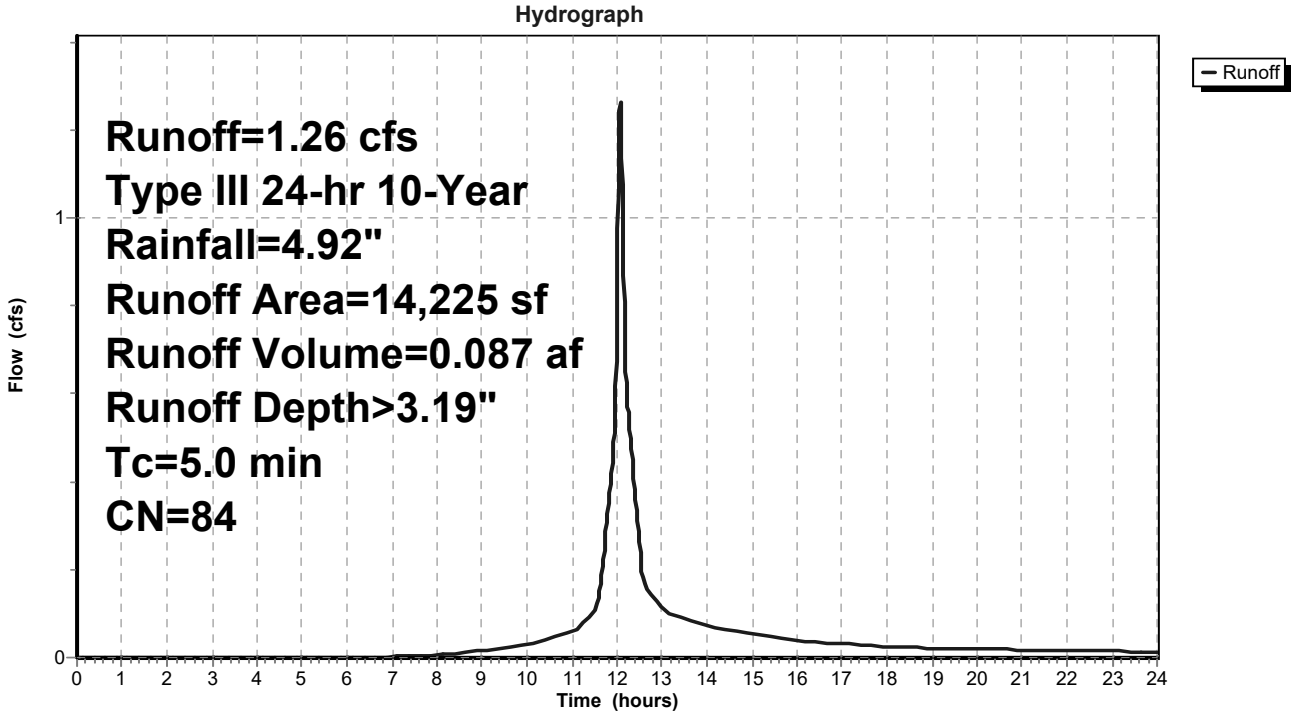
Runoff = 1.26 cfs @ 12.07 hrs, Volume= 0.087 af, Depth> 3.19"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.92"

Area (sf)	CN	Description
5,717	98	Paved parking, HSG C
8,508	74	>75% Grass cover, Good, HSG C
14,225	84	Weighted Average
8,508		59.81% Pervious Area
5,717		40.19% Impervious Area

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

Subcatchment PR3: SE of Building



Summary for Pond UG1: Recharge 1

Inflow Area = 1.487 ac, 71.84% Impervious, Inflow Depth > 3.90" for 10-Year event
Inflow = 6.76 cfs @ 12.07 hrs, Volume= 0.483 af
Outflow = 4.40 cfs @ 12.15 hrs, Volume= 0.424 af, Atten= 35%, Lag= 5.0 min
Primary = 4.40 cfs @ 12.15 hrs, Volume= 0.424 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 591.56' @ 12.15 hrs Surf.Area= 3,587 sf Storage= 6,295 cf

Plug-Flow detention time= 108.7 min calculated for 0.424 af (88% of inflow)
Center-of-Mass det. time= 52.7 min (838.6 - 785.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	589.00'	3,184 cf	**49.00'W x 73.20'L x 3.50'H Field A** 12,554 cf Overall - 4,594 cf Embedded = 7,960 cf x 40.0% Voids
#2A	589.50'	4,594 cf	**ADS_StormTech SC-740 +Cap** x 100 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap
#3	592.00'	10,225 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		18,003 cf	Total Available Storage

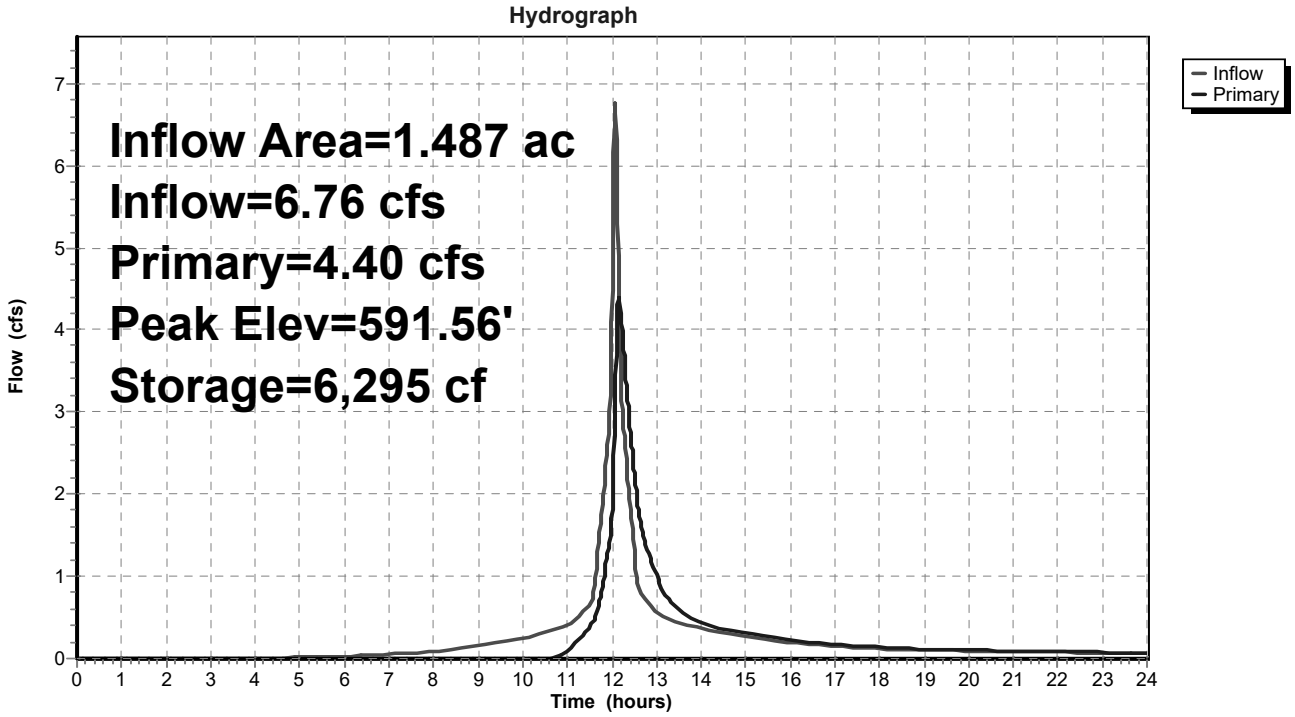
Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
592.00	100	0	0
592.50	100	50	50
593.00	100	50	100
594.00	100	100	200
594.50	10,000	2,525	2,725
595.00	20,000	7,500	10,225

Device	Routing	Invert	Outlet Devices
#1	Primary	590.00'	**9.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	590.75'	**12.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	592.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.0' Crest Height

Primary OutFlow Max=4.39 cfs @ 12.15 hrs HW=591.56' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 2.31 cfs @ 5.24 fps)
- **2=Orifice/Grate** (Orifice Controls 2.08 cfs @ 3.06 fps)
- **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond UG1: Recharge 1



Summary for Pond UG2: Recharge 2

Inflow Area = 1.880 ac,100.00% Impervious, Inflow Depth > 4.68" for 10-Year event
Inflow = 9.37 cfs @ 12.07 hrs, Volume= 0.733 af
Outflow = 8.56 cfs @ 12.10 hrs, Volume= 0.690 af, Atten= 9%, Lag= 2.0 min
Primary = 8.56 cfs @ 12.10 hrs, Volume= 0.690 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 579.96' @ 12.10 hrs Surf.Area= 1,187 sf Storage= 3,227 cf

Plug-Flow detention time= 65.5 min calculated for 0.690 af (94% of inflow)
Center-of-Mass det. time= 32.2 min (779.1 - 746.9)

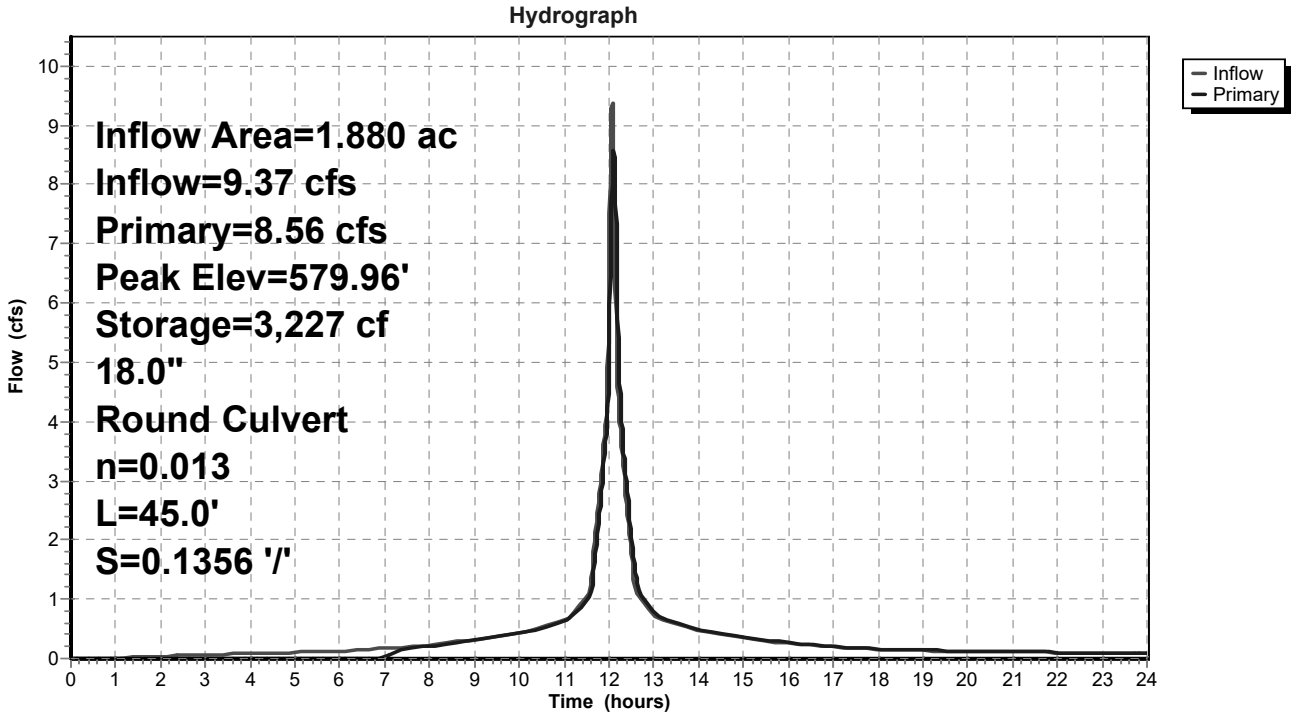
Volume	Invert	Avail.Storage	Storage Description
#1A	576.00'	1,689 cf	**22.75'W x 52.19'L x 5.50'H Field A** 6,530 cf Overall - 2,309 cf Embedded = 4,221 cf x 40.0% Voids
#2A	576.75'	2,309 cf	**ADS_StormTech MC-3500 d +Cap** x 21 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
		3,998 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	578.20'	**18.0" Round Culvert** L= 45.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 578.20' / 572.10' S= 0.1356 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=8.55 cfs @ 12.10 hrs HW=579.96' (Free Discharge)
└**1=Culvert** (Inlet Controls 8.55 cfs @ 4.84 fps)

Pond UG2: Recharge 2



Summary for Pond UG3: Detention 3

Inflow Area = 0.618 ac, 74.77% Impervious, Inflow Depth > 4.01" for 10-Year event
Inflow = 2.86 cfs @ 12.07 hrs, Volume= 0.207 af
Outflow = 1.32 cfs @ 12.22 hrs, Volume= 0.206 af, Atten= 54%, Lag= 8.9 min
Primary = 1.32 cfs @ 12.22 hrs, Volume= 0.206 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 585.58' @ 12.22 hrs Surf.Area= 1,024 sf Storage= 1,820 cf

Plug-Flow detention time= 20.7 min calculated for 0.205 af (99% of inflow)
Center-of-Mass det. time= 17.7 min (799.5 - 781.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	583.00'	1,462 cf	**22.75'W x 45.02'L x 5.50'H Field A** 5,633 cf Overall - 1,979 cf Embedded = 3,654 cf x 40.0% Voids
#2A	583.75'	1,979 cf	**ADS_StormTech MC-3500 c +Cap** x 18 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
#3	587.50'	5,100 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		8,541 cf	Total Available Storage

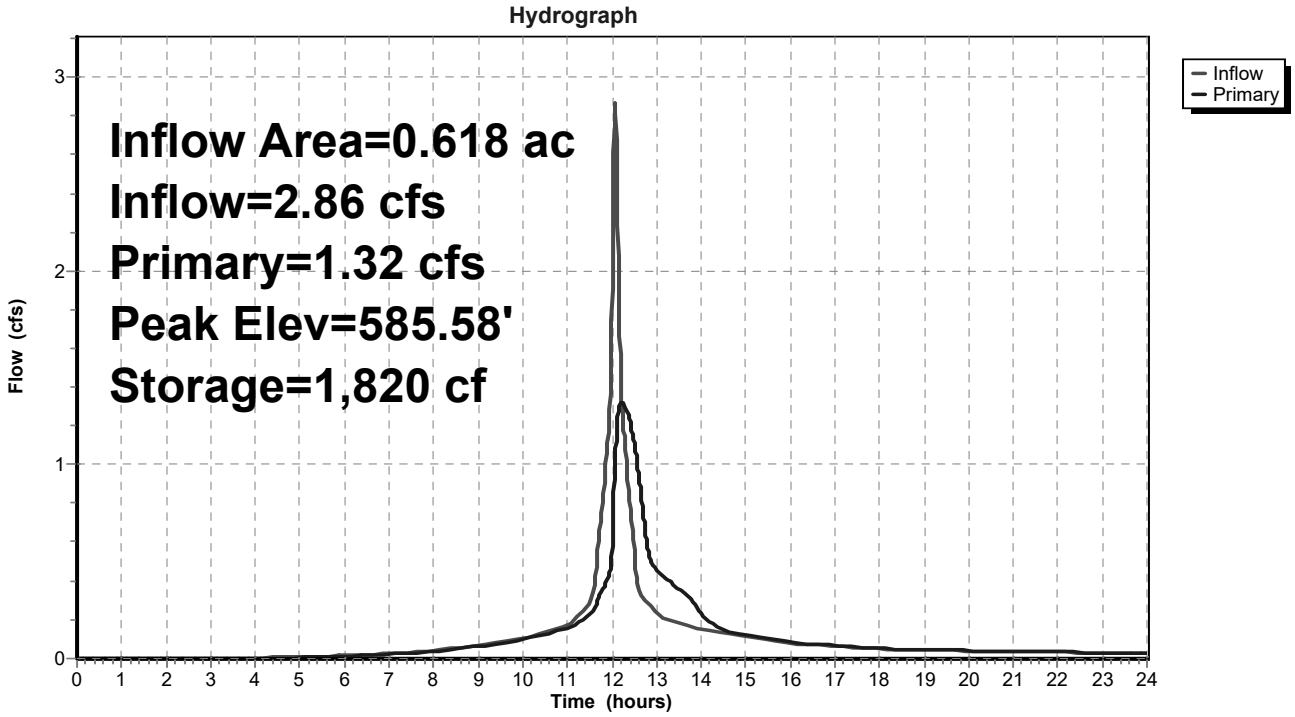
Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
587.50	100	0	0
587.80	100	30	30
588.00	100	20	50
589.00	10,000	5,050	5,100

Device	Routing	Invert	Outlet Devices
#1	Primary	583.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	584.33'	**5.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	587.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.0' Crest Height

Primary OutFlow Max=1.32 cfs @ 12.22 hrs HW=585.58' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.65 cfs @ 7.48 fps)
- **2=Orifice/Grate** (Orifice Controls 0.67 cfs @ 4.92 fps)
- **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond UG3: Detention 3

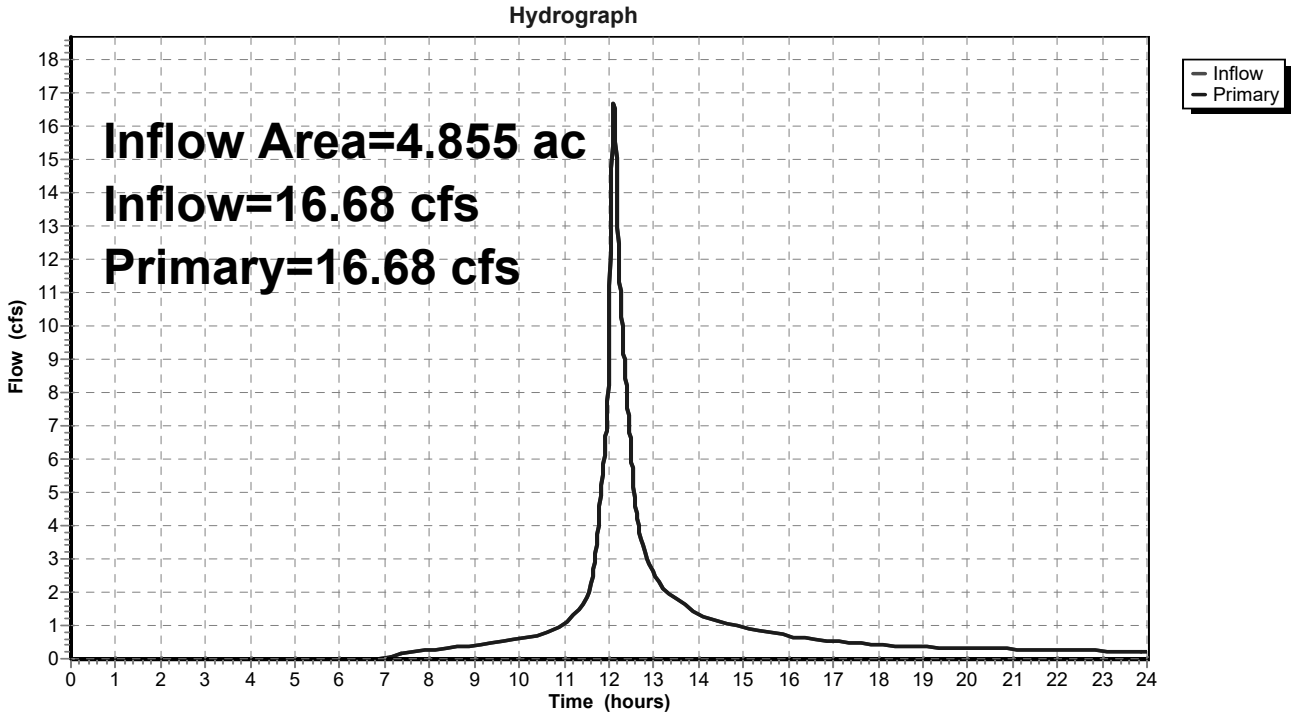


Summary for Link DP1: Goldsberry Drain

Inflow Area = 4.855 ac, 76.33% Impervious, Inflow Depth > 3.80" for 10-Year event
Inflow = 16.68 cfs @ 12.11 hrs, Volume= 1.537 af
Primary = 16.68 cfs @ 12.11 hrs, Volume= 1.537 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP1: Goldsberry Drain

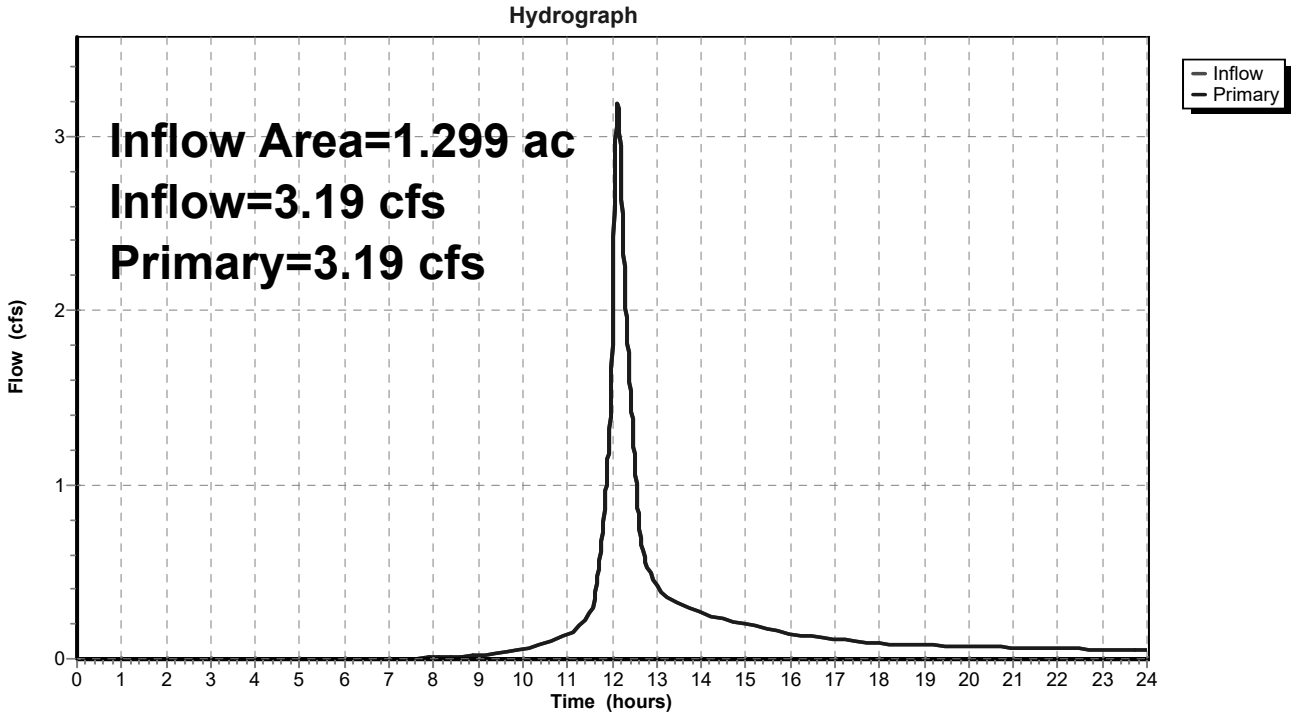


Summary for Link DP2: Clocktower Drain

Inflow Area = 1.299 ac, 11.79% Impervious, Inflow Depth > 2.58" for 10-Year event
Inflow = 3.19 cfs @ 12.12 hrs, Volume= 0.280 af
Primary = 3.19 cfs @ 12.12 hrs, Volume= 0.280 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP2: Clocktower Drain



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR1A: Parkting Area Runoff Area=64,777 sf 71.84% Impervious Runoff Depth>4.95"
Tc=5.0 min CN=91 Runoff=8.47 cfs 0.614 af

Subcatchment PR1B: Roof Area Runoff Area=81,874 sf 100.00% Impervious Runoff Depth>5.76"
Tc=5.0 min CN=98 Runoff=11.45 cfs 0.902 af

Subcatchment PR1C: Loading Area Runoff Area=26,937 sf 74.77% Impervious Runoff Depth>5.07"
Tc=5.0 min CN=92 Runoff=3.57 cfs 0.261 af

Subcatchment PR1D: South of Bldg Runoff Area=37,900 sf 33.98% Impervious Runoff Depth>3.98"
Tc=5.0 min CN=82 Runoff=4.18 cfs 0.289 af

Subcatchment PR2: NE of Building Runoff Area=42,363 sf 2.25% Impervious Runoff Depth>3.27"
Tc=11.4 min CN=75 Runoff=3.13 cfs 0.265 af

Subcatchment PR3: SE of Building Runoff Area=14,225 sf 40.19% Impervious Runoff Depth>4.19"
Tc=5.0 min CN=84 Runoff=1.64 cfs 0.114 af

Pond UG1: Recharge 1 Peak Elev=591.94' Storage=6,965 cf Inflow=8.47 cfs 0.614 af
Outflow=5.79 cfs 0.553 af

Pond UG2: Recharge 2 Peak Elev=580.46' Storage=3,505 cf Inflow=11.45 cfs 0.902 af
18.0" Round Culvert n=0.013 L=45.0' S=0.1356 '/' Outflow=10.47 cfs 0.858 af

Pond UG3: Detention 3 Peak Elev=586.25' Storage=2,315 cf Inflow=3.57 cfs 0.261 af
Outflow=1.60 cfs 0.260 af

Link DP1: Goldsberry Drain Inflow=21.18 cfs 1.960 af
Primary=21.18 cfs 1.960 af

Link DP2: Clocktower Drain Inflow=4.33 cfs 0.379 af
Primary=4.33 cfs 0.379 af

Total Runoff Area = 6.154 ac Runoff Volume = 2.445 af Average Runoff Depth = 4.77"
37.29% Pervious = 2.295 ac 62.71% Impervious = 3.859 ac

Summary for Subcatchment PR1A: Parkting Area

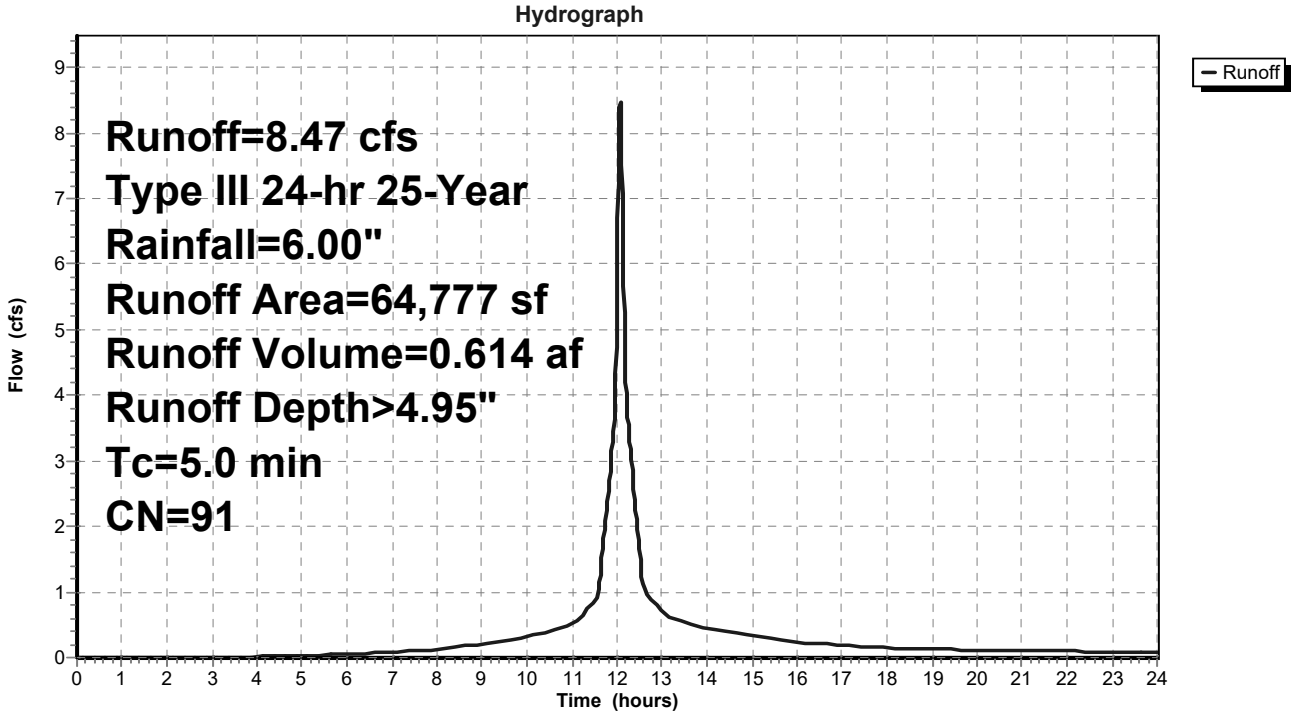
Runoff = 8.47 cfs @ 12.07 hrs, Volume= 0.614 af, Depth> 4.95"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.00"

Area (sf)	CN	Description
46,538	98	Paved parking, HSG C
18,239	74	>75% Grass cover, Good, HSG C
64,777	91	Weighted Average
18,239		28.16% Pervious Area
46,538		71.84% Impervious Area

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

Subcatchment PR1A: Parkting Area



Summary for Subcatchment PR1B: Roof Area

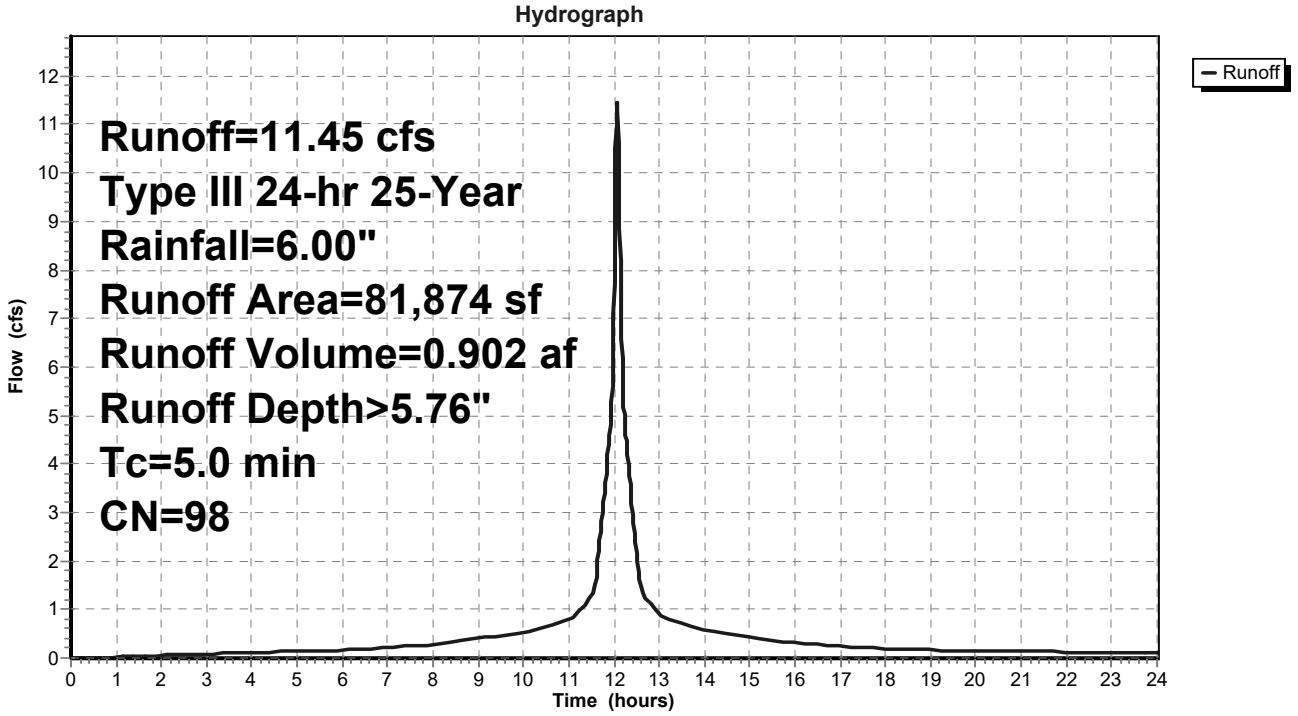
Runoff = 11.45 cfs @ 12.07 hrs, Volume= 0.902 af, Depth> 5.76"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.00"

Area (sf)	CN	Description
81,874	98	Roofs, HSG C
81,874		100.00% Impervious Area

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

Subcatchment PR1B: Roof Area



Summary for Subcatchment PR1C: Loading Area

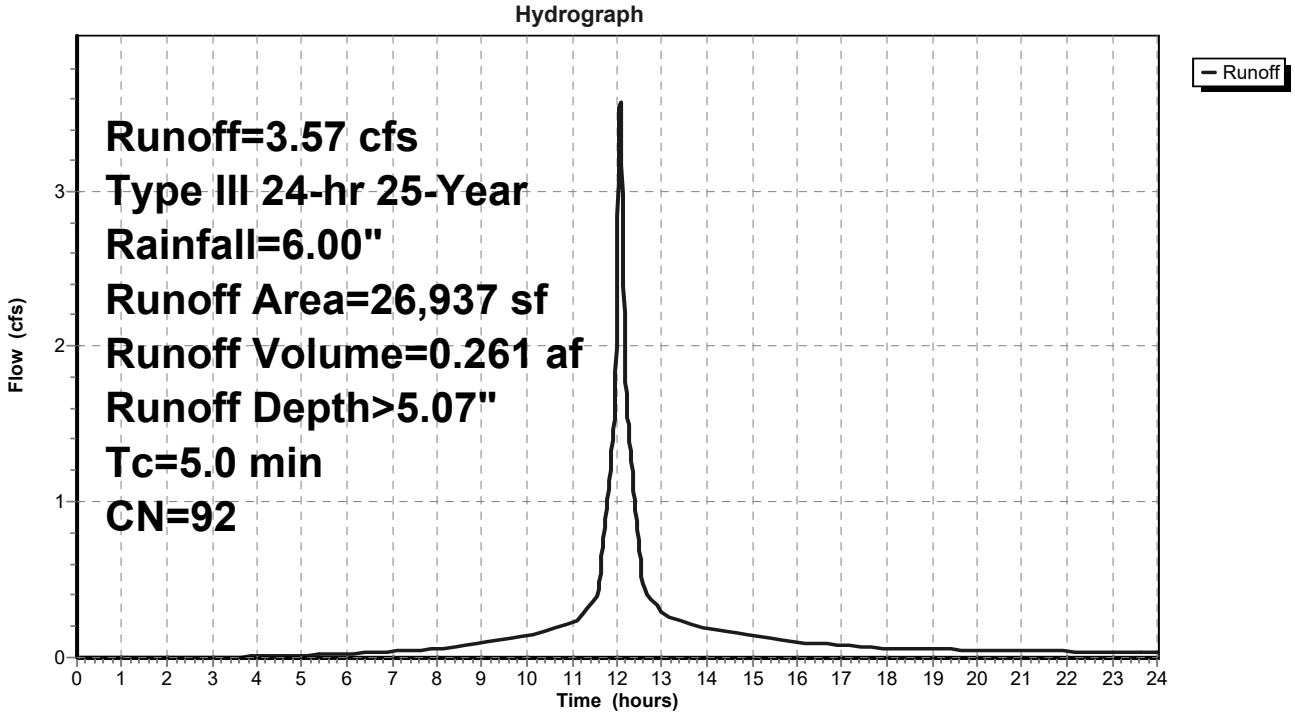
Runoff = 3.57 cfs @ 12.07 hrs, Volume= 0.261 af, Depth> 5.07"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.00"

Area (sf)	CN	Description
20,142	98	Paved parking, HSG C
6,795	74	>75% Grass cover, Good, HSG C
26,937	92	Weighted Average
6,795		25.23% Pervious Area
20,142		74.77% Impervious Area

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

Subcatchment PR1C: Loading Area



Summary for Subcatchment PR1D: South of Bldg

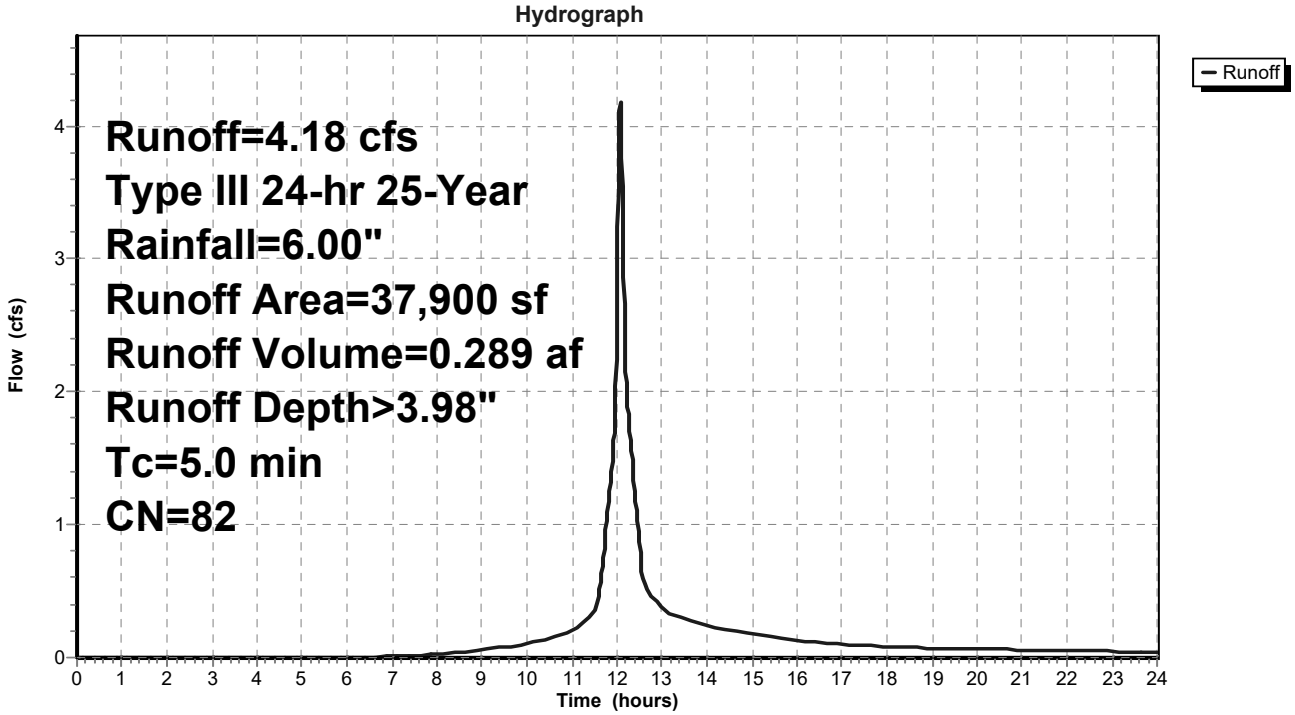
Runoff = 4.18 cfs @ 12.07 hrs, Volume= 0.289 af, Depth> 3.98"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.00"

Area (sf)	CN	Description
12,880	98	Paved parking, HSG C
25,020	74	>75% Grass cover, Good, HSG C
37,900	82	Weighted Average
25,020		66.02% Pervious Area
12,880		33.98% Impervious Area

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

Subcatchment PR1D: South of Bldg



Summary for Subcatchment PR2: NE of Building

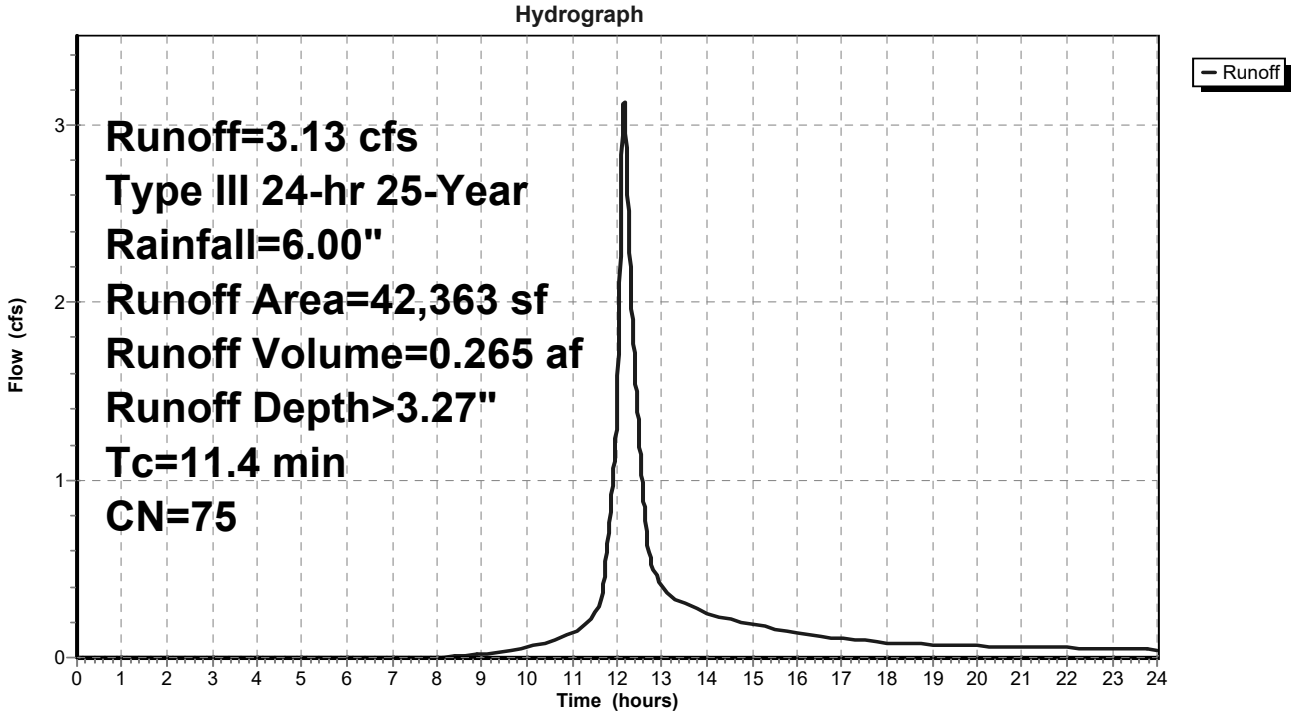
Runoff = 3.13 cfs @ 12.16 hrs, Volume= 0.265 af, Depth> 3.27"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.00"

Area (sf)	CN	Description
954	98	Paved parking, HSG C
41,409	74	>75% Grass cover, Good, HSG C
42,363	75	Weighted Average
41,409		97.75% Pervious Area
954		2.25% Impervious Area

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

Subcatchment PR2: NE of Building



Summary for Subcatchment PR3: SE of Building

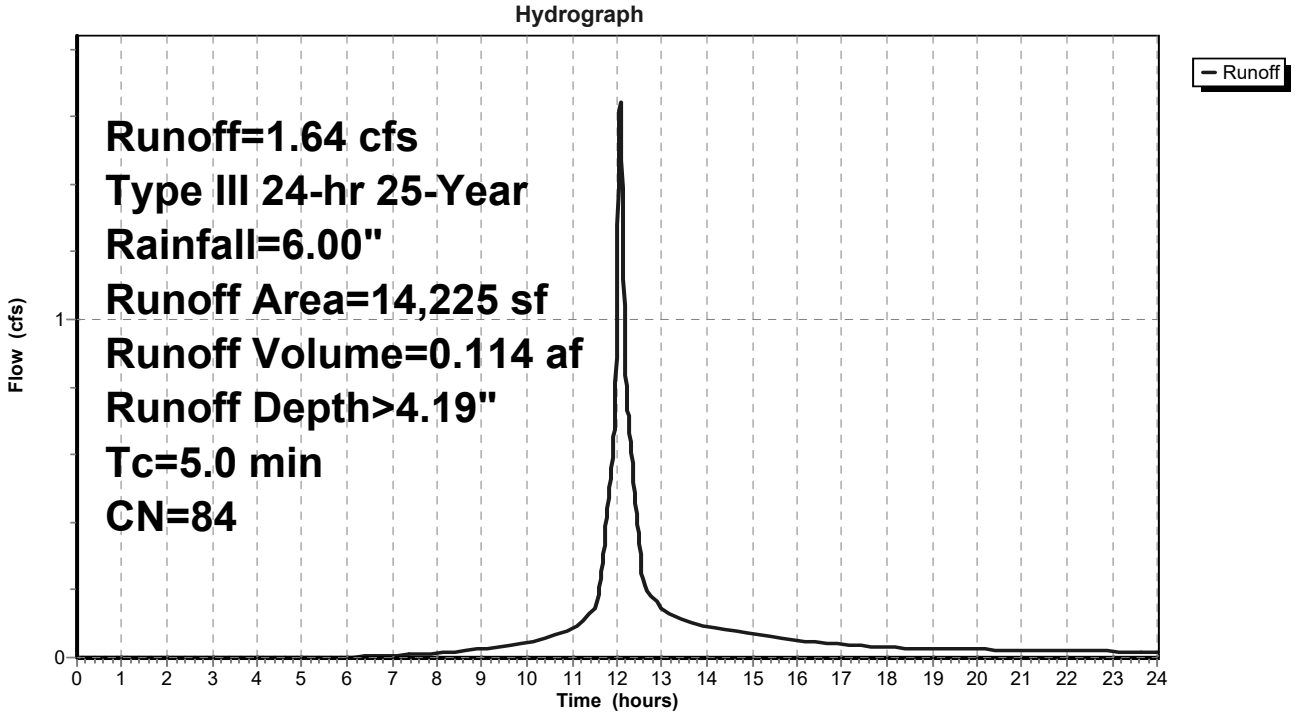
Runoff = 1.64 cfs @ 12.07 hrs, Volume= 0.114 af, Depth> 4.19"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year Rainfall=6.00"

Area (sf)	CN	Description
5,717	98	Paved parking, HSG C
8,508	74	>75% Grass cover, Good, HSG C
14,225	84	Weighted Average
8,508		59.81% Pervious Area
5,717		40.19% Impervious Area

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

Subcatchment PR3: SE of Building



Summary for Pond UG1: Recharge 1

Inflow Area = 1.487 ac, 71.84% Impervious, Inflow Depth > 4.95" for 25-Year event
Inflow = 8.47 cfs @ 12.07 hrs, Volume= 0.614 af
Outflow = 5.79 cfs @ 12.15 hrs, Volume= 0.553 af, Atten= 32%, Lag= 4.6 min
Primary = 5.79 cfs @ 12.15 hrs, Volume= 0.553 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 591.94' @ 12.15 hrs Surf.Area= 3,587 sf Storage= 6,965 cf

Plug-Flow detention time= 96.0 min calculated for 0.553 af (90% of inflow)
Center-of-Mass det. time= 48.0 min (827.7 - 779.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	589.00'	3,184 cf	**49.00'W x 73.20'L x 3.50'H Field A** 12,554 cf Overall - 4,594 cf Embedded = 7,960 cf x 40.0% Voids
#2A	589.50'	4,594 cf	**ADS_StormTech SC-740 +Cap** x 100 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap
#3	592.00'	10,225 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		18,003 cf	Total Available Storage

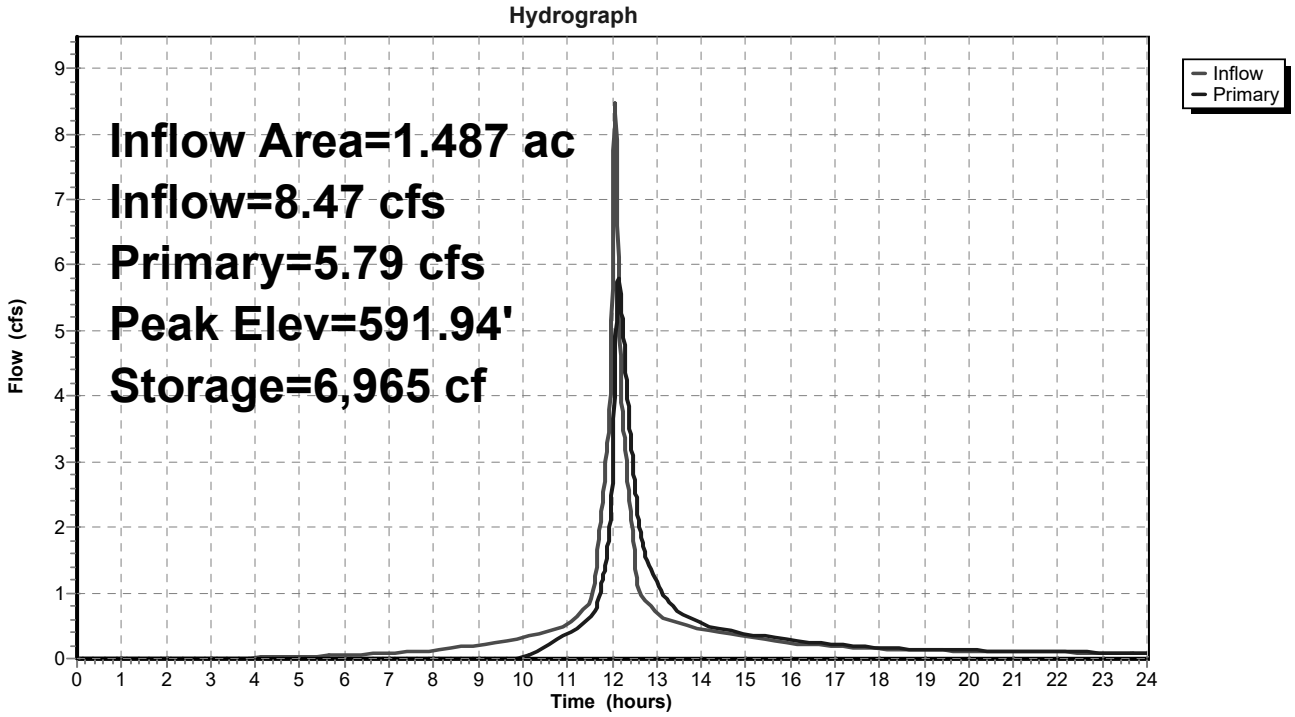
Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
592.00	100	0	0
592.50	100	50	50
593.00	100	50	100
594.00	100	100	200
594.50	10,000	2,525	2,725
595.00	20,000	7,500	10,225

Device	Routing	Invert	Outlet Devices
#1	Primary	590.00'	**9.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	590.75'	**12.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	592.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.0' Crest Height

Primary OutFlow Max=5.78 cfs @ 12.15 hrs HW=591.93' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 2.66 cfs @ 6.01 fps)
- **2=Orifice/Grate** (Orifice Controls 3.13 cfs @ 3.98 fps)
- **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond UG1: Recharge 1



Summary for Pond UG2: Recharge 2

Inflow Area = 1.880 ac,100.00% Impervious, Inflow Depth > 5.76" for 25-Year event
Inflow = 11.45 cfs @ 12.07 hrs, Volume= 0.902 af
Outflow = 10.47 cfs @ 12.10 hrs, Volume= 0.858 af, Atten= 9%, Lag= 2.0 min
Primary = 10.47 cfs @ 12.10 hrs, Volume= 0.858 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 580.46' @ 12.10 hrs Surf.Area= 1,187 sf Storage= 3,505 cf

Plug-Flow detention time= 56.8 min calculated for 0.858 af (95% of inflow)
Center-of-Mass det. time= 28.5 min (772.2 - 743.8)

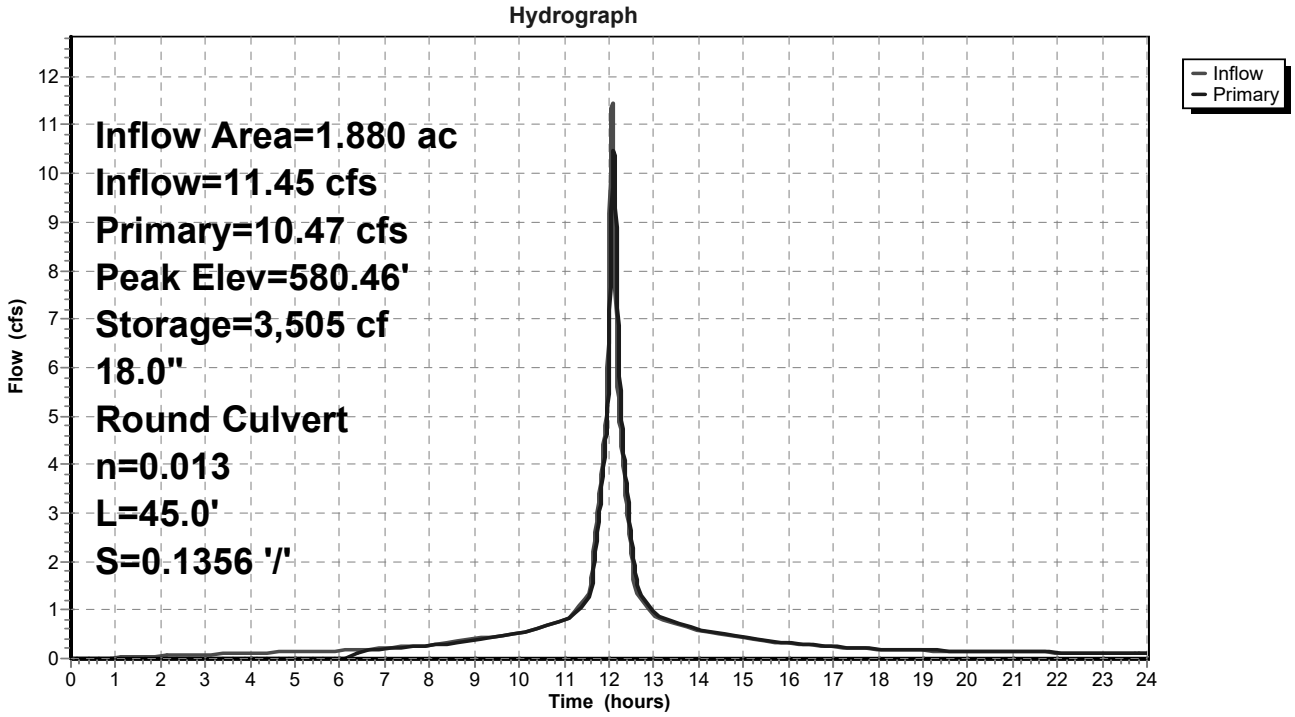
Volume	Invert	Avail.Storage	Storage Description
#1A	576.00'	1,689 cf	**22.75'W x 52.19'L x 5.50'H Field A** 6,530 cf Overall - 2,309 cf Embedded = 4,221 cf x 40.0% Voids
#2A	576.75'	2,309 cf	**ADS_StormTech MC-3500 d +Cap** x 21 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
		3,998 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	578.20'	**18.0" Round Culvert** L= 45.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 578.20' / 572.10' S= 0.1356 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=10.45 cfs @ 12.10 hrs HW=580.46' (Free Discharge)
└**1=Culvert** (Inlet Controls 10.45 cfs @ 5.92 fps)

Pond UG2: Recharge 2



Summary for Pond UG3: Detention 3

Inflow Area = 0.618 ac, 74.77% Impervious, Inflow Depth > 5.07" for 25-Year event
Inflow = 3.57 cfs @ 12.07 hrs, Volume= 0.261 af
Outflow = 1.60 cfs @ 12.23 hrs, Volume= 0.260 af, Atten= 55%, Lag= 9.5 min
Primary = 1.60 cfs @ 12.23 hrs, Volume= 0.260 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 586.25' @ 12.23 hrs Surf.Area= 1,024 sf Storage= 2,315 cf

Plug-Flow detention time= 20.7 min calculated for 0.260 af (100% of inflow)
Center-of-Mass det. time= 17.9 min (793.7 - 775.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	583.00'	1,462 cf	**22.75'W x 45.02'L x 5.50'H Field A** 5,633 cf Overall - 1,979 cf Embedded = 3,654 cf x 40.0% Voids
#2A	583.75'	1,979 cf	**ADS_StormTech MC-3500 c +Cap** x 18 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
#3	587.50'	5,100 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		8,541 cf	Total Available Storage

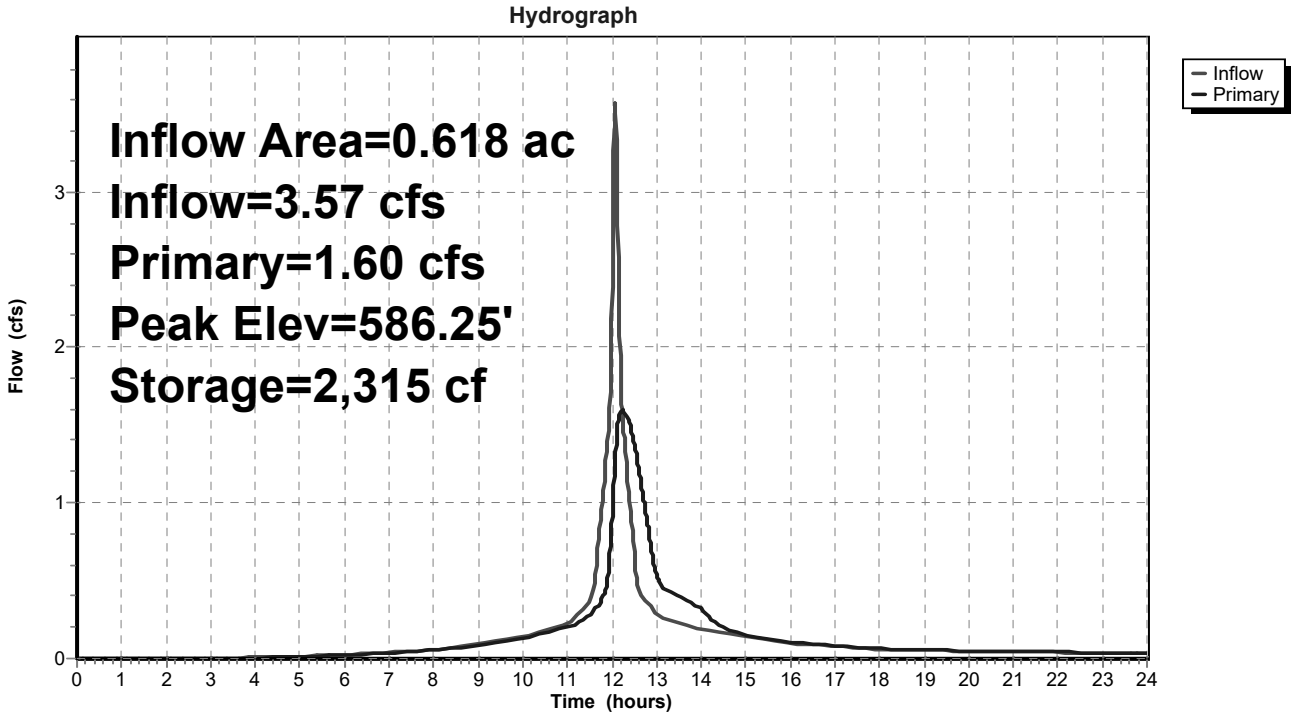
Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
587.50	100	0	0
587.80	100	30	30
588.00	100	20	50
589.00	10,000	5,050	5,100

Device	Routing	Invert	Outlet Devices
#1	Primary	583.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	584.33'	**5.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	587.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.0' Crest Height

Primary OutFlow Max=1.60 cfs @ 12.23 hrs HW=586.25' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.74 cfs @ 8.45 fps)
- **2=Orifice/Grate** (Orifice Controls 0.86 cfs @ 6.30 fps)
- **3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond UG3: Detention 3

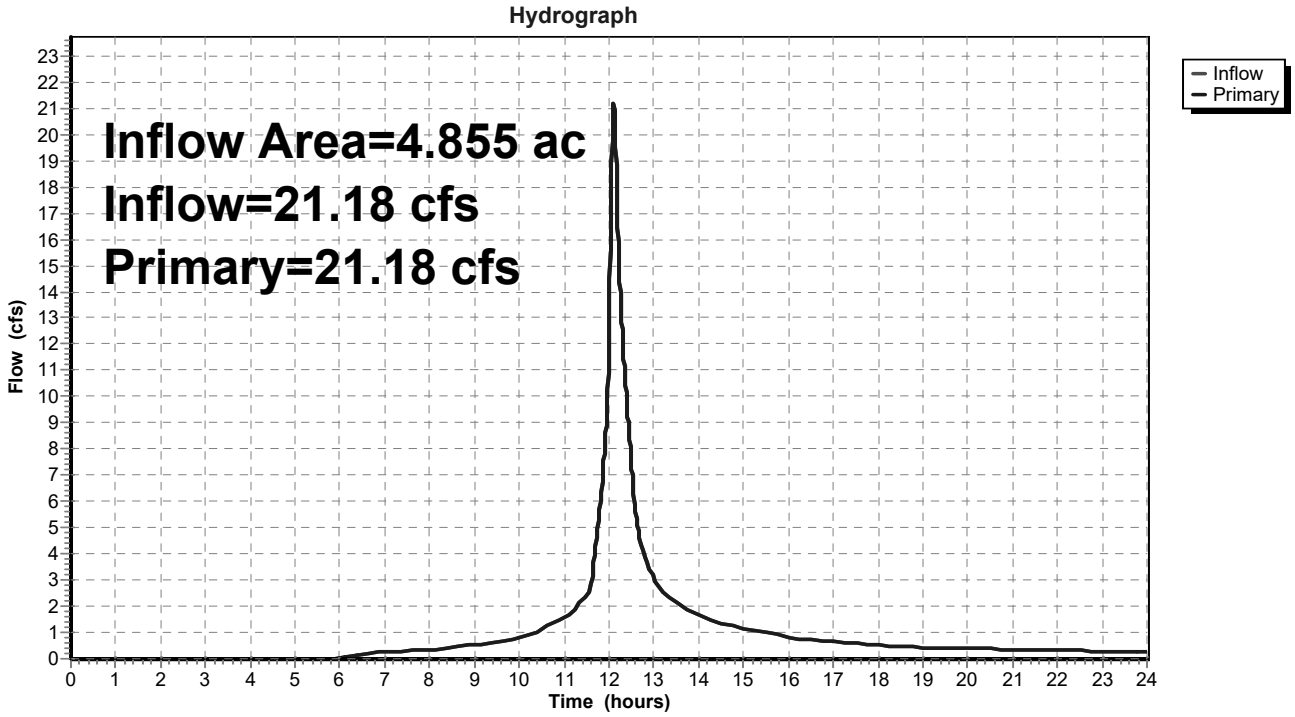


Summary for Link DP1: Goldsberry Drain

Inflow Area = 4.855 ac, 76.33% Impervious, Inflow Depth > 4.85" for 25-Year event
Inflow = 21.18 cfs @ 12.11 hrs, Volume= 1.960 af
Primary = 21.18 cfs @ 12.11 hrs, Volume= 1.960 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP1: Goldsberry Drain

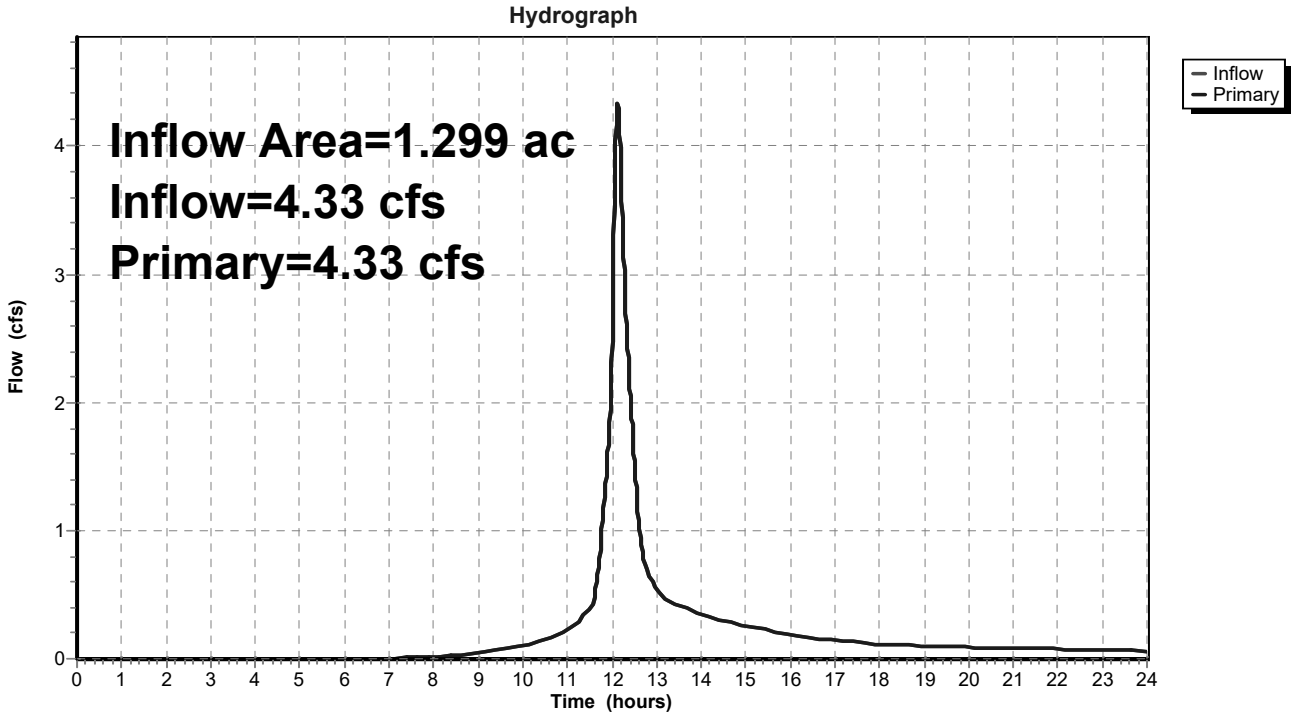


Summary for Link DP2: Clocktower Drain

Inflow Area = 1.299 ac, 11.79% Impervious, Inflow Depth > 3.51" for 25-Year event
Inflow = 4.33 cfs @ 12.12 hrs, Volume= 0.379 af
Primary = 4.33 cfs @ 12.12 hrs, Volume= 0.379 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP2: Clocktower Drain



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR1A: Parkting Area Runoff Area=64,777 sf 71.84% Impervious Runoff Depth>6.58"
Tc=5.0 min CN=91 Runoff=11.07 cfs 0.816 af

Subcatchment PR1B: Roof Area Runoff Area=81,874 sf 100.00% Impervious Runoff Depth>7.42"
Tc=5.0 min CN=98 Runoff=14.64 cfs 1.162 af

Subcatchment PR1C: Loading Area Runoff Area=26,937 sf 74.77% Impervious Runoff Depth>6.70"
Tc=5.0 min CN=92 Runoff=4.65 cfs 0.345 af

Subcatchment PR1D: South of Bldg Runoff Area=37,900 sf 33.98% Impervious Runoff Depth>5.53"
Tc=5.0 min CN=82 Runoff=5.73 cfs 0.401 af

Subcatchment PR2: NE of Building Runoff Area=42,363 sf 2.25% Impervious Runoff Depth>4.73"
Tc=11.4 min CN=75 Runoff=4.51 cfs 0.383 af

Subcatchment PR3: SE of Building Runoff Area=14,225 sf 40.19% Impervious Runoff Depth>5.76"
Tc=5.0 min CN=84 Runoff=2.22 cfs 0.157 af

Pond UG1: Recharge 1 Peak Elev=592.33' Storage=7,570 cf Inflow=11.07 cfs 0.816 af
Outflow=9.43 cfs 0.754 af

Pond UG2: Recharge 2 Peak Elev=581.38' Storage=3,941 cf Inflow=14.64 cfs 1.162 af
18.0" Round Culvert n=0.013 L=45.0' S=0.1356 '/' Outflow=13.27 cfs 1.118 af

Pond UG3: Detention 3 Peak Elev=587.19' Storage=2,894 cf Inflow=4.65 cfs 0.345 af
Outflow=2.99 cfs 0.344 af

Link DP1: Goldsberry Drain Inflow=29.59 cfs 2.617 af
Primary=29.59 cfs 2.617 af

Link DP2: Clocktower Drain Inflow=6.14 cfs 0.540 af
Primary=6.14 cfs 0.540 af

Total Runoff Area = 6.154 ac Runoff Volume = 3.264 af Average Runoff Depth = 6.36"
37.29% Pervious = 2.295 ac 62.71% Impervious = 3.859 ac

Summary for Subcatchment PR1A: Parkting Area

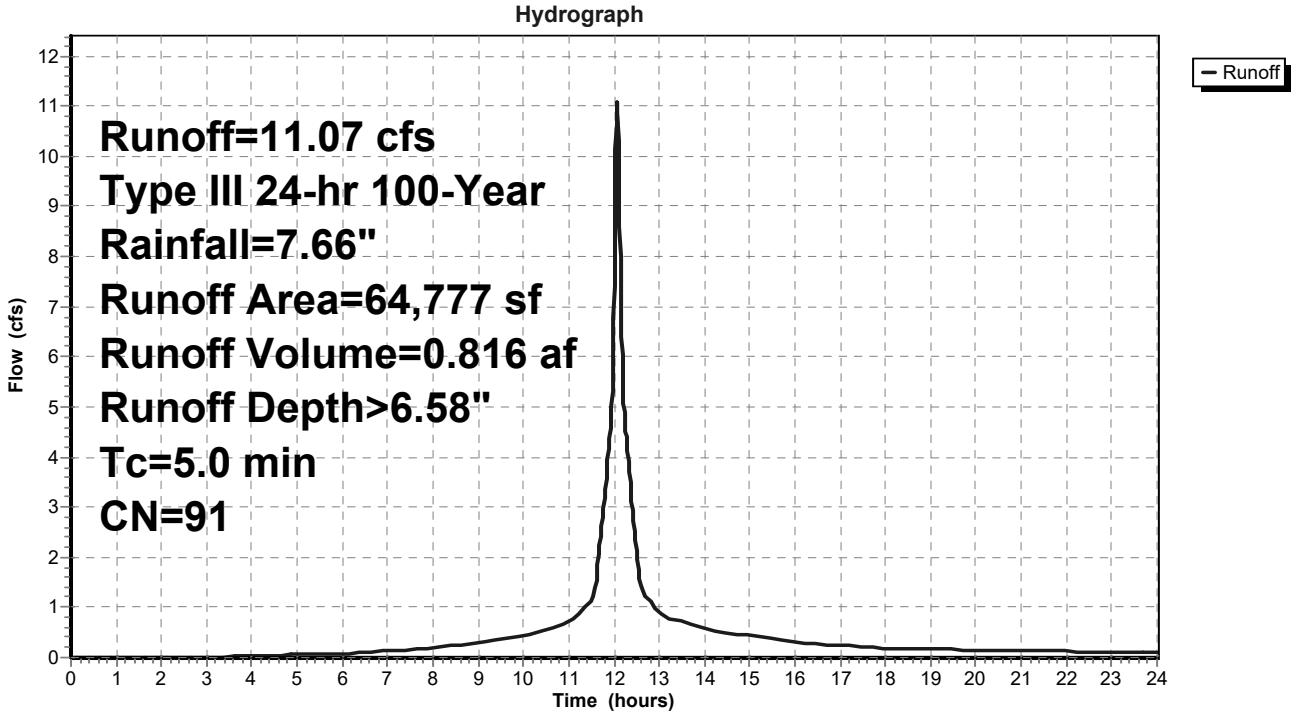
Runoff = 11.07 cfs @ 12.07 hrs, Volume= 0.816 af, Depth> 6.58"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.66"

Area (sf)	CN	Description
46,538	98	Paved parking, HSG C
18,239	74	>75% Grass cover, Good, HSG C
64,777	91	Weighted Average
18,239		28.16% Pervious Area
46,538		71.84% Impervious Area

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

Subcatchment PR1A: Parkting Area



Summary for Subcatchment PR1B: Roof Area

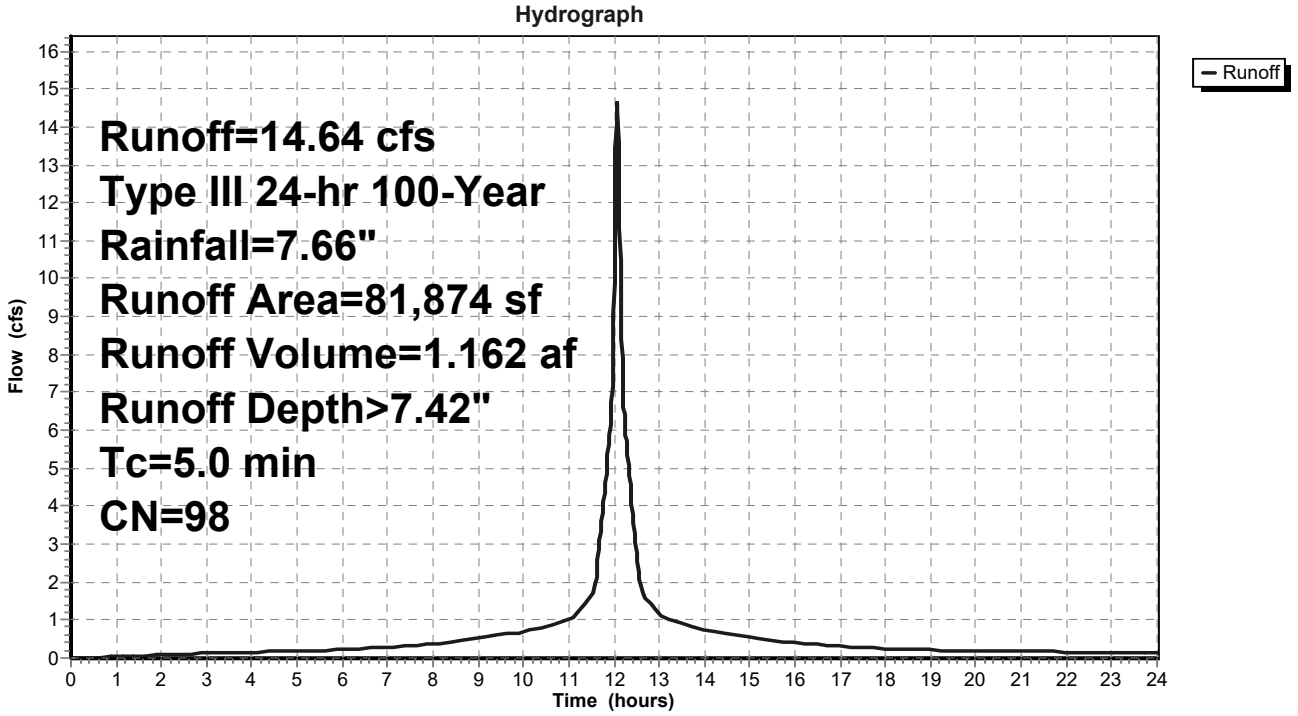
Runoff = 14.64 cfs @ 12.07 hrs, Volume= 1.162 af, Depth> 7.42"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.66"

Area (sf)	CN	Description
81,874	98	Roofs, HSG C
81,874		100.00% Impervious Area

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

Subcatchment PR1B: Roof Area



Summary for Subcatchment PR1C: Loading Area

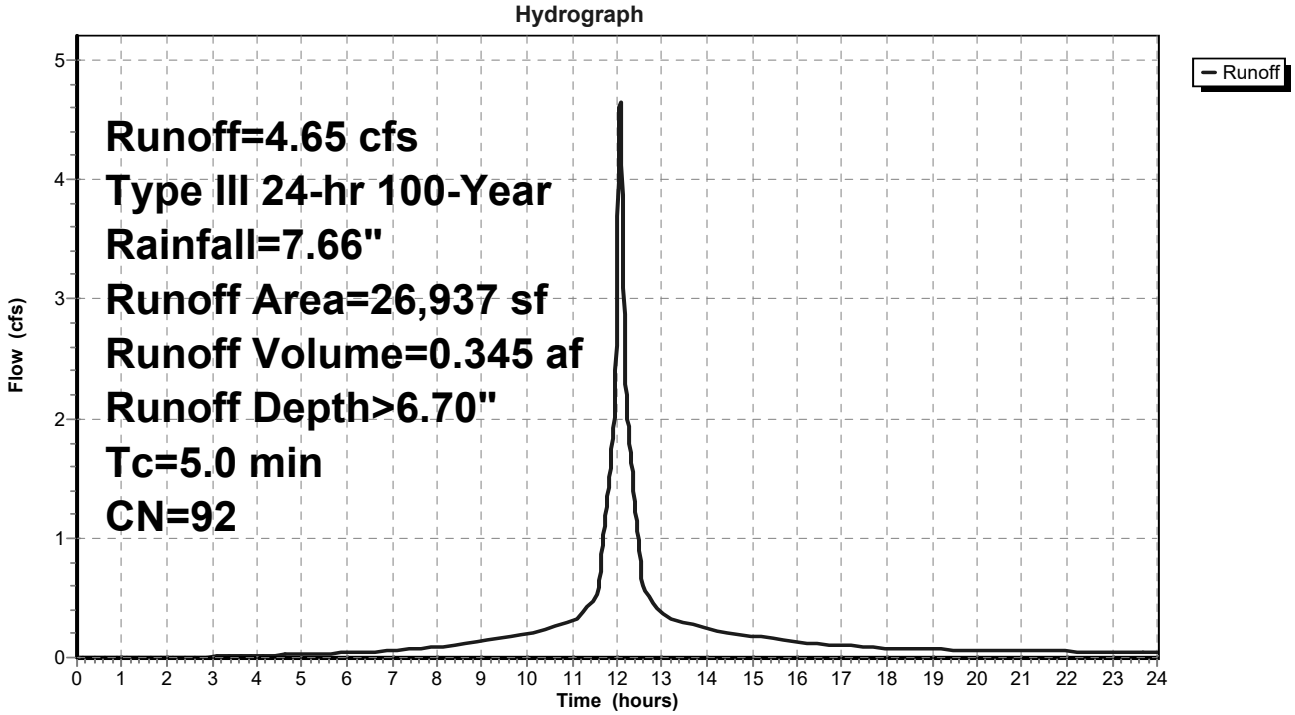
Runoff = 4.65 cfs @ 12.07 hrs, Volume= 0.345 af, Depth> 6.70"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.66"

Area (sf)	CN	Description
20,142	98	Paved parking, HSG C
6,795	74	>75% Grass cover, Good, HSG C
26,937	92	Weighted Average
6,795		25.23% Pervious Area
20,142		74.77% Impervious Area

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

Subcatchment PR1C: Loading Area



Summary for Subcatchment PR1D: South of Bldg

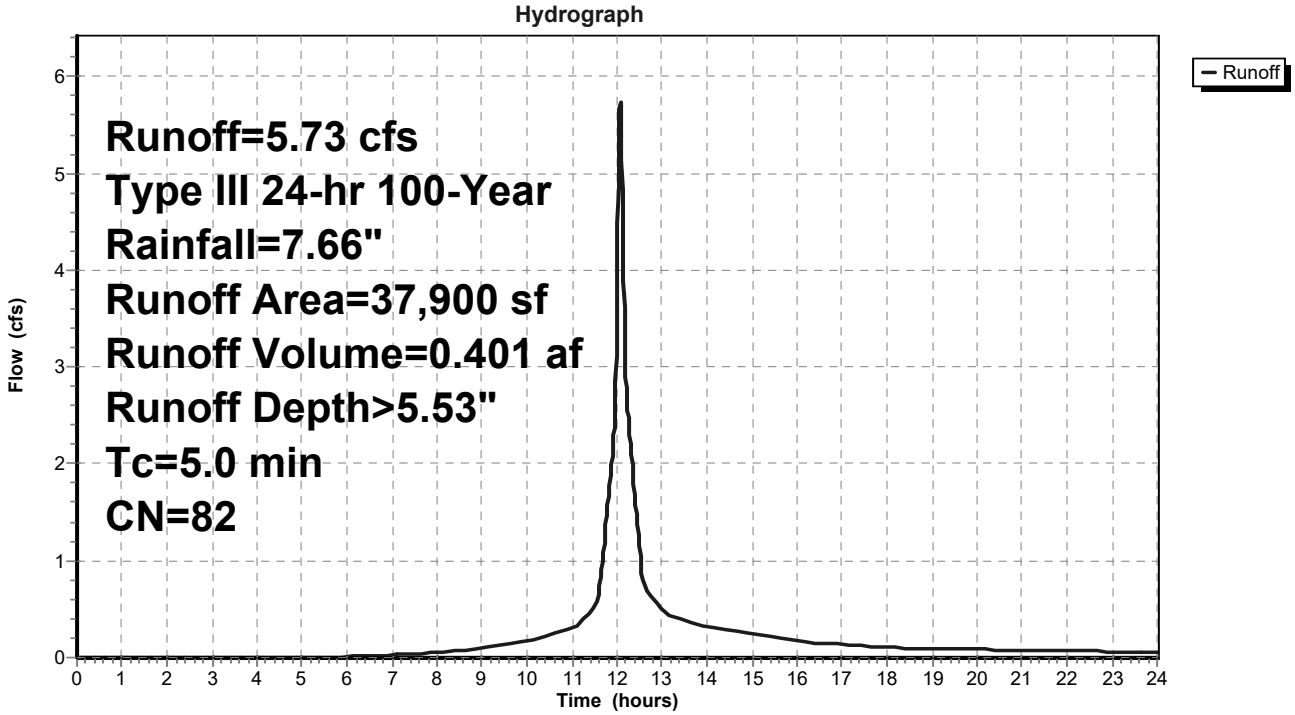
Runoff = 5.73 cfs @ 12.07 hrs, Volume= 0.401 af, Depth> 5.53"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.66"

Area (sf)	CN	Description
12,880	98	Paved parking, HSG C
25,020	74	>75% Grass cover, Good, HSG C
37,900	82	Weighted Average
25,020		66.02% Pervious Area
12,880		33.98% Impervious Area

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

Subcatchment PR1D: South of Bldg



Summary for Subcatchment PR2: NE of Building

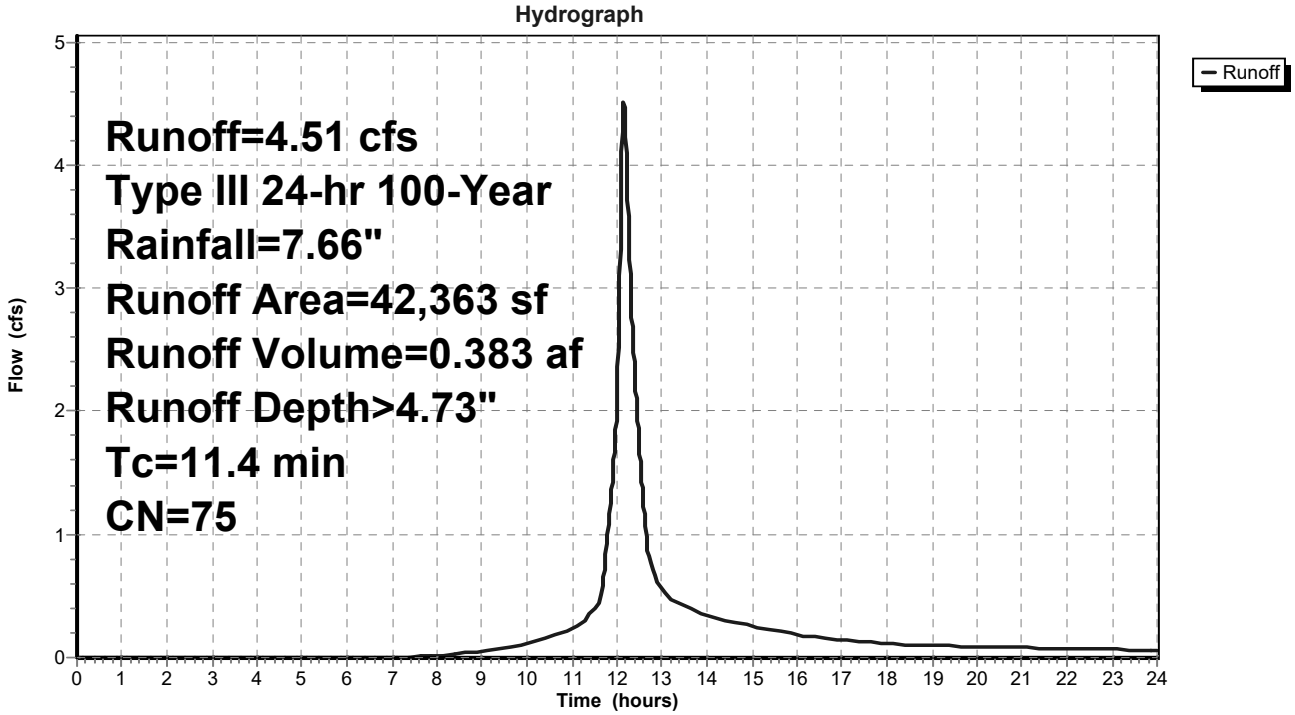
Runoff = 4.51 cfs @ 12.15 hrs, Volume= 0.383 af, Depth> 4.73"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.66"

Area (sf)	CN	Description
954	98	Paved parking, HSG C
41,409	74	>75% Grass cover, Good, HSG C
42,363	75	Weighted Average
41,409		97.75% Pervious Area
954		2.25% Impervious Area

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

Subcatchment PR2: NE of Building



Summary for Subcatchment PR3: SE of Building

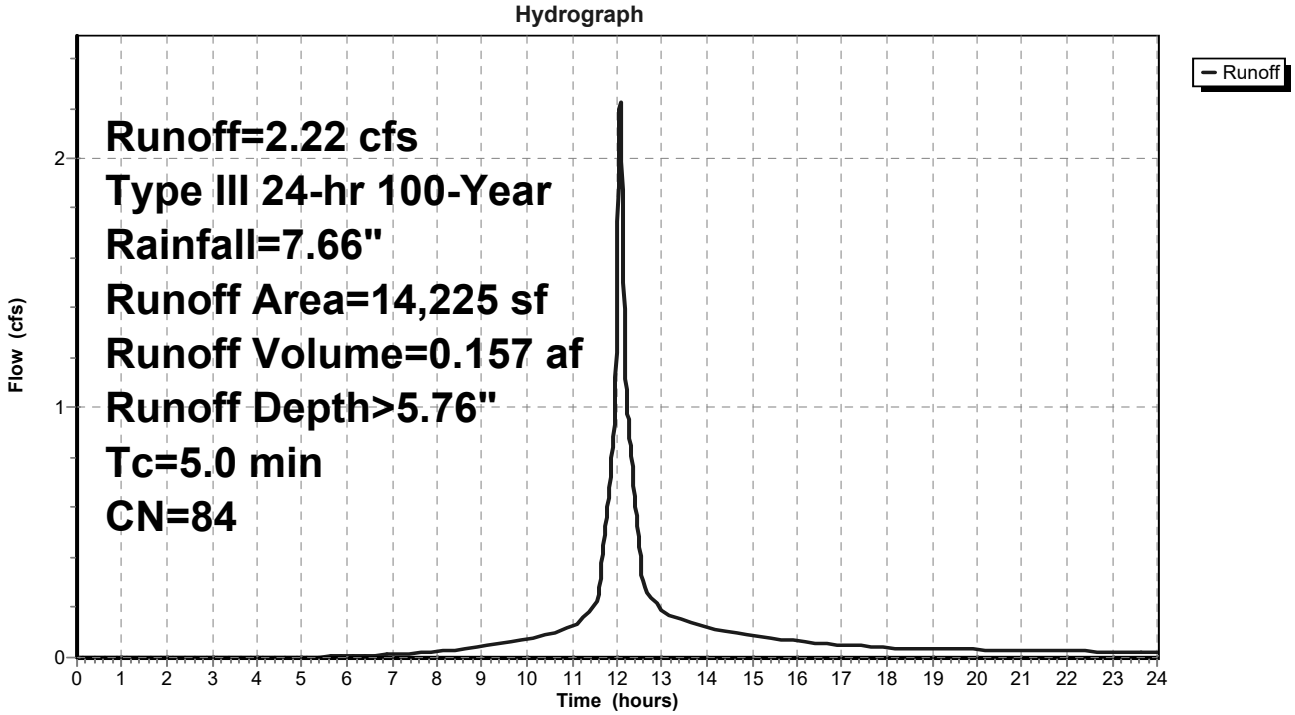
Runoff = 2.22 cfs @ 12.07 hrs, Volume= 0.157 af, Depth> 5.76"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=7.66"

Area (sf)	CN	Description
5,717	98	Paved parking, HSG C
8,508	74	>75% Grass cover, Good, HSG C
14,225	84	Weighted Average
8,508		59.81% Pervious Area
5,717		40.19% Impervious Area

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

Subcatchment PR3: SE of Building



Summary for Pond UG1: Recharge 1

Inflow Area = 1.487 ac, 71.84% Impervious, Inflow Depth > 6.58" for 100-Year event
Inflow = 11.07 cfs @ 12.07 hrs, Volume= 0.816 af
Outflow = 9.43 cfs @ 12.12 hrs, Volume= 0.754 af, Atten= 15%, Lag= 2.8 min
Primary = 9.43 cfs @ 12.12 hrs, Volume= 0.754 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 592.33' @ 12.12 hrs Surf.Area= 3,687 sf Storage= 7,570 cf

Plug-Flow detention time= 82.5 min calculated for 0.753 af (92% of inflow)
Center-of-Mass det. time= 42.8 min (815.2 - 772.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	589.00'	3,184 cf	**49.00'W x 73.20'L x 3.50'H Field A** 12,554 cf Overall - 4,594 cf Embedded = 7,960 cf x 40.0% Voids
#2A	589.50'	4,594 cf	**ADS_StormTech SC-740 +Cap** x 100 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap
#3	592.00'	10,225 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		18,003 cf	Total Available Storage

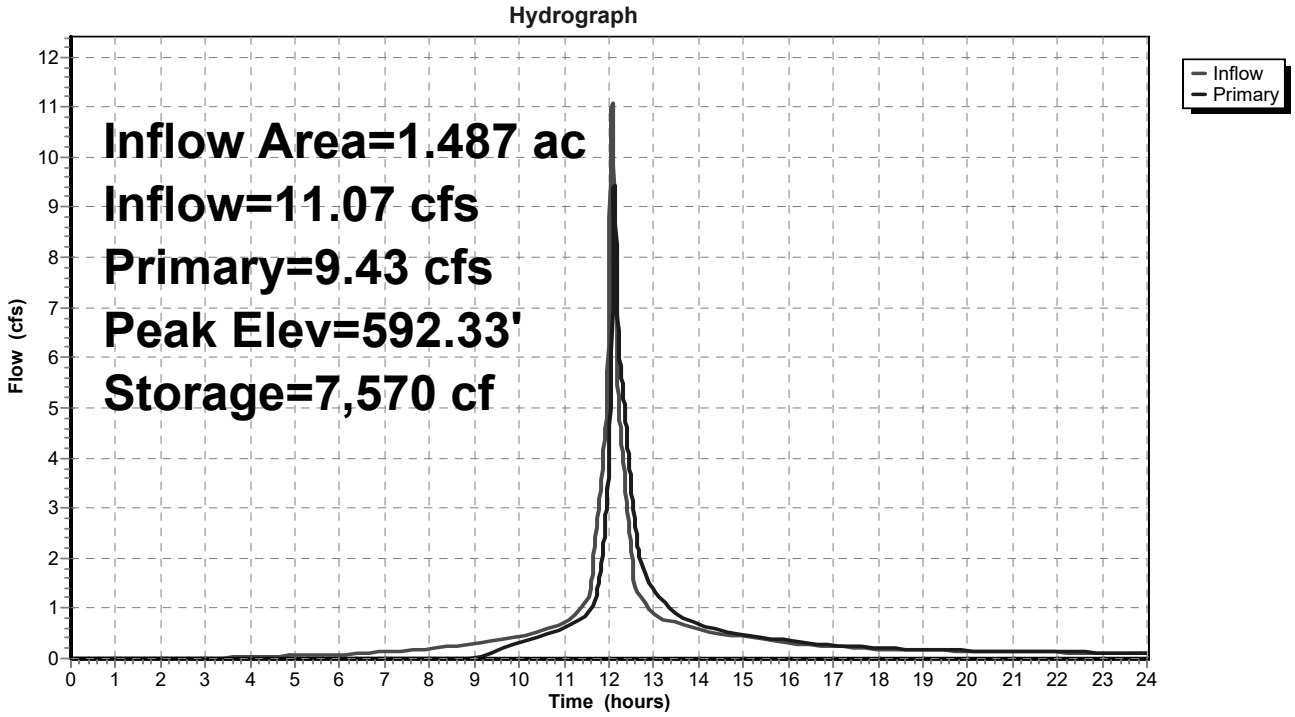
Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
592.00	100	0	0
592.50	100	50	50
593.00	100	50	100
594.00	100	100	200
594.50	10,000	2,525	2,725
595.00	20,000	7,500	10,225

Device	Routing	Invert	Outlet Devices
#1	Primary	590.00'	**9.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	590.75'	**12.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	592.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.0' Crest Height

Primary OutFlow Max=9.40 cfs @ 12.12 hrs HW=592.33' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 2.97 cfs @ 6.73 fps)
- **2=Orifice/Grate** (Orifice Controls 3.93 cfs @ 5.01 fps)
- **3=Sharp-Crested Rectangular Weir** (Weir Controls 2.50 cfs @ 1.92 fps)

Pond UG1: Recharge 1



Summary for Pond UG2: Recharge 2

Inflow Area = 1.880 ac,100.00% Impervious, Inflow Depth > 7.42" for 100-Year event
Inflow = 14.64 cfs @ 12.07 hrs, Volume= 1.162 af
Outflow = 13.27 cfs @ 12.11 hrs, Volume= 1.118 af, Atten= 9%, Lag= 2.1 min
Primary = 13.27 cfs @ 12.11 hrs, Volume= 1.118 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 581.38' @ 12.11 hrs Surf.Area= 1,187 sf Storage= 3,941 cf

Plug-Flow detention time= 47.2 min calculated for 1.117 af (96% of inflow)
Center-of-Mass det. time= 24.2 min (764.6 - 740.4)

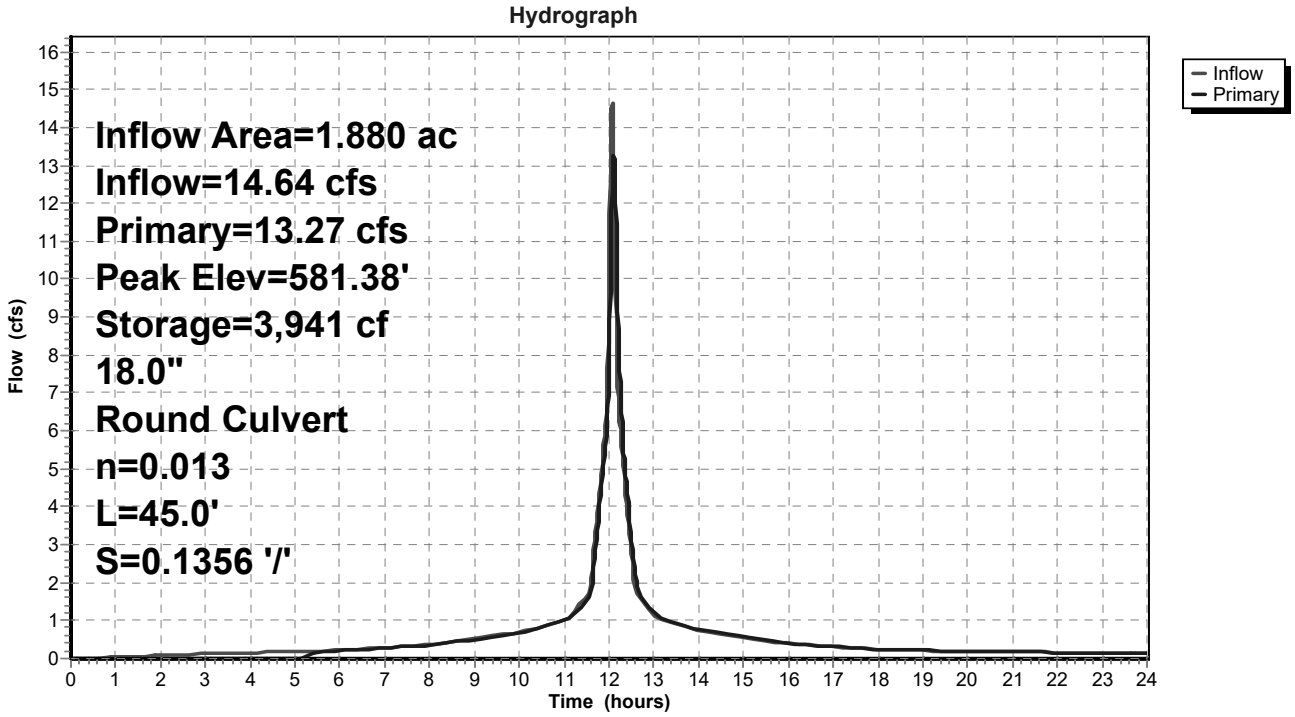
Volume	Invert	Avail.Storage	Storage Description
#1A	576.00'	1,689 cf	**22.75'W x 52.19'L x 5.50'H Field A** 6,530 cf Overall - 2,309 cf Embedded = 4,221 cf x 40.0% Voids
#2A	576.75'	2,309 cf	**ADS_StormTech MC-3500 d +Cap** x 21 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
		3,998 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	578.20'	**18.0" Round Culvert** L= 45.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 578.20' / 572.10' S= 0.1356 '/' Cc= 0.900 n= 0.013

Primary OutFlow Max=13.25 cfs @ 12.11 hrs HW=581.37' (Free Discharge)
└**1=Culvert** (Inlet Controls 13.25 cfs @ 7.50 fps)

Pond UG2: Recharge 2



Summary for Pond UG3: Detention 3

Inflow Area = 0.618 ac, 74.77% Impervious, Inflow Depth > 6.70" for 100-Year event
Inflow = 4.65 cfs @ 12.07 hrs, Volume= 0.345 af
Outflow = 2.99 cfs @ 12.16 hrs, Volume= 0.344 af, Atten= 36%, Lag= 5.1 min
Primary = 2.99 cfs @ 12.16 hrs, Volume= 0.344 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 587.19' @ 12.16 hrs Surf.Area= 1,024 sf Storage= 2,894 cf

Plug-Flow detention time= 20.5 min calculated for 0.344 af (100% of inflow)
Center-of-Mass det. time= 18.0 min (786.9 - 768.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	583.00'	1,462 cf	**22.75'W x 45.02'L x 5.50'H Field A** 5,633 cf Overall - 1,979 cf Embedded = 3,654 cf x 40.0% Voids
#2A	583.75'	1,979 cf	**ADS_StormTech MC-3500 c +Cap** x 18 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap
#3	587.50'	5,100 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)
		8,541 cf	Total Available Storage

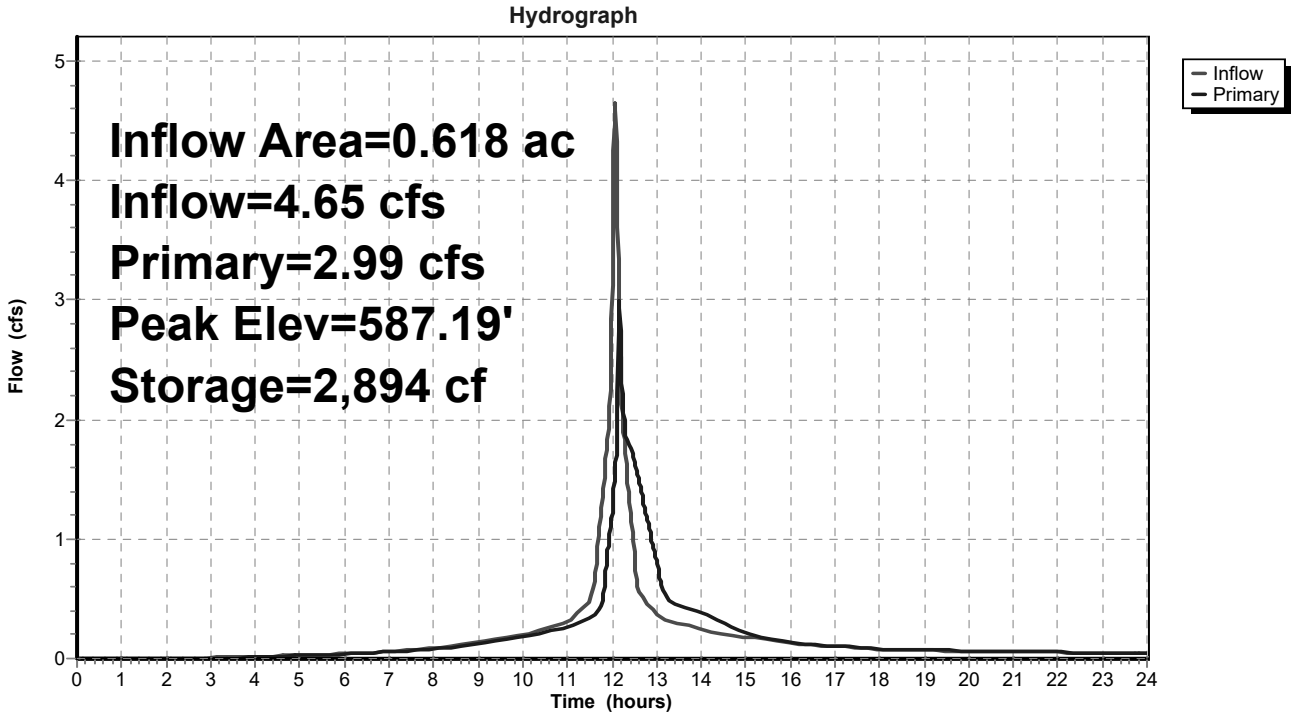
Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
587.50	100	0	0
587.80	100	30	30
588.00	100	20	50
589.00	10,000	5,050	5,100

Device	Routing	Invert	Outlet Devices
#1	Primary	583.00'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	584.33'	**5.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	587.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) 2.0' Crest Height

Primary OutFlow Max=2.97 cfs @ 12.16 hrs HW=587.19' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.84 cfs @ 9.65 fps)
- **2=Orifice/Grate** (Orifice Controls 1.07 cfs @ 7.84 fps)
- **3=Sharp-Crested Rectangular Weir** (Weir Controls 1.06 cfs @ 1.43 fps)

Pond UG3: Detention 3

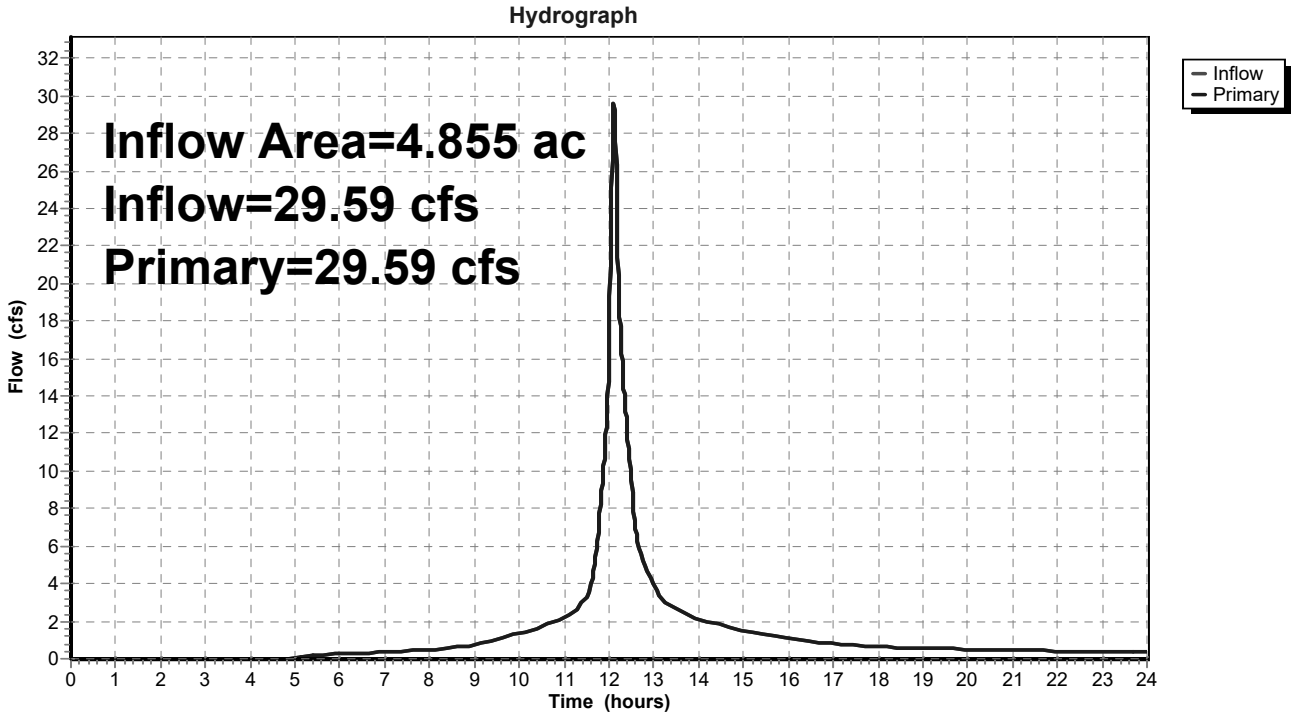


Summary for Link DP1: Goldsberry Drain

Inflow Area = 4.855 ac, 76.33% Impervious, Inflow Depth > 6.47" for 100-Year event
Inflow = 29.59 cfs @ 12.11 hrs, Volume= 2.617 af
Primary = 29.59 cfs @ 12.11 hrs, Volume= 2.617 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP1: Goldsberry Drain

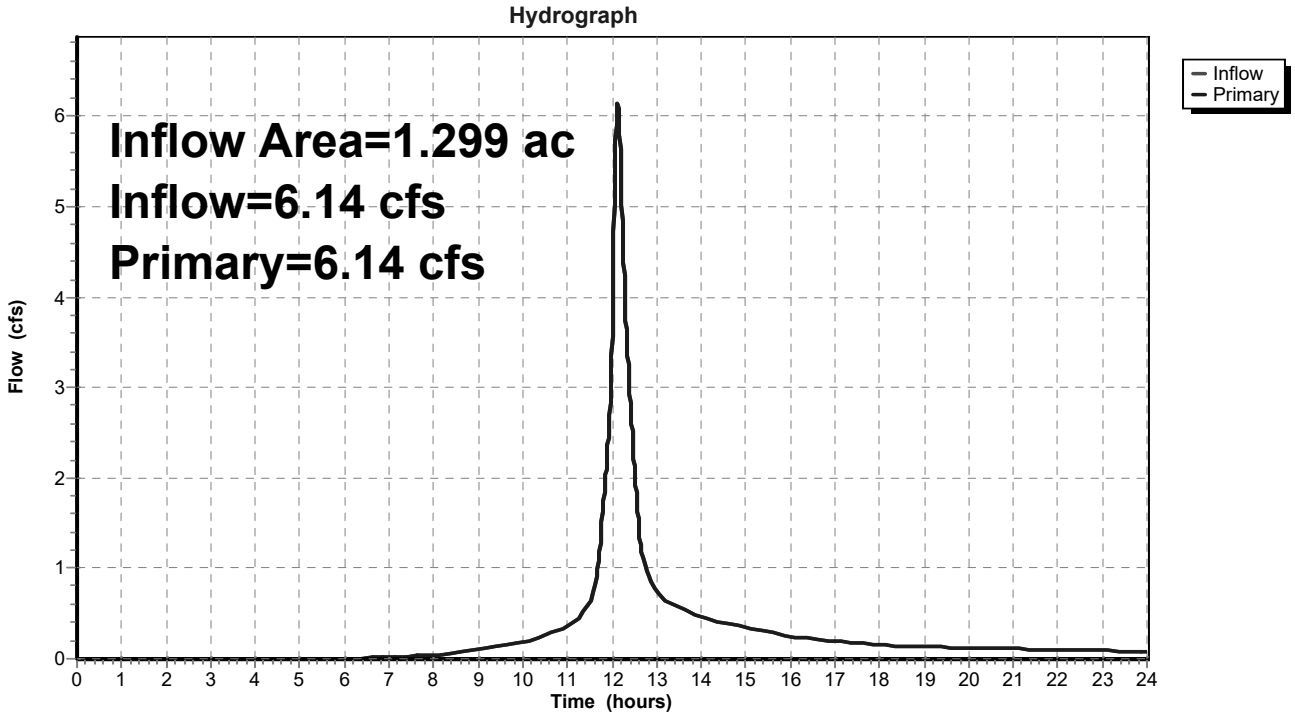


Summary for Link DP2: Clocktower Drain

Inflow Area = 1.299 ac, 11.79% Impervious, Inflow Depth > 4.99" for 100-Year event
Inflow = 6.14 cfs @ 12.12 hrs, Volume= 0.540 af
Primary = 6.14 cfs @ 12.12 hrs, Volume= 0.540 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Link DP2: Clocktower Drain



Appendix E: Hydraulic Analysis

Hydraulic Spreadsheet

Recharge Calculations

Water Quality Volume Calculations

Hydraulic Spreadsheet

MIDPOINT
ENGINEERING + CONSULTING

PIPE DESIGN CALCULATIONS

Project: Lot 3B Hospital D Location: Worcester, MA

Date: 9/3/2020 Design By: ppd

rev

DESIGN STORM: 10-year Mannings Coeff: 0.013

LOCATION			DRAINAGE AREA				FLOW TIME (min)			RUNOFF (cfs)		Other Flow (CFS)		PIPE DATA					FULL FLOW		COVER		RIM		INVERT	
Description	From	To	Area (Ac.)	Runoff Coeff.C	Incr. CA	Sum CA	Overld Time	Time In Pipe	Tc	Intensity (In/Hr)	Peak Flow		Design Flow	Diam (In.)	Drop (Ft.)	Length (Ft.)	Slope (Ft./Ft.)	Manning Coeff.	Capacity (Cfs)	Velocity (Fps)	Upper (Ft.)	Lower (Ft.)	Upper	Lower	Upper	Lower
	CB-4	DMH-3	0.06	0.67	0.042	0.042	5	0.62	5.0	5.8	0.24		0.24	8	0.75	107	0.0070	0.013	1.01	2.90	2.58	2.63	595.00	594.30	591.50	590.75
	CB-3	DMH-3	0.47	0.78	0.367	0.367	5	0.14	5.0	5.8	2.13		2.13	8	0.1	20	0.0050	0.013	0.85	2.45	2.23	2.63	594.00	594.30	590.85	590.75
	DMH-3	DMH-2				0.409		0.15	5.6	5.6	2.29		2.29	12	0.4	40	0.0100	0.013	3.56	4.54	2.40	3.70	594.30	595.20	590.65	590.25
	CB-1	DMH-2	0.72	0.66	0.474	0.474	5	0.36	5.0	5.8	2.75		2.75	8	0.65	72	0.0090	0.013	1.15	3.29	2.58	4.03	594.40	595.20	590.90	590.25
	CB-2	DMH-2	0.24	0.86	0.205	0.205	5	0.12	5.0	5.8	1.19		1.19	8	0.65	35	0.0186	0.013	1.65	4.72	2.58	4.03	594.40	595.20	590.90	590.25
	DMH-2	DMH-1				1.087		0.14	5.8	5.6	6.09		6.09	15	0.45	45	0.0100	0.013	6.46	5.26	3.55	5.10	595.20	596.30	590.15	589.70
	OC-1	DMH-4									4.40		4.40	12	0.75	37.5	0.0200	0.013	5.04	6.42	5.75	5.80	596.00	595.30	589.00	588.25
	DMH-4	DMH-5									4.40		4.40	12	6.6	165	0.0400	0.013	7.13	9.07	5.90	2.40	595.30	585.20	588.15	581.55
	RD-1	DMH-11	1.88	0.90	1.692	1.692	5	0.03	5.0	5.8	9.81		9.81	15	0.8	20	0.0400	0.013	12.92	10.53	14.45	7.25	596.00	588.00	580.05	579.25
	DMH-11	UG-2				1.692		0.09	5.0	5.8	9.81		9.81	15	2.4	60	0.0400	0.013	12.92	10.53	7.25	9.65	588.00	588.00	579.25	576.85
	OC-2	EXDMH-2									8.82		8.82	18	6.1	55	0.1109	0.013	34.98	19.80	7.05	3.59	587.00	577.44	578.20	572.10
	CB-7	DMH-8	0.16	0.64	0.104	0.104	5	1.16	5.0	5.8	0.60		0.60	8	0.85	170	0.0050	0.013	0.85	2.45	2.08	4.73	588.00	589.80	585.00	584.15
	CB-6	DMH-8	0.18	0.61	0.107	0.107	5	0.03	5.0	5.8	0.62		0.62	8	1.85	18	0.1028	0.013	3.87	11.10	2.58	4.73	589.50	589.80	586.00	584.15
	DMH-8	DMH-7				0.211		0.11	6.2	5.6	1.18		1.18	12	0.3	30	0.0100	0.013	3.56	4.54	4.50	4.80	589.80	589.80	584.05	583.75
	CB-5	DMH-7	0.28	0.90	0.253	0.253	5	0.26	5.0	5.8	1.46		1.46	8	0.55	55	0.0100	0.013	1.21	3.46	2.58	5.13	587.80	589.80	584.30	583.75
	DMH-7	DMH-6				0.463		0.17	6.3	5.6	2.59		2.59	15	0.55	55	0.0100	0.013	6.46	5.26	4.65	5.20	589.80	589.80	583.65	583.10
	OC-3	DMH-9									1.30		1.30	12	0.56	40	0.0140	0.013	4.22	5.37	7.05	5.41	591.20	589.00	582.90	582.34
	DMH-9	DMH-10									1.30		1.30	12	1.18	85	0.0139	0.013	4.20	5.34	5.51	4.69	589.00	587.00	582.24	581.06
	DMH-10	EXDMH-1									1.30		1.30	12	0.26	15	0.0173	0.013	4.69	5.97	4.79	3.63	587.00	585.58	580.96	580.70

Recharge Calculations

Water Quality Volume Calculations

TSS Removal Calculations

Project Name: **Lot 3B Hospital Drive**

Project Location: **Worcester, MA** Date: 9/3/2020

Calculated by: ppd

Design Parameters

Required Separation to Groundwater is 2'

Required Recharge is 0.25" x impervious area (Hyd Group C soils)

Required Water Quality Volume is 1" for areas of the site considered LUHPPL .5" other areas

Required TSS Removal is 44% prior to infiltration BMP (areas considered LUHPPPL)

Recharge Volume determined based on Static Method - Rawls rate is 0.27 for Silt Loam

Basin drawdown is less than 72 hours

Drainage Area P1A - Parking Area	Impervious Area = 1.07 Acre
Drainage Area P1B - Roof Area	Impervious Area = 1.88 Acre
Drainage Area P1C - Loading Area	Impervious Area = 0.47 Acre
Drainage Area P1D - South of Building	Impervious Area = 0.03 Acre
Drainage Area P2 - North of Building	Impervious Area = 0.02 Acre
Drainage Area P3 - SE of Building	Impervious Area = 0.03 Acre

Recharge Requirements

	Soil Hyd Group	Impervious Area	Requuired Recharge (in)	Recharge Volume Required (cubic feet)	Infiltration BMP
Subarea P1A	C	1.07	0.25	971	Yes
Subarea P1B	C	1.88	0.25	1,706	Yes
Subarea P1C	C	0.47	0.25	427	NO
Subarea P1D	C	0.03	0.25	27	NO
Subarea P2	C	0.02	0.25	18	NO
Subarea P3	C	0.03	0.25	27	NO
			Site recharge required	**3,176**	

Capture Area Adjustement	Total Site Impervious coverage	3.50
	Site impervious to infiltration BMP	2.95
	Total Impervious / Impervious to Inf. BMP	1.19
	Adjusted recharge required	3,768

Water Quality Volume Calculation

	Area (Acres)	Runoff Depth (in)	Water Quality Volume Required (cubic feet)	Infiltration BMP
Subarea P1A	1.07	0.5	1942	YES
Subarea P1C	0.47	1	1706	NO
Subarea P2 & P3	0.05	1	182	NO

Project Name: **Lot 3B Hospital Drive**

Project Location: **Worcester, MA** Date: 9/3/2020

Calculated by: ppd

BMP Design Calculations

Water Quality Flow Rate Calculations

WQU 1 - Loading Area

MassDEP Standard Method to Converti Requred WQV to Discharge Rate for sizing Proprietary BMPs

Tc = 0.083 hour

qu = 795 (From Fig. 4)

Area = 0.47 Acre

WQV = 1 inch

1 Acre = 0.0015625 SqMi

Water Quality Flow (Q) = (qu)(A)(WQV)

Q =795*(0.47)*(0.0015625)*(1) = 0.583828125 CFS

WQU 2 - Parking Area

MassDEP Standard Method to Converti Requred WQV to Discharge Rate for sizing Proprietary BMPs

Tc = 0.083 hour

qu = 795 (From Fig. 4)

Area = 0.67 Acre

WQV = 1 inch

1 Acre = 0.0015625 SqMi

Water Quality Flow (Q) = (qu)(A)(WQV)

Q =773*(1.07)*(0.0015625)*(.5) = .6461796875 CFS

UG-1 Basin Data

StormTech SC 740	Elevation	(cf)	
10 x 10 Chamber Configuration	589.00	0	Bottom of Stone
Recharge Basin	589.50	718	Bottom of Chambe
	590.00	**2,213**	Outlet Invert
	592.00	7,061	Top of Chamber
	592.50	7,779	Top of Stone

UG-2 Basin Data

StormTech MC 3500	Elevation	(cf)	
3 x 7 Chamber Configuration	576.00	0	Bottom of Stone
Recharge Basin	576.75	356	Bottom of Chambe
	578.20	**1,768**	Outlet Invert
	580.50	3,522	Top of Chamber
	581.50	3,950	Top of Stone

Project Name: **Lot 3B Hospital Drive**

Project Location: **Worcester, MA** Date: 9/3/2020

Calculated by: ppd

UG-3 Basin Data

	Elevation	(cf)	
StormTech MC 3500			
3 x 6 Chamber Configuration	583.00	0	Bottom of Stone
Basin to be lined with	583.00	**0**	Outlet Invert
impermeable barrier	583.75	369	Bottom of Chambe
	587.50	3,081	Top of Chamber
	588.50	3,440	Top of Stone

Drawdown Tiime

$$\text{Time} = \frac{\text{Volume}}{(k) \times \text{bottom area} \times n}$$

	k (in/hr)	Volume (cf)	Bottom Area (sf)	Drawdown Time (hrs)
UG-1	0.27	2213.0	3,587	27
UG-2	0.27	1768.0	1,187	66

Compliance:

Recharge Basin volume below the outlet invert is greater than required Recharge volumes and Water Quality Volume requirements

Barricuda S-4 certification notes 50% TSS removal at flow rates less than 1.25 CFS. Calcluated WQ flow rates are less than 1.25 CFS

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TSS Removal Calculation Worksheet

Project Name:	Lot 3B Hospital Drive	Sheet:	1 of 2
Project Number:		Date:	3-Sep-2020
Location:	Worcester, MA	Computed by:	ppd
Discharge Point:	1	Checked by:	
Drainage Area(s):	PR-1A		

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	25%	1.00	0.25	0.75
Barracuda WQU	50%	0.75	0.38	0.38
Infiltration Basin	80%	0.38	0.30	0.08
	0%	0.08	0.00	0.08
	0%	0.08	0.00	0.08

* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1.
Removal rates for proprietary devices are from approved studies and/or manufacturer data (attach study or data source, or remove this sentence if not applicable).
** Equals remaining load from previous BMP (E)

Treatment Train TSS Removal = **93%**

MIDPOINT ENGINEERING + CONSULTING

TSS Removal Calculation Worksheet

Project Name:	Lot 3B Hospital Drive	Sheet:	2 of 2
Project Number:		Date:	3-Sep-2020
Location:	Worcester, MA	Computed by:	ppd
Discharge Point:	1	Checked by:	
Drainage Area(s):	PR-1C		

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	25%	1.00	0.25	0.75
Barracuda WQU	50%	0.75	0.38	0.38
Isolator Row	50%	0.38	0.19	0.19
	0%	0.19	0.00	0.19
	0%	0.19	0.00	0.19

* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1.
Removal rates for proprietary devices are from approved studies and/or manufacturer data (attach study or data source, or remove this sentence if not applicable).
** Equals remaining load from previous BMP (E)

Treatment Train TSS Removal = **81%**

KIM GUADAGNO

CHRIS CHRISTIE
Governor

Lt. Governor

State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION
Bureau of Nonpoint Pollution Control
Division of Water Quality
401-02B
Post Office Box 420
Trenton, New Jersey 08625-0420
609-633-7021 Fax: 609-777-0432
http://www.state.nj.us/dep/dwq/bnpc_home.htm

BOB MARTIN
Commissioner

September 18, 2017

Daniel J. Figola, P.E.
General Manager
BaySaver Technologies, LLC
1030 Deer Hollow Drive
Mt. Airy, MD 21771

Re: MTD Lab Certification
BaySaver Barracuda™ Hydrodynamic Separator by BaySaver Technologies, LLC
Online Installation

TSS Removal Rate 50%

Dear Mr. Figola:

The Stormwater Management rules under N.J.A.C. 7:8-5.5(b) and 5.7 (c) allow the use of manufactured treatment devices (MTDs) for compliance with the design and performance standards at N.J.A.C. 7:8-5 if the pollutant removal rates have been verified by the New Jersey Corporation for Advanced Technology (NJCAT) and have been certified by the New Jersey Department of Environmental Protection (NJDEP). BaySaver Technologies, LLC has requested an MTD Laboratory Certification for the BaySaver Barracuda™ Hydrodynamic Separator (BaySaver Barracuda).

The project falls under the "Procedure for Obtaining Verification of a Stormwater Manufactured Treatment Device from New Jersey Corporation for Advance Technology" dated January 25, 2013. The applicable protocol is the "New Jersey Laboratory Testing Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device" dated January 25, 2013.

NJCAT verification documents submitted to the NJDEP indicate that the requirements of the aforementioned protocol have been met or exceeded. The NJCAT letter also included a recommended certification TSS removal rate and the required maintenance plan. The NJCAT Verification Report with the Verification Appendix (dated September 2017) for this device is published online at http://www.njcat.org/verification-process/technology-verification-database.html.

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The NJDEP certifies the use of the BaySaver Barracuda by BaySaver Technologies, LLC at a TSS removal rate of 50% when designed, operated, and maintained in accordance with the information provided in the Verification Appendix and the following conditions:

1. The maximum treatment flow rate (MTFR) for the manufactured treatment device (MTD) is calculated using the New Jersey Water Quality Design Storm (1.25 inches in 2 hrs) in N.J.A.C. 7:8-5.5.

2. The BaySaver Barracuda shall be installed using the same configuration reviewed by NJCAT and shall be sized in accordance with the criteria specified in item 6 below.

3. This BaySaver Barracuda cannot be used in series with another MTD or a media filter (such as a sand filter) to achieve an enhanced removal rate for total suspended solids (TSS) removal under N.J.A.C. 7:8-5.5.

4. Additional design criteria for MTDs can be found in Chapter 9.6 of the New Jersey Stormwater Best Management Practices (NJ Stormwater BMP) Manual, which can be found online at www.njstormwater.org.

5. The maintenance plan for a site using this device shall incorporate, at a minimum, the maintenance requirements for the BaySaver Barracuda. A copy of the maintenance plan is attached to this certification. However, it is recommended to review the maintenance website at http://www.ads-pipe.com/pdf/en/Barracuda_Maintenance_07_17.pdf for any changes to the maintenance requirements.

6. Sizing Requirement:

   The example below demonstrates the sizing procedure for the BaySaver Barracuda:

   Example: A 0.25-acre impervious site is to be treated to 50% TSS removal using a BaySaver Barracuda. The impervious site runoff (Q) based on the New Jersey Water Quality Design Storm was determined to be 0.79 cfs.

   Maximum Treatment Flow Rate (MTFR) Evaluation:

   The site runoff (Q) was based on the following:
   time of concentration = 10 minutes
   i = 3.2 in/hr (page 5-8, Fig. 5-3 of the NJ Stormwater BMP Manual)
   c = 0.99 (curve number for impervious)
   Q = ciA = 0.99 x 3.2 x 0.25 = 0.79 cfs

   Given the site runoff is 0.79 cfs and based on Table 1 below, the Barracuda Model S4 with a MTFR of 1.25 cfs could be used for this site to remove 50% of the TSS from the impervious area without exceeding the MTFR.

   The sizing table corresponding to the available system models is noted below. Additional specifications regarding each model can be found in the Verification Appendix under Table A-1.

Table 1 BaySaver Barracuda Sizing Information

Barracuda Model	NJDEP 50% TSS Maximum Treatment Flow Rate (cfs)	Treatment Area (ft^2)	Hydraulic Loading Rate (gpm/ft^2)	50% Maximum Sediment Storage (ft^3)
S3	0.70	7.07	44.6	5.89
S4	1.25	12.57	44.6	10.47
S5	1.95	19.63	44.6	16.36
S6	2.80	28.27	44.6	23.56
S8	5.00	50.27	44.6	41.89
S10	7.80	78.54	44.6	65.45

A detailed maintenance plan is mandatory for any project with a Stormwater BMP subject to the Stormwater Management Rules, N.J.A.C. 7:8. The plan must include all of the items identified in the Stormwater Management Rules, N.J.A.C. 7:8-5.8. Such items include, but are not limited to, the list of inspection and maintenance equipment and tools, specific corrective and preventative maintenance tasks, indication of problems in the system, and training of maintenance personnel. Additional information can be found in Chapter 8: Maintenance and Retrofit of Stormwater Management Measures.

If you have any questions regarding the above information, please contact Mr. Shashi Nayak of my office at (609) 633-7021.

Sincerely,

James J. Murphy, Chief
Bureau of Nonpoint Pollution Control

Attachment: Maintenance Plan

cc: Chron File
Richard Magee, NJCAT
Vince Mazzei, NJDEP - DLUR
Ravi Patraju, NJDEP - BES
Gabriel Mahon, NJDEP - BNPC
Shashi Nayak, NJDEP - BNPC

Maintenance Guide

BaySaver Barracuda

July 2017

One of the advantages of the BaySaver Barracuda is the ease of maintenance. Like any system that collects pollutants, the BaySaver Barracuda must be maintained for continued effectiveness. Maintenance is a simple procedure performed using a vacuum truck or similar equipment. The systems were designed to minimize the volume of water removed during routine maintenance, reducing disposal costs.

Contractors can access the pollutants stored in the manhole through the manhole cover. This allows them to gain vacuum hose access to the bottom of the manhole to remove sediment and trash. There is no confined space entry necessary for inspection or maintenance.

The entire maintenance procedure typically takes from 2 to 4 hours, depending on the size of the system, the captured material, and the capacity of the vacuum truck.

Local regulations may apply to the maintenance procedure. Safe and legal disposal of pollutants is the responsibility of the maintenance contractor. Maintenance should be performed only by a qualified contractor.

Inspection and Cleaning Cycle

Periodic inspection is needed to determine the need for and frequency of maintenance. You should begin inspecting as soon as construction is complete and thereafter on an annual basis. Typically, the system needs to be cleaned every 1-3 years.

Excessive oils, fuels or sediments may reduce the maintenance cycle. Periodic inspection is important.

Determining When to Clean

To determine the sediment depth, the maintenance contractor should lower a stadia rod into the manhole until it contacts the top of the captured sediment and mark that spot on the rod. Then push the probe through to the bottom of the sump and mark that spot to determine sediment depth.

Maintenance should occur when the sediment has reached the levels indicated in the Storage Capacity Chart.

BaySaver Barracuda Storage Capacities

Model	Manhole Diameter	Treatment Chamber Capacity	Standard Sediment Capacity (20” depth)	NJDEP Sediment Capacity (50% of standard depth)
S3	36”	212 gallons	0.44 cubic yards	0.22 cubic yards
S4	48”	564 gallons	0.78 cubic yards	0.39 cubic yards
S5	60”	881 gallons	1.21 cubic yards	0.61 cubic yards
S6	72”	1269 gallons	1.75 cubic yards	0.88 cubic yards
S8	96”	3835 gallons	3.10 cubic yards	1.55 cubic yards
S10	120”	7496 gallons	4.85 cubic yards	2.43 cubic yards

Maintenance Instructions

1. Remove the manhole cover to provide access to the pollutant storage. Pollutants are stored in the sump, below the bowl assembly visible from the surface. You’ll access this area through the 10” diameter access cylinder.

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2. Use a vacuum truck or other similar equipment to remove all water, debris, oils and sediment. See figure 1.
3. Use a high pressure hose to clean the manhole of all the remaining sediment and debris. Then, use the vacuum truck to remove the water.
4. Fill the cleaned manhole with water until the level reaches the invert of the outlet pipe.
5. Replace the manhole cover.
6. Dispose of the polluted water, oils, sediment and trash at an approved facility.
   - Local regulations prohibit the discharge of solid material into the sanitary system. Check with the local sewer authority for authority to discharge the liquid.
   - Some localities treat the pollutants as leachate. Check with local regulators about disposal requirements.
   - Additional local regulations may apply to the maintenance procedure.

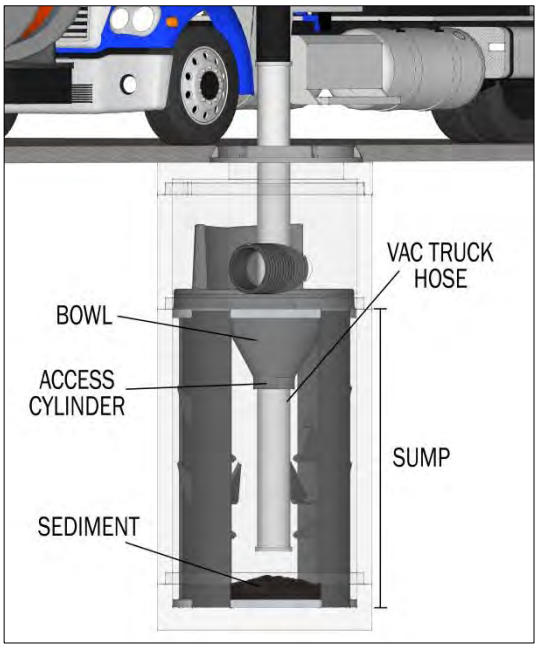

Figure 1

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Appendix F: Erosion and Sedimentation Control Measures

Erosion and Sedimentation Control Measures

The following erosion and sedimentation controls are for use during the earthwork and construction phases of the project. The following controls are provided as recommendations for the site contractor and do not constitute or replace the final Stormwater Pollution Prevention Plan that must be fully implemented by the Contractor and owner in Compliance with EPA NPDES regulations.

Perimeter Controls

Compost Filter Socks will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site. Filter socks will be set at on the existing ground and staked at 10 feet on center.

Catch Basin Protection

Newly constructed and existing catch basins will be protected with silt sacks throughout construction.

Gravel and Construction Entrance/Exit

A temporary crushed-stone construction entrance/exit will be constructed. A cross slope will be placed in the entrance to direct runoff to a protected catch basin inlet or settling area. If deemed necessary after construction begins, a wash pad may be included to wash off vehicle wheels before leaving the project site.

Diversion Channels

Diversion channels will be used to collect runoff from construction areas and discharge to either sedimentation basins or protected catch basin inlets.

Temporary Sediment Basins

Temporary sediment basins will be designed either as excavations or bermed stormwater detention structures (depending on grading) that will retain runoff for a sufficient period of time to allow suspended soil particles to settle out prior to discharge. These temporary basins will be located based on construction needs as determined by the contractor and outlet devices will be designed to control velocity and sediment. Points of discharge from sediment basins will be stabilized to minimize erosion.

Vegetative Slope Stabilization

Stabilization of open soil surfaces will be implemented within 14 days after grading or construction activities have temporarily or permanently ceased, unless there is sufficient snow cover to prohibit implementation. Vegetative slope stabilization will be used to minimize erosion on slopes of 3:1 or flatter. 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. Mulch will also be used after permanent seeding to protect soil from the impact of falling rain and to increase the capacity of the soil to absorb water.

Maintenance

- The contractor or subcontractor will be responsible for implementing each control shown on the Sedimentation and Erosion Control Plan. In accordance with EPA regulations, the contractor must sign a copy of a certification to verify that a plan has been prepared and that permit regulations are understood.

- The on-site contractor will inspect all sediment and erosion control structures periodically and after each rainfall event. Records of the inspections will be prepared and maintained on-site by the contractor.

- Silt shall be removed from behind barriers if greater than 6-inches deep or as needed.

- Damaged or deteriorated items will be repaired immediately after identification.

- Sediment that is collected in structures shall be disposed of properly and covered if stored on-site.

- Erosion control structures shall remain in place until all disturbed earth has been securely stabilized. After removal of structures, disturbed areas shall be regraded and stabilized as necessary.

The sedimentation and erosion control plan is included in project plan set; a reduced version and Erosion Control Maintenance checklist is included here for quick reference.

Construction Best Management Practices - Maintenance/Evaluation Checklist

The Reactory Biomanufacturing Campus
Lot 3B Hospital Drive, Worcester, MA

Construction Best Management Practices - Maintenance Evaluation Checklist

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and key items to check	Cleaning/Repair Needed Y/N Describe	Date of Cleaning/Repair	Performed by:
Gravel Construction Entrance	Once Per Week						
Catch Basin Protection	Once Per Week or after rain event						
Diversion Channels (if applicable)	Once Per Week or after rain event						
Compost Filter Sock	Once Per Week or after rain event						
Vegetated Slope Stabilization	Once Per Week or after rain event						

Appendix G: Long Term Stormwater Operation and Maintenance Measures

Long Term Stormwater Operation and Maintenance Plan

BMP's Ownership
The OWNERS of the BMP's shall be the person, persons, trust, corporation, etc., or their successors who have title to the land on which the BMP is located. It is anticipated that all BMP's will be owned and maintained by Galaxy Reactory, LLC, until the title of land upon which they are located is transferred. At that time, the purchaser of the property will assume all responsibilities set forth within this document.

This project is subject to review and issuance of an Order of Conditions (OOC) by the City of Worcester Conservation Commission. The decision and OOC issued by the Commission, which references this document, shall be recorded at the Worcester County Registry of deeds to ensure future owners of the property will have knowledge of the requirements of the Long Term Stormwater Operation and Maintenance Procedures.

Operation and Maintenance Responsibilities:
The party or parties responsible for the funding, operation and maintenance of the BMP's shall be the OWNER or their designees. BMP's each have specific maintenance requirements to ensure long-term effectiveness. These stormwater management systems will be operated, inspected and maintained on a regular basis **by a qualified professional with expertise in inspecting drainage system components**. All of the stormwater BMP's shall be kept in good working order at all times.

Approximate estimated annual maintenance costs for the site are:

Street Sweeping - $2,000
Deep sump hooded catch basins - $1,300
Subsurface Infiltration Systems - $500

Total Estimated Annual maintenance Cost - $3,800.00

Description of site BMPs with maintenance requirements

Pavement Systems

Standard Asphalt Pavement

- Sweep or vacuum standard asphalt pavement areas at least four times per year with a commercial cleaning unit and properly dispose of removed material.
- Recommended sweeping schedule:
    - Oct/Nov
    - Feb/Mar
    - Apr/May
    - Aug/Sep

- More frequent sweeping of paved surfaces will result in less accumulation in catch basins, less cleaning of subsurface structures, and less disposal costs.
- Check loading docks and dumpster areas frequently for spillage and/or pavement staining and clean as necessary.

Structural Stormwater Management Devices

Catch Basins

- All catch basins shall be inspected a minimum of four times per year.
- Sediment (if more than 24 inches deep) and/or floatable pollutants shall be pumped from the basin and disposed of at an approved offsite facility in accordance with all applicable regulations.
- Any structural damage or other indication of malfunction will be reported to the site manager and repaired as necessary
- During colder periods, the catch basin grates must be kept free of snow and ice.
- During warmer periods, the catch basin grates must be kept free of leaves, litter, sand, and debris.

"Barracuda" Proprietary Water Quality Units

- All water quality units shall be inspected a minimum of four times per year.
- Sediment (if more than twenty inches deep) and/or floatable pollutants shall be pumped from the structure and disposed of at an approved offsite facility in accordance with all applicable regulations.
- Any structural damage or other indication of malfunction will be reported to the site manager and repaired as necessary

Subsurface Recharge Chamber System

- The subsurface infiltration systems will be inspected at least twice each year by removing the manhole/access port covers and determining the thickness of sediment that has accumulated.
- If sediment is more than three inches deep, it must be suspended via flushing with clean water and removed using a vactor truck.
- Manufacturer's specifications and instructions for cleaning the sediment removal row is provided as an attachment to this section.
- System will be observed after rainfalls to see if it is properly draining.

Stormwater Outfalls

- Inspect outfall locations monthly for the first three months after construction to ensure proper functioning and correct any areas that have settled or experienced washouts.
- Inspect outfalls annually after initial three month period.
- Annual inspections should be supplemented after large storms, when washouts may occur.
- Maintain vegetation around outfalls to prevent blockages at the outfall.
- Maintain rip rap pad below each outfall and replace any washouts.
- Remove and dispose of any trash or debris at the outfall.

Vegetated Stormwater Management Devices

Vegetated Areas Maintenance

Although not a structural component of the drainage system, the maintenance of vegetated areas may affect the functioning of stormwater management practices. This includes the health/density of vegetative cover and activities such as the application and disposal of lawn and garden care products, disposal of leaves and yard trimmings.

- Inspect planted areas on a semi-annual basis and remove any litter.
- Maintain planted areas adjacent to pavement to prevent soil washout.
- 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.
- Plant alternative mixture of grass species in the event of unsuccessful establishment.
- The grass vegetation should not be cut to a height less than four inches.
- Pesticide/Herbicide Usage – No pesticides are to be used unless a single spot treatment is required for a specific control application.
- Fertilizer usage should be avoided. If deemed necessary, slow release fertilizer should be used. Fertilizer may be used to begin the establishment of vegetation in bare or damaged areas, but should not be applied on a regular basis unless necessary.

- The Long-Term BMP Maintenance/Evaluation Map and Checklist is attached.

The Reactory Biormanfacturing Campus
Lot 3B Hospital Drive, Worcester, MA

Long Term Best Management Practices - Maintenance/Evaluation Checklist

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and key items to check	Cleaning/Repair Needed Y/N Describe	Date of Cleaning/Repair	Performed by:
Pavement Sweeping	Monthly			Quarterly with vacuum or monthly with mechanical sweeper			
Deep Sump Hooded Catch Basin	4 times per year			clean when deposits accumulate to halfway between invert and bottom of unit			
Baysaver Water Quality Unit	4 times per year			clean when deposits accumulate to twenty (20) inches from bottom of unit			
Vegetated Areas	4 times per year and after major storm events			Mow a minimum of twice per year.			
UG infiltration Chamber	2 times per year			Measure accumulated sediment. Remove with vac-truck if sediment is 3" thick			