HANCOCK
ASSOCIATES

Attachment B Stormwater Report
revised December 30, 2019

HANCOCK ASSOCIATES

Stormwater Report
In Support of
Permit Site Plan
for
259 & 267 Main Street
Reading, MA

Prepared By:
Hancock Associates
#20882
Prepared For:
Stonegate Construction Corp.

December 2, 2019
Revised Thru December 30, 2019

Reference: Site Plan prepared by Hancock Associates, Rev. December 30, 2019

DANVERS OFFICE
185 Centre Street, Danvers, MA 01923
Phone: (978) 777-3050 Fax: (978) 774-7816

MARLBOROUGH OFFICE
315 Elm Street, Marlborough, MA 01752
Phone: (508) 460-1111 Fax: (508) 460-1121

Table of Contents

Appendices

INTRODUCTION

A Stormwater Report must be submitted to document compliance with the Stormwater Management Standards. The 259 & 267 Main Street project is subject to the Stormwater Management Standards and regulated by the Wetlands Protection Act Regulations, 310 CMR 10.00, and or the 401 Water Quality Certification Regulations. This Stormwater Report has been completed by Hancock Associates to accompany the various permit applications. The Report outlines how the design meets each Standard, providing calculations and information documenting compliance.

Excerpt from MADEP Stormwater Management Standards Chapter 1:

> *Stormwater runoff results from rainfall and snow melt and represents the single largest source responsible for water quality impairments in the Commonwealth's rivers, lakes, ponds, and marine waters. New and existing development typically adds impervious surfaces and, if not properly managed, may alter natural drainage features, increase peak discharge rates and volumes, reduce recharge to wetlands and streams, and increase the discharge of pollutants to wetlands and water bodies.*
>
> *The Stormwater Management Standards address water quality (pollutants) and water quantity (flooding, low base flow and recharge) by establishing standards that require the implementation of a wide variety of stormwater management strategies. These strategies include environmentally sensitive site design and LID techniques to minimize impervious surface and land disturbance, source control and pollution prevention, structural BMPs, construction period erosion and sedimentation control, and the long-term operation and maintenance of stormwater management systems.*

Applicability of standards is documented as follows:

Excerpt from MADEP Stormwater Management Handbook – Legal Framework for Stormwater Management:

Project proponents and municipal officials should work together to ensure adequate pretreatment prior to discharge to the municipal storm drain system. Municipal separate storm drain systems covered by the MS4 permit can ensure such pretreatment by establishing and implementing adequate post construction stormwater controls as required by that permit.

Excerpt from 974 CMR 4.08 Stormwater Management

4.08 1.a. *All Applications, regardless of whether the project is subject to the Wetlands Protection Act or not, shall design the stormwater management system in compliance with the goals and objectives of the Massachusetts Department of Environmental Protection Stormwater Management Policy (DEP SMP) to the greatest extent possible given the specific site constraints*

of each site. These apply to industrial, commercial, institutional, residential subdivision, and roadway projects, including site preparation, construction, redevelopment, and on-going operation. The Applicant shall submit a completed and endorsed Stormwater Management Form (SMF) that indicates compliance to the greatest extent possible, with the SMP's ten (10) Stormwater Management Standards, as most recently amended. The applicant shall also provide calculations indicating compliance with each standard. Refer to the DEP SMP and its referenced sources for specific application of these stormwater management categories.

EXISTING CONDITIONS

The subject property is located on the east side of Main Street in Reading Massachusetts and is bounded by Main Street to the west, a commercial property to the north, a residential condominium development to the south and a wetlands/stream system at the eastern side of the property. The parcels, designated assessor's Map 12 Lots 39 & 40 total approximately 4.01 acres in land area. The current owner of record is 259-267 Main Street LLC for both parcels.

The parcel currently contains a 1.5 story dwelling/office building with a footprint of approximately 1,500 s.f., an approximately 550 s.f. garage, and associated driveways and parking areas. There are wooded wetlands and a stream that occupy the rear (eastern) portion of the site. The site has previously been in use as an oil supply/storage business.

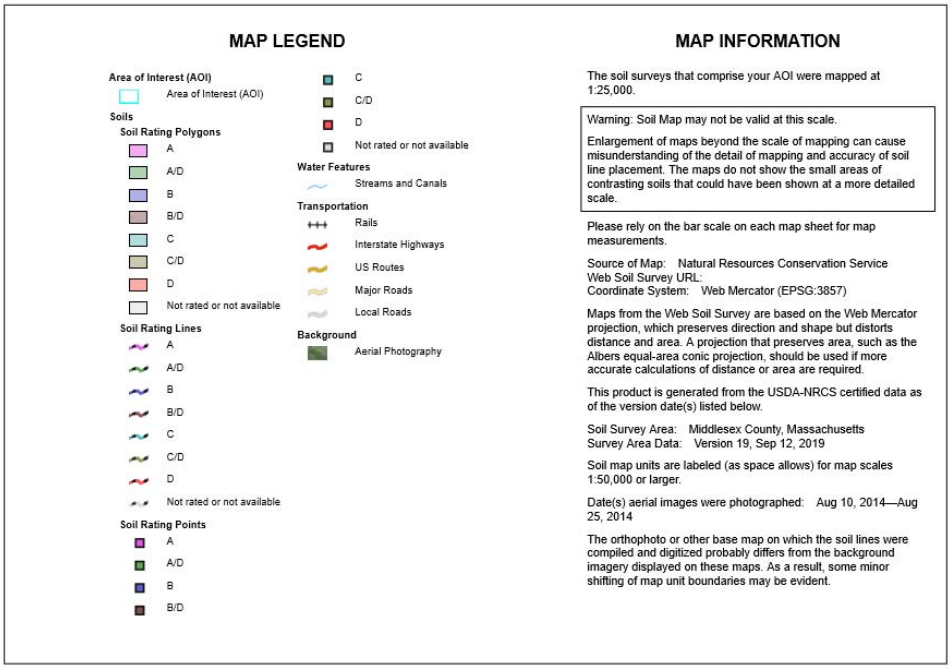
Topography on site ranges from elevation 97.0 (NAVD88) at the western side of the site adjacent to Main Street to an elevation of 87.0 at the eastern side of the parcel at the stream.

Soils on site have been classified by the USDA Natural Resource Conservation Service as Urban land in areas near Main Street and Wareham Loamy Fine Sand (HSG A/D). See NRCS Figures 1 and 2 below. Geotechnical borings were performed on the site in the building location by KMM Geotechnical consultants, LLC (KMM) which revealed the presence of primarily sandy soils. Hancock Associates will perform supplemental soil test pits in the in the location of the infiltration BMPs prior to construction to confirm soil conditions.

Figure 1: NRCS Mapping

Figure 2: NRCS Legend

Hydrologic Soil Group—Middlesex County, Massachusetts
(259-267 Main Street, Reading MA)



Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
32B	Wareham loamy fine sand, 0 to 5 percent slopes	A/D	3.2	58.5%
420B	Canton fine sandy loam, 3 to 8 percent slopes	B	0.2	3.2%
602	Urban land		2.1	38.3%
Totals for Area of Interest			**5.5**	**100.0%**

PROPOSED CONDITIONS:

The Applicant proposes to construct a 3-story residential condominium building that will contain 24 dwelling units. The project will include associated access drives, parking for forty-eight (48) vehicles, pedestrian walkways, drainage and landscaped areas. Thirty-five (35) of the proposed parking spaces will be located within a parking garage located under the building. The project will be served by town water and sewer connections. The proposed development will result in an increase of approximately 21,800 s.f. of impervious area.

Stormwater will be captured via standard deep sump hood catch basins and trench drains and pipe system directing runoff from the new parking/paved areas proposed on-site to a subsurface infiltration system composed of Stormtech SC-740 chambers and an extended dry detention basin. Overflow from the systems will be directed through an overflow outlet and discharge to the exiting wooded wetland areas. Treatment of runoff will be provided via deep sump hooded catch basins, Stormtech isolator rows, and the infiltration/detention systems.

COMPLIANCE DOCUMENTATION:

STANDARD 1:

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

Treatment: All runoff is treated.

Stormwater Discharge Velocity: The maximum velocity of proposed outlet pipes is 4.9 fps.

Ability of Ground Surface to Resist Erosion: A riprap apron is proposed to mitigate any potential erosion caused by new outfall.

Standard 1 is met.

STANDARD 2:

An evaluation of post-development runoff rates demonstrating there will not be an increase from the pre-development runoff rate at project extents is presented herein. To prevent storm damage and downstream and off-site flooding, Standard 2 requires that the post-development peak discharge rate is equal to or less than the pre-development rate from the 2-year and the 10-year 24-hour storms. The impact of peak discharges from the 100-year 24-hour storm has been mitigated by also limiting the rates to pre-development rates. Precipitation information has been taken from the latest National Oceanic and Atmospheric administration (NOAA) Atlas 14, point precipitation frequency estimates.

In the pre- vs post-development drainage analysis, one (1) design point was considered, the existing stream located along the eastern side of the site. The stream is identified as Node 1R – Stream-Pre and Node 2R – Stream Post.

Analysis Point – Stream at east side of site (see table 1)
The entirety of the site currently flows easterly to the existing stream. In the post-development condition, runoff from the entirety of the contributing area will be collected, treated, and controlled via stormwater management systems, a Subsurface Infiltration chamber system and an extended dry detention basin. Post-development rates for all rainfall events are less than or equal to those under pre-development conditions.

Table 1:

	2-year 24-hour Storm (3.31 inches) cubic feet per second	10-year 24-hour Storm (5.21 inches) cubic feet per second	25-year 24-hour Storm (6.40 inches) cubic feet per second	100-year 24-hour Storm (8.23 inches) cubic feet per second
Pre-development to Stream (Node 1R)	0.06	1.31	2.92	6.15
Post-development to Stream (Node 2R)	0.04	0.99	2.90	6.12

Standard 2 is met.

STANDARD 3:

Loss of annual recharge to groundwater shall be eliminated or minimized through the use of environmentally sensitive site design, low impact development techniques, stormwater 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 pre-development conditions based on soil type**.**

The Hydrologic Soil Group (HSG) rating is undefined for Urban type soils, and the nearby soil types are classified as HSG A (for drained areas). Also, the Geotechnical report by KMM indicates sandy soils in the area of the proposed building. Therefore, an infiltration rate of 2.41 in/hr has been assumed for the infiltration BMPs per *Table 2.3.3. 1982 Rawls Rates* from *Volume 3* of the Massachusetts Stormwater Management Standards.

Total increase in impervious area = 24,802 sq. ft.

Total new impervious area to recharge facilities = 20,775 sq. ft.

A Soils new Impervious Area = 24,802 sq. ft. x 0.60 inches x 1/12 = 1,240 cubic feet

Capture Area Adjustment:
24,802 sq. ft. / 20,775 sq. ft. = 1.19. (84% of total impervious directed to recharge facilities)

Total Recharge Volume Required= 1,240 cubic feet x 1.19 = 1,476 cubic feet

Total volume provided below the outlets = 2,090± cubic feet (see Table 2)

Table 2:

Pond 2P: Subsurface Infiltration System - 21839 Hydr

Summary | Wizards | Hydrograph | Discharge | Storage

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
93.00	**1,364**	0
93.10	1,364	55
93.20	1,364	109
93.30	1,364	164
93.40	1,364	218
93.50	1,364	273
93.60	1,364	385
93.70	1,364	497
93.80	1,364	608
93.90	1,364	718
94.00	1,364	828
94.10	1,364	936
94.20	1,364	1,044
94.30	1,364	1,150
94.40	1,364	1,256
94.50	1,364	1,360
94.60	1,364	1,462
94.70	1,364	1,564
94.80	1,364	1,663
94.90	1,364	1,761
95.00	1,364	1,857
95.10	1,364	1,951
95.20	1,364	2,043
95.30	1,364	2,132
95.40	1,364	2,217
95.50	1,364	2,300
95.60	1,364	2,379
95.70	1,364	2,453
95.80	1,364	2,519
95.90	1,364	2,579
96.00	1,364	2,636
96.10	1,364	2,690
96.20	1,364	2,745
96.30	1,364	2,799
96.40	1,364	2,854
96.50	1,364	**2,908**
96.60	1,364	2,908
96.70	1,364	2,908

System Volume Below Outlet at Elevation 95.25 = ***2,090± cubic feet***

Drawdown Analysis

Drawdown time must be less than 72 hours, using the storage volume below the lowest outlet invert. Drawdown time will be calculated for HSG type “A” soil as a factor of safety even though the geotechnical observations indicate “A” type soils. The Rawl's Rate for saturated hydraulic conductivity (2.41 in/hour for HSG "A"-type soil).

Stormtech System = 2,090±ft^3 / ((2.41 in/hour / 12 in/ft) * 546±ft^2) =* ***19± hours***

Standard 3 is met.

STANDARD 4:

Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS).

Table 3: Treatment Chain – Subsurface Infiltration System

1, 2, & 3		Removal Rate	Remains	
1st Link	Deep Sump Hooded Catch Basin	25%	75.00%	
2nd Link	Isolator Row	84%	12.00%	
3rd Link	Infiltration	80%	2.40%	
Final Rate		97.60%		removal

Table 4: Treatment Chain – Extended Dry Detention Basin

1, 2, & 3		Removal Rate	Remains	
1nd Link	Isolator Row	84%	16.00%	
2nd Link	Extended Dry Detention	50%	8.00%	
Final Rate		92.00%		removal

The site is located within the Zone A of a surface water supply. Thus, a water quality depth of 1.0 inch of Water Quality Volume infiltration has been used for all new-development impervious areas. Additional soil observations shall be performed prior to construction to confirm the soil conditions in the areas of Infiltration BMPs for infiltration rate and depth to estimated seasonal high groundwater table.

Catchbasin Verification.

	tributary impervious area should be less than 1/4 acre	*10-yr storm inflow thru grate must not exceed 3 cfs*
CB-1	*0.10 acres*	*0.45 cfs*
CB-2	*0.10 acres*	*0.5 cfs*

Isolator Row Verification
The isolator rows, consisting of Stormtech chambers wrapped in filter fabric have been sized to provide 84% TSS removal per the Stormtech Isolator Row Sizing Chart (Attached) and the DEP's Equivalent Water Quality Peak Flow Rate guidelines:

System 1 (Pretreatment for Subsurface Infiltration)
Time of Concentration, Tc = 0.083 Hours
Unit Peak Discharge, qu = 795 csm/in
Impervious Surface Area, A = 0.00067 mi^2
Water Quality Volume, WQV = 1.0 Inches
Water Quality Flow, WQF = 0.533 cfs
SC-740 Isolator Row Chambers Required = 0.533 cfs / 0.15 cfs = ***4 Chambers***
Isolator Row Chambers Provided = ***9 Chambers***

System 2 (Pretreatment for Extended Dry Detention Basin)
Time of Concentration, Tc = 0.083 Hours
Unit Peak Discharge, qu = 795 csm/in
Impervious Surface Area, A = 0.00031 mi^2
Water Quality Volume, WQV = 1.0 Inches
Water Quality Flow, WQF = 0.246 cfs
SC-310 Isolator Row Chambers Required = 0.246 cfs / 0.11 cfs = ***3 Chambers***
Isolator Row Chambers Provided = ***3 Chambers***

Table 5: Stormtech Isolator Row Sizing

StormTech®
Detention • Retention • Water Quality
Division of ADS

STORMTECH ISOLATOR ROW SIZING CHART					
	SC-310	SC-740	DC-780	MC-3500	MC-4500
Chamber Area (Sq.Ft.)	20	27.8	27.8	43.2	30.1
Treated Flow Rate per chamber (CFS)	0.11	0.15	0.15	0.24	0.17

NOTE: Testing of the Isolator Row completed by Tennesse Tech has been verified by NJCAT and it has shown to have a TSS removal efficiency of 84% for SIL-CO-SIL 250
NJCAT verified Treated Flow Rate (GPM / Sq.Ft.) 2.5

Standard 4 is met.

STANDARD 5:

Land uses with higher potential pollutant loads.
The site is not a Land Use with Higher Potential Pollutants loads.

Standard 5 is met.

STANDARD 6:

Critical Areas

"Standard 6 applies to discharges within a Zone II, Interim Wellhead Protection Areas or near or to other Critical Areas: Shellfish Growing Areas, Bathing Beaches, Outstanding Resource Waters Special Resource Waters, and Cold-Water Fisheries" per Volume 3: Documenting Compliance with the Massachusetts Stormwater Management Standards Chapter 1.

The site is within a Zone A to a public surface water supply which is classified as a critical area. The stormwater management systems have been designed to treat the 1.0 inch water quality depth.

Standard 6 is met.

STANDARD 7:

Redevelopment
This project is not being proposed as redevelopment.

Standard 7 is met.

STANDARD 8:

Construction Period Controls
See Wetland migtigation plan for construction period erosion & sedimentation controls. Site is over 1 acre, therefore a Construction General Permit (CGP) from the Environmental Protection Agency (EPA) will be required and a Stormwater Pollution Prevention Plan (SWPPP) will be developed and provided prior to construction.

Standard 8 is met.

STANDARD 9:

Operation and Maintenance plan
An Operation and Maintenance Plan has been developed and included at the end of this report.

Standard 9 is met.

STANDARD 10:

Illicit discharges to drainage system

> ***Illicit Discharge Compliance Statement***
> *To the best of my knowledge no illicit discharges currently exist on the site and no future illicit discharge will be allowed, including wastewater discharges and discharges of stormwater contaminated by contact with process wastes, raw materials, toxic pollutants, hazardous substances, oil, or grease.*
>
> _____
> *Signed by Owner* *Date*

Measures to prevent illicit discharges have been included in this report.

Stonegate Construction Corp. will provide an Illicit Discharge Compliance Statement before stormwater is discharged to the post-construction stormwater BMPs.

EROSION AND SEDIMENTATION PLAN:

Best management practices (BMP) for erosion and sedimentation control are staked wattles, filter fences, hydro seeding, and phased development. Many stormwater BMP technologies (e.g., infiltration technologies) are not designed to handle the high concentrations of sediments typically found in construction runoff and must be protected from construction-related sediment loadings. Construction BMP's **must** be maintained.

In developing the proposed project certain measures will be implemented to minimize impacts erosion and sedimentation could have on surrounding areas. This section addresses items that involve proper construction techniques, close surveillance of workmanship, and immediate response to emergency situations. The developer must be prepared to provide whatever reasonable measures are necessary to protect the environment during construction and to stabilize all disturbed areas as soon as construction ends.

Pre-Construction

1. The contractor shall have a stockpile of materials required to control erosion on-site to be used to supplement or repair erosion control devices. These materials shall include, but are not limited to wattles, silt fence and crushed stone.
2. The contractor is responsible for erosion control on site and shall utilize erosion control measures where needed, regardless of whether the measures are specified on the plan or in the order of conditions.

Preliminary Site Work

1. Excavated materials should be stockpiled, separating the topsoil for future use on the site. Erosion control shall be utilized along the down slope side of the piles and side slopes shall not exceed 2:1.
2. If intense rainfall is anticipated, the installation of supplemental wattles, silt fences, or armored dikes shall be considered.

Landscaping

1. Landscaping shall occur as soon as possible to provide permanent stabilization of disturbed surfaces.
2. If the season or adverse weather conditions do not allow the establishment of vegetation, temporary mulching with straw, wood chips weighted with snow fence or branches, or other methods shall be provided.
3. A minimum of 4 inches of topsoil shall be placed and its surface smoothed to the specified grades.
4. The use of herbicides is strongly discouraged.
5. Hydro seeding is encouraged for steep slopes. Application rates on slopes greater than 3:1 shall have a minimum seeding rate of 5-lbs/1000 SF. A latex or fiber tackifier shall be used on these slopes at a minimum rate of 50 lbs. of tackifier per 500 gallons of water used.

STORMWATER OPERATION AND MAINTENANCE PLAN (POLLUTION PREVENTION)

Stormwater management system owner: Stonegate Construction Corp.
The party or parties responsible for operation and maintenance: Stonegate Construction Corp.

- **The town of Reading shall be allowed to enter the property at reasonable times and in a reasonable manner for the purpose of inspecting the stormwater system.**
- **The responsible parties shall maintain a log of all operation and maintenance activities, including without limitation, inspections, repairs, replacement and disposal.**
- **All drainage components shall be maintained to function as designed.**

Deep Sump Catch Basins / Trench Drains

Inspect or clean deep sump catch basins four times per year including at the end of the foliage and snow removal seasons. Sediments must also be removed four times per year or when the depth of deposits is greater than or equal to one half the depth from the bottom of the lowest pipe in the basin. Vacuum trucks are to be used to remove trapped sediment and supernatant.
Although catch basin debris often contains concentrations of oil and hazardous materials such as petroleum hydrocarbons and metals, MassDEP classifies them as solid waste. Any contaminated materials must be evaluated in accordance with the Hazardous Waste Regulations, 310 CMR 30.00, and handled as hazardous waste. MassDEP regulations prohibit landfills from accepting materials that contain free draining liquids.

Infiltration Structures

Inspect inlets at least twice a year. Remove any debris that might clog the system. Open inspection port and inspect for standing water.

Roof Drain Leaders

Routine roof inspections shall be performed two times per year. The roof shall be kept clean and free of debris, and the roof drainage systems shall be kept clear. Gutters and downspouts shall be cleaned at least twice per year, or more frequently as necessary.

Infiltration BMP

The infiltration BMP (subsurface chamber system) shall be inspected after every major storm for the first few months to ensure it is stabilized and functioning properly. If necessary, corrective action shall be taken until the system functions properly. Inspectors should note how long water remains standing in the inspection port after a storm; standing water within the basin 48 to 72 hours after a storm indicates that the infiltration capacity may have been overestimated. If the ponding is due to clogging, immediately address the reasons for the clogging. Thereafter, inspect the infiltration BMP at least twice per year.

Extended Dry Detention Basin

The extended dry detention basin shall be inspected at least twice per year and during and after every major storm to ensure it is stabilized and functioning properly. If necessary, corrective action shall be taken until the system functions properly. Inspection of the outlet structure, mowing, and removal of trash and debris shall occur twice per year. Sediment shall be removed from the basin at least once every 5 years.

Isolator Row

*See next page for Isolator Row O&M Manual from Stormtech.

STORMWATER BEST MANAGEMENT PRACTICES (BMP) YEARLY MAINTENANCE LOG

See Operation and Maintenance Plan for required frequency.
Site Owner: Stonegate Construction Corp.
Site Address: 259-267 Main Street
Stormwater BMP's On-site: See Below

Deep Sump Catch Basins
Maintenance Schedule: 4 times per year

Date	Inspector	Depth of Sediment	Sediment Disposal Site	Notes

Roof Drain leaders
Maintenance Schedule: 2 times per year

Date	Inspector	Problem Observed	Action taken	Notes

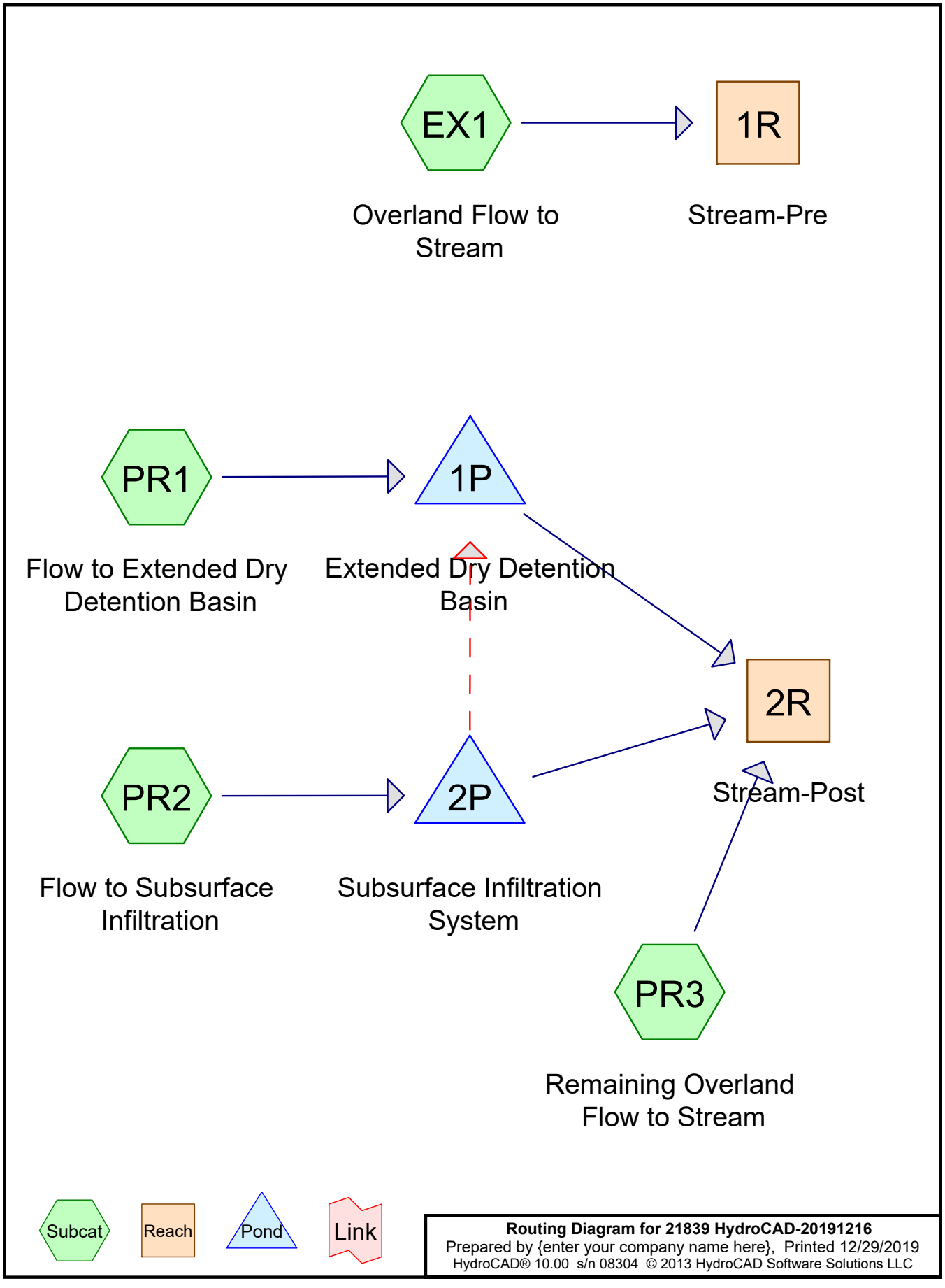
Stormtech Isolator Row / Infiltration Chambers
Maintenance Schedule: 2 times per year

Date	Inspector	Problem Observed	Action taken	Notes

Stormtech Isolator Row / Extended Dry Detention Basin
Maintenance Schedule: 2 times per year

Date	Inspector	Problem Observed	Action taken	Notes

APPENDIX A
HYDROCAD STORMWATER MANAGEMENT CALCULATIONS



Routing Diagram for 21839 HydroCAD-20191216
Prepared by {enter your company name here}, Printed 12/29/2019

Summary for Subcatchment EX1: Overland Flow to Stream

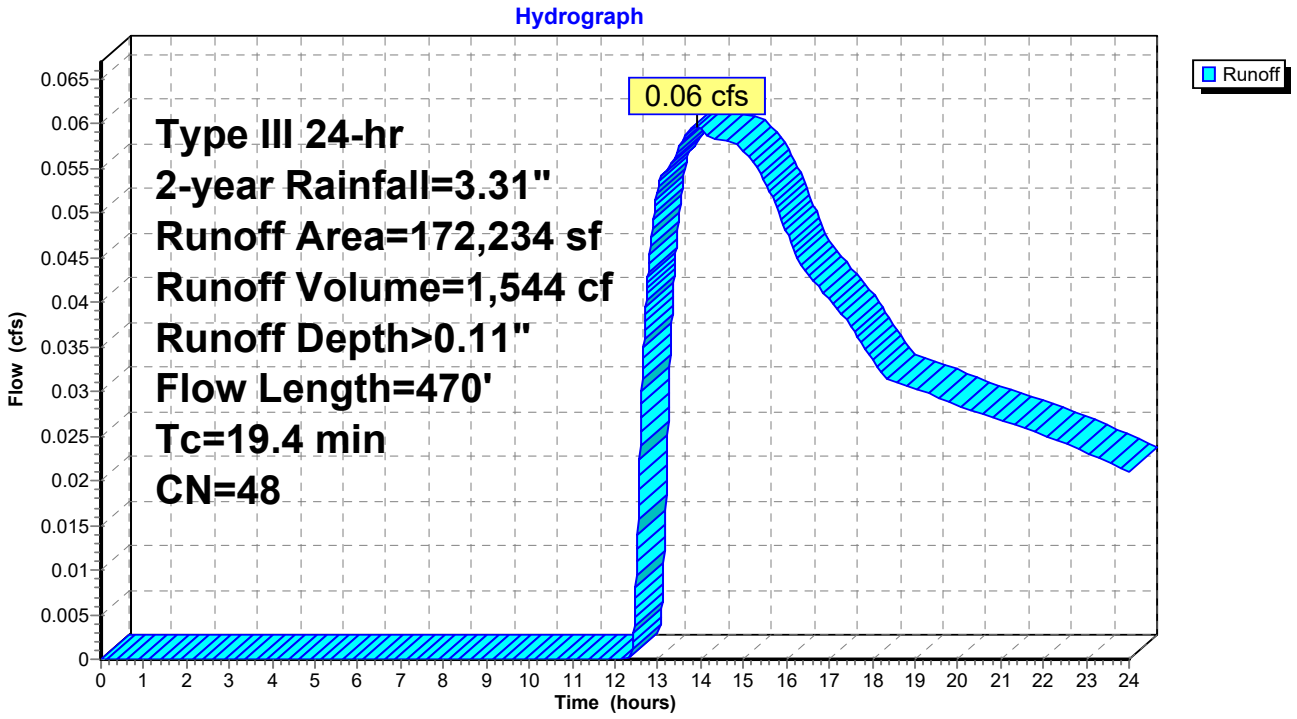
Runoff = 0.06 cfs @ 13.90 hrs, Volume= 1,544 cf, Depth> 0.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.31"

	Area (sf)	CN	Description
	154,934	43	Woods/grass comb., Fair, HSG A
	10,790	96	Gravel surface, HSG A
*	4,423	98	Impervious
*	2,087	98	Roof
	172,234	48	Weighted Average
	165,724		96.22% Pervious Area
	6,510		3.78% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.9	150	0.0330	2.92		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
14.2	270	0.0040	0.32		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
19.4	470	Total			

Subcatchment EX1: Overland Flow to Stream



Summary for Subcatchment PR1: Flow to Extended Dry Detention Basin

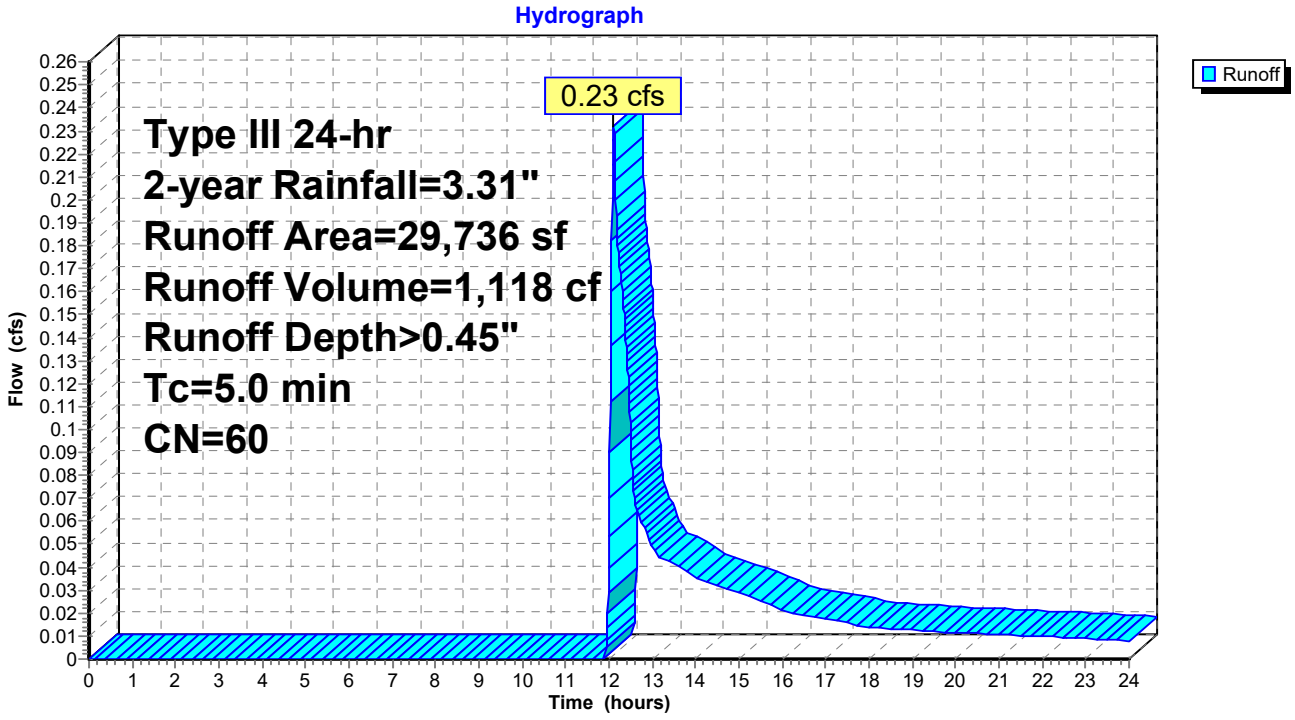
Runoff = 0.23 cfs @ 12.11 hrs, Volume= 1,118 cf, Depth> 0.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.31"

	Area (sf)	CN	Description
	19,196	39	>75% Grass cover, Good, HSG A
*	10,540	98	Impervious
	29,736	60	Weighted Average
	19,196		64.55% Pervious Area
	10,540		35.45% Impervious Area

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

Subcatchment PR1: Flow to Extended Dry Detention Basin



Summary for Subcatchment PR2: Flow to Subsurface Infiltration

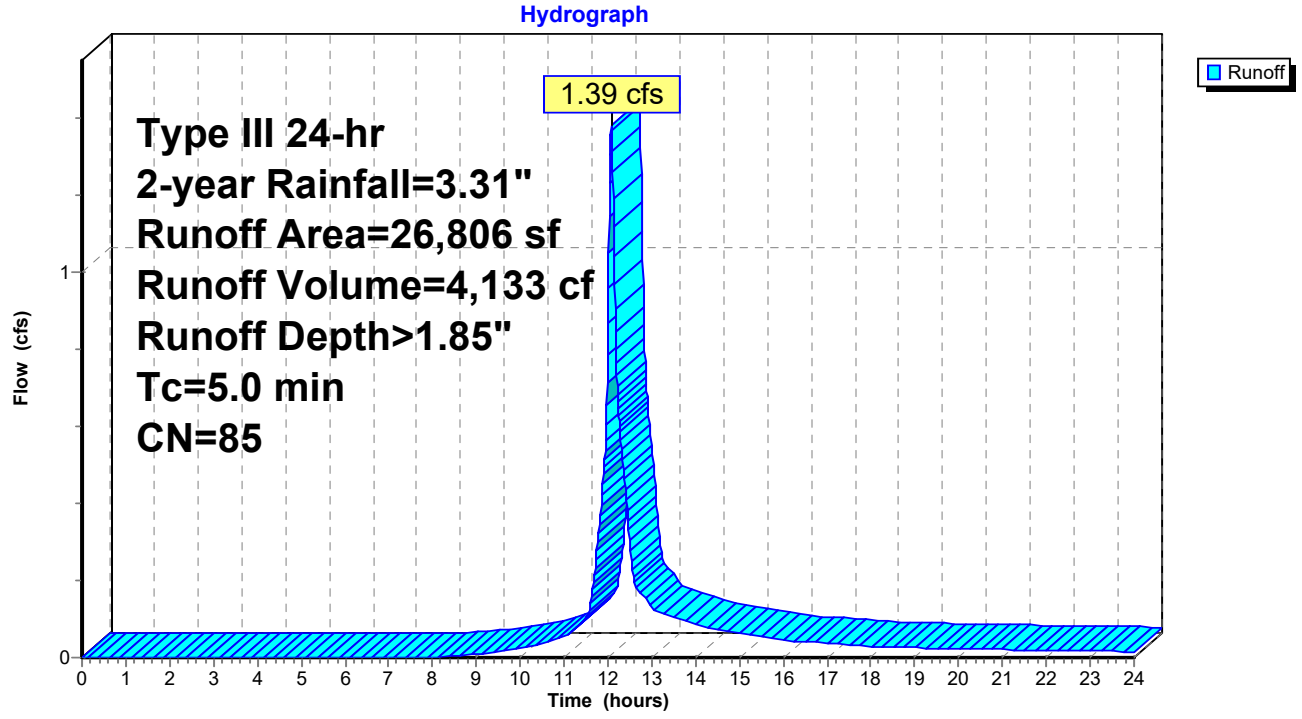
Runoff = 1.39 cfs @ 12.07 hrs, Volume= 4,133 cf, Depth> 1.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.31"

	Area (sf)	CN	Description
	6,031	39	>75% Grass cover, Good, HSG A
*	6,200	98	Impervious
*	14,575	98	Roof
	26,806	85	Weighted Average
	6,031		22.50% Pervious Area
	20,775		77.50% Impervious Area

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

Subcatchment PR2: Flow to Subsurface Infiltration



Summary for Subcatchment PR3: Remaining Overland Flow to Stream

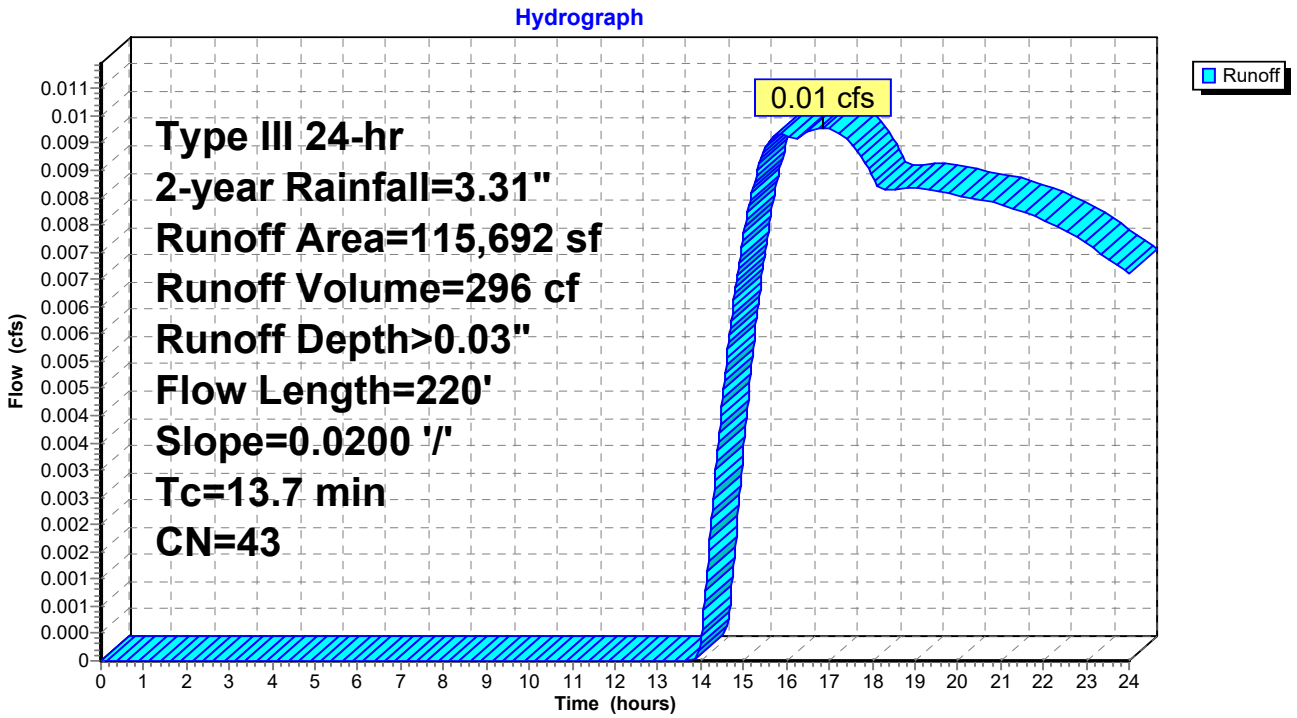
Runoff = 0.01 cfs @ 16.85 hrs, Volume= 296 cf, Depth> 0.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.31"

Area (sf)	CN	Description
115,692	43	Woods/grass comb., Fair, HSG A
115,692		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.2	170	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.7	220	Total			

Subcatchment PR3: Remaining Overland Flow to Stream

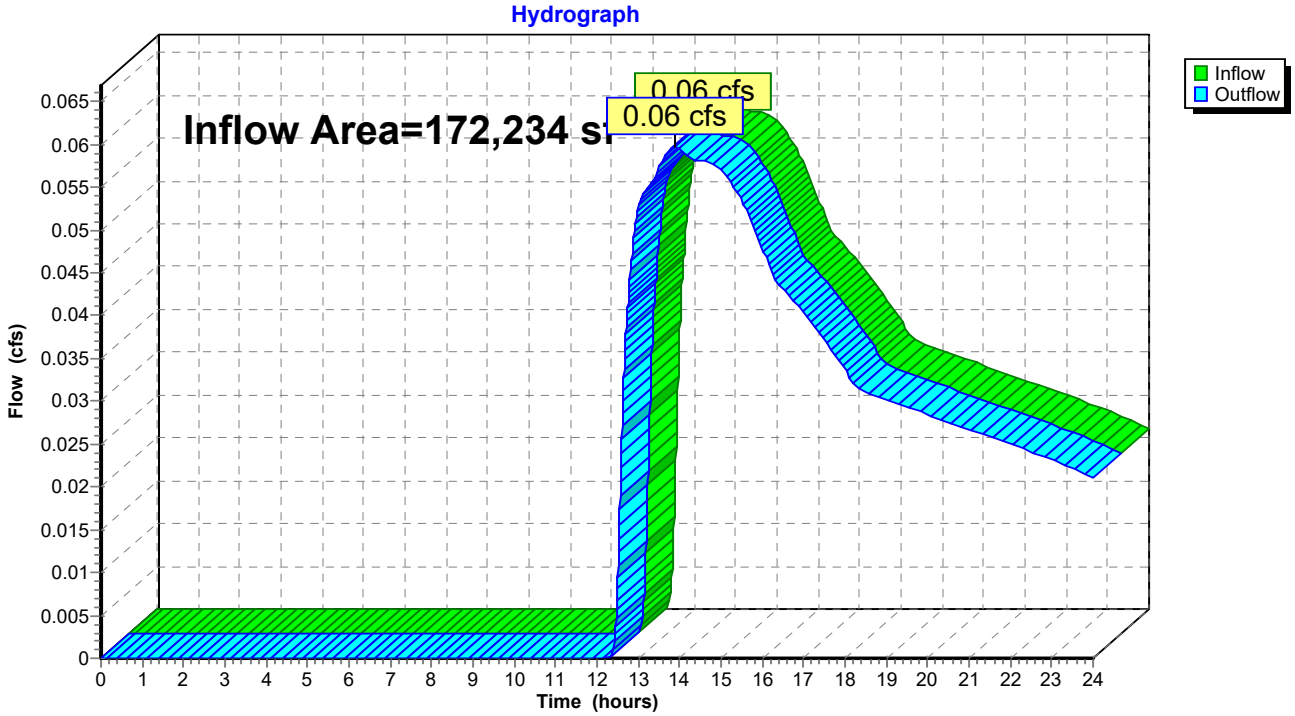


Summary for Reach 1R: Stream-Pre

Inflow Area = 172,234 sf, 3.78% Impervious, Inflow Depth > 0.11" for 2-year event
Inflow = 0.06 cfs @ 13.90 hrs, Volume= 1,544 cf
Outflow = 0.06 cfs @ 13.90 hrs, Volume= 1,544 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 1R: Stream-Pre

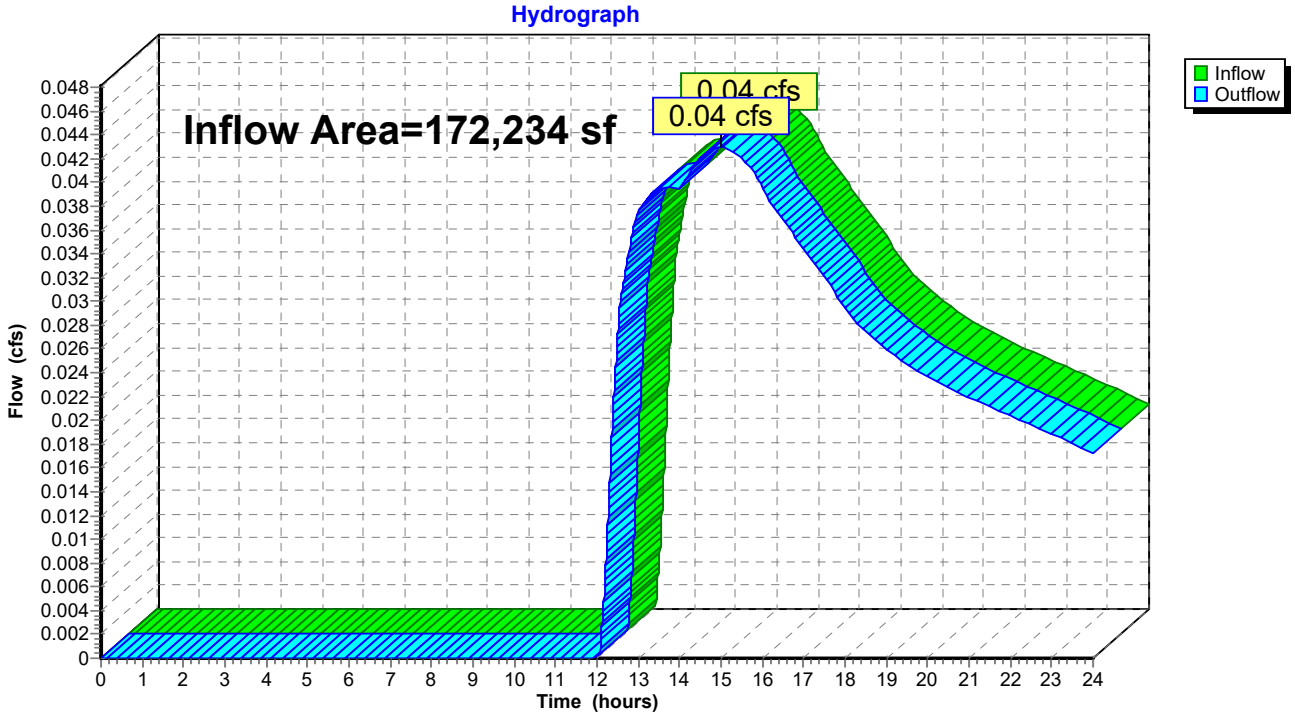


Summary for Reach 2R: Stream-Post

Inflow Area = 172,234 sf, 18.18% Impervious, Inflow Depth > 0.09" for 2-year event
Inflow = 0.04 cfs @ 14.99 hrs, Volume= 1,253 cf
Outflow = 0.04 cfs @ 14.99 hrs, Volume= 1,253 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 2R: Stream-Post



Summary for Pond 1P: Extended Dry Detention Basin

Inflow Area = 29,736 sf, 35.45% Impervious, Inflow Depth > 0.45" for 2-year event
Inflow = 0.23 cfs @ 12.11 hrs, Volume= 1,118 cf
Outflow = 0.04 cfs @ 13.67 hrs, Volume= 957 cf, Atten= 83%, Lag= 93.8 min
Primary = 0.04 cfs @ 13.67 hrs, Volume= 957 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 88.63' @ 13.67 hrs Surf.Area= 2,595 sf Storage= 335 cf

Plug-Flow detention time= 154.5 min calculated for 957 cf (86% of inflow)
Center-of-Mass det. time= 90.2 min (1,004.1 - 913.9)

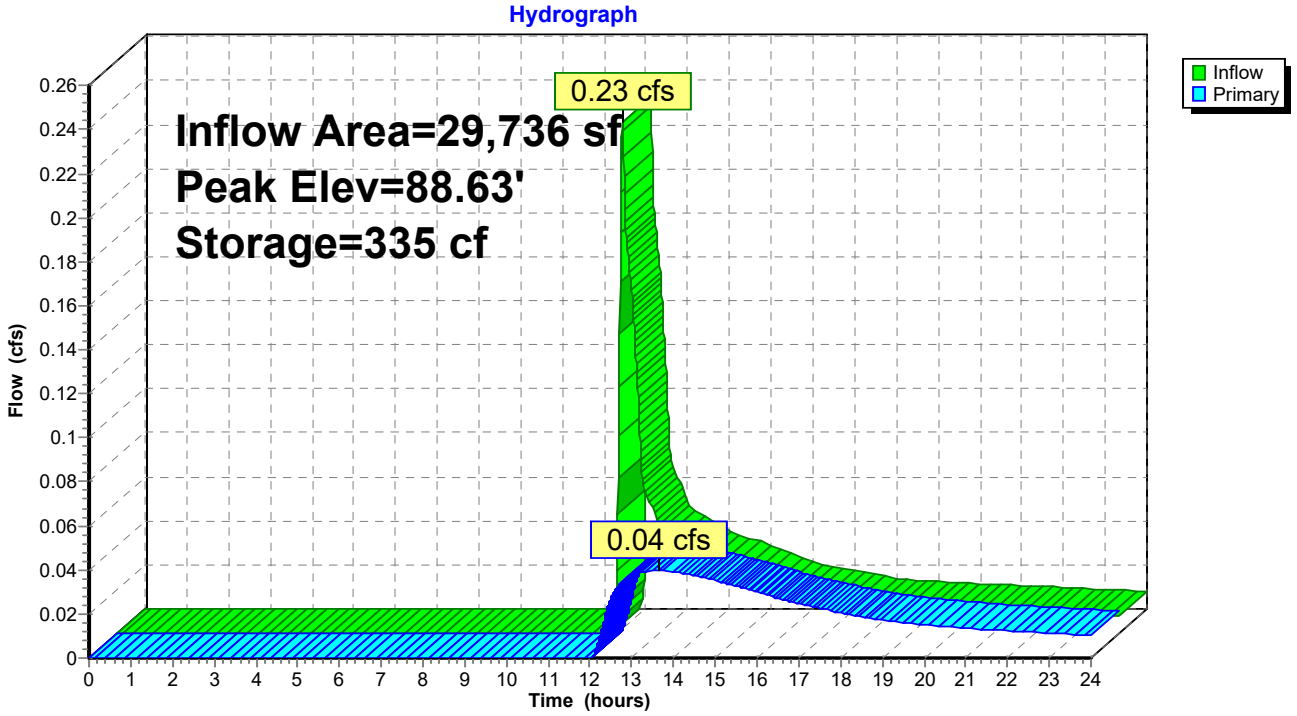
Volume	Invert	Avail.Storage	Storage Description
#1	88.50'	6,533 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
88.50	2,502	256.0	0	0	2,502
90.50	4,096	289.0	6,533	6,533	4,033

Device	Routing	Invert	Outlet Devices
#1	Primary	88.50'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	89.50'	**4.0' long x 1.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s) 1.0' Crest Height

Primary OutFlow Max=0.04 cfs @ 13.67 hrs HW=88.63' (Free Discharge)
1=Orifice/Grate (Orifice Controls 0.04 cfs @ 1.23 fps)
2=Sharp-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 1P: Extended Dry Detention Basin



Summary for Pond 2P: Subsurface Infiltration System

Inflow Area = 26,806 sf, 77.50% Impervious, Inflow Depth > 1.85" for 2-year event
Inflow = 1.39 cfs @ 12.07 hrs, Volume= 4,133 cf
Outflow = 0.08 cfs @ 11.35 hrs, Volume= 3,739 cf, Atten= 95%, Lag= 0.0 min
Discarded = 0.08 cfs @ 11.35 hrs, Volume= 3,739 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 95.10' @ 14.40 hrs Surf.Area= 1,364 sf Storage= 1,948 cf

Plug-Flow detention time= 252.5 min calculated for 3,739 cf (90% of inflow)
Center-of-Mass det. time= 205.9 min (1,028.9 - 823.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	93.00'	1,243 cf	**20.50'W x 66.52'L x 3.50'H Field A** 4,773 cf Overall - 1,665 cf Embedded = 3,108 cf x 40.0% Voids
#2A	93.50'	1,665 cf	**ADS_StormTech SC-740** x 36 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 Row Length Adjustment= +0.44' x 6.45 sf x 4 rows
		2,908 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	93.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	90.50'	**12.0" Round Culvert** L= 30.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 90.50' / 89.50' S= 0.0333 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Device 2	95.75'	**24.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600
#4	Secondary	95.25'	**6.0" Round Culvert** L= 175.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 95.25' / 89.50' S= 0.0329 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf

Discarded OutFlow Max=0.08 cfs @ 11.35 hrs HW=93.04' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=93.00' (Free Discharge)
└**2=Culvert** (Passes 0.00 cfs of 5.35 cfs potential flow)
└**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=93.00' (Free Discharge)
└**4=Culvert** (Controls 0.00 cfs)

Pond 2P: Subsurface Infiltration System - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 (ADS StormTech® SC-740)
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
Row Length Adjustment= +0.44' x 6.45 sf x 4 rows

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

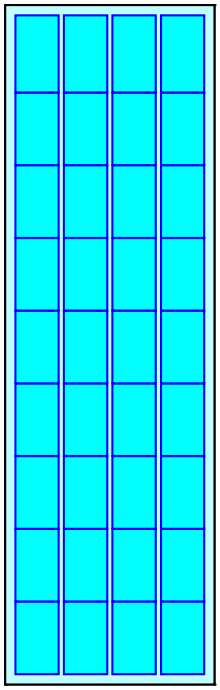
9 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 64.52' Row Length +12.0" End Stone x 2 = 66.52' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 12.0" Side Stone x 2 = 20.50' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

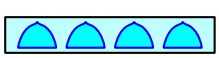
36 Chambers x 45.9 cf +0.44' Row Adjustment x 6.45 sf x 4 Rows = 1,665.2 cf Chamber Storage

4,772.8 cf Field - 1,665.2 cf Chambers = 3,107.6 cf Stone x 40.0% Voids = 1,243.0 cf Stone Storage

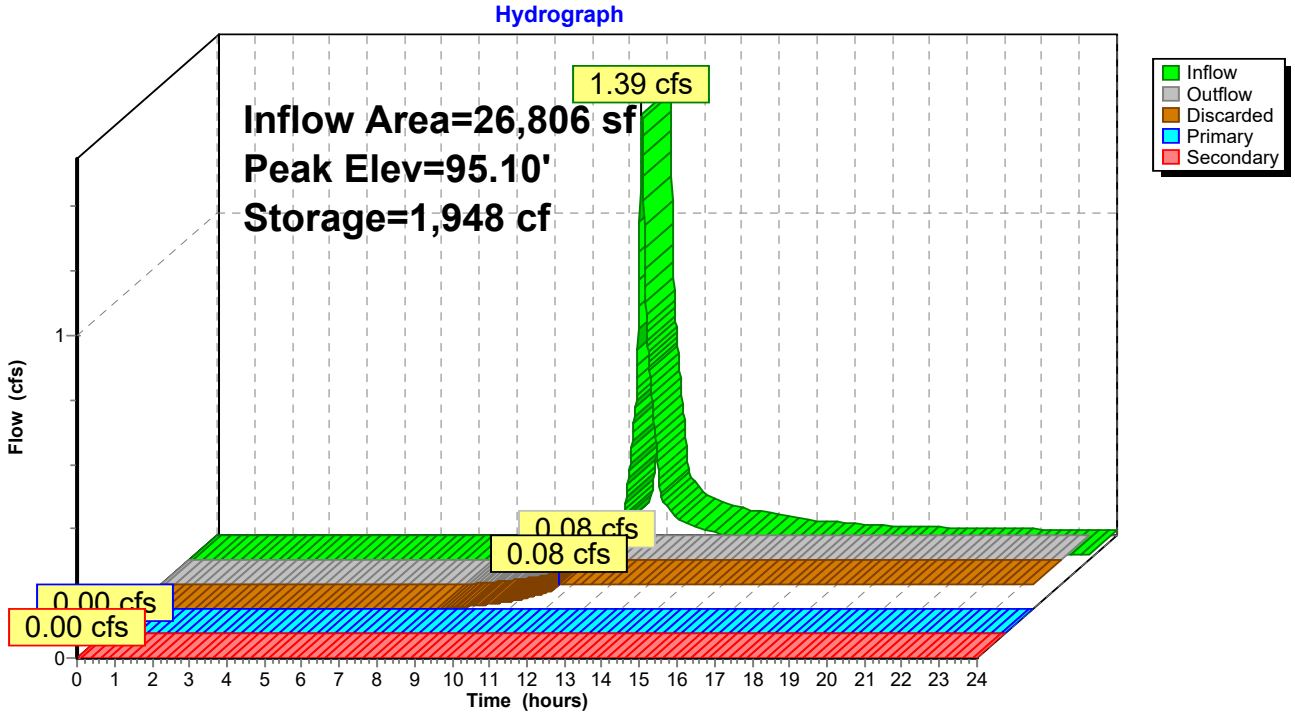
Chamber Storage + Stone Storage = 2,908.2 cf = 0.067 af
Overall Storage Efficiency = 60.9%

36 Chambers
176.8 cy Field
115.1 cy Stone





Pond 2P: Subsurface Infiltration System



Summary for Subcatchment EX1: Overland Flow to Stream

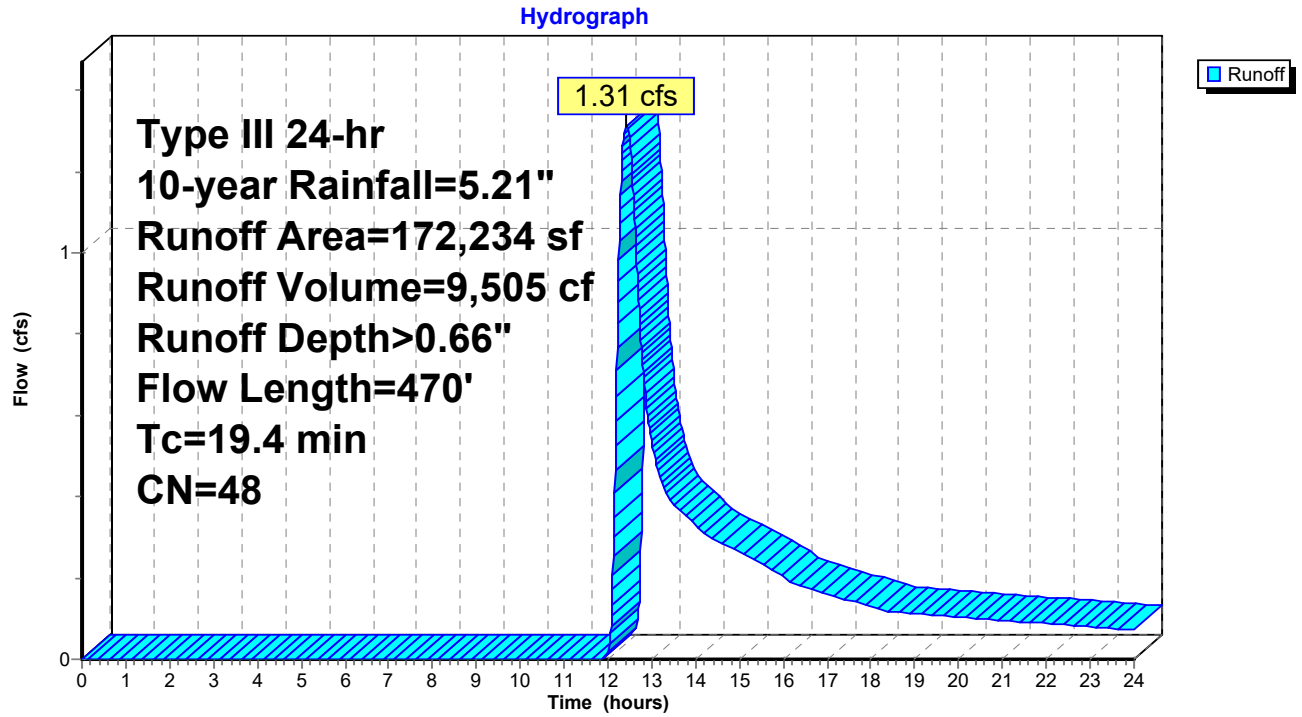
Runoff = 1.31 cfs @ 12.40 hrs, Volume= 9,505 cf, Depth> 0.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.21"

	Area (sf)	CN	Description
	154,934	43	Woods/grass comb., Fair, HSG A
	10,790	96	Gravel surface, HSG A
*	4,423	98	Impervious
*	2,087	98	Roof
	172,234	48	Weighted Average
	165,724		96.22% Pervious Area
	6,510		3.78% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.9	150	0.0330	2.92		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
14.2	270	0.0040	0.32		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
19.4	470	Total			

Subcatchment EX1: Overland Flow to Stream



Summary for Subcatchment PR1: Flow to Extended Dry Detention Basin

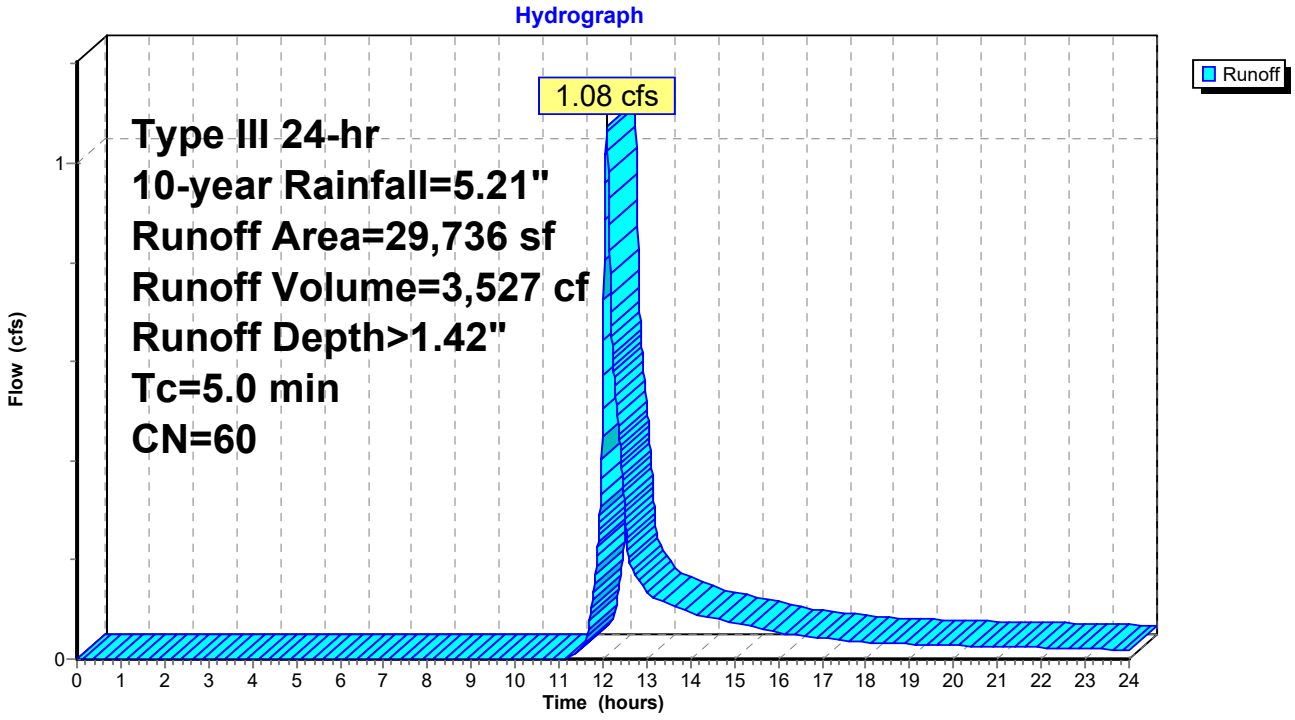
Runoff = 1.08 cfs @ 12.08 hrs, Volume= 3,527 cf, Depth> 1.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.21"

	Area (sf)	CN	Description
	19,196	39	>75% Grass cover, Good, HSG A
*	10,540	98	Impervious
	29,736	60	Weighted Average
	19,196		64.55% Pervious Area
	10,540		35.45% Impervious Area

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

Subcatchment PR1: Flow to Extended Dry Detention Basin



Summary for Subcatchment PR2: Flow to Subsurface Infiltration

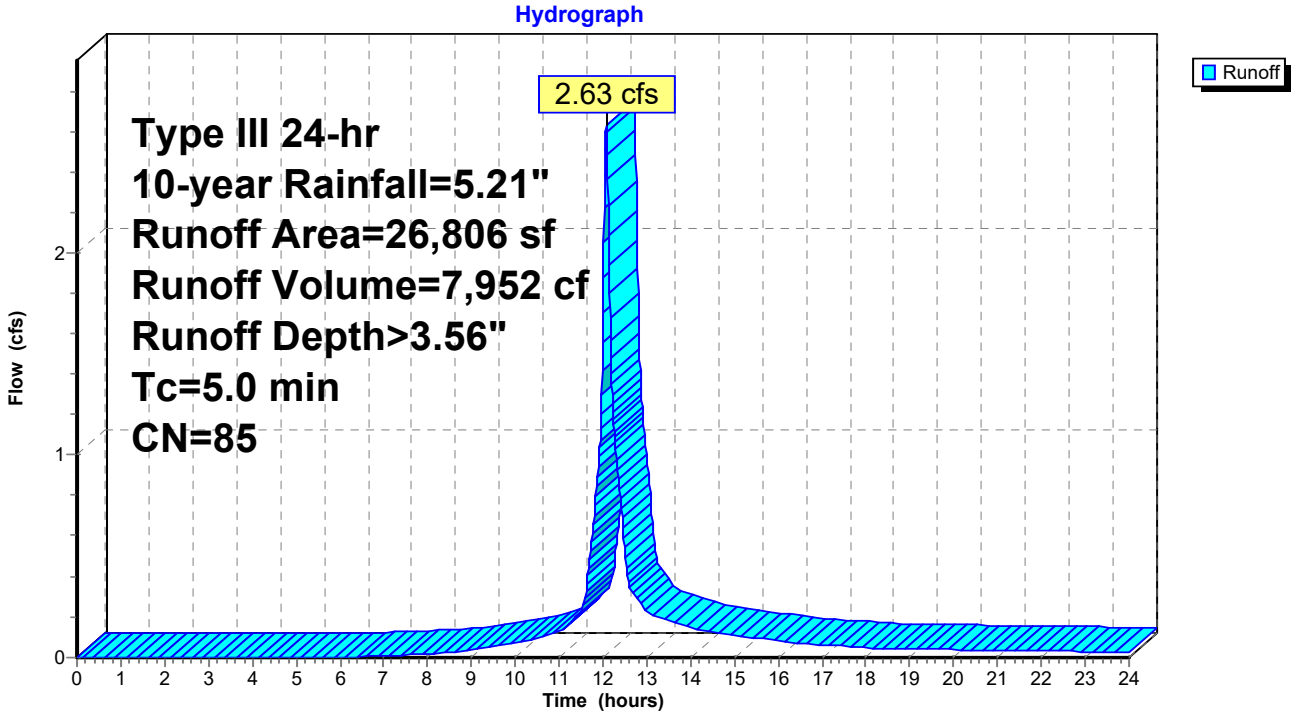
Runoff = 2.63 cfs @ 12.07 hrs, Volume= 7,952 cf, Depth> 3.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.21"

	Area (sf)	CN	Description
	6,031	39	>75% Grass cover, Good, HSG A
*	6,200	98	Impervious
*	14,575	98	Roof
	26,806	85	Weighted Average
	6,031		22.50% Pervious Area
	20,775		77.50% Impervious Area

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

Subcatchment PR2: Flow to Subsurface Infiltration



Summary for Subcatchment PR3: Remaining Overland Flow to Stream

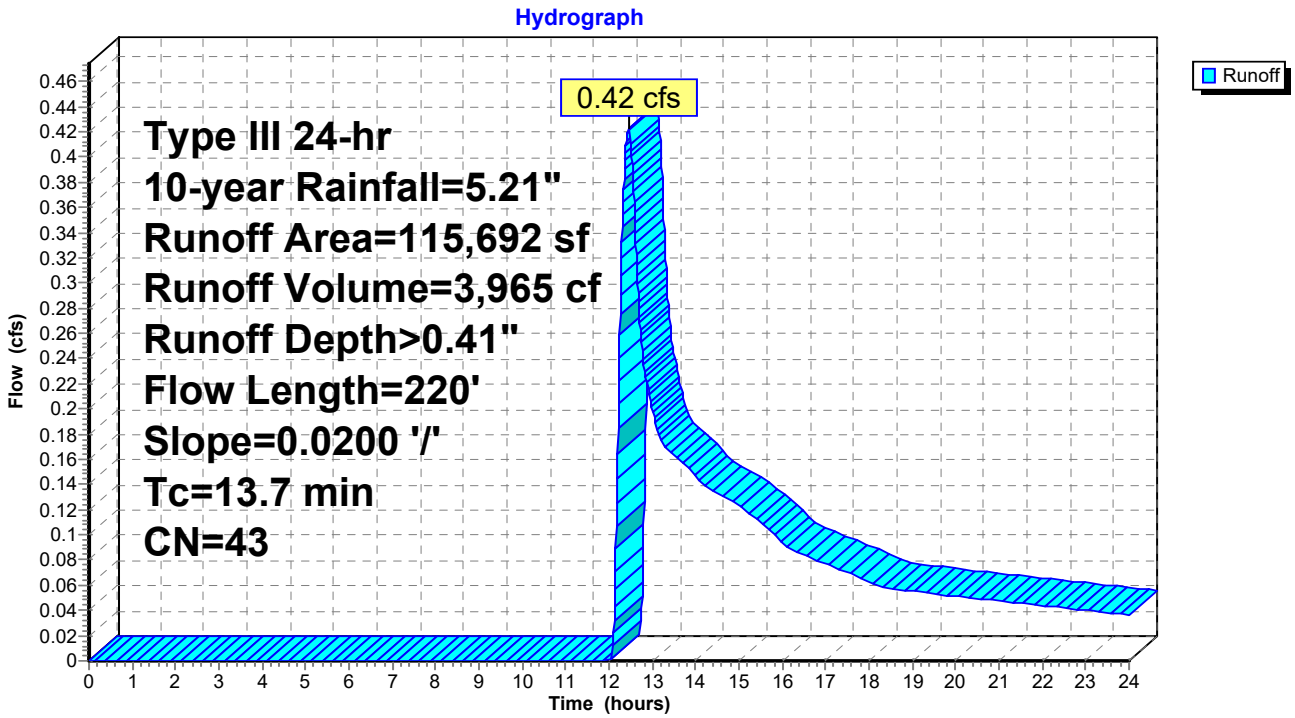
Runoff = 0.42 cfs @ 12.45 hrs, Volume= 3,965 cf, Depth> 0.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=5.21"

Area (sf)	CN	Description
115,692	43	Woods/grass comb., Fair, HSG A
115,692		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.2	170	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.7	220	Total			

Subcatchment PR3: Remaining Overland Flow to Stream

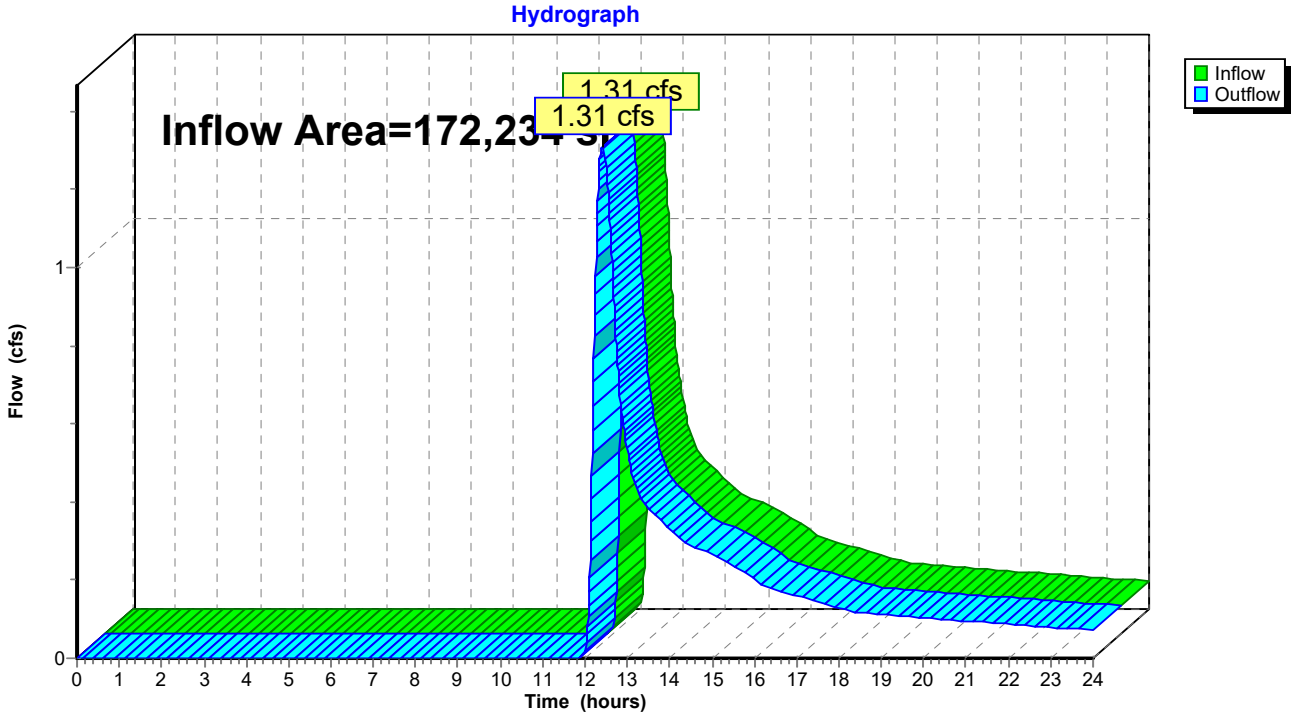


Summary for Reach 1R: Stream-Pre

Inflow Area = 172,234 sf, 3.78% Impervious, Inflow Depth > 0.66" for 10-year event
Inflow = 1.31 cfs @ 12.40 hrs, Volume= 9,505 cf
Outflow = 1.31 cfs @ 12.40 hrs, Volume= 9,505 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 1R: Stream-Pre

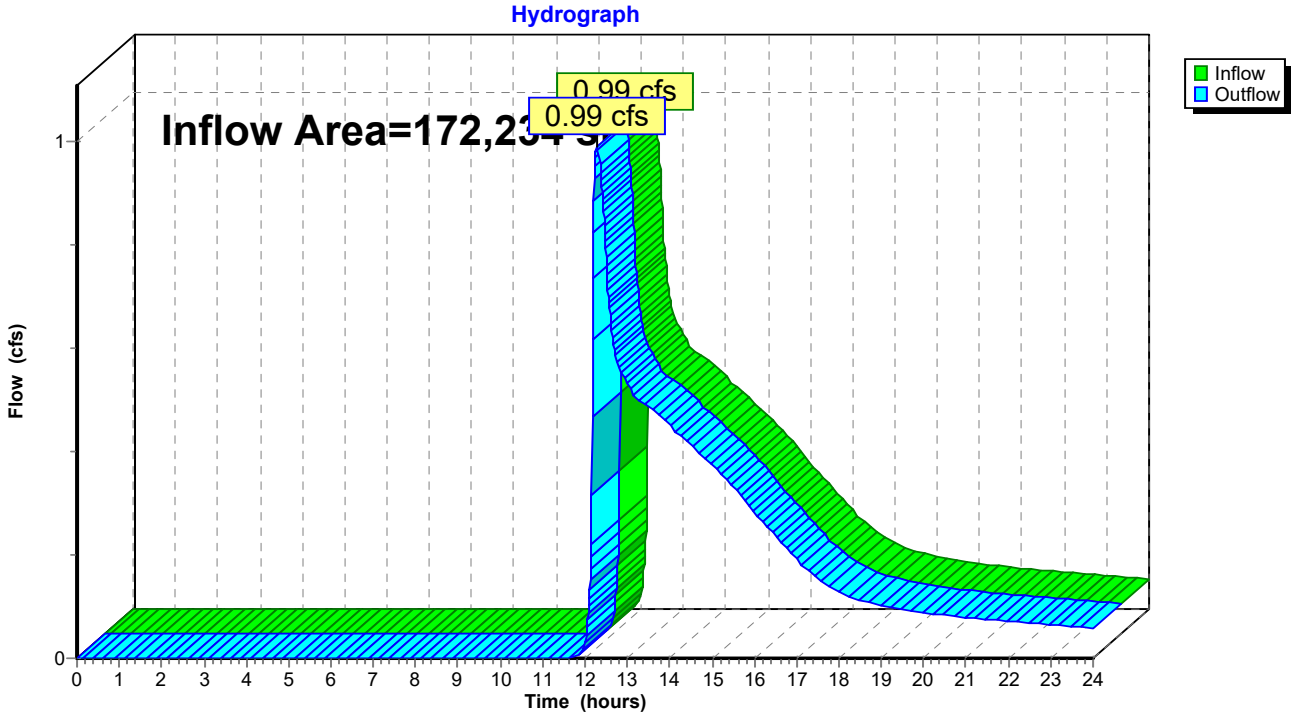


Summary for Reach 2R: Stream-Post

Inflow Area = 172,234 sf, 18.18% Impervious, Inflow Depth > 0.69" for 10-year event
Inflow = 0.99 cfs @ 12.28 hrs, Volume= 9,864 cf
Outflow = 0.99 cfs @ 12.28 hrs, Volume= 9,864 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 2R: Stream-Post



Summary for Pond 1P: Extended Dry Detention Basin

Inflow Area = 29,736 sf, 35.45% Impervious, Inflow Depth > 2.32" for 10-year event
Inflow = 1.29 cfs @ 12.17 hrs, Volume= 5,754 cf
Outflow = 0.33 cfs @ 13.04 hrs, Volume= 5,509 cf, Atten= 74%, Lag= 52.1 min
Primary = 0.33 cfs @ 13.04 hrs, Volume= 5,509 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 89.28' @ 13.04 hrs Surf.Area= 3,080 sf Storage= 2,182 cf

Plug-Flow detention time= 101.7 min calculated for 5,507 cf (96% of inflow)
Center-of-Mass det. time= 79.2 min (917.2 - 837.9)

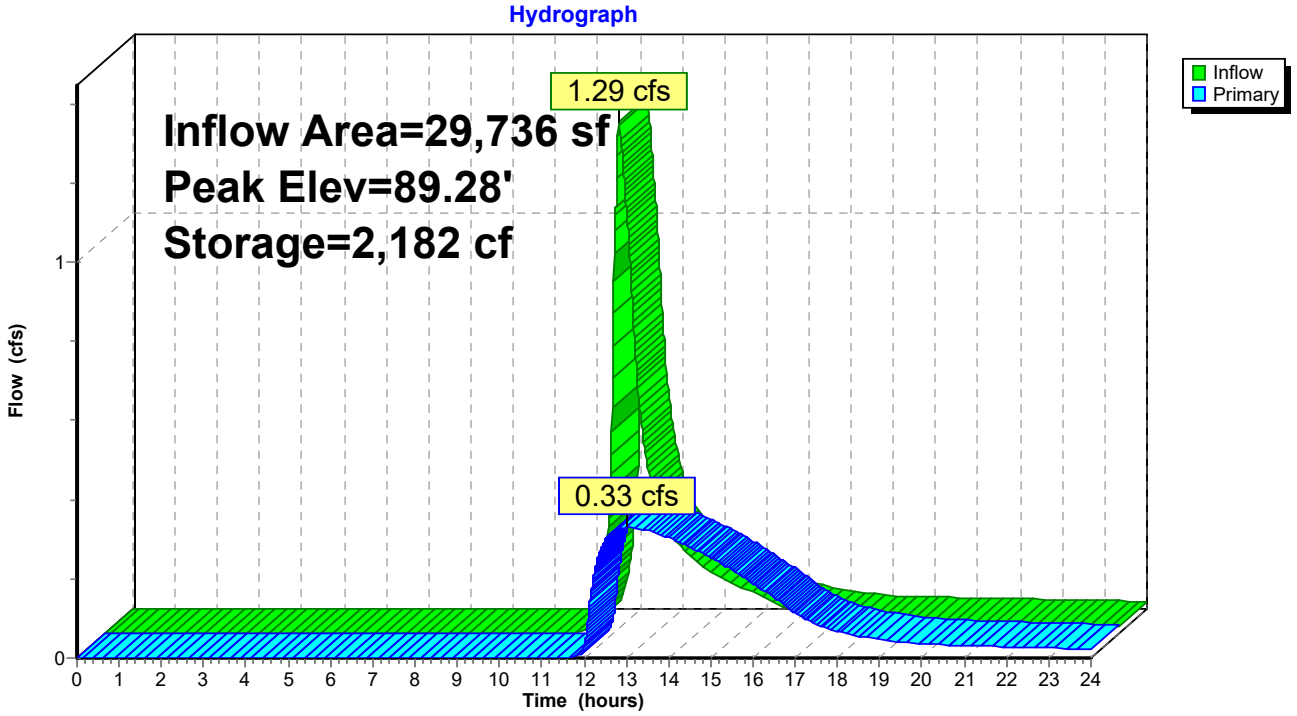
Volume	Invert	Avail.Storage	Storage Description
#1	88.50'	6,533 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
88.50	2,502	256.0	0	0	2,502
90.50	4,096	289.0	6,533	6,533	4,033

Device	Routing	Invert	Outlet Devices
#1	Primary	88.50'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	89.50'	**4.0' long x 1.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s) 1.0' Crest Height

Primary OutFlow Max=0.33 cfs @ 13.04 hrs HW=89.28' (Free Discharge)
1=Orifice/Grate (Orifice Controls 0.33 cfs @ 3.78 fps)
2=Sharp-Crested Rectangular Weir (Controls 0.00 cfs)

Pond 1P: Extended Dry Detention Basin



Summary for Pond 2P: Subsurface Infiltration System

Inflow Area = 26,806 sf, 77.50% Impervious, Inflow Depth > 3.56" for 10-year event
Inflow = 2.63 cfs @ 12.07 hrs, Volume= 7,952 cf
Outflow = 1.23 cfs @ 12.23 hrs, Volume= 6,783 cf, Atten= 53%, Lag= 9.3 min
Discarded = 0.08 cfs @ 10.22 hrs, Volume= 4,166 cf
Primary = 0.53 cfs @ 12.23 hrs, Volume= 390 cf
Secondary = 0.63 cfs @ 12.23 hrs, Volume= 2,227 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 95.94' @ 12.23 hrs Surf.Area= 1,364 sf Storage= 2,601 cf

Plug-Flow detention time= 161.7 min calculated for 6,780 cf (85% of inflow)
Center-of-Mass det. time= 98.9 min (903.4 - 804.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	93.00'	1,243 cf	**20.50'W x 66.52'L x 3.50'H Field A** 4,773 cf Overall - 1,665 cf Embedded = 3,108 cf x 40.0% Voids
#2A	93.50'	1,665 cf	**ADS_StormTech SC-740** x 36 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 Row Length Adjustment= +0.44' x 6.45 sf x 4 rows
		2,908 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	93.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	90.50'	**12.0" Round Culvert** L= 30.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 90.50' / 89.50' S= 0.0333 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Device 2	95.75'	**24.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600
#4	Secondary	95.25'	**6.0" Round Culvert** L= 175.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 95.25' / 89.50' S= 0.0329 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf

Discarded OutFlow Max=0.08 cfs @ 10.22 hrs HW=93.04' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=0.52 cfs @ 12.23 hrs HW=95.94' (Free Discharge)
└**2=Culvert** (Passes 0.52 cfs of 8.40 cfs potential flow)
└**3=Orifice/Grate** (Orifice Controls 0.52 cfs @ 1.39 fps)

Secondary OutFlow Max=0.63 cfs @ 12.23 hrs HW=95.94' (Free Discharge)
└**4=Culvert** (Inlet Controls 0.63 cfs @ 3.19 fps)

Pond 2P: Subsurface Infiltration System - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 (ADS StormTech® SC-740)
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
Row Length Adjustment= +0.44' x 6.45 sf x 4 rows

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

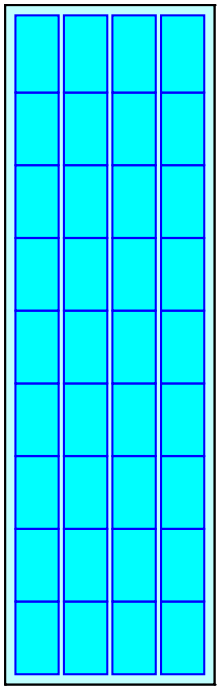
9 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 64.52' Row Length +12.0" End Stone x 2 = 66.52' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 12.0" Side Stone x 2 = 20.50' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

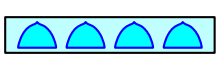
36 Chambers x 45.9 cf +0.44' Row Adjustment x 6.45 sf x 4 Rows = 1,665.2 cf Chamber Storage

4,772.8 cf Field - 1,665.2 cf Chambers = 3,107.6 cf Stone x 40.0% Voids = 1,243.0 cf Stone Storage

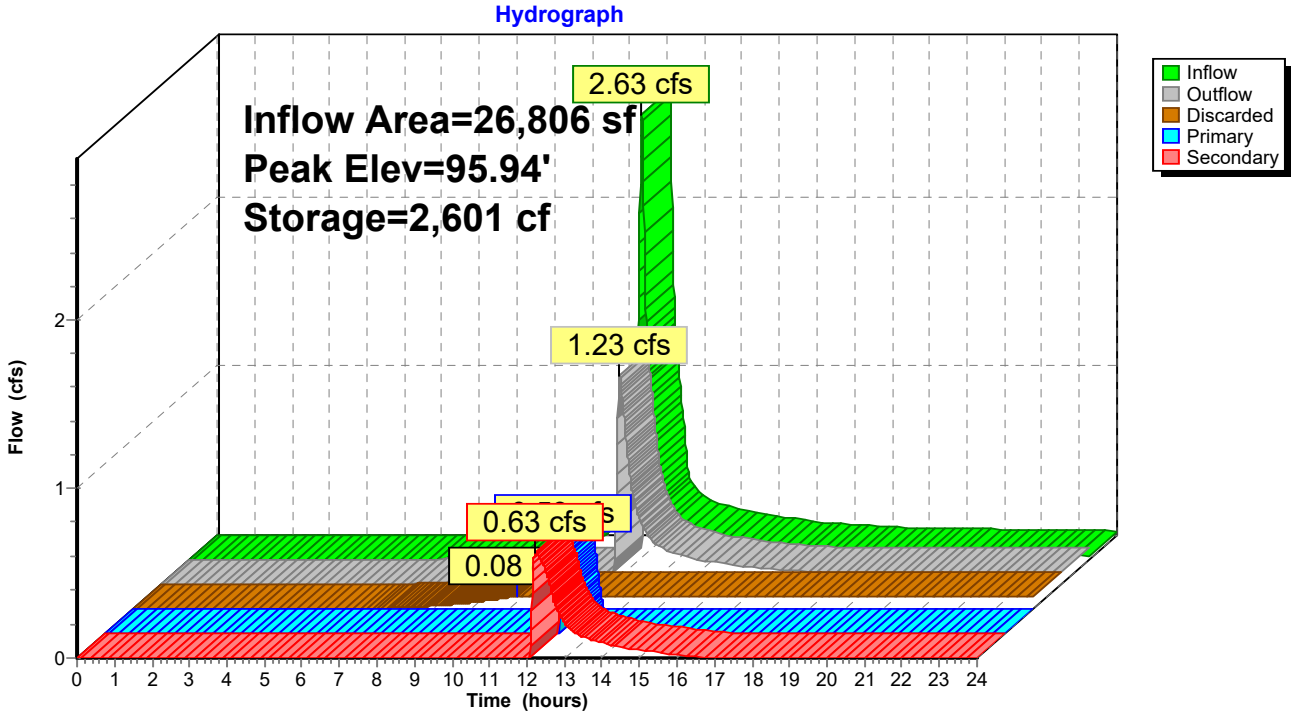
Chamber Storage + Stone Storage = 2,908.2 cf = 0.067 af
Overall Storage Efficiency = 60.9%

36 Chambers
176.8 cy Field
115.1 cy Stone





Pond 2P: Subsurface Infiltration System



Summary for Subcatchment EX1: Overland Flow to Stream

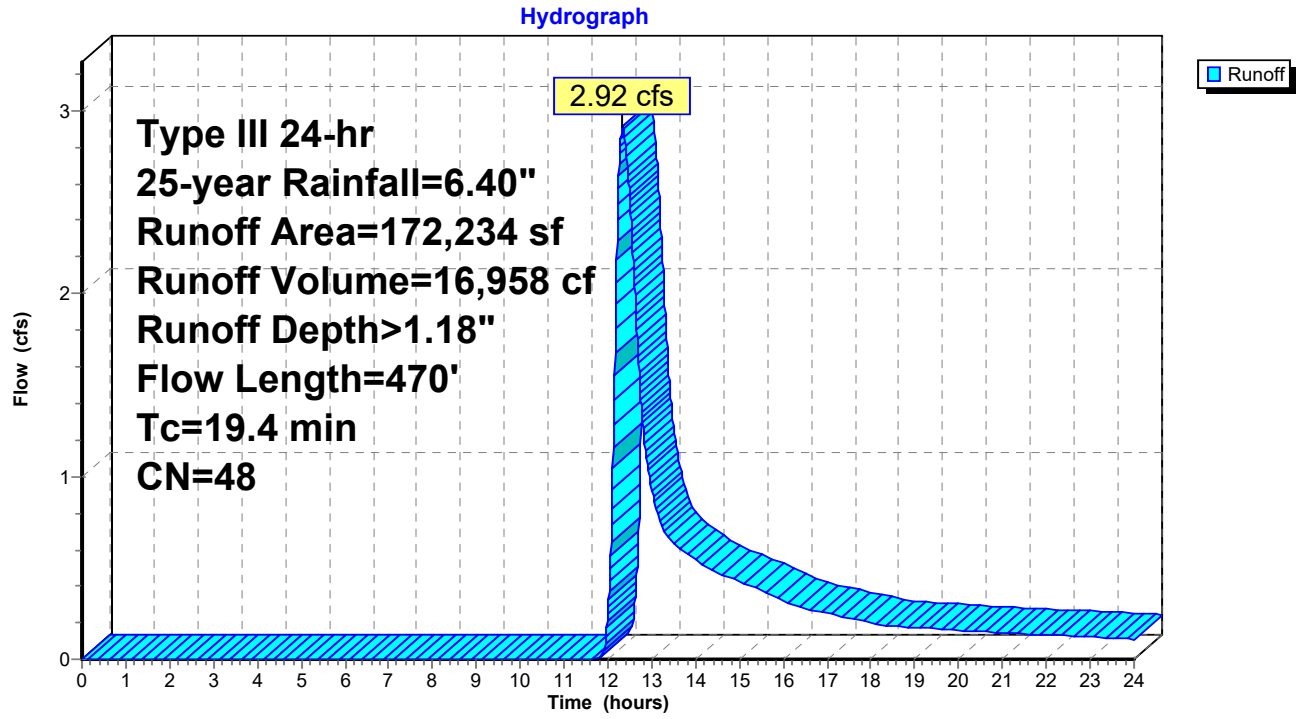
Runoff = 2.92 cfs @ 12.33 hrs, Volume= 16,958 cf, Depth> 1.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

	Area (sf)	CN	Description
	154,934	43	Woods/grass comb., Fair, HSG A
	10,790	96	Gravel surface, HSG A
*	4,423	98	Impervious
*	2,087	98	Roof
	172,234	48	Weighted Average
	165,724		96.22% Pervious Area
	6,510		3.78% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.9	150	0.0330	2.92		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
14.2	270	0.0040	0.32		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
19.4	470	Total			

Subcatchment EX1: Overland Flow to Stream



Summary for Subcatchment PR1: Flow to Extended Dry Detention Basin

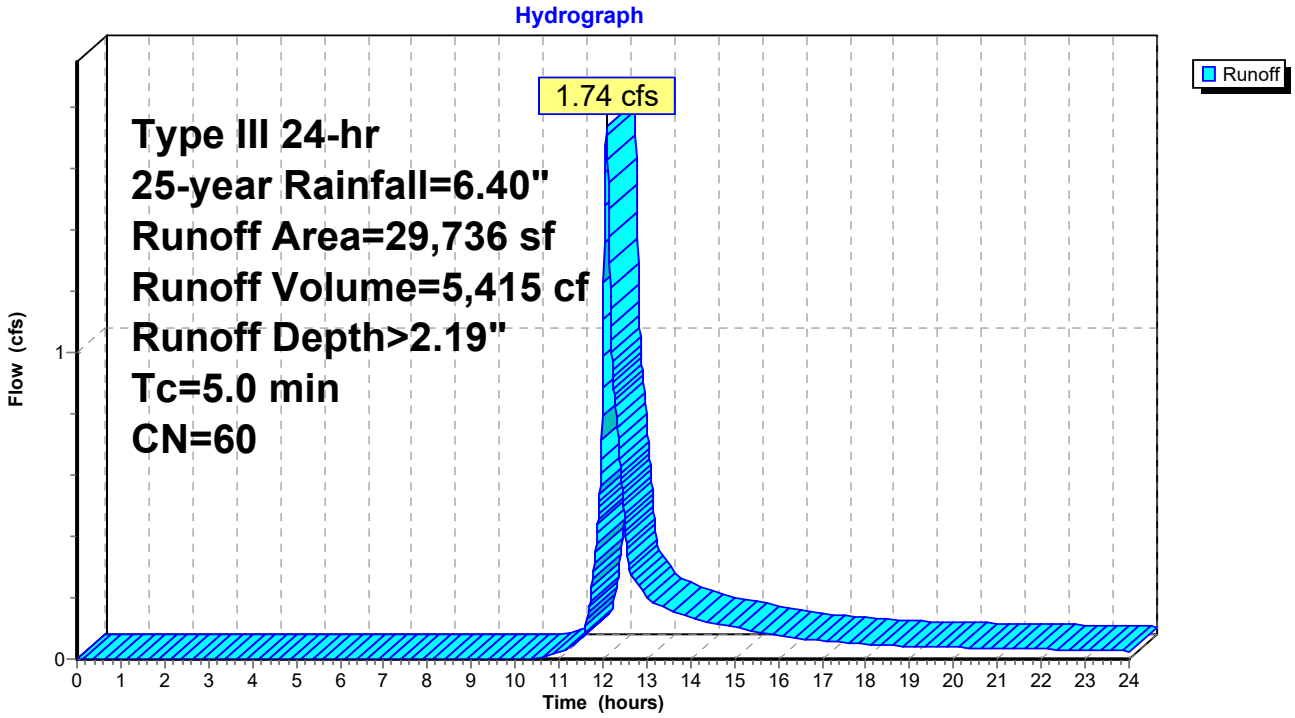
Runoff = 1.74 cfs @ 12.08 hrs, Volume= 5,415 cf, Depth> 2.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

	Area (sf)	CN	Description
	19,196	39	>75% Grass cover, Good, HSG A
*	10,540	98	Impervious
	29,736	60	Weighted Average
	19,196		64.55% Pervious Area
	10,540		35.45% Impervious Area

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

Subcatchment PR1: Flow to Extended Dry Detention Basin



Summary for Subcatchment PR2: Flow to Subsurface Infiltration

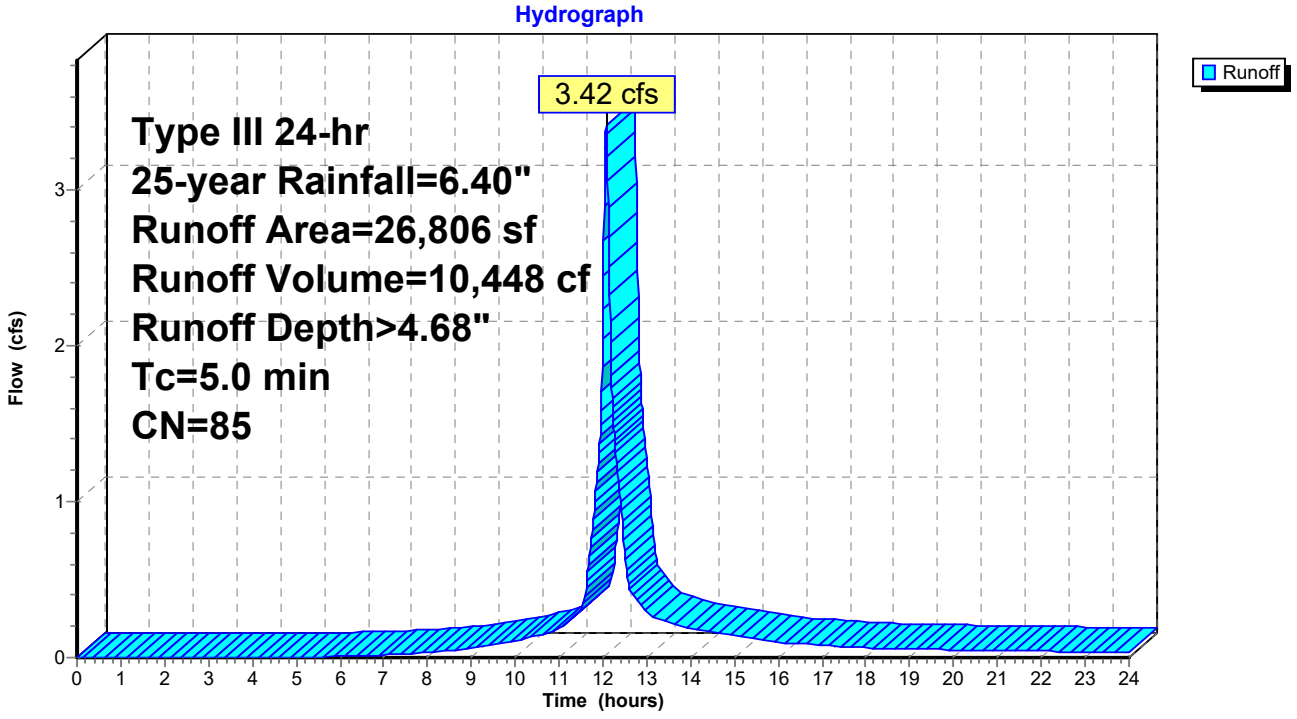
Runoff = 3.42 cfs @ 12.07 hrs, Volume= 10,448 cf, Depth> 4.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

	Area (sf)	CN	Description
	6,031	39	>75% Grass cover, Good, HSG A
*	6,200	98	Impervious
*	14,575	98	Roof
	26,806	85	Weighted Average
	6,031		22.50% Pervious Area
	20,775		77.50% Impervious Area

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

Subcatchment PR2: Flow to Subsurface Infiltration



Summary for Subcatchment PR3: Remaining Overland Flow to Stream

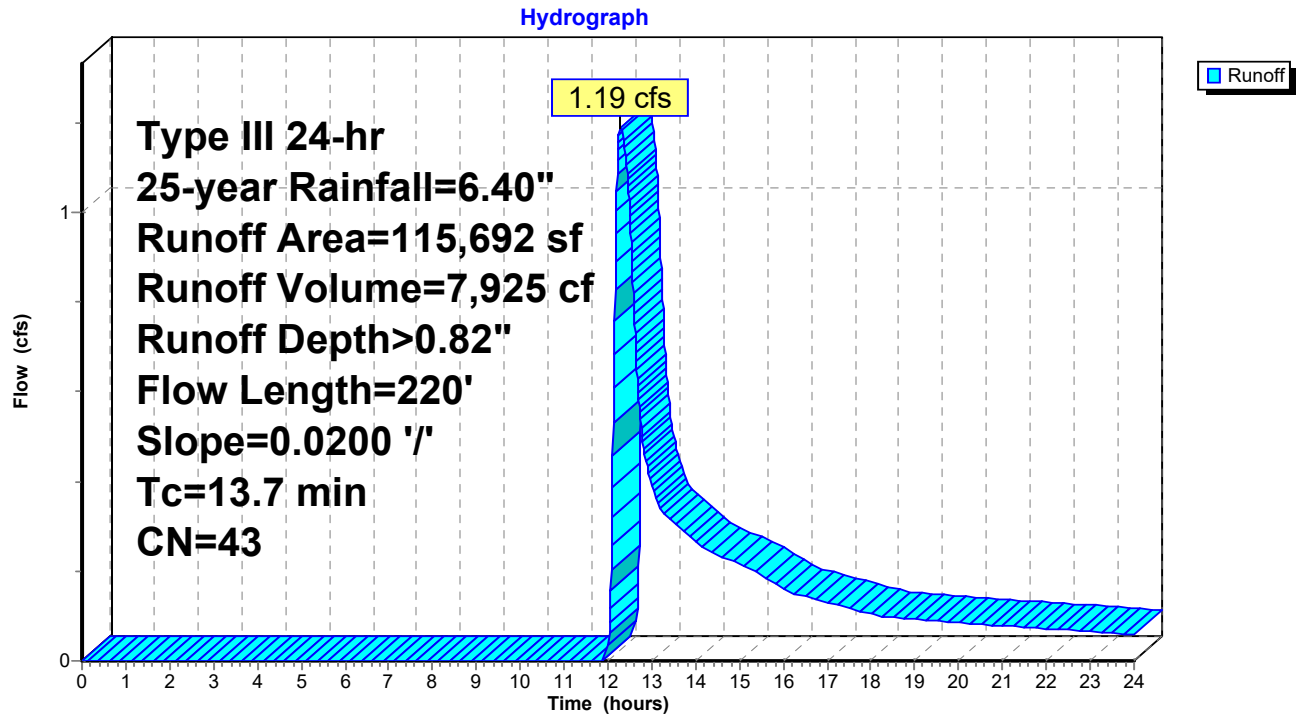
Runoff = 1.19 cfs @ 12.29 hrs, Volume= 7,925 cf, Depth> 0.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-year Rainfall=6.40"

Area (sf)	CN	Description
115,692	43	Woods/grass comb., Fair, HSG A
115,692		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.2	170	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.7	220	Total			

Subcatchment PR3: Remaining Overland Flow to Stream

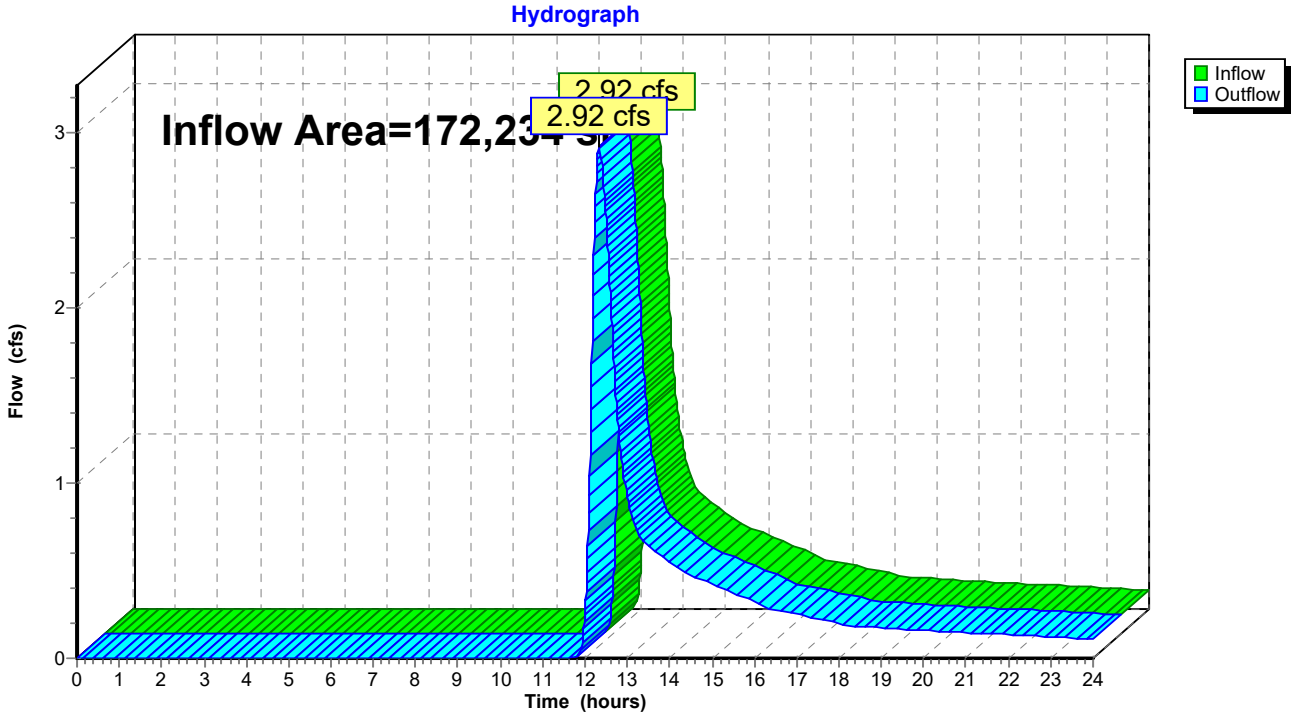


Summary for Reach 1R: Stream-Pre

Inflow Area = 172,234 sf, 3.78% Impervious, Inflow Depth > 1.18" for 25-year event
Inflow = 2.92 cfs @ 12.33 hrs, Volume= 16,958 cf
Outflow = 2.92 cfs @ 12.33 hrs, Volume= 16,958 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 1R: Stream-Pre

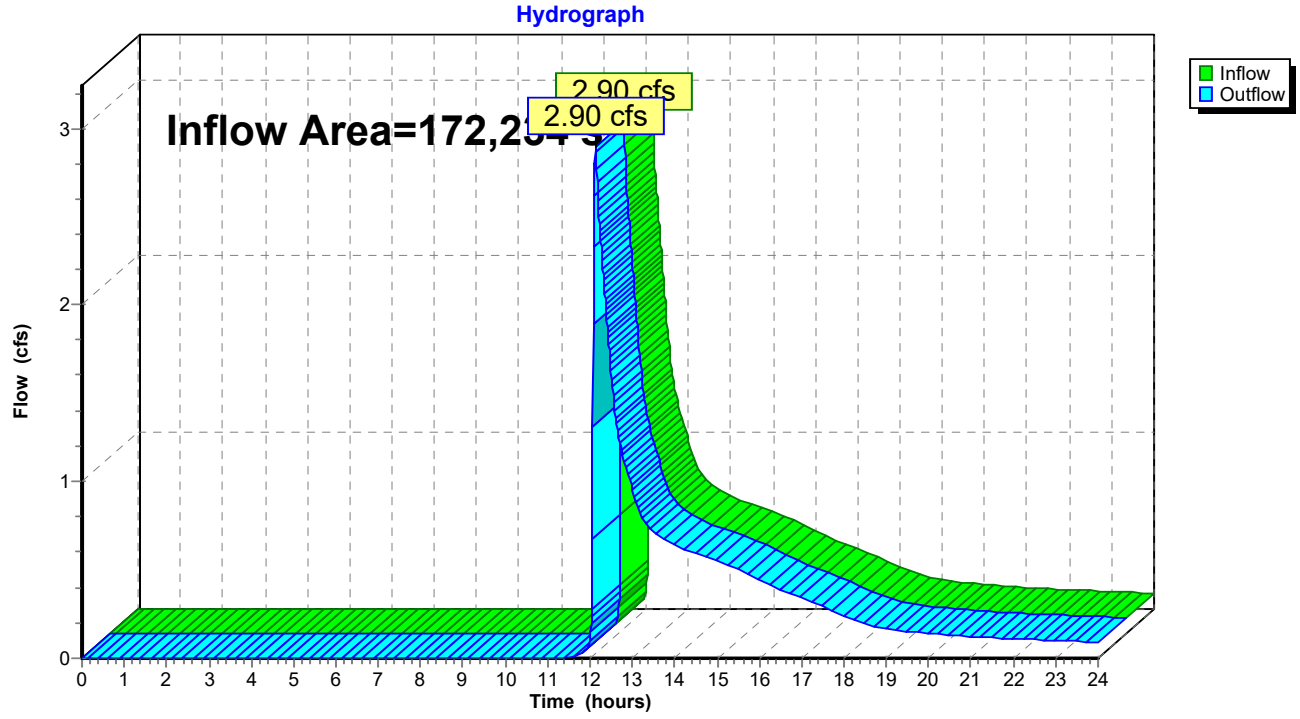


Summary for Reach 2R: Stream-Post

Inflow Area = 172,234 sf, 18.18% Impervious, Inflow Depth > 1.23" for 25-year event
Inflow = 2.90 cfs @ 12.13 hrs, Volume= 17,678 cf
Outflow = 2.90 cfs @ 12.13 hrs, Volume= 17,678 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 2R: Stream-Post



Summary for Pond 1P: Extended Dry Detention Basin

Inflow Area = 29,736 sf, 35.45% Impervious, Inflow Depth > 3.46" for 25-year event
Inflow = 2.50 cfs @ 12.09 hrs, Volume= 8,573 cf
Outflow = 0.65 cfs @ 12.74 hrs, Volume= 8,283 cf, Atten= 74%, Lag= 39.1 min
Primary = 0.65 cfs @ 12.74 hrs, Volume= 8,283 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 89.57' @ 12.74 hrs Surf.Area= 3,307 sf Storage= 3,100 cf

Plug-Flow detention time= 103.3 min calculated for 8,279 cf (97% of inflow)
Center-of-Mass det. time= 85.0 min (918.7 - 833.7)

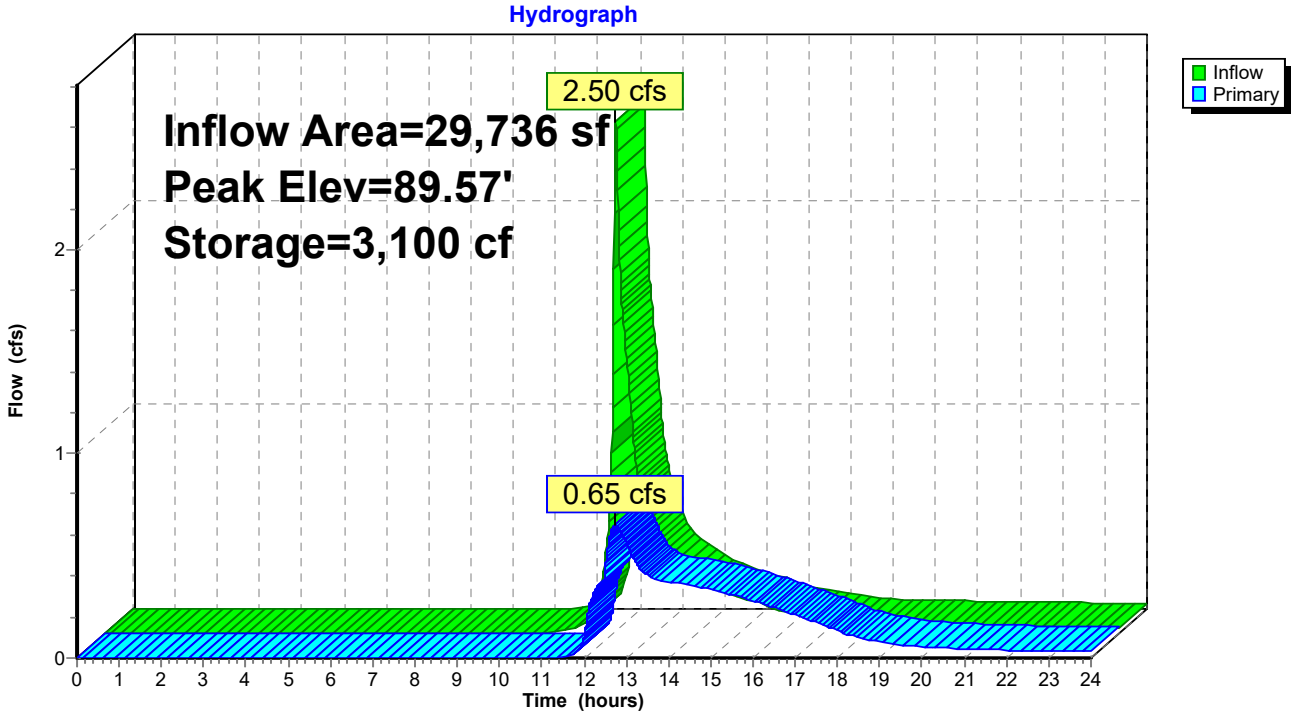
Volume	Invert	Avail.Storage	Storage Description
#1	88.50'	6,533 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
88.50	2,502	256.0	0	0	2,502
90.50	4,096	289.0	6,533	6,533	4,033

Device	Routing	Invert	Outlet Devices
#1	Primary	88.50'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	89.50'	**4.0' long x 1.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s) 1.0' Crest Height

Primary OutFlow Max=0.65 cfs @ 12.74 hrs HW=89.57' (Free Discharge)
1=Orifice/Grate (Orifice Controls 0.40 cfs @ 4.58 fps)
2=Sharp-Crested Rectangular Weir (Weir Controls 0.25 cfs @ 0.88 fps)

Pond 1P: Extended Dry Detention Basin



Summary for Pond 2P: Subsurface Infiltration System

Inflow Area = 26,806 sf, 77.50% Impervious, Inflow Depth > 4.68" for 25-year event
Inflow = 3.42 cfs @ 12.07 hrs, Volume= 10,448 cf
Outflow = 2.99 cfs @ 12.11 hrs, Volume= 9,011 cf, Atten= 13%, Lag= 2.6 min
Discarded = 0.08 cfs @ 9.45 hrs, Volume= 4,382 cf
Primary = 2.11 cfs @ 12.11 hrs, Volume= 1,470 cf
Secondary = 0.81 cfs @ 12.11 hrs, Volume= 3,158 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 96.23' @ 12.11 hrs Surf.Area= 1,364 sf Storage= 2,759 cf

Plug-Flow detention time= 126.6 min calculated for 9,007 cf (86% of inflow)
Center-of-Mass det. time= 66.6 min (863.4 - 796.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	93.00'	1,243 cf	**20.50'W x 66.52'L x 3.50'H Field A** 4,773 cf Overall - 1,665 cf Embedded = 3,108 cf x 40.0% Voids
#2A	93.50'	1,665 cf	**ADS_StormTech SC-740** x 36 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 Row Length Adjustment= +0.44' x 6.45 sf x 4 rows
		2,908 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	93.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	90.50'	**12.0" Round Culvert** L= 30.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 90.50' / 89.50' S= 0.0333 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Device 2	95.75'	**24.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600
#4	Secondary	95.25'	**6.0" Round Culvert** L= 175.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 95.25' / 89.50' S= 0.0329 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf

Discarded OutFlow Max=0.08 cfs @ 9.45 hrs HW=93.04' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=2.10 cfs @ 12.11 hrs HW=96.22' (Free Discharge)
└**2=Culvert** (Passes 2.10 cfs of 8.64 cfs potential flow)
└**3=Orifice/Grate** (Orifice Controls 2.10 cfs @ 2.21 fps)

Secondary OutFlow Max=0.80 cfs @ 12.11 hrs HW=96.22' (Free Discharge)
└**4=Culvert** (Inlet Controls 0.80 cfs @ 4.10 fps)

Pond 2P: Subsurface Infiltration System - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 (ADS StormTech® SC-740)
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
Row Length Adjustment= +0.44' x 6.45 sf x 4 rows

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

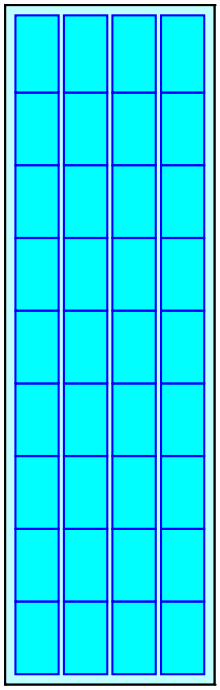
9 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 64.52' Row Length +12.0" End Stone x 2 = 66.52' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 12.0" Side Stone x 2 = 20.50' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

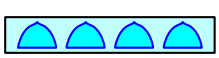
36 Chambers x 45.9 cf +0.44' Row Adjustment x 6.45 sf x 4 Rows = 1,665.2 cf Chamber Storage

4,772.8 cf Field - 1,665.2 cf Chambers = 3,107.6 cf Stone x 40.0% Voids = 1,243.0 cf Stone Storage

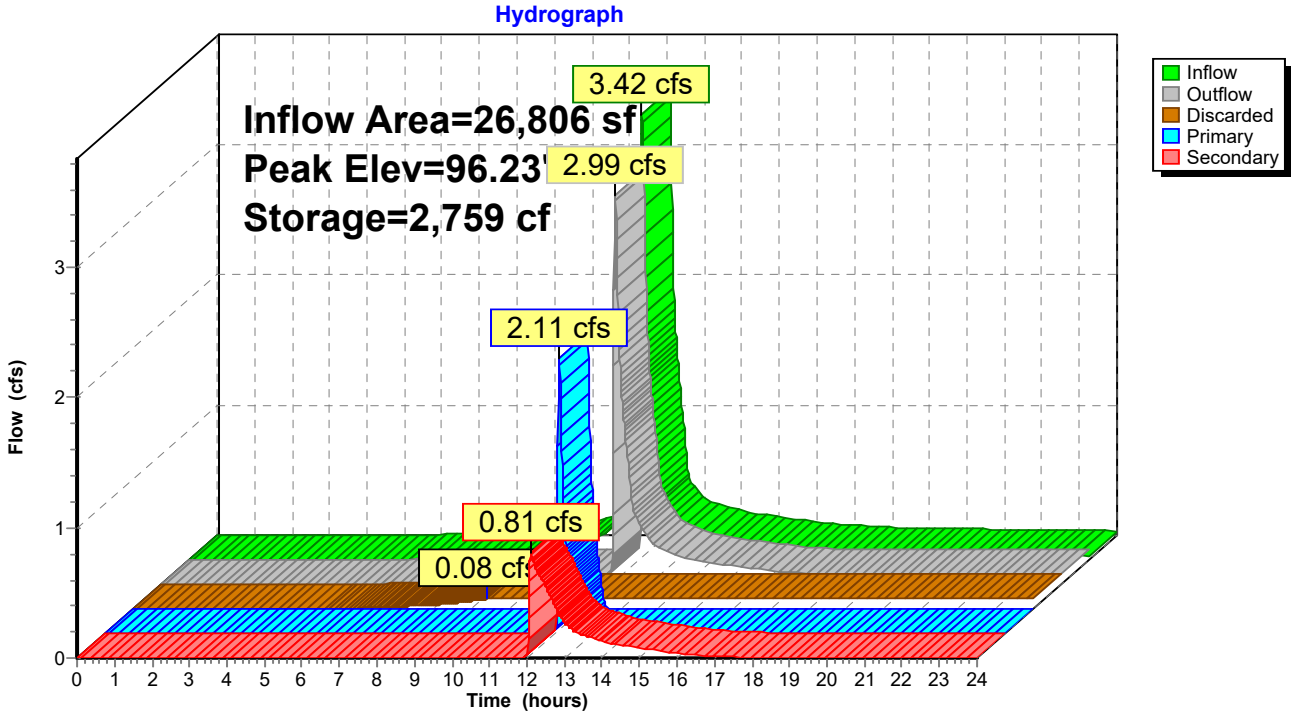
Chamber Storage + Stone Storage = 2,908.2 cf = 0.067 af
Overall Storage Efficiency = 60.9%

36 Chambers
176.8 cy Field
115.1 cy Stone





Pond 2P: Subsurface Infiltration System



Summary for Subcatchment EX1: Overland Flow to Stream

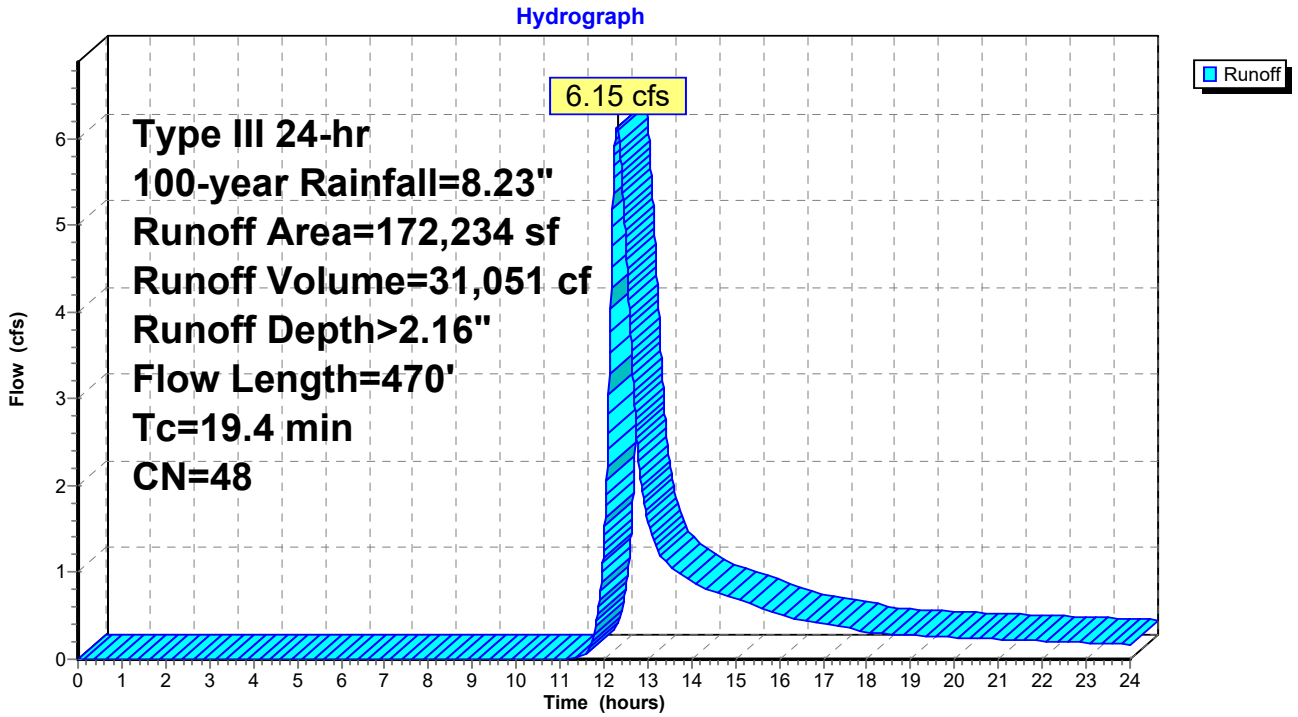
Runoff = 6.15 cfs @ 12.31 hrs, Volume= 31,051 cf, Depth> 2.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.23"

	Area (sf)	CN	Description
	154,934	43	Woods/grass comb., Fair, HSG A
	10,790	96	Gravel surface, HSG A
*	4,423	98	Impervious
*	2,087	98	Roof
	172,234	48	Weighted Average
	165,724		96.22% Pervious Area
	6,510		3.78% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.9	150	0.0330	2.92		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
14.2	270	0.0040	0.32		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
19.4	470	Total			

Subcatchment EX1: Overland Flow to Stream



Summary for Subcatchment PR1: Flow to Extended Dry Detention Basin

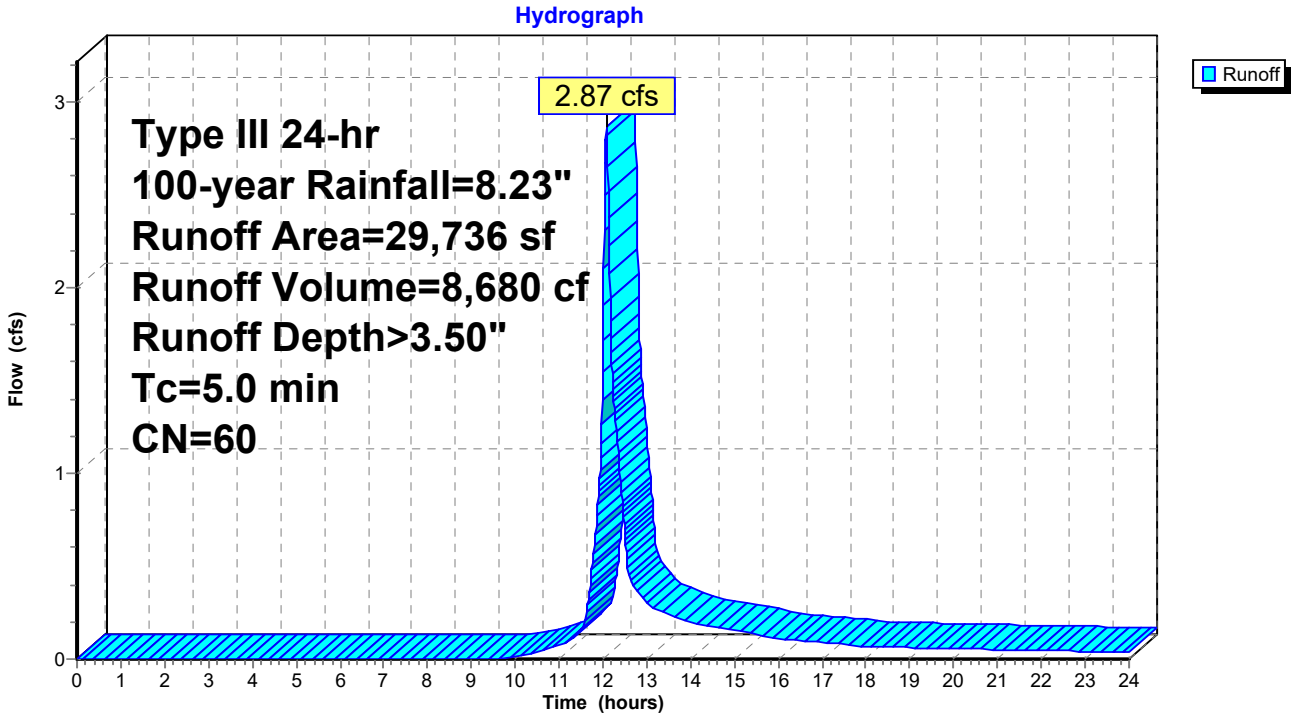
Runoff = 2.87 cfs @ 12.08 hrs, Volume= 8,680 cf, Depth> 3.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.23"

	Area (sf)	CN	Description
	19,196	39	>75% Grass cover, Good, HSG A
*	10,540	98	Impervious
	29,736	60	Weighted Average
	19,196		64.55% Pervious Area
	10,540		35.45% Impervious Area

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

Subcatchment PR1: Flow to Extended Dry Detention Basin



Summary for Subcatchment PR2: Flow to Subsurface Infiltration

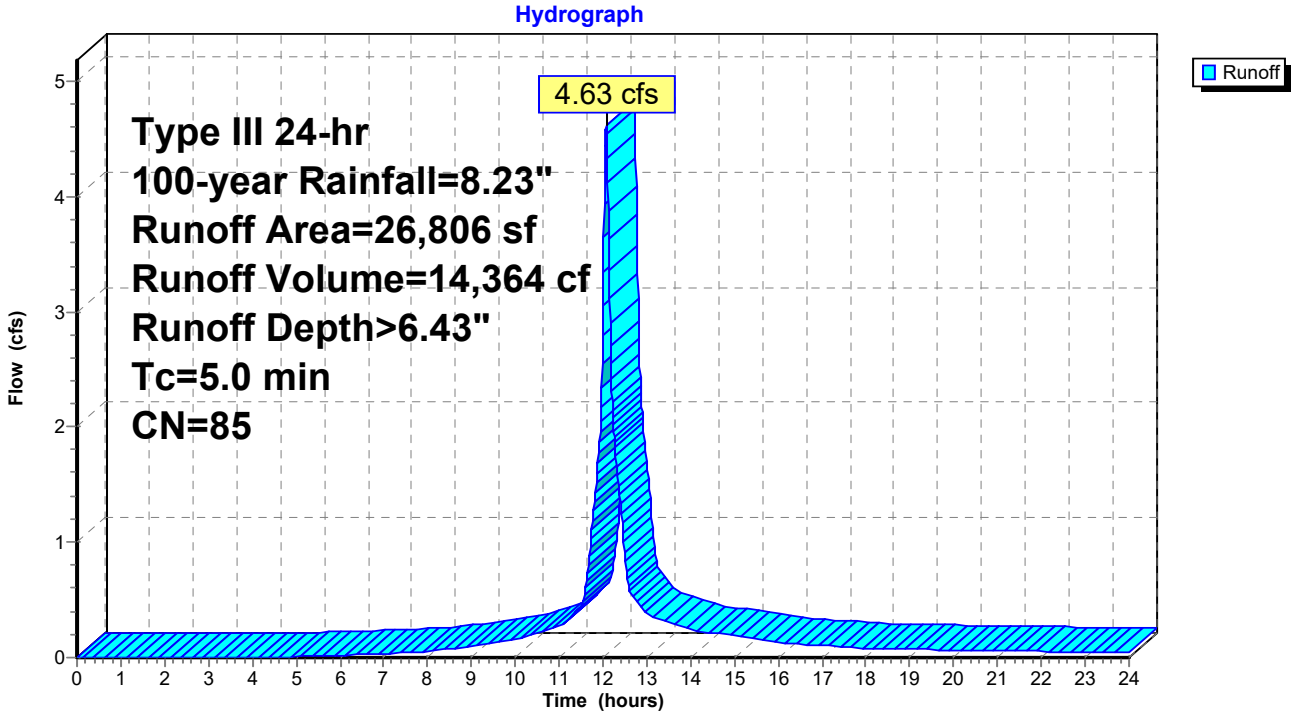
Runoff = 4.63 cfs @ 12.07 hrs, Volume= 14,364 cf, Depth> 6.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.23"

	Area (sf)	CN	Description
	6,031	39	>75% Grass cover, Good, HSG A
*	6,200	98	Impervious
*	14,575	98	Roof
	26,806	85	Weighted Average
	6,031		22.50% Pervious Area
	20,775		77.50% Impervious Area

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

Subcatchment PR2: Flow to Subsurface Infiltration



Summary for Subcatchment PR3: Remaining Overland Flow to Stream

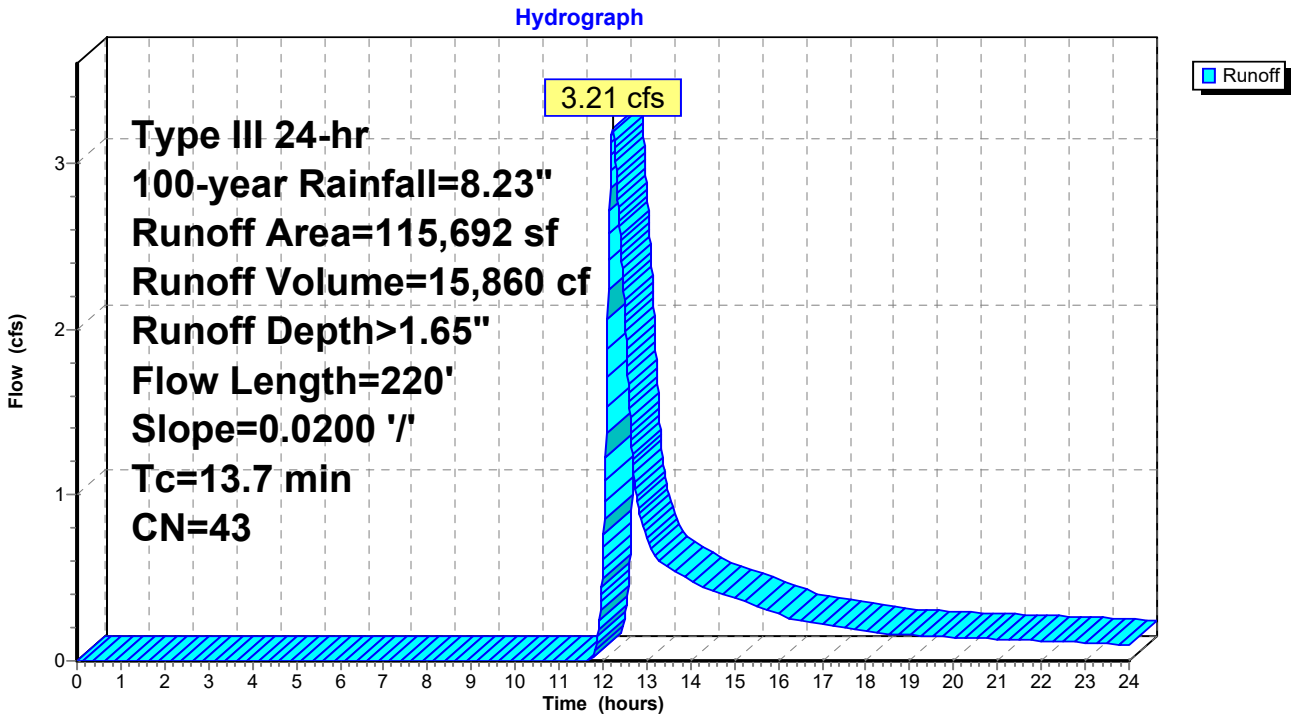
Runoff = 3.21 cfs @ 12.22 hrs, Volume= 15,860 cf, Depth> 1.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-year Rainfall=8.23"

Area (sf)	CN	Description
115,692	43	Woods/grass comb., Fair, HSG A
115,692		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
1.2	170	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.7	220	Total			

Subcatchment PR3: Remaining Overland Flow to Stream

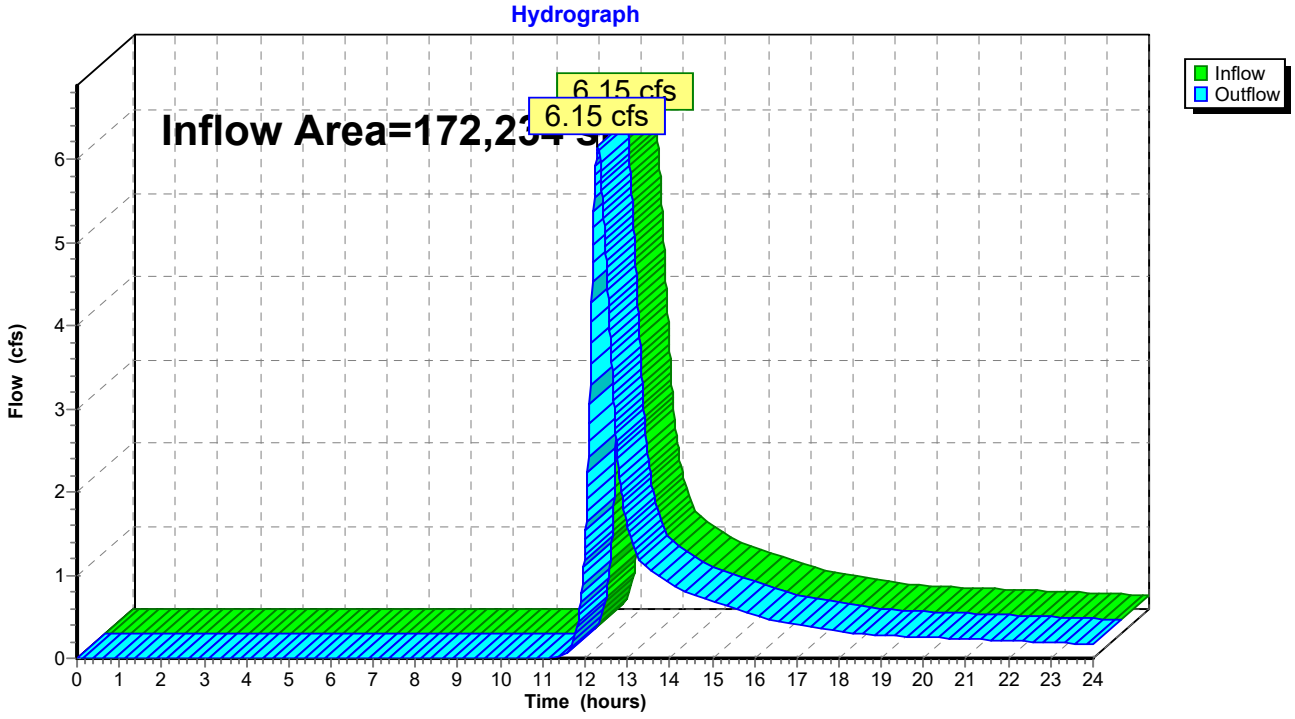


Summary for Reach 1R: Stream-Pre

Inflow Area = 172,234 sf, 3.78% Impervious, Inflow Depth > 2.16" for 100-year event
Inflow = 6.15 cfs @ 12.31 hrs, Volume= 31,051 cf
Outflow = 6.15 cfs @ 12.31 hrs, Volume= 31,051 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 1R: Stream-Pre

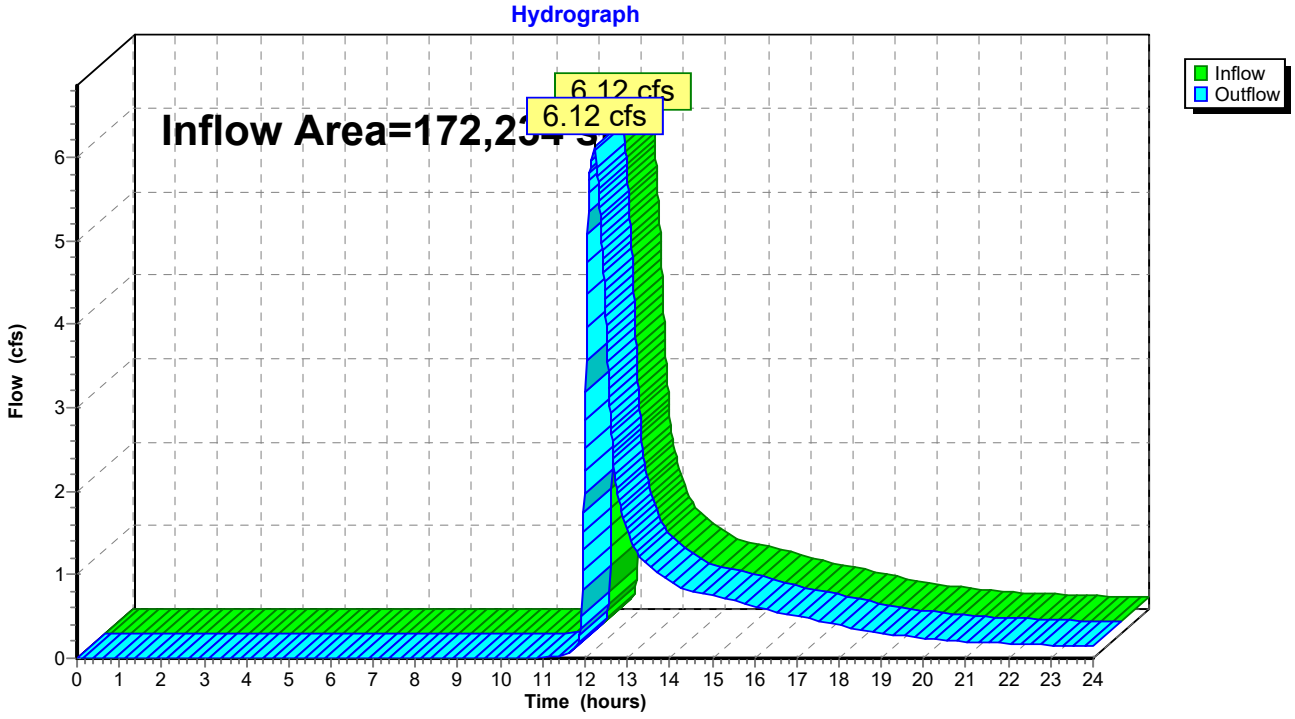


Summary for Reach 2R: Stream-Post

Inflow Area = 172,234 sf, 18.18% Impervious, Inflow Depth > 2.24" for 100-year event
Inflow = 6.12 cfs @ 12.22 hrs, Volume= 32,143 cf
Outflow = 6.12 cfs @ 12.22 hrs, Volume= 32,143 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach 2R: Stream-Post



Summary for Pond 1P: Extended Dry Detention Basin

Inflow Area = 29,736 sf, 35.45% Impervious, Inflow Depth > 5.37" for 100-year event
Inflow = 3.78 cfs @ 12.08 hrs, Volume= 13,310 cf
Outflow = 1.78 cfs @ 12.35 hrs, Volume= 12,957 cf, Atten= 53%, Lag= 16.3 min
Primary = 1.78 cfs @ 12.35 hrs, Volume= 12,957 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 89.72' @ 12.35 hrs Surf.Area= 3,426 sf Storage= 3,596 cf

Plug-Flow detention time= 84.8 min calculated for 12,957 cf (97% of inflow)
Center-of-Mass det. time= 70.1 min (899.3 - 829.2)

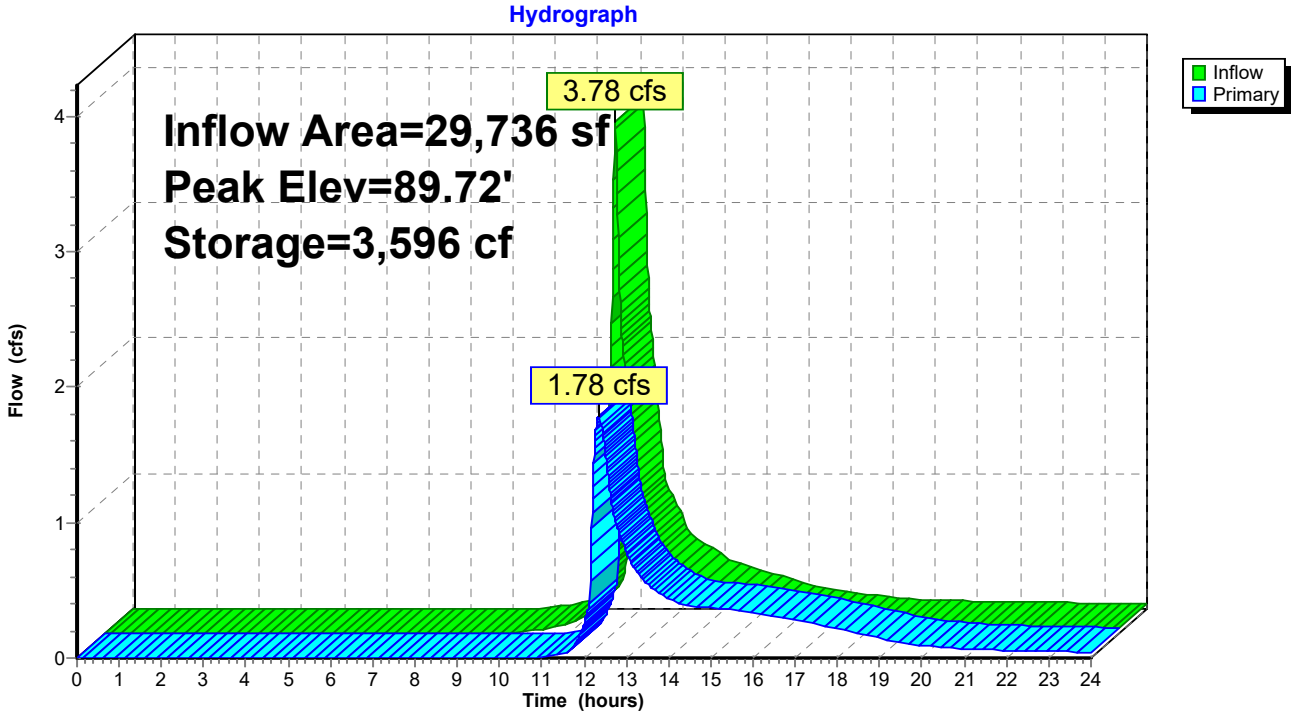
Volume	Invert	Avail.Storage	Storage Description
#1	88.50'	6,533 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
88.50	2,502	256.0	0	0	2,502
90.50	4,096	289.0	6,533	6,533	4,033

Device	Routing	Invert	Outlet Devices
#1	Primary	88.50'	**4.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	89.50'	**4.0' long x 1.00' rise Sharp-Crested Rectangular Weir** 2 End Contraction(s) 1.0' Crest Height

Primary OutFlow Max=1.78 cfs @ 12.35 hrs HW=89.72' (Free Discharge)
1=Orifice/Grate (Orifice Controls 0.43 cfs @ 4.94 fps)
2=Sharp-Crested Rectangular Weir (Weir Controls 1.35 cfs @ 1.57 fps)

Pond 1P: Extended Dry Detention Basin



Summary for Pond 2P: Subsurface Infiltration System

Inflow Area = 26,806 sf, 77.50% Impervious, Inflow Depth > 6.43" for 100-year event
Inflow = 4.63 cfs @ 12.07 hrs, Volume= 14,364 cf
Outflow = 4.50 cfs @ 12.09 hrs, Volume= 12,610 cf, Atten= 3%, Lag= 1.1 min
Discarded = 0.08 cfs @ 8.59 hrs, Volume= 4,653 cf
Primary = 3.52 cfs @ 12.09 hrs, Volume= 3,327 cf
Secondary = 0.91 cfs @ 12.09 hrs, Volume= 4,629 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 96.42' @ 12.09 hrs Surf.Area= 1,364 sf Storage= 2,864 cf

Plug-Flow detention time= 97.4 min calculated for 12,610 cf (88% of inflow)
Center-of-Mass det. time= 41.8 min (829.9 - 788.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	93.00'	1,243 cf	**20.50'W x 66.52'L x 3.50'H Field A** 4,773 cf Overall - 1,665 cf Embedded = 3,108 cf x 40.0% Voids
#2A	93.50'	1,665 cf	**ADS_StormTech SC-740** x 36 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 Row Length Adjustment= +0.44' x 6.45 sf x 4 rows
		2,908 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	93.00'	**2.410 in/hr Exfiltration over Surface area**
#2	Primary	90.50'	**12.0" Round Culvert** L= 30.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 90.50' / 89.50' S= 0.0333 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#3	Device 2	95.75'	**24.0" W x 12.0" H Vert. Orifice/Grate** C= 0.600
#4	Secondary	95.25'	**6.0" Round Culvert** L= 175.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 95.25' / 89.50' S= 0.0329 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf

Discarded OutFlow Max=0.08 cfs @ 8.59 hrs HW=93.04' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=3.52 cfs @ 12.09 hrs HW=96.42' (Free Discharge)
└**2=Culvert** (Passes 3.52 cfs of 8.80 cfs potential flow)
└**3=Orifice/Grate** (Orifice Controls 3.52 cfs @ 2.63 fps)

Secondary OutFlow Max=0.91 cfs @ 12.09 hrs HW=96.42' (Free Discharge)
└**4=Culvert** (Inlet Controls 0.91 cfs @ 4.62 fps)

Pond 2P: Subsurface Infiltration System - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-740 (ADS StormTech® SC-740)
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
Row Length Adjustment= +0.44' x 6.45 sf x 4 rows

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

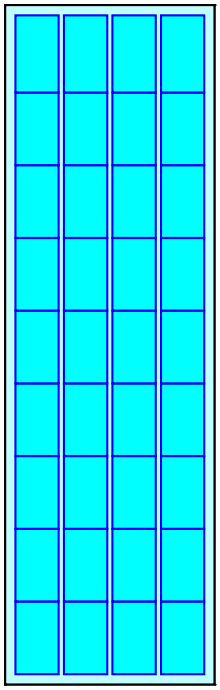
9 Chambers/Row x 7.12' Long +0.44' Row Adjustment = 64.52' Row Length +12.0" End Stone x 2 = 66.52' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 12.0" Side Stone x 2 = 20.50' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

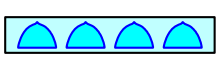
36 Chambers x 45.9 cf +0.44' Row Adjustment x 6.45 sf x 4 Rows = 1,665.2 cf Chamber Storage

4,772.8 cf Field - 1,665.2 cf Chambers = 3,107.6 cf Stone x 40.0% Voids = 1,243.0 cf Stone Storage

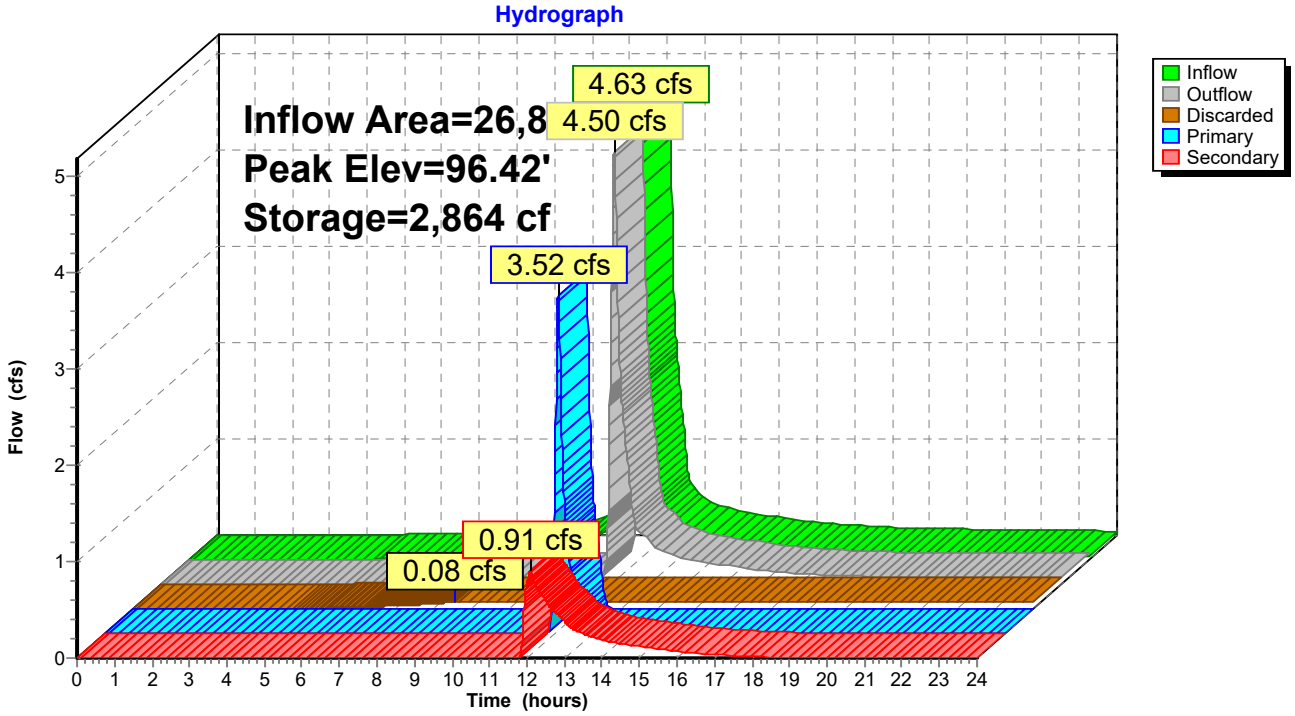
Chamber Storage + Stone Storage = 2,908.2 cf = 0.067 af
Overall Storage Efficiency = 60.9%

36 Chambers
176.8 cy Field
115.1 cy Stone

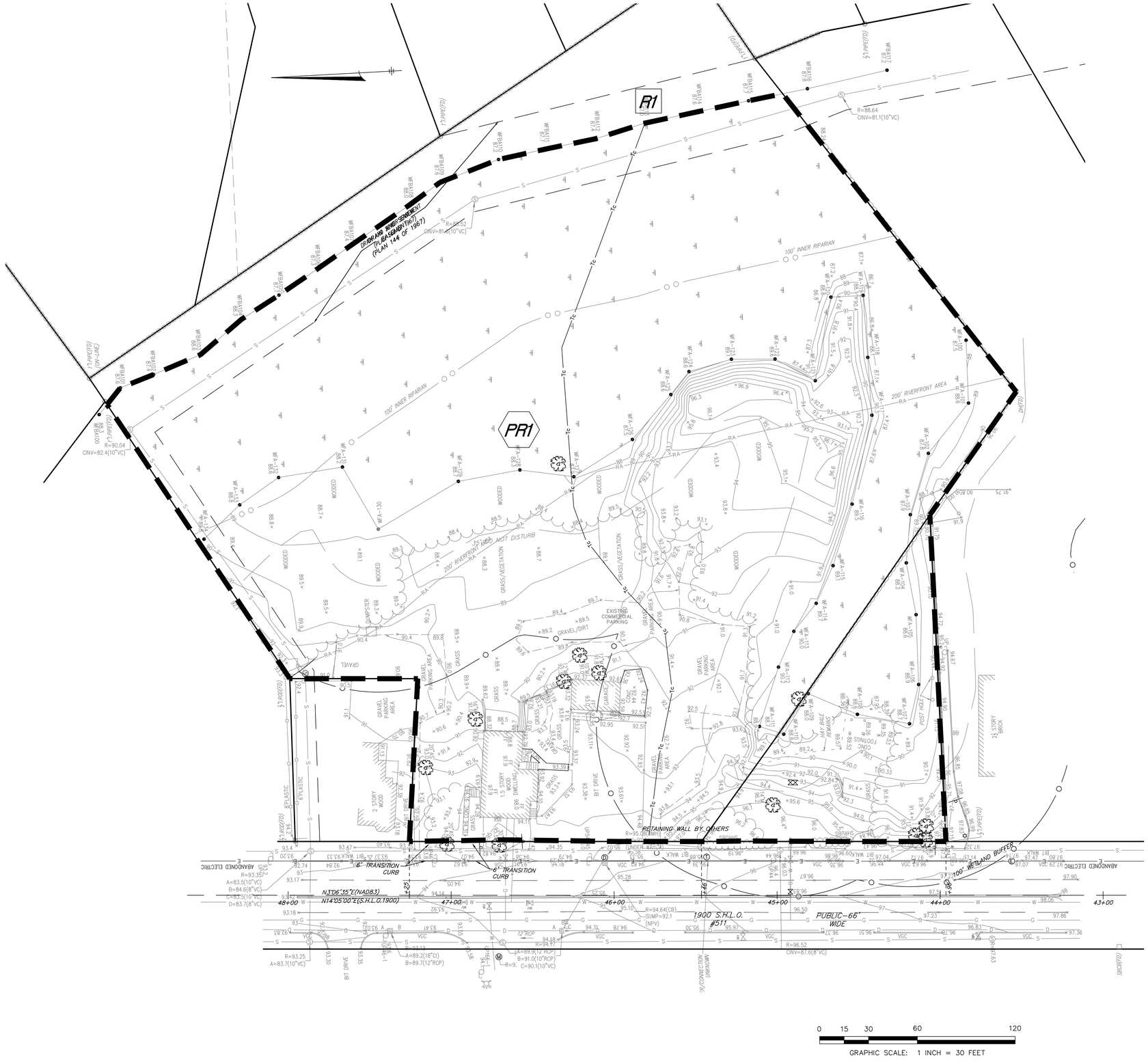




Pond 2P: Subsurface Infiltration System



APPENDIX B
PRE/POST DRAINAGE MAPS



PERMIT SITE PLAN

259 & 267 Main Street
Reading, Massachusetts 02180

ASSESSORS:

MAP	PARCEL
12	39 & 40

PREPARED FOR:

Stonegate Construction Corp.

33 Bedford Street
Reading, Massachusetts 02180

HANCOCK ASSOCIATES

Civil Engineers

Land Surveyors

Wetland Scientists

185 CENTRE STREET, DANVERS, MA 01923
VOICE (978) 777-3050, FAX (978) 774-7816
WWW.HANCOCKASSOCIATES.COM

NO.	BY	APP	DATE	ISSUE/REVISION DESCRIPTION

DATE:	10/8/19	DESIGN BY:	RLG
SCALE:		DRAWN BY:	RLG
APPRVD. BY:		CHECK BY:	JP

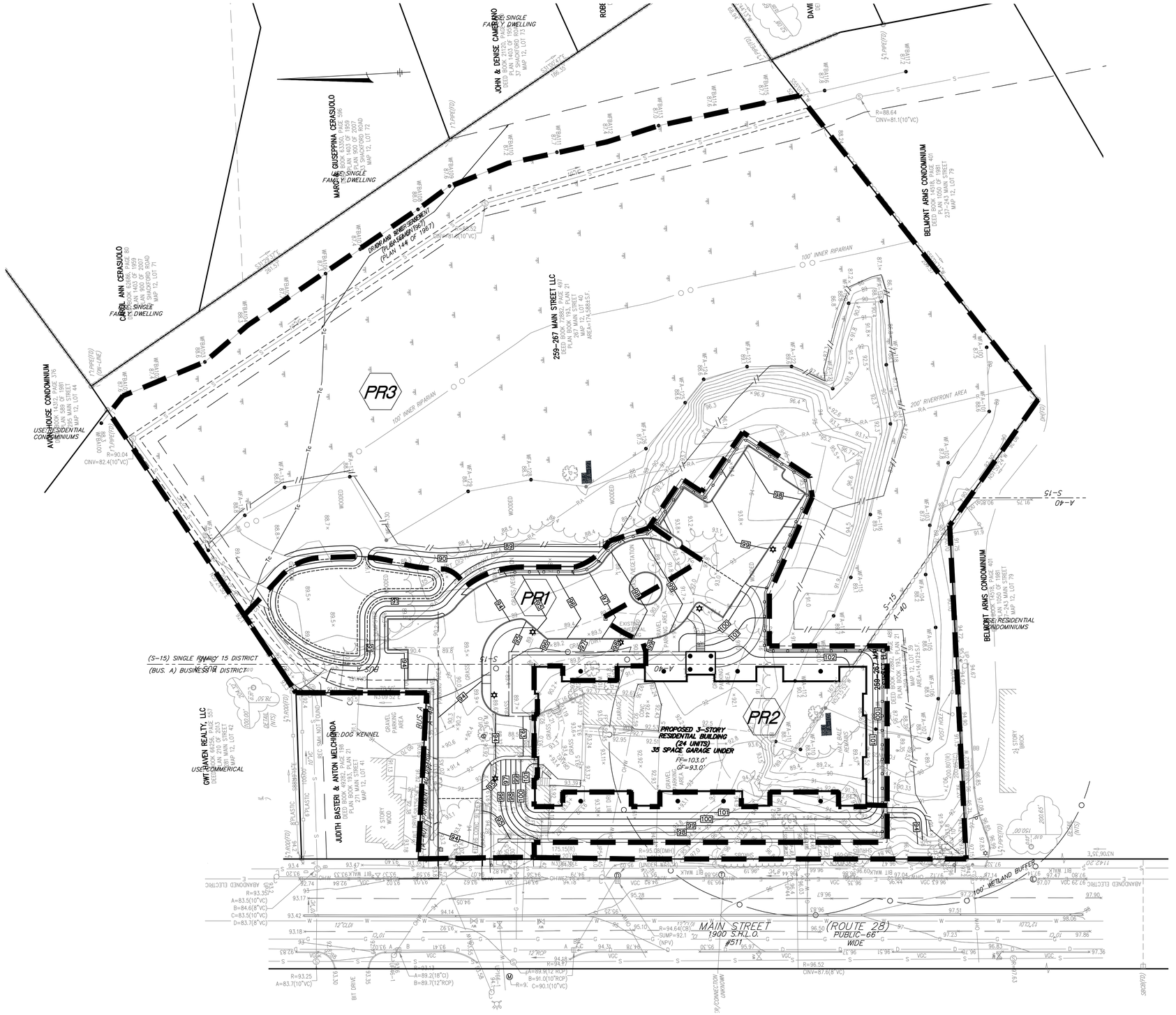
PRE-DEVELOPMENT DRAINAGE MAP

PLOT DATE: Oct 08, 2019 1:26 pm
PATH: F:\HSA\Civil 3D Projects\21839 Finnegan-Reading\DWG\

DWG:	21839WS-Maps.dwg
LAYOUT:	PRE MAP
SHEET:	3 OF 1

D1

PROJECT NO.: 21839



PERMIT SITE PLAN

259 & 267 Main Street
Reading, Massachusetts 02180

ASSESSORS:

MAP	PARCEL
12	39 & 40

PREPARED FOR:

Stonegate Construction Corp.

33 Bedford Street
Reading, Massachusetts 02180

HANCOCK ASSOCIATES

Civil Engineers

Land Surveyors

Wetland Scientists

185 CENTRE STREET, DANVERS, MA 01923
VOICE (978) 777-3050, FAX (978) 774-7816
WWW.HANCOCKASSOCIATES.COM

NO.	BY	APP	DATE	ISSUE/REVISION DESCRIPTION

DATE:	10/8/19	DESIGN BY:	RLG
SCALE:		DRAWN BY:	RLG
APPRVD. BY:		CHECK BY:	JP

POST-DEVELOPMENT DRAINAGE MAP

PLOT DATE: Dec 29, 2019 3:00 pm
PATH: F:\hao\civil 3d projects\21839 finnegan-reading\dwg\

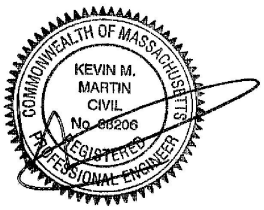
DWG:	21839pr121719-2.dwg
LAYOUT:	POST MAP
SHEET:	3 OF 1
PROJECT NO.:	21839

APPENDIX C
GEOTECH REPORT
BY KMM GEOTECHNICAL CONSULTANTS, LLC.

KEVIN M. MARTIN, P.E.
KMM GEOTECHNICAL CONSULTANTS, LLC
7 Marshall Road
Hampstead, NH 03841
603-489-5556 (p)/ 603-489-5558 (f)/781-718-4084(m)
kevinmartinpe@aol.com

MEMORANDUM

TO: Katz Group
273 Corporate Drive, Suite 150
Portsmouth, NH 03801



FROM: Kevin M. Martin, P.E.
Geotechnical Engineer

DATE: May 21, 2019

RE: **PRELIMINARY GEOTECHNICAL SUMMARY**
PROPOSED RESIDENTIAL BUILDING
267 MAIN STREET
READING, MASSACHUSETTS

This memorandum report serves as a preliminary geotechnical summary report for the referenced project. The contents of this memorandum are subject to the attached ***Limitations***.

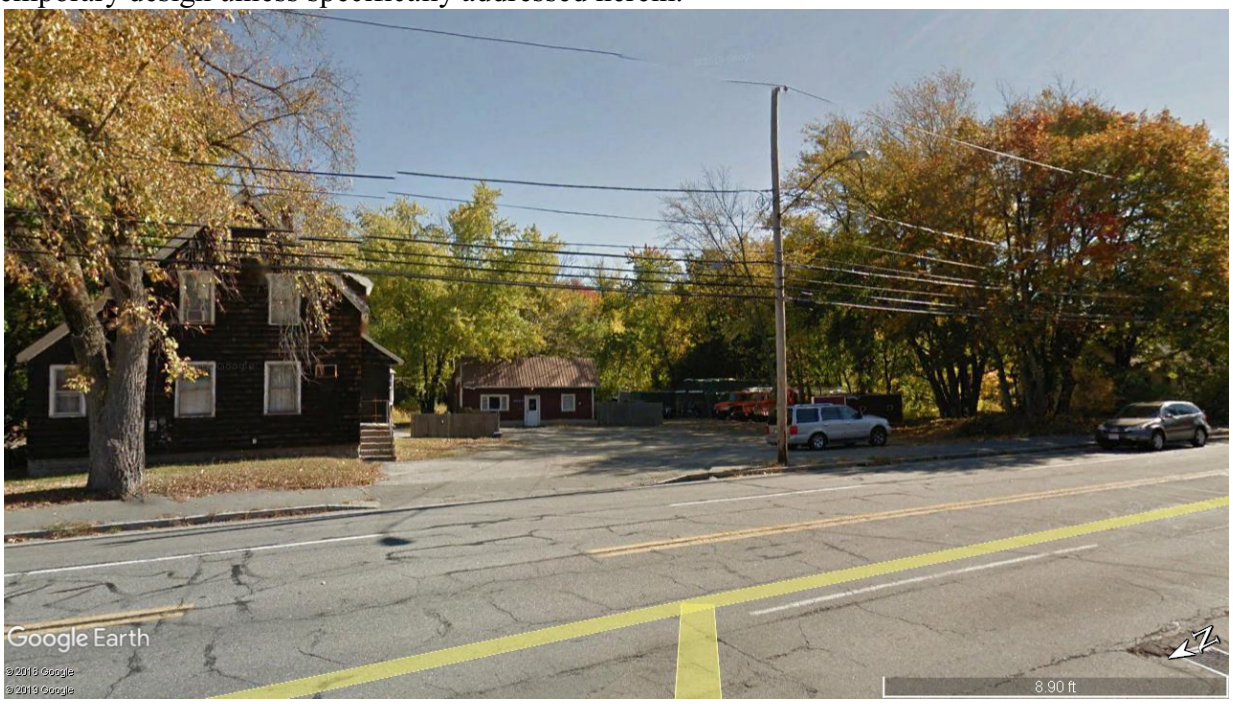
SITE & PROJECT DESCRIPTION

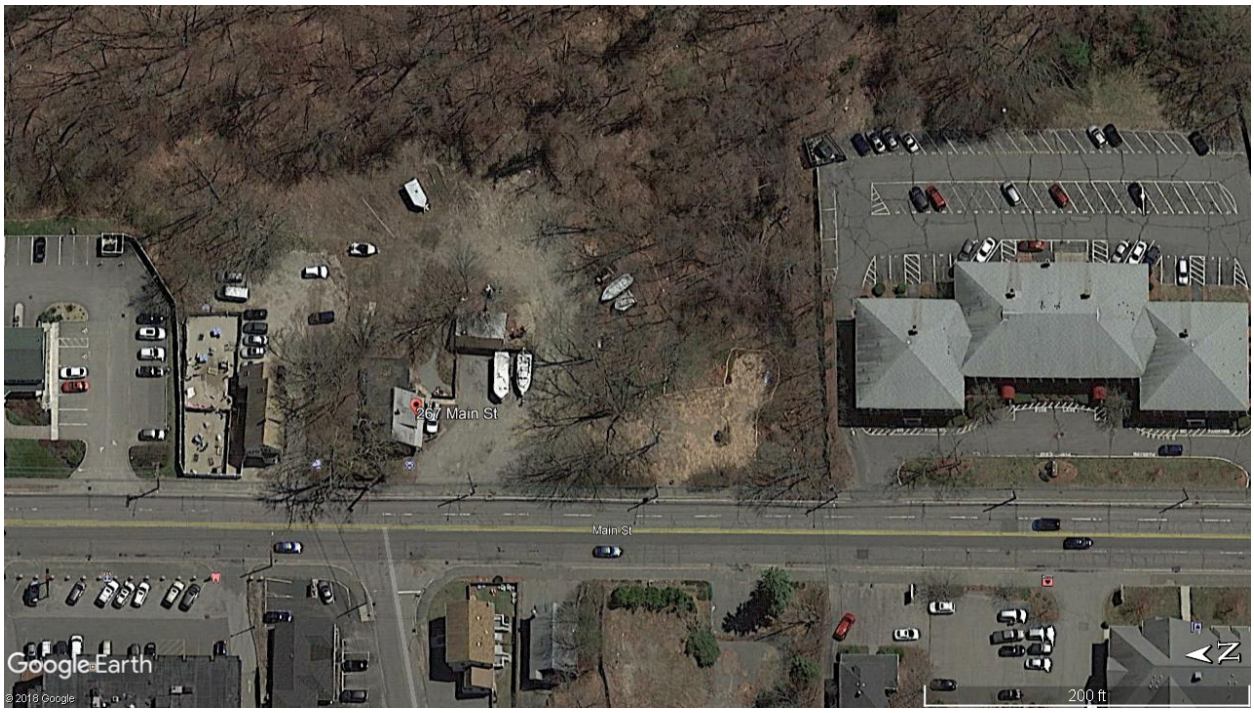
Present site development includes a vacant residence with a detached garage. There was also a former residence which was razed. The remainder of the site includes cleared gravel areas, unmaintained scrub vegetation and/or woodlands. KMM has no other knowledge of past construction, use and/or development of the property except what is visibly apparent or shown on the *Site Plan*. Based on review of the *Site Plan*, grades across the site vary from elevation ≈97-89 ft possessing a gradual downward slope to the east (rear). Shallow wetlands are delineated towards the rear of the site near elevation ≈88-90 ft.

The project includes a new four-story, steel and wood-framed residential building about ≈15,000 ft² in footprint. The plans are still in the conceptual phase. The building is understood to have ground level parking with 3-levels of residential units above. It is intended to support the building on a conventional shallow spread footing foundation (no basement). The ground floor garage slab is expected near elevation ≈93 ft. Limited plans were available at this time.

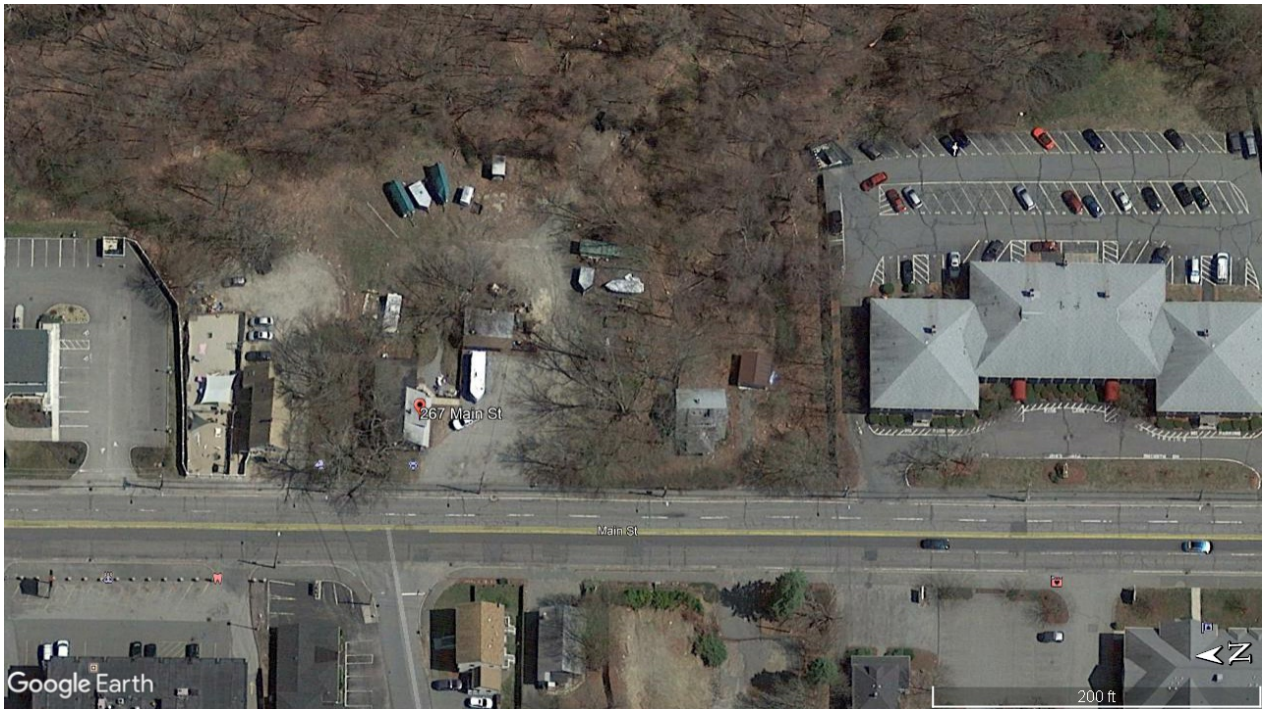
The purpose of this study is to review the subgrade conditions and provide a preliminary geotechnical evaluation related to foundation design and construction per the *Massachusetts State*

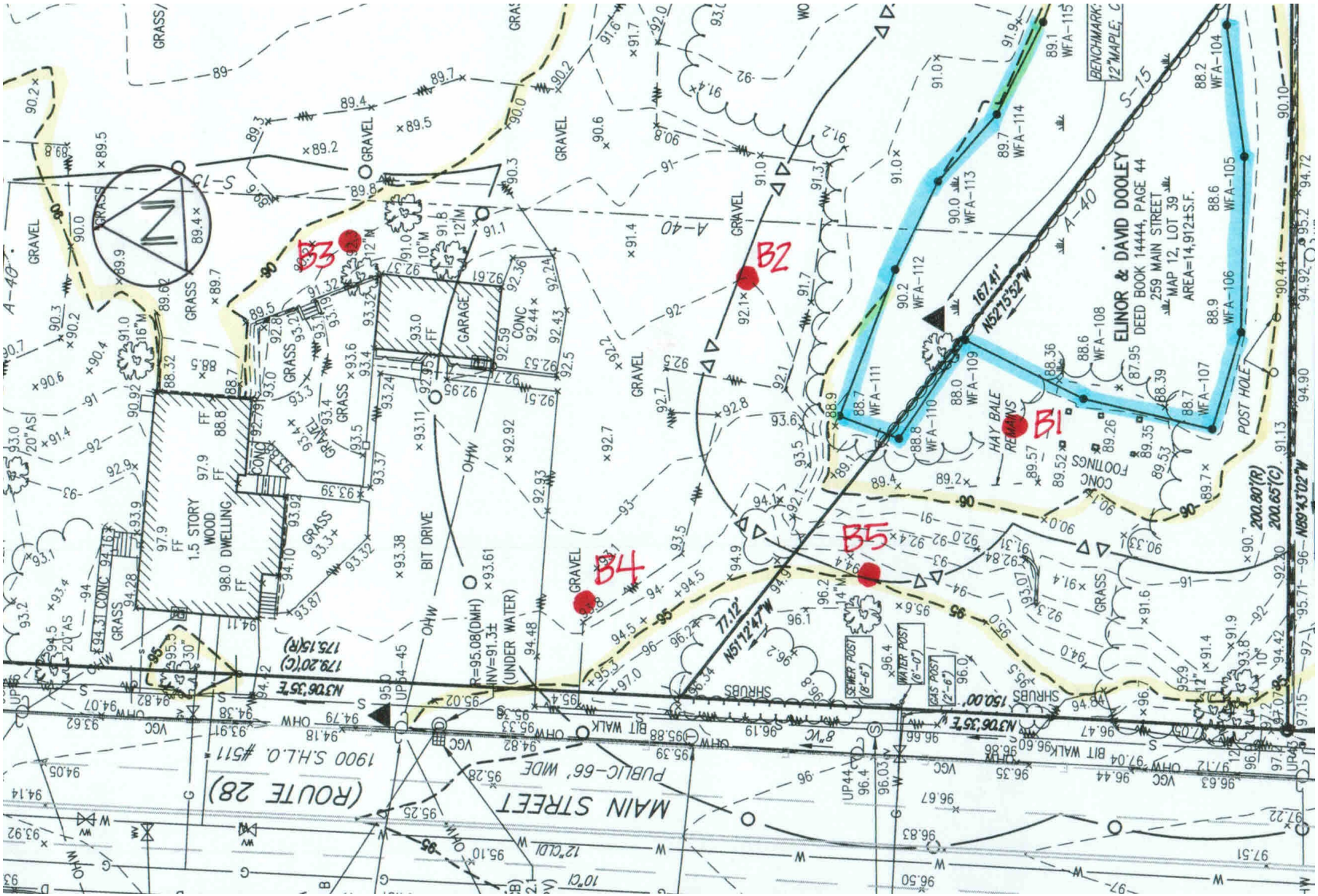
Building Code (MSBC). This study is considered preliminary given lack of definitive plans. This report does not include an environmental assessment relative to oil, gasoline, solid waste and/or other hazardous materials. The environmental conditions of the property should be addressed by others as necessary. This study also does not include review of site design or construction issues such as infiltration systems, excavation support systems, underground utilities, retaining walls, protection of surrounding buildings/utilities, crane pads, temporary shoring or other site and/or temporary design unless specifically addressed herein.

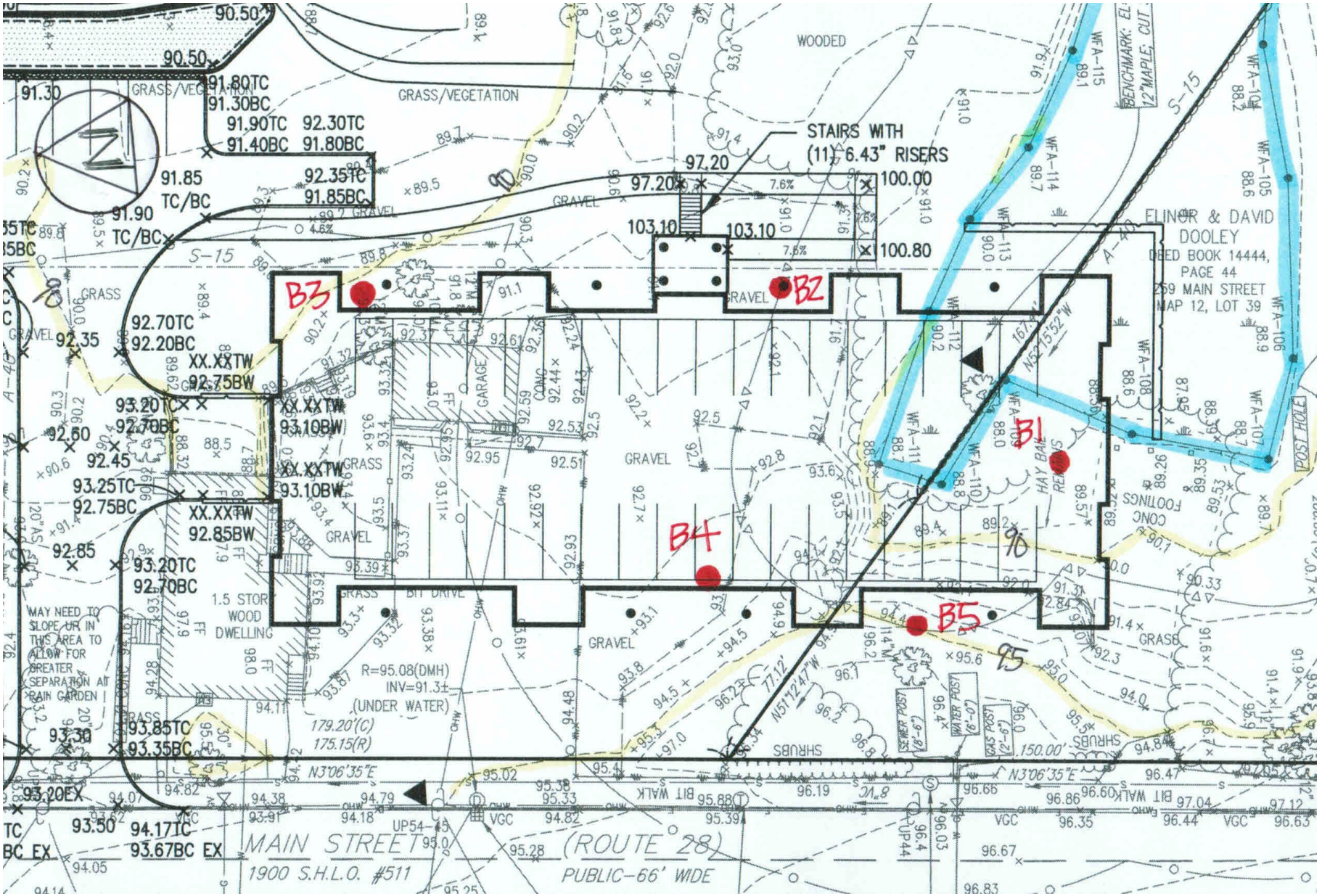




PRESENT CONDITIONS (ABOVE) / APRIL 2007 (BELOW)




B1
B2
B3
B4
B5
ELINOR & DAVID DOOLEY
DEED BOOK 14444, PAGE 44
259 MAIN STREET
MAP 12, LOT 39
AREA=14,912±S.F.
1.5 STORY WOOD DWELLING
98.0 DWELLING FF
GARAGE
BIT DRIVE
MAIN STREET (ROUTE 28)
PUBLIC-66' WIDE
1900 S.H.L.O. #511
HAY BALE REMAINS
POST HOLE
BENCHMARK:
12"MAPLE
167.41'
N52°15'52"W
77.12'
N51°12'47"W
150.00'
N37°06'35"E
179.20'(C)
179.15'(R)
200.80'(R)
200.65'(C)
N89°43'02"W
GRAVEL
GRASS
SHRUBS
CONC FOOTINGS
SEWER POST (8'-6")
WATER POST (6'-0")
GAS POST (2'-6")
BIT WALK
VGC
OHW
UP54-45
UP44
WFA-104
WFA-105
WFA-106
WFA-107
WFA-108
WFA-109
WFA-110
WFA-111
WFA-112
WFA-113
WFA-114
WFA-115


B3
B2
B1
B4
B5
STAIRS WITH (11) 6.43" RISERS
97.20
100.00
103.10
100.80
WOODED
GRASS/VEGETATION
GRAVEL
GRASS
ELINOR & DAVID DOOLEY
DEED BOOK 14444, PAGE 44
259 MAIN STREET
MAP 12, LOT 39
1.5 STOR WOOD DWELLING
GARAGE
CONC FOOTINGS
MAY NEED TO SLOPE UP IN THIS AREA TO ALLOW FOR GREATER SEPARATION AT RAIN GARDEN
R=95.08(DMH)
INV=91.3±
(UNDER WATER)
179.20'(C)
175.15(R)
N3°06'35"E
150.00'
N51°12'47"W
77.12'
SHRUBS
BIT WALK
VGC
MAIN STREET (ROUTE 28)
1900 S.H.L.O. #511
PUBLIC-66' WIDE

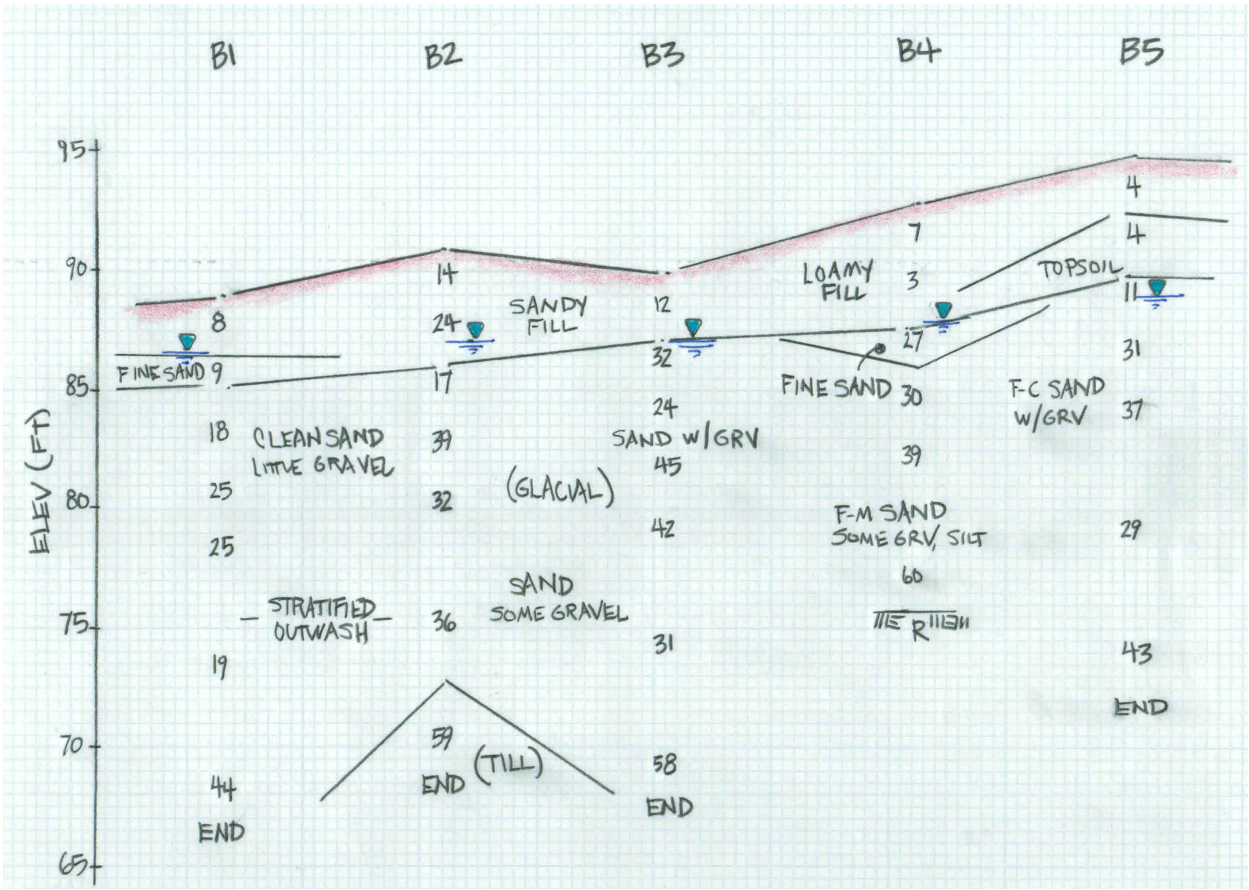
SUBSURFACE EXPLORATION PROGRAM

Test Borings

The exploration program involved five (5) test bores around the proposed pad where accessible. The test bores (B1 to B5) were advanced to refusal depths of ≈17-22 ft utilizing 4 inch hollow stem augers. Soil samples were typically retrieved at no greater than 5 ft intervals with a 2 inch diameter split-spoon sampler. Standard Penetration Tests (SPTs) were performed at the sampling intervals in general accordance with ASTM-D1586 (*Standard Method for Penetration Test and Split-Barrel Sampling of Soils*). Field descriptions and penetration resistance of the soils encountered, observed depth to groundwater, depth to refusal and other pertinent data are contained on the attached *Test Boring Logs*. The attached *Sketch* shows the test bore locations. Building corners and limits were surveyed by others.

SUBSURFACE CONDITIONS

The subgrade conditions below (1) shallow Fill and/or Organic laden soils include (2) Stratified Glacial Outwash deposits then (3) deeper Glacial Till or Refusal. A *Subsurface Profile* depicting the soil and groundwater conditions is attached for review.



SUBSURFACE PROFILE

Shallow Fill and Organic laden soils were encountered at ALL the test holes to depths ≈2-6 ft below grade (typically ≈4-5 ft). The Fill varies from Granular Fill to Loamy Fill. The Granular Fill (B2 & B3) appears to be re-worked site soils with a darker color and minor loam. The Loamy Fill includes a dark brown, loamy, silty Sand, trace gravel, roots, organic, rubble, etc. The Loamy Fill was generally loose. Organic soils are present at the surface in wooded and grass areas. Some buried Topsoil & Subsoil were present at B5 to about ≈6 ft. Other Fill should be expected given the building foundations, intersecting utilities, existing construction and past grading.

The parent site soils consist of a brown, stratified, glacial Outwash. These soils include Clean Sand, Fine Sand, gravelly Sand and/or sandy Gravel with trace to little silt. These soils are clean, granular and well-draining. At depth, there is a Glacial Till encountered at B2 (≈20 ft depth). Test bore refusal was only encountered at B4 (≈17 ft depth).

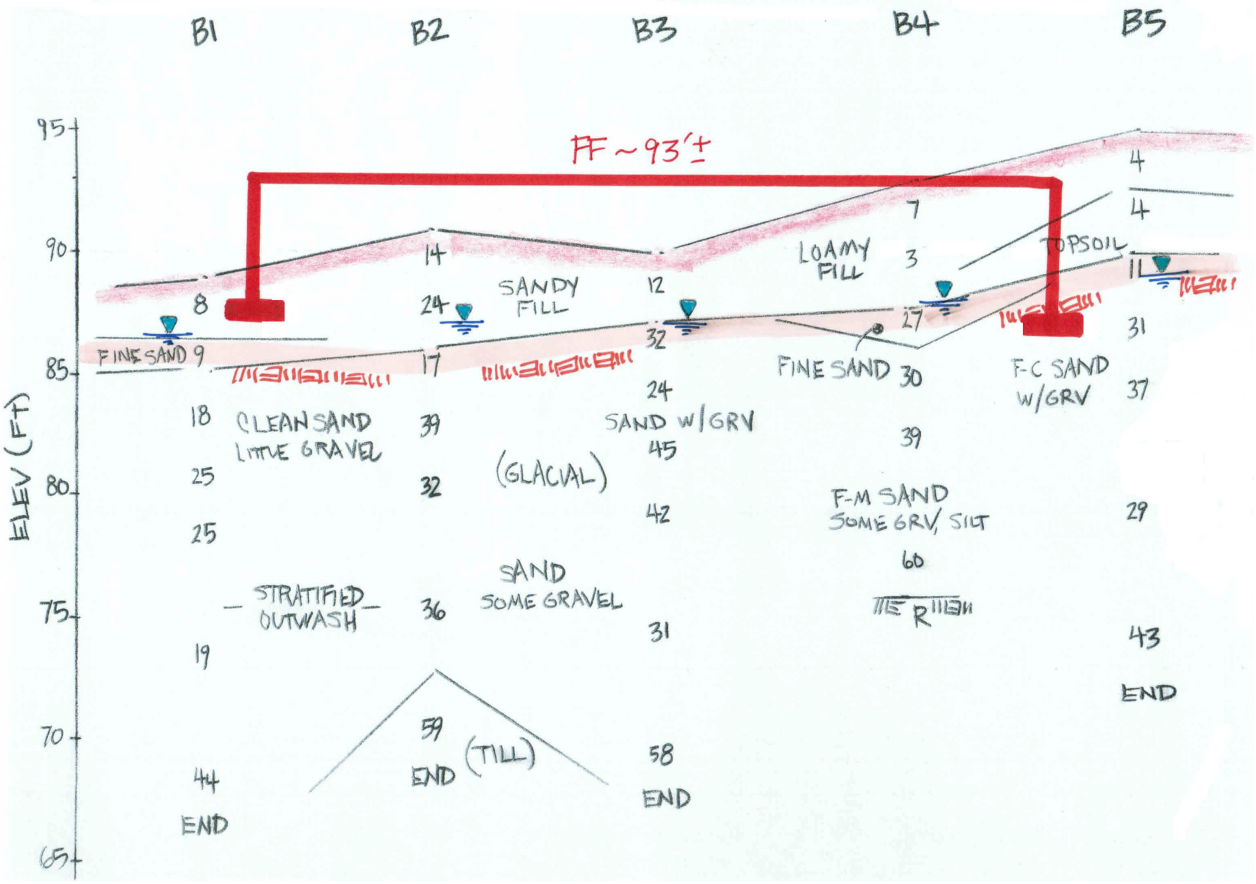
Groundwater was encountered at shallow depths of ≈2-6 ft in the test holes for this study. Wet and saturated soils were present at these shallow depths. These depths correspond to near elevation ≈87-89 ft. Shallow wetlands are delineated near elevation ≈89-90 ft. It should be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, utilities, flooding and other factors differing from the time of the measurements. This study was completed at a time of seasonally normal to high groundwater.

FOUNDATION SUBGRADE RECOMMENDATIONS

The subgrade conditions are favorable for supporting the proposed building on a conventional spread footing foundation. The undocumented Fill & Organic laden soils, however, are **not** considered suitable for foundation support. As such, these soils, abandoned foundations, intersecting utilities and other questionable matter should be fully removed from the building footprint including the *Footing Zone of Influence* (*FZOI*) to expose the Glacial soils. The *FZOI* is defined as that area extending laterally one foot from the edge of footing then outward and downward at a 1H:1V splay. In most areas, there is expected to be at least ≈4-5 ft of undocumented Fill and/or Organic laden soils. Structural Fill necessary to achieve foundation grade should conform to the *Specifications* (Table 1).

The parent subgrade soils (Glacial) should be exposed in the foundation areas prior to casting the footings or placing structural fill. It is recommended that the parent subgrade soils be proof-rolled with vibratory densification and exhibit stable and compact conditions. The purpose of the proof-rolling is to densify the site soils and identify potential loose or unstable areas which should be removed as necessary. Proof-rolling should involve at least 4-5 passes with a vibratory compactor (minimum 850 pound static weight) operating at peak energy. During the proof rolling process, the subgrade should be observed by an Engineer to identify areas exhibiting weaving or instability. It will be necessary to remove weakened or unstable soils and replace with a Structural Fill or crushed stone. Proof-rolling should not be used when the subgrade is wet (groundwater, storm water, perched water, etc) as this may result in soil pumping and instability. The contractor should exercise extra precaution to minimize subgrade disturbance in these wet areas. Specifically, the groundwater table should be continuously maintained at least one foot below construction grade until the

backfilling is complete. A base of ¾-inch minus crushed stone (or larger graded stone) should be placed atop the earthen subgrade if wet conditions and groundwater seepage are present. The stone should be *immediately* placed atop the undisturbed subgrade then tamped with a plate compactor exhibiting stable conditions. The purpose of the stone base is to protect the wet subgrade, facilitate necessary dewatering and provide a dry/stable base upon which to progress foundation construction. Groundwater is typically more problematic if construction occurs during the wetter winter or spring season. The drier summer months are more favorable for groundwater control. Proper groundwater control and storm water management are also necessary to maintain site stability.



CONCEPTUAL SPREAD FOOTING FOUNDATION

The subgrade should ultimately be stable, dewatered, compact and protected from frost throughout construction. Bearing subgrades that become weakened or disturbed due to wet conditions will be rendered unsuitable for structural support. The Contractor shall ultimately be responsible for the means and methods of temporary groundwater control, subgrade protection and site stability during construction. An Engineer from KMM should be scheduled to review the foundation subgrade conditions and preparation during construction.

FOUNDATION DESIGN RECOMMENDATIONS

The footings are expected to gain bearing support atop the parent soils and/or compacted structural fill. Footings may be designed using an allowable bearing capacity of 5 ksf (FS=3). The allowable bearing capacity may be increased a third (⅓) when considering transient loads such as wind or seismic. The bearing capacity is contingent upon the perimeter strip footings and isolated column footings being no less than 2 ft and 3 ft in width respectively. For footings less than 3 ft in lateral dimension, the allowable bearing capacity should be reduced to one-third and multiplied by the least lateral footing dimension in feet. Foundation settlement should be less than 1 inch with differential settlement less than ½ inch. The settlement should be elastic and occur during construction. Exterior footings shall be provided with at least 4 ft of frost protection.

The subsurface conditions were reviewed with respect to seismic criteria set forth in the ***Massachusetts State Building Code***. Based on the relative density of the soils and the depth to groundwater, the site does not appear susceptible to liquefaction in the event of an earthquake. Based on interpretation of the *Building Code*, the *Site Classification* is "D" (Stable Soil Profile).

It is recommended that a minimum 12-inch base of *Gravel Base Fill* (Table 1) be placed below the garage floor slab for moisture, strength and frost control. The gravel base shall be no less than 12 inches for exterior concrete slabs exposed to frost (≈15 inches at ramps and entrances). A vapor retarder should be used below the floor slab dependent upon the floor treatment. A vapor barrier should be specified by others per ACI Standards. A typical vapor retarder includes minimum 10-mil polyethylene or StegoWrap™ with joints lapped 10 inches.

Structural fill necessary within and below the foundation should also conform to the attached *Specifications* (Table 1). The Granular Outwash soils are suitable for re-use as Structural Fill or backfill around the foundation. The Outwash soils are suitable for re-use provided they are segregated from the organic laden soils, are screened of large stones and conform to Specification.

CONSTRUCTION CONCERNS

The contractor should be required to maintain a stable-dewatered subgrade for the building foundation and other concerned areas during construction. Subgrade disturbance may be influenced by excavation methods, moisture, precipitation, groundwater control and construction activities. The glacial outwash soils are not considered vulnerable to disturbance when exposed to wet conditions and construction activities given their good drainage. Steady groundwater seepage, however, will likely disturb these soils if not properly managed during construction. The contractor should take precautions to reduce subgrade disturbance. Such precautions may include diverting storm run-off away from construction areas, reducing traffic in sensitive areas, minimizing the extent of exposed subgrade if inclement weather is forecast, backfilling footings as soon as practicable and maintaining an effective dewatering program. Soils exhibiting weaving or instability should be over-excavated to a competent bearing subgrade then replaced with a free draining structural fill or crushed stone. The moisture concerns are typically more problematic if construction takes place during the winter to spring season or other periods of inclement weather. A protective base of ¾-inch minus crushed stone may be placed at least ≈6 inches below and laterally beyond the footing limits for protection

during construction. The stone base is to protect the site soils, facilitate necessary dewatering and provide a dry/stable base upon which to progress foundation construction. The protective base should be considered elective and dependent upon the site conditions. The stone base should be considered necessary if wet conditions are present at footing grade. The protective stone base shall be tamped with a plate compactor and exhibit stable conditions.

The groundwater table will need to be temporarily controlled during construction to complete work in dry conditions and protect the competency of the subgrade. The groundwater table should be continuously maintained at least one foot below construction grade until backfilling is complete. The groundwater is expected to be controlled with conventional sumps and pumps. The temporary sumps should be filtered with stone and fabric and extend at least ≈30 inches below construction grade. A ≈6 inch lift of ¾-inch minus crushed stone should be placed atop the wet subgrade to protect its competency and facilitate dewatering. The stone base should have positive slope to the sump. Adequate dewatering and storm water management are necessary for maintaining the competency of the site soils. The discharge of the collected water should be reviewed by others.

The subgrade should ultimately be stable, dewatered, compact and protected from frost throughout construction. Bearing subgrades that become weakened or disturbed due to wet conditions will be rendered unsuitable for structural support. The Contractor shall ultimately be responsible for the means and methods of temporary groundwater control, subgrade protection and site stability during construction. An Engineer from KMM should be scheduled to review the foundation subgrade conditions and preparation during construction.

CONSTRUCTION MONITORING

It is recommended that a qualified engineer or representative be retained to review earthwork activities such as the preparation of the foundation bearing subgrade and the placement/compaction of Structural Fill. It is recommended that KMM be retained to provide construction monitoring services. This is to observe compliance with the design concepts presented herein.

CLOSURE

This study was completed for preliminary geotechnical review given lack of definitive plans. Additional geotechnical exploration and engineering may be necessary as the project progresses. The final foundation design shall be completed in accordance with the *Massachusetts State Building Code*.

We trust the contents of this memorandum report are responsive to your needs at this time. Should you have any questions or require additional assistance, please do not hesitate to contact our office.

LIMITATIONS

Explorations

1. The analyses, recommendations and designs submitted in this report are based in part upon the data obtained from preliminary subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations of this report.

2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretation of widely spaced explorations and samples; actual soil transitions are probably more gradual. For specific information, refer to the individual test pit and/or boring logs.

3. Water level readings have been made in the test pits and/or test borings under conditions stated on the logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, and other factors differing from the time the measurements were made.

Review

4. It is recommended that this firm be given the opportunity to review final design drawings and specifications to evaluate the appropriate implementation of the recommendations provided herein.

5. In the event that any changes in the nature, design, or location of the proposed areas are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of the report modified or verified in writing by KMM Geotechnical Consultants, LLC.

Construction

6. It is recommended that this firm be retained to provide geotechnical engineering services during the earthwork phases of the work. This is to observe compliance with the design concepts, specifications, and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction.

Use of Report

7. This report has been prepared for the exclusive use of Katz Group in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

8. This report has been prepared for this project by KMM Geotechnical Consultants, LLC. This report was completed for preliminary design purposes and may be limited in its scope to complete an accurate bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to preliminary geotechnical design considerations only.

TABLE 1

Proposed Building
267 Main Street
Reading, MA

Recommended Soil Gradation & Compaction Specifications

Gravel Base Fill
(Crushed Gravel Fill)

SIEVE SIZE	PERCENT PASSING BY WEIGHT
3 inch	100
3/4 inch	60-90
No. 4	20-70
No. 200	2-8

NOTE: For minimum 8-inch base below Concrete Floor Slab-on-Grade
For minimum 12-inch base for exterior concrete slabs exposed to frost
For minimum 12-inch base below garage level slab
Shall have less than 12% fines (No. 200 sieve) based on the Sand fraction

Structural Fill
(Gravelly SAND, trace Silt)

SIEVE SIZE	PERCENT PASSING BY WEIGHT
5 inch	100
3/4 inch	50-100
No. 4	20-80
No. 200	0-10

NOTE: For use as structural load support below the foundations
For use as backfill behind unbalanced foundation/retaining walls
A ¾-inch crushed stone may be used in wet conditions
Shall have less than 20% fines (No. 200 sieve) based on the Sand fraction

Structural Fill placed beneath the foundation should include the *Footing Zone of Influence* which is defined as that area extending laterally one foot from the edge of the footing then outward and downward at a 1H:1V splay. Structural Fill should be placed in loose lifts not exceeding 12 inches for heavy vibratory rollers and 8 inches for vibratory plate compactors. All Structural Fill should be compacted to at least 95 percent of maximum dry density as determined by the Modified Proctor Test (ASTM-D1557). Structural Fill should be compacted within ±3% of optimum moisture content. The adequacy of the compaction efforts should be verified by field density testing which is also a requirement of the *Massachusetts State Building Code*.

TEST BORING LOG

SOIL X, Corp.
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Site: Proposed Building
267 Main Street
Reading, MA.

BORING B-1

PROJECT NO. 1905032

DATE: May 15, 2019

Ground Elevation: 89 ft+/-
Date Started: May 14, 2019
Date Finished: May 14, 2019
Driller: PG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATI
5/14/19	2 ft		

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
1		1	3"	0'0" – 2'0"	1-4-4-3		Dark Brown, loamy, silty SAND, little organic, trace gravel, root (LOAMY FILL)
		2	3"	2'0" – 3'0"	2-1	3'	
		2A	6"	3'0" – 4'0"	8-11		Brown, Fine Sand, little silt, wet
5		3	18"	5'0" – 7'0"	7-8-10-11	5'	Brown, fine to coarse Sand, trace fine gravel, wet
		4	21"	7'0" – 9'0"	11-13-12-15		Brown, f-c Sand, trace silt, wet
10		5	21"	10'0" – 12'0"	8-10-15-18		Brown, f-m Sand, little silt Brown, Fine Sand w/ Silt (GLACIAL OUTWASH)
15		6	18"	15'0" – 17'0"	8-8-11-13		Brown, fine to medium Sand, little silt
20		7	21"	20'0" – 22'0"	18-21-23-28		Brown, fine to coarse Sand, some gravel, trace silt, wet
							End of boring 22 ft Water encountered at 2 ft upon completion
25							
30							

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SOIL X, Corp.
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Site: **Proposed Building**
267 Main Street
Reading, MA.

BORING B-2

PROJECT NO. 1905032

DATE: May 15, 2019

Ground Elevation: 91 ft+/-
Date Started: May 14, 2019
Date Finished: May 14, 2019
Driller: PG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATI
5/14/19	4 ft		

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
1		1	15"	0'0" – 2'0"	6-7-7-8		Dark Brown, fine to coarse Sand, some gravel, little silt (FILL)
		2	18"	2'0" – 4'0"	8-11-13-26	5'	
5		3	18"	5'0" – 7'0"	6-8-9-11		Grey, fine to medium Sand, little gravel, trace/little silt, wet
		4	21"	7'0" – 9'0"	11-18-21-20		Brown, f-m Sand, trace silt, wet Brown, f-c Sand, little gravel, trace silt, wet
10		5	18"	10'0" – 12'0"	8-13-19-23		Brown, fine to coarse Sand, some gravel, trace silt (STRATIFIED GLACIAL OUTWASH)
15		6	18"	15'0" – 17'0"	16-18-18-21		Brown, f-c Sand, little gravel, trace silt, wet
20		7	18"	20'0" – 22'0"	21-28-31-37	20'	Olive, fine to medium Sand, some gravel, some silt
25							End of Boring 22 ft Water encountered at 4 ft upon completion
30							

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SOIL X, Corp.
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Site: **Proposed Building**
267 Main Street
Reading, MA.

BORING B-3

PROJECT NO. 1905032

DATE: May 15, 2019

Ground Elevation: 90 ft+/-
Date Started: May 14, 2019
Date Finished: May 14, 2019
Driller: PG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATI
5/14/19	3 ft		

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
1		1	6"	0'0" – 2'0"	3-6-6-7	2'	Dark Brown, fine to coarse Sand, little gravel, little silt (FILL)
		2	21"	2'0" – 4'0"	10-14-18-26		Brown, f-c Sand w/ Gravel, wet
5		3	18"	5'0" – 7'0"	10-11-13-13		
		4	21"	7'0" – 9'0"	16-18-27-33		Brown, f-c Sand & Gravel, wet
10		5	21"	10'0" – 12'0"	17-19-23-23		Brown, fine to coarse SAND, little gravel, trace silt, wet
							(STRATIFIED GLACIAL OUTWASH)
15		6	18"	15'0" – 17'0"	15-13-18-22		Brown, f-c Sand, some gravel, trace silt, wet
20		7	18"	20'0" – 22'0"	23-25-33-40		Same
							End of boring 22 ft Water encountered at 3 ft upon completion
25							
30							

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SOIL X, Corp.
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Site: **Proposed Building**
267 Main Street
Reading, MA.

BORING B-4

PROJECT NO. 1905032

DATE: May 15, 2019

Ground Elevation: 93 ft+/-
Date Started: May 14, 2019
Date Finished: May 14, 2019
Driller: PG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATI
5/14/19	5 ft		

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
1		1	15"	0'0" – 2'0"	2-3-4-2		Dark Brown, loamy, silty Sand, little gravel, trace ash, rubble, coal, organic (LOAMY FILL)
		2	12"	2'0" – 4'0"	2-2-1-2	5'	
5		3	18"	5'0" – 7'0"	8-10-17-21		Brown, Fine Sand, little silt., wet
		4	18"	7'0" – 9'0"	22-13-17-18	7'	
10		5	21"	10'0" – 12'0"	16-21-18-22		Brown, fine to medium Sand, some gravel, little silt, wet (STRATIFIED GLACIAL OUTWASH)
15		6	15"	15'0" – 16'9"	21-27-33-100/3"	17'	Same
20							Auger Refusal at 17 ft Water encountered at 5 ft upon completion
25							
30							

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SOIL X, Corp.
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Site: **Proposed Building**
267 Main Street
Reading, MA.

BORING B-5

PROJECT NO. 1905032

DATE: May 15, 2019

Ground Elevation: 95 ft+/-
Date Started: May 14, 2019
Date Finished: May 14, 2019
Driller: PG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATI
5/14/19	6 ft		

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
1		1	15"	0'0" – 2'0"	1-2-2-3		Dark Brown, loamy silty Sand, trace gravel (LOAMY FILL)
		2	12"	2'0" – 4'0"	2-2-2-3	4'	Topsoil Loamy Subsoil, roots
5		3	6"	5'0" – 6'0"	3-4	6'	
		3A	12"	6'0" – 7'0"	7-10		
		4	21"	7'0" – 9'0"	11-13-18-25		Dark Brown, fine to coarse Sand, some gravel, little/trace silt
10		5	21"	10'0" – 12'0"	16-18-19-21		Brown, f-m Sand & Gravel, trace silt, wet (STRATIFIED GLACIAL OUTWASH)
15		6	21"	15'0" – 17'0"	12-13-16-18		Brown, fine to coarse Sand, some gravel, trace silt
20		7	21"	20'0" – 22'0"	18-21-22-31		Same
25							End of Boring at 22 ft Water encountered at 6 ft upon completion
30							

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	


Brooks
& Brooks

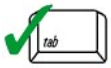
APPENDIX D
STORMWATER MANAGEMENT FORM AND CHECKLIST

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

Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

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

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

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

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

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

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

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.

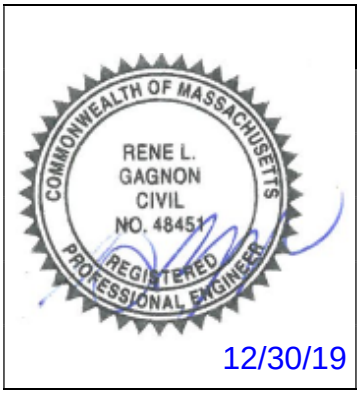
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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



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.