STORMWATER REPORT

AYER COMMONS

65 FITCHBURG ROAD
AYER, MASSACHUSETTS

NOVEMBER 3, 2022

Applicant:

Neighborhood of Affordable Housing, Inc.

Neighborhood of Affordable Housing, Inc.
143 Border Street
East Boston, MA

BSC Job Number: 8-9926.01

Prepared by:

BSC GROUP

803 Summer Street
Boston, MA 02127

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SECTION 1.0

PROJECT NARRATIVE

1.01 PROJECT DESCRIPTION

The Neighborhood of Affordable Housing (The Applicant), is proposing to redevelop the existing property comprised of a landscaping lay down yard and welding business, located at 65 Fitchburgh Road in Ayer, Massachusetts, hereinafter referred to as "the Project". The total site area is 10.59 acres (461,100 square feet). The project will disturb approximately 5.1 acres of land. The site is bounded by Anderson Funeral Home to the east, an HVAC company to the West, a residential neighborhood to the North, and across Fitchburgh Road to the South is an industrial/warehouse facility.

The project involves construction of seven (7) multi-family residential buildings (one having interior parking) and a community building, surface parking lots, and associated utilities to support the development. Improvements will be made to the boulevard-style driveway including addition of a sidewalk and stormwater improvements.

The Project is a redevelopment project designed to comply with the Massachusetts Wetlands Protection Act (The Act) and its enacting regulations (310 CMR 10.00), as well as the Department of Environmental Protection's Stormwater Management Standards and the Town of Ayer Wetlands Protection Bylaw. Portions of the project will occur within the 100-foot buffer to bordering vegetated wetlands (BVW). The project is located adjacent to, but fully outside, the Zone A Flood Area (1% chance of annual flood zone) according to the most recent FEMA Flood Insurance Rate Map included in the Appendix of this report.

1.02 PRE-DEVELOPMENT DRAINAGE CONDITIONS

The existing property, approximately 10.59 acres, is currently in use as a Landscaping business lay down yard, a welding business, and an abandoned home. The site is bisected by a wetland system, with associated buffer zones. North of the wetland system is undeveloped land within the same property sloping toward the wetlands with average slopes between 2 – 10%.

The existing site drains to the wetland system that bisects the property. The current stormwater does not pass through any treatment prior to reaching the wetlands. Existing surface conditions to the south of the wetlands are largely gravel and broken pavement, along with woods related to the forested wetland. North of the wetlands is entirely wooded.

The NRCS Web Soil Survey (see Appendix), has identified four primary soil classifications underlying the project site. The soil map units classified as 6A, 259B and 626B and 652 account for nearly all of the project area and range from coarse sand, well-draining soils to Scarboro muck with low infiltration rates. Test pits were performed by Northeast Geotechnical, Inc. in July 2021, and detailed test pit information is included in the Appendix of this Report. Results of soil testing indicate that the in-situ sandy soils are acceptable for recharge in the areas tested, even though a large band of surrounding soils are classified as Udorthents (i.e. fill) in the Soil Survey. As all surrounding upland area adjacent to this band and throughout the site are rated as hydrologic soil group (HSG) type "A", and test pit data within this band found all in-situ soil to be sand and loamy sand, the area of Udorthents in the middle of the site will assume to act as HSG-A soil, as well. This is shown in the Watershed Plans of Section 4 of this Report.

1.03 POST-DEVELOPMENT DRAINAGE CONDITIONS

Specifics of the proposed site stormwater management are as follows:

The proposed stormwater management system has been designed to meet the provisions of the Department of Environmental Protection (DEP) Stormwater Management Standards for a redevelopment project. Stormwater runoff from the proposed project will be captured and routed to three infiltration systems to attenuate peak runoff rates, provide treatment of stormwater prior to discharge, and to provide infiltration back to groundwater. Stormwater from roof runoff will be directed to the infiltration systems prior to discharge. Stormwater runoff from the surface parking lots will be collected in deep-sump, hooded catch basins or inlet water quality units for pre-treatment prior to infiltration and attenuation. In larger storm events, stormwater will overflow through outlet control structures from the infiltration systems and be discharged through proposed flared end sections with rip-rap protection to the wetlands in the center of the site.

The attached site plan shows a mix of 1, 2 and 3 bedroom units, associated parking and amenity areas, along with stormwater management features to mitigate the development of the site.

Catchment area S1A and S1D each have their own system and are proposed for Phase 1. Each have their own discharge point to the central wetlands. Catchment area S1B is for Phase 2 and also discharges to the wetlands.

Standard 1 - New Stormwater Conveyances

Per Massachusetts Stormwater Management Standard #1, no new outfalls may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth. The project proposes to discharge through new outfalls to the existing wetland along the intermittent stream to

the Northeast. All runoff will be treated to a minimum 80% TSS removal as required. See Section 6.05 of this Report for outfall sizing calculations.

Standard 2 - Stormwater Runoff Rates

Watershed modeling was performed using HydroCAD Stormwater Modeling Software version 10.0, a computer aided design program that combines SCS runoff methodology with standard hydraulic calculations. A model of the site's hydrology was developed for both pre- and post-development conditions to assess the effects of the proposed development.

The stormwater management system for the project has been designed such that the post-development conditions do not increase the peak runoff rates for the 2-year, 10-year, and 100-year, 24-hour storm events. A reduction in peak runoff rates is achieved through the use of stormwater infiltration ponds and subsurface infiltration chambers to attenuate and recharge runoff from paved surfaces and new building roof as detailed in the tables below.

Table 1.1 – Peak Flow Rates Summary to Wetland (R1)

	Existing Conditions (cfs)	Proposed Improvements (cfs)	Peak Runoff Decrease (cfs)
2-year Peak Runoff	5.52	0.95	-4.57
10-year Peak Runoff	12.71	3.2	-9.51
25-year Peak Runoff	18.55	5.40	-13.15
100-year Peak Runoff	22.95	7.49	-15.46

Standard 3 - Groundwater Recharge

The existing ground water recharge is estimated based on the Massachusetts Stormwater Management Standards #3, as follows:

Rv = F x impervious area

Rv = *Required Recharge Volume*, in Ft^3, cubic yards, or acre-feet

F = Target Depth Factor associated with each Hydrologic Soil Group

Impervious Area = pavement and rooftop area on site

Table: Recharge Target Depth by Hydrologic Soil Group

NRCS HYDROLOGIC SOIL TYPE	APPROX. SOIL TEXTURE	TARGET DEPTH FACTOR (F)
A	sand	**0.6-inch**
B	loam	**0.35-inch**
C	silty loam	**0.25-inch**
D	clay	**0.1-inch**

The Natural Resources Conservation Service (NRCS) classified the site under four separate soil types; two of which (259C and 626B; Carver and Merrimack, respectively) have an HSG-A classification, and one (6A; Scarboro) has an HSG-A/D classification. One soil (652; Udorthents) has no NRCS rating, but will be assumed HSG-A consistent with all surrounding soil types and with the findings of local test pits. Test pits were performed on site by Northeast Geotechnical in July of 2021, with detailed field logs included in the Appendix of this report.

The following table summarizes the prescribed stormwater runoff volume required to be recharged to the groundwater based on existing global soil conditions within the proposed limit of work determined from current soils maps of the area along with onsite soil evaluations.

Hydrologic Group	Proposed Impervious Area	Inches of Recharge Required	Total Prescribed Stormwater Runoff Volume to Recharge
A	2.80 acres	0.60	0.1400 acre-feet
B	0 acres	0.35	0 acre-feet
C	0 acres	0.25	0 acre-feet
D	0 acres	0.10	0 acre-feet
Totals	**2.80 acres**	**-**	**0.1400 acre-feet, 6,094 cubic feet**

To meet/exceed the prescribed stormwater runoff volume to be recharged to the groundwater, the Project proposes the construction of new subsurface infiltration chamber systems. These have been sized per the *Static* Method as outlined in the Massachusetts Stormwater Handbook as follows;

Static Method

Infiltration System-1 (HydroCAD pond 1P)
Recharge Volume from Elevation 219.00' – 220.00' (bottom elevation to lowest invert out)
= 7,906 cf (see attached HydroCAD printout in Section 6.01)

Infiltration System-2 (HydroCAD pond 2P)
Recharge Volume from Elevation 218.00' – 218.70' (bottom elevation to lowest invert out)
= 904 cf (see attached HydroCAD printout in Section 6.01)

Infiltration System-3 (HydroCAD pond 3P)
Recharge Volume from Elevation 215.00' – 215.75' (bottom elevation to lowest invert out)
= 1,863 cf (see attached HydroCAD printout in Section 6.01)

Total = 10,673 cf provided (> 6,094 cf required) (>10,164 cf required for 1 inch of recharge)

Draw Down Calculation

$$Time_{drawdown} = \frac{Rv}{(K)(Bottom\ Area)}$$

Where:
Rv = Storage Volume
K = Saturated Hydraulic Conductivity For "Static" and "Simple Dynamic" Methods, use Rawls Rate (see Table 2.3.3)
Bottom Area = Bottom Area of Recharge Structure

Infiltration System-1 (Pond 1P) Drawdown

$$Time_{drawdown} = \frac{9{,}820\ cf}{(2.41 inches/hr)(1ft/12inches)(12{,}963sf)}$$

$Time_{drawdown}$ = 3.77 hrs*

*3.77 hours is less than the 72 hours required maximum draw down time.

Infiltration System-2 (Pond 2P) Drawdown

$$Time_{drawdown} = \frac{2{,}579\ cf}{(2.41 inches/hr)(1ft/12inches)(2{,}975sf)}$$

$Time_{drawdown}$ = 4.32 hrs*

*4.32 hours is less than the 72 hours required maximum draw down time.

Infiltration System-3 (Pond 3P) Drawdown

$$Time_{drawdown} = \frac{1{,}863\ cf}{(2.41 inches/hr)(1ft/12inches)(4{,}592sf)}$$

$Time_{drawdown}$ = 2.02 hrs*

*2.02 hours is less than the 72 hours required maximum draw down time.

Table: 1982 Rawls Rates (Rawls, Brakensiek and Saxton, 1982_

Texture Class	NRCS Hydrologic Soil Group (HSG)	Infiltration Rate Inches/Hour
Sand	A	8.27
Loamy Sand	**A**	**2.41**
Sandy Loam	B	1.02
Loam	B	0.52
Silt Loam	C	0.27
Sandy Clay Loam	C	0.17
Clay Loam	D	0.09
Silty Clay Loam	D	0.06
Sandy Clay	D	0.05
Silty Clay	D	0.04
Clay	D	0.02

Standard 4 - Water Quality

The stormwater management system has been designed to provide treatment for stormwater runoff from all the new impervious areas. Water Quality Unit (WQU) sizing calculations are included in Section 6.03 of this report. These sizing calculations were performed using the Water Quality flow rate as outlined in the *2013 MA DEP Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Systems* (2013 MADEP Q Rate).

$Q_{WQ} = (q_u)(A)(D_{WQ})$

Q_{WQ} = Water Quality Flow Rate for first 0.5-inch of runoff (in cubic feet per second)
q_u = unit peak discharge (in csm/in*, see 2013 MADEP Q Rate for T_c=0.1 hours)
A_{IMP} = Impervious Area (in square miles)
D_{WQ} = Water Quality Depth: **0.5**-inch.

*csm/in: cubic feet per second per square mile per watershed inch

Refer to Sections 6.02 and 6.03 of this Report for calculations and sizing information of each individual water quality unit proposed.

The proposed stormwater management system has been designed to meet the Massachusetts Stormwater Handbook Standard #4 for the removal of a minimum of 80% Total Suspended Solids (TSS). This is achieved by the following structural and non-structural Best Management Practices (BMP's):

- Deep-sump hooded catch basins (25%)
- Hydrodynamic Water Quality Units (77%)
- Infiltration Basins (80%, with adequate pretreatment)

See Section 6.04 TSS Removal Calculations for Treatment Train Calculations

Standard 5 – Land Uses with Higher Potential Pollutant Loads (LUHPPL)

The Project is not considered a land use with higher potential pollutant loads.

Standard 6 – Stormwater Discharges to a Critical Area

The project is not subject to Standard 6. There are no discharges to any Critical Areas as defined by the Stormwater Handbook.

Standard 7 – Redevelopment Projects

This project is not a redevelopment project, and all standards are met fully.

Standard 8 – Sedimentation and Erosion Control Plan

A Sedimentation and Erosion Control Plan is included within the plan set as Sheet C-101 along with a narrative in Section 3.0 of this Report.

Standard 9 – Long Term Operation and Maintenance Plan

A long-term operation and maintenance plan is included in Section 2.0 of this Report

Standard 10 –Illicit Discharges to the Stormwater Management System are Prohibited

There are no known illicit discharges to the proposed Stormwater Management System and none are proposed.

Conclusions

The project has been designed to meet, and in some cases exceed, the applicable provisions of the Stormwater Management Standards. With the provisions of deep-sump hooded catch basins, water quality units, and surface infiltration basins, along with nonstructural BMP's (landscaping, street sweeping, etc.), the proposed development of the property has been designed to reduce the impacts to the surrounding Resource Areas and properties.

SECTION 2.0

LONG-TERM POLLUTION PREVENTION & OPERATION AND MAINTENANCE PLAN

2.0 LONG-TERM POLLUTION PREVENTION & OPERATION AND MAINTENANCE PLAN

As required by Stormwater Standard #4, this Long-Term Pollution Prevention Plan has been developed for source control and pollution prevention at the site after construction.

MAINTENANCE RESPONSIBILITY

As required by Stormwater Standard #4, this Long-Term Pollution Prevention Plan has been developed for source control and pollution prevention at the site after construction.

GOOD HOUSEKEEPING PRACTICES

The site is to be kept clean of trash and debris at all times. Trash, junk, etc. is not to be left outside and will be subject to removal at the owner's expense.

REQUIREMENTS FOR ROUTINE INSPECTIONS AND MAINTENANCE OF STORMWATER BEST MANAGEMENT PRACTICES

All stormwater Best Management Practices (BMP's) are to be inspected and maintained as follows:

Straw Wattles, Silt Fences, and other temporary measures

The temporary erosion control measures will be installed up gradient of any wetland resource area where any disturbance or alteration might otherwise allow for erosion or sedimentation. They will be regularly inspected to insure that they are functioning adequately. Additional supplies of these temporary measures will be stockpiled on site for any immediate needs or routine replacement. Temporary BMP's will be removed and disposed of appropriately upon site stabilization.

Deep Sump Hooded Catch Basins

Regular maintenance is essential. Deep sump catch basins remain effective at removing pollutants only if they are cleaned out frequently. Inspect at least four times per year including at the end of the foliage and snow removal seasons. Sediments must be removed two times per year or whenever the depth of the deposits in the catch basin sump is greater than or equal to one foot. Maintenance of these units should be done by a vacuum truck that will remove the water, sediment, debris, floating hydrocarbons and other materials in unit. The proper cleaning and disposal of the removed materials and liquid must be followed.

Infiltration Basins

Infiltration basins perform an important role, as they provide 80% TSS removal at the end of the treatment train system. Maintenance is required for the proper operation of the Infiltration Basins. The use of pretreatment BMPs such as deep sump and hooded catch basins, and Stormceptor units will minimize failure and maintenance requirements.

After construction, the infiltration basins should be inspected after every major storm for the first few months to ensure proper stabilization and function. Water levels in the ponds should be recorded over several days to check the drainage of the systems. It is recommended that a log book be maintained showing the depth of water in the infiltration systems at each observation in order to determine the rate at which the system dewaters after runoff producing storm events. Once the performance characteristics of the detention/infiltration have been verified, the monitoring schedule can be reduced to an annual basis, unless the performance data suggests that a more frequent schedule is required.

Preventive maintenance on the infiltration systems should be performed at least four times a year, and sediment should be removed from any and all pretreatment and collection structures. Sediment should be removed when deposits approach a depth of six inches. Ponded water inside the system after several days most likely indicates the bottom of the system is clogged and requires cleaning.

Stormceptor Water Quality Units or approved equal

The Stormceptor water quality units or approved equal will require periodic inspection and cleaning to maintain operation and function. Owners should have these units inspected on a quarterly basis and after periods of intense precipitation. Inspections of the units can be done by using a clear Plexiglas tube ("sludge judge") to extract a water column sample. When sediment depths exceed 12-inches or other depth recommended by the manufacturer, then cleaning of the unit is required.

These water quality structures must and will be checked and cleaned immediately after petroleum spills. In the event of a spill, the appropriate regulatory agency must be notified.

Maintenance of these units should be done by a vacuum truck that will remove the water, sediment, debris, floating hydrocarbons and other materials in unit. The proper cleaning and disposal of the removed materials and liquid must be followed.

Inlet and outlet pipes must be checked for any obstructions and if any obstructions are found, they must be removed. Structural parts of the units will be repaired as needed.

Pipe Outlet Protection

The outlet protection should be checked at least annually and after every major storm. If the rip-rap has been displaced, undermined, or damaged, it should be repaired immediately. The channel immediately below the outlet should be checked to see that erosion is not occurring. The downstream channel should be kept clear of obstructions such as fallen trees, debris, and sediment that could change flow patterns and/or tailwater depths on the pipes. Repairs must be carried out immediately to avoid additional damage to the outlet protection apron.

SNOW DISPOSAL AND PLOWING

The purpose of the snow and snowmelt management plan is to provide guidelines regarding snow disposal site selection, site preparation and maintenance that are acceptable to the Department of Environmental Protection. For the areas that require snow removal, snow storage onsite will largely be accomplished by using pervious upland areas along the shoulder of the roadway as windrowed by plows. No snow shall be pushed into the wetlands.

- Avoid dumping of snow into any water body, including rivers, ponds, or wetlands. In addition to water quality impacts and flooding, snow disposed of in open water can cause navigational hazards when it freezes into ice blocks.
- Avoid disposing of snow on top of storm drain catch basins or in stormwater basins. Snow combined with sand and debris may block a storm drainage system, causing localized flooding. A high volume of sand, sediment, and litter released from melting snow also may be quickly transported through the system into surface water.

WINTER ROAD SALT AND/OR SAND USE AND STORAGE RESTRICTIONS

Road salt and sand shall not be stored onsite.

STREET SWEEPING SCHEDULES

There are three types of sweepers: Mechanical, Regenerative Air, and Vacuum Filter.

1) Mechanical: Mechanical sweepers use brooms or rotary brushes to scour the pavement.
2) Regenerative Air: These sweepers blow air onto the road or parking lot surface, causing fines to rise where they are vacuumed.
3) Vacuum Filter: These sweepers remove fines along roads. Two general types of vacuum filter sweepers are available - wet and dry. The dry type uses a broom in combination with the vacuum. The wet type uses water for dust suppression

Regardless of the type chosen, the efficiency of street sweeping is increased when sweepers are operated in tandem.

It is recommended that street sweeping of the parking areas occur four times a year using a Regenerative Air or Vacuum Filter sweeper, including once after the spring snow melt.

Reuse and Disposal of Street Sweepings

Once removed from paved surfaces, the sweepings must be handled and disposed of properly. Mass DEP's Bureau of Waste Prevention has issued a written policy regarding the reuse and disposal of street sweepings. These sweepings are regulated as a solid waste, and can be used in three ways:

- In one of the ways already approved by Mass DEP (e.g., daily cover in a landfill, additive to compost, fill in a public way)
- If approved under a Beneficial Use Determination
- Disposed in a landfill

TRAINING OF STAFF OR PERSONNEL INVOLVED WITH IMPLEMENTING LONG-TERM POLLUTION PREVENTION PLAN

The Long-Term Pollution Prevention Plan is to be implemented by property owner each individual lot. Trained and, if required, licensed Professionals are to be hired by the owner as applicable to implement the Long-Term Pollution Prevention Plan.

LIST OF EMERGENCY CONTACTS FOR IMPLEMENTING LONG-TERM POLLUTION PREVENTION PLAN

The Owner will be required to maintain an updated list of Emergency Contacts for the site. This list will be provided during construction.

CONTACT INFORMATION AND RESPONSIBLE PARTIES

The following is a list of all project-associated parties:

Current Owner/Applicant
Neighborhood of Affordable Housing
143 Border Street
East Boston, MA
617-567-5882

Engineering Consultant
BSC Group, Inc.
300 Brickstone Square, 901A
Andover, MA
617-896-4300

POST CONSTRUCTION PHASE INSPECTION SCHEDULE AND EVALUATION CHECKLIST

Inspection Date	Inspector	BMP Inspected	Inspection Frequency Requirements	Comments	Recommendation	Follow-up Inspection Required (yes/no)
		Catch Basins	Four times a year			
		Pipe Outlet Protection	Once a year			
		Infiltration Basin	Four times a year			
		Stormceptor Water Quality Units	Four times a year			

1. Refer to the Massachusetts Stormwater Handbook Volume Two: Stormwater Technical Handbook (February 2008) for recommendations regarding frequency for inspections and maintenance of specific BMP's

2. Inspections to be conducted by a qualified professional such as an environmental scientist or civil engineer.

3. Limited or no use of sodium chloride salts, fertilizers or pesticides recommended.

4. Annual reports shall be submitted to the DPW each year within 30 days of approval.

Other Notes: (Include deviations from Conservation Commission Approvals, Planning Board Approvals and Approved Plans)

SECTION 3.0

CONSTRUCTION PERIOD POLLUTION PREVENTION AND EROSION AND SEDIMENTATION CONTROL PLAN (STORM WATER POLLUTION PREVENTION PLAN - SWPPP)

3.0 CONSTRUCTION PERIOD POLLUTION PREVENTION AND EROSION AND SEDIMENTATION CONTROL PLAN (STORM WATER POLLUTION PREVENTION PLAN - SWPPP)

This Section specifies requirements and suggestions for implementation of a Storm Water Pollution Prevention Plan (SWPPP) for the construction of the Project. The SWPPP shall be provided and maintained on-site by the Contractor(s) during all construction activities. The SWPPP shall be updated as required to reflect changes to construction activity.

The storm water pollution prevention measures contained in the SWPPP shall be at least the minimum required by Local Regulations. The Contractor shall provide additional measures to prevent pollution from stormwater discharges in compliance with the Environmental Protection Agency's (EPA) National Pollution Discharge Elimination System (NPDES) 2022 Construction General Permit requirements and all other local, state and federal requirements.

The SWPPP shall include provisions for, but not be limited to, the following:

1. Construction Trailers
2. Lay-down Areas
3. Equipment Storage Areas
4. Stockpile Areas
5. Disturbed Areas

The Contractor shall NOT begin construction without submitting evidence that a NPDES Notice of Intent (NOI) governing the discharge of storm water from the construction site for the entire construction period has been filed at least **fourteen (14) days** prior to construction. It is the Contractor's responsibility to complete and file the NOI.

The cost of any fines, construction delays and remedial actions resulting from the Contractor's failure to comply with all provisions of local regulations and Federal NPDES permit requirements shall be paid for by the Contractor at no additional cost to the Owner.

As a requirement of the EPA's NPDES permitting program, each Contractor and Subcontractor responsible for implementing and maintaining stormwater Best Management Practices shall execute a Contractor's Certification/Agreement form.

Erosion and Sedimentation Control

The Contractor shall be solely responsible for erosion and sedimentation control at the site. The Contractor shall utilize a system of operations and all necessary erosion and sedimentation control measures, even if not specified herein or elsewhere, to minimize erosion damage at the site to prevent the migration of sediment into environmentally sensitive areas. Environmentally sensitive areas include all wetland resource areas within, and downstream of, the site, and those areas of the site that are not being altered.

Erosion and sedimentation control shall be in accordance with this Section, the design drawings, and the following:

- "Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices" (EPA 832-R92-005, Sept. 1992).
- "Storm Water Management for Construction Activities, Developing Pollution Prevention Plans and Best Management Practices – Summary Guidance" (EPA 833-R92-001, Oct. 1992).
- Massachusetts Stormwater Management Handbook issued by the Massachusetts Department of Environmental Protection, February 2008.
- Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas, A Guide

for Planners, Designers and Municipal Officials, March 1997.

The BMP's presented here should be used as a guide for erosion and sedimentation control and are not intended to be considered specifications for construction. The most important BMP is maintaining a rapid construction process, resulting in prompt stabilization of surfaces, thereby reducing erosion potential. Given the primacy of rapid construction, these guidelines have been designed to allow construction to progress with essentially no hindrance by the erosion control methods prescribed. These guidelines have also been designed with sufficient flexibility to allow the contractor to modify the suggested methods as required to suit seasonal, atmospheric, and site-specific physical constraints.

Another important BMP is the prevention of concentrated water flow. Sheet flow does not have the erosive potential of a concentrated rivulet. These guidelines recommend construction methods that allow localized erosion control and a system of construction, which inhibits the development of shallow concentrated flow. These BMP's shall be maintained throughout the construction process.

CONTACT INFORMATION AND RESPONSIBLE PARTIES

The following is a list of all project-associated parties:

Current Owner/Applicant
Neighborhood of Affordable Housing
143 Border Street
East Boston, MA

Contractor
TBD

Engineering Consultant
BSC Group, Inc.
300 Brickstone Square, 901A
Andover, MA

4.01 Procedural Conditions of the Construction General Permit (CGP)

The following list outlines the Stormwater responsibilities for all construction operators working on the Project. The operators below agree, through a cooperative agreement, to abide by the following conditions throughout the duration of the construction project, effective the date of signature of the required SWPPP. These conditions apply to all operators on the project site.

The project is subject to EPA's NPDES General Permit through the CGP. The goal of this permit is to prevent the discharge of pollutants associated with construction activity from entering the existing and proposed storm drain system or surface waters.

All contractors/operators involved in clearing, grading, and excavation construction activities must sign the appropriate certification statement, which will remain with the SWPPP. The owner must also sign a certification, which is to remain with the SWPPP in accordance with the signatory requirements of the SWPPP.

Once the SWPPP is finalized, a signed copy, plus supporting documents, must be maintained at the project site during construction. A copy must remain available to EPA, state and local agencies, and other interested parties during normal business hours.

The following items associated with this SWPPP must be posted in a prominent place at the construction site until final stabilization has been achieved:

- The completed/submitted NOI form

- Location where the public can view the SWPPP during normal business hours
- A copy of the signed/submitted NOI, permit number issued by the EPA and a copy of the current CGP.

Project specific SWPPP documents are not submitted to the US EPA unless the agency specifically requests a copy for review. If SWPPP documents are requested by a permitting authority, the permittee(s) will submit them in a timely manner.

EPA inspectors will be allowed free and unrestricted access to the project site and all related documentation and records kept under the conditions of the permit.

The permitee is expected to keep all BMP's and Storm Water controls operating correctly and maintained regularly.

Any additions to the project which will significantly change the anticipated discharges of pollutants, must be reported to the EPA. The EPA should also be notified in advance of any anticipated events of noncompliance. The permittee must also orally inform the EPA of any discharge, which may endanger health or the environment within 24 hours, with a written report following within 5 days.

In maintaining the SWPPP, all records and supporting documents will be compiled together in an orderly fashion. Inspection reports and amendments to the SWPPP must remain with the document. Federal regulations require permitee(s) to keep their Project Specific SWPPP and all reports and documents for at least three years after the project is complete.

4.02 Project Description and Intended Construction Sequence

The applicant is planning to redevelop the site. The existing property is currently in use as a Landscaping business lay down yard, a welding business, and an abandoned home. The development activities will include the following major components:

- Demolition of existing buildings;
- Site grading and installation of site utilities, including stormwater management systems and stormwater treatment features;
- Construction of parking areas and building;
- Landscaping associated with utilities and grading.

Soil disturbing activities will include site demolition, installing stabilized construction exits, installation of erosion and sedimentation controls, grading, stormwater management system, utilities, construction of roadways and preparation for final seeding, mulching and landscaping. Please refer to Table 1 for the projects anticipated construction timetable. A description of BMP's associated with project timetable and construction-phasing elements is provided in this SWPPP.

Table 1 – Anticipated Construction Timetable

Construction Phasing Activity	Anticipated Timetable
Demolition, Grubbing and Stripping of Limits of Construction	Summer 2022
Rough Site Grading and Site Utilities	Summer/Fall 2022
Building/Parking	2022-2023
Final Clean-up	Summer 2023

4.03 Potential Sources of Pollution

Any project site activities that have the potential to add pollutants to runoff are subject to the requirements of this sample SWPPP. Listed below are a description of potential sources of pollution from both sediment addition to stormwater runoff, and pollutants from sources other than sedimentation.

Table 2 – Potential Sources of Sediment to Storm Water Runoff

Potential Source	Activities/Comments
Construction Site Entrance and Site Vehicles	Vehicles leaving the site can track soils onto public roadways. Site Vehicles can readily transport exposed soils throughout the site and off-site areas.
Grading Operations	Exposed soils have the potential for erosion and discharge of sediment to off-site areas.
Material Excavation, Relocation, and Stockpiling	Stockpiling of materials during excavation and relocation of soils can contribute to erosion and sedimentation. In addition fugitive dust from stockpiled material, vehicle transport and site grading can be deposited in wetlands and waterway.
Landscaping Operations	Landscaping operations specifically associated with exposed soils can contribute to erosion and sedimentation. Hydroseeding, if not properly applied, can run off to adjacent wetlands and waterways.

Table 3 – Potential Pollutants and Sources, other than Sediment to Storm Water Runoff

Potential Source	Activities/Comments
Staging Areas and Construction Vehicles	Vehicle refueling, minor equipment maintenance, sanitary facilities and hazardous waste storage
Materials Storage Area	General building materials, solvents, adhesives, paving materials, paints, aggregates, trash, etc.
Construction Activities	Construction, paving, curb/gutter installation, concrete pouring/mortar/stucco

4.04 Erosion and Sedimentation Control Best Management Practices

The project site is characterized primarily by impervious surface. All construction activities will implement Best Management Practices (BMP's) in order to minimize overall site disturbance and impacts to the sites natural features. Please refer to the following sections for a detailed description of site specific BMP's. In addition, an Erosion and Sedimentation Control Plan is provided in the Site Plans.

4.05 Timetable and Construction Phasing

This section provides the Owner and Contractor with a suggested order of construction that shall minimize erosion and the transport of sediments. The individual objectives of the construction techniques described herein shall be considered an integral component of the project design intent of each project phase. The construction sequence is not intended to prescribe definitive construction methods and should not be interpreted as a construction specification document. It is likely that portions of the development area will be constructed in phases. However, the Contractor shall follow the general construction phase principles provided below:

- Protect and maintain existing vegetation wherever possible.
- Minimize the area of disturbance.
- To the extent possible, route unpolluted flows around disturbed areas.
- Install mitigation devices as early as possible.
- Minimize the time disturbed areas are left unstabilized.

- Maintain siltation control devices in proper condition.
- The contractor should use the suggested sequence and techniques as a general guide and modify the suggested methods and procedures as required to best suit seasonal, atmospheric, and site specific physical constraints for the purpose of minimizing the environmental impact of construction.

Demolition, Grubbing and Stripping to Limits of Construction

- Install TEC devices as required to prevent sediment transport into resource areas.
- Place a ring of silt socks and/or hay bales around stockpiles.
- Stabilize all exposed surfaces that will not be under immediate construction.
- Store and/or dispose all pavement and building demolition debris as indicated in accordance with all applicable local, state, and federal regulations.

Roadway Sub-base Construction

- Install temporary culverts and diversion ditches and additional TEC devices as required by individual construction area constraints to direct potential runoff toward detention areas designated for the current construction phase.
- Compact gravel as work progresses to control erosion potential.
- Apply water to control air suspension of dust.
- Avoid creating an erosive condition due to over-watering.
- Install piped utility systems as required as work progresses, keeping all inlets sealed until all downstream drainage system components are functional.

Binder Construction

- Fine grade gravel base and install processed gravel to the design grades.
- Compact pavement base as work progresses.
- Install pavement binder course starting from the downhill end of the site and work toward the top.

Finish Paving

- Repair and stabilize damaged side slopes.
- Clean inverts of drainage structures.
- Install final top course of pavement.

Final Clean-up

- Clean inverts of culverts and catch basins.
- Remove sediment and debris from rip-rap outlet areas.
- Remove TEC devices only after permanent vegetation and erosion control has been fully established.

4.06 Site Stabilization

Grubbing Stripping and Grading

- Erosion control devices shall be in place as shown on the design plans before grading commences.
- Stripping shall be done in a manner, which will not concentrate runoff. If precipitation is expected, earthen berms shall be constructed around the area being stripped, with a silt sock, silt fence or hay bale dike situated in an arc at the low point of the berm.
- If intense precipitation is anticipated, silt socks, hay bales, dikes and /or silt fences shall be used as required to prevent erosion and sediment transport. The materials required shall be stored on site at all time.

- If water is required for soil compaction, it shall be added in a uniform manner that does not allow excess water to flow off the area being compacted.
- Dust shall be held at a minimum by sprinkling exposed soil with an appropriate amount of water.

Maintenance of Disturbed Surfaces

- Runoff shall be diverted from disturbed side slopes in both cut and fill.
- Mulching may be used for temporary stabilization.
- Silt sock, hay bale or silt fences shall be set where required to trap products of erosion and shall be maintained on a continuing basis during the construction process.

Loaming and Seeding

- Loam shall not be placed unless it is to be seeded directly thereafter.
- All disturbed areas shall have a minimum of 4-inches of loam placed before seeding and mulching.
- Consideration shall be given to hydro-mulching, especially on slopes in excess of 3H:1V.
- Loamed and seeded slopes shall be protected from washout by mulching or other acceptable slope protection until vegetation begins to grow.

Stormwater Management System Installation

- The stormwater management system shall be installed from the downstream end up and in a manner which will not allow runoff from disturbed areas to enter pipes.
- Excavation for the system shall not be left open when rainfall is expected overnight. If left open under other circumstances, pipe ends shall be closed by a staked board or by an equivalent method.
- All catch basin openings shall be covered by a silt bag between the grate and the frame or protected from sediment by silt fence surrounding the catch basin grate.

Completion of Paved Areas

- During the placement of sub-base and pavement, entrances to the stormwater management system shall be sealed when rain is expected. When these entrances are closed, consideration must be given to the direction of run-off and measures shall be undertaken to minimize erosion and to provide for the collection of sediment.
- In some situations, it may be necessary to keep catch basins open.
- Appropriate arrangements shall be made downstream to remove all sediment deposition.

Stabilization of Surfaces

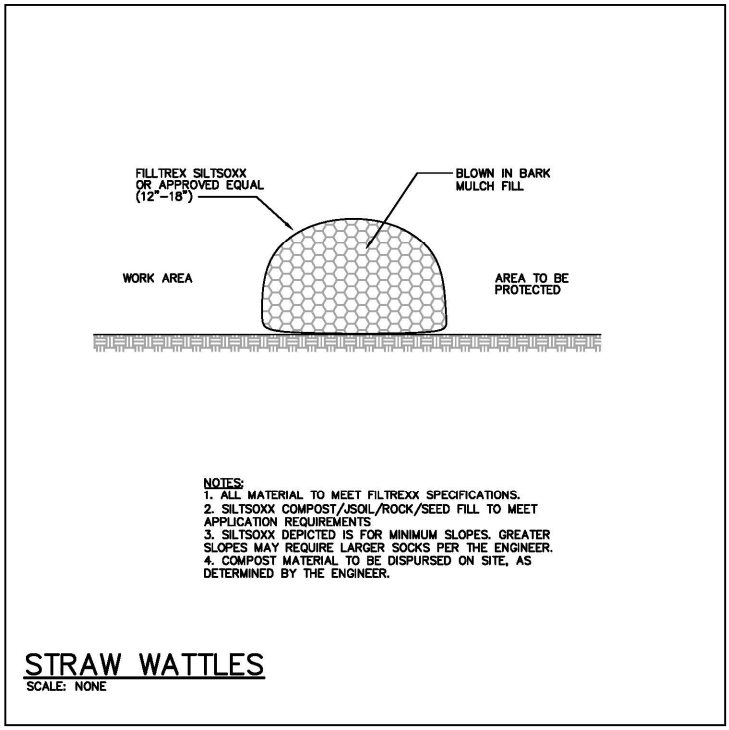
- Stabilization of surfaces includes the placement of pavement, rip-rap, wood bark mulch and the establishment of vegetated surfaces.
- Upon completion of construction, all surfaces shall be stabilized even though it is apparent that future construction efforts will cause their disturbance.
- Vegetated cover shall be established during the proper growing season and shall be enhanced by soil adjustment for proper pH, nutrients and moisture content.
- Surfaces that are disturbed by erosion processes or vandalism shall be stabilized as soon as possible.
- Areas where construction activities have permanently or temporarily ceased shall be stabilized within 14-days from the last construction activity, except when construction activity will resume within 21-days (e.g., the total time period that construction activity is temporarily ceased is less than 21-days).
- Hydro-mulching of grass surfaces is recommended, especially if seeding of the surfaces is required outside the normal growing season.
- Hay mulch is an effective method of temporarily stabilizing surfaces, but only if it is properly secured by branches, weighted snow fences or weighted chicken wire.

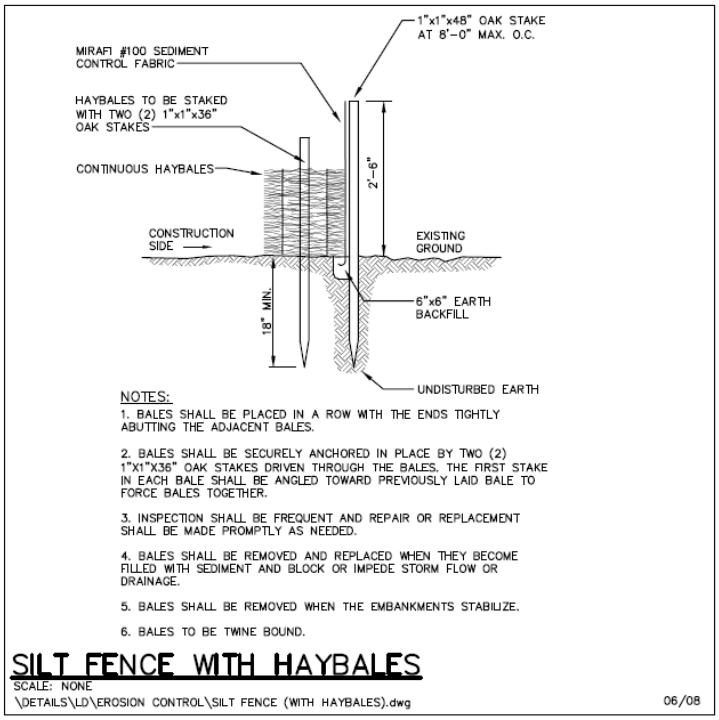
4.07 Temporary Structural Erosion Control Measures

Temporary erosion control measures serve to minimize construction-associated impacts to wetland resource and undisturbed areas. Please refer to the following sections for a description of temporary erosion control measures implemented as part of the project and this sample SWPPP.

3.07.1 Silt Socks, Straw Wattles, Haybales and Silt Fencing

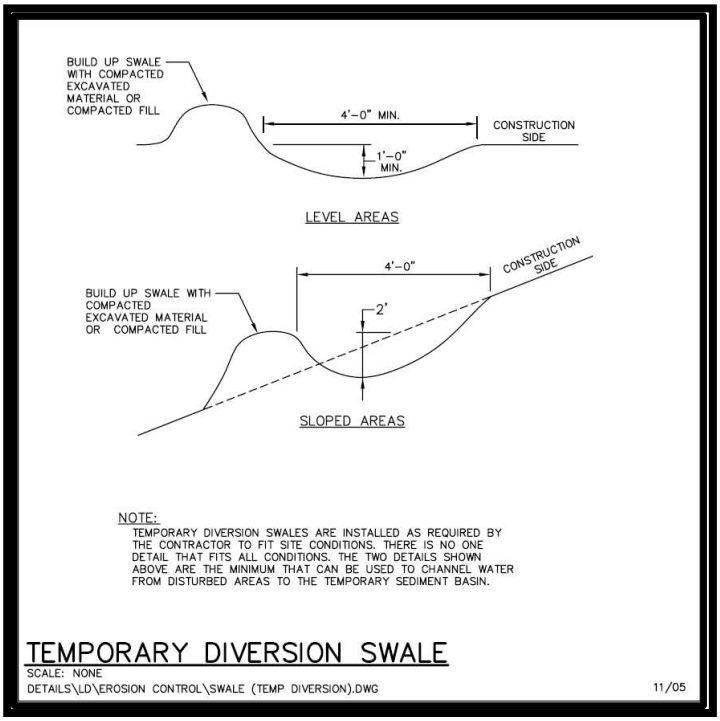
Siltation barriers composed of silt socks or straw wattles or haybales and trenched silt fence will be installed as shown on the Site Plans. The siltation barriers will demarcate the limit of work, form a work envelope and provide additional assurance that construction equipment will not enter the adjacent wetlands or undisturbed portions of the site. All barriers will remain in place until disturbed areas are stabilized.





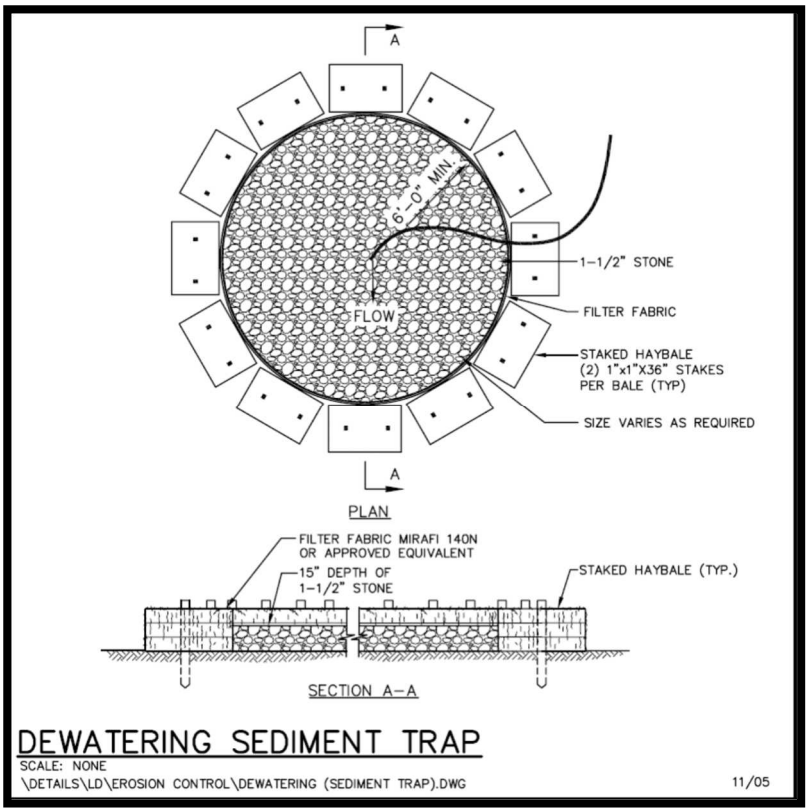
3.07.2 Temporary Storm Water Diversion Swale

A temporary diversion swale is an effective practice for temporarily diverting stormwater flows and to reduce stormwater runoff velocities during storm events. The swale channel can be installed before infrastructure construction begins at the site, or as needed throughout the construction process. The diversion swale should be routinely compacted or seeded to minimize the amount of exposed soil.



3.07.3 Dewatering Basins

Dewatering may be required during stormwater management system installation, foundation construction, and/or utility installation. Should the need for dewatering arise, groundwater will be pumped directly into a temporary settling basin, which will act as a sediment trap during construction. All temporary settling basins will be located within close proximity of daily work activities. Prior to discharge, all groundwater will be treated by means of the settling basin or acceptable substitute. Discharges from sediment basins will be free of visible floating, suspended and settleable solids that would impair the functions of a wetland or degrade the chemical composition of the wetland resource area receiving ground or surface water flows and will be to the combined system.



3.07.4 Material Stockpiling Locations

There will be no storage of soil, gravel or construction debris within the 100-foot buffer zone to wetland resource areas. It is anticipated that all excavated material will be placed in a dump truck and stockpiled outside the 100-foot buffer zone during construction activities. Materials from piping and trench excvation associated with the subsurface utility work will be contained with a single row of silt socks and/or wattles.

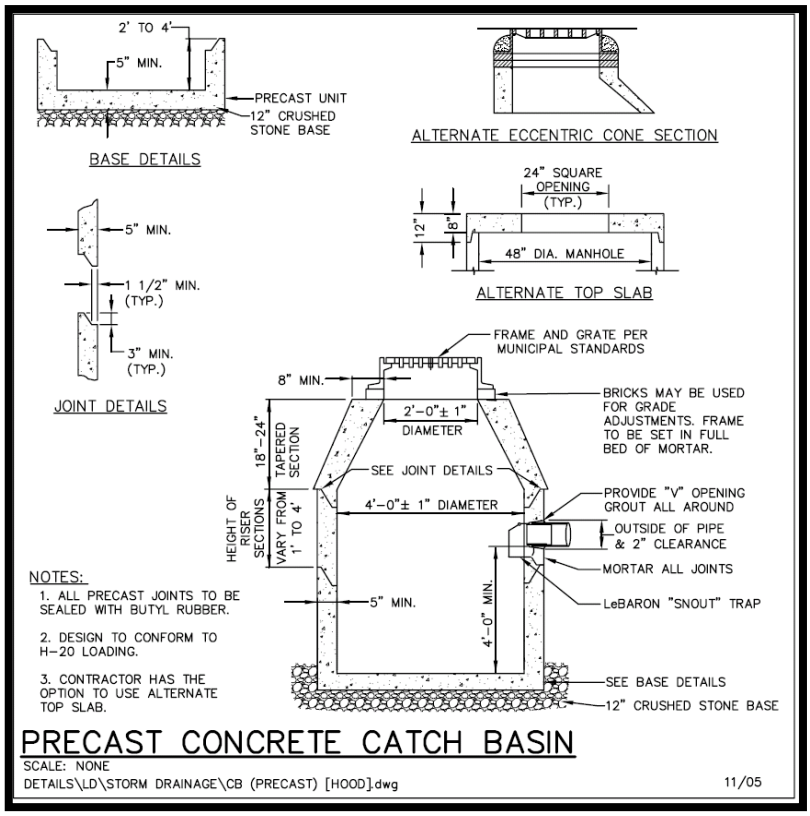
4.08 Permanent Structural Erosion Control Measures

Permanent erosion control measures serve to minimize post-construction impacts to wetland resource areas and undisturbed areas. Please refer to the following sections for a description of permanent erosion control measures implemented as part of the project and this SWPPP.

3.08.1 Catch Basins with Deep Sumps and Hooded Traps

Parking lots will be curbed and provided with catch basins to collect runoff. The entire stormwater management system for each respective project phase will be installed during the initial phases of construction. The system will be installed from the downstream end up, and in a manner which will not allow runoff from disturbed areas to enter the pipes.

Inspect at least four times per year including at the end of the foliage and snow removal seasons. Sediments must be removed two times per year or whenever the depth of the deposits in the catch basin sump is greater than or equal to one foot. Maintenance of these units should be done by a vacuum truck that will remove the water, sediment, debris, floating hydrocarbons and other materials in unit. The proper cleaning and disposal of the removed materials and liquid must be followed.



3.08.2 Infiltration Basins

Infiltration basins perform an important role in LUHPPL's as they provide 80% TSS removal at the end of the treatment train system. Maintenance is required for the proper operation of the Infiltration Basins. The use of pretreatment BMPs such as deep sump and hooded catch basins will minimize failure and maintenance requirements.

After construction, the infiltration basins should be inspected after every major storm for the first few months to ensure proper stabilization and function. Water levels in the ponds should be recorded over several days to check the drainage of the systems. It is recommended that a log book be maintained showing the depth of water in the infiltration systems at each observation in order to determine the rate at which the system dewaters after runoff producing storm events. Once the performance characteristics of the detention/infiltration have been verified, the monitoring

schedule can be reduced to an annual basis, unless the performance data suggests that a more frequent schedule is required.

Preventive maintenance on the infiltration systems should be performed at least four times a year, and sediment should be removed from any and all pretreatment and collection structures. Sediment should be removed when deposits approach a depth of six inches. Ponded water inside the system after several days most likely indicates the bottom of the system is clogged and requires cleaning.

3.08.3 Stormceptor Water Quality Units or approved equal

The Stormceptor water quality structure or approved equal will require periodic inspection and cleaning to maintain operation and function. Owners should have these units inspected on a quarterly basis and after periods of intense precipitation. Inspections of the units can be done by using a clear Plexiglas tube ("sludge judge") to extract a water column sample. When sediment depths exceed 12-inches or other depth as recommended by the manufacturer, then cleaning of the unit is required.

These water quality structures must and will be checked and cleaned immediately after petroleum spills; contact appropriate regulatory agencies

Maintenance of these units should be done by a vacuum truck that will remove the water, sediment, debris, floating hydrocarbons and other materials in unit. The proper cleaning and disposal of the removed materials and liquid must be followed.

4.09 Good Housekeeping Best Management Practices

3.09.1 Material Handling and Waste Management

Solid waste generation during the construction period will be primarily construction debris. The debris will include scrap lumber (used forming and shoring pallets and other shipping containers), waste packaging materials (plastic sheeting and cardboard), scrap cable and wire, roll-off containers (or dumpsters) and will be removed by a contract hauler to a properly licensed landfill. The roll-off containers will be covered with a properly secured tarp before the hauler exits the site. In addition to construction debris, the construction work force will generate some amount of household-type wastes (food packing, soft drink containers, and other paper). Trash containers for these wastes will be located around the site and will be emptied regularly so as to prevent wind-blown litter. This waste will also be removed by a contract hauler.

All hazardous waste material such as oil filters, petroleum products, paint and equipment maintenance fluids will be stored in structurally sound and sealed shipping containers in the hazardous-materials storage area and segregated from other non-waste materials. Secondary containment will be provided for all materials in the hazardous materials storage area and will consist of commercially available spill pallets. Additionally, all hazardous materials will be disposed of in accordance with federal, state and municipal regulations.

Temporary sanitary facilities (portable toilets) will be provided at the site. The toilets will be located away from a concentrated flow path and traffic flow and will have collection pans underneath as secondary treatment. All sanitary waste will be collected from an approved party at a minimum of three times per week.

3.09.2 Material Staging Areas

Construction equipment and maintenance materials will be stored at the combined staging area and materials storage areas. Silt fence will be installed around the perimeter to designate the staging

and materials storage area. A watertight shipping container will be used to store hand tools, small parts and other construction materials.

All hazardous-waste materials such as oil filters, petroleum products, paint and equipment maintenance fluids will be stored in structurally sound and sealed containers under cover within the hazardous materials storage area.

Large items such as piping will be stored in the open storage area. Such materials will be elevated on wood blocks to minimize contact with runoff.

The combined storage areas are expected to remain clean, well organized and equipped with ample cleaning supplies as appropriate for the materials being stored. Perimeter controls such as containment structures, covers and liners will be repaired or replaced as necessary to maintain proper function.

3.09.3 Designated Washout Areas

Designated temporary, below-ground concrete washout areas will be constructed, as required, to minimize the pollution potential associated with concrete, paint, stucco, mixers etc. Signs will, if required, be posted marking the location of the washout area to ensure that concrete equipment operators use the proper facility. Concrete pours will not be conducted during or before an anticipated precipitation event. All excess concrete and concrete washout slurries from the concrete mixer trucks and chutes will be discharged to the washout area or hauled off-site for disposal.

3.09.4 Equipment/Vehicle Maintenance and Fueling Areas

Several types of vehicles and equipment will be used on-site throughout the project including graders, scrapers, excavators, loaders, paving equipment, rollers, trucks and trailers, backhoes and forklifts. All major equipment/vehicle fueling and maintenance will be performed off-site. A small, 20-gallon pickup bed fuel tank will be kept on-site in the combined staging area. When vehicle fueling must occur on-site, the fueling activity will occur in the staging area. Only minor equipment maintenance will occur on-site. All equipment fluids generated from maintenance activities will be disposed of into designated drums stored on spill pallets. Absorbent, spill-cleanup materials and spill kits will be available at the combined staging and materials storage area. Drip pans will be placed under all equipment receiving maintenance and vehicles and equipment parked overnight.

3.09.5 Equipment/Vehicle Wash down Area

All equipment and vehicle washing will be performed off-site.

3.09.6 Spill Prevention Plan

A spill containment kit will be kept on-site in the Contractor's trailer and/or the designated staging area throughout the duration of construction. Should there be an accidental release of petroleum product into a wetland or within 100-feet of a wetland, the appropriate agencies will be immediately notified.

4.10 Inspections

Maintenance of existing and proposed BMP's to address stormwater management facilities during construction is an on-going process. The purpose of the inspections is to observe all sources of stormwater or non-stormwater discharge as identified in the SWPPP as well as the status of the receiving waters and fulfill the requirements of the Order of Conditions (OOC). The following sections describe the appropriate inspection measures to adequately implement the project's SWPPP. A blank inspection form is provided at the end of this section. Completed inspection forms are to be maintained on site.

4.10.1 Inspection Personnel

The owner's appointed representative will be responsible for performing regular inspections of erosion controls and ordering repairs as necessary.

4.10.2 Inspection Frequency

Inspections will be performed by qualified personnel once every 7 days in accordance with the CGP and as required by the OOC. The inspections must be documented on the inspection form provided at the end of this section, and completed forms will be provided to the on-site supervisor and maintained at the Owner's office throughout the entire duration of construction.

4.10.3 Inspection Reporting

Each inspection report will summarize the scope of the inspection, name(s) and qualifications of personnel making the inspection, and major observations relating to the implementation of the SWPPP, including compliance and non-compliance items. Completed inspection reports will remain with the completed SWPPP on site.

4.11 Amendment Requirements

The final SWPPP is intended to be a working document that is utilized regularly on the construction site, and provides guidance to the Contractor. It must reflect changes made to the originally proposed plan and will be updated to include project specific activities and ensure that they are in compliance with the NPDES General Permit and state and local laws and regulations. It should be amended whenever there is a change in design, construction, operation or maintenance that affects discharge of pollutants. The following items should be addressed should an amendment to the SWPPP occur:

- Dates of certain construction activities such as major grading activities, clearing and initiation of and completion of stabilization measures should be recorded.
- Future amendments to the SWPPP will be recorded as required. As this SWPPP is amended, all amendments will be kept on site and made part of the SWPPP.
- Upon completion of site stabilization (completed as designed and/or 70% background vegetative cover), it can be documented and marked on the plans. Inspections are no longer required at this time.
- Inspections often identify areas not included in the original SWPPP, which will require the SWPPP to be amended. These updates should be made within seven days of being recognized by the inspector.

SWPPP INSPECTION AND MAINTENANCE REPORT

Ayer Commons
Ayer, MA

TO BE COMPLETED AT LEAST EVERY 7 DAYS. AFTER SITE STABILIZATION, TO BE COMPLETED AT LEAST ONCE PER MONTH FOR THREE YEARS OR UNTIL A NOTICE OF TERMINATION IS FILED.

General Information			
Project Name			
NPDES Tracking No.		**Location**	
Date of Inspection		**Start/End Time**	
Inspector's Name(s)			
Inspector's Title(s)			
Inspector's Contact Information			
Inspector's Qualifications			
Describe present phase of construction			
Type of Inspection: ❑ Regular ❑ Pre-storm event ❑ During storm event ❑ Post-storm event			
Weather Information			
Has there been a storm event since the last inspection? ❑Yes ❑No **If yes, provide:** Storm Start Date & Time: Storm Duration (hrs): Approximate Amount of Precipitation (in):			
Weather at time of this inspection? ❑ Clear ❑Cloudy ❑ Rain ❑ Sleet ❑ Fog ❑ Snowing ❑ High Winds ❑ Other: Temperature:			
Have any discharges occurred since the last inspection? ❑Yes ❑No **If yes, describe:**			
Are there any discharges at the time of inspection? ❑Yes ❑No **If yes, describe:**			

Site-specific BMPs

- *Number the structural and non-structural BMPs identified in your SWPPP on your site map and list them below (add as many BMPs as necessary). Carry a copy of the numbered site map with you during your inspections. This list will ensure that you are inspecting all required BMPs at your site.*
- *Describe corrective actions initiated, date completed, and note the person that completed the work in the Corrective Action Log.*

	BMP	BMP Installed?	BMP Maintenance Required?	Corrective Action Needed and Notes
1		❑Yes ❑No	❑Yes ❑No	
2		❑Yes ❑No	❑Yes ❑No	
3		❑Yes ❑No	❑Yes ❑No	
4		❑Yes ❑No	❑Yes ❑No	
5		❑Yes ❑No	❑Yes ❑No	
6		❑Yes ❑No	❑Yes ❑No	
7		❑Yes ❑No	❑Yes ❑No	
8		❑Yes ❑No	❑Yes ❑No	
9		❑Yes ❑No	❑Yes ❑No	
10		❑Yes ❑No	❑Yes ❑No	
11		❑Yes ❑No	❑Yes ❑No	
12		❑Yes ❑No	❑Yes ❑No	
13		❑Yes ❑No	❑Yes ❑No	
14		❑Yes ❑No	❑Yes ❑No	
15		❑Yes ❑No	❑Yes ❑No	
16		❑Yes ❑No	❑Yes ❑No	
17		❑Yes ❑No	❑Yes ❑No	
18		❑Yes ❑No	❑Yes ❑No	
19		❑Yes ❑No	❑Yes ❑No	
20		❑Yes ❑No	❑Yes ❑No	

Overall Site Issues

Below are some general site issues that should be assessed during inspections. Customize this list as needed for conditions at your site.

	BMP/activity	Implemented?	Maintenance Required?	Corrective Action Needed and Notes
1	Are all slopes and disturbed areas not actively being worked properly stabilized?	❑Yes ❑No	❑Yes ❑No	
2	Are natural resource areas (e.g., streams, wetlands, mature trees, etc.) protected with barriers or similar BMPs?	❑Yes ❑No	❑Yes ❑No	
3	Are perimeter controls and sediment barriers adequately installed (keyed into substrate) and maintained?	❑Yes ❑No	❑Yes ❑No	
4	Are discharge points and receiving waters free of any sediment deposits?	❑Yes ❑No	❑Yes ❑No	
5	Are storm drain inlets properly protected?	❑Yes ❑No	❑Yes ❑No	
6	Is the construction exit preventing sediment from being tracked into the street?	❑Yes ❑No	❑Yes ❑No	
7	Is trash/litter from work areas collected and placed in covered dumpsters?	❑Yes ❑No	❑Yes ❑No	
8	Are washout facilities (e.g., paint, stucco, concrete) available, clearly marked, and maintained?	❑Yes ❑No	❑Yes ❑No	
9	Are vehicle and equipment fueling, cleaning, and maintenance areas free of spills, leaks, or any other deleterious material?	❑Yes ❑No	❑Yes ❑No	
10	Are materials that are potential stormwater contaminants stored inside or under cover?	❑Yes ❑No	❑Yes ❑No	

	BMP/activity	Implemented?	Maintenance Required?	Corrective Action Needed and Notes
11	Are non-stormwater discharges (e.g., wash water, dewatering) properly controlled?	❑Yes ❑No	❑Yes ❑No	
12	(Other)	❑Yes ❑No	❑Yes ❑No	

Non-Compliance

Describe any incidents of non-compliance not described above:

CERTIFICATION STATEMENT

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

Print name and title: _____
(Qualified Person performing the Inspection)

Signature:_____ **Date:**_____

Print name and title:_____
(Duly Authorized Representative)

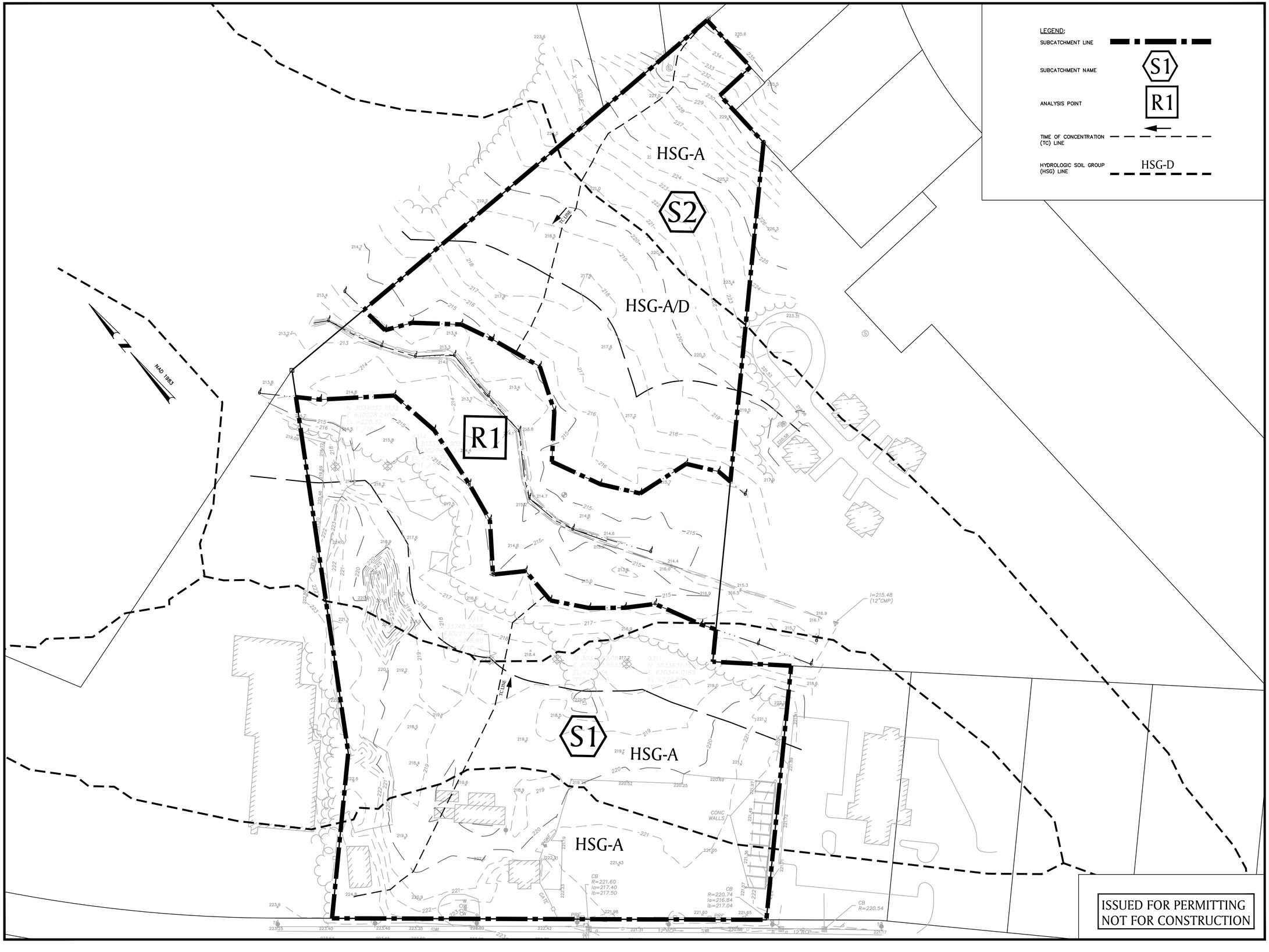
Signature:_____ **Date:**_____

SECTION 4.0

PEAK RUNOFF RATE CALCULATIONS

4.01

EXISTING CONDITIONS WATERSHED PLAN



NOAH
Neighborhood of Affordable Housing, Inc.

DATE

AYER COMMONS

65 FITCHBURG ROAD
IN
AYER
MASSACHUSETTS
(MIDDLESEX COUNTY)

EXISTING CONDITIONS WATERSHED PLAN

JUNE 14, 2022

REVISIONS:

NO.	DATE	DESC.

PREPARED FOR:
NEIGHBORHOOD OF
AFFORDABLE HOUSING
143 BORDER STREET
EAST BOSTON, MA

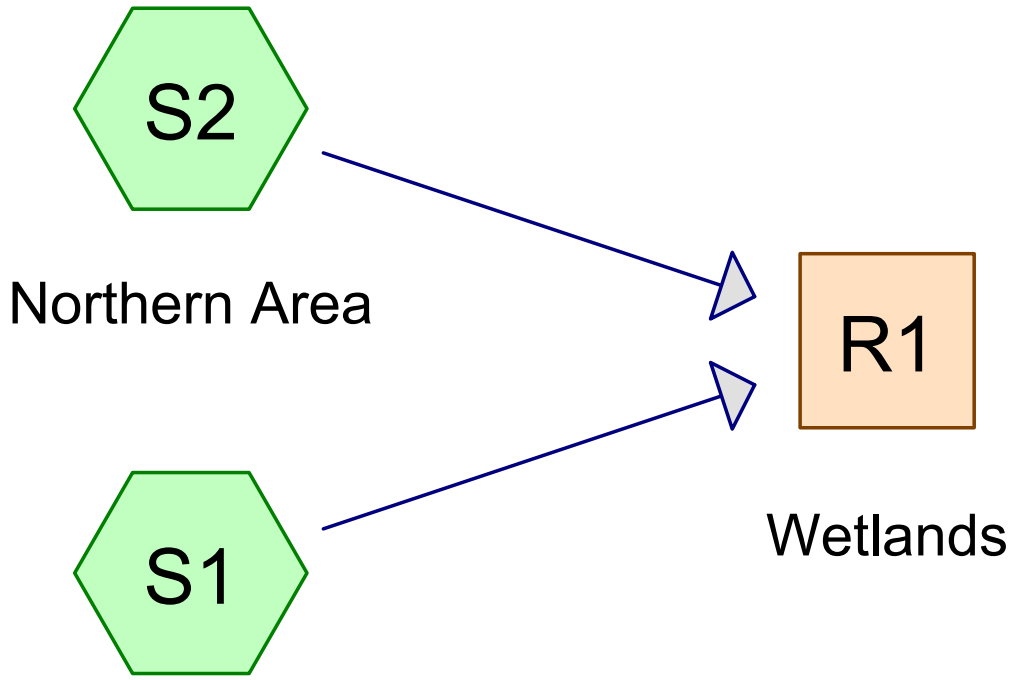
BSC GROUP
300 Brickstone Square
Andover, Massachusetts
01810
617 896 4300

SCALE: 1" = 50'
0 25 50 100 FEET

FILE: Proj-AND/8992601/C/DD/EC WATERSHED
DWG.: EC WATERSHED
JOB. NO: 8-9926.01
SHEET 1 of 2

4.02

EXISTING CONDITIONS HYDROCAD PRINTOUTS



Subcat Reach Pond Link

Routing Diagram for 8992601-EC
Prepared by BSC Group, Printed 11/29/2022

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.00	2
2	10-Year	Type III 24-hr		Default	24.00	1	4.50	2
3	25-Year	Type III 24-hr		Default	24.00	1	5.60	2
4	100-Year	Type III 24-hr		Default	24.00	1	6.40	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
161,871	76	Gravel roads, HSG A (S1)
42,022	98	Paved parking, HSG A (S1)
5,405	98	Roofs, HSG A (S1)
165,468	30	Woods, Good, HSG A (S1, S2)
7,460	32	Woods/grass comb., Good, HSG A (S1)
382,226	**58**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
382,226	HSG A	S1, S2
0	HSG B	
0	HSG C	
0	HSG D	
0	Other	
382,226		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	S N
161,871	0	0	0	0	161,871	Gravel roads	
42,022	0	0	0	0	42,022	Paved parking	
5,405	0	0	0	0	5,405	Roofs	
165,468	0	0	0	0	165,468	Woods, Good	
7,460	0	0	0	0	7,460	Woods/grass comb., Good	
382,226	**0**	**0**	**0**	**0**	**382,226**	**TOTAL AREA**	

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

Subcatchment S1: Southern Area Runoff Area=241,833 sf 19.61% Impervious Runoff Depth>0.91"
Flow Length=454' Tc=6.0 min CN=74 Runoff=5.520 cfs 18,275 cf

Subcatchment S2: Northern Area Runoff Area=140,393 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=479' Tc=15.3 min CN=30 Runoff=0.000 cfs 0 cf

Reach R1: Wetlands Inflow=5.520 cfs 18,275 cf
Outflow=5.520 cfs 18,275 cf

Total Runoff Area = 382,226 sf Runoff Volume = 18,275 cf Average Runoff Depth = 0.57"
87.59% Pervious = 334,799 sf 12.41% Impervious = 47,427 sf

Summary for Subcatchment S1: Southern Area

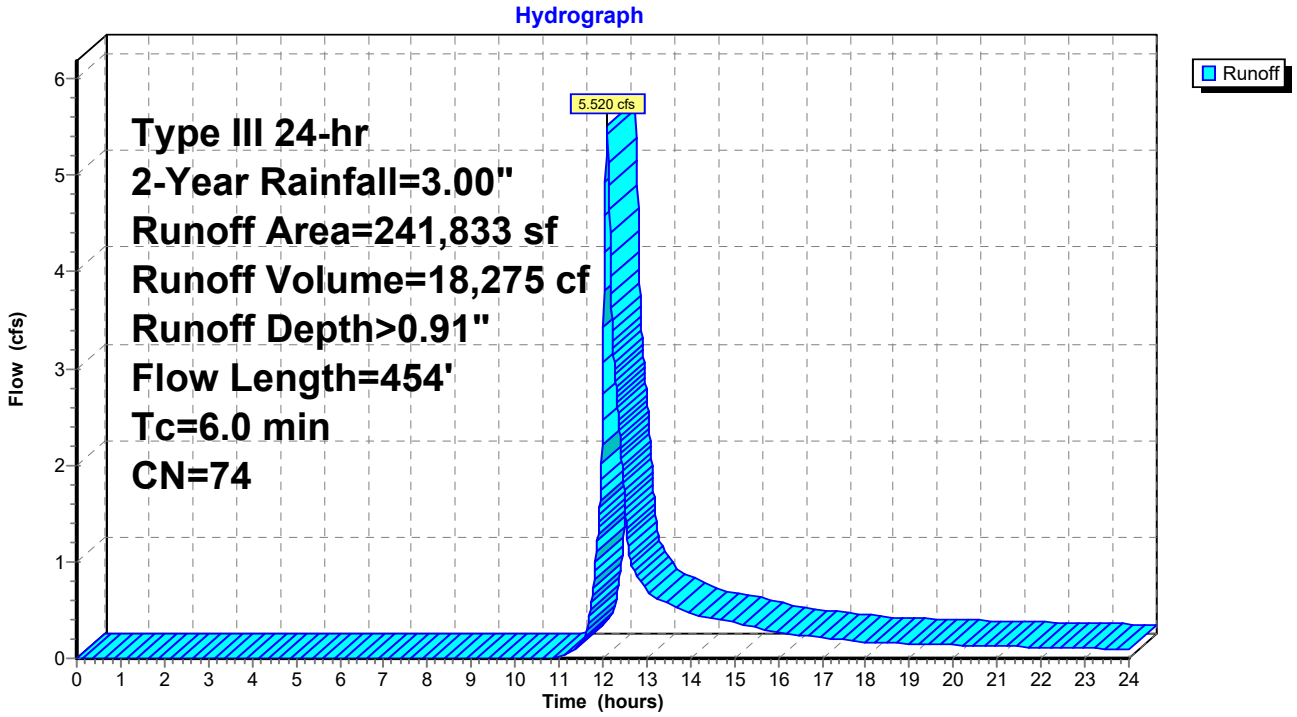
Runoff = 5.520 cfs @ 12.10 hrs, Volume= 18,275 cf, Depth> 0.91"
Routed to Reach R1 : Wetlands

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=3.00"

Area (sf)	CN	Description
42,022	98	Paved parking, HSG A
5,405	98	Roofs, HSG A
161,871	76	Gravel roads, HSG A
7,460	32	Woods/grass comb., Good, HSG A
25,075	30	Woods, Good, HSG A
241,833	74	Weighted Average
194,406		80.39% Pervious Area
47,427		19.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	50	0.0600	1.86		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.22"
0.1	29	0.0620	4.01		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.7	300	0.0070	1.35		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	32	0.0560	3.81		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	43	0.0560	1.18		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
4.9	454	Total, Increased to minimum Tc = 6.0 min			

Subcatchment S1: Southern Area



Summary for Subcatchment S2: Northern Area

[45] Hint: Runoff=Zero

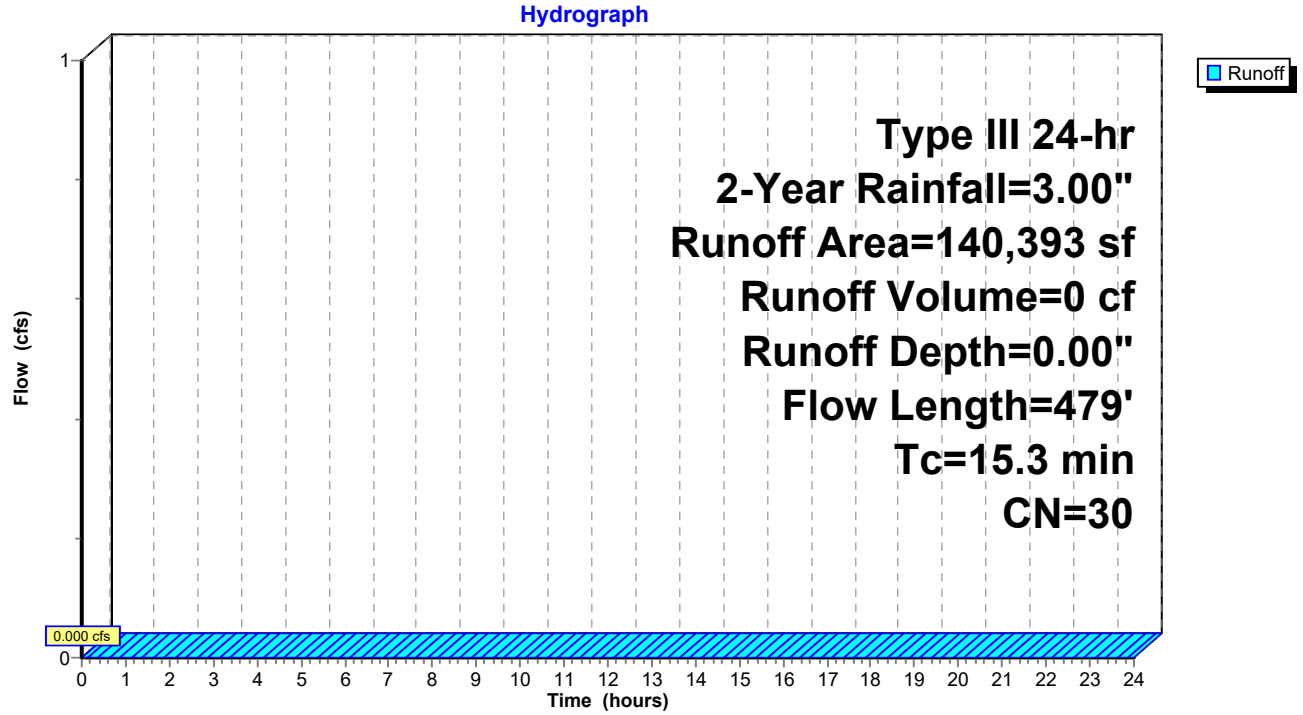
Runoff = 0.000 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Reach R1 : Wetlands

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=3.00"

Area (sf)	CN	Description
140,393	30	Woods, Good, HSG A
140,393		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	50	0.0620	0.11		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.22"
2.5	179	0.0590	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.0	250	0.0280	0.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	479	Total			

Subcatchment S2: Northern Area



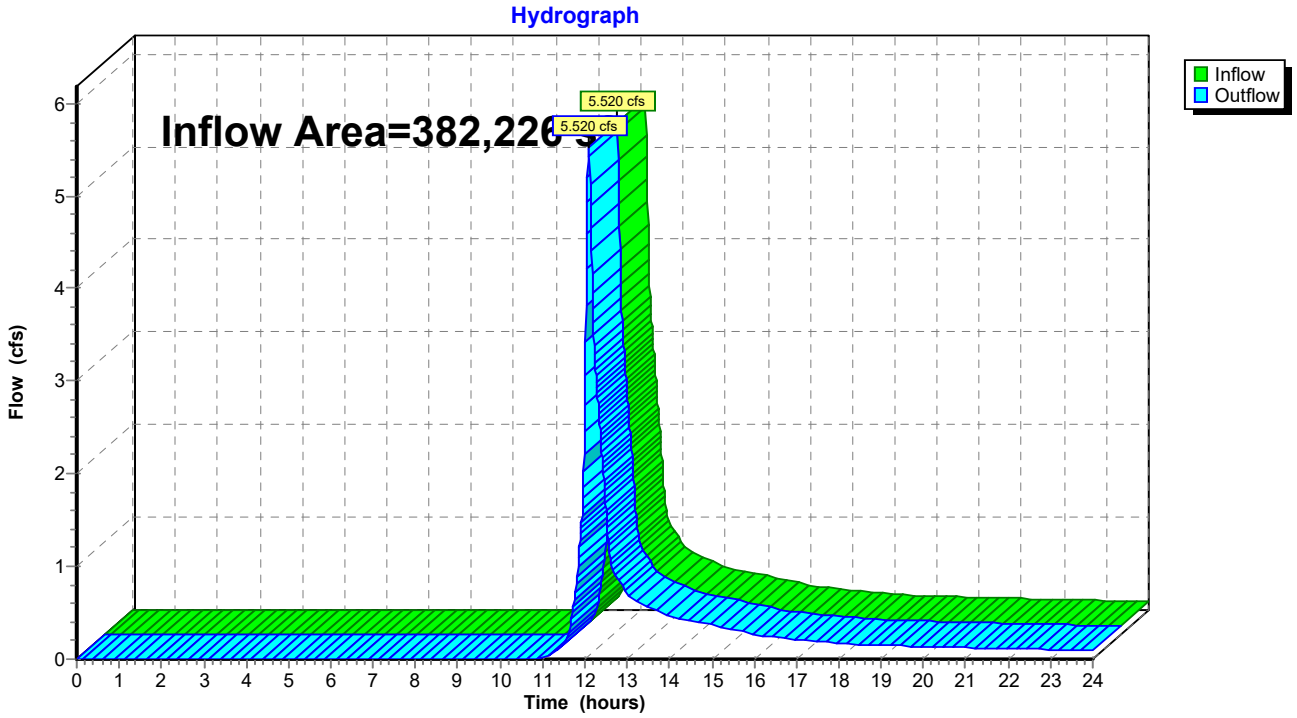
Summary for Reach R1: Wetlands

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 382,226 sf, 12.41% Impervious, Inflow Depth > 0.57" for 2-Year event
Inflow = 5.520 cfs @ 12.10 hrs, Volume= 18,275 cf
Outflow = 5.520 cfs @ 12.10 hrs, Volume= 18,275 cf, Atten= 0%, Lag= 0.0 min

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

Reach R1: Wetlands



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

Subcatchment S1: Southern Area Runoff Area=241,833 sf 19.61% Impervious Runoff Depth>1.97"
Flow Length=454' Tc=6.0 min CN=74 Runoff=12.710 cfs 39,696 cf

Subcatchment S2: Northern Area Runoff Area=140,393 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=479' Tc=15.3 min CN=30 Runoff=0.000 cfs 0 cf

Reach R1: Wetlands Inflow=12.710 cfs 39,696 cf
Outflow=12.710 cfs 39,696 cf

Total Runoff Area = 382,226 sf Runoff Volume = 39,696 cf Average Runoff Depth = 1.25"
87.59% Pervious = 334,799 sf 12.41% Impervious = 47,427 sf

Summary for Subcatchment S1: Southern Area

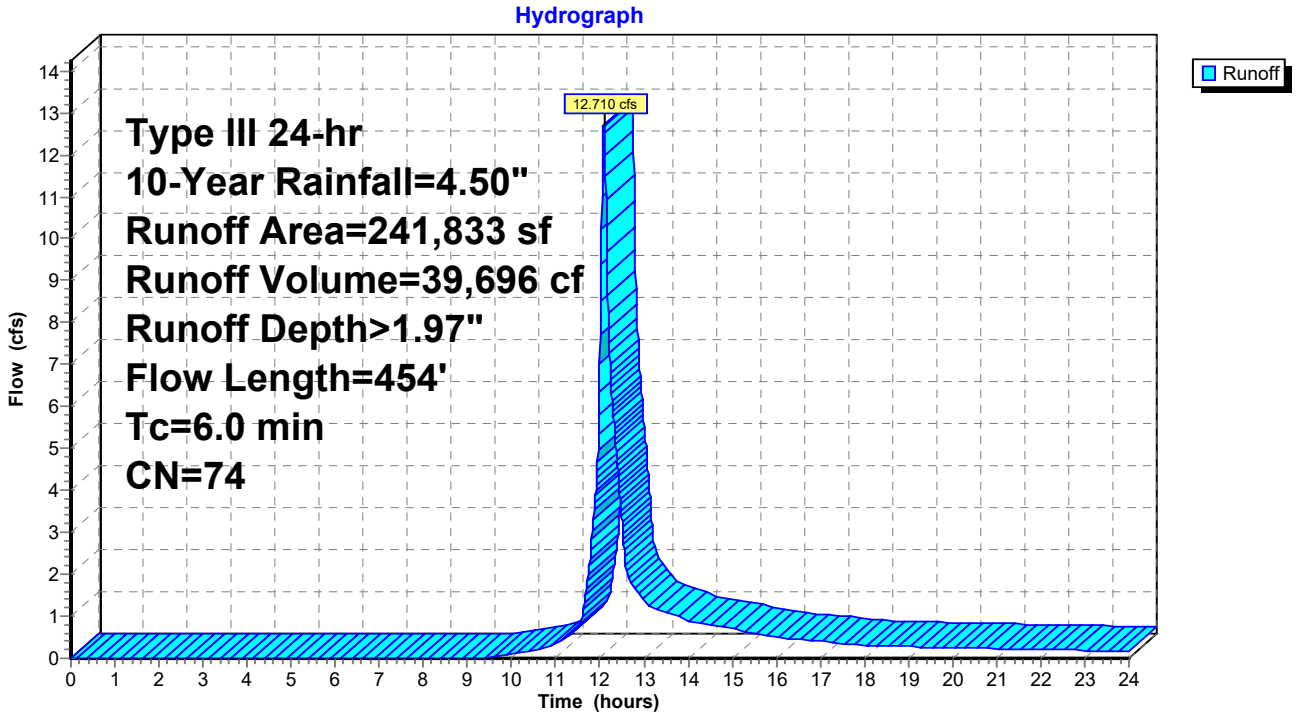
Runoff = 12.710 cfs @ 12.09 hrs, Volume= 39,696 cf, Depth> 1.97"
Routed to Reach R1 : Wetlands

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=4.50"

Area (sf)	CN	Description
42,022	98	Paved parking, HSG A
5,405	98	Roofs, HSG A
161,871	76	Gravel roads, HSG A
7,460	32	Woods/grass comb., Good, HSG A
25,075	30	Woods, Good, HSG A
241,833	74	Weighted Average
194,406		80.39% Pervious Area
47,427		19.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	50	0.0600	1.86		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.22"
0.1	29	0.0620	4.01		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.7	300	0.0070	1.35		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	32	0.0560	3.81		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	43	0.0560	1.18		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
4.9	454	Total, Increased to minimum Tc = 6.0 min			

Subcatchment S1: Southern Area



Summary for Subcatchment S2: Northern Area

[45] Hint: Runoff=Zero

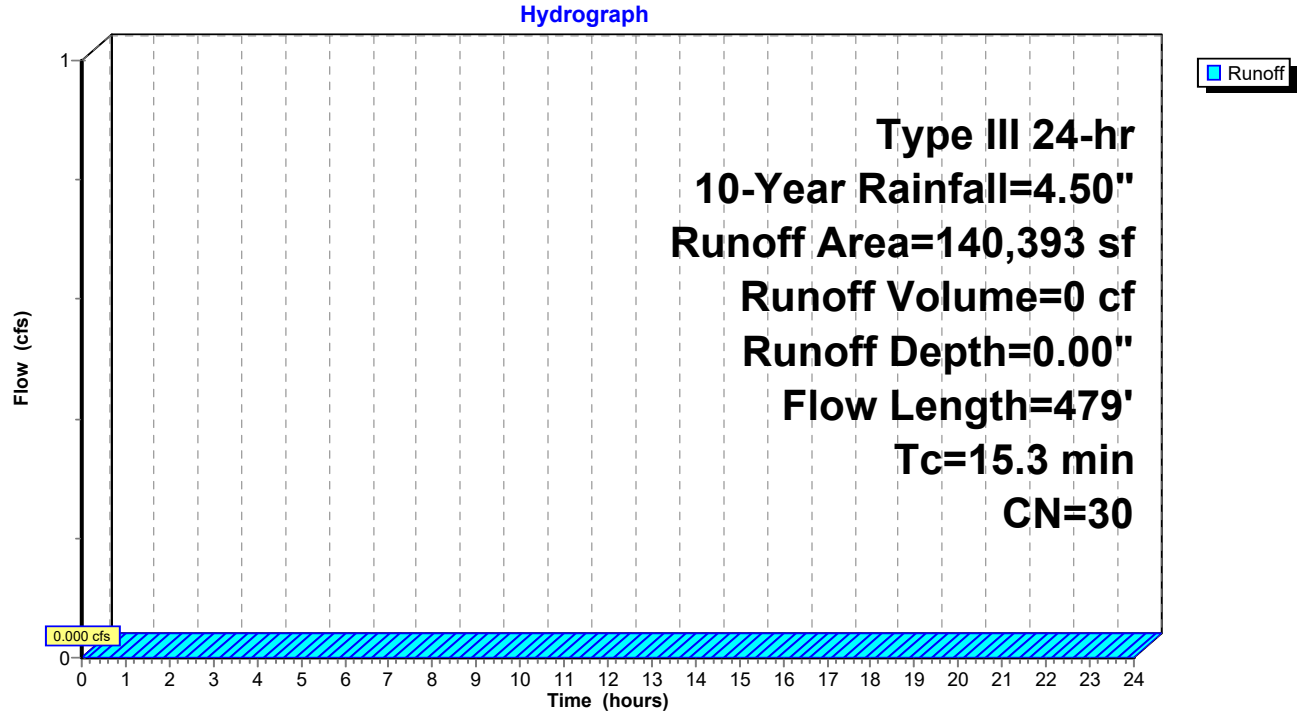
Runoff = 0.000 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Reach R1 : Wetlands

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=4.50"

Area (sf)	CN	Description
140,393	30	Woods, Good, HSG A
140,393		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	50	0.0620	0.11		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.22"
2.5	179	0.0590	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.0	250	0.0280	0.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	479	Total			

Subcatchment S2: Northern Area



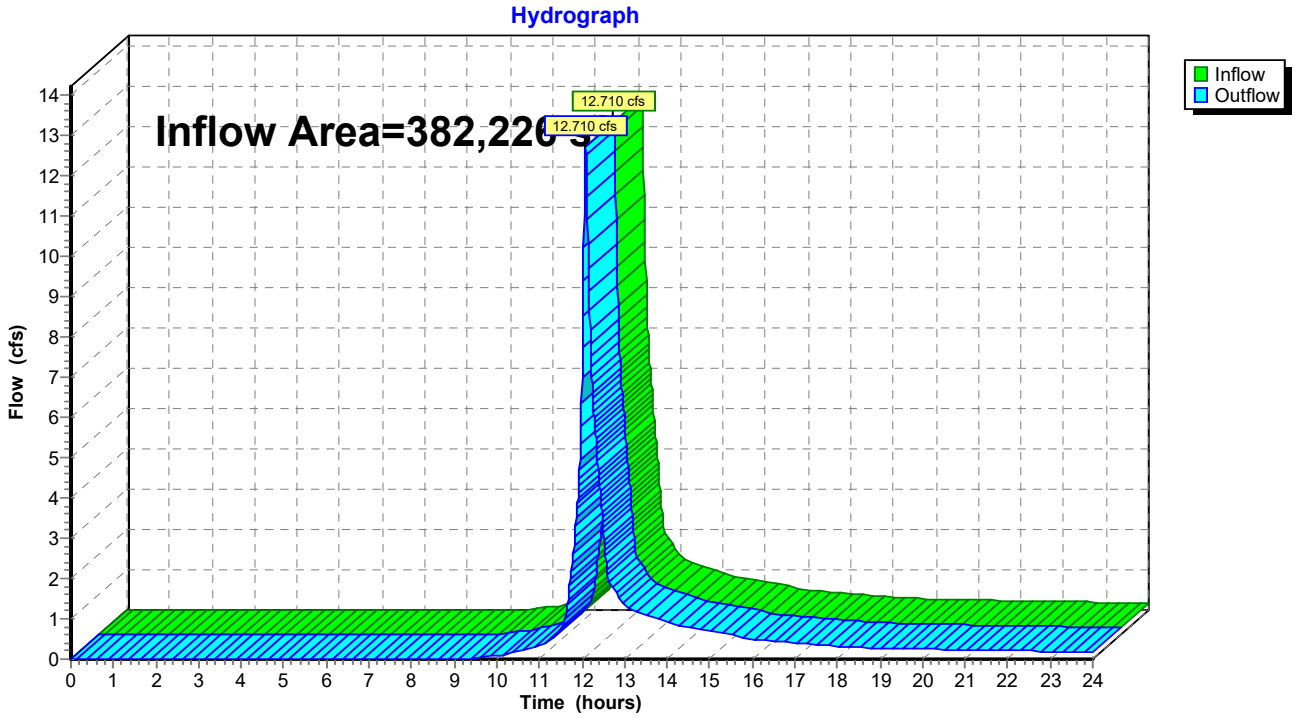
Summary for Reach R1: Wetlands

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 382,226 sf, 12.41% Impervious, Inflow Depth > 1.25" for 10-Year event
Inflow = 12.710 cfs @ 12.09 hrs, Volume= 39,696 cf
Outflow = 12.710 cfs @ 12.09 hrs, Volume= 39,696 cf, Atten= 0%, Lag= 0.0 min

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

Reach R1: Wetlands



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

Subcatchment S1: Southern Area Runoff Area=241,833 sf 19.61% Impervious Runoff Depth>2.85"
Flow Length=454' Tc=6.0 min CN=74 Runoff=18.548 cfs 57,396 cf

Subcatchment S2: Northern Area Runoff Area=140,393 sf 0.00% Impervious Runoff Depth>0.04"
Flow Length=479' Tc=15.3 min CN=30 Runoff=0.014 cfs 410 cf

Reach R1: Wetlands Inflow=18.548 cfs 57,806 cf
Outflow=18.548 cfs 57,806 cf

Total Runoff Area = 382,226 sf Runoff Volume = 57,806 cf Average Runoff Depth = 1.81"
87.59% Pervious = 334,799 sf 12.41% Impervious = 47,427 sf

Summary for Subcatchment S1: Southern Area

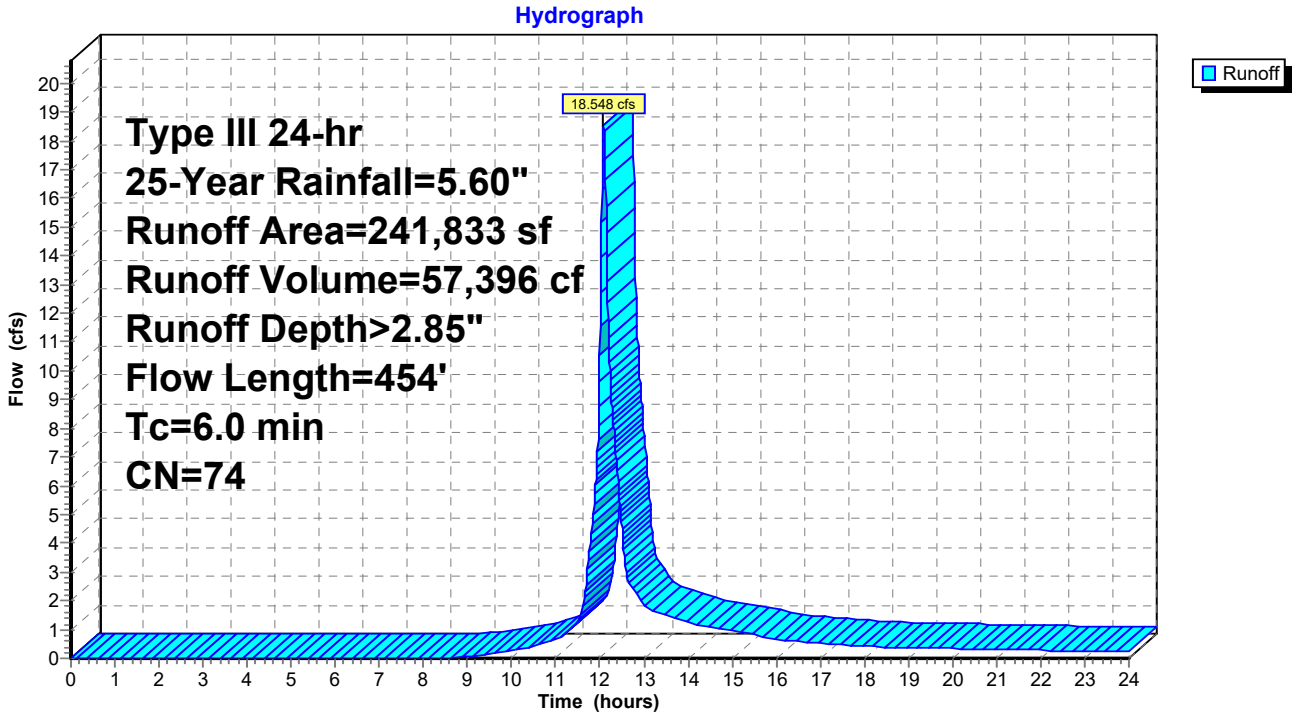
Runoff = 18.548 cfs @ 12.09 hrs, Volume= 57,396 cf, Depth> 2.85"
Routed to Reach R1 : Wetlands

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=5.60"

Area (sf)	CN	Description
42,022	98	Paved parking, HSG A
5,405	98	Roofs, HSG A
161,871	76	Gravel roads, HSG A
7,460	32	Woods/grass comb., Good, HSG A
25,075	30	Woods, Good, HSG A
241,833	74	Weighted Average
194,406		80.39% Pervious Area
47,427		19.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	50	0.0600	1.86		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.22"
0.1	29	0.0620	4.01		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.7	300	0.0070	1.35		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	32	0.0560	3.81		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	43	0.0560	1.18		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
4.9	454	Total, Increased to minimum Tc = 6.0 min			

Subcatchment S1: Southern Area



Summary for Subcatchment S2: Northern Area

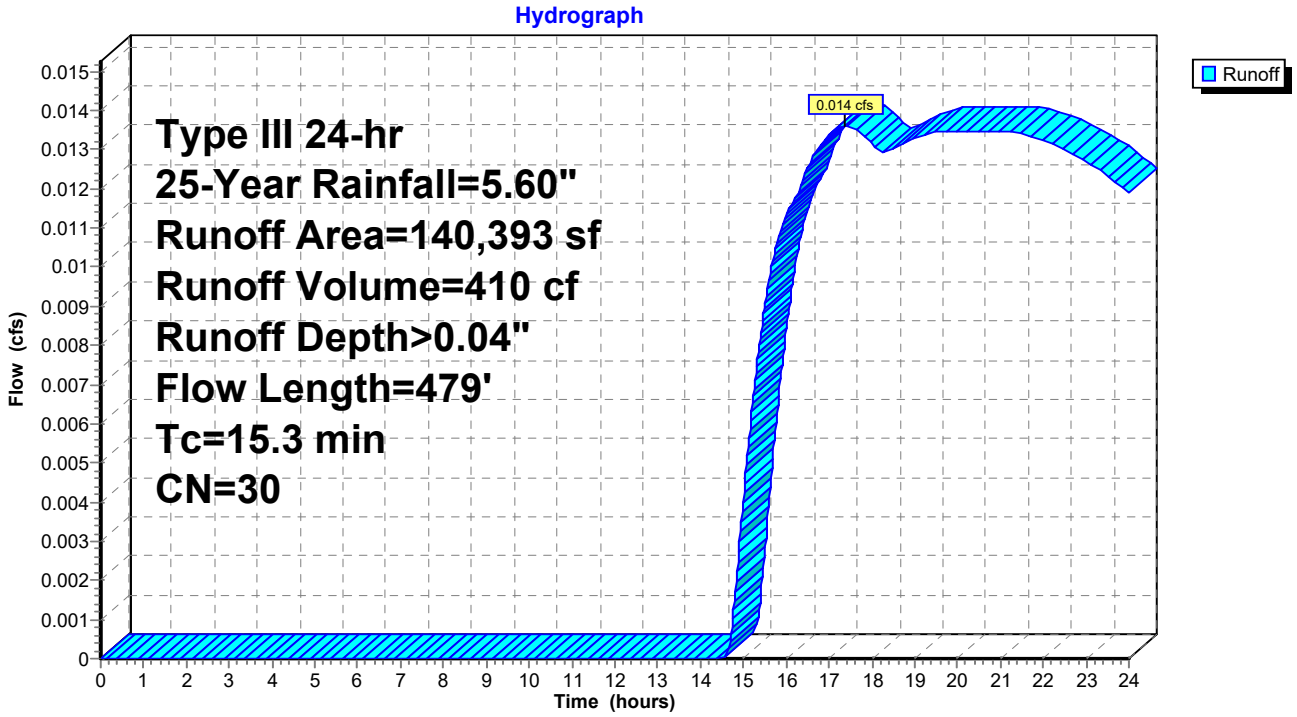
Runoff = 0.014 cfs @ 17.39 hrs, Volume= 410 cf, Depth> 0.04"
Routed to Reach R1 : Wetlands

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=5.60"

Area (sf)	CN	Description
140,393	30	Woods, Good, HSG A
140,393		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	50	0.0620	0.11		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.22"
2.5	179	0.0590	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.0	250	0.0280	0.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	479	Total			

Subcatchment S2: Northern Area



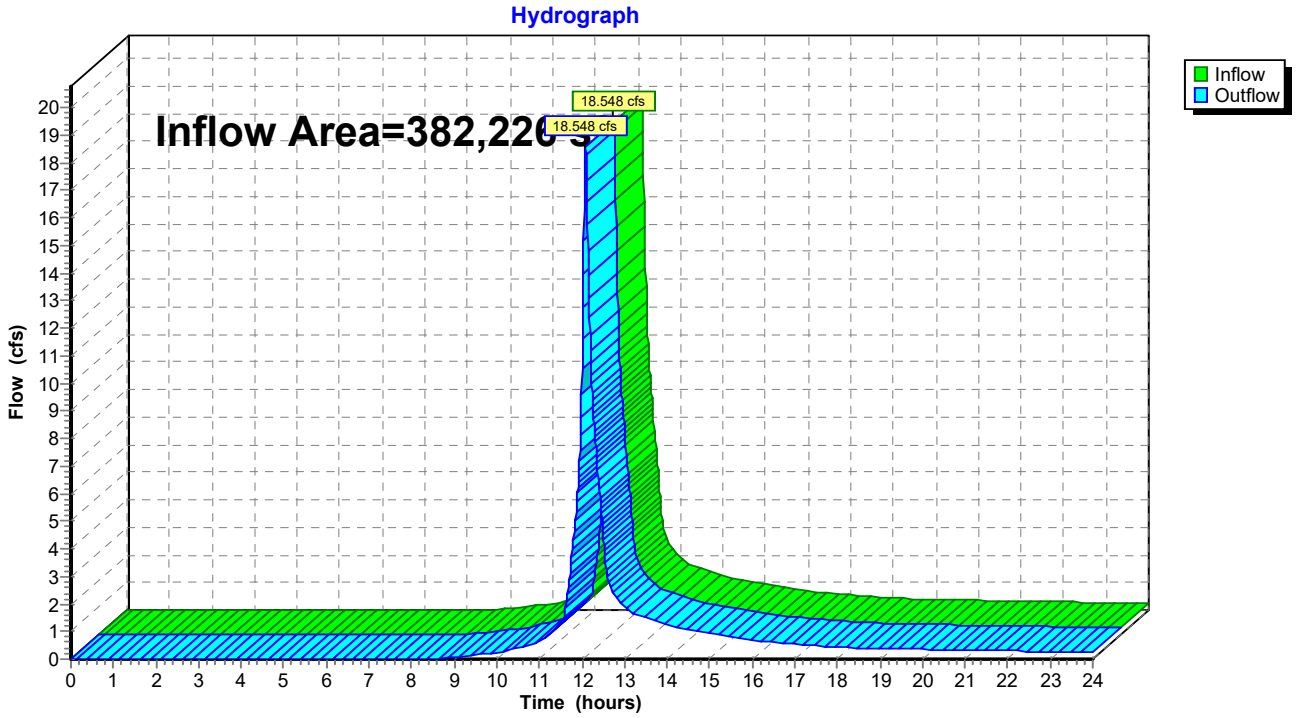
Summary for Reach R1: Wetlands

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 382,226 sf, 12.41% Impervious, Inflow Depth > 1.81" for 25-Year event
Inflow = 18.548 cfs @ 12.09 hrs, Volume= 57,806 cf
Outflow = 18.548 cfs @ 12.09 hrs, Volume= 57,806 cf, Atten= 0%, Lag= 0.0 min

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

Reach R1: Wetlands



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

Subcatchment S1: Southern Area Runoff Area=241,833 sf 19.61% Impervious Runoff Depth>3.52"
Flow Length=454' Tc=6.0 min CN=74 Runoff=22.953 cfs 70,936 cf

Subcatchment S2: Northern Area Runoff Area=140,393 sf 0.00% Impervious Runoff Depth>0.12"
Flow Length=479' Tc=15.3 min CN=30 Runoff=0.051 cfs 1,382 cf

Reach R1: Wetlands Inflow=22.953 cfs 72,318 cf
Outflow=22.953 cfs 72,318 cf

Total Runoff Area = 382,226 sf Runoff Volume = 72,318 cf Average Runoff Depth = 2.27"
87.59% Pervious = 334,799 sf 12.41% Impervious = 47,427 sf

Summary for Subcatchment S1: Southern Area

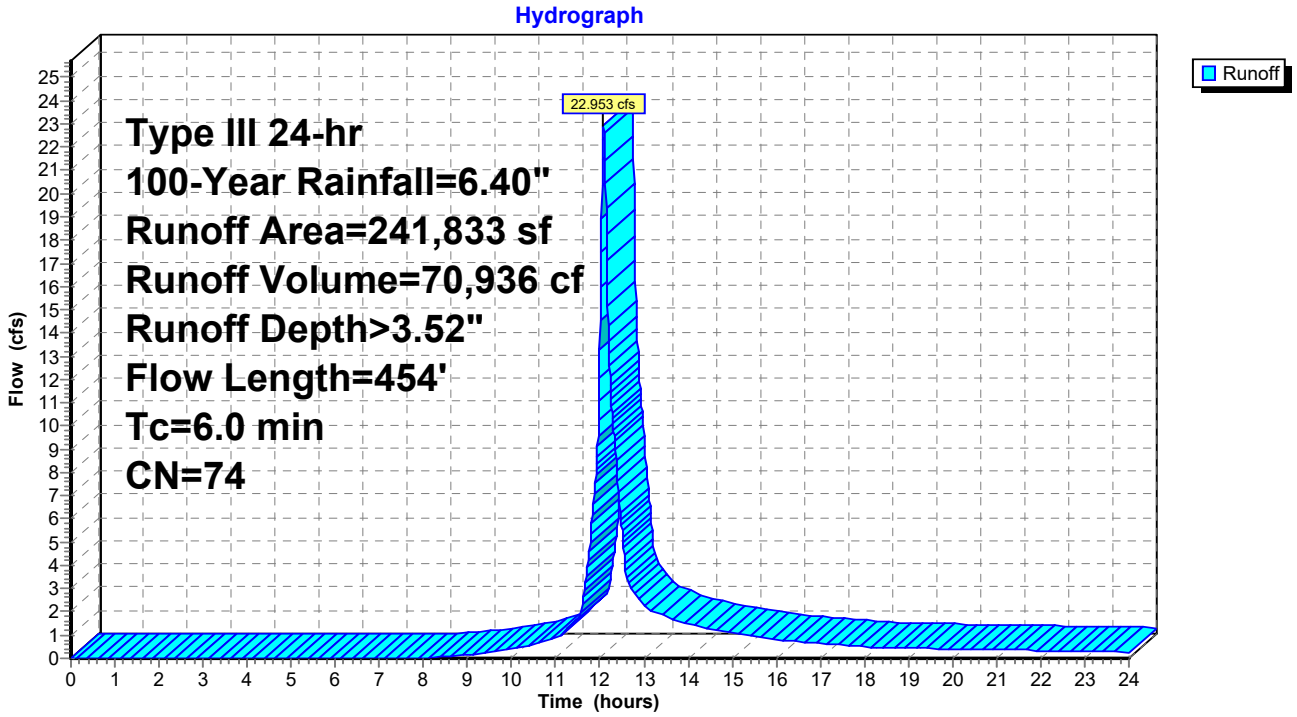
Runoff = 22.953 cfs @ 12.09 hrs, Volume= 70,936 cf, Depth> 3.52"
Routed to Reach R1 : Wetlands

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=6.40"

Area (sf)	CN	Description
42,022	98	Paved parking, HSG A
5,405	98	Roofs, HSG A
161,871	76	Gravel roads, HSG A
7,460	32	Woods/grass comb., Good, HSG A
25,075	30	Woods, Good, HSG A
241,833	74	Weighted Average
194,406		80.39% Pervious Area
47,427		19.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	50	0.0600	1.86		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.22"
0.1	29	0.0620	4.01		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.7	300	0.0070	1.35		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.1	32	0.0560	3.81		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.6	43	0.0560	1.18		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
4.9	454	Total, Increased to minimum Tc = 6.0 min			

Subcatchment S1: Southern Area



Summary for Subcatchment S2: Northern Area

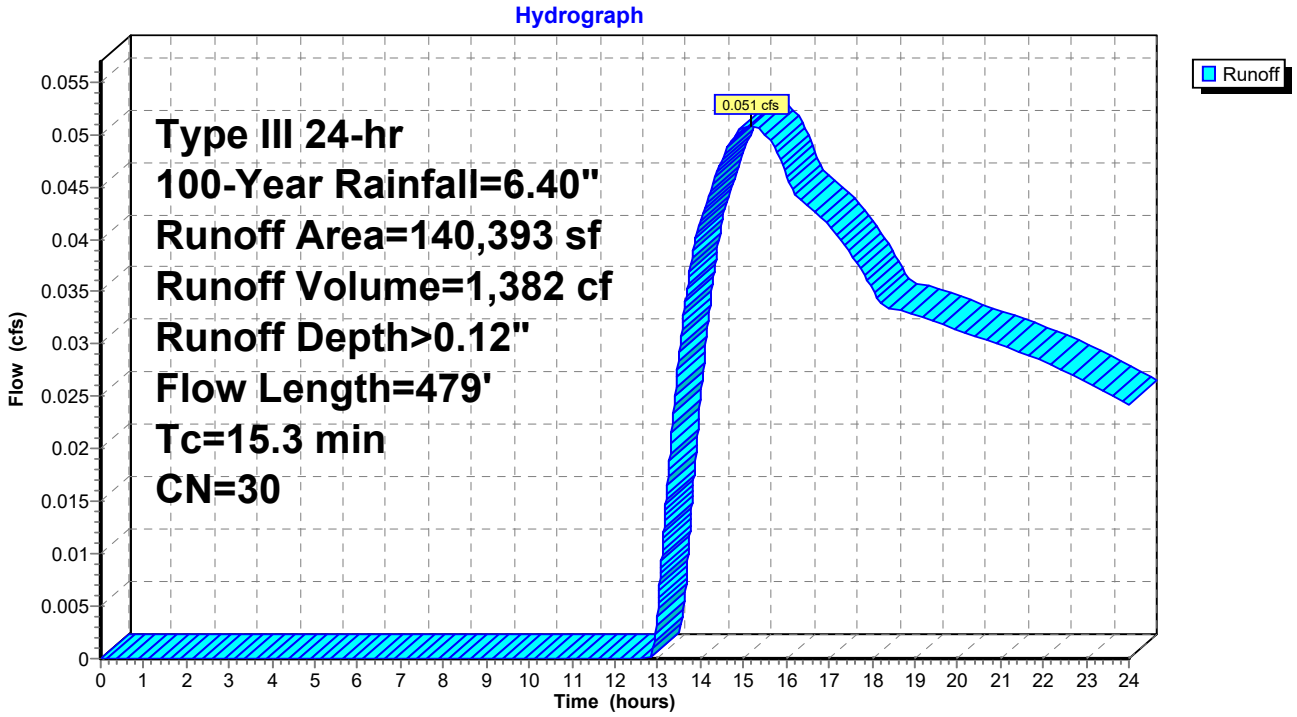
Runoff = 0.051 cfs @ 15.18 hrs, Volume= 1,382 cf, Depth> 0.12"
Routed to Reach R1 : Wetlands

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=6.40"

Area (sf)	CN	Description
140,393	30	Woods, Good, HSG A
140,393		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	50	0.0620	0.11		**Sheet Flow, A-B** Woods: Light underbrush n= 0.400 P2= 3.22"
2.5	179	0.0590	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.0	250	0.0280	0.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	479	Total			

Subcatchment S2: Northern Area



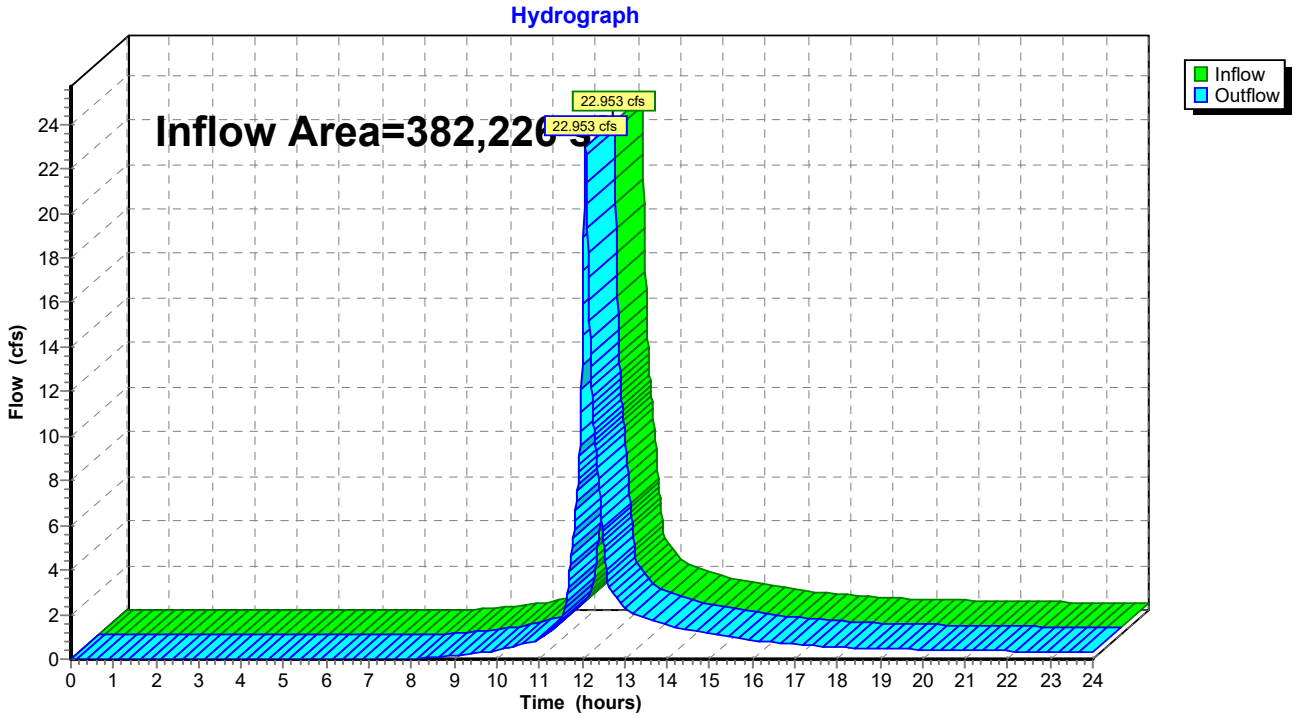
Summary for Reach R1: Wetlands

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 382,226 sf, 12.41% Impervious, Inflow Depth > 2.27" for 100-Year event
Inflow = 22.953 cfs @ 12.09 hrs, Volume= 72,318 cf
Outflow = 22.953 cfs @ 12.09 hrs, Volume= 72,318 cf, Atten= 0%, Lag= 0.0 min

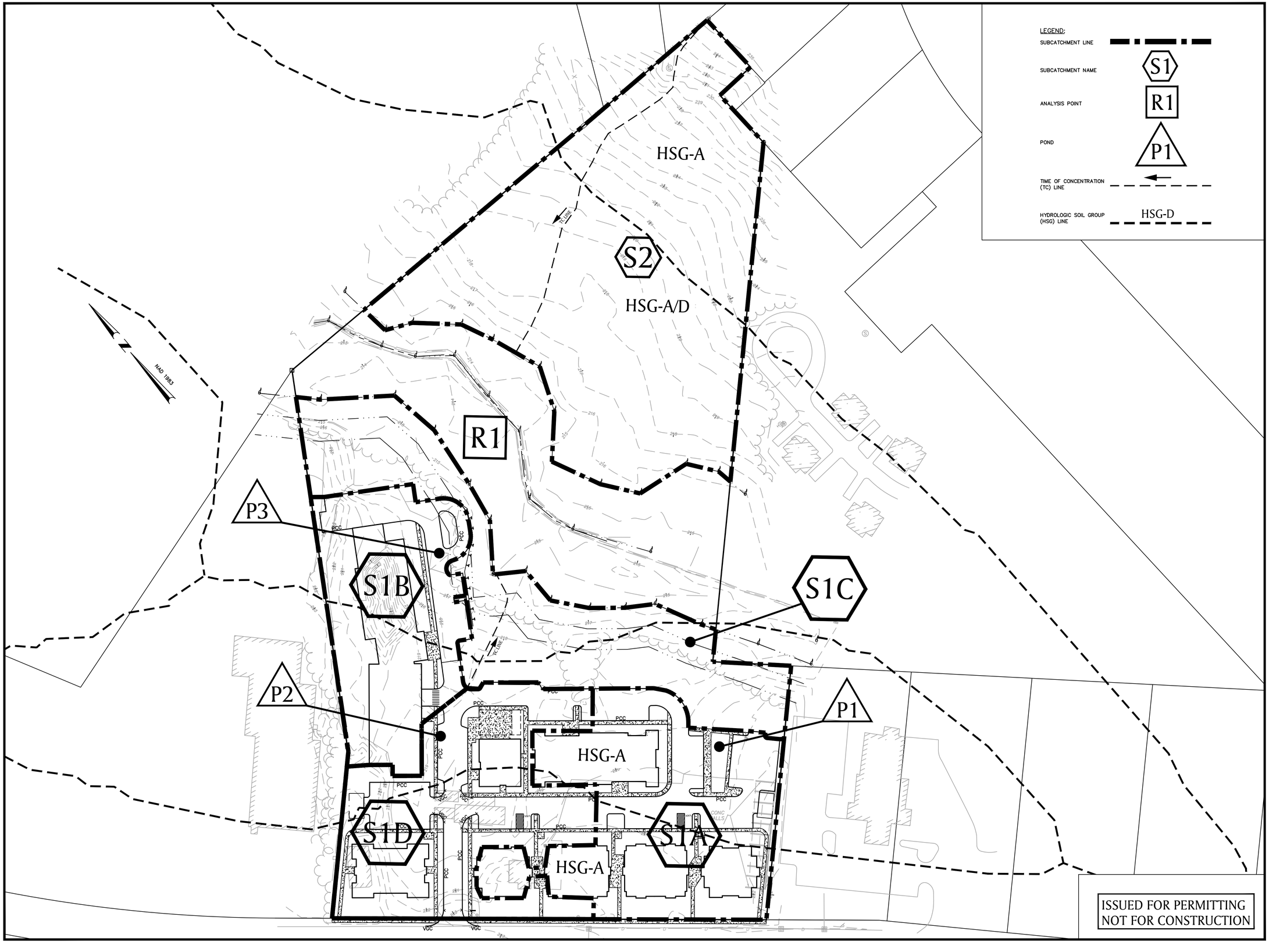
Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Reach R1: Wetlands



4.03

PROPOSED CONDITIONS WATERSHED PLAN



LEGEND:

SUBCATCHMENT LINE

SUBCATCHMENT NAME — S1

ANALYSIS POINT — R1

POND — P1

TIME OF CONCENTRATION (TC) LINE

HYDROLOGIC SOIL GROUP (HSG) LINE — HSG-D

NOAH
Neighborhood of Affordable Housing, Inc.

DATE

AYER COMMONS

65 FITCHBURG ROAD
IN
AYER
MASSACHUSETTS
(MIDDLESEX COUNTY)

PROPOSED CONDITIONS WATERSHED PLAN

JUNE 14, 2022

REVISIONS:

NO.	DATE	DESC.
1	8/15/22	TOWN COMMENTS
2	10/11/22	PLAN UPDATES
3	11/03/22	PEER REVIEW

PREPARED FOR:
NEIGHBORHOOD OF
AFFORDABLE HOUSING
143 BORDER STREET
EAST BOSTON, MA

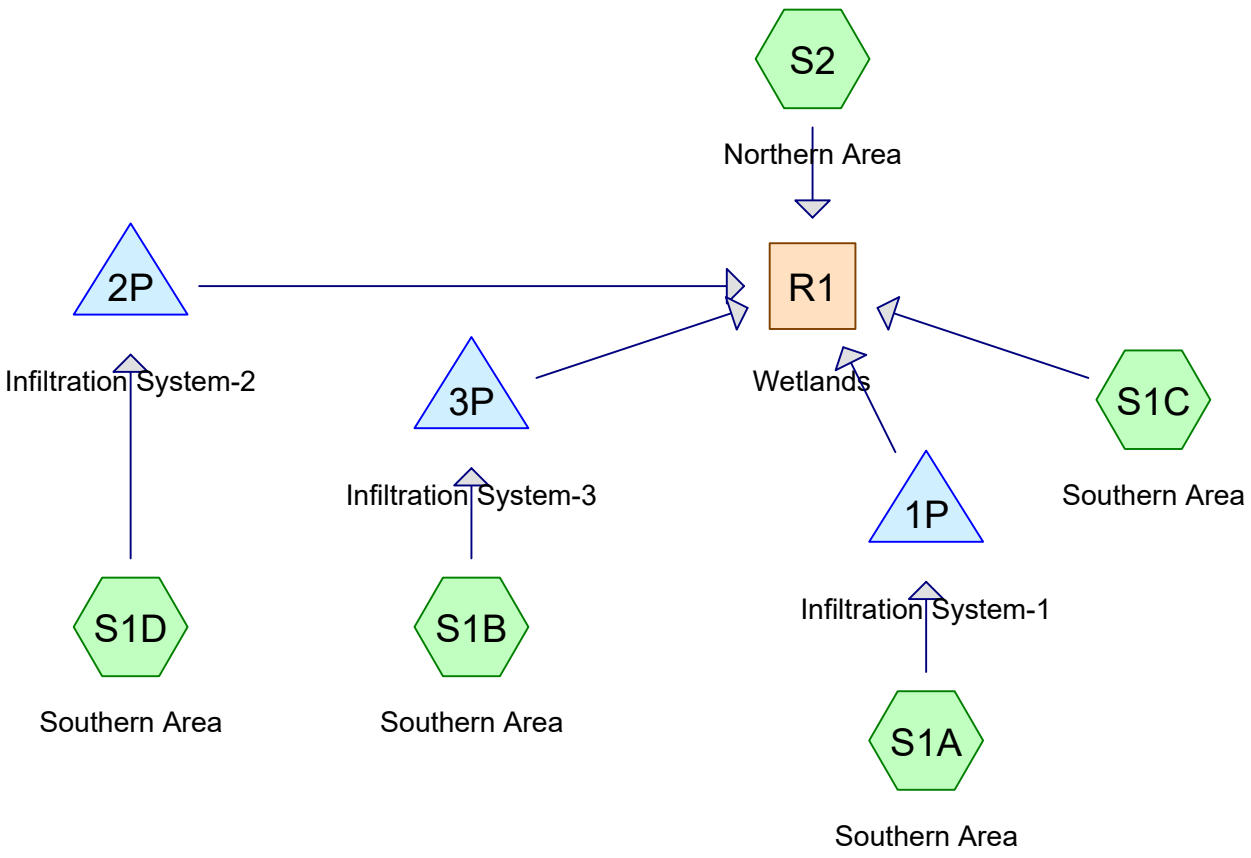
BSC GROUP
300 Brickstone Square
Andover, Massachusetts
01810
617 896 4300

SCALE: 1" = 50'
0 25 50 100 FEET

FILE: Proj-AND/B992601/C/DD/PC WATERSHED
DWG.: PC WATERSHED
JOB. NO: 8-9926.01
SHEET 2 of 2

4.04

PROPOSED CONDITIONS HYDROCAD PRINTOUTS



Subcat Reach Pond Link

Routing Diagram for 8992601-PC
Prepared by BSC Group, Printed 11/3/2022

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	Type III 24-hr		Default	24.00	1	3.00	2
2	10-Year	Type III 24-hr		Default	24.00	1	4.50	2
3	25-Year	Type III 24-hr		Default	24.00	1	5.60	2
4	100-Year	Type III 24-hr		Default	24.00	1	6.40	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
92,217	39	>75% Grass cover, Good, HSG A (S1A, S1B, S1C, S1D)
5,746	76	Gravel roads, HSG A (S1A, S1C)
72,166	98	Paved parking, HSG A (S1A, S1B, S1D)
50,907	98	Roofs, HSG A (S1A, S1B, S1D)
160,981	30	Woods, Good, HSG A (S1C, S2)
382,017	**55**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
382,017	HSG A	S1A, S1B, S1C, S1D, S2
0	HSG B	
0	HSG C	
0	HSG D	
0	Other	
382,017		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Su Nu
92,217	0	0	0	0	92,217	>75% Grass cover, Good	
5,746	0	0	0	0	5,746	Gravel roads	
72,166	0	0	0	0	72,166	Paved parking	
50,907	0	0	0	0	50,907	Roofs	
160,981	0	0	0	0	160,981	Woods, Good	
382,017	**0**	**0**	**0**	**0**	**382,017**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	1P	219.50	219.50	114.0	0.0000	0.013	0.0	10.0	0.0
2	2P	218.50	216.00	140.0	0.0179	0.013	0.0	10.0	0.0
3	2P	218.50	216.50	140.0	0.0143	0.010	0.0	10.0	0.0
4	3P	215.60	215.00	30.0	0.0200	0.013	0.0	15.0	0.0

Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentS1A: Southern Area Runoff Area=65,937 sf 72.93% Impervious Runoff Depth>1.44"
Tc=6.0 min CN=83 Runoff=2.56 cfs 7,939 cf

SubcatchmentS1B: Southern Area Runoff Area=49,148 sf 66.41% Impervious Runoff Depth>1.13"
Tc=6.0 min CN=78 Runoff=1.45 cfs 4,617 cf

SubcatchmentS1C: Southern Area Runoff Area=63,462 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=150' Tc=10.7 min CN=39 Runoff=0.00 cfs 0 cf

SubcatchmentS1D: Southern Area Runoff Area=63,077 sf 67.14% Impervious Runoff Depth>1.19"
Tc=6.0 min CN=79 Runoff=1.98 cfs 6,238 cf

SubcatchmentS2: Northern Area Runoff Area=140,393 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=479' Tc=15.3 min CN=30 Runoff=0.00 cfs 0 cf

Reach R1: Wetlands Inflow=0.95 cfs 1,691 cf
Outflow=0.95 cfs 1,691 cf

Pond 1P: Infiltration System-1 Peak Elev=219.28' Storage=1,448 cf Inflow=2.56 cfs 7,939 cf
Discarded=0.73 cfs 7,939 cf Primary=0.00 cfs 0 cf Outflow=0.73 cfs 7,939 cf

Pond 2P: Infiltration System-2 Peak Elev=218.87' Storage=1,232 cf Inflow=1.98 cfs 6,238 cf
Discarded=0.15 cfs 4,548 cf Primary=0.95 cfs 1,691 cf Outflow=1.10 cfs 6,239 cf

Pond 3P: Infiltration System-3 Peak Elev=215.58' Storage=1,210 cf Inflow=1.45 cfs 4,617 cf
Discarded=0.27 cfs 4,617 cf Primary=0.00 cfs 0 cf Outflow=0.27 cfs 4,617 cf

Total Runoff Area = 382,017 sf Runoff Volume = 18,794 cf Average Runoff Depth = 0.59"
67.78% Pervious = 258,944 sf 32.22% Impervious = 123,073 sf

Summary for Subcatchment S1A: Southern Area

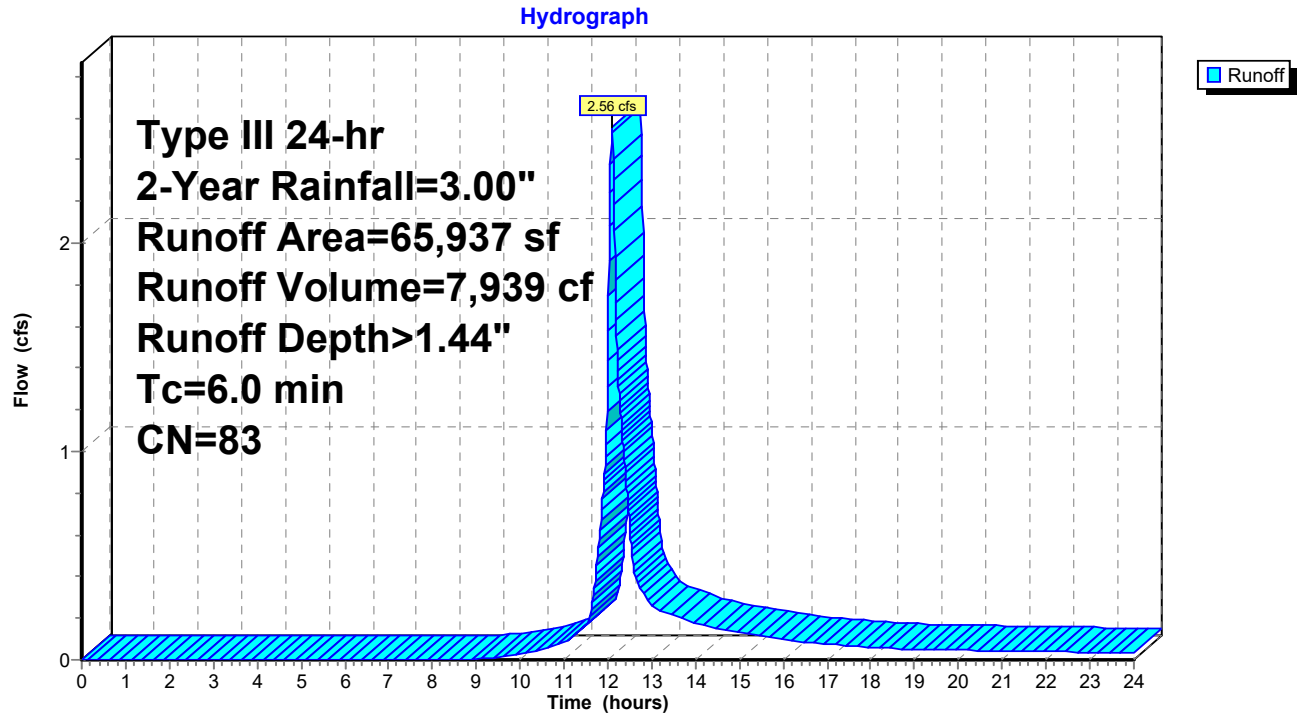
Runoff = 2.56 cfs @ 12.09 hrs, Volume= 7,939 cf, Depth> 1.44"
Routed to Pond 1P : Infiltration System-1

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=3.00"

Area (sf)	CN	Description
16,473	39	>75% Grass cover, Good, HSG A
1,379	76	Gravel roads, HSG A
23,130	98	Paved parking, HSG A
24,955	98	Roofs, HSG A
65,937	83	Weighted Average
17,852		27.07% Pervious Area
48,085		72.93% Impervious Area

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

Subcatchment S1A: Southern Area



Summary for Subcatchment S1B: Southern Area

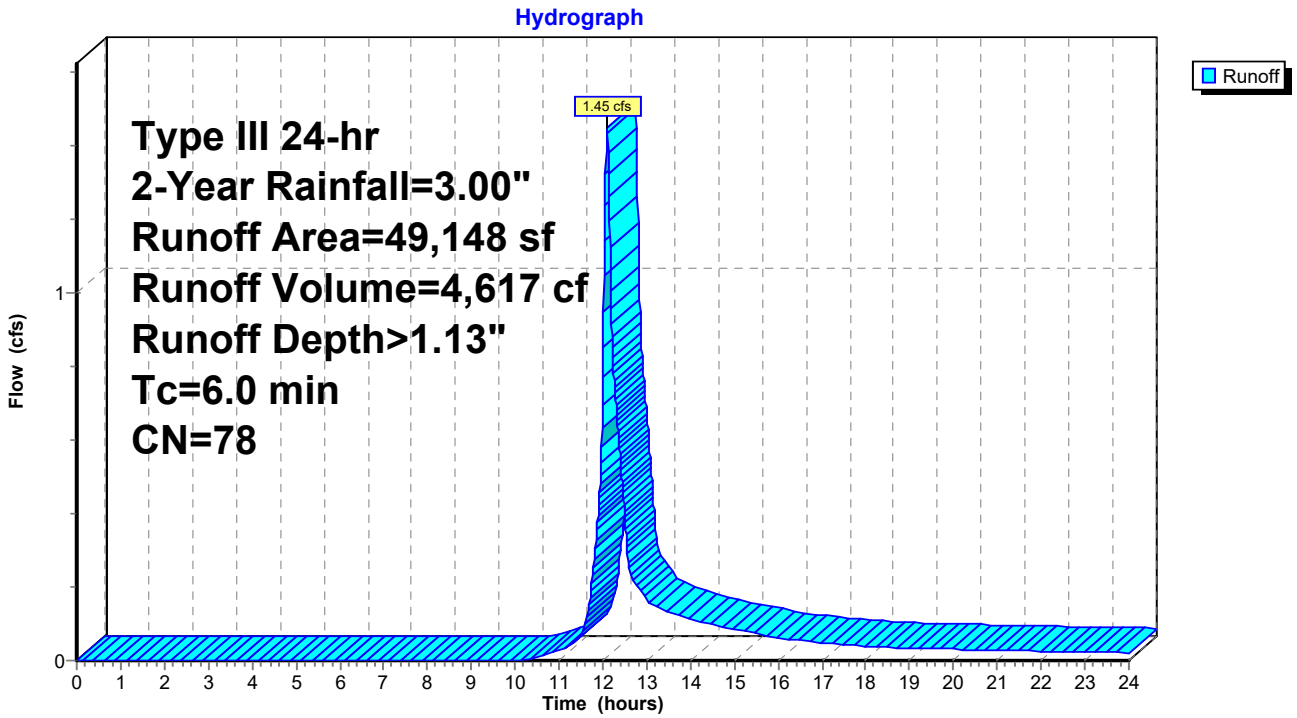
Runoff = 1.45 cfs @ 12.09 hrs, Volume= 4,617 cf, Depth> 1.13"
Routed to Pond 3P : Infiltration System-3

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=3.00"

Area (sf)	CN	Description
16,511	39	>75% Grass cover, Good, HSG A
14,685	98	Paved parking, HSG A
17,952	98	Roofs, HSG A
49,148	78	Weighted Average
16,511		33.59% Pervious Area
32,637		66.41% Impervious Area

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

Subcatchment S1B: Southern Area



Summary for Subcatchment S1C: Southern Area

[45] Hint: Runoff=Zero

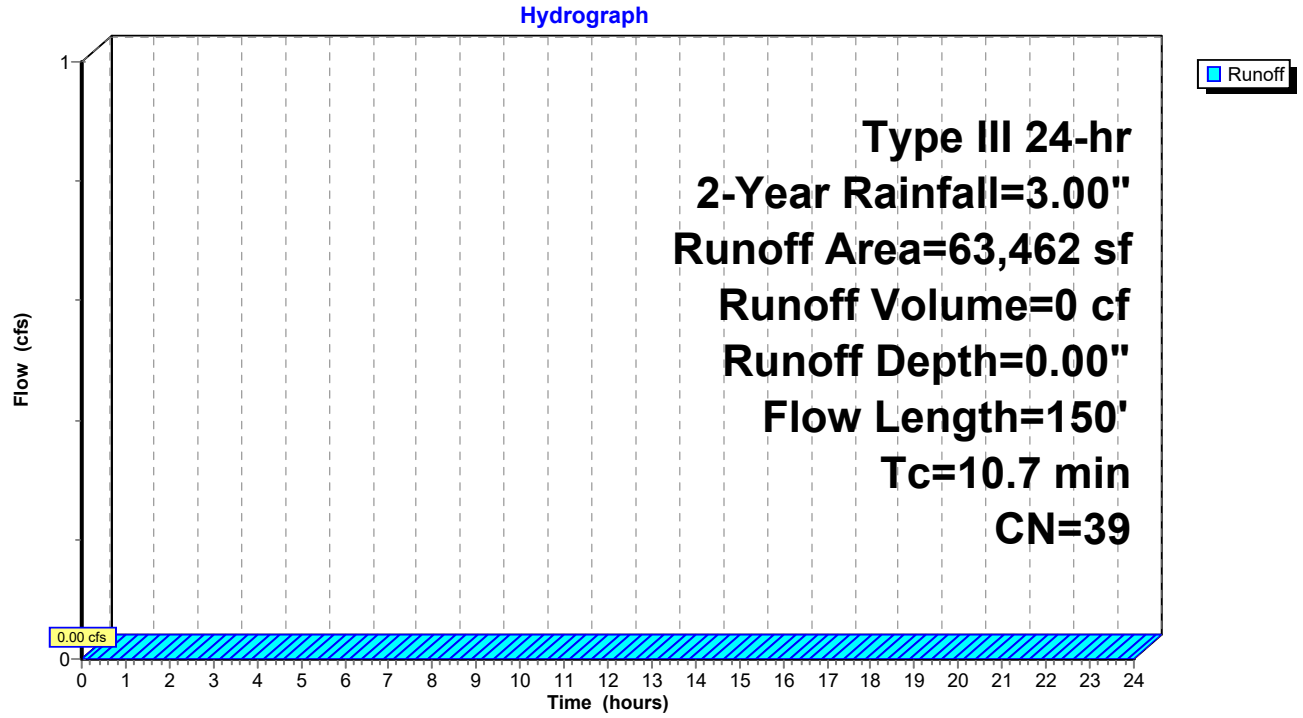
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Reach R1 : Wetlands

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=3.00"

Area (sf)	CN	Description
20,588	30	Woods, Good, HSG A
38,507	39	>75% Grass cover, Good, HSG A
4,367	76	Gravel roads, HSG A
63,462	39	Weighted Average
63,462		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0143	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22"
0.6	55	0.0465	1.51		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	45	0.0333	0.91		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
10.7	150	Total			

Subcatchment S1C: Southern Area



Summary for Subcatchment S1D: Southern Area

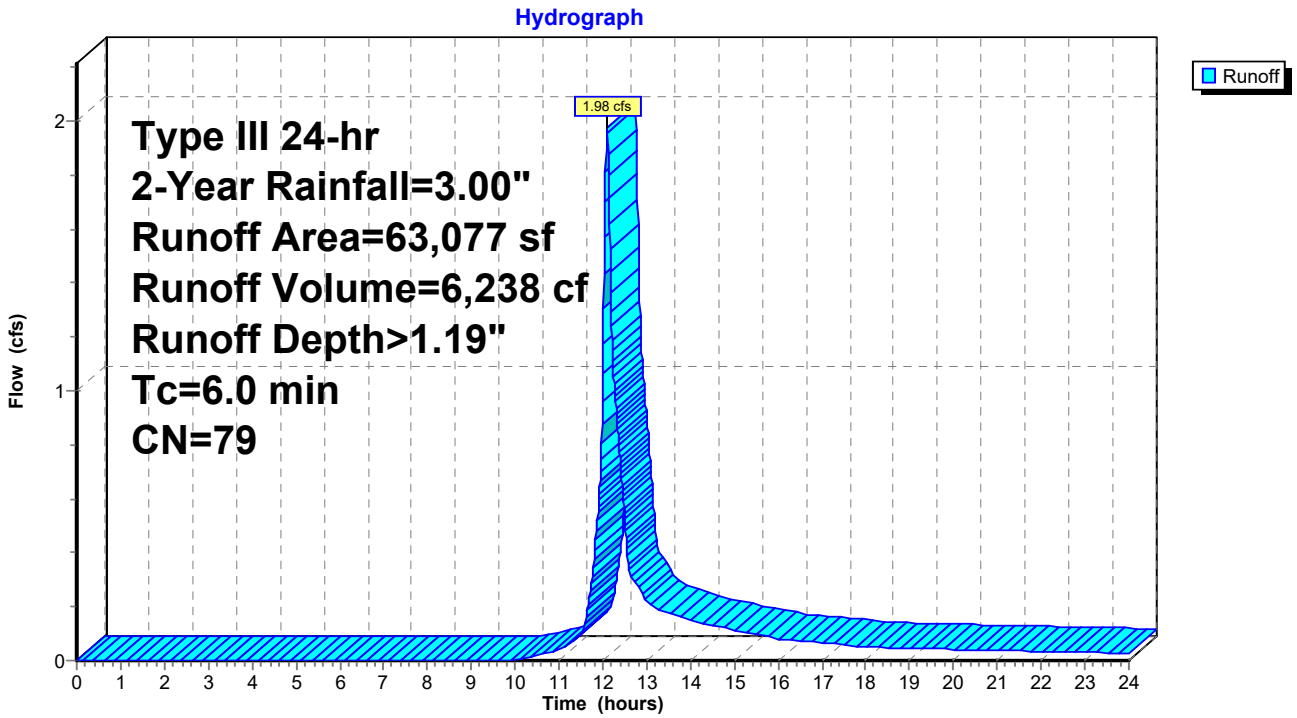
Runoff = 1.98 cfs @ 12.09 hrs, Volume= 6,238 cf, Depth> 1.19"
Routed to Pond 2P : Infiltration System-2

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=3.00"

Area (sf)	CN	Description
20,726	39	>75% Grass cover, Good, HSG A
34,351	98	Paved parking, HSG A
8,000	98	Roofs, HSG A
63,077	79	Weighted Average
20,726		32.86% Pervious Area
42,351		67.14% Impervious Area

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

Subcatchment S1D: Southern Area



Summary for Subcatchment S2: Northern Area

[45] Hint: Runoff=Zero

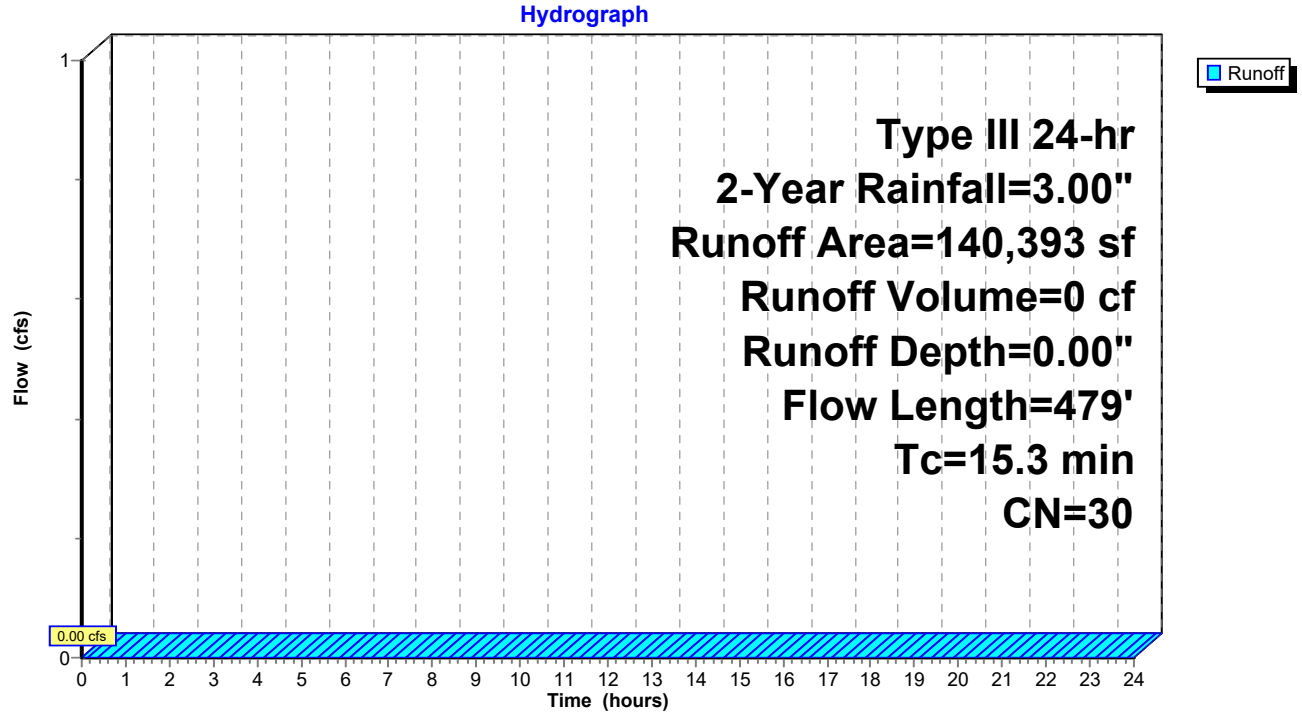
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Reach R1 : Wetlands

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=3.00"

Area (sf)	CN	Description
140,393	30	Woods, Good, HSG A
140,393		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	50	0.0620	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.22"
2.5	179	0.0590	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.0	250	0.0280	0.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	479	Total			

Subcatchment S2: Northern Area



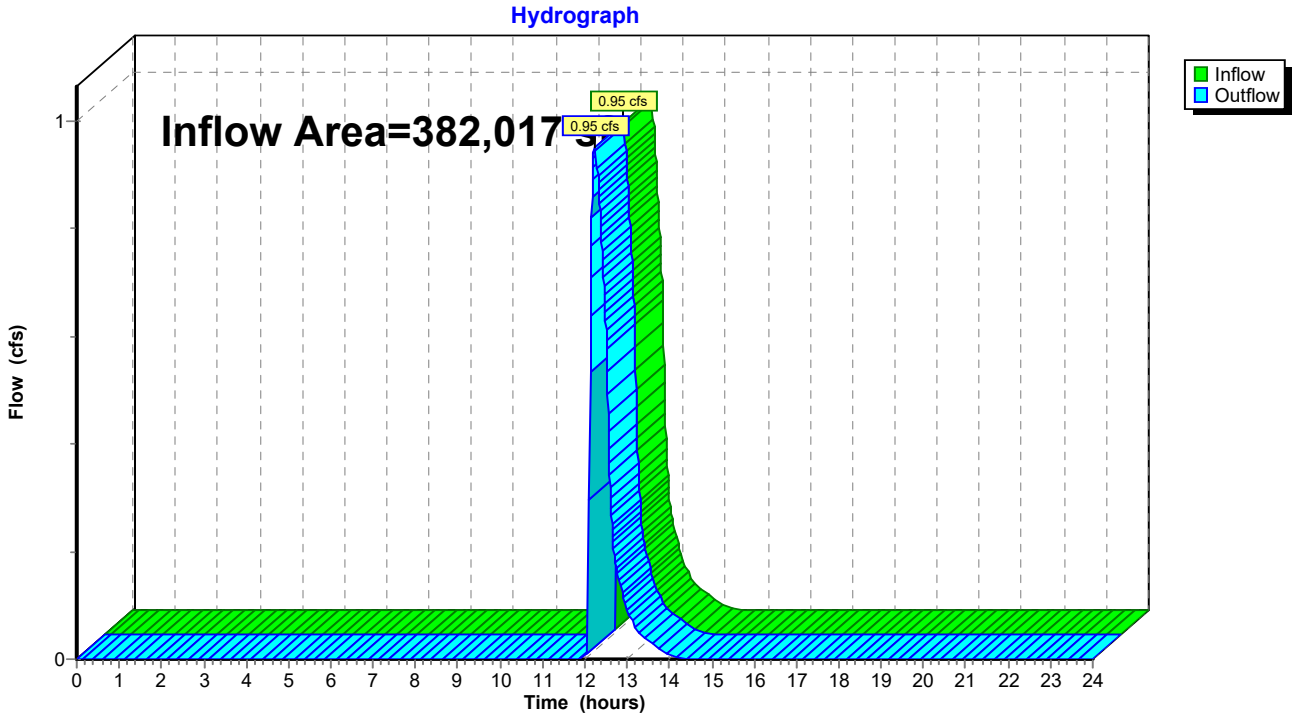
Summary for Reach R1: Wetlands

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 382,017 sf, 32.22% Impervious, Inflow Depth = 0.05" for 2-Year event
Inflow = 0.95 cfs @ 12.23 hrs, Volume= 1,691 cf
Outflow = 0.95 cfs @ 12.23 hrs, Volume= 1,691 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3

Reach R1: Wetlands



Summary for Pond 1P: Infiltration System-1

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=525)

Inflow Area = 65,937 sf, 72.93% Impervious, Inflow Depth > 1.44" for 2-Year event
Inflow = 2.56 cfs @ 12.09 hrs, Volume= 7,939 cf
Outflow = 0.73 cfs @ 12.46 hrs, Volume= 7,939 cf, Atten= 71%, Lag= 22.4 min
Discarded = 0.73 cfs @ 12.46 hrs, Volume= 7,939 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach R1 : Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 219.28' @ 12.46 hrs Surf.Area= 12,962 sf Storage= 1,448 cf
Flood Elev= 221.50' Surf.Area= 12,962 sf Storage= 14,788 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 9.7 min (845.0 - 835.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	219.00'	7,784 cf	**85.00'W x 152.50'L x 2.04'H Field A** 26,465 cf Overall - 7,004 cf Embedded = 19,461 cf x 40.0% Voids
#2A	219.50'	7,004 cf	**Cultec C-100HD** x 500 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 25 rows
		14,788 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	219.50'	**10.0" Round Culvert** L= 114.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 219.50' / 219.50' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Discarded	219.00'	**2.410 in/hr Exfiltration over Wetted area**
#3	Device 1	220.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.73 cfs @ 12.46 hrs HW=219.28' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.73 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=219.00' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Controls 0.00 cfs)
└**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Infiltration System-1 - Chamber Wizard Field A

Chamber Model = Cultec C-100HD (Cultec Contactor® 100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 25 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

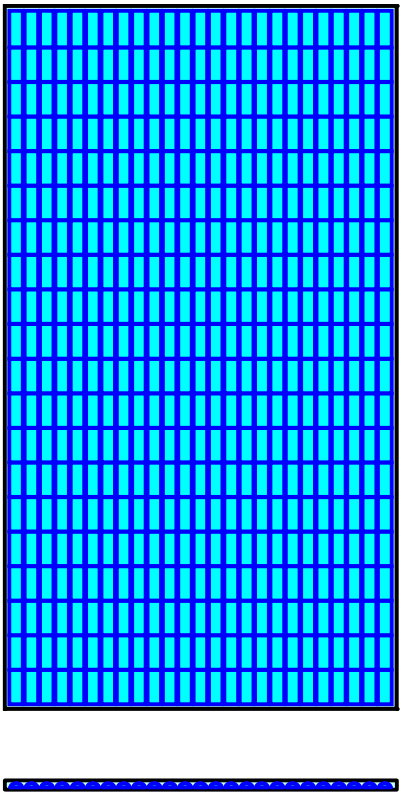
20 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 150.50' Row Length +12.0" End Stone x 2 = 152.50' Base Length
25 Rows x 36.0" Wide + 4.0" Spacing x 24 + 12.0" Side Stone x 2 = 85.00' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

500 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 25 Rows = 7,003.9 cf Chamber Storage

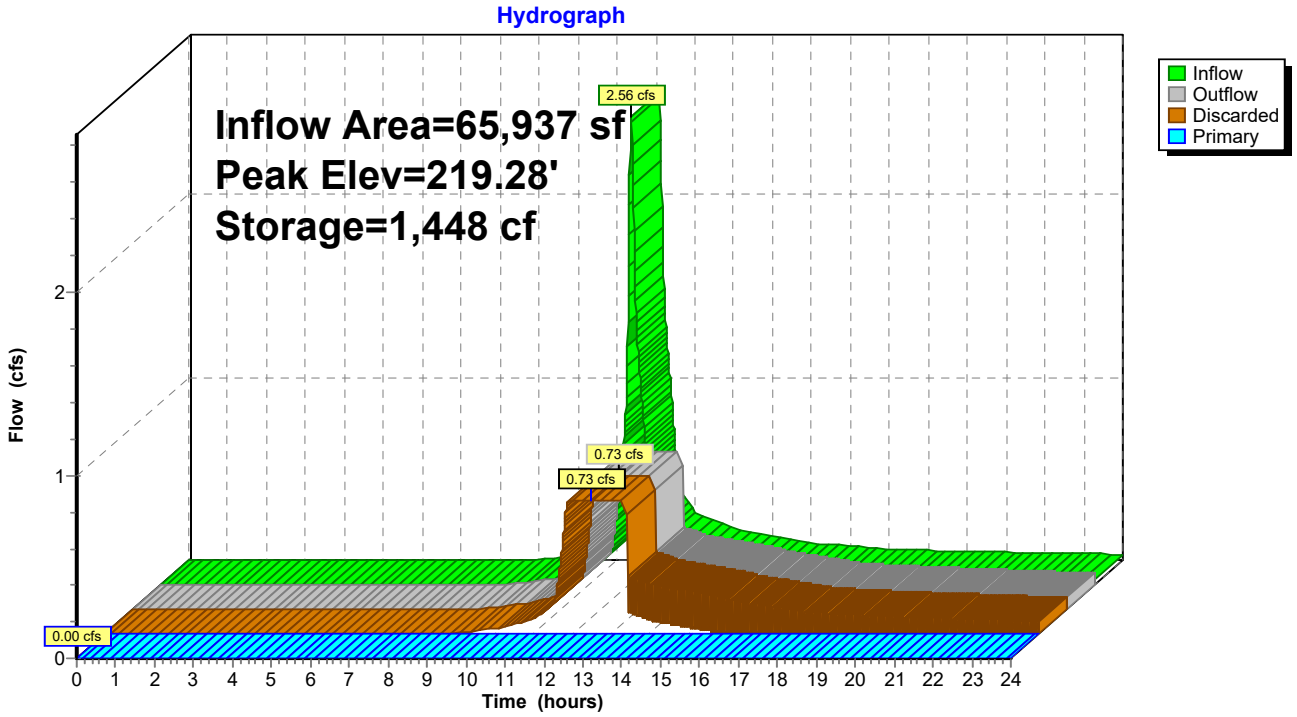
26,465.1 cf Field - 7,003.9 cf Chambers = 19,461.2 cf Stone x 40.0% Voids = 7,784.5 cf Stone Storage

Chamber Storage + Stone Storage = 14,788.4 cf = 0.339 af
Overall Storage Efficiency = 55.9%
Overall System Size = 152.50' x 85.00' x 2.04'

500 Chambers
980.2 cy Field
720.8 cy Stone



Pond 1P: Infiltration System-1



Summary for Pond 2P: Infiltration System-2

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=283)

Inflow Area = 63,077 sf, 67.14% Impervious, Inflow Depth > 1.19" for 2-Year event
Inflow = 1.98 cfs @ 12.09 hrs, Volume= 6,238 cf
Outflow = 1.10 cfs @ 12.23 hrs, Volume= 6,239 cf, Atten= 44%, Lag= 8.4 min
Discarded = 0.15 cfs @ 12.23 hrs, Volume= 4,548 cf
Primary = 0.95 cfs @ 12.23 hrs, Volume= 1,691 cf
Routed to Reach R1 : Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 218.87' @ 12.23 hrs Surf.Area= 2,492 sf Storage= 1,232 cf
Flood Elev= 221.00' Surf.Area= 2,492 sf Storage= 2,792 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 42.7 min (891.3 - 848.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	218.00'	1,530 cf	**21.67'W x 115.00'L x 2.04'H Field A** 5,087 cf Overall - 1,262 cf Embedded = 3,825 cf x 40.0% Voids
#2A	218.50'	1,262 cf	**Cultec C-100HD** x 90 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 6 rows
		2,792 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	218.50'	**10.0" Round Culvert** L= 140.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 218.50' / 216.00' S= 0.0179 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Discarded	218.00'	**2.410 in/hr Exfiltration over Wetted area**
#3	Primary	218.50'	**10.0" Round Culvert** L= 140.0' Ke= 0.500 Inlet / Outlet Invert= 218.50' / 216.50' S= 0.0143 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.55 sf
#4	Device 1	218.70'	**4.0' long Sharp-Crested Vee/Trap Weir** Cv= 2.62 (C= 3.28)
#5	Device 3	218.70'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.15 cfs @ 12.23 hrs HW=218.87' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.15 cfs)

Primary OutFlow Max=0.95 cfs @ 12.23 hrs HW=218.87' TW=0.00' (Dynamic Tailwater)
├**1=Culvert** (Inlet Controls 0.48 cfs @ 2.06 fps)
│ └**4=Sharp-Crested Vee/Trap Weir** (Passes 0.48 cfs of 0.89 cfs potential flow)
└**3=Culvert** (Inlet Controls 0.48 cfs @ 2.06 fps)
└**5=Sharp-Crested Rectangular Weir** (Passes 0.48 cfs of 0.88 cfs potential flow)

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

Chamber Model = Cultec C-100HD (Cultec Contactor®100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 6 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

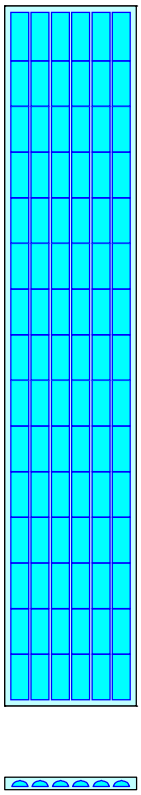
15 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 113.00' Row Length +12.0" End Stone x 2 = 115.00' Base Length
6 Rows x 36.0" Wide + 4.0" Spacing x 5 + 12.0" Side Stone x 2 = 21.67' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

90 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 6 Rows = 1,262.1 cf Chamber Storage

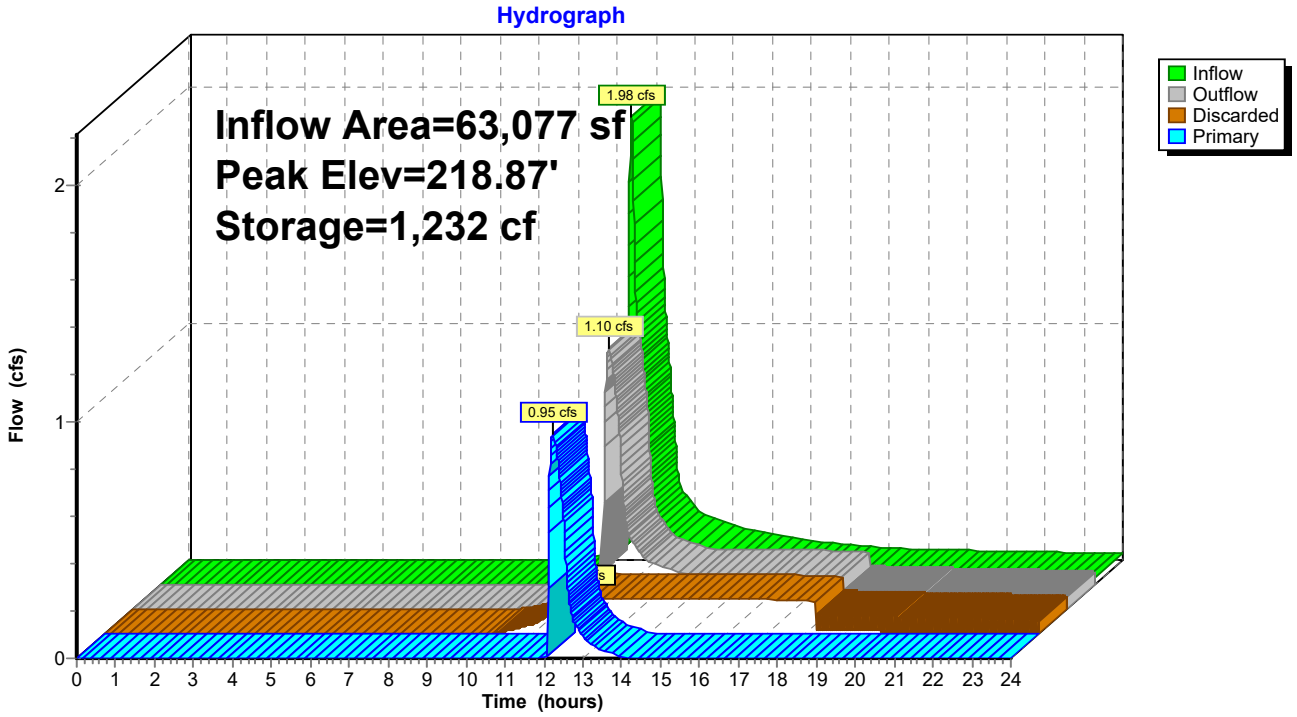
5,087.2 cf Field - 1,262.1 cf Chambers = 3,825.1 cf Stone x 40.0% Voids = 1,530.0 cf Stone Storage

Chamber Storage + Stone Storage = 2,792.1 cf = 0.064 af
Overall Storage Efficiency = 54.9%
Overall System Size = 115.00' x 21.67' x 2.04'

90 Chambers
188.4 cy Field
141.7 cy Stone



Pond 2P: Infiltration System-2



Summary for Pond 3P: Infiltration System-3

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=442)

Inflow Area = 49,148 sf, 66.41% Impervious, Inflow Depth > 1.13" for 2-Year event
Inflow = 1.45 cfs @ 12.09 hrs, Volume= 4,617 cf
Outflow = 0.27 cfs @ 12.59 hrs, Volume= 4,617 cf, Atten= 82%, Lag= 29.6 min
Discarded = 0.27 cfs @ 12.59 hrs, Volume= 4,617 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach R1 : Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 215.58' @ 12.59 hrs Surf.Area= 4,592 sf Storage= 1,210 cf
Flood Elev= 218.60' Surf.Area= 4,592 sf Storage= 5,187 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 29.5 min (881.4 - 851.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	215.00'	2,792 cf	**31.67'W x 145.00'L x 2.04'H Field A** 9,375 cf Overall - 2,396 cf Embedded = 6,979 cf x 40.0% Voids
#2A	215.50'	2,396 cf	**Cultec C-100HD** x 171 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 9 rows
		5,187 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	215.60'	**15.0" Round Culvert** L= 30.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 215.60' / 215.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Discarded	215.00'	**2.410 in/hr Exfiltration over Wetted area**
#3	Device 1	215.75'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.27 cfs @ 12.59 hrs HW=215.58' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.27 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=215.00' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Controls 0.00 cfs)
└**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Infiltration System-3 - Chamber Wizard Field A

Chamber Model = Cultec C-100HD (Cultec Contactor® 100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 9 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

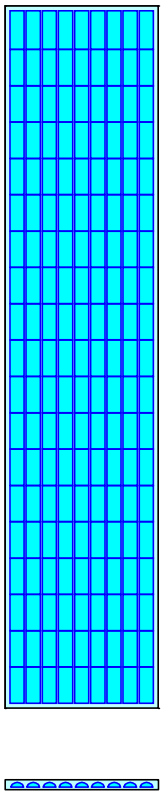
19 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 143.00' Row Length +12.0" End Stone x 2 = 145.00' Base Length
9 Rows x 36.0" Wide + 4.0" Spacing x 8 + 12.0" Side Stone x 2 = 31.67' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

171 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 9 Rows = 2,395.8 cf Chamber Storage

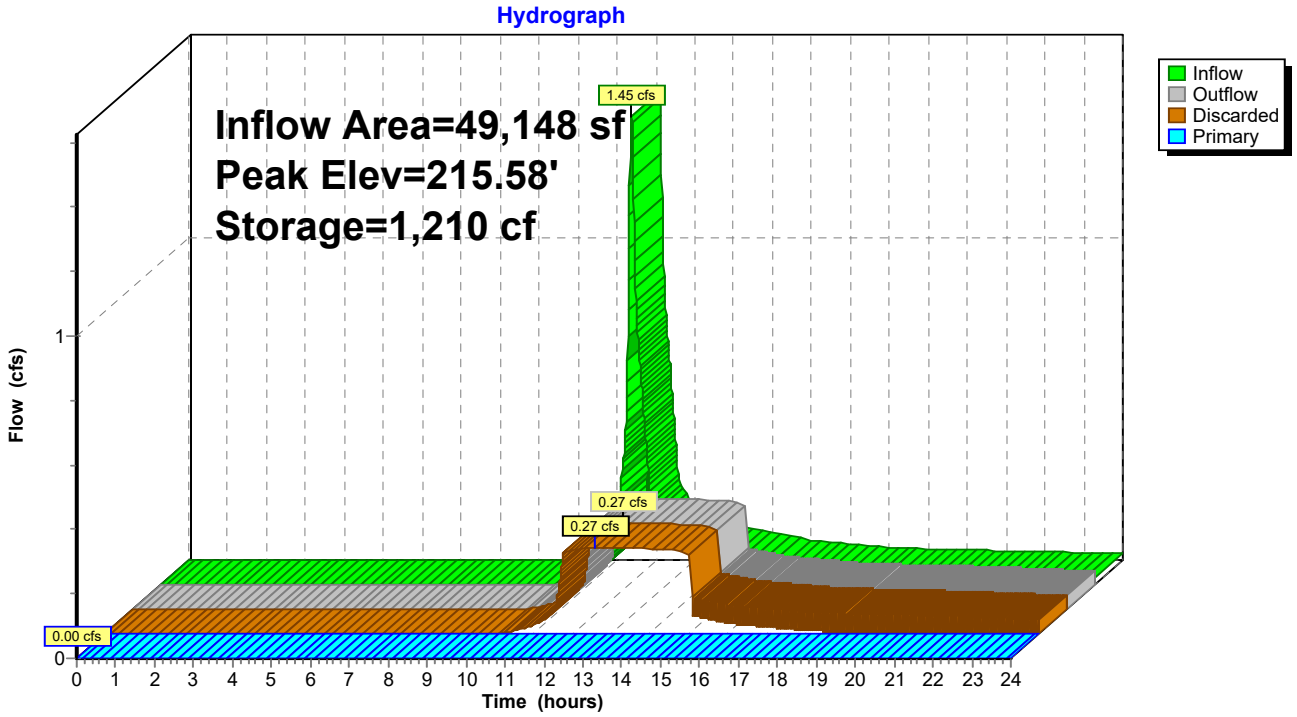
9,374.7 cf Field - 2,395.8 cf Chambers = 6,978.9 cf Stone x 40.0% Voids = 2,791.6 cf Stone Storage

Chamber Storage + Stone Storage = 5,187.3 cf = 0.119 af
Overall Storage Efficiency = 55.3%
Overall System Size = 145.00' x 31.67' x 2.04'

171 Chambers
347.2 cy Field
258.5 cy Stone



Pond 3P: Infiltration System-3



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentS1A: Southern Area Runoff Area=65,937 sf 72.93% Impervious Runoff Depth>2.72"
Tc=6.0 min CN=83 Runoff=4.83 cfs 14,960 cf

SubcatchmentS1B: Southern Area Runoff Area=49,148 sf 66.41% Impervious Runoff Depth>2.29"
Tc=6.0 min CN=78 Runoff=3.03 cfs 9,379 cf

SubcatchmentS1C: Southern Area Runoff Area=63,462 sf 0.00% Impervious Runoff Depth>0.11"
Flow Length=150' Tc=10.7 min CN=39 Runoff=0.02 cfs 580 cf

SubcatchmentS1D: Southern Area Runoff Area=63,077 sf 67.14% Impervious Runoff Depth>2.37"
Tc=6.0 min CN=79 Runoff=4.04 cfs 12,477 cf

SubcatchmentS2: Northern Area Runoff Area=140,393 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=479' Tc=15.3 min CN=30 Runoff=0.00 cfs 0 cf

Reach R1: Wetlands Inflow=3.20 cfs 8,357 cf
Outflow=3.20 cfs 8,357 cf

Pond 1P: Infiltration System-1 Peak Elev=219.67' Storage=4,444 cf Inflow=4.83 cfs 14,960 cf
Discarded=0.74 cfs 14,968 cf Primary=0.00 cfs 0 cf Outflow=0.74 cfs 14,968 cf

Pond 2P: Infiltration System-2 Peak Elev=219.24' Storage=1,909 cf Inflow=4.04 cfs 12,477 cf
Discarded=0.16 cfs 6,371 cf Primary=2.99 cfs 6,106 cf Outflow=3.15 cfs 12,477 cf

Pond 3P: Infiltration System-3 Peak Elev=215.98' Storage=2,690 cf Inflow=3.03 cfs 9,379 cf
Discarded=0.28 cfs 7,708 cf Primary=0.65 cfs 1,671 cf Outflow=0.93 cfs 9,379 cf

Total Runoff Area = 382,017 sf Runoff Volume = 37,396 cf Average Runoff Depth = 1.17"
67.78% Pervious = 258,944 sf 32.22% Impervious = 123,073 sf

Summary for Subcatchment S1A: Southern Area

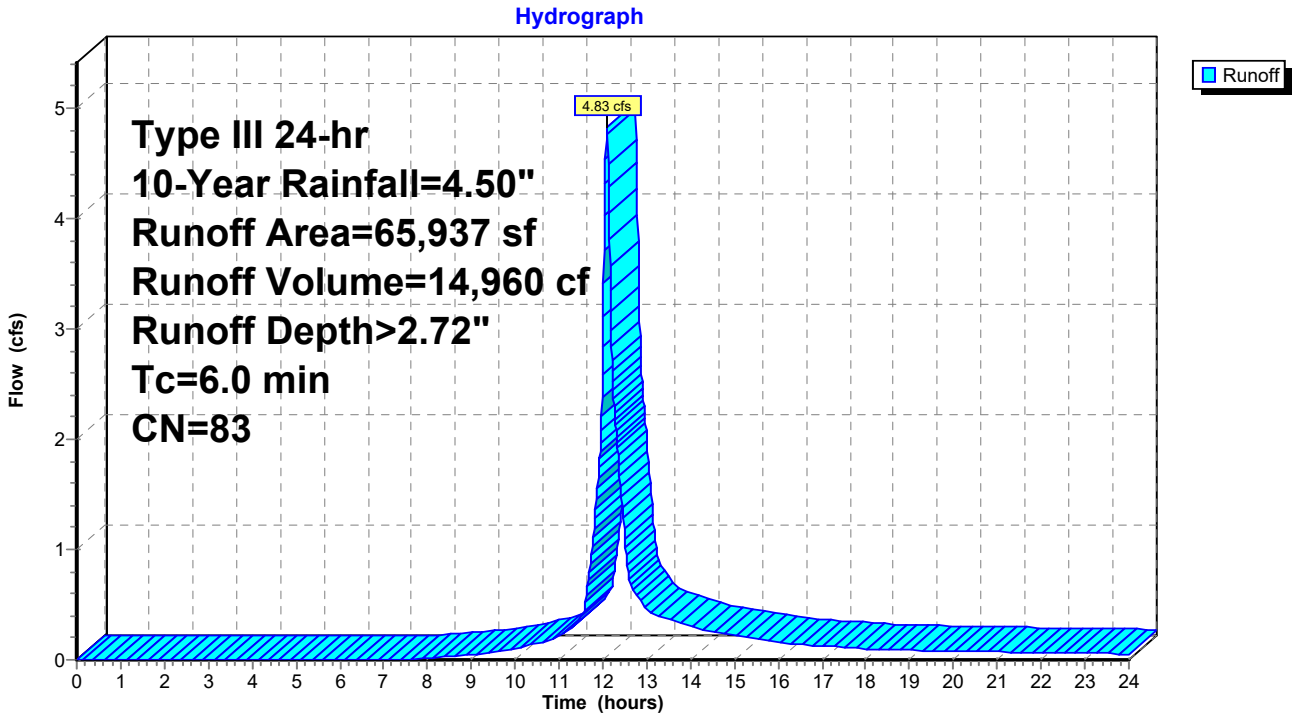
Runoff = 4.83 cfs @ 12.09 hrs, Volume= 14,960 cf, Depth> 2.72"
Routed to Pond 1P : Infiltration System-1

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=4.50"

Area (sf)	CN	Description
16,473	39	>75% Grass cover, Good, HSG A
1,379	76	Gravel roads, HSG A
23,130	98	Paved parking, HSG A
24,955	98	Roofs, HSG A
65,937	83	Weighted Average
17,852		27.07% Pervious Area
48,085		72.93% Impervious Area

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

Subcatchment S1A: Southern Area



Summary for Subcatchment S1B: Southern Area

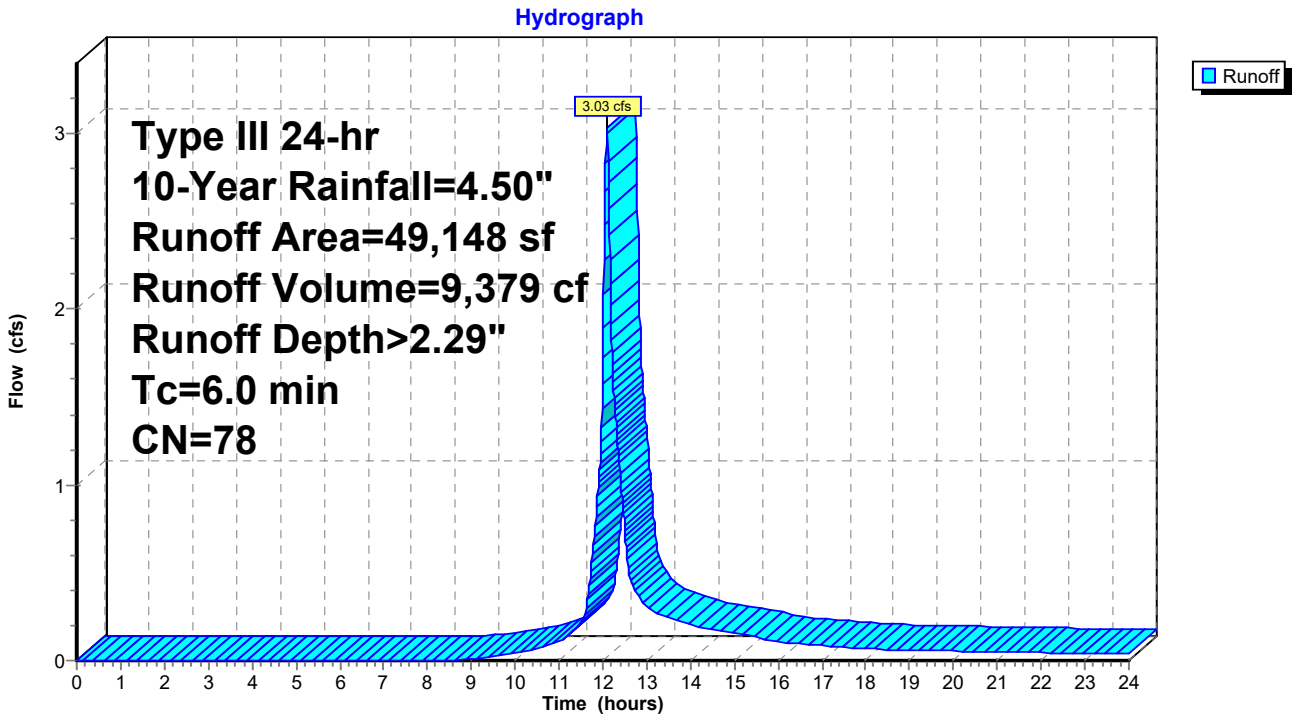
Runoff = 3.03 cfs @ 12.09 hrs, Volume= 9,379 cf, Depth> 2.29"
Routed to Pond 3P : Infiltration System-3

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=4.50"

Area (sf)	CN	Description
16,511	39	>75% Grass cover, Good, HSG A
14,685	98	Paved parking, HSG A
17,952	98	Roofs, HSG A
49,148	78	Weighted Average
16,511		33.59% Pervious Area
32,637		66.41% Impervious Area

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

Subcatchment S1B: Southern Area



Summary for Subcatchment S1C: Southern Area

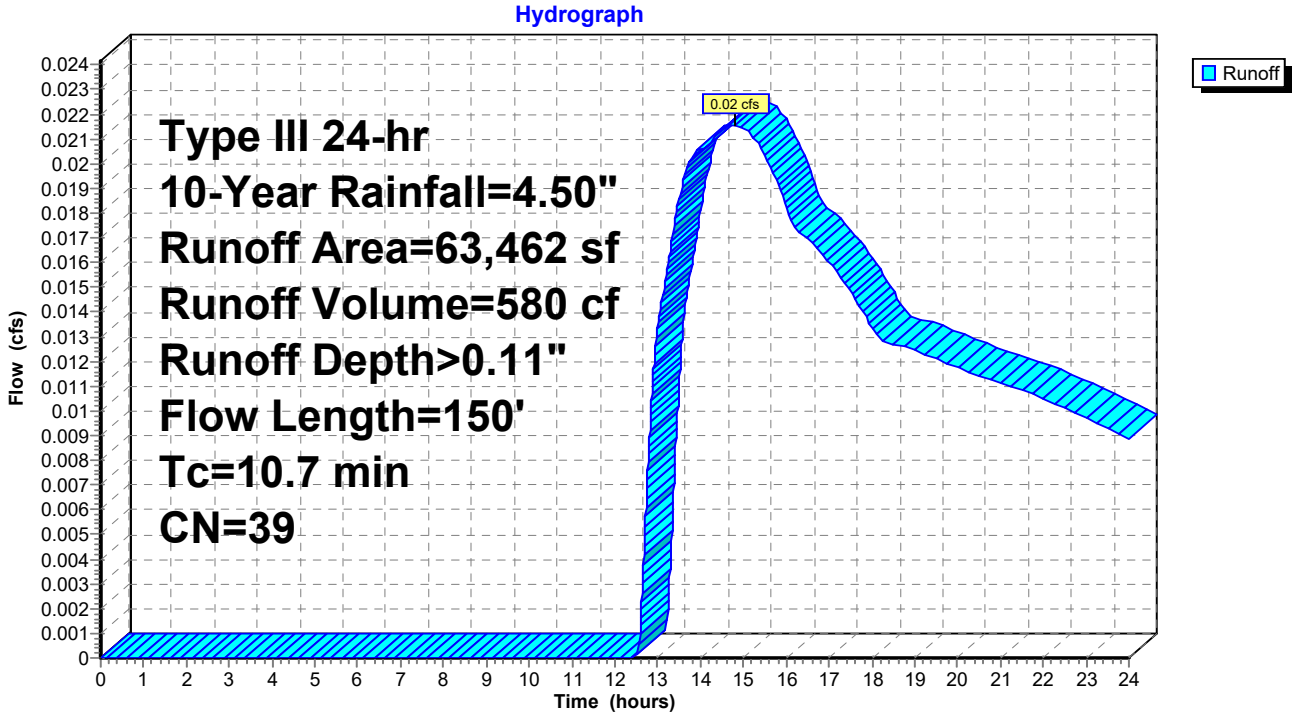
Runoff = 0.02 cfs @ 14.78 hrs, Volume= 580 cf, Depth> 0.11"
Routed to Reach R1 : Wetlands

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=4.50"

Area (sf)	CN	Description
20,588	30	Woods, Good, HSG A
38,507	39	>75% Grass cover, Good, HSG A
4,367	76	Gravel roads, HSG A
63,462	39	Weighted Average
63,462		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0143	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22"
0.6	55	0.0465	1.51		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	45	0.0333	0.91		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
10.7	150	Total			

Subcatchment S1C: Southern Area



Summary for Subcatchment S1D: Southern Area

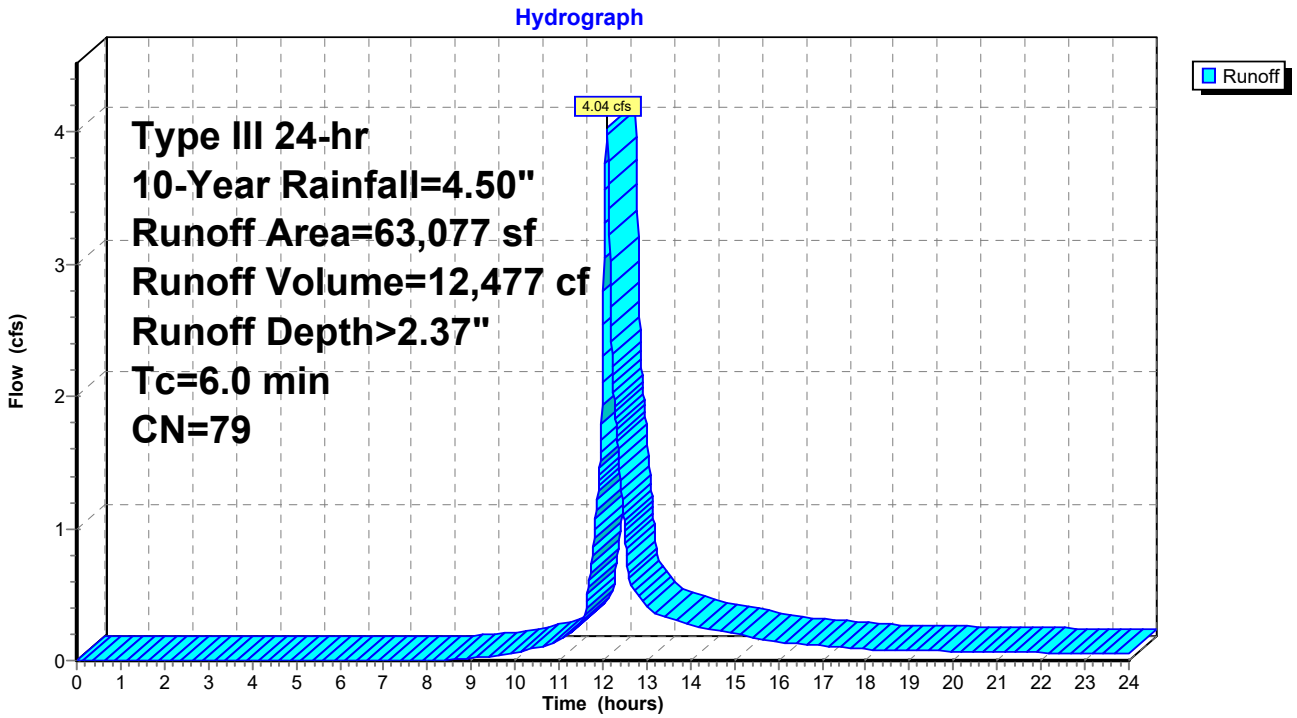
Runoff = 4.04 cfs @ 12.09 hrs, Volume= 12,477 cf, Depth> 2.37"
Routed to Pond 2P : Infiltration System-2

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=4.50"

Area (sf)	CN	Description
20,726	39	>75% Grass cover, Good, HSG A
34,351	98	Paved parking, HSG A
8,000	98	Roofs, HSG A
63,077	79	Weighted Average
20,726		32.86% Pervious Area
42,351		67.14% Impervious Area

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

Subcatchment S1D: Southern Area



Summary for Subcatchment S2: Northern Area

[45] Hint: Runoff=Zero

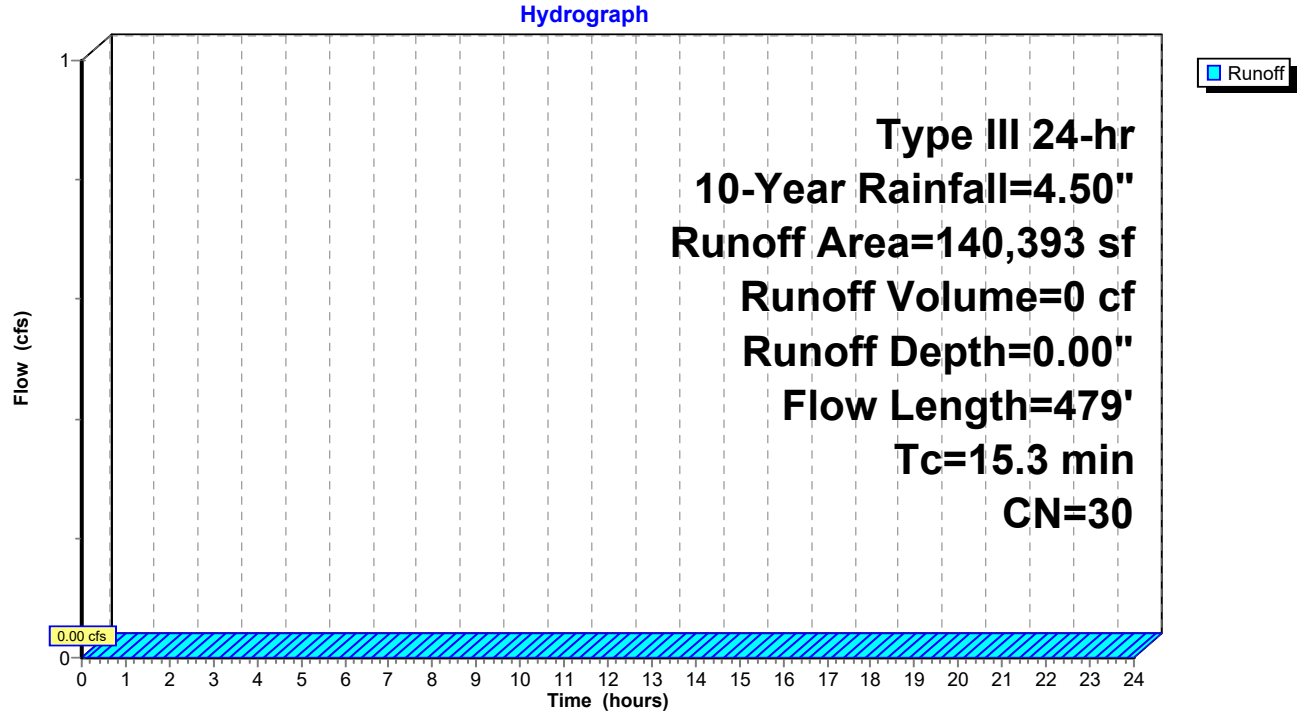
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"
Routed to Reach R1 : Wetlands

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=4.50"

Area (sf)	CN	Description
140,393	30	Woods, Good, HSG A
140,393		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	50	0.0620	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.22"
2.5	179	0.0590	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.0	250	0.0280	0.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	479	Total			

Subcatchment S2: Northern Area



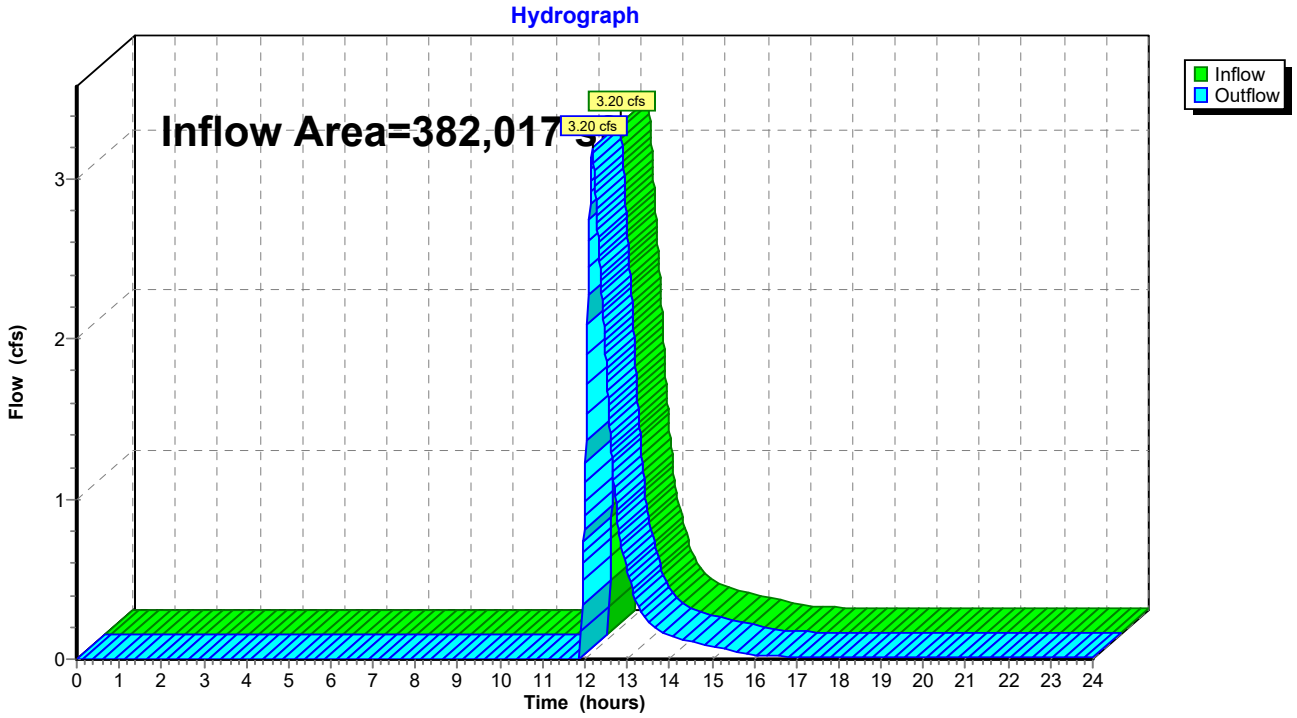
Summary for Reach R1: Wetlands

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 382,017 sf, 32.22% Impervious, Inflow Depth > 0.26" for 10-Year event
Inflow = 3.20 cfs @ 12.17 hrs, Volume= 8,357 cf
Outflow = 3.20 cfs @ 12.17 hrs, Volume= 8,357 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3

Reach R1: Wetlands



Summary for Pond 1P: Infiltration System-1

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=416)

Inflow Area = 65,937 sf, 72.93% Impervious, Inflow Depth > 2.72" for 10-Year event
Inflow = 4.83 cfs @ 12.09 hrs, Volume= 14,960 cf
Outflow = 0.74 cfs @ 12.59 hrs, Volume= 14,968 cf, Atten= 85%, Lag= 30.3 min
Discarded = 0.74 cfs @ 12.59 hrs, Volume= 14,968 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach R1 : Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 219.67' @ 12.59 hrs Surf.Area= 12,962 sf Storage= 4,444 cf
Flood Elev= 221.50' Surf.Area= 12,962 sf Storage= 14,788 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 39.5 min (856.6 - 817.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	219.00'	7,784 cf	**85.00'W x 152.50'L x 2.04'H Field A** 26,465 cf Overall - 7,004 cf Embedded = 19,461 cf x 40.0% Voids
#2A	219.50'	7,004 cf	**Cultec C-100HD** x 500 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 25 rows
		14,788 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	219.50'	**10.0" Round Culvert** L= 114.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 219.50' / 219.50' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Discarded	219.00'	**2.410 in/hr Exfiltration over Wetted area**
#3	Device 1	220.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.74 cfs @ 12.59 hrs HW=219.67' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.74 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=219.00' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Controls 0.00 cfs)
└**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Infiltration System-1 - Chamber Wizard Field A

Chamber Model = Cultec C-100HD (Cultec Contactor® 100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 25 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

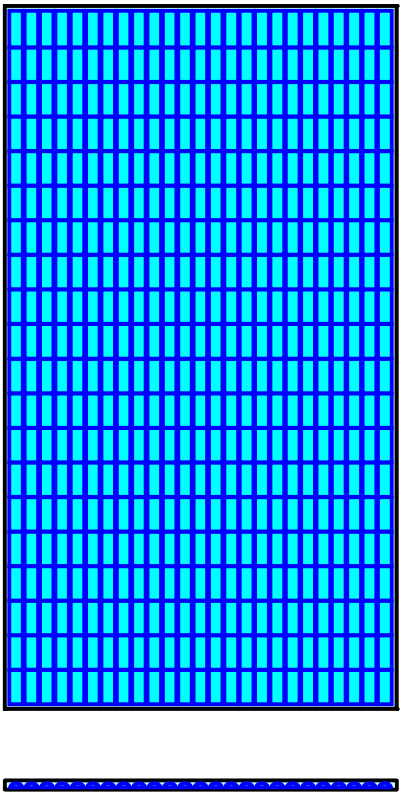
20 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 150.50' Row Length +12.0" End Stone x 2 = 152.50' Base Length
25 Rows x 36.0" Wide + 4.0" Spacing x 24 + 12.0" Side Stone x 2 = 85.00' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

500 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 25 Rows = 7,003.9 cf Chamber Storage

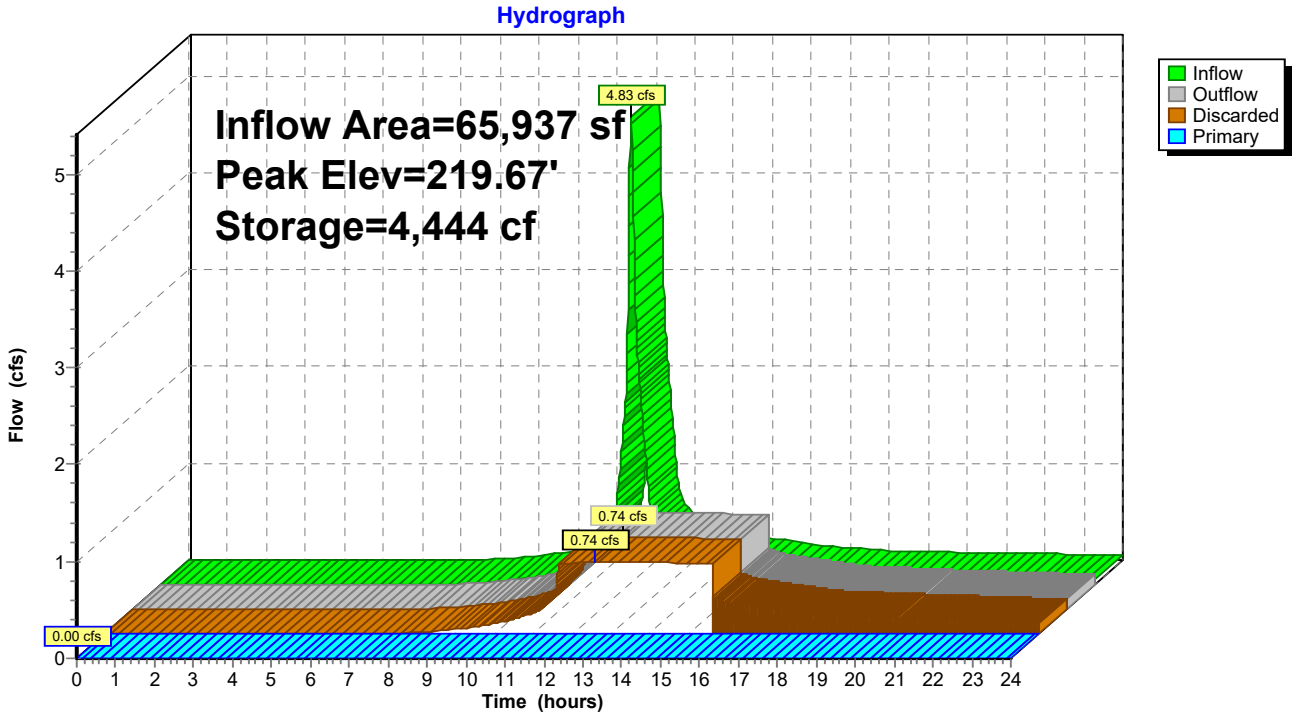
26,465.1 cf Field - 7,003.9 cf Chambers = 19,461.2 cf Stone x 40.0% Voids = 7,784.5 cf Stone Storage

Chamber Storage + Stone Storage = 14,788.4 cf = 0.339 af
Overall Storage Efficiency = 55.9%
Overall System Size = 152.50' x 85.00' x 2.04'

500 Chambers
980.2 cy Field
720.8 cy Stone



Pond 1P: Infiltration System-1



Summary for Pond 2P: Infiltration System-2

Inflow Area = 63,077 sf, 67.14% Impervious, Inflow Depth > 2.37" for 10-Year event
Inflow = 4.04 cfs @ 12.09 hrs, Volume= 12,477 cf
Outflow = 3.15 cfs @ 12.15 hrs, Volume= 12,477 cf, Atten= 22%, Lag= 3.9 min
Discarded = 0.16 cfs @ 12.15 hrs, Volume= 6,371 cf
Primary = 2.99 cfs @ 12.15 hrs, Volume= 6,106 cf
Routed to Reach R1 : Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 219.24' @ 12.15 hrs Surf.Area= 2,492 sf Storage= 1,909 cf
Flood Elev= 221.00' Surf.Area= 2,492 sf Storage= 2,792 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 34.0 min (862.5 - 828.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	218.00'	1,530 cf	**21.67'W x 115.00'L x 2.04'H Field A** 5,087 cf Overall - 1,262 cf Embedded = 3,825 cf x 40.0% Voids
#2A	218.50'	1,262 cf	**Cultec C-100HD** x 90 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 6 rows
		2,792 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	218.50'	**10.0" Round Culvert** L= 140.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 218.50' / 216.00' S= 0.0179 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Discarded	218.00'	**2.410 in/hr Exfiltration over Wetted area**
#3	Primary	218.50'	**10.0" Round Culvert** L= 140.0' Ke= 0.500 Inlet / Outlet Invert= 218.50' / 216.50' S= 0.0143 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.55 sf
#4	Device 1	218.70'	**4.0' long Sharp-Crested Vee/Trap Weir** Cv= 2.62 (C= 3.28)
#5	Device 3	218.70'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.16 cfs @ 12.15 hrs HW=219.24' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.16 cfs)

Primary OutFlow Max=2.99 cfs @ 12.15 hrs HW=219.24' TW=0.00' (Dynamic Tailwater)
├**1=Culvert** (Inlet Controls 1.50 cfs @ 2.93 fps)
│ └**4=Sharp-Crested Vee/Trap Weir** (Passes 1.50 cfs of 5.18 cfs potential flow)
└**3=Culvert** (Inlet Controls 1.50 cfs @ 2.93 fps)
└**5=Sharp-Crested Rectangular Weir** (Passes 1.50 cfs of 5.03 cfs potential flow)

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

Chamber Model = Cultec C-100HD (Cultec Contactor®100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 6 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

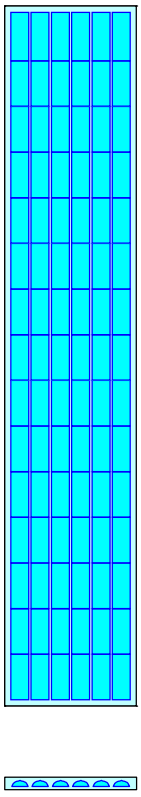
15 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 113.00' Row Length +12.0" End Stone x 2 = 115.00' Base Length
6 Rows x 36.0" Wide + 4.0" Spacing x 5 + 12.0" Side Stone x 2 = 21.67' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

90 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 6 Rows = 1,262.1 cf Chamber Storage

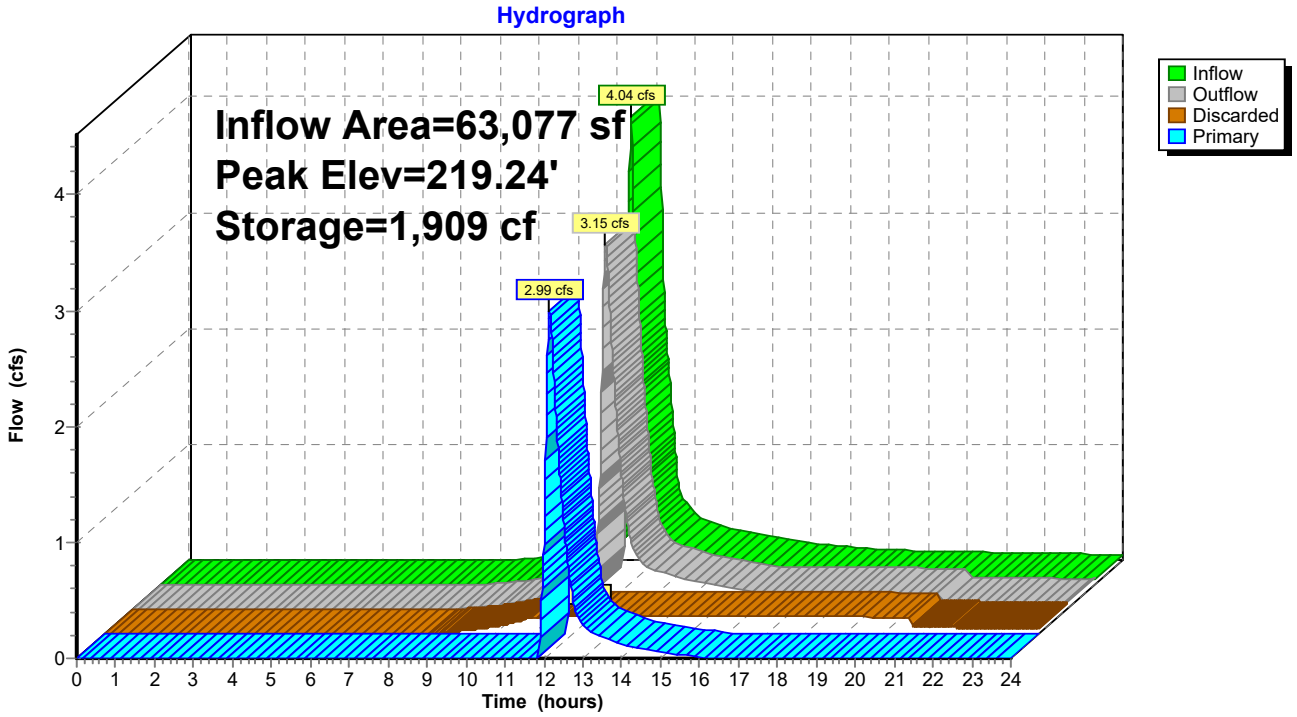
5,087.2 cf Field - 1,262.1 cf Chambers = 3,825.1 cf Stone x 40.0% Voids = 1,530.0 cf Stone Storage

Chamber Storage + Stone Storage = 2,792.1 cf = 0.064 af
Overall Storage Efficiency = 54.9%
Overall System Size = 115.00' x 21.67' x 2.04'

90 Chambers
188.4 cy Field
141.7 cy Stone



Pond 2P: Infiltration System-2



Summary for Pond 3P: Infiltration System-3

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=315)

Inflow Area = 49,148 sf, 66.41% Impervious, Inflow Depth > 2.29" for 10-Year event
Inflow = 3.03 cfs @ 12.09 hrs, Volume= 9,379 cf
Outflow = 0.93 cfs @ 12.44 hrs, Volume= 9,379 cf, Atten= 69%, Lag= 20.9 min
Discarded = 0.28 cfs @ 12.44 hrs, Volume= 7,708 cf
Primary = 0.65 cfs @ 12.44 hrs, Volume= 1,671 cf
Routed to Reach R1 : Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 215.98' @ 12.44 hrs Surf.Area= 4,592 sf Storage= 2,690 cf
Flood Elev= 218.60' Surf.Area= 4,592 sf Storage= 5,187 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 52.0 min (883.2 - 831.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	215.00'	2,792 cf	**31.67'W x 145.00'L x 2.04'H Field A** 9,375 cf Overall - 2,396 cf Embedded = 6,979 cf x 40.0% Voids
#2A	215.50'	2,396 cf	**Cultec C-100HD** x 171 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 9 rows
		5,187 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	215.60'	**15.0" Round Culvert** L= 30.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 215.60' / 215.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Discarded	215.00'	**2.410 in/hr Exfiltration over Wetted area**
#3	Device 1	215.75'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.28 cfs @ 12.44 hrs HW=215.98' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.28 cfs)

Primary OutFlow Max=0.65 cfs @ 12.44 hrs HW=215.98' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 0.65 cfs @ 2.09 fps)
└**3=Sharp-Crested Rectangular Weir** (Passes 0.65 cfs of 1.41 cfs potential flow)

Pond 3P: Infiltration System-3 - Chamber Wizard Field A

Chamber Model = Cultec C-100HD (Cultec Contactor® 100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 9 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

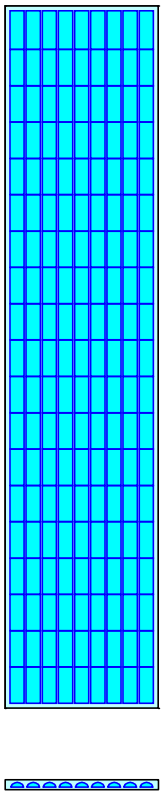
19 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 143.00' Row Length +12.0" End Stone x 2 = 145.00' Base Length
9 Rows x 36.0" Wide + 4.0" Spacing x 8 + 12.0" Side Stone x 2 = 31.67' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

171 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 9 Rows = 2,395.8 cf Chamber Storage

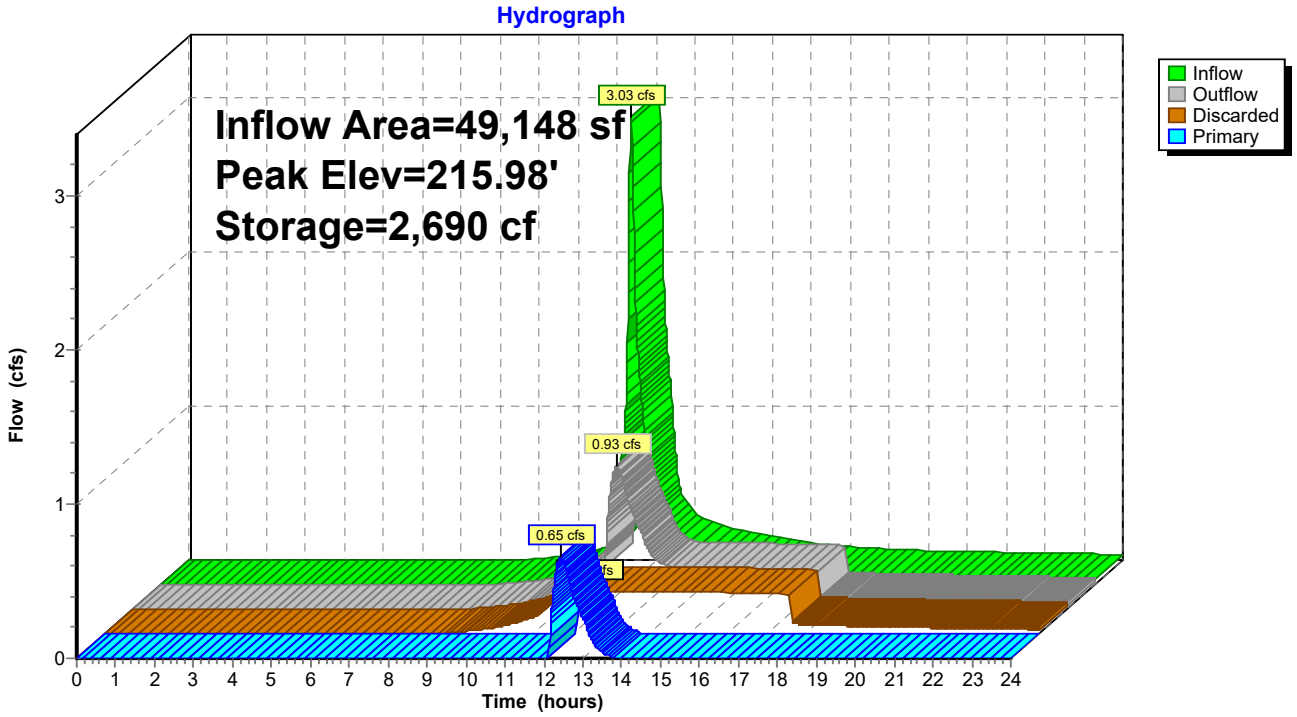
9,374.7 cf Field - 2,395.8 cf Chambers = 6,978.9 cf Stone x 40.0% Voids = 2,791.6 cf Stone Storage

Chamber Storage + Stone Storage = 5,187.3 cf = 0.119 af
Overall Storage Efficiency = 55.3%
Overall System Size = 145.00' x 31.67' x 2.04'

171 Chambers
347.2 cy Field
258.5 cy Stone



Pond 3P: Infiltration System-3



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentS1A: Southern Area Runoff Area=65,937 sf 72.93% Impervious Runoff Depth>3.72"
Tc=6.0 min CN=83 Runoff=6.55 cfs 20,429 cf

SubcatchmentS1B: Southern Area Runoff Area=49,148 sf 66.41% Impervious Runoff Depth>3.22"
Tc=6.0 min CN=78 Runoff=4.27 cfs 13,206 cf

SubcatchmentS1C: Southern Area Runoff Area=63,462 sf 0.00% Impervious Runoff Depth>0.34"
Flow Length=150' Tc=10.7 min CN=39 Runoff=0.15 cfs 1,774 cf

SubcatchmentS1D: Southern Area Runoff Area=63,077 sf 67.14% Impervious Runoff Depth>3.32"
Tc=6.0 min CN=79 Runoff=5.64 cfs 17,456 cf

SubcatchmentS2: Northern Area Runoff Area=140,393 sf 0.00% Impervious Runoff Depth>0.04"
Flow Length=479' Tc=15.3 min CN=30 Runoff=0.01 cfs 410 cf

Reach R1: Wetlands Inflow=5.40 cfs 16,171 cf
Outflow=5.40 cfs 16,171 cf

Pond 1P: Infiltration System-1 Peak Elev=219.91' Storage=6,991 cf Inflow=6.55 cfs 20,429 cf
Discarded=0.75 cfs 20,431 cf Primary=0.00 cfs 0 cf Outflow=0.75 cfs 20,431 cf

Pond 2P: Infiltration System-2 Peak Elev=219.60' Storage=2,350 cf Inflow=5.64 cfs 17,456 cf
Discarded=0.16 cfs 7,423 cf Primary=4.34 cfs 10,033 cf Outflow=4.50 cfs 17,456 cf

Pond 3P: Infiltration System-3 Peak Elev=216.19' Storage=3,411 cf Inflow=4.27 cfs 13,206 cf
Discarded=0.28 cfs 9,251 cf Primary=1.50 cfs 3,954 cf Outflow=1.78 cfs 13,205 cf

Total Runoff Area = 382,017 sf Runoff Volume = 53,274 cf Average Runoff Depth = 1.67"
67.78% Pervious = 258,944 sf 32.22% Impervious = 123,073 sf

Summary for Subcatchment S1A: Southern Area

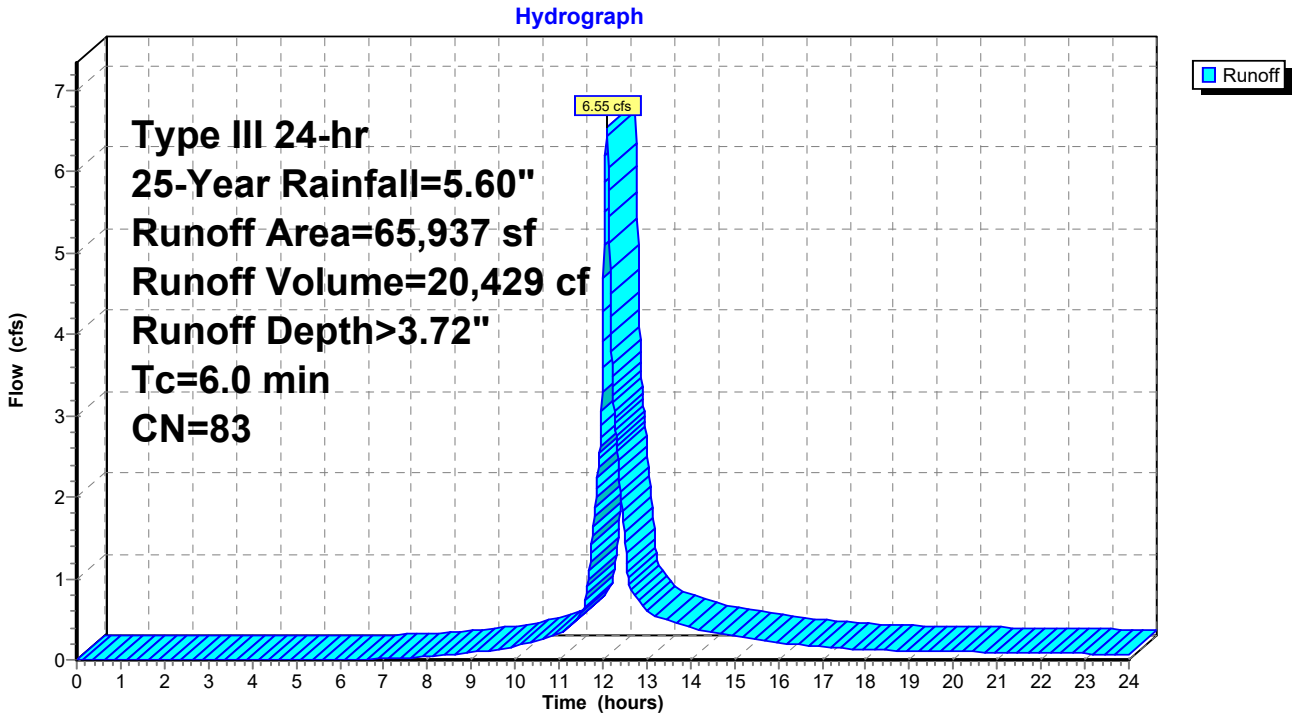
Runoff = 6.55 cfs @ 12.09 hrs, Volume= 20,429 cf, Depth> 3.72"
Routed to Pond 1P : Infiltration System-1

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=5.60"

Area (sf)	CN	Description
16,473	39	>75% Grass cover, Good, HSG A
1,379	76	Gravel roads, HSG A
23,130	98	Paved parking, HSG A
24,955	98	Roofs, HSG A
65,937	83	Weighted Average
17,852		27.07% Pervious Area
48,085		72.93% Impervious Area

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

Subcatchment S1A: Southern Area



Summary for Subcatchment S1B: Southern Area

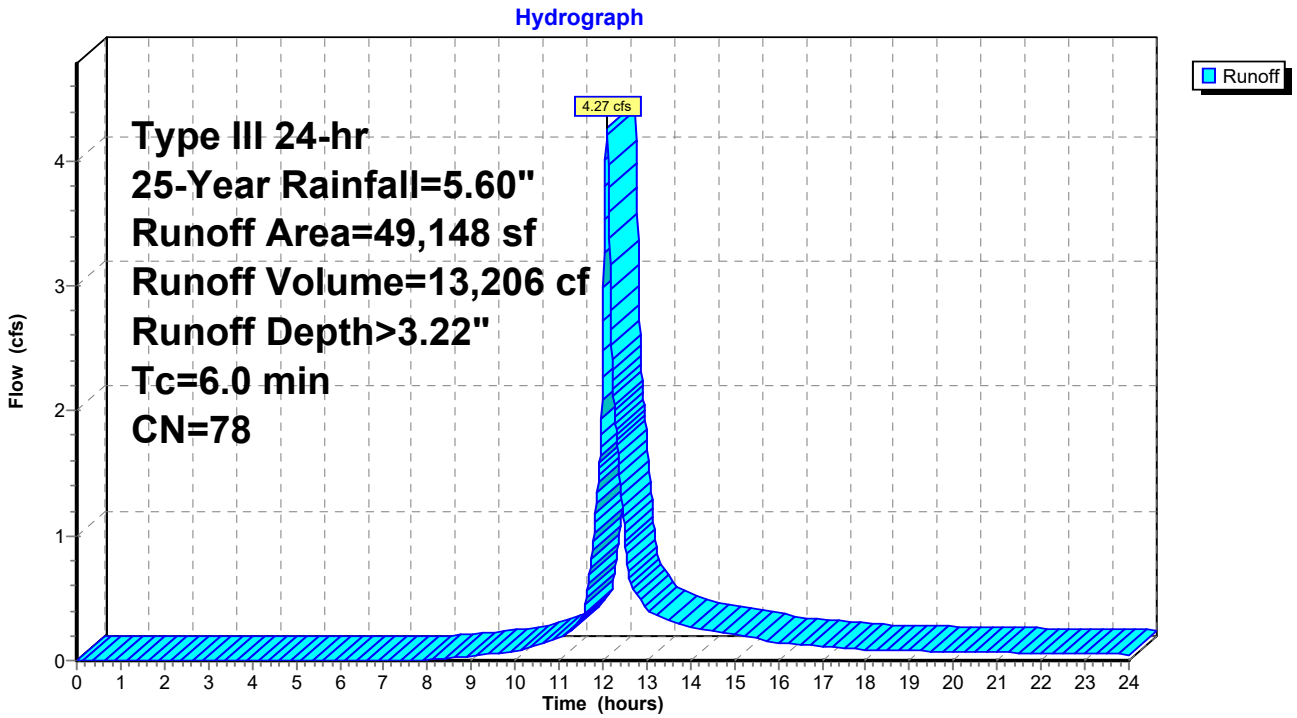
Runoff = 4.27 cfs @ 12.09 hrs, Volume= 13,206 cf, Depth> 3.22"
Routed to Pond 3P : Infiltration System-3

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=5.60"

Area (sf)	CN	Description
16,511	39	>75% Grass cover, Good, HSG A
14,685	98	Paved parking, HSG A
17,952	98	Roofs, HSG A
49,148	78	Weighted Average
16,511		33.59% Pervious Area
32,637		66.41% Impervious Area

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

Subcatchment S1B: Southern Area



Summary for Subcatchment S1C: Southern Area

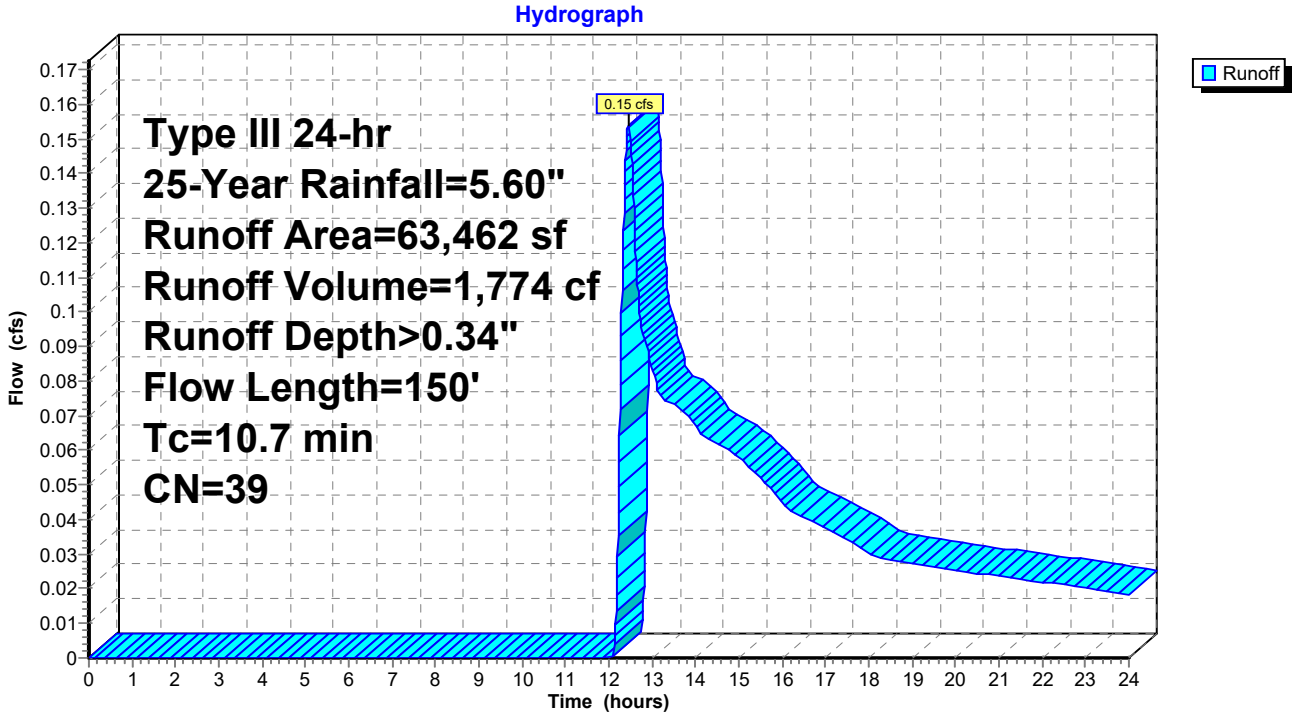
Runoff = 0.15 cfs @ 12.46 hrs, Volume= 1,774 cf, Depth> 0.34"
Routed to Reach R1 : Wetlands

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=5.60"

Area (sf)	CN	Description
20,588	30	Woods, Good, HSG A
38,507	39	>75% Grass cover, Good, HSG A
4,367	76	Gravel roads, HSG A
63,462	39	Weighted Average
63,462		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0143	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22"
0.6	55	0.0465	1.51		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	45	0.0333	0.91		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
10.7	150	Total			

Subcatchment S1C: Southern Area



Summary for Subcatchment S1D: Southern Area

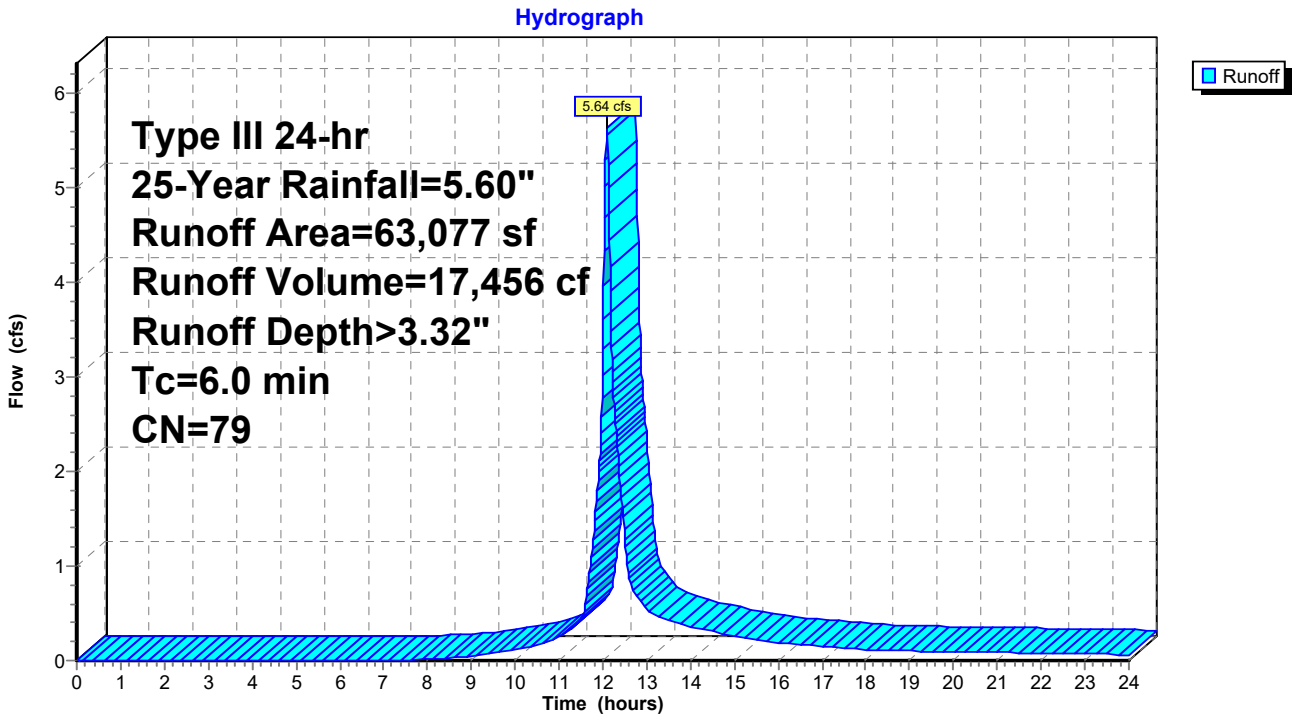
Runoff = 5.64 cfs @ 12.09 hrs, Volume= 17,456 cf, Depth> 3.32"
Routed to Pond 2P : Infiltration System-2

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=5.60"

Area (sf)	CN	Description
20,726	39	>75% Grass cover, Good, HSG A
34,351	98	Paved parking, HSG A
8,000	98	Roofs, HSG A
63,077	79	Weighted Average
20,726		32.86% Pervious Area
42,351		67.14% Impervious Area

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

Subcatchment S1D: Southern Area



Summary for Subcatchment S2: Northern Area

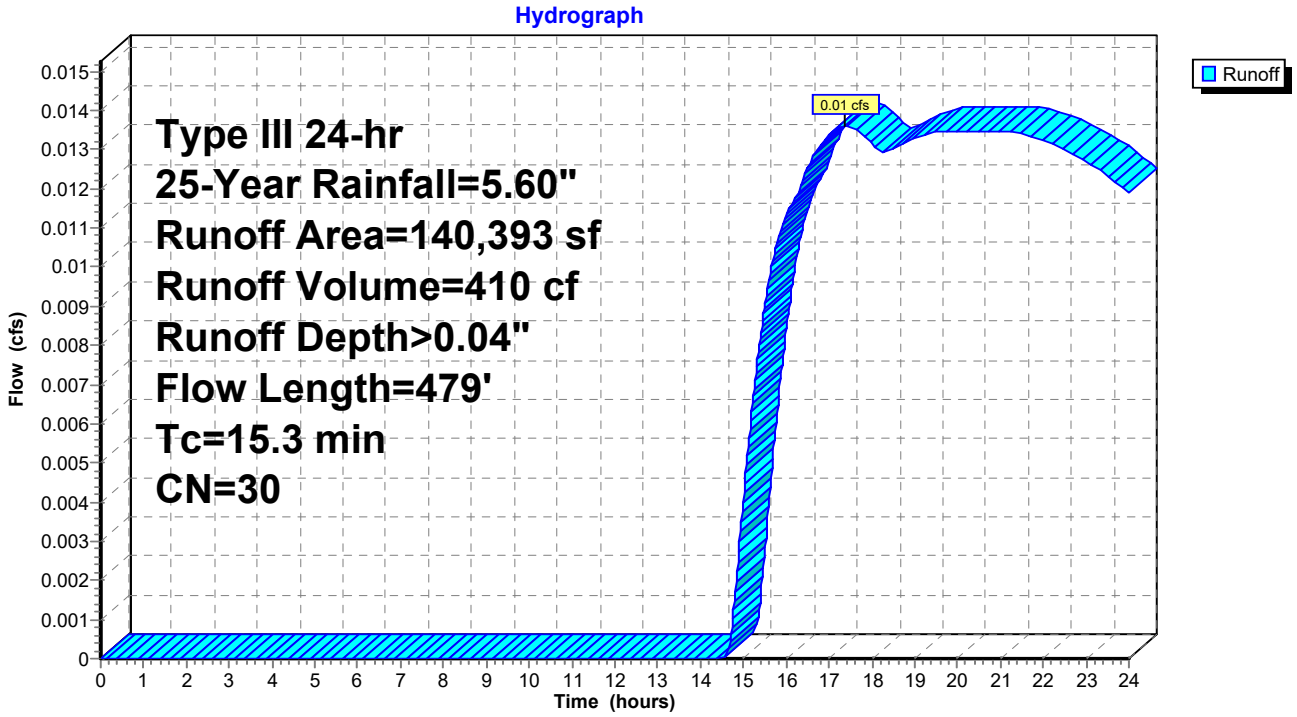
Runoff = 0.01 cfs @ 17.39 hrs, Volume= 410 cf, Depth> 0.04"
Routed to Reach R1 : Wetlands

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=5.60"

Area (sf)	CN	Description
140,393	30	Woods, Good, HSG A
140,393		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	50	0.0620	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.22"
2.5	179	0.0590	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.0	250	0.0280	0.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	479	Total			

Subcatchment S2: Northern Area



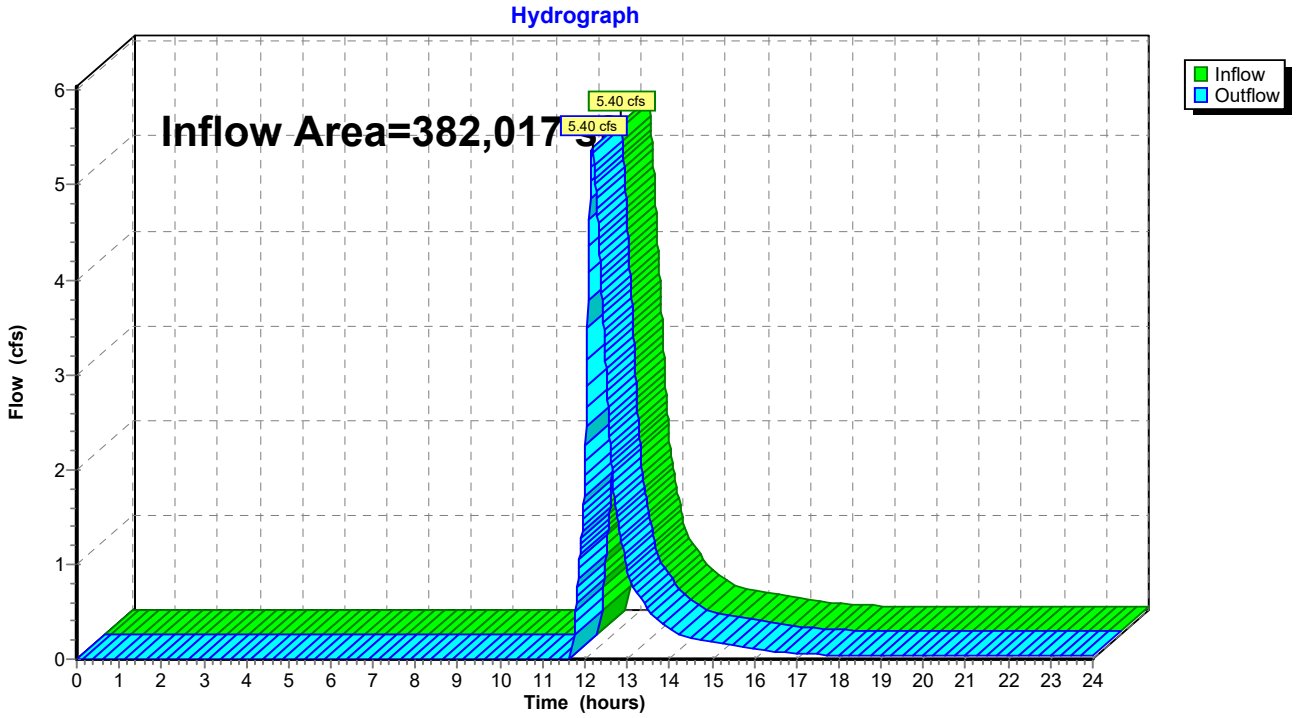
Summary for Reach R1: Wetlands

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 382,017 sf, 32.22% Impervious, Inflow Depth > 0.51" for 25-Year event
Inflow = 5.40 cfs @ 12.18 hrs, Volume= 16,171 cf
Outflow = 5.40 cfs @ 12.18 hrs, Volume= 16,171 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3

Reach R1: Wetlands



Summary for Pond 1P: Infiltration System-1

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=327)

Inflow Area = 65,937 sf, 72.93% Impervious, Inflow Depth > 3.72" for 25-Year event
Inflow = 6.55 cfs @ 12.09 hrs, Volume= 20,429 cf
Outflow = 0.75 cfs @ 12.79 hrs, Volume= 20,431 cf, Atten= 89%, Lag= 42.5 min
Discarded = 0.75 cfs @ 12.79 hrs, Volume= 20,431 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Routed to Reach R1 : Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 219.91' @ 12.79 hrs Surf.Area= 12,962 sf Storage= 6,991 cf
Flood Elev= 221.50' Surf.Area= 12,962 sf Storage= 14,788 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 69.3 min (877.6 - 808.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	219.00'	7,784 cf	**85.00'W x 152.50'L x 2.04'H Field A** 26,465 cf Overall - 7,004 cf Embedded = 19,461 cf x 40.0% Voids
#2A	219.50'	7,004 cf	**Cultec C-100HD** x 500 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 25 rows
		14,788 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	219.50'	**10.0" Round Culvert** L= 114.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 219.50' / 219.50' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Discarded	219.00'	**2.410 in/hr Exfiltration over Wetted area**
#3	Device 1	220.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.75 cfs @ 12.79 hrs HW=219.91' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.75 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=219.00' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Controls 0.00 cfs)
└**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1P: Infiltration System-1 - Chamber Wizard Field A

Chamber Model = Cultec C-100HD (Cultec Contactor® 100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 25 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

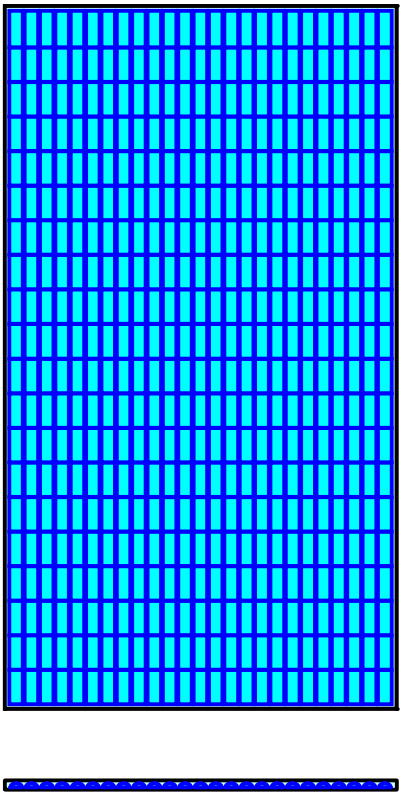
20 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 150.50' Row Length +12.0" End Stone x 2 = 152.50' Base Length
25 Rows x 36.0" Wide + 4.0" Spacing x 24 + 12.0" Side Stone x 2 = 85.00' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

500 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 25 Rows = 7,003.9 cf Chamber Storage

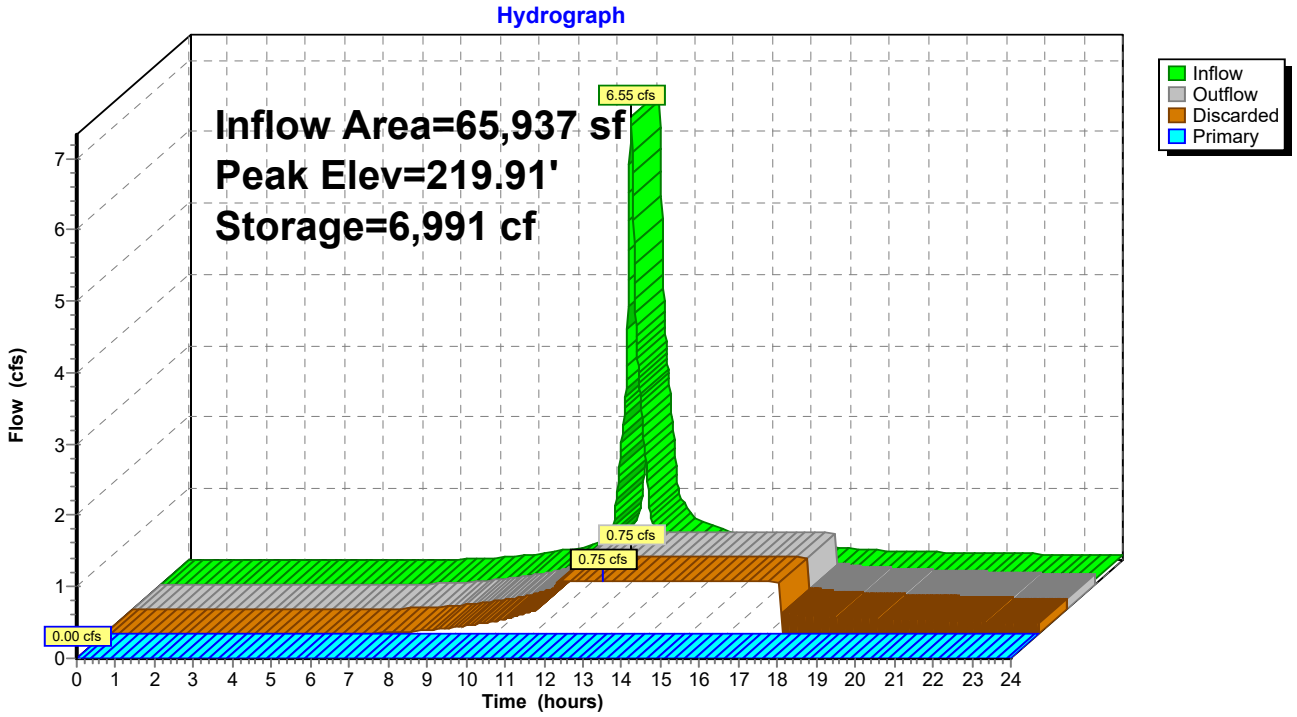
26,465.1 cf Field - 7,003.9 cf Chambers = 19,461.2 cf Stone x 40.0% Voids = 7,784.5 cf Stone Storage

Chamber Storage + Stone Storage = 14,788.4 cf = 0.339 af
Overall Storage Efficiency = 55.9%
Overall System Size = 152.50' x 85.00' x 2.04'

500 Chambers
980.2 cy Field
720.8 cy Stone



Pond 1P: Infiltration System-1



Summary for Pond 2P: Infiltration System-2

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=72)

Inflow Area = 63,077 sf, 67.14% Impervious, Inflow Depth > 3.32" for 25-Year event
Inflow = 5.64 cfs @ 12.09 hrs, Volume= 17,456 cf
Outflow = 4.50 cfs @ 12.15 hrs, Volume= 17,456 cf, Atten= 20%, Lag= 3.6 min
Discarded = 0.16 cfs @ 12.15 hrs, Volume= 7,423 cf
Primary = 4.34 cfs @ 12.15 hrs, Volume= 10,033 cf
Routed to Reach R1 : Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 219.60' @ 12.15 hrs Surf.Area= 2,492 sf Storage= 2,350 cf
Flood Elev= 221.00' Surf.Area= 2,492 sf Storage= 2,792 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 31.1 min (850.0 - 818.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	218.00'	1,530 cf	**21.67'W x 115.00'L x 2.04'H Field A** 5,087 cf Overall - 1,262 cf Embedded = 3,825 cf x 40.0% Voids
#2A	218.50'	1,262 cf	**Cultec C-100HD** x 90 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 6 rows
		2,792 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	218.50'	**10.0" Round Culvert** L= 140.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 218.50' / 216.00' S= 0.0179 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Discarded	218.00'	**2.410 in/hr Exfiltration over Wetted area**
#3	Primary	218.50'	**10.0" Round Culvert** L= 140.0' Ke= 0.500 Inlet / Outlet Invert= 218.50' / 216.50' S= 0.0143 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.55 sf
#4	Device 1	218.70'	**4.0' long Sharp-Crested Vee/Trap Weir** Cv= 2.62 (C= 3.28)
#5	Device 3	218.70'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.16 cfs @ 12.15 hrs HW=219.60' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.16 cfs)

Primary OutFlow Max=4.33 cfs @ 12.15 hrs HW=219.60' TW=0.00' (Dynamic Tailwater)
├**1=Culvert** (Inlet Controls 2.17 cfs @ 3.97 fps)
│└**4=Sharp-Crested Vee/Trap Weir** (Passes 2.17 cfs of 11.14 cfs potential flow)
└**3=Culvert** (Inlet Controls 2.17 cfs @ 3.97 fps)
└**5=Sharp-Crested Rectangular Weir** (Passes 2.17 cfs of 10.62 cfs potential flow)

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

Chamber Model = Cultec C-100HD (Cultec Contactor®100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 6 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

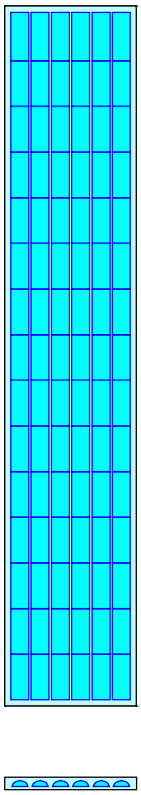
15 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 113.00' Row Length +12.0" End Stone x 2 = 115.00' Base Length
6 Rows x 36.0" Wide + 4.0" Spacing x 5 + 12.0" Side Stone x 2 = 21.67' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

90 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 6 Rows = 1,262.1 cf Chamber Storage

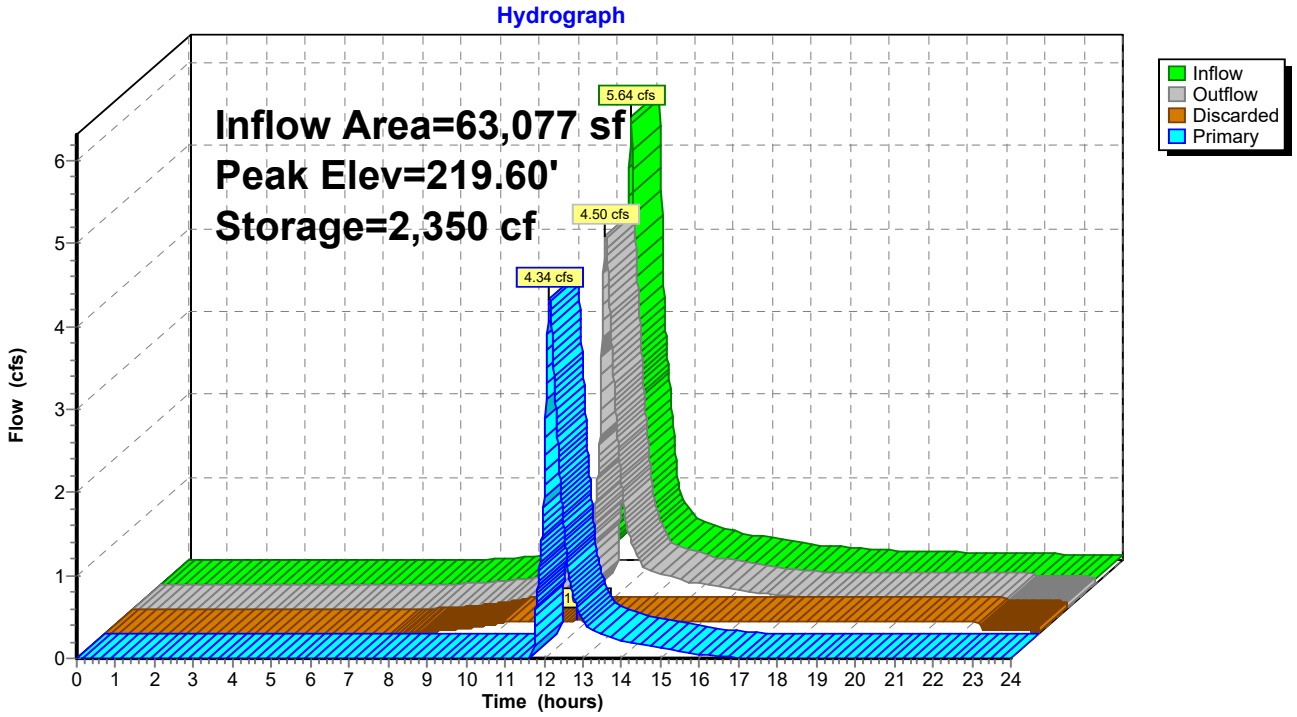
5,087.2 cf Field - 1,262.1 cf Chambers = 3,825.1 cf Stone x 40.0% Voids = 1,530.0 cf Stone Storage

Chamber Storage + Stone Storage = 2,792.1 cf = 0.064 af
Overall Storage Efficiency = 54.9%
Overall System Size = 115.00' x 21.67' x 2.04'

90 Chambers
188.4 cy Field
141.7 cy Stone



Pond 2P: Infiltration System-2



Summary for Pond 3P: Infiltration System-3

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=267)

Inflow Area = 49,148 sf, 66.41% Impervious, Inflow Depth > 3.22" for 25-Year event
Inflow = 4.27 cfs @ 12.09 hrs, Volume= 13,206 cf
Outflow = 1.78 cfs @ 12.32 hrs, Volume= 13,205 cf, Atten= 58%, Lag= 13.7 min
Discarded = 0.28 cfs @ 12.32 hrs, Volume= 9,251 cf
Primary = 1.50 cfs @ 12.32 hrs, Volume= 3,954 cf
Routed to Reach R1 : Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 216.19' @ 12.32 hrs Surf.Area= 4,592 sf Storage= 3,411 cf
Flood Elev= 218.60' Surf.Area= 4,592 sf Storage= 5,187 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 48.4 min (869.8 - 821.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	215.00'	2,792 cf	**31.67'W x 145.00'L x 2.04'H Field A** 9,375 cf Overall - 2,396 cf Embedded = 6,979 cf x 40.0% Voids
#2A	215.50'	2,396 cf	**Cultec C-100HD** x 171 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 9 rows
		5,187 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	215.60'	**15.0" Round Culvert** L= 30.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 215.60' / 215.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Discarded	215.00'	**2.410 in/hr Exfiltration over Wetted area**
#3	Device 1	215.75'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.28 cfs @ 12.32 hrs HW=216.19' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.28 cfs)

Primary OutFlow Max=1.50 cfs @ 12.32 hrs HW=216.19' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 1.50 cfs @ 2.62 fps)
└**3=Sharp-Crested Rectangular Weir** (Passes 1.50 cfs of 3.76 cfs potential flow)

Pond 3P: Infiltration System-3 - Chamber Wizard Field A

Chamber Model = Cultec C-100HD (Cultec Contactor® 100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 9 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

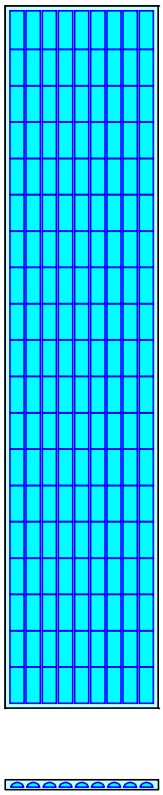
19 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 143.00' Row Length +12.0" End Stone x 2 = 145.00' Base Length
9 Rows x 36.0" Wide + 4.0" Spacing x 8 + 12.0" Side Stone x 2 = 31.67' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

171 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 9 Rows = 2,395.8 cf Chamber Storage

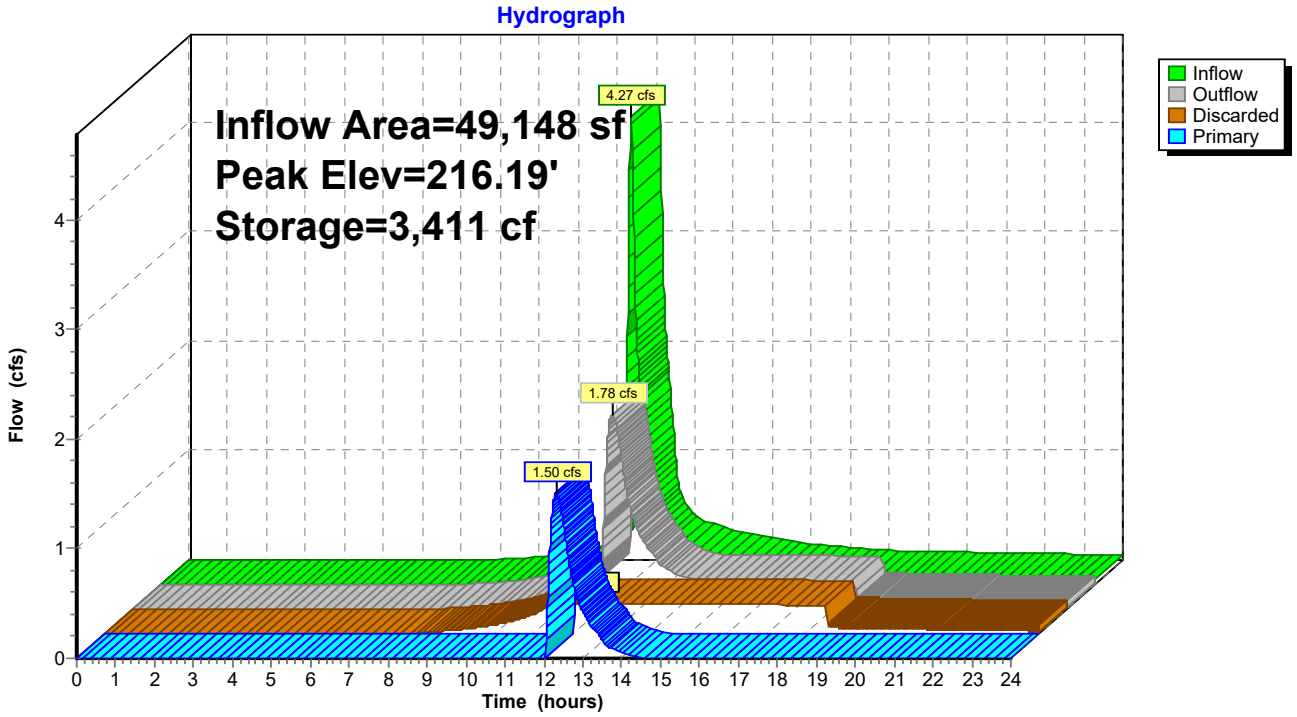
9,374.7 cf Field - 2,395.8 cf Chambers = 6,978.9 cf Stone x 40.0% Voids = 2,791.6 cf Stone Storage

Chamber Storage + Stone Storage = 5,187.3 cf = 0.119 af
Overall Storage Efficiency = 55.3%
Overall System Size = 145.00' x 31.67' x 2.04'

171 Chambers
347.2 cy Field
258.5 cy Stone



Pond 3P: Infiltration System-3



Time span=0.00-24.00 hrs, dt=0.01 hrs, 2401 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentS1A: Southern Area Runoff Area=65,937 sf 72.93% Impervious Runoff Depth>4.46"
Tc=6.0 min CN=83 Runoff=7.81 cfs 24,504 cf

SubcatchmentS1B: Southern Area Runoff Area=49,148 sf 66.41% Impervious Runoff Depth>3.93"
Tc=6.0 min CN=78 Runoff=5.19 cfs 16,096 cf

SubcatchmentS1C: Southern Area Runoff Area=63,462 sf 0.00% Impervious Runoff Depth>0.56"
Flow Length=150' Tc=10.7 min CN=39 Runoff=0.36 cfs 2,979 cf

SubcatchmentS1D: Southern Area Runoff Area=63,077 sf 67.14% Impervious Runoff Depth>4.03"
Tc=6.0 min CN=79 Runoff=6.83 cfs 21,207 cf

SubcatchmentS2: Northern Area Runoff Area=140,393 sf 0.00% Impervious Runoff Depth>0.12"
Flow Length=479' Tc=15.3 min CN=30 Runoff=0.05 cfs 1,382 cf

Reach R1: Wetlands Inflow=7.49 cfs 24,013 cf
Outflow=7.49 cfs 24,013 cf

Pond 1P: Infiltration System-1 Peak Elev=220.08' Storage=8,673 cf Inflow=7.81 cfs 24,504 cf
Discarded=0.75 cfs 23,828 cf Primary=0.28 cfs 681 cf Outflow=1.03 cfs 24,509 cf

Pond 2P: Infiltration System-2 Peak Elev=219.92' Storage=2,666 cf Inflow=6.83 cfs 21,207 cf
Discarded=0.17 cfs 8,072 cf Primary=5.25 cfs 13,134 cf Outflow=5.42 cfs 21,207 cf

Pond 3P: Infiltration System-3 Peak Elev=216.36' Storage=3,894 cf Inflow=5.19 cfs 16,096 cf
Discarded=0.28 cfs 10,260 cf Primary=2.32 cfs 5,837 cf Outflow=2.61 cfs 16,097 cf

Total Runoff Area = 382,017 sf Runoff Volume = 66,168 cf Average Runoff Depth = 2.08"
67.78% Pervious = 258,944 sf 32.22% Impervious = 123,073 sf

Summary for Subcatchment S1A: Southern Area

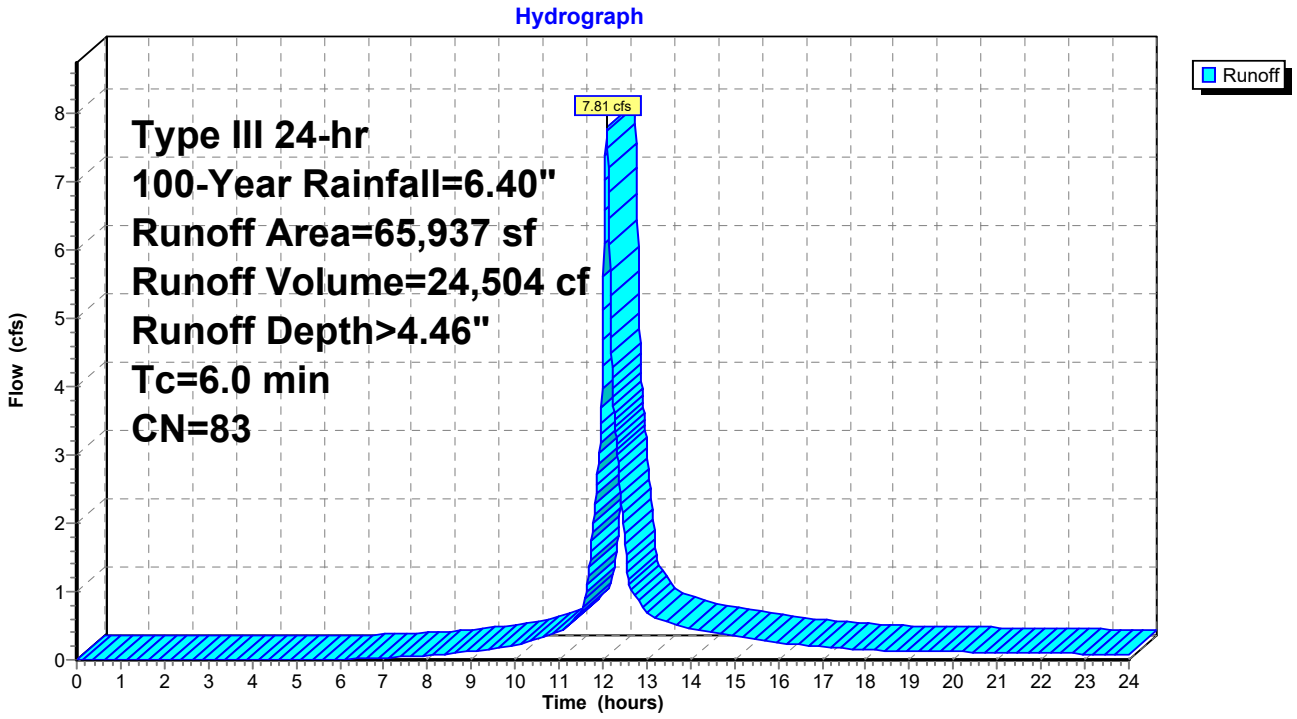
Runoff = 7.81 cfs @ 12.09 hrs, Volume= 24,504 cf, Depth> 4.46"
Routed to Pond 1P : Infiltration System-1

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=6.40"

Area (sf)	CN	Description
16,473	39	>75% Grass cover, Good, HSG A
1,379	76	Gravel roads, HSG A
23,130	98	Paved parking, HSG A
24,955	98	Roofs, HSG A
65,937	83	Weighted Average
17,852		27.07% Pervious Area
48,085		72.93% Impervious Area

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

Subcatchment S1A: Southern Area



Summary for Subcatchment S1B: Southern Area

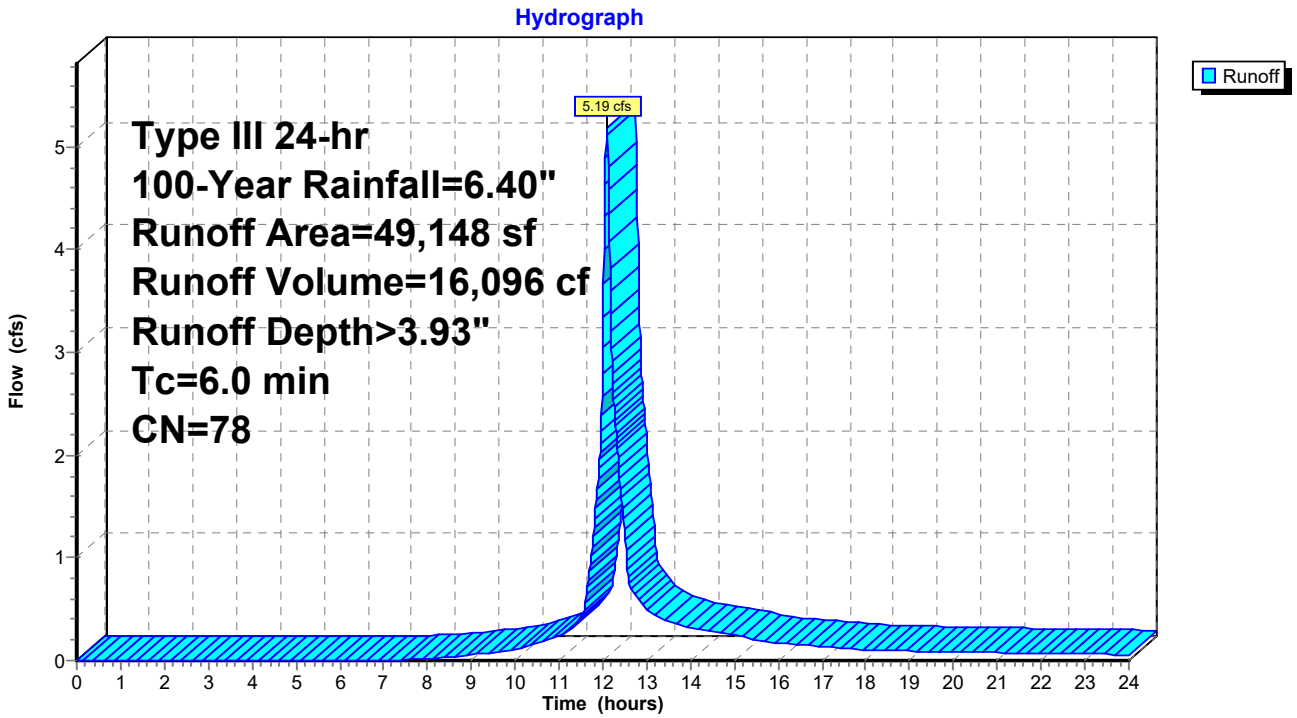
Runoff = 5.19 cfs @ 12.09 hrs, Volume= 16,096 cf, Depth> 3.93"
Routed to Pond 3P : Infiltration System-3

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=6.40"

Area (sf)	CN	Description
16,511	39	>75% Grass cover, Good, HSG A
14,685	98	Paved parking, HSG A
17,952	98	Roofs, HSG A
49,148	78	Weighted Average
16,511		33.59% Pervious Area
32,637		66.41% Impervious Area

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

Subcatchment S1B: Southern Area



Summary for Subcatchment S1C: Southern Area

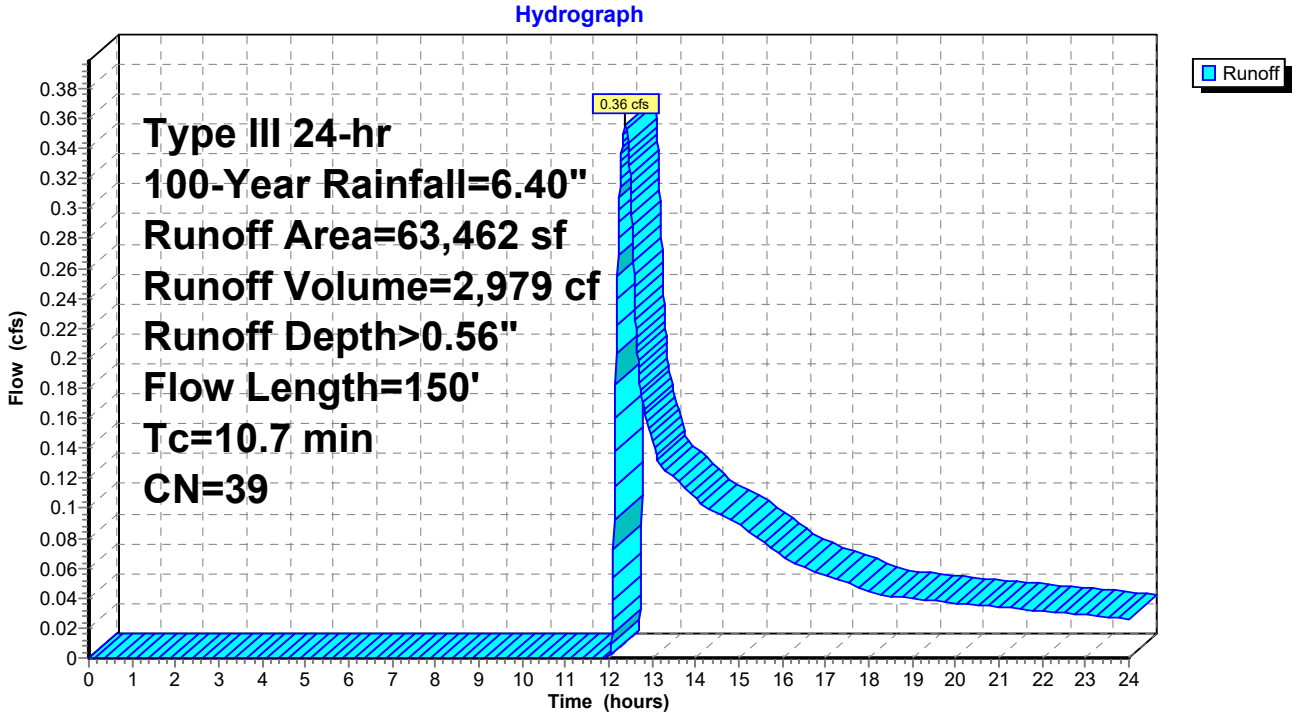
Runoff = 0.36 cfs @ 12.38 hrs, Volume= 2,979 cf, Depth> 0.56"
Routed to Reach R1 : Wetlands

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=6.40"

Area (sf)	CN	Description
20,588	30	Woods, Good, HSG A
38,507	39	>75% Grass cover, Good, HSG A
4,367	76	Gravel roads, HSG A
63,462	39	Weighted Average
63,462		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.3	50	0.0143	0.09		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.22"
0.6	55	0.0465	1.51		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	45	0.0333	0.91		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
10.7	150	Total			

Subcatchment S1C: Southern Area



Summary for Subcatchment S1D: Southern Area

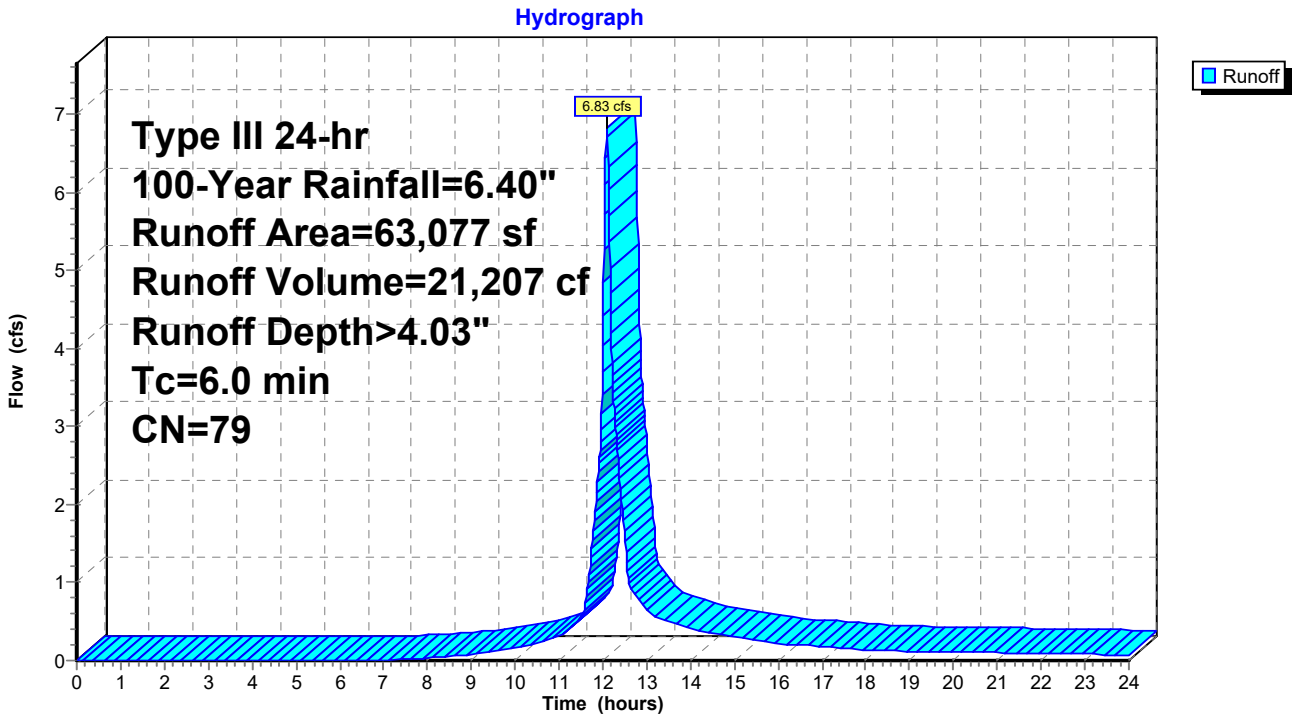
Runoff = 6.83 cfs @ 12.09 hrs, Volume= 21,207 cf, Depth> 4.03"
Routed to Pond 2P : Infiltration System-2

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=6.40"

Area (sf)	CN	Description
20,726	39	>75% Grass cover, Good, HSG A
34,351	98	Paved parking, HSG A
8,000	98	Roofs, HSG A
63,077	79	Weighted Average
20,726		32.86% Pervious Area
42,351		67.14% Impervious Area

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

Subcatchment S1D: Southern Area



Summary for Subcatchment S2: Northern Area

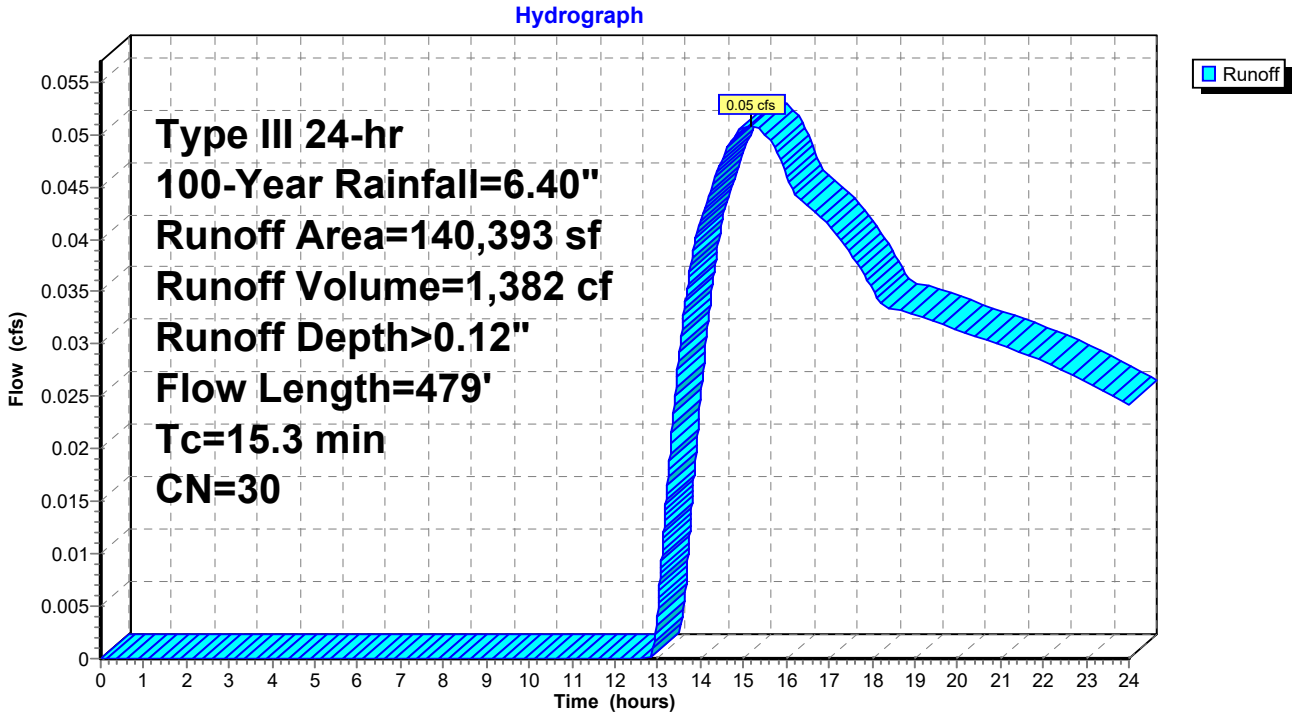
Runoff = 0.05 cfs @ 15.18 hrs, Volume= 1,382 cf, Depth> 0.12"
Routed to Reach R1 : Wetlands

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=6.40"

Area (sf)	CN	Description
140,393	30	Woods, Good, HSG A
140,393		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	50	0.0620	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.22"
2.5	179	0.0590	1.21		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.0	250	0.0280	0.84		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	479	Total			

Subcatchment S2: Northern Area



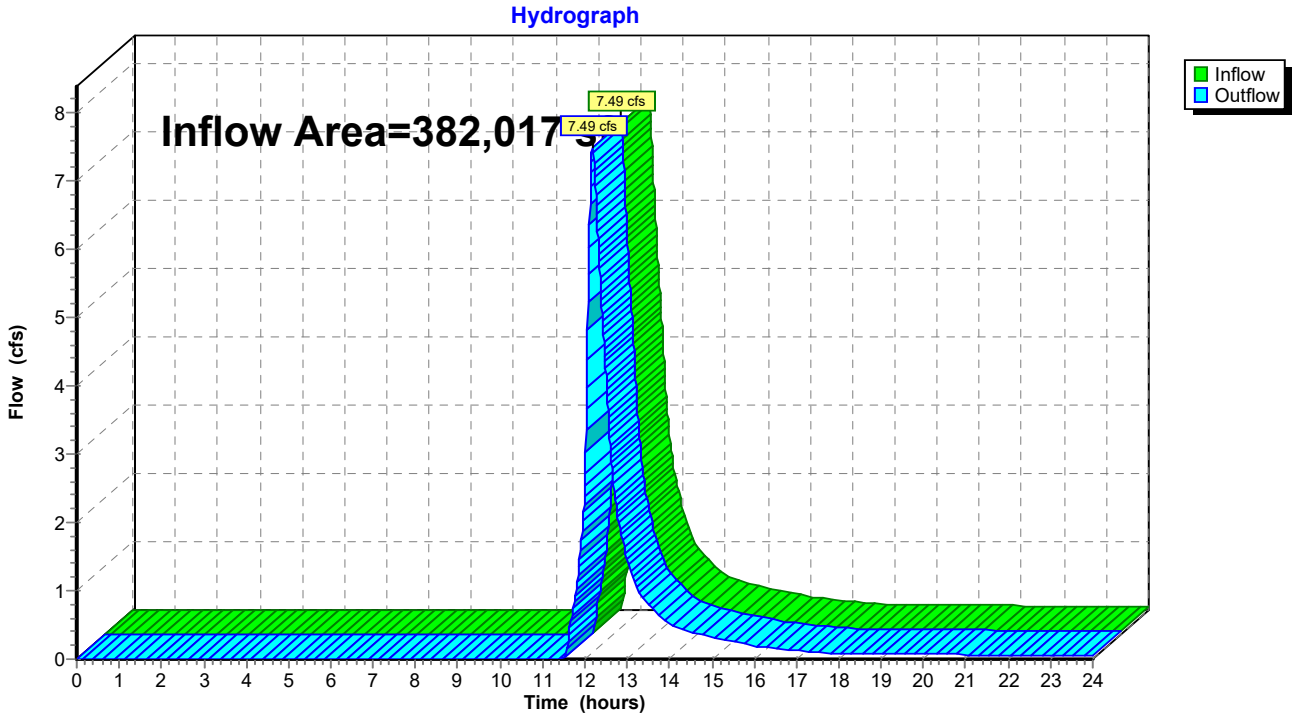
Summary for Reach R1: Wetlands

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 382,017 sf, 32.22% Impervious, Inflow Depth > 0.75" for 100-Year event
Inflow = 7.49 cfs @ 12.18 hrs, Volume= 24,013 cf
Outflow = 7.49 cfs @ 12.18 hrs, Volume= 24,013 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3

Reach R1: Wetlands



Summary for Pond 1P: Infiltration System-1

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=277)

Inflow Area = 65,937 sf, 72.93% Impervious, Inflow Depth > 4.46" for 100-Year event
Inflow = 7.81 cfs @ 12.09 hrs, Volume= 24,504 cf
Outflow = 1.03 cfs @ 12.64 hrs, Volume= 24,509 cf, Atten= 87%, Lag= 33.2 min
Discarded = 0.75 cfs @ 12.64 hrs, Volume= 23,828 cf
Primary = 0.28 cfs @ 12.64 hrs, Volume= 681 cf
Routed to Reach R1 : Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 220.08' @ 12.64 hrs Surf.Area= 12,962 sf Storage= 8,673 cf
Flood Elev= 221.50' Surf.Area= 12,962 sf Storage= 14,788 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 84.0 min (887.1 - 803.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	219.00'	7,784 cf	**85.00'W x 152.50'L x 2.04'H Field A** 26,465 cf Overall - 7,004 cf Embedded = 19,461 cf x 40.0% Voids
#2A	219.50'	7,004 cf	**Cultec C-100HD** x 500 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 25 rows
		14,788 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	219.50'	**10.0" Round Culvert** L= 114.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 219.50' / 219.50' S= 0.0000 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Discarded	219.00'	**2.410 in/hr Exfiltration over Wetted area**
#3	Device 1	220.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.75 cfs @ 12.64 hrs HW=220.08' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.75 cfs)

Primary OutFlow Max=0.28 cfs @ 12.64 hrs HW=220.08' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Passes 0.28 cfs of 0.36 cfs potential flow)
└**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.28 cfs @ 0.91 fps)

Pond 1P: Infiltration System-1 - Chamber Wizard Field A

Chamber Model = Cultec C-100HD (Cultec Contactor® 100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 25 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

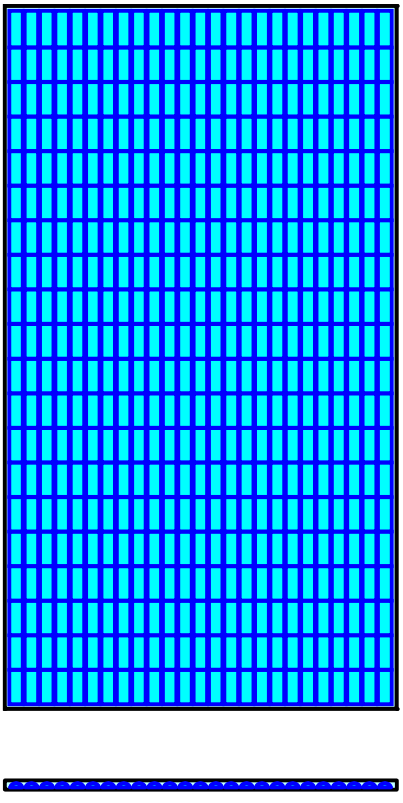
20 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 150.50' Row Length +12.0" End Stone x 2 = 152.50' Base Length
25 Rows x 36.0" Wide + 4.0" Spacing x 24 + 12.0" Side Stone x 2 = 85.00' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

500 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 25 Rows = 7,003.9 cf Chamber Storage

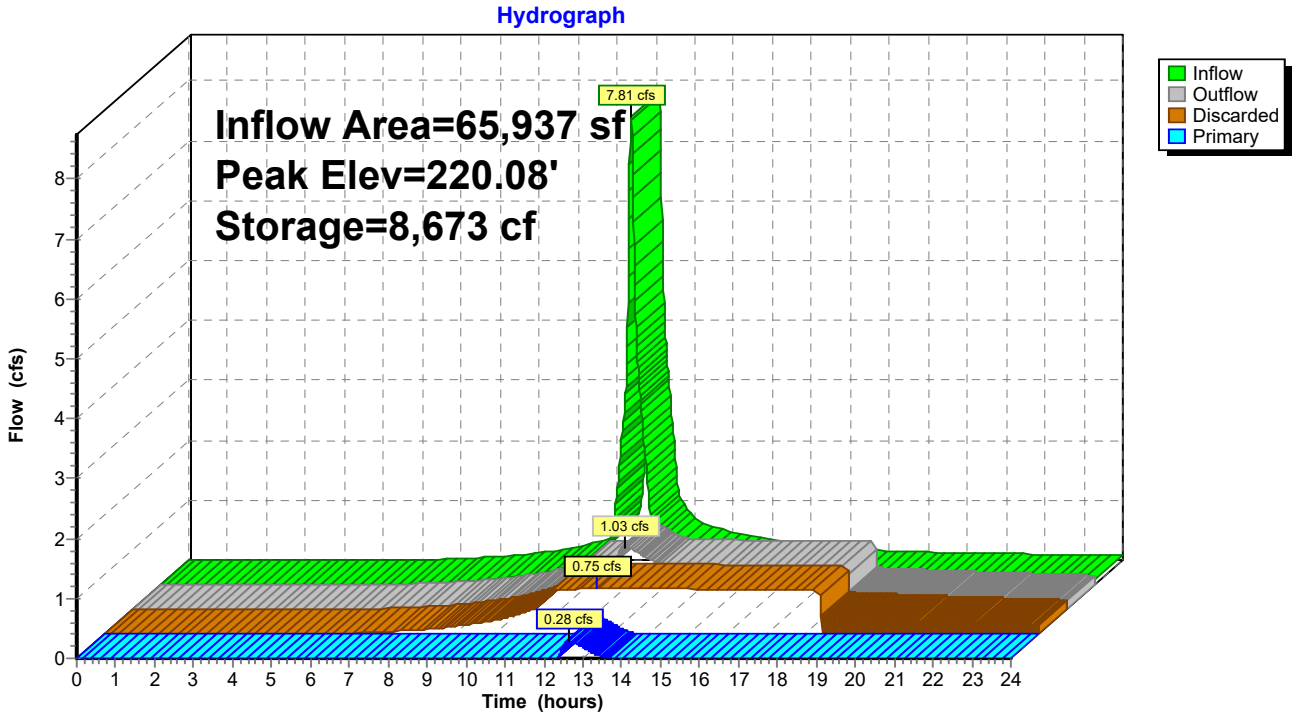
26,465.1 cf Field - 7,003.9 cf Chambers = 19,461.2 cf Stone x 40.0% Voids = 7,784.5 cf Stone Storage

Chamber Storage + Stone Storage = 14,788.4 cf = 0.339 af
Overall Storage Efficiency = 55.9%
Overall System Size = 152.50' x 85.00' x 2.04'

500 Chambers
980.2 cy Field
720.8 cy Stone



Pond 1P: Infiltration System-1



Summary for Pond 2P: Infiltration System-2

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=9)

Inflow Area = 63,077 sf, 67.14% Impervious, Inflow Depth > 4.03" for 100-Year event
Inflow = 6.83 cfs @ 12.09 hrs, Volume= 21,207 cf
Outflow = 5.42 cfs @ 12.15 hrs, Volume= 21,207 cf, Atten= 21%, Lag= 3.7 min
Discarded = 0.17 cfs @ 12.15 hrs, Volume= 8,072 cf
Primary = 5.25 cfs @ 12.15 hrs, Volume= 13,134 cf
Routed to Reach R1 : Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 219.92' @ 12.15 hrs Surf.Area= 2,492 sf Storage= 2,666 cf
Flood Elev= 221.00' Surf.Area= 2,492 sf Storage= 2,792 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 30.1 min (843.4 - 813.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	218.00'	1,530 cf	**21.67'W x 115.00'L x 2.04'H Field A** 5,087 cf Overall - 1,262 cf Embedded = 3,825 cf x 40.0% Voids
#2A	218.50'	1,262 cf	**Cultec C-100HD** x 90 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 6 rows
		2,792 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	218.50'	**10.0" Round Culvert** L= 140.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 218.50' / 216.00' S= 0.0179 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf
#2	Discarded	218.00'	**2.410 in/hr Exfiltration over Wetted area**
#3	Primary	218.50'	**10.0" Round Culvert** L= 140.0' Ke= 0.500 Inlet / Outlet Invert= 218.50' / 216.50' S= 0.0143 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.55 sf
#4	Device 1	218.70'	**4.0' long Sharp-Crested Vee/Trap Weir** Cv= 2.62 (C= 3.28)
#5	Device 3	218.70'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.17 cfs @ 12.15 hrs HW=219.91' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.17 cfs)

Primary OutFlow Max=5.25 cfs @ 12.15 hrs HW=219.91' TW=0.00' (Dynamic Tailwater)
├**1=Culvert** (Inlet Controls 2.62 cfs @ 4.81 fps)
│└**4=Sharp-Crested Vee/Trap Weir** (Passes 2.62 cfs of 17.53 cfs potential flow)
└**3=Culvert** (Inlet Controls 2.62 cfs @ 4.81 fps)
└**5=Sharp-Crested Rectangular Weir** (Passes 2.62 cfs of 16.44 cfs potential flow)

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

Chamber Model = Cultec C-100HD (Cultec Contactor®100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 6 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

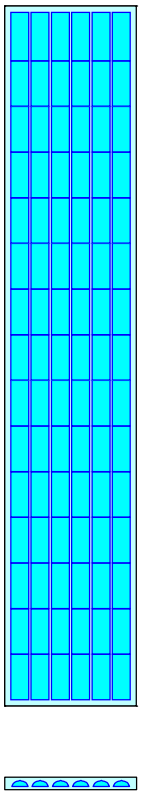
15 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 113.00' Row Length +12.0" End Stone x 2 = 115.00' Base Length
6 Rows x 36.0" Wide + 4.0" Spacing x 5 + 12.0" Side Stone x 2 = 21.67' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

90 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 6 Rows = 1,262.1 cf Chamber Storage

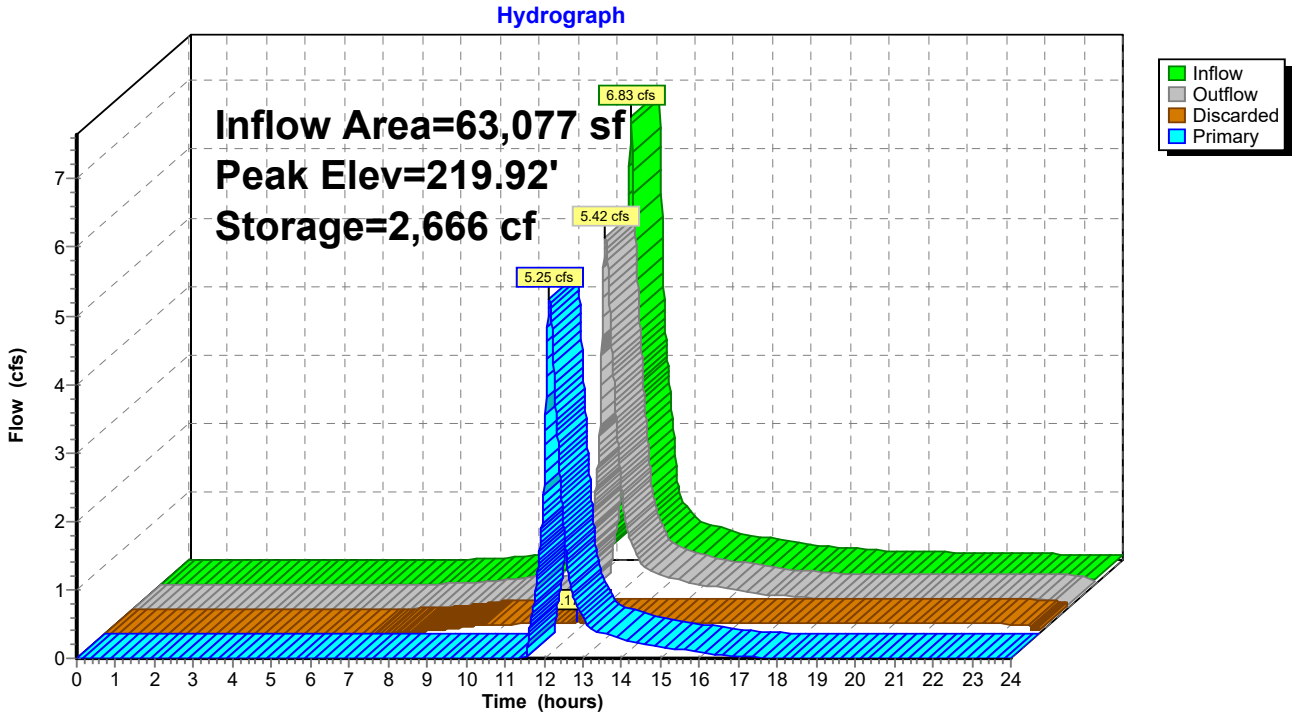
5,087.2 cf Field - 1,262.1 cf Chambers = 3,825.1 cf Stone x 40.0% Voids = 1,530.0 cf Stone Storage

Chamber Storage + Stone Storage = 2,792.1 cf = 0.064 af
Overall Storage Efficiency = 54.9%
Overall System Size = 115.00' x 21.67' x 2.04'

90 Chambers
188.4 cy Field
141.7 cy Stone



Pond 2P: Infiltration System-2



Summary for Pond 3P: Infiltration System-3

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=236)

Inflow Area = 49,148 sf, 66.41% Impervious, Inflow Depth > 3.93" for 100-Year event
Inflow = 5.19 cfs @ 12.09 hrs, Volume= 16,096 cf
Outflow = 2.61 cfs @ 12.24 hrs, Volume= 16,097 cf, Atten= 50%, Lag= 9.2 min
Discarded = 0.28 cfs @ 12.24 hrs, Volume= 10,260 cf
Primary = 2.32 cfs @ 12.24 hrs, Volume= 5,837 cf
Routed to Reach R1 : Wetlands

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 216.36' @ 12.24 hrs Surf.Area= 4,592 sf Storage= 3,894 cf
Flood Elev= 218.60' Surf.Area= 4,592 sf Storage= 5,187 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 46.0 min (861.8 - 815.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	215.00'	2,792 cf	**31.67'W x 145.00'L x 2.04'H Field A** 9,375 cf Overall - 2,396 cf Embedded = 6,979 cf x 40.0% Voids
#2A	215.50'	2,396 cf	**Cultec C-100HD** x 171 Inside #1 Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap Row Length Adjustment= +0.50' x 1.86 sf x 9 rows
		5,187 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	215.60'	**15.0" Round Culvert** L= 30.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 215.60' / 215.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Discarded	215.00'	**2.410 in/hr Exfiltration over Wetted area**
#3	Device 1	215.75'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.28 cfs @ 12.24 hrs HW=216.36' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.28 cfs)

Primary OutFlow Max=2.32 cfs @ 12.24 hrs HW=216.36' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 2.32 cfs @ 2.97 fps)
└**3=Sharp-Crested Rectangular Weir** (Passes 2.32 cfs of 6.05 cfs potential flow)

Pond 3P: Infiltration System-3 - Chamber Wizard Field A

Chamber Model = Cultec C-100HD (Cultec Contactor® 100HD)
Effective Size= 32.1"W x 12.0"H => 1.86 sf x 7.50'L = 14.0 cf
Overall Size= 36.0"W x 12.5"H x 8.00'L with 0.50' Overlap
Row Length Adjustment= +0.50' x 1.86 sf x 9 rows

36.0" Wide + 4.0" Spacing = 40.0" C-C Row Spacing

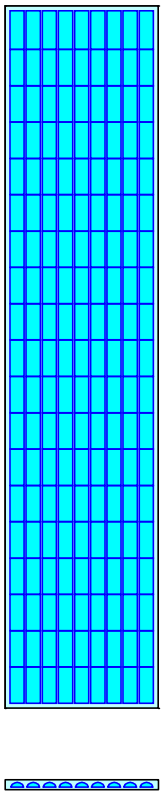
19 Chambers/Row x 7.50' Long +0.50' Row Adjustment = 143.00' Row Length +12.0" End Stone x 2 = 145.00' Base Length
9 Rows x 36.0" Wide + 4.0" Spacing x 8 + 12.0" Side Stone x 2 = 31.67' Base Width
6.0" Stone Base + 12.5" Chamber Height + 6.0" Stone Cover = 2.04' Field Height

171 Chambers x 14.0 cf +0.50' Row Adjustment x 1.86 sf x 9 Rows = 2,395.8 cf Chamber Storage

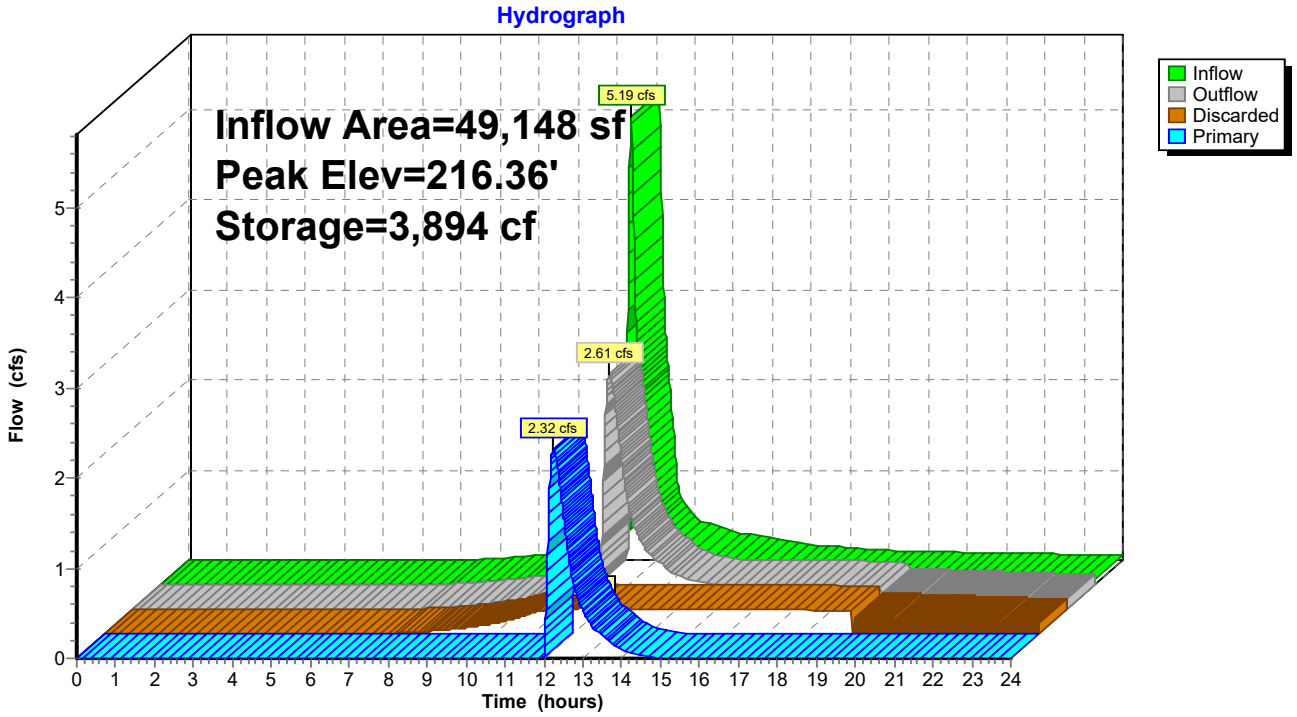
9,374.7 cf Field - 2,395.8 cf Chambers = 6,978.9 cf Stone x 40.0% Voids = 2,791.6 cf Stone Storage

Chamber Storage + Stone Storage = 5,187.3 cf = 0.119 af
Overall Storage Efficiency = 55.3%
Overall System Size = 145.00' x 31.67' x 2.04'

171 Chambers
347.2 cy Field
258.5 cy Stone



Pond 3P: Infiltration System-3



SECTION 5.0

PIPE SIZING CALCULATIONS

BSC GROUP
300 Brickstone Square
Andover, MA 01810
(617) 896-4300
Fax: (617) 896-4301

Project: Ayer Community Development
Location: Ayer, MA
Project #: 89926.01
Date: 10/31/2022
Calculate: JD
Check: -

Design Parameters:
Year Storm Event: 25 Years
IDF Curve: Boston
Minimum Pipe Size: 12" (Except for Pipes to and from INF-1 which has a Max of 10")
Pipe Material: CPP
Mannings N Value: 0.013
Weighted Ca: 1.1

PIPE SIZING TABLE

								A						B		
FROM	TO	AREA (Acres)	A*C	A*C*Ca	Tc (Min)	Tc (Pipe) T=(L/Va)/60 (min)	RAINFALL INTENSITY [I] (in./hr.)	**DESIGN** Q_{ACTUAL} Q_A = CxAxI (cfs)	**DESIGN** VEL_{ACTUAL} V_A = (Q_A/Q_F)xVAR	LENGTH (FT)	SLOPE	SIZE (IN)	N	**FULL VELOCITY** VEL_{FULL} VF = (1.49/n) $(R^{2/3})(S^{1/2})$	**FULL CAPACITY** Q_{FULL} $Q_F = V_F$xA (cfs)	CONCLUSION Design Q (A) is less than Full Capacity Q (B)
WQU-1	INF-1	0.11	0.09	0.10	6.0	0.0	6.0	0.61	5.01	11	0.027	6	0.013	4.70	0.92	O.K.
WQU-2	INF-1	0.32	0.22	0.24	6.0	0.0	6.0	1.42	6.88	11	0.036	8	0.013	6.54	2.23	O.K.
WQU-3	INF-1	0.21	0.17	0.19	6.0	0.2	6.0	1.11	3.59	41	0.007	10	0.013	3.38	1.74	O.K.
WQU-4	INF-1	0.31	0.18	0.20	6.0	0.3	6.0	1.20	3.61	55	0.007	10	0.013	3.35	1.73	O.K.
OCS-1	FES-1	Design values from HydroCAD software analysis:						0.00	0.00	118	0.038	12	0.013	8.86	6.96	O.K.
WQU-5	INF-2	0.22	0.13	0.15	6.0	0.0	6.0	0.88	4.73	11	0.018	8	0.013	4.62	1.58	O.K.
WQU-6	INF-2	0.86	0.55	0.60	6.0	0.0	6.0	3.63	6.61	17	0.018	12	0.013	6.01	4.72	O.K.
OCS-2	FES-2	Design values from HydroCAD software analysis:						4.34	6.83	141	0.018	12	0.013	6.04	4.74	O.K.
WQU-7	INF-3	0.72	0.42	0.46	6.0	0.0	6.0	2.76	5.11	10	0.011	12	0.013	4.65	3.65	O.K.
OCS-3	FES-3	Design values from HydroCAD software analysis:						0.51	4.41	26	0.024	10	0.013	6.03	3.11	O.K.

SECTION 6.0

ADDITIONAL DRAINAGE CALCULATIONS

6.01

GROUNDWATER RECHARGE STORAGE TABLES

Stage-Area-Storage for Pond 1P: Infiltration System-1

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
219.00	12,962	0
219.05	12,986	259
219.10	13,010	518
219.15	13,034	778
219.20	13,057	1,037
219.25	13,081	1,296
219.30	13,105	1,556
219.35	13,129	1,815
219.40	13,152	2,074
219.45	13,176	2,333
219.50	13,200	2,592
219.55	13,224	3,150
219.60	13,247	3,699
219.65	13,271	4,240
219.70	13,295	4,775
219.75	13,319	5,309
219.80	13,342	5,841
219.85	13,366	6,368
219.90	13,390	6,888
219.95	13,414	7,401
220.00	13,437	7,906
220.05	13,461	8,403
220.10	13,485	8,889
220.15	13,509	9,362
220.20	13,532	9,820
220.25	13,556	10,257
220.30	13,580	10,671
220.35	13,604	11,054
220.40	13,627	11,399
220.45	13,651	11,705
220.50	13,675	11,980
220.55	13,699	12,239
220.60	13,722	12,498
220.65	13,746	12,758
220.70	13,770	13,017
220.75	13,794	13,276
220.80	13,817	13,535
220.85	13,841	13,795
220.90	13,865	14,054
220.95	13,889	14,313
221.00	13,912	14,572
221.05	**13,932**	**14,788**
221.10	13,932	14,788
221.15	13,932	14,788
221.20	13,932	14,788
221.25	13,932	14,788
221.30	13,932	14,788
221.35	13,932	14,788
221.40	13,932	14,788
221.45	13,932	14,788
221.50	13,932	14,788

Stage-Area-Storage for Pond 2P: Infiltration System-2

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
218.00	2,492	0
218.05	2,505	50
218.10	2,519	100
218.15	2,533	150
218.20	2,546	199
218.25	2,560	249
218.30	2,574	299
218.35	2,587	349
218.40	2,601	399
218.45	2,615	448
218.50	2,628	498
218.55	2,642	602
218.60	2,656	704
218.65	2,669	805
218.70	2,683	904
218.75	2,697	1,003
218.80	2,710	1,102
218.85	2,724	1,200
218.90	2,738	1,297
218.95	2,751	1,393
219.00	2,765	1,487
219.05	2,779	1,580
219.10	2,792	1,670
219.15	2,806	1,759
219.20	2,820	1,844
219.25	2,833	1,926
219.30	2,847	2,004
219.35	2,861	2,076
219.40	2,874	2,141
219.45	2,888	2,200
219.50	2,902	2,252
219.55	2,915	2,302
219.60	2,929	2,352
219.65	2,943	2,402
219.70	2,956	2,452
219.75	2,970	2,501
219.80	2,984	2,551
219.85	2,997	2,601
219.90	3,011	2,651
219.95	3,025	2,701
220.00	3,038	2,751
220.05	**3,050**	**2,792**
220.10	3,050	2,792
220.15	3,050	2,792
220.20	3,050	2,792
220.25	3,050	2,792
220.30	3,050	2,792
220.35	3,050	2,792
220.40	3,050	2,792
220.45	3,050	2,792
220.50	3,050	2,792
220.55	3,050	2,792
220.60	3,050	2,792
220.65	3,050	2,792
220.70	3,050	2,792
220.75	3,050	2,792
220.80	3,050	2,792
220.85	3,050	2,792
220.90	3,050	2,792
220.95	3,050	2,792
221.00	3,050	2,792

Stage-Area-Storage for Pond 3P: Infiltration System-3

Elevation (feet)	Wetted (sq-ft)	Storage (cubic-feet)
215.00	4,592	0
215.05	4,609	92
215.10	4,627	184
215.15	4,645	276
215.20	4,662	367
215.25	4,680	459
215.30	4,698	551
215.35	4,715	643
215.40	4,733	735
215.45	4,751	826
215.50	4,768	918
215.55	4,786	1,112
215.60	4,804	1,303
215.65	4,821	1,491
215.70	4,839	1,677
215.75	4,857	1,863
215.80	4,874	2,048
215.85	4,892	2,232
215.90	4,910	2,413
215.95	4,927	2,592
216.00	4,945	2,768
216.05	4,963	2,941
216.10	4,980	3,110
216.15	4,998	3,275
216.20	5,016	3,435
216.25	5,033	3,588
216.30	5,051	3,732
216.35	5,069	3,866
216.40	5,086	3,987
216.45	5,104	4,095
216.50	5,122	4,192
216.55	5,139	4,284
216.60	5,157	4,376
216.65	5,175	4,468
216.70	5,192	4,560
216.75	5,210	4,652
216.80	5,228	4,743
216.85	5,245	4,835
216.90	5,263	4,927
216.95	5,281	5,019
217.00	5,298	5,111
217.05	**5,313**	**5,187**
217.10	5,313	5,187
217.15	5,313	5,187
217.20	5,313	5,187
217.25	5,313	5,187
217.30	5,313	5,187
217.35	5,313	5,187
217.40	5,313	5,187
217.45	5,313	5,187
217.50	5,313	5,187
217.55	5,313	5,187
217.60	5,313	5,187
217.65	5,313	5,187
217.70	5,313	5,187
217.75	5,313	5,187
217.80	5,313	5,187
217.85	5,313	5,187
217.90	5,313	5,187
217.95	5,313	5,187
218.00	5,313	5,187
218.05	5,313	5,187
218.10	5,313	5,187
218.15	5,313	5,187
218.20	5,313	5,187
218.25	5,313	5,187
218.30	5,313	5,187
218.35	5,313	5,187
218.40	5,313	5,187
218.45	5,313	5,187
218.50	5,313	5,187
218.55	5,313	5,187
218.60	5,313	5,187

6.02

WATER QUALITY FLOW RATE CALCULATIONS

Calculation Sheet

BSC GROUP

Project No.	8-9926.01	**Calc By**	DMG
Subject	Proprietary WQV Sizing - 1	**Date**	6/14/2022
Location	Ayer, MA	**Checked by**	
		Date	

2013 MA DEP Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Systems (2013 MADEP Q Rate)

WQU #1

For 0.5-inch Water Quality Volume Requirement

Q = (qu)(A)(WQV) **0.06** **cfs**

Q = peak flow rate associated with the first 1-inch of runoff

qu = the unit peak discharge (csm/in)	752	(see 2013 MADEP Q Rate for Tc=0.1 hours)
A = impervious surface (sq.miles)	0.000153	
WQV = water quality volume (in)	0.5	

STC 450i Maximum Water Quality Flow Rate = 0.40 cfs

Calculation Sheet

BSC GROUP

Project No.	8-9926.01	**Calc By**	DMG
Subject	Proprietary WQV Sizing - 2	**Date**	6/14/2022
Location	Ayer, MA	**Checked by**	
		Date	

2013 MA DEP Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Systems (2013 MADEP Q Rate)

WQU #2

For 0.5-inch Water Quality Volume Requirement

Q = (qu)(A)(WQV) **0.27** **cfs**

Q = peak flow rate associated with the first 1-inch of runoff

qu = the unit peak discharge (csm/in)	752	(see 2013 MADEP Q Rate for Tc=0.1 hours)
A = impervious surface (sq.miles)	0.000729	
WQV = water quality volume (in)	0.5	

STC 450i Maximum Water Quality Flow Rate = 0.40 cfs

Calculation Sheet

BSC GROUP

Project No.	8-9926.01	**Calc By**	DMG
Subject	Proprietary WQV Sizing - 3	**Date**	6/14/2022
Location	Ayer, MA	**Checked by**	
		Date	

2013 MA DEP Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Systems (2013 MADEP Q Rate)

WQU #3

For 0.5-inch Water Quality Volume Requirement

Q = (qu)(A)(WQV) **0.21** **cfs**

Q = peak flow rate associated with the first 1-inch of runoff

qu = the unit peak discharge (csm/in)	752	(see 2013 MADEP Q Rate for Tc=0.1 hours)
A = impervious surface (sq.miles)	0.000563	
WQV = water quality volume (in)	0.5	

STC 450i Maximum Water Quality Flow Rate = 0.40 cfs

Calculation Sheet

BSC GROUP

Project No.	8-9926.01	**Calc By**	DMG
Subject	Proprietary WQV Sizing - 4	**Date**	6/14/2022
Location	Ayer, MA	**Checked by**	
		Date	

2013 MA DEP Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Systems (2013 MADEP Q Rate)

WQU #4

For 0.5-inch Water Quality Volume Requirement

Q = (qu)(A)(WQV) **0.30** **cfs**

Q = peak flow rate associated with the first 1-inch of runoff

qu = the unit peak discharge (csm/in)	752	(see 2013 MADEP Q Rate for Tc=0.1 hours)
A = impervious surface (sq.miles)	0.000794	
WQV = water quality volume (in)	0.5	

STC 450i Maximum Water Quality Flow Rate = 0.40 cfs

Calculation Sheet

BSC GROUP

Project No.	8-9926.01	**Calc By**	DMG
Subject	Proprietary WQV Sizing - 5	**Date**	6/14/2022
Location	Ayer, MA	**Checked by**	
		Date	

2013 MA DEP Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Systems (2013 MADEP Q Rate)

WQU #5

For 0.5-inch Water Quality Volume Requirement

Q = (qu)(A)(WQV) **0.10** **cfs**

Q = peak flow rate associated with the first 1-inch of runoff

qu = the unit peak discharge (csm/in)	752	(see 2013 MADEP Q Rate for Tc=0.1 hours)
A = impervious surface (sq.miles)	0.000265	
WQV = water quality volume (in)	0.5	

STC 450i Maximum Water Quality Flow Rate = 0.40 cfs

Calculation Sheet

BSC GROUP

Project No.	8-9926.01	**Calc By**	DMG
Subject	Proprietary WQV Sizing - 6	**Date**	6/14/2022
Location	Ayer, MA	**Checked by**	
		Date	

2013 MA DEP Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Systems (2013 MADEP Q Rate)

WQU #6

For 0.5-inch Water Quality Volume Requirement

Q = (qu)(A)(WQV) **0.12** **cfs**

Q = peak flow rate associated with the first 1-inch of runoff

qu = the unit peak discharge (csm/in)	752	(see 2013 MADEP Q Rate for Tc=0.1 hours)
A = impervious surface (sq.miles)	0.000324	
WQV = water quality volume (in)	0.5	

STC 450i Maximum Water Quality Flow Rate = 0.40 cfs

Calculation Sheet

BSC GROUP

Project No.	8-9926.01	**Calc By**	DMG
Subject	Proprietary WQV Sizing - 7	**Date**	6/14/2022
Location	Ayer, MA	**Checked by**	
		Date	

2013 MA DEP Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Systems (2013 MADEP Q Rate)

WQU #7

For 0.5-inch Water Quality Volume Requirement

Q = (qu)(A)(WQV) **0.20** **cfs**

Q = peak flow rate associated with the first 1-inch of runoff

qu = the unit peak discharge (csm/in)	752	(see 2013 MADEP Q Rate for Tc=0.1 hours)
A = impervious surface (sq.miles)	0.000528	
WQV = water quality volume (in)	0.5	

STC 450i Maximum Water Quality Flow Rate = 0.40 cfs

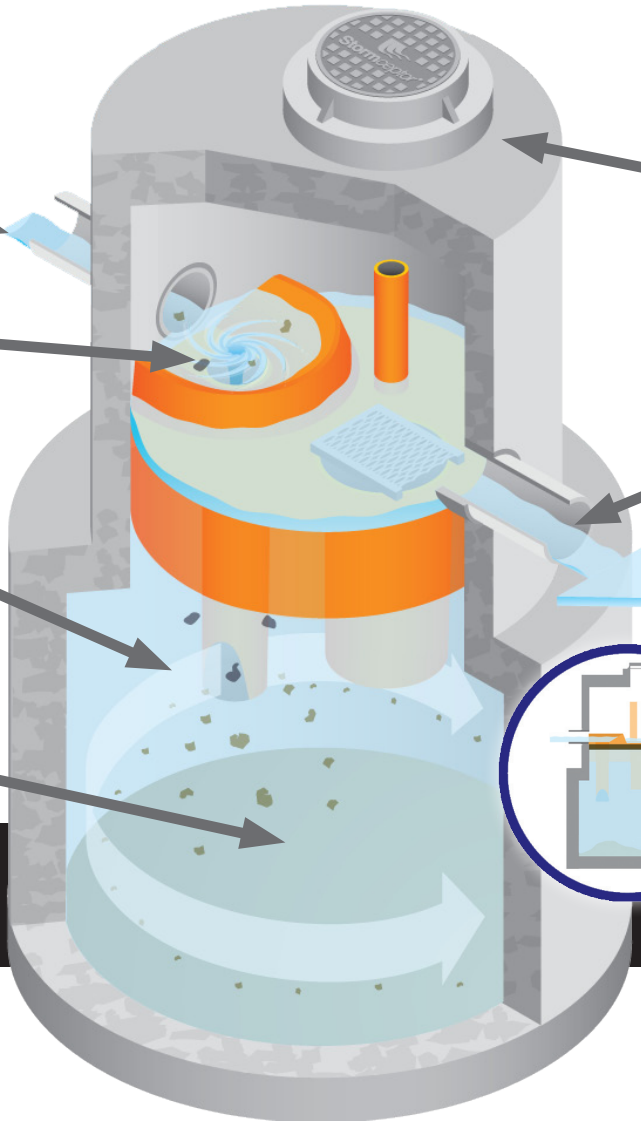
6.03

WATER QUALITY UNIT SIZING INFORMATION

Stormceptor®

Stormwater Treatment Made Simple!

TSS & Oil Removal ■ *Scour Prevention* ■ *Small Footprint*



Design Flexibility

Proven Performance

Environmentally Engineered Stormwater Solutions...
that exceed your client's needs!

www.rinkerstormceptor.com
Phone: (413) 562-3647

Rinker MATERIALS™

Stormceptor® STC

Stormceptor® is an underground stormwater quality treatment device that is unparalleled in its effectiveness for pollutant capture and retention. With thousands of systems operating worldwide, Stormceptor delivers protection every day in every storm.

With patented technology, optimal treatment occurs by allowing free oil to rise and sediment to settle. The Stormceptor design prohibits scour and release of previously captured pollutants, ensuring superior treatment and protection during even the most extreme storm events.

Stormceptor is very easy to design and provides flexibility under varying site constraints such as tight right-of-ways, zero lot lines and retrofit projects. Design flexibility allows for a cost-effective approach to stormwater treatment. Stormceptor has proven performance backed by the longest record of lab and field verification in the industry.

Tested Performance

- Fine particle capture
- Prevents scour or release
- 95%+ Oil removal

Massachusetts – Water Quality (Q) Flow Rate

Stormceptor STC Model	Inside Diameter	Typical Depth Below Inlet Pipe Invert [1]	Water Quality Flow Rate Q [2]	Peak Conveyance Flow Rate [3]	Hydrocarbon Capacity [4]	Maximum Sediment Capacity [4]
	(ft)	(in)	(cfs)	(cfs)	(Gallons)	(ft^3)
STC 450i	4	68	0.40	5.5	86	46
STC 900	6	63	0.89	22	251	89
STC 2400	8	104	1.58	22	840	205
STC 4800	10	140	2.47	22	909	543
STC 7200	12	148	3.56	22	1,059	839
STC 11000	2 x 10	142	4.94	48	2,792	1,086
STC 16000	2 x 12	148	7.12	48	3,055	1,677

[1] Depth Below Pipe Inlet Invert to the Bottom of Base Slab, and Maximum Sediment Capacity can vary to accommodate specific site designs and pollutant loads. Depths can vary to accommodate special designs or site conditions. Contact your local representative for assistance.
[2] Water Quality Flow Rate (Q) is based on 80% annual average TSS removal of the OK110 particle size distribution.
[3] Peak Conveyance Flow Rate is based upon ideal velocity of 3 feet per second and outlet pipe diameters of 18-inch, 36-inch, and 54-inch diameters.
[4] Hydrocarbon & Sediment capacities can be modified to accommodate specific site design requirements, contact your local representative for assistance.

Rinker MATERIALS™
www.rinkerstormceptor.com
Manufacturing Plant: Westfield, MA
Phone: (413) 562-3647
11-22-13-R13-802 MDEP

Stormceptor®
www.stormceptor.com

6.04

TSS REMOVAL CALCULATIONS

TSS Removal Calculation Worksheet

Location: 65 Fitchburg Road, Ayer, MA

Project: 89926.01

Prepared By: J. Daley

Date: 06/14/2022

Proposed Watershed Areas - All

Pretreatment - WQU

Total Impervious Area, Acres= 4.290

A	B	C	D	E
BMP	TSS Removal Rate	Starting TSS Load*	Amount Removed (BxC)	Remaining Load (C-D)
Infiltration Chambers (with WQU pretretment)	0.8	1.00	0.80	0.20

TSS Removal = 0.80

6.05

OUTLET PROTECTION SIZING (RIP RAP)

OUTLET PROTECTION SIZING

BSC GROUP

Project No.	89926.01	**Calc By**	JD
Subject	Outlet Protection Sizing Calcs	**Date**	6/14/2022
Location	65 Fitchburg Road, Ayer, MA	**Checked by**	
		Date	

FES-1

Q=Design Discharge, (ft^3/s)	=	1.6	cfs
D=Culvert Diameter, (ft)	=	1.00	ft
TW=Tailwater Depth, (ft)	=	0.4	ft, (0.4xD for unknow tailwater, or enter known tailwater)
			(Tailwater depth is to be limited to between 0.4D and 1.0D)

Riprap Rock Sizing

$$D_{50} = 0.2D\left[\frac{Q}{\sqrt{gD^{2.5}}}\right]^{4/3}\left[\frac{D}{TW}\right]$$

g=32.2 fps

D_{50} = median rock size, ft

$$D_{50} = 0.2\,\frac{1.60}{5.67}^{(4/3)}\,\frac{1.00}{0.40} = 0.09 \text{ ft}$$

= 1.11 inches

Table 1 : Riprap Classes and Apron Dimensions

Class	D_{50} (in)	Apron Length	Apron Depth	
1	5	4D	$3.5D_{50}$	
2	**6**	**4D**	**$3.5D_{50}$**	**Use Class 2**
3	10	5D	$3.3D_{50}$	
4	14	6D	$2.2D_{50}$	
5	20	7D	$2.0D_{50}$	
6	22	8D	$2.0D_{50}$	

Apron Dimensions

Length, L=4D	=	**4 ft**	
Depth=$3.5D_{50}$	=	**21.00 Inches**	
Width=3D+(2/3)L	=	**5.67 ft**	(at apron end)

Riprap Rock Sizing Gradation

Given Size	Size of Stone, inches		
100	**9**	to	**12**
85	**8**	to	**11**
50	**6**	to	**9**
15	**3**	to	**8**

OUTLET PROTECTION SIZING

BSC GROUP

Project No.	89926.01	**Calc By**	JD
Subject	Outlet Protection Sizing Calcs	**Date**	6/14/2022
Location	65 Fitchburg Road, Ayer, MA	**Checked by**	
		Date	

FES-2

Q=Design Discharge, (ft^3/s)	=	1.45	cfs
D=Culvert Diameter, (ft)	=	1.00	ft
TW=Tailwater Depth, (ft)	=	0.4	ft, (0.4xD for unknow tailwater, or enter known tailwater)
			(Tailwater depth is to be limited to between 0.4D and 1.0D)

Riprap Rock Sizing

$$D_{50} = 0.2D\left[\frac{Q}{\sqrt{gD^{2.5}}}\right]^{4/3}\left[\frac{D}{TW}\right]$$

g=32.2 fps

D_{50} = median rock size, ft

$$D_{50} = 0.2\,\frac{1.45}{5.67}^{(4/3)}\,\frac{1.00}{0.40} = 0.08 \text{ ft}$$

= 0.97 inches

Table 1 : Riprap Classes and Apron Dimensions

Class	D_{50} (in)	Apron Length	Apron Depth	
1	5	4D	$3.5D_{50}$	
2	**6**	**4D**	**$3.5D_{50}$**	**Use Class 2**
3	10	5D	$3.3D_{50}$	
4	14	6D	$2.2D_{50}$	
5	20	7D	$2.0D_{50}$	
6	22	8D	$2.0D_{50}$	

Apron Dimensions

Length, L=4D	=	**4 ft**	
Depth=$3.5D_{50}$	=	**21.00 Inches**	
Width=3D+(2/3)L	=	**5.67 ft**	(at apron end)

Riprap Rock Sizing Gradation

Given Size	Size of Stone, inches		
100	**9**	to	**12**
85	**8**	to	**11**
50	**6**	to	**9**
15	**3**	to	**8**

OUTLET PROTECTION SIZING

BSC GROUP

Project No.	89926.01	**Calc By**	JD
Subject	Outlet Protection Sizing Calcs	**Date**	6/14/2022
Location	65 Fitchburg Road, Ayer, MA	**Checked by**	
		Date	

FES-3

Q=Design Discharge, (ft^3/s)	=	2.22	cfs
D=Culvert Diameter, (ft)	=	1.00	ft
TW=Tailwater Depth, (ft)	=	0.4	ft, (0.4xD for unknow tailwater, or enter known tailwater)
			(Tailwater depth is to be limited to between 0.4D and 1.0D)

Riprap Rock Sizing

$$D_{50} = 0.2D\left[\frac{Q}{\sqrt{gD^{2.5}}}\right]^{4/3}\left[\frac{D}{TW}\right]$$

g=32.2 fps

D_{50} = median rock size, ft

$$D_{50} = 0.2\left|\frac{2.22}{5.67}\right|^{(4/3)}\left|\frac{1.00}{0.40}\right| = 0.14 \text{ ft}$$

= **1.72 inches**

Table 1 : Riprap Classes and Apron Dimensions

Class	D_{50} (in)	Apron Length	Apron Depth	
1	5	4D	$3.5D_{50}$	
2	**6**	**4D**	**$3.5D_{50}$**	**Use Class 2**
3	10	5D	$3.3D_{50}$	
4	14	6D	$2.2D_{50}$	
5	20	7D	$2.0D_{50}$	
6	22	8D	$2.0D_{50}$	

Apron Dimensions

Length, L=4D	=	**4 ft**	
Depth=$3.5D_{50}$	=	**21.00 Inches**	
Width=3D+(2/3)L	=	**5.67 ft**	(at apron end)

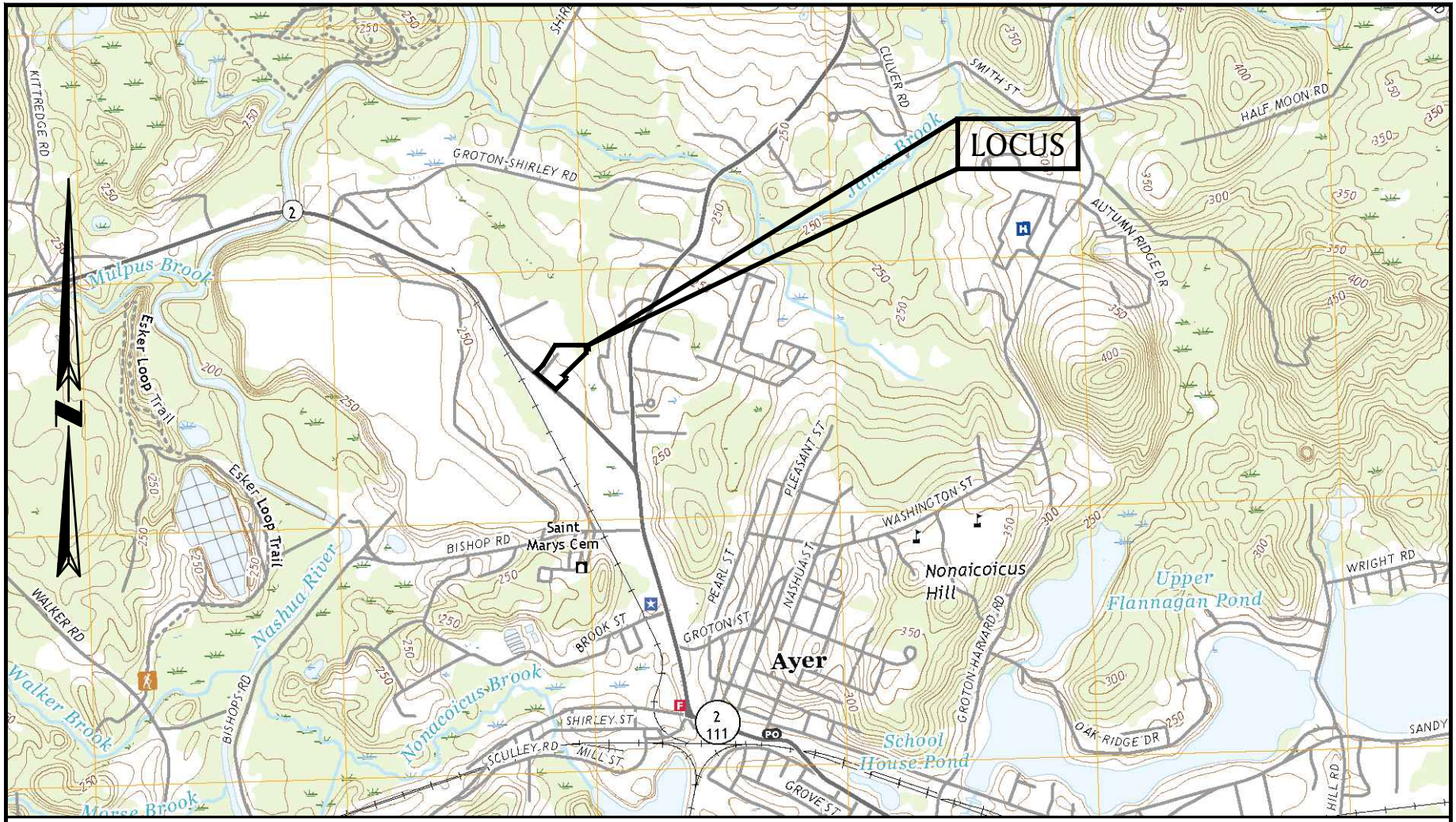
Riprap Rock Sizing Gradation

Given Size	Size of Stone, inches		
100	**9**	to	**12**
85	**8**	to	**11**
50	**6**	to	**9**
15	**3**	to	**8**

Reference Note: Sizing based in accordance with HEC #14 as required by MassHighway Design Manual

APPENDICES

USGS – SITE LOCUS MAP



SCALE: 1" = 500'

0 250 500 1,000 FEET

PREPARED FOR:

NEIGHBORHOOD OF
AFFORDABLE HOUSING
143 BORDER STREET
EAST BOSTON, MA

USGS LOCUS

Source: USGS

AYER COMMONS
65 FITCHBURG ROAD
AYER, MA

BSC GROUP
300 Brickstone Square
Andover, Massachusetts
01810
617 896 4300

Job No.: 8-9926.01 Date: JUNE 14, 2022
Scale: 1"=500' Revised:
Dwg. No: 89926.01 Figure:

FEMA MAP

National Flood Hazard Layer FIRMette

FEMA

71°36'6"W 42°34'35"N

71°35'29"W 42°34'8"N

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

1:6,000

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

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

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

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

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

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

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

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

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 6/13/2022 at 9:39 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

SOIL SURVEY MAP

Hydrologic Soil Group—Middlesex County, Massachusetts
(8-9926.01 Ayer Community)

Map Scale: 1:2,330 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 30 60 120 180

Feet
0 100 200 400 600

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

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

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

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

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

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

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

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 21, Sep 2, 2021

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

Date(s) aerial images were photographed: Sep 9, 2020—Oct 15, 2020

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
6A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	A/D	5.5	49.0%
259C	Carver loamy coarse sand, 8 to 15 percent slopes	A	1.3	11.8%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	A	2.0	17.8%
652	Udorthents, refuse substratum		2.4	21.4%
Totals for Area of Interest			**11.3**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

GEOTECHNICAL REPORT

NORTHEAST GEOTECHNICAL, INC.
Delivering Practical Engineering Solutions

GEOTECHNICAL ENGINEERING REPORT
PROPOSED AYER COMMONS
MULTI-FAMILY HOUSING
65 FITCHBURG ROAD
AYER, MA

Prepared For:
BSC Group
300 Brickstone Square, Suite 901A
Andover, MA 01810

Prepared By:
Northeast Geotechnical, Inc.
166 Raymond Hall Drive
North Attleborough, MA 02760

Project No. O438.00
July 29, 2021

NORTHEAST GEOTECHNICAL, INC.
Delivering Practical Engineering Solutions

July 29, 2021 Project No. O438.00

David P. Biancavilla, P.E., LEED AP
BSC Group (BSC)
300 Blackstone Square, Suite 901A
Andover, MA 01810

SUBJECT: Geotechnical Engineering Report
Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Dear David:

Northeast Geotechnical, Inc. is pleased to present the results of our geotechnical engineering services provided in support of the proposed project at the subject site. The objective of our services has been to develop geotechnical engineering recommendations for: use by the project's structural engineer in design of the buildings' foundations and floor slabs, and in seismic design; for your use in development of pavement sections and stormwater management areas; and for use in planning and performing earthwork construction activities.

Our studies have been performed in accordance with our proposal to you dated May 24, 2021. This report is subject to the Limitations and Service Constraints included in Appendix A of this report.

The attached report contains a summary of our studies and presents our findings, conclusions and recommendations for use in design and construction of the proposed project. Please feel free to contact Glenn Olson at 508-274-0887 or at golson@northeastgeotechnical.com should you have any questions or need anything further.

Sincerely,

Northeast Geotechnical, Inc.

Christian B. Rice, P.E.
Senior Project Engineer

Glenn A. Olson, P.E.
Principal Engineer

TABLE OF CONTENTS

NORTHEAST GEOTECHNICAL, INC.
Delivering Practical Engineering Solutions

1.0 INTRODUCTION

Our understanding of the project is based on our review of the following documents provided by BSC Group:

- "Grading Plan", Sheet No. C-103, dated April 28, 2021, prepared by BSC Group,
- "Existing Conditions", Sheet No. 1 of 2, dated November 3, 2020, prepared by BSC Group, and
- "Site Plan", Sheet No. A-100, dated April 13, 2021, prepared by Dimella Shaffer Associates, Inc.

The site of the Ayer Commons project is located on the north side of Fitchburg Road in Ayer, Massachusetts. We understand that the project will be developed in two phases. Available project plans depict five, multi-unit, two-story apartment buildings are proposed at the southern end of the site fronting on Fitchburg Road. A community center building and a three-story apartment building are both proposed to be located to the north of the aforementioned five buildings. Proposed pavement and landscaping will surround these seven buildings which are part of the Phase I development plans. The planned Phase I buildings will have finished floor elevations (FFEs) of 221 to 223 feet with ground floor level slabs-on-grade.

A second future phase includes a four-story apartment building at the northwest portion of the site with a planned FFE of 220.5 feet. Based on available grading plans, cuts and fills on the order of one to two feet will be required to develop the site under both phases. Two stormwater management basins are planned at the north end of the site.

The majority of the site in the vicinity of the proposed development is actively used for landscaping and tree service businesses. Portions of the site are covered with bituminous concrete pavement and other areas are earthen covered with stockpiles of logs and landscaping materials. Several one- to two-story buildings, both in-use and vacant, are present. The north end of the site, beyond the limits of the planned development, are wooded and delineated wetlands. Plans depict the site as being relatively level, sloping slightly downward to the north from approximately elevation (El) 223± feet to El 217± feet. Based on our discussions with personnel present during our time on-site, we understand the site has a history of filling operations dating back to the 1950s.

2.0 SUBSURFACE EXPLORATIONS

Northeast Geotechnical observed a subsurface exploration program consisting of ten soil test borings (B-1 through B-10) and nine test pits (TP-1 through TP-9) at the subject site. The test borings were performed on July 6, 7, and 8, 2021 by Drilex Environmental, Inc. of Auburn, Massachusetts. The test pits were performed on July 14, 2021 by Sidney Landscaping Services, Inc. of Ayer, Massachusetts.

The test boring and five of the nine test pit locations were survey located in the field by BSC. Select test pits and test borings were offset from the staked locations for accessibility with the subsurface exploration equipment. The remaining four test pits were located by Northeast Geotechnical, Inc. by taping and pacing from existing surficial features. The approximate test boring and test pit locations are shown on the attached Subsurface Exploration Location Plan (Figure No. 1). Existing ground surface elevations depicted on the individual exploration logs (see Appendices B and C of this report) were estimated by interpolating between contours on available project plans.

The test borings were advanced with a truck-mounted Mobile B-57 drill rig using a combination of 4¼-inch inside diameter continuous flight hollow-stem augers (HSAs) and 3-inch diameter flush-joint casing with roller bit by drive-and-wash drilling techniques to depths of approximately 11± to 32± feet below existing ground surface. Boring B-7 encountered a refusal condition on a possible boulder at a depth of approximately 24± feet. The remaining borings terminated without refusal in natural granular soils.

Standard Penetration Testing (SPT) was performed during each test boring. The SPT was performed at increments of 5 feet or less. The SPT was performed by driving a standard 2-inch outside diameter split spoon sampler up to 24 inches using a 140-pound auto-trip hammer falling 30 inches. The number of hammer blows required to drive the sampler in 6-inch increments is recorded on the boring logs attached in Appendix B. The sum of the blows required to drive the split spoon sampler from the 6 to 12-inch interval and the 12 to 18-inch interval is defined as the Standard Penetration Resistance of the soil.

The soil samples retrieved in the split spoon sampler during each SPT were visually described in the field by Northeast Geotechnical, Inc. personnel using Burmister's soil descriptions. The visual descriptions, the hammer blow counts required to drive the split spoon sampler during the SPTs, groundwater observations, approximate changes in soil strata, and other observations are shown on the boring logs contained in Appendix B. Note that the soil descriptions are representative of the minus 1.4± inch size fraction of the overall soil deposits sampled as that is the inside diameter of the split spoon sampler.

The test pits were performed with a Caterpillar 320E LRR excavator, with a 1± cubic yard capacity toothed bucket and a 22± foot maximum reach. The test pits were advanced to depths ranging from approximately 4± to 11± feet below the existing ground surface terminating without refusal in existing fill or apparent natural granular soils. Test pits TP-1 through TP-5 were advanced at proposed stormwater management areas. Test pits TP-6 through TP-9 were advanced within proposed building footprints. The soils exposed in the test pits were visually described in the field by a Northeast Geotechnical, Inc. licensed Massachusetts Soil Evaluator using the USDA soil textural classification system at TP-1 through TP-5 and Burmister's soil descriptions at TP-6 through TP-9.

The depths of estimated seasonal high groundwater in test pits TP-1 through TP-5 were based on the observed ground water conditions and the presence of redoximorphic features. The visual descriptions, groundwater observations, approximate changes in soil strata, and other observations are shown on the test pit logs contained in Appendix C. Test pit photographs are presented in Appendix D.

3.0 LABORATORY TESTING

Northeast Geotechnical submitted selected representative samples of the existing fill and natural soils collected from the test borings and test pits to Thielsch Engineering of Cranston, Rhode Island for laboratory testing to assess basic geotechnical engineering characteristics of the soils. The laboratory testing consisted of three combined sieve and hydrometer tests with USDA soil textural classifications and six additional grain size distribution tests. The test results are attached to this report in Appendix E.

4.0 SUBSURFACE CONDITIONS

Generalized subsurface conditions at the site consist of surficial materials overlying existing fill soils with percentages of miscellaneous debris. The natural soils at the site below the fill consist of sands, sands and gravels, and silty sand/sandy silt and are referred to as firm natural ground in this report. Groundwater was generally observed at depths of approximately 1.5 to 6 feet below ground surface at the time of the subsurface exploration program. Further details about each of the encountered strata are presented below.

4.1 Surficial Materials

Approximately 3± inches of bituminous concrete pavement was encountered at the surface of test borings B-2 and B-6. Approximately 6± to 10± inches of wood chips was encountered at the surface of test pits TP-6 and TP-10, respectively.

4.2 Existing Fill

Existing fill was encountered below the pavement in B-2 and B-6, below the wood chips in TP-6 and TP-10, and below the ground surface of the remaining explorations. The existing fill was observed to vary from being primarily granular in nature to organic in nature and extended to depths ranging from 0.5± feet to greater than 11± feet below ground surface (TP-3 terminated in existing granular fill at approximately 11± feet).

The granular portions of the existing fill appeared to generally consist of very loose to medium dense, gray/tan/brown/black, fine to medium or fine to coarse sand with about 5± to 70± percent silt, less than 5± to 30± percent fine or fine to coarse gravel, and up to about 40± percent deleterious materials including wires, glass, metal, brick, ash, rubber, plastic, wood, organic fibers, and tree stumps. Rubber tires, blasting mats and logs were also observed in the fill within the test pits. Occasional to frequent cobbles and boulders up to about 18± inches in diameter were observed within the existing granular fill in the test pits.

The organic portions of the existing fill appeared to generally consist of medium dense, brown/dark brown/black, fine to medium sand and silt, about 15± to 30± percent roots and wood, and about 5± to 15± percent fine or fine to coarse gravel. Occasional cobbles were observed in the fill in the test pits, and occasional deleterious materials including wood, stumps, plastic, and brick were observed within the organic fill at TP-4.

A buried topsoil layer was encountered beneath the granular fill in test pits TP-3, TP-6, and TP-7 and was observed to be approximately 0.5± to 1± foot thick, extending to depths of approximately 5± to

6.3± feet below ground surface. The buried topsoil layer appeared to generally consist of dark brown silt with about 30± percent roots and 5± percent fine sand.

4.3 Natural Sand as well as Natural Sand and Gravel

Natural sand as well as natural sand and gravel was encountered below the existing fill in each of the explorations, with the exception of test pits TP-1 and TP-3 which terminated in existing fill. These natural granular soils were encountered at depths ranging from approximately 0.5± to 7± feet below existing grade. The natural sand generally consisted of loose to medium dense gray/tan/rust/light brown fine to medium or fine to coarse sand, less than 5 to 15 percent fine gravel, and less than 5 to 20 percent silt. Generally the natural sand stratum was observed overlying the natural sand and gravel stratum.

The natural sand and gravel generally consisted of medium dense (occasionally very loose or dense), gray/tan/rust/light brown, fine to coarse sand, about 20 to 50± percent fine to coarse gravel, and about 5± to about 15± percent silt. Test borings B-4, B-6, and B-10, and test pits TP-2 and TP-4 through TP-9 terminated without refusal in the natural sand and gravel at depths ranging from approximately 4.7± to 21± feet below existing grade. Test boring B-7 terminated upon roller bit refusal on a possible boulder in the natural sand and gravel layer at a depth of approximately 24± feet.

4.4 Natural Silty Sand/Sandy Silt

Natural silty sand/sandy silt was encountered below the natural sand as well as below the natural sand and gravel at depths ranging from approximately 20± to 25.5± feet below existing grade in B-1, B-2, B-3, B-5, B-8, and B-9. The natural silty sand/sandy silt appeared to be typically medium dense to dense (occasionally loose), gray/tan, fine to medium or fine to coarse sand, about 25± to 70± percent silt, and about 5± to 50± percent fine or fine to coarse gravel. The split spoon sampler advanced within the natural silty sand/sandy silt layer in borings B-2 and B-3 was observed to be bent from possible boulders upon extraction. Test borings B-1, B-2, B-3, B-5, B-8, and B-9 terminated without refusal in the natural silty sand/sandy silt at depths ranging from approximately 26± to 32± feet below existing grade.

4.5 Groundwater

Groundwater was observed in the explorations at depths ranging from approximately 1.5± to 6± feet below existing grade. Perched water was encountered in test pit TP-7 at a depth of approximately 2± feet. Groundwater levels will fluctuate due to variations in temperature, precipitation and other factors. Additionally, groundwater may become temporarily perched above dense and/or silty soil surfaces, as was observed in test pit TP-7. Therefore, groundwater levels at any time could be different from that reported herein.

The depths of estimated seasonal high groundwater in the test pits were based on the observed ground water conditions and the presence of redoximorphic features. Refer to the individual exploration logs in Appendices B and C for additional information.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The following conclusions and recommendations are presented subject to the attached Limitations and Service Constraints in Appendix A.

The surficial materials and existing fill are not considered suitable to support building foundations and ground floor slab loads based on the presence of miscellaneous debris, organic materials and the indications that it was randomly placed. The surficial materials and existing fill are collectively referred to as unsuitables in this report. The test borings and test pits indicate a profile where the depths to firm natural granular soils vary from approximately 0.5± to 7± feet below ground surface within the footprints of the proposed buildings. However, nearby test pit TP-3 terminated in existing fill at a depth of approximately 10 feet below ground surface which indicates deeper fill is present at the site and could extend to within the proposed building footprints.

The observed depths of fill within the proposed building areas corresponds to elevations ranging from approximately El 212± feet to El 221.5± feet, i.e. about 2± to 8.5± feet below planned FFEs. The fill was observed to extend below observed groundwater levels at the time of the subsurface exploration program in the middle to western portions of the site, more specifically in the proposed community building as part of the Phase I project and within the southern portion of the Phase II building. However, fluctuations in groundwater levels at the time of construction could impact the limits of fill extending below groundwater levels.

5.1 Building Support

In our opinion, the unsuitable soils should be excavated and replaced with off-site structural fill to provide foundation and ground floor slab support for the proposed buildings at this site. In areas where existing fill extends below groundwater (which was in the vicinity of borings B-4, B-7, and B-9, and test pits TP-7 and TP-8 at the time of the subsurface exploration program), about 1.5± to 4.5± feet of dewatering is expected to be required to excavate the fill, reach firm natural soils, and to allow backfilling with controlled compacted lifts of structural fill "in the dry".

The contractor should be prepared to perform a dewatering effort to excavate to firm natural ground and backfill with controlled compacted lifts of off-site structural fill "in the dry". The size of open excavations to natural ground should be limited to that which can be maintained in a dry condition by the contractor's chosen method of dewatering. The on-site geotechnical engineer should verify that the excavation has extended to natural ground and that the base of the excavation is in a firm and stable condition prior to filling.

The limits of removal of existing fill should be a minimum of 10 feet outside of the proposed building wall lines as measured at the surface of the exposed natural ground (i.e. at the **bottom of the excavation**). The distance is recommended to accommodate the stress zone of the proposed foundations. The contractor should attempt to lay back the excavation slopes to a safe slope to allow worker access to the excavations.

Given the relatively high silt content and frequency of deleterious and organic materials observed in the existing fill during our explorations, we do not consider the existing fill suitable for re-use as structural fill. This fill should be disposed of off-site.

The initial lift of structural fill placed over the natural ground surface should consist of a 12-inch thick lift of off-site sand and gravel or ¾-inch crushed stone. Off-site structural fill should be placed in controlled, compacted lifts. Structural fill placed within the proposed building areas should be placed in 12-inch thick maximum lifts and be compacted to at least 95 percent of the soils' maximum dry density as established by ASTM D1557. The lifts of structural fill should be compacted by a minimum

of six passes of a self-propelled vibratory drum compactor having a minimum weight at the drum of 15,000 pounds. Besides meeting the minimum compaction requirements, each lift of fill should be assessed by the on-site geotechnical engineer to be compacted to a firm and stable condition.

Fill placed within the proposed building areas should be compacted to the recommended minimum degree of compaction the day it is placed. Dewatering should be continuous until the lifts of properly compacted structural fill has reached at least two feet above groundwater levels.

Fill materials should be placed in 6- to 12-inch maximum thick lifts depending on the compaction equipment used. Each lift of fill should be compacted to a firm and stable condition and to at least the following minimum compaction percentages as determined by ASTM D1557:

1. Below foundations: 95%
2. Slab base course fill: 95%
3. Building area above bottom of footing elevation and below slab base course: 92%
4. Pavement areas below base course: 92%

Recommended gradations of fill materials are presented in Section 5.2 of this report (Fill Materials). Structural fill should be placed and compacted up to the bottom of the building's slab base course levels.

5.2 Fill Materials

Northeast Geotechnical anticipates structural fill, ¾-inch crushed stone, as well as sand and gravel will need to be obtained from off-site sources to complete the project. Recommended gradation criteria for off-site fill soils and aggregates are presented below:

Off-site structural fill should conform to the following gradation requirements and be free from ice, snow, roots, sod, rubbish, and other deleterious or organic matter:

Off-Site Structural Fill Gradation Recommendations

Sieve Size	Percent Finer by Weight
2/3 the loose lift thickness	100
No. 10	30 – 95
No. 40	10 – 70
No. 200	0 – 15

Off-site sand and gravel should conform to the following gradation requirements and be free from ice, snow, roots, sod, rubbish, and other deleterious or organic matter:

Off-Site Sand and Gravel Fill Gradation Recommendations

Sieve Size	Percent Finer by Weight
4 inch	100
½ inch	50 – 85
No. 4	40 – 75
No. 10	30 – 60
No. 40	10 – 35
No. 100	5 – 20
No. 200	0 – 10

Crushed Stone should consist of durable crushed rock or durable crushed gravel stone, and be free from ice and snow, sand, clay, loam or other deleterious material. Crushed stone should be uniformly blended and should conform to the Commonwealth of Massachusetts Department of Transportation Standard Specifications for Highways and Bridges for ¾ inch crushed stone (i.e. M2.01.4).

5.3 Foundations

The buildings may be designed using typical shallow spread footing foundations provided the building areas are prepared as recommended herein. Spread footings may derive support from suitably placed and compacted structural fill or natural granular soils. The soils at the base of foundation excavations should be recompacted to a firm and stable condition by making at least four passes from a hand operated vibratory plate compactor above groundwater levels. If groundwater is encountered at bottom of footing, then the excavation should be extended a minimum of 6 inches below bottom and the excavation should be backfilled with a compacted lift of ¾-inch crushed stone.

Provided that the foundation subgrades are prepared as recommended, the foundations may be designed utilizing a maximum allowable soil bearing capacity of one and a half tons per square foot (1.5 TSF). Total settlement less than 1 inch and differential settlement less than 0.75 inches are anticipated.

Regardless of the recommended allowable bearing capacity, continuous wall footings should be at least 24 inches wide in the least lateral dimension. Exterior footings should be founded at least 48 inches below the finished exterior grade for frost protection. Interior footings not exposed to outside temperatures should bear at a minimum of 18 inches below finished grade. If interior foundations are constructed during cold weather months, the minimum depth for frost protection should be extended to 48 inches.

5.4 Floor Slabs-On-Grade

Slab-on-grade construction is recommended for the ground floor building slabs provided the building area earthwork is performed as recommended herein. Floor slabs should bear directly on a minimum 12-inch thick sand and gravel slab base course layer compacted to at least 95 percent maximum laboratory dry density as determined by ASTM D1557.

5.5 Seismic Design Criteria

The site soils in the area of the proposed buildings are not considered susceptible to liquefaction under moderate earthquake loading in accordance with Section 1806.4 of the ninth edition of The Massachusetts State Building Code. Provided earthwork is performed, and foundations are designed and constructed as recommended in this report, the site will be considered Site Class D in accordance with Chapter 20 of ASCE 7, which is referenced in Section 1613.3.2 of the Massachusetts State Building Code.

5.6 Pavement Areas

Surficial asphalt pavement and landscaping materials should be removed from proposed pavement areas. The existing fill soils exposed following removal of the asphalt pavement and landscaping materials within should be systematically densified by making a minimum of four passes with a self-propelled vibratory compactor having a minimum weight at the drum of 15,000 pounds. Areas which appear weak or unstable should be investigated with test pits to assess whether there are shallow underlying unsuitable materials which should be removed and replaced.

Soils which are observed to be unstable under the action of the compactor and/or organic fill encountered at near surface should be removed and replaced with controlled, compacted lifts of structural fill. However, it is not the intention to remove underlying organic fill from beneath the existing granular fill within the proposed parking areas provided the exposed subgrade following removal of the asphalt pavement can be systematically densified in place to a firm and stable condition.

The project owner should be made aware that there is risk of settlement/deterioration of pavement areas which could be caused by decay of organics, filling of voids in miscellaneous debris and other factors over time during the life of the project. This pavement settlement may require periodic maintenance. However, we anticipate the maintenance may be more cost effective than excavating and replacing the on-site existing fill soils/materials with off-site structural fill to support pavement sections.

Structural fill placed to the underside of the proposed pavement base course layer should be placed in 12-inch-thick maximum lifts and each lift should be compacted to a minimum of 92 percent of the soils' maximum dry density as determined by ASTM D1557. The structural fill should also be compacted to a firm and stable condition as assessed by the on-site geotechnical engineer.

Provided the proposed pavement areas are prepared as recommended, the following minimum pavement sections are recommended:

FLEXIBLE PAVEMENT SECTIONS

	Standard Duty (Passenger Car Parking)	**Heavy Duty (High Traffic and Truck Areas)**
Bituminous Pavement		
Top Course	1.5”	1.5”
Binder Course	2”	3”
Base Course Sand & Gravel	12”	16”

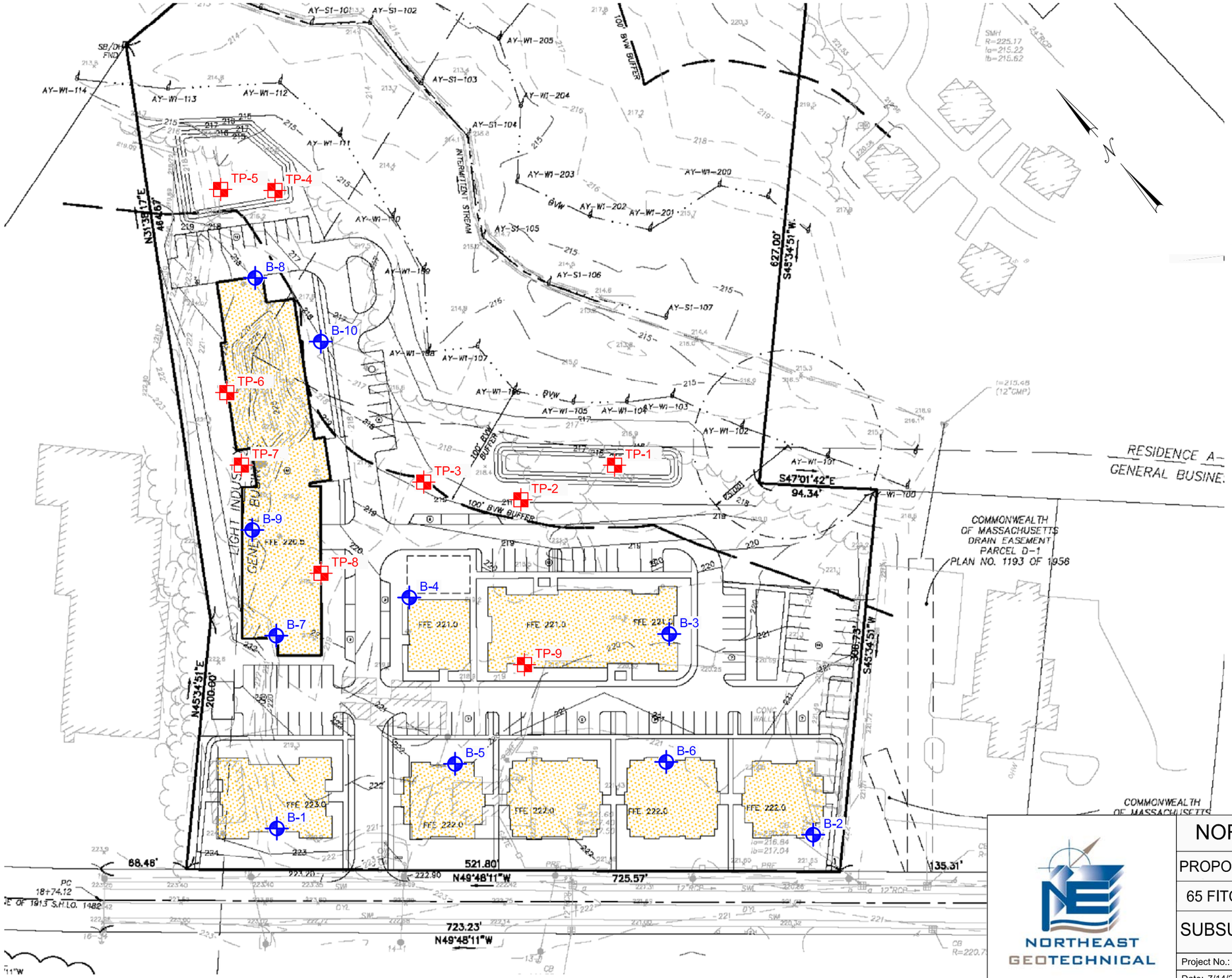
Pavement base course sand and gravel should meet the recommended gradation criteria for sand and gravel as presented in Section 5.2 Fill Materials of this report. Pavement base course fill should also be compacted to at least 95 percent of the soil’s maximum dry density as determined by ASTM 1557. Besides meeting the minimum compaction requirements, the base course fill should be compacted to a firm and stable condition.

6.0 CONSTRUCTION OBSERVATION, TESTING AND REVIEW

Northeast Geotechnical, Inc. should be retained to provide construction observation and soil testing services during the earthwork construction and foundation installation and bakfilling phases of the project. The purpose of our participation is twofold. One is to observe that the contractors perform earthwork activities in general compliance with the requirements of the pertinent sections of the plans and specifications as well as recommendations presented in this report. Our second objective is to verify our design assumptions in the field. In addition, we can provide engineering input in a timely manner if subsurface conditions are found to vary from those anticipated prior to construction and warrant a design change or a change in earthwork procedures.

We also recommend Northeast Geotechnical be afforded the opportunity to review the foundation and site plans as well as the earthwork specifications prior to bidding for construction to see that our recommendations have been properly interpreted and included.

FIGURE



NOTES:

1. BASE MAP DEVELOPED FROM PLAN TITLED "GRADING PLAN", SHEET No.C-103, DATED APRIL 28, 2021, PREPARED BY BSC GROUP.
2. TEST BORING AND TEST PIT LOCATIONS ESTABLISHED IN THE FIELD BY OTHERS. SOME EXPLORATIONS OFFSET FROM STAKED LOCATIONS FOR ACCESSIBILITY WITH EQUIPMENT. EXPLORATION LOCATIONS SHOWN ON THIS PLAN SHOULD BE CONSIDERED APPROXIMATE.
3. TEST BORINGS AND TEST PITS OBSERVED AND LOGGED BY NORTHEAST GEOTECHNICAL, INC. PERSONNEL.

LEGEND:

- TEST BORINGS PERFORMED BY DRILEX ENVIRONMENTAL, INC. OF AUBURN, MA ON JULY 6, 7, AND 8, 2021.
- TEST PITS EXCAVATED BY SIDNEY LANDSCAPING SERVICES, INC. OF AYER, MA ON JULY 14, 2021.

NORTHEAST GEOTECHNICAL

NORTHEAST GEOTECHNICAL, INC.

PROPOSED AYER COMMONS MULTI-FAMILY HOUSING

65 FITCHBURG ROAD — AYER, MA

SUBSURFACE EXPLORATION LOCATION PLAN

Project No.: O438.00	Drawn By: JJP	Reviewed By: G. OLSON, P.E.
Date: 7/14/2021	Scale: 1"-80'	Figure No.: 1

JACK POWERS, 07/16/2021, 17:09:29 | FILE: C:\NORTHEAST\2021\O438.00 AYER\PLANS\043800F01.DWG

APPENDIX A

Limitations and Service Constraints

LIMITATIONS AND SERVICE CONSTRAINTS
Geotechnical Engineering Consulting Services

The opinions, conclusions and recommendations presented in this report are based upon the scope of services, information obtained through the performance of the services, and the schedule as agreed upon by Northeast Geotechnical, Inc. and the party for whom this report was originally prepared. This report is an instrument of professional service and was prepared in accordance with the generally accepted standards and level of skill and care under similar conditions and circumstances established by the geotechnical consulting industry. No representation, warranty, or guarantee, express or implied, is intended or given. To the extent that Northeast Geotechnical, Inc. relied upon any information prepared by other parties not under contract to Northeast Geotechnical, Inc. , Northeast Geotechnical, Inc. makes no representation as to the accuracy or completeness of such information. This report is expressly for the sole and exclusive use of the party for whom this report was originally prepared and/or other specifically named parties have the right to make use of and rely upon this report. Reuse of this report or any portion thereof for other than its intended purpose, or if modified, or if used by third parties, shall be at the user's sole risk.

Furthermore, nothing contained in this document shall relieve any other party of its responsibility to abide by contract documents and applicable laws, codes, regulations, or standards.

Subsurface Explorations and Testing

Results of any observations, subsurface exploration or testing, and any findings presented in this report apply solely to conditions existing at the time when Northeast Geotechnical, Inc.'s exploratory work was performed. It must be recognized that any such observations and exploratory or testing activities are inherently limited and do not represent a conclusive or complete characterization. Conditions in other parts of the project site may vary from those at the locations where data were collected and conditions can change with time. Northeast Geotechnical, Inc.'s ability to interpret exploratory and test results is related to the availability of the data and the extent of the exploratory and testing activities.

The findings, conclusions and recommendations submitted in this report are based, in part, on data obtained from subsurface borings, test pits, and specific, discrete sampling locations. The nature and extent of variation between these test locations, which may be widely spaced, may not become evident until construction. If variations are subsequently encountered, it will be necessary to re-evaluate the conclusions and recommendations of this report.

Correlations and descriptions of subsurface conditions presented in boring logs, test pit logs, subsurface profiles, and other materials are approximate only. Subsurface conditions may vary significantly from those encountered in borings and sampling locations and transitions between subsurface materials may be gradual or highly variable.

Conditions at the time water level measurements and other subsurface observations were made are presented in the boring logs or other sampling forms. This field data has been reviewed and interpretations provided in this report. However, groundwater levels may be variable and may fluctuate due to variation in precipitation, temperature, and other factors. Therefore, groundwater levels at the site at any time may be different than stated in this report.

Review

In the event that any change in the nature, design, or location of the proposed structure(s) is planned, the conclusions and recommendations in this report shall not be considered valid unless the changes are reviewed and the conclusions and recommendations of this report are modified or verified in writing.

Northeast Geotechnical, Inc. should be provided the opportunity for a general review of final design plans and specifications to assess that our recommendations have been properly interpreted and included in the design and construction documents.

Construction

To verify conditions presented in this report and modify recommendations based on field conditions encountered in the field, Northeast Geotechnical, Inc. should be retained to provide geotechnical engineering services during the construction phase of the project. This is to observe compliance with design concepts, specifications, and recommendations contained in this report, and to verify and refine our recommendations as necessary in the event that subsurface conditions differ from those anticipated prior to the start of construction.

APPENDIX B

Test Boring Logs

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Boring No.: B-1
Page: 1 of 1
File No.: O438.00
Reviewed By: Glenn Olson, P.E.

Boring Co.: Drilex Environmental, Inc.
Foreman: Chris Hogan
Boring Equipment: Mobile B-57 Drill Rig
3-inch Diam. Casing with Roller Bit
2.0" O.D. Split Spoon, 140 lb Auto Hammer

Date/Weather: 7-7-2021 / Clear, 70s to 80s °F
Northeast Geotechnical Observer: Christian Rice, P.E.
Test Boring Location: See Exploration Location Plan
Ground Surface Elevation: 222± feet
Depth to Water: 5.5± feet

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
	S-1A	0-0.5'	6"	6"	7	1	Existing Fill, 0.5'±	Brown, F/C SAND, some F/C Gravel, little Silt, trace roots
	S-1B	0.5-2'	18"	12"	6-6-6		Natural Sand	Medium dense, tan, F/C SAND, little F/C Gravel, trace Silt
	S-2	2-4'	24"	17"	5-5-5-5			Medium dense, tan, F/M SAND, little (-) F/C Gravel, trace Silt
5'								
	S-3A	5-5.5'	6"	6"	3	2	5.5'±	Loose, gray, F/C SAND, little F. Gravel, trace Silt, wet
	S-3B	5.5-7'	18"	5"	7-8-8		Natural Sand and Gravel	Med. dense, gray-brown, F/C SAND and F/C GRAVEL, trace (+) Silt, wet
	S-4	7-9'	24"	19"	8-8-11-9		9'±	Medium dense, gray-brown, F/C SAND, some (-) F/C Gravel, trace Silt, wet
10'	S-5	9-11'	24"	5"	5-4-4-4		Natural Sand and Silt	Loose, gray-tan-rust, F. SAND and SILT, wet
15'	S-6	14-16'	24"	18"	3-2-2-2			Loose, gray-tan, F. SAND, little Silt, wet
20'	S-7	19-21'	24"	14"	3-4-6-6		23'±	Medium dense, light brown, fine SAND and SILT, wet
25'	S-8	24-26'	24"	17"	6-4-2-1		Natural Silty Sand and Gravel	Loose, gray-tan, F/M SAND and Clayey SILT, some F/C Gravel, wet
	S-9	29-31'	24"	12"	14-13-11-13	3	31'±	Medium dense, gray-tan, F/C SAND, some F/C Gravel, some (-) Silt, wet

Notes:
1) Cobbles observed at ground surface in vicinity of boring.
2) Groundwater measured at 5.5± feet below ground surface (bgs) following casing removal at completion of boring.
3) Boring terminated at 31± feet bgs.

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse

Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Boring No.: B-2
Page: 1 of 1
File No.: O438.00
Reviewed By: Glenn Olson, P.E.

Boring Co.	Drilex Environmental, Inc.	Date/Weather:	7-2-2021 / Overcast, 60s to 70s °F
Foreman:	Chris Hogan	Northeast Geotechnical Observer:	Christian Rice, P.E.
Boring Equipment:	Mobile B-57 Drill Rig	Test Boring Location:	See Exploration Location Plan
	3-inch Diam. Casing with Roller Bit	Ground Surface Elevation:	221.5± feet
	2.0" O.D. Split Spoon, 140 lb Auto Hammer	Depth to Water:	5.5± feet

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
							Pavement, 0.3'±	3 inches BITUMINOUS CONCRETE
	S-1A	0.3-0.8'	7"	7"	11		Existing Fill	M. dense, brown, SILT, little F. Gravel, , little F/C Sand, little Ash/Wood
	S-1B	0.8-2.3'	17"	10"	9-13-10			Medium dense, gray-brown, F/C SAND and F/C GRAVEL, little (-) Silt
	S-2	2.3-4.3'	24"	18"	7-4-2-3			Loose, black, F/M SAND and SILT, trace (-) roots
5'							4.5'±	
	S-3	5-7'	24"	14"	5-7-10-12	1	Natural Sand	Medium dense, tan-rust, F/M SAND, trace (-) Silt, wet
	S-4	7-9'	24"	19"	12-12-11-14			Medium dense, gray-tan, F/C SAND, trace (+) Silt, wet
							9'±	
10'	S-5	9-11'	24"	17"	15-19-19-16		Natural Sand and Gravel	Dense, gray-tan, F/C SAND, some (+) F/C Gravel, trace (+) Silt, wet
15'	S-6	14-16'	24"	14"	8-4-3-4			Loose, tan, F/C SAND, some (-) F/C Gravel, trace Silt, wet
20'	S-7A	19-20.5'	18"	9"	6-5-5		20.5'±	Med. dense, gray, F/C SAND, some (+) F/C Gravel, trace Silt, wet
	S-7B	20.5-21'	6"	5"	3		Natural Silty Sand and Gravel	Loose, gray, F/M SAND and SILT, little F/C Gravel, wet
						2		
25'	S-8	24-26'	24"	4"	43-15-14-19			Medium dense, gray, F/C GRAVEL (possible fractured cobble or boulder pieces), trace Silt, trace F/M Sand, wet
						3,4	26'±	
								Bottom of boring at 26± feet

Notes:
1) Groundwater measured at 5.5± feet below ground surface (bgs) following casing removal at completion of boring.
2) Drilling resistance increased at approximately 22± feet bgs.
3) Split spoon sampler observed to be bent from possible boulder upon extraction.
4) Boring terminated at 26± feet bgs.

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse

Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Boring No.: B-3
Page: 1 of 1
File No.: O438.00
Reviewed By: Glenn Olson, P.E.

Boring Co.	Drilex Environmental, Inc.	Date/Weather:	7-8-2021 / Overcast, 60s to 70s °F
Foreman:	Chris Hogan	Northeast Geotechnical Observer:	Christian Rice, P.E.
Boring Equipment:	Mobile B-57 Drill Rig	Test Boring Location:	See Exploration Location Plan
	3-inch Diam. Casing with Roller Bit	Ground Surface Elevation:	221± feet
	2.0" O.D. Split Spoon, 140 lb Auto Hammer	Depth to Water:	4± feet

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
	S-1A	0-0.8'	10"	10"	9-3			Med. dense, gray-brown, F/C SAND, some Silt, little F/C Gravel, little Wood
	S-1B	0.8-2'	14"	11"	10-8		Existing Fill	Medium dense, gray-tan, F/C SAND, little Silt, little F/C Gravel, trace (-) roots
	S-2A	2-3'	12"	12"	6-5			Medium dense, tan, F/C SAND, little F/C Gravel, trace (+) Silt
	S-2B	3-4'	12"	4"	4-6	1		Loose, black, F/M SAND and SILT, little Deleterious Materials (Rubber,
5'							4.5'±	Organic Fibers)
	S-3	5-7'	24"	12"	6-9-9-13			Medium dense, gray-tan, F/M SAND, little (-) Silt, wet
	S-4	7-9'	24"	18"	14-15-14-14		Natural Sand	Medium dense, gray-tan, F/M SAND, little (+) Silt, wet
10'	S-5	9-11'	24"	17"	4-6-10-15			Medium dense, gray-tan, F/C SAND, little (+) Silt; in split spoon sampler
							11'±	tip: gray-brown, F/C GRAVEL and F/C SAND, trace Silt, wet
							Natural Sand and Gravel	
								Medium dense, gray-tan, F/C SAND, some (+) F/C Gravel, trace (+) Silt,
15'	S-6A	14-15'	12"	8"	10-5		15'±	wet
	S-6B	15-16'	12"	5"	2-2			Loose, gray-tan, F/C SAND, littleF. Gravel, little (-) Silt, wet
							Natural Sand	
20'	S-7	19-21'	24"	8"	6-4-7-11			Med. dense, gray-black-rust, F/C SAND, trace (+) Silt, trace F. Gravel,
								wet
							23'±	
						2	Natural Silty	
25'	S-8	24-26'	24"	7"	50-18-16-17	3	Sand and	Dense, gray, F/C GRAVEL, some F/C Sand, some Silt, wet
						4	Gravel, 26'±	
								Bottom of boring at 26± feet

Notes:
1) Groundwater encountered at 4± feet below ground surface (bgs) while drilling.
2) Drilling resistance increased at approximately 23± feet bgs.
3) Split spoon sampler observed to be bent from possible cobble or boulder upon extraction.
4) Boring termintaed at 26± feet bgs.

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse

Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Boring No.: B-4
Page: 1 of 1
File No.: O438.00
Reviewed By: Glenn Olson, P.E.

Boring Co.	Drilex Environmental, Inc.	Date/Weather:	7-8-2021 / Overcast, 60s to 70s °F
Foreman:	Chris Hogan	Northeast Geotechnical Observer:	Christian Rice, P.E.
Boring Equipment:	Mobile B-57 Drill Rig	Test Boring Location:	See Exploration Location Plan
	3-inch Diam. Casing with Roller Bit	Ground Surface Elevation:	220± feet
	2.0" O.D. Split Spoon, 140 lb Auto Hammer	Depth to Water:	4± feet

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
	S-1A	0-1'	12"	12"	8-7		Existing Fill	Medium dense, light brown, F/M SAND, some F/C Gravel, little Silt
	S-1B	1-2'	12"	4"	7-7			Medium dense, tan, F/C SAND, trace Silt, trace F. Gravel
	S-2	2-4'	24"	16"	5-5-2-3			Loose, gray-brown, F/C SAND, some Silt, little F/C Gravel, trace wood & piece of wood in split spoon sampler tip
						1		
5'								
	S-3A	5-6.5'	18"	7"	3-1-4		6.5'±	Loose, brown, F/M SAND and WOOD, trace Silt, trace (-) F. Gravel, wet
	S-3B	6.5-7'	6"	4"	10		Natural Sand	Medium dense, brown, F/M SAND, trace (+) Silt, wet
	S-4	7-9'	24"	18"	16-14-14-14			Medium dense, gray-tan, F/M SAND, trace Silt, wet
10'	S-5	9-11'	24"	15"	7-8-7-6			Medium dense, gray-tan, F/M SAND, little Silt, wet
						2	11'±	
								Bottom of boring at 11± feet
15'								
20'								
25'								

Notes:
1) Groundwater encountered at 4± feet below ground surface (bgs) while drilling.
2) Boring terminated at 11± feet bgs.

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse

Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Boring No.: B-5
Page: 1 of 1
File No.: O438.00
Reviewed By: Glenn Olson, P.E.

Boring Co.	Drilex Environmental, Inc.	Date/Weather:	7-7-2021 / Clear, 70s to 80s °F
Foreman:	Chris Hogan	Northeast Geotechnical Observer:	Christian Rice, P.E.
Boring Equipment:	Mobile B-57 Drill Rig	Test Boring Location:	See Exploration Location Plan
	3-inch Diam. Casing with Roller Bit	Ground Surface Elevation:	219.5± feet
	2.0" O.D. Split Spoon, 140 lb Auto Hammer	Depth to Water:	4± feet

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
	S-1A	0-1'	12"	12"	8-6		Existing Fill, 1'±	Medium dense, gray-brown, F/M SAND, little (+) F/C Gravel, little (-) Silt
	S-1B	1-2'	12"	10"	6-5			Medium dense, tan, F/M SAND, trace (+) Silt
	S-2	2-4'	24"	19"	3-4-3-4			Loose, tan, F/C SAND, little Silt
						1		
5'							Natural Sand	
	S-3	5-7'	24"	11"	2-4-5-8			Loose, gray-tan, F/C SAND, little Silt, wet
	S-4	7-9'	24"	24"	7-7-7-10			Medium dense, gray-tan, F/C SAND, little (-) Silt, wet
							9'±	
10'	S-5	9-11'	24"	6"	7-5-12-14			
							Natural Sand and Gravel	Med. dense, gray-brown, F/C SAND and F/C GRAVEL, trace (+) Silt, wet
							14'±	
15'	S-6	14-16'	24"	5"	2-2-3-5			Loose, gray-brown, F/C SAND, trace F. Gravel, trace (-) Silt, wet
							Natural Sand	
20'	S-7A	19-20'	12"	6"	4-3		20'±	Loose, gray-brown, F/C SAND, some (+) F/C Gravel, trace Silt, wet
	S-7B	20-21'	12"	5"	7-10	2		Medium dense, gray, SILT, some F/M Sand, little F. Gravel, wet
							Natural Silty Sand	
25'	S-8	24-26'	24"	10"	18-17-13-10			Dense, gray, F/M SAND and SILT, little F. Gravel, wet
						3	26'±	
								Bottom of boring at 26± feet

Notes:
1) Groundwater encountered at 4± feet below ground surface (bgs) while drilling.
2) Drilling resistance increased at approximately 20± feet bgs.
3) Boring terminated at 26± feet bgs.

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse

Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Boring No.: B-6
Page: 1 of 1
File No.: O438.00
Reviewed By: Glenn Olson, P.E.

Boring Co.	Drilex Environmental, Inc.	Date/Weather:	7-8-2021 / Overcast, 60s to 70s °F
Foreman:	Chris Hogan	Northeast Geotechnical Observer:	Christian Rice, P.E.
Boring Equipment:	Mobile B-57 Drill Rig	Test Boring Location:	See Exploration Location Plan
	3-inch Diam. Casing with Roller Bit	Ground Surface Elevation:	221± feet
	2.0" O.D. Split Spoon, 140 lb Auto Hammer	Depth to Water:	5.5± feet

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
							Pavement, 0.3'±	3 inches BITUMINOUS CONCRETE
	S-1	0.3-2.3'	24"	16"	9-5-9-14		Existing Fill	M. dense, gray-brown, SILT, some F/M Sand, some F/C Gravel, little Ash/Wood
	S-2A	2.3-3'	9"	9"	11-7		3'±	Medium dense, black, F/M SAND, some Silt
	S-2B	3-4.3'	15"	10"	8-7			Medium dense, tan-brown, F/M SAND, little Silt
5'								
	S-3	5-7'	24"	6"	6-7-9-11	1		Medium dense, gray-tan, F/C SAND, little (+) Silt, wet
	S-4	7-9'	24"	20"	12-18-20-22			Dense, gray-brown, F/C SAND, little Silt, trace F. Gravel, wet
10'	S-5	9-11'	24"	5"	9-7-6-13		Natural Sand	Medium dense, tan, F/C SAND, little (-) Silt, trace F. Gravel, wet
15'	S-6	14-16'	24"	8"	13-15-16-16			Dense, gray-tan-brown, F/C SAND, little F. Gravel, little (-) Silt, wet
							18'±	
							Natural Sand and Gravel	
20'	S-7	19-21'	24"	7"	14-6-5-5			Medium dense, gray-brown, F/C SAND and F/C GRAVEL, little (+) Silt, wet
						2	21'±	
								Bottom of boring at 21± feet
25'								

Notes:
1) Groundwater measured at 5.5± feet below ground surface (bgs) following casing removal at completion of boring.
2) Boring terminated at 21± feet bgs.

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse

Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Boring No.: B-7
Page: 1 of 1
File No.: O438.00
Reviewed By: Glenn Olson, P.E.

Boring Co.	Drilex Environmental, Inc.	Date/Weather:	7-6-2021 / Overcast, 70s to 80s °F
Foreman:	Chris Hogan	Northeast Geotechnical Observer:	Christian Rice, P.E.
Boring Equipment:	Mobile B-57 Drill Rig	Test Boring Location:	See Exploration Location Plan
	3-inch Diam. Casing with Roller Bit	Ground Surface Elevation:	222± feet
	2.0" O.D. Split Spoon, 140 lb Auto Hammer	Depth to Water:	5± feet

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
	S-1	0-2'	24"	19"	11-6-7-6			Medium dense, black, F/C SAND, little (+) F/C Gravel, little (+) Silt
	S-2	2-4'	24"	18"	4-3-1-2		Existing Fill	Medium dense, black, F/M SAND, some Silt, trace (-) Organic Fibers
5'	S-3	5-7'	24"	16"	5-6-14-17	1		Med. dense, brown, F/C SAND, some Silt, little wood/organic fibers, wet
	S-4A	7-8.5'	18"	18"	12-11-10		8.5'±	Med. dense, brown, F/M SAND, trace (+) Silt, trace organic fibers, wet
	S-4B	8.5-9'	6"	4"	10		Natural Sand	Medium dense, tan, F/M SAND, trace Silt, wet
10'	S-5	9-11'	24"	6"	5-6-3-4			Loose, gray-tan, F/C SAND, little F/C Gravel, trace Silt, wet
							12'±	
15'	S-6	14-16'	24"	8"	8-5-3-3		Natural Sand and Gravel	Loose, gray-tan, F/C SAND, some F/C Gravel, trace (+) Silt, wet
20'	S-7	19-21'	24"	10"	4-4-7-4			Medium dense, gray-brown, F/C SAND, some (+) F/C Gravel, trace (+) Silt, wet
						2		
	S-8	24-24'	0"	0"	50/0"	3,4	24'±	No sampler penetration
25'								Bottom of boring at 24± feet

Notes:
1) Groundwater measured at 5± feet below ground surface (bgs) following casing removal at completion of boring.
2) Drilling resistance increased at approximately 23± feet bgs.
3) Sampler and roller bit refusal at 24± feet bgs.
4) Boring terminated at 24± feet bgs.

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse

Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Boring No.: B-8
Page: 1 of 1
File No.: O438.00
Reviewed By: Glenn Olson, P.E.

Boring Co.	Drilex Environmental, Inc.	Date/Weather:	7-7-2021 / Clear, 70s to 80s °F
Foreman:	Chris Hogan	Northeast Geotechnical Observer:	Christian Rice, P.E.
Boring Equipment:	Mobile B-57 Drill Rig	Test Boring Location:	See Exploration Location Plan
	3-inch Diam. Casing with Roller Bit	Ground Surface Elevation:	219± feet
	2.0" O.D. Split Spoon, 140 lb Auto Hammer	Depth to Water:	4± feet

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
	S-1A	0-0.5'	6"	6"	11		Organic Fill, 0.5'±	M. dense, dark brown, F/M SAND and SILT, some Wood, trace F. Gravel
	S-1B	0.5-2'	18"	18"	12-11-23		Existing Fill	Medium dense, gray-tan, SILT, little F/M Sand, little F/C Gravel
	S-2	2-4'	24"	2"	50-8-7-6			Medium dense, brown, WOOD, little F/M Sand, little Silt
						1	4'±	
5'							Natural Sand	
	S-3	5-7'	24"	13"	5-7-9-10			Medium dense, rust, F/C SAND, little Silt, wet
							7'±	
	S-4	7-9'	24"	18"	21-26-24-26			Very dense, gray-tan, F/C SAND, some (+) F/C Gravel, little Silt, wet
10'	S-5	9-11'	24"	11"	14-11-11-14			Medium dense, gray-tan, F/C SAND, some (-) F/C Gravel, trace (+) Silt, wet
15'	S-6	14-16'	24"	10"	5-6-10-10		Natural Sand and Gravel	Medium dense, gray-tan, F/C SAND, little F/C Gravel, trace (+) Silt, wet
20'	S-7	19-21'	24"	0"	5-6-5-6			No recovery
25'	S-8A	24-25.5'	18"	10"	7-8-4		25.5'±	Medium dense, gray-tan, F/C SAND and F/C GRAVEL, trace Silt, wet
	S-8B	25.5-26'	6"	2"	8	2	* 26'±	Gray, SILT, some F/M Sand, trace F. Gravel, wet
								Bottom of boring at 26± feet

Notes: *Natural Sandy Silt

1) Groundwater encountered at 4± feet below ground surface (bgs) while drilling.
2) Boring terminated at 26± feet bgs.

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse

Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Boring No.: B-9
Page: 1 of 2
File No.: O438.00
Reviewed By: Glenn Olson, P.E.

Boring Co.	Drilex Environmental, Inc.	Date/Weather:	7-6-2021 / Overcast, 70s to 80s °F
Foreman:	Chris Hogan	Northeast Geotechnical Observer:	Christian Rice, P.E.
Boring Equipment:	Mobile B-57 Drill Rig	Test Boring Location:	See Exploration Location Plan
	4¼-inch I.D. Hollow-Stem Augers	Ground Surface Elevation:	220± feet
	2.0" O.D. Split Spoon, 140 lb Auto Hammer	Depth to Water:	5± feet

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
	S-1A	0-0.4'	5"	5"	5		Organic Fill, 0.4'±	Medium dense, brown, F/M SAND and SILT, some Wood, trace F. Gravel
	S-1B	0.4-2'	19"	14"	6-10-10			Medium dense, gray-brown, F/M SAND, little F/C Gravel, little (+) Silt, trace Deleterious Materials (Plastic, Glass, Organic Fibers)
	S-2	2-4'	24"	12"	9-6-3-4	1	Existing Fill	Loose, gray-brown-black, F/M SAND, little Deleterious Materials (Ash, Glass, Plastic, Paper), trace (+) Silt, trace F. Gravel
5'								
	S-3	5-7'	24"	10"	2-6-1-4	2		Loose, brown, WOOD, little Silt, little F/M Sand, trace F. Gravel, trace (-) plastic, wet
	S-4A	7-8'	12"	12"	7-10		8'±	Medium dense, black, F/M SAND, some Deleterious Materials (Wood, Glass, Organic Fibers), little Silt, trace F. Gravel, wet
	S-4B	8-9'	12"	8"	11-12			Medium dense, gay, F/C SAND, little Silt, wet
10'								
	S-5	10-12'	24"	12"	WOH/12"-3-3	3	Natural Sand	Very loose, gray-tan, F/M SAND, little (-) F. Gravel, trace Silt, wet
							14'±	
15'								
	S-6	15-17'	24"	6"	2-1-3-4			Loose, tan, F/C SAND, some F/C Gravel, little Silt, wet
							Natural Sand and Gravel	
20'								
	S-7	20-22'	24"	10"	2-3-6-6			Loose, tan-light brown, F/C SAND and F/C GRAVEL, trace (+) Silt, wet
							23'±	
25'								
	S-8	25-27'	24"	14"	6-10-15-25		Natural Silty Sand and Gravel	Medium dense, gray-tan, F/M SAND, some (+) Silt, some (-) F/C Gravel
							cont. pg. 2	

Notes:
1) Auger grinding on possible cobbles and/or boulders observed from approximately 3± to 4± feet below ground surface (bgs).
2) Groundwater encountered at 5± feet bgs while sampling.
3) WOH = Weight of Hammer

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse

Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Boring No.: B-9
Page: 2 of 2
File No.: O438.00
Reviewed By: Glenn Olson, P.E.

Boring Co.	Drilex Environmental, Inc.	Date/Weather:	7-6-2021 / Overcast, 70s to 80s °F
Foreman:	Chris Hogan	Northeast Geotechnical Observer:	Christian Rice, P.E.
Boring Equipment:	Mobile B-57 Drill Rig	Test Boring Location:	See Exploration Location Plan
	4¼-inch I.D. Hollow-Stem Augers	Ground Surface Elevation:	220± feet
	2.0" O.D. Split Spoon, 140 lb Auto Hammer	Depth to Water:	5± feet

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
	S-9	30-32'	24"	14"	10-14-18-20		Nat. Silty S&G	Dense, gray-tan, F/M SAND, some Silt, little (+) F/C Gravel
						4	32'±	
								Bottom of boring at 32± feet
35'								
40'								
45'								
50'								
55'								

Notes:
4) Boring terminated at 32± feet below ground surface.

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse

Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

NORTHEAST GEOTECHNICAL, INC.

TEST BORING LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Boring No.: B-10
Page: 1 of 1
File No.: O438.00
Reviewed By: Glenn Olson, P.E.

Boring Co.: Drilex Environmental, Inc.
Foreman: Chris Hogan
Boring Equipment: Mobile B-57 Drill Rig, 4¼-inch I.D. HSA to 5', then 3-inch Diam. Casing w/ Roller Bit, 2.0" O.D. Split Spoon, 140 lb Auto Hammer

Date/Weather: 7-6-2021 / Overcast, 70s to 80s °F
Northeast Geotechnical Observer: Christian Rice, P.E.
Test Boring Location: See Exploration Location Plan
Ground Surface Elevation: 217± feet
Depth to Water: 4± feet

	Sample Data						Strata Change	Sample Description
	No.	Depth	Pen.	Rec.	Blows per 6 in.	Rem.		
	S-1A	0-0.5'	6"	3"	2		Existing Fill	Very loose, light brown, F/M SAND, some Silt, little F. Gravel, little Wood
	S-1B	0.5-2'	18"	12"	1-1-1			Very loose, brown, SILT and F/M SAND, little Roots
	S-2A	2-2.5'	6"	6"	4		2.5'±	Loose, brown, SILT and F. SAND, little Roots
	S-2B	2.5-4'	18"	18"	4-7-8		Natural Sand	Medium dense, light brown, F/C SAND, trace (+) Silt, trace F. Gravel
5'						1		
	S-3	5-7'	24"	19"	4-6-8-10			Medium dense, tan-light brown, F/C SAND, little (-) Silt, trace F. Gravel, wet
	S-4A	7-7.5'	6"	6"	12	2	7.5'±	Medium dense, light brown, F/C SAND, little (-) F/C Gravel, trace (+) Silt, wet
	S-4B	7.5-9'	18"	18"	24-30-38		Natural Sand and Gravel	Very dense, gray-tan, F/C SAND and F/C GRAVEL, little Silt, wet
10'								
	S-5	10-12'	24"	9"	13-14-8-10			Med. dense, gray-tan, F/C SAND, some F/C Gravel, trace (+) Silt, wet
15'	S-6	14-16'	24"	6"	5-5-5-7			Medium dense, gray-tan-light brown, F/C SAND, some (-) F/C Gravel, trace (+) Silt, wet
20'	S-7	19-21'	24"	0"	4-5-5-6			No recovery
						3	21'±	
25'								Bottom of boring at 21± feet

Notes:
1) Groundwater encountered at 4± feet below ground surface (bgs) while drilling.
2) Switch from hollow-stem augers to drive-and-wash drilling methods following S-4 sample.
3) Boring terminated at 21± feet bgs.

Standard Penetration Resistance (Blows/Foot)	Density
0 -4	Very Loose
4 - 10	Loose
10 - 30	Med. Dense
30 - 50	Dense
50+	Very Dense

Abbreviations
F = Fine
M = Medium
C = Coarse
F/M = Fine to Medium
F/C = Fine to Coarse

Proportions Used
Trace (T) = 0 - 10%
Little (Li) = 10 - 20%
Some (So) = 20 - 35%
AND = 35-50%

APPENDIX C

Test Pit Logs

NORTHEAST GEOTECHNICAL, INC.

TEST PIT LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Pit/Deep Observation Hole Number: TP-1

Subcontractor: Sidney Landscaping Services, Inc.
Operator: Sidney
Equipment: Caterpillar 320E LRR Excavator
Capacity/Reach: 1 CY Toothed Bucket / 22± feet

Date/Weather: 7-14-2021 / Overcast, 60s to 80s °F
Northeast Geotechnical Observer: Christian Rice, P.E.
Test Pit Location: See Exploration Location Plan
Ground Surface Elevation: 218± feet

Page: 1 of 1
File No. O438.00
Reviewed By: Glenn Olson, P.E.

Depth (in.)	Soil Horizon/Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments		Soil Structure	Soil Consistence (Moist)	Other
			Depth (in.)	Color	Percent		Gravel	Cobbles & Stones			
0 - 48	Cobbly/Stoney Fill	10YR/4/3	---	---	---	Very Gravelly/Cobbly Loamy Sand	40±%	30±%	Granular	Friable	Occasional boulders, occasional deleterious materials (brick, wood, metal)

Groundwater Observed: Yes
Depth Weeping from Pit: 18± inches (1.5± feet)
Depth Standing Water in Hole: 18± inches (1.5± feet)

Estimated Depth (Elevation) to Seasonal High Groundwater: 18± inches (El 216.5± feet)

Notes:

1) Test Pit Dimensions: 12± feet (N/S) x 5± feet (E/W)
2) Test pit terminated at 48± inches (4± feet) below ground surface (bgs). Unable to visually observe test pit deeper than 48± inches bgs due to groundwater filling test pit at fast rate.

NORTHEAST GEOTECHNICAL, INC.

TEST PIT LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Pit/Deep Observation Hole Number: TP-2

Subcontractor: Sidney Landscaping Services, Inc.
Operator: Sidney
Equipment: Caterpillar 320E LRR Excavator
Capacity/Reach: 1 CY Toothed Bucket / 22± feet

Date/Weather: 7-14-2021 / Overcast, 60s to 80s °F
Northeast Geotechnical Observer: Christian Rice, P.E.
Test Pit Location: See Exploration Location Plan
Ground Surface Elevation: 219± feet

Page: 1 of 1
File No. O438.00
Reviewed By: Glenn Olson, P.E.

Depth (in.)	Soil Horizon/Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments		Soil Structure	Soil Consistence (Moist)	Other
			Depth (in.)	Color	Percent		Gravel	Cobbles & Stones			
0 - 33	Organic Fill	10YR/2/2	---	---	---	Sandy Loam	5±%	5±%	Granular	Very Friable	Frequent roots/wood, trace metal/plastic
33 - 78	Natural Sand (C)	2.5Y/4/3	38	10YR/4/6	15±%	Sand	5±%	0%	Granular	Firm	Trace fine roots to 50± inches bgs

Groundwater Observed: Yes
Depth Weeping from Pit: 38± inches (3.2± feet)
Depth Standing Water in Hole: 52± inches (4.3± feet)

Estimated Depth (Elevation) to Seasonal High Groundwater: 38± inches (El 215.8± feet)

Notes:

1) Test Pit Dimensions: 4.5± feet (N/S) x 12± feet (E/W)
2) Test pit terminated at 72± inches (6± feet) below ground surface.

NORTHEAST GEOTECHNICAL, INC.

TEST PIT LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Pit/Deep Observation Hole Number: TP-3

Subcontractor: Sidney Landscaping Services, Inc.
Operator: Sidney
Equipment: Caterpillar 320E LRR Excavator
Capacity/Reach: 1 CY Toothed Bucket / 22± feet

Date/Weather: 7-14-2021 / Overcast, 60s to 80s °F
Northeast Geotechnical Observer: Christian Rice, P.E.
Test Pit Location: See Exploration Location Plan
Ground Surface Elevation: 219± feet

Page: 1 of 1
File No. O438.00
Reviewed By: Glenn Olson, P.E.

Depth (in.)	Soil Horizon/Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments		Soil Structure	Soil Consistence (Moist)	Other
			Depth (in.)	Color	Percent		Gravel	Cobbles & Stones			
0 - 9	Organic Fill	10YR/2/1	---	---	---	Sandy Loam	10±%	0%	Granular	Friable	Frequent roots
9 - 64	Granular Fill	5Y/3/1	---	---	---	Sand	15±%	5±%	Granular	Friable	Freq. deleter. materials (metal, wood, rubber)
64 - 70	Organic Fill (Former Topsoil)	10YR/2/1	---	---	---	Sandy Loam	0%	0%	Granular	Friable	Frequent roots
70 - 132	Granular Fill	5Y/3/1	---	---	---	Loamy Sand	15±%	5±%	Granular	Friable	Freq. deleter. materials (metal, wood, rubber)

Groundwater Observed: Yes
Depth Weeping from Pit: 38± inches (3.2± feet)
Depth Standing Water in Hole: 80± inches (6.7± feet)

Estimated Depth (Elevation) to Seasonal High Groundwater: 38± inches (El 218.8± feet)

Notes:

1) Test Pit Dimensions: 5± feet (N/S) x 13± feet (E/W)
2) Rubber tire encountered at approximately 120± inches (10± feet) below ground surface (bgs)
3) Test pit terminated upon soils caving in at approximately 132± inches (11± feet) bgs.

NORTHEAST GEOTECHNICAL, INC.

TEST PIT LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Pit/Deep Observation Hole Number: TP-4

Subcontractor: Sidney Landscaping Services, Inc.
Operator: Sidney
Equipment: Caterpillar 320E LRR Excavator
Capacity/Reach: 1 CY Toothed Bucket / 22± feet

Date/Weather: 7-14-2021 / Overcast, 60s to 80s °F
Northeast Geotechnical Observer: Christian Rice, P.E.
Test Pit Location: See Exploration Location Plan
Ground Surface Elevation: 215.5± feet

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File No. O438.00
Reviewed By: Glenn Olson, P.E.

Depth (in.)	Soil Horizon/Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments		Soil Structure	Soil Consistence (Moist)	Other
			Depth (in.)	Color	Percent		Gravel	Cobbles & Stones			
0 - 44	Organic Fill	5YR/2.5/1	---	---	---	Sandy Loam	10±%	5±%	Granular	Very Friable	Frequent roots, occasional deleterious materials (wood, stumps, plastic, brick), organic/trash odor
44 - 84	Granular Fill	7.5YR/2.5/3	---	---	---	Loamy Sand	10±%	10±%	Granular	Friable	Occasional deleterious materials (plastic, wires, metal), organic/trash odor
84 - 102	Natural Sand (C)	10YR/3/2	---	---	---	Sandy Loam	10%±	5%±	Granular	Friable	

Groundwater Observed: Yes
Depth Weeping from Pit: 44± inches (3.7± feet)
Depth Standing Water in Hole: 62± inches (5.2± feet)

Estimated Depth (Elevation) to Seasonal High Groundwater: 44± inches (El 211.8± feet)

Notes:

1) Test Pit Dimensions: 15± feet (N/S) x 8± feet (E/W)
2) Test pit terminated upon soils caving in at approximately 102± inches (8.5± feet) below ground surface.

NORTHEAST GEOTECHNICAL, INC.

TEST PIT LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Pit/Deep Observation Hole Number: TP-5

Subcontractor: Sidney Landscaping Services, Inc.
Operator: Sidney
Equipment: Caterpillar 320E LRR Excavator
Capacity/Reach: 1 CY Toothed Bucket / 22± feet

Date/Weather: 7-14-2021 / Overcast, 60s to 80s °F
Northeast Geotechnical Observer: Christian Rice, P.E.
Test Pit Location: See Exploration Location Plan
Ground Surface Elevation: 215± feet

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File No. O438.00
Reviewed By: Glenn Olson, P.E.

Depth (in.)	Soil Horizon/Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments		Soil Structure	Soil Consistence (Moist)	Other
			Depth (in.)	Color	Percent		Gravel	Cobbles & Stones			
0 - 17	Organic Fill	7.5YR/2.5/2	---	---	---	Sandy Loam	5±%	0%	Granular	Very Friable	Frequent roots, occasional stumps
17 - 96	Natural Sand (C)	5Y/4/2	---	---	---	Loamy Sand	5±%	5±%	Granular	Friable	

Groundwater Observed: Yes
Depth Weeping from Pit: 38± inches (3.2± feet)
Depth Standing Water in Hole: 44± inches (3.7± feet)

Estimated Depth (Elevation) to Seasonal High Groundwater: 38± inches (El 211.8± feet)

Notes:

1) Test Pit Dimensions: 5feet (N/S) x 13± feet (E/W)
2) Test pit terminated upon soils caving in at approximately 96± inches (8± feet) below ground surface.

NORTHEAST GEOTECHNICAL, INC.

TEST PIT LOG

Project: Proposed Ayer Commons Multi-Family Housing, 65 Fitchburg Road, Ayer, MA

Test Pit No.: TP-6
Page: 1 of 1
File No.: O438.00
Reviewed By: Glenn Olson, P.E.

Subcontractor: Sidney Landscaping Services, Inc.
Operator: Sidney
Equipment: Caterpillar 320E LRR Excavator
Capacity/Reach: 1 CY Toothed Bucket / 22± feet

Date/Weather: 7-14-2021 / Overcast, 60s to 80s °F
Northeast Geotechnical Observer: Christian Rice, P.E.
Test Pit Location: See Exploration Location Plan
Ground Surface Elevation: 220± feet
Depth to Water: 6± feet

Depth	Strata Change	Soil Description (Burmister Identification System)	Excavation Effort	Boulder Count	Note No.
	Wood Chips, 0.5'±	6 inches WOOD CHIPS	E	0	
1'					
2'	Existing Fill	Gray-tan-brown, F/M SAND, some Deleterious Materials (Wood, Roots, Plastic, Wires, Rubber Blasting Mat at 2.5± feet bgs), little to some F/C Gravel, little Silt, trace to little Cobbles, moist	M	0	
3'					
4'	4'±				
	Former Topsoil	Dark brown, SILT, some Roots, trace F. Sand, moist	E	0	
5'	5'±				
6'	Natural Sand	Gray-tan-rust, F/M SAND, trace (+) Silt, moist to wet	E/M	0	1
7'	7'±				2
8'		Bottom of test pit at 7± feet			
9'					
10'					
11'					
12'					
13'					
14'					
15'					

Notes:
1. Groundwater encountered at 6± feet below ground surface (bgs).
2. Test pit termintaed at 7± feet bgs.

Test Pit Dimensions	Boulder Classification		Proportions Used	Abbreviations	Excavation Effort
N/S = 11± feet	Diameter	Class	Trace (T): 0-10%	F = Fine	E = Easy
	6" - 18"	A	Little (Li): 10-20%	M = Medium	M = Moderate
E/W = 6± feet	18" - 36"	B	Some (So): 20-35%	C = Coarse	D = Difficult
	>36"	C	And: 35-50%	F/M = Fine to Medium	

NORTHEAST GEOTECHNICAL, INC.

TEST PIT LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Pit No.: TP-7
Page: 1 of 1
File No.: O438.00
Reviewed By: Glenn Olson, P.E.

Subcontractor: Sidney Landscaping Services, Inc.
Operator: Sidney
Equipment: Caterpillar 320E LRR Excavator
Capacity/Reach: 1 CY Toothed Bucket / 22± feet

Date/Weather: 7-14-2021 / Overcast, 60s to 80s °F
Northeast Geotechnical Observer: Christian Rice, P.E.
Test Pit Location: See Exploration Location Plan
Ground Surface Elevation: 220± feet
Depth to Water: 2± feet (perched)

Depth	Strata Change	Soil Description (Burmister Identification System)	Excavation Effort	Boulder Count	Note No.
1'	Wood Chips 0.8'±	10 inches WOOD CHIPS	E	0	
2'	Existing Fill	Gray-brown-tan, F/M SAND, trace to some Silt, trace to some F/C Gravel, little Deleterious Materials (Metal, Plastic, Brick, Wood Stumps, Roots), trace Cobbles, moist to wet	M	5± (Class A)	1
3'					
4'					
5'	5.5'±				
6'	Former Topsoil 6.3'±	Dark brown, SILT, some Roots, trace F. Sand	E	0	
7'	Natural Sand 7.4'±	Tan-rust, F/M SAND, trace (+) Silt, trace F. Gravel	E/M	0	2
8'					
9'					
10'					
11'					
12'					
13'					
14'					
15'					

Notes:
1. Perched groundwater encountered at 2± feet below ground surface (bgs). Free groundwater table not encountered.
2. Test pit terminated at 7.4± feet bgs.

Test Pit Dimensions	Boulder Classification		Proportions Used	Abbreviations	Excavation Effort
N/S = 14± feet	Diameter	Class	Trace (T): 0-10%	F = Fine	E = Easy
	6" - 18"	A	Little (Li): 10-20%	M = Medium	M = Moderate
E/W = 4.5± feet	18" - 36"	B	Some (So): 20-35%	C = Coarse	D = Difficult
	>36"	C	And: 35-50%	F/M = Fine to Medium	

NORTHEAST GEOTECHNICAL, INC.

TEST PIT LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Pit No.: TP-8
Page: 1 of 1
File No.: O438.00
Reviewed By: Glenn Olson, P.E.

Subcontractor: Sidney Landscaping Services, Inc.
Operator: Sidney
Equipment: Caterpillar 320E LRR Excavator
Capacity/Reach: 1 CY Toothed Bucket / 22± feet

Date/Weather: 7-14-2021 / Overcast, 60s to 80s °F
Northeast Geotechnical Observer: Christian Rice, P.E.
Test Pit Location: See Exploration Location Plan
Ground Surface Elevation: 219± feet
Depth to Water: 5.3± feet

Depth	Strata Change	Soil Description (Burmister Identification System)	Excavation Effort	Boulder Count	Note No.
1'	Organic Fill 0.8'±	Brown, F/M SAND and SILT, little Roots, little F/C Gravel, moist	E	0	
2'	Granular Existing Fill 2'±	Tan, F/M SAND, trace Silt, trace F. Gravel, moist	E	0	
3'	Organic Fill	Dark brown-black, SILT, some F/M Sand, little Deleterious Materials (Wood, Roots, Stumps, Brick, String, Plastic), trace F/C Gravel, trace Cobbles, moist to wet	E	0	1
4'					
5'					
6'					
7'	7'±				
8'	Natural Sand 8'±	Rust-tan, F/M SAND, trace (+) Silt, wet	E	0	2
9'					
10'					
11'					
12'					
13'					
14'					
15'					

Notes:
1. Groundwater encountered at 5.3± feet below ground surface (bgs).
2. Test pit terminated at 8± feet bgs.

Test Pit Dimensions	Boulder Classification		Proportions Used	Abbreviations	Excavation Effort
N/S = 4± feet	Diameter	Class	Trace (T): 0-10%	F = Fine	E = Easy
	6" - 18"	A	Little (Li): 10-20%	M = Medium	M = Moderate
E/W = 14± feet	18" - 36"	B	Some (So): 20-35%	C = Coarse	D = Difficult
	>36"	C	And: 35-50%	F/M = Fine to Medium	

NORTHEAST GEOTECHNICAL, INC.

TEST PIT LOG

Project: Proposed Ayer Commons
Multi-Family Housing
65 Fitchburg Road
Ayer, MA

Test Pit No.: TP-9
Page: 1 of 1
File No.: O438.00
Reviewed By: Glenn Olson, P.E.

Subcontractor: Sidney Landscaping Services, Inc.
Operator: Sidney
Equipment: Caterpillar 320E LRR Excavator
Capacity/Reach: 1 CY Toothed Bucket / 22± feet

Date/Weather: 7-14-2021 / Overcast, 60s to 80s °F
Northeast Geotechnical Observer: Christian Rice, P.E.
Test Pit Location: See Exploration Location Plan
Ground Surface Elevation: 219± feet
Depth to Water: 4.3± feet

Depth	Strata Change	Soil Description (Burmister Identification System)	Excavation Effort	Boulder Count	Note No.
1'	Organic Fill 0.6'±	Dark brown, F/M SAND and SILT, little F/C Gravel, little Roots, trace Cobbles, moist	E	0	
2'	Existing Fill	Gray-tan-brown, F/M SAND, some F/C Gravel, little Silt, little Deleterious Materials (Wood, Metal, Rubber Tire), trace Cobbles, moist			
3'			E	0	
4'	4'±				
5'	Natural Sand 4.7'±	Gray-tan, F/M SAND, trace Silt, wet	E	0	1 2
6'					
7'					
8'					
9'					
10'					
11'					
12'					
13'					
14'					
15'					

Notes:
1. Groundwater encountered at 4.3± feet below ground surface (bgs).
2. Test pit terminated at 4.7± feet bgs.

Test Pit Dimensions	Boulder Classification		Proportions Used	Abbreviations	Excavation Effort
N/S =	Diameter	Class	Trace (T): 0-10%	F = Fine	E = Easy
	6" - 18"	A	Little (Li): 10-20%	M = Medium	M = Moderate
E/W =	18" - 36"	B	Some (So): 20-35%	C = Coarse	D = Difficult
	>36"	C	And: 35-50%	F/M = Fine to Medium	

APPENDIX D

Test Pit Photos

NORTHEAST GEOTECHNICAL, INC.

Photograph #1

Description of Photograph:
Test Pit TP-1

Photograph Taken By:
Christian Rice dated 7-14-21

Photograph #2

Description of Photograph:
Test Pit TP-2

Photograph Taken By:
Christian Rice dated 7-14-21

Photograph #3

Description of Photograph:
Test Pit TP-3

Photograph Taken By:
Christian Rice dated 7-14-21

Photograph #4

Description of Photograph:
Test Pit TP-4

Photograph Taken By:
Christian Rice dated 7-14-21

Photograph #5

Description of Photograph:
Test Pit TP-5

Photograph Taken By:
Christian Rice dated 7-14-21

Photograph #6

Description of Photograph:
Test Pit TP-6

Photograph Taken By:
Christian Rice dated 7-14-21

Photograph #7

Description of Photograph:
Test Pit TP-7

Photograph Taken By:
Christian Rice dated 7-14-21

Photograph #8

Description of Photograph:
Test Pit TP-8

Photograph Taken By:
Christian Rice dated 7-14-21

Photograph #9

Description of Photograph:
Test Pit TP-9

Photograph Taken By:
Christian Rice dated 7-14-21

APPENDIX E

Laboratory Soil Test Results

THIELSCH ENGINEERING
195 Frances Avenue
Cranston RI, 02910
Phone: (401)-467-6454
Fax: (401)-467-2398
thielsch.com
Let's Build a Solid Foundation

Client Information:
Northeast Geotechnical Inc.
North Attleborough, MA
PM: Glenn Olson
Assigned By: Glenn Olson
Collected By: Glenn Olson

Project Information:
Ayer Commons
65 Fitchburg Road, Ayer, MA
NEG Project Number: O438.00
Summary Page: 1 of 1
Report Date: 07.21.21

LABORATORY TESTING DATA SHEET, Report No.: 7421-G-160

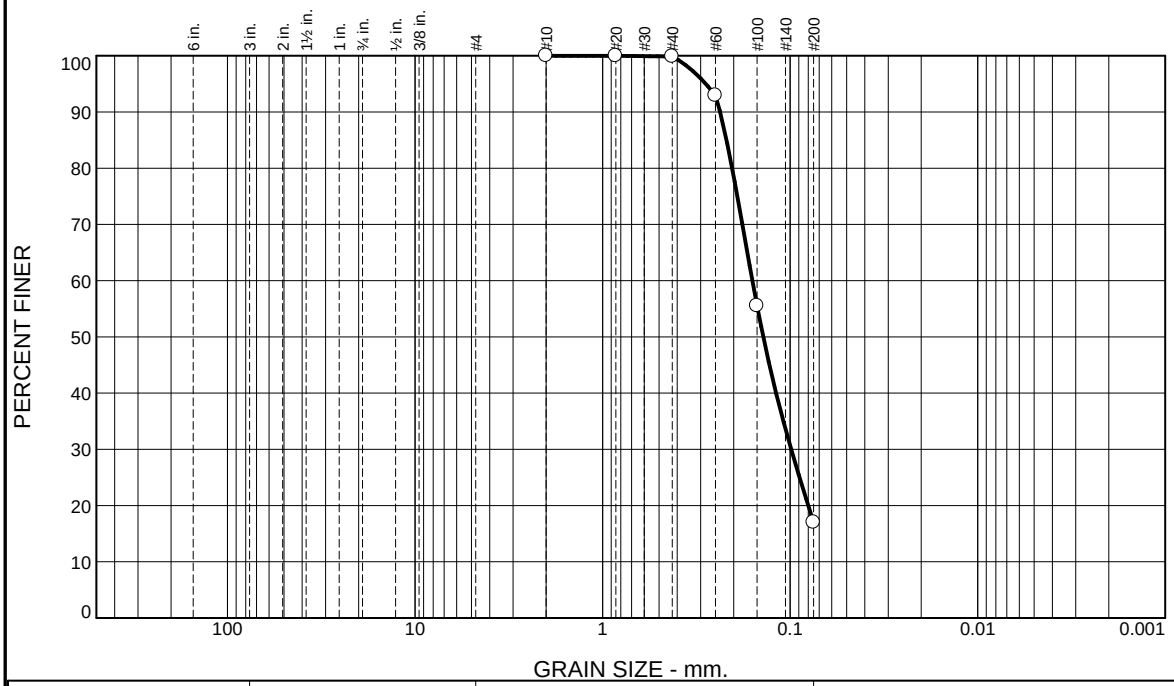
Boring No.	Sample No.	Depth (Ft)	Laboratory No.	Identification Tests								Proctor / CBR / Permeability Tests								Laboratory Log and Soil Description
				As Received Moisture Content %	LL %	PL %	Gravel %	Sand %	Fines %	Org. %	G_s	Dry unit wt. pcf	Test Moisture Content %	γ_d MAX (pcf) / W_{opt} (%)	γ_d MAX (pcf) / W_{opt} (%) (Corr.)	Target Test Setup as % of Proctor	CBR @ 0.1"	CBR @ 0.2"	Permeability cm/sec	
				D2216	D4318		D6913			D2974	D854			D1557						
B-1	S-6	14-16	21-S-2890				0.0	83.0	17.0											Light Brown silty sand
B-3	S-3	5-7	21-S-2891				0.0	88.7	11.3											Light Brown poorly graded sand with silt
B-4	S-4	7-9	21-S-2892				0.0	93.9	6.1											Brown poorly graded sand with silt
B-5	S-6	14-16	21-S-2893				7.8	90.7	1.5											Brown poorly graded sand
B-7	S-4B	8.5-9	21-S-2894				0.0	94.3	5.7											Brown poorly graded sand with silt
B-9	S-5	10-12	21-S-2895				11.7	85.6	2.7											Brown poorly graded sand

Date Received: *07.19.21*

Reviewed By: SAH

Date Reviewed: *07.22.21*

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	0.1	82.9	17.0	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#10	100.0		
#20	100.0		
#40	99.9		
#60	92.9		
#100	55.5		
#200	17.0		

* (no specification provided)

Material Description

Light Brown silty sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.2364 D_{85}= 0.2184 D_{60}= 0.1589
D_{50}= 0.1390 D_{30}= 0.0987 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 7.19.21 **Date Tested:** 7.21.21

Tested By: MS

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Boring **Depth:** 14'-16' **Date Sampled:**
Sample Number: B-1 / S-6

Thielsch Engineering Inc.

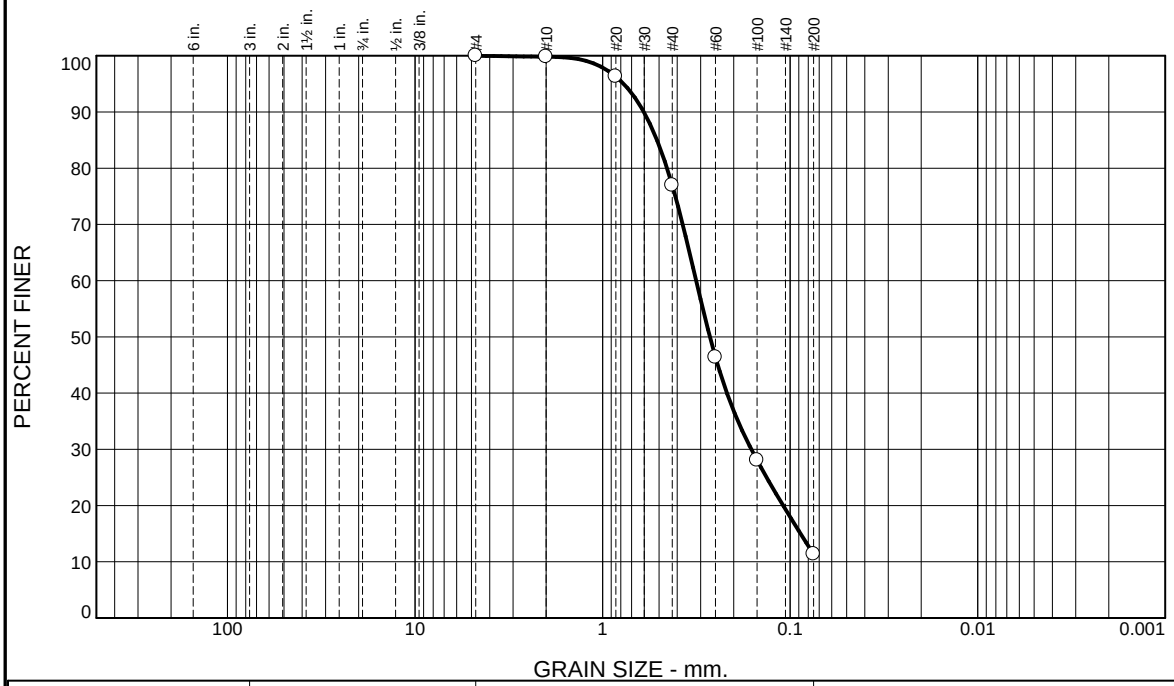
Cranston, RI

Client: Northeast Geotechnical Inc.

Project: Ayer Commons
65 Fitchburg Road, Ayer, MA

Project No: O438.00 **Figure** 21-S-2890

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	22.8	65.7	11.3	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.8		
#20	96.3		
#40	77.0		
#60	46.4		
#100	28.1		
#200	11.3		

* (no specification provided)

Material Description

Light Brown poorly graded sand with silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-2-4(0)

Coefficients

D_{90}= 0.6024 D_{85}= 0.5126 D_{60}= 0.3170
D_{50}= 0.2676 D_{30}= 0.1609 D_{15}= 0.0880
D_{10}= C_u= C_c=

Remarks

Date Received: 7.19.21 **Date Tested:** 7.21.21

Tested By: MS

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Boring **Depth:** 5'-7' **Date Sampled:**
Sample Number: B-3 / S-3

Thielsch Engineering Inc.

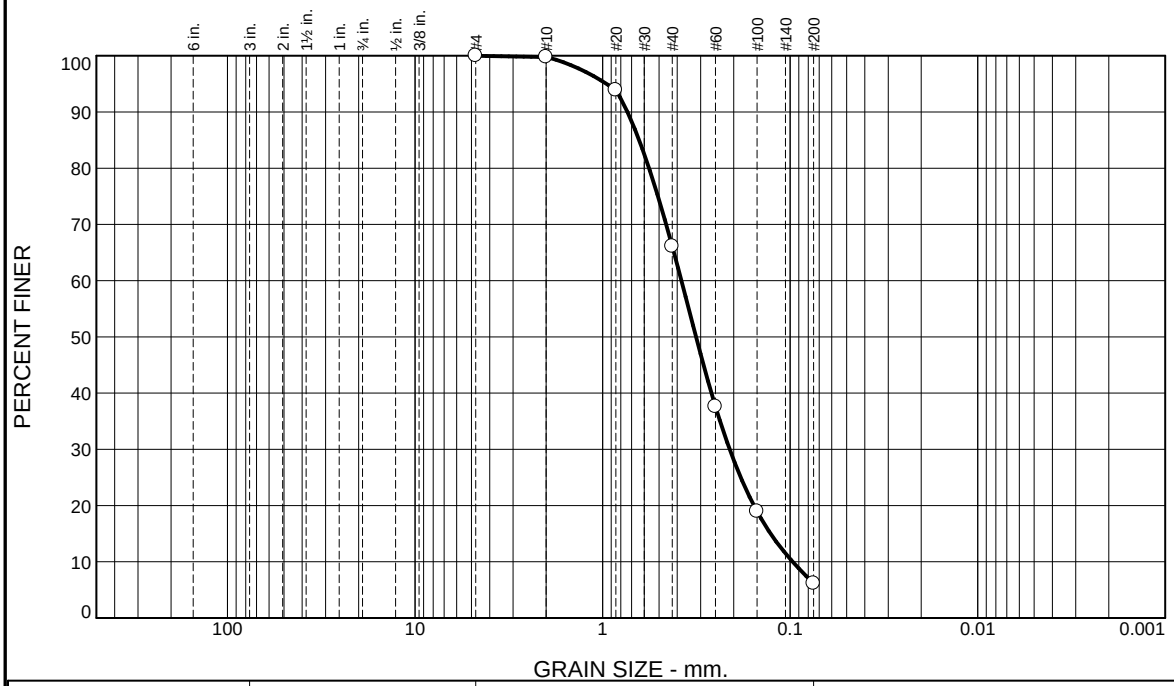
Cranston, RI

Client: Northeast Geotechnical Inc.

Project: Ayer Commons
65 Fitchburg Road, Ayer, MA

Project No: O438.00 **Figure** 21-S-2891

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.2	33.7	60.0	6.1	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.8		
#20	93.9		
#40	66.1		
#60	37.6		
#100	19.0		
#200	6.1		

* (no specification provided)

Material Description

Brown poorly graded sand with silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.7373 D_{85}= 0.6387 D_{60}= 0.3799
D_{50}= 0.3174 D_{30}= 0.2100 D_{15}= 0.1270
D_{10}= 0.0969 C_u= 3.92 C_c= 1.20

Remarks

Date Received: 7.19.21 **Date Tested:** 7.21.21

Tested By: MS

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Boring **Depth:** 7'-9' **Date Sampled:**
Sample Number: B-4 / S-4

Thielsch Engineering Inc.

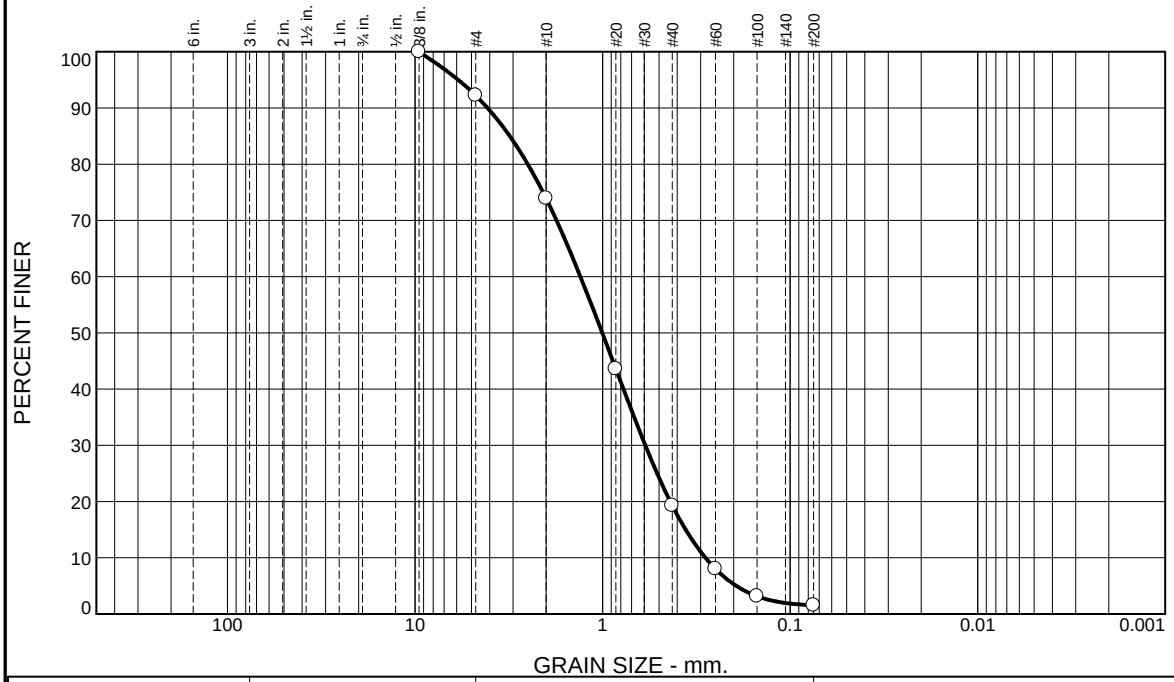
Cranston, RI

Client: Northeast Geotechnical Inc.

Project: Ayer Commons
65 Fitchburg Road, Ayer, MA

Project No: O438.00 **Figure** 21-S-2892

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	7.8	18.3	54.6	17.8	1.5	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.375"	100.0		
#4	92.2		
#10	73.9		
#20	43.6		
#40	19.3		
#60	8.0		
#100	3.2		
#200	1.5		

* (no specification provided)

Material Description

Brown poorly graded sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 4.1038 D_{85}= 3.1255 D_{60}= 1.3131
D_{50}= 1.0045 D_{30}= 0.5918 D_{15}= 0.3607
D_{10}= 0.2829 C_u= 4.64 C_c= 0.94

Remarks

Date Received: 7.19.21 **Date Tested:** 7.21.21

Tested By: MS

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Boring **Depth:** 14'-16' **Date Sampled:**
Sample Number: B-5 / S-6

Thielsch Engineering Inc.

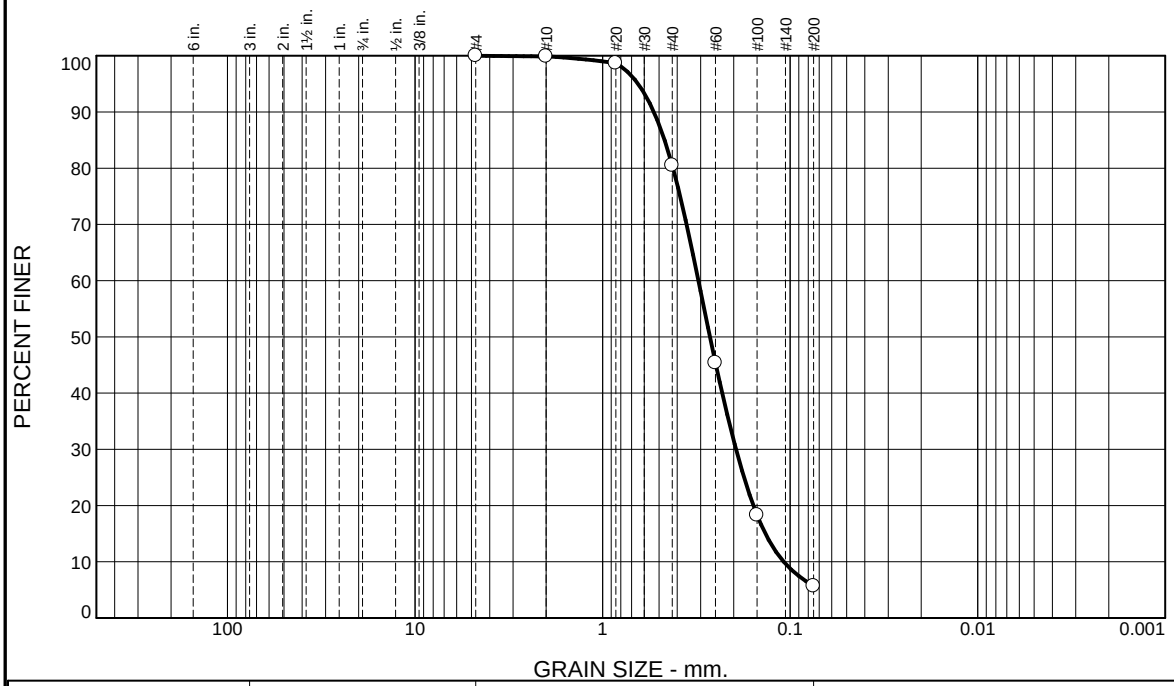
Cranston, RI

Client: Northeast Geotechnical Inc.

Project: Ayer Commons
65 Fitchburg Road, Ayer, MA

Project No: O438.00 **Figure** 21-S-2893

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.1	19.4	74.8	5.7	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
#4	100.0		
#10	99.9		
#20	98.7		
#40	80.5		
#60	45.4		
#100	18.3		
#200	5.7		

* (no specification provided)

Material Description

Brown poorly graded sand with silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.5328 D_{85}= 0.4669 D_{60}= 0.3083
D_{50}= 0.2675 D_{30}= 0.1942 D_{15}= 0.1355
D_{10}= 0.1083 C_u= 2.85 C_c= 1.13

Remarks

Date Received: 7.19.21 **Date Tested:** 7.21.21

Tested By: MS

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Boring **Depth:** 8.5'-9' **Date Sampled:**
Sample Number: B-7 / S-4B

Thielsch Engineering Inc.

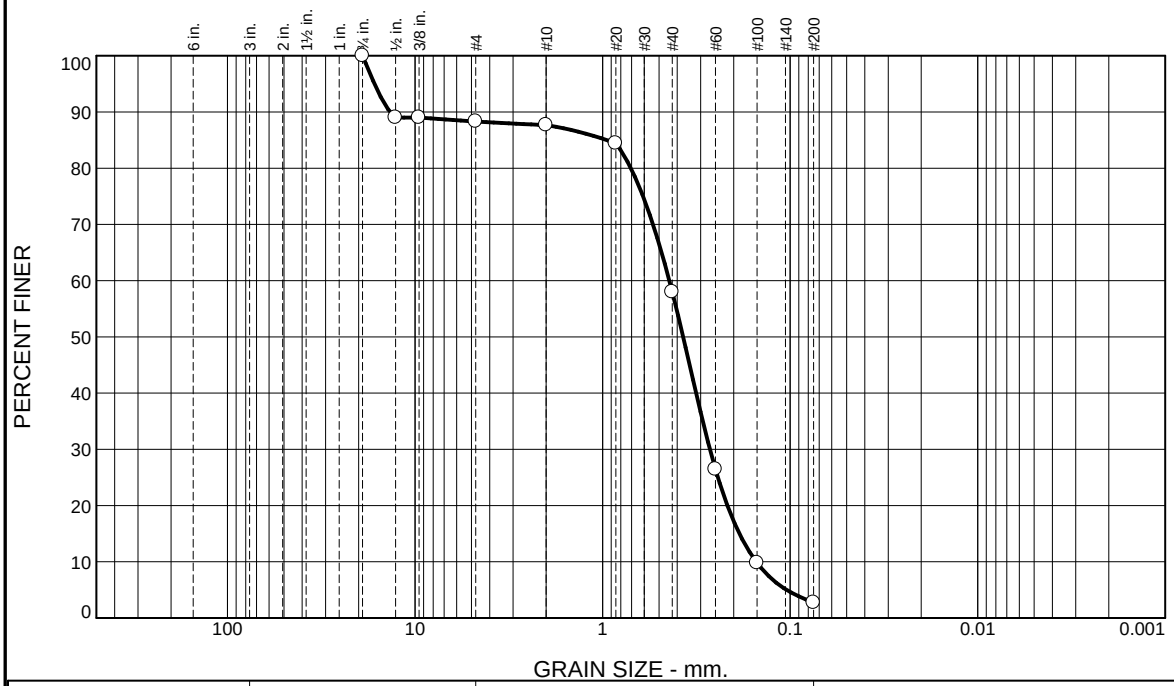
Cranston, RI

Client: Northeast Geotechnical Inc.

Project: Ayer Commons
65 Fitchburg Road, Ayer, MA

Project No: O438.00 **Figure** 21-S-2894

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	11.7	0.6	29.7	55.3	2.7	

Test Results (D6913 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.75"	100.0		
0.5"	89.0		
0.375"	89.0		
#4	88.3		
#10	87.7		
#20	84.4		
#40	58.0		
#60	26.4		
#100	9.8		
#200	2.7		

* (no specification provided)

Material Description

Brown poorly graded sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 13.5902 D_{85}= 0.9505 D_{60}= 0.4405
D_{50}= 0.3720 D_{30}= 0.2676 D_{15}= 0.1864
D_{10}= 0.1515 C_u= 2.91 C_c= 1.07

Remarks

Date Received: 7.19.21 **Date Tested:** 7.21.21

Tested By: MS

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Boring **Depth:** 10'-12' **Date Sampled:**
Sample Number: B-9 / S-5

Thielsch Engineering Inc.

Cranston, RI

Client: Northeast Geotechnical Inc.

Project: Ayer Commons
65 Fitchburg Road, Ayer, MA

Project No: O438.00 **Figure** 21-S-2895

THIELSCH ENGINEERING
195 Frances Avenue
Cranston RI, 02910
Phone: (401)-467-6454
Fax: (401)-467-2398
thielsch.com
Let's Build a Solid Foundation

Client Information:
Northeast Geotechnical Inc.
North Attleborough, MA
PM: Glenn Olson
Assigned By: Christian Rice
Collected By: Christian Rice

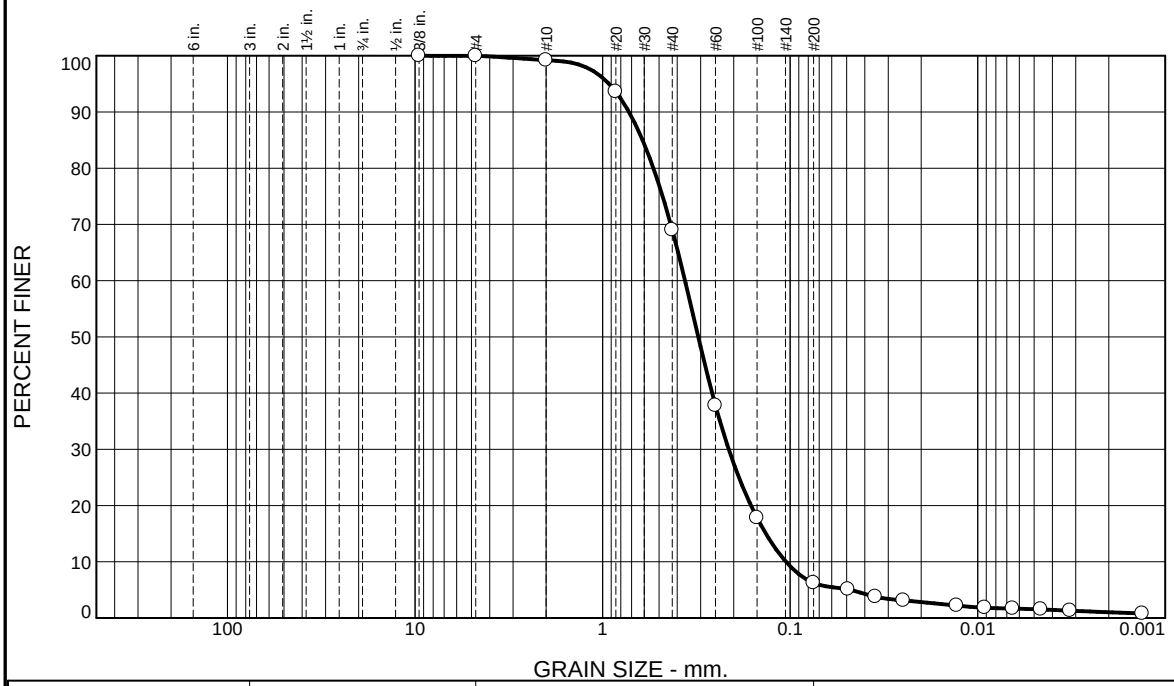
Project Information:
Ayer Commons
65 Fitchburg Road, Ayer, MA
NEG Project Number: O438.00
Summary Page: 1 of 1
Report Date: 07.28.21

LABORATORY TESTING DATA SHEET, Report No.: 7421-G-173

Test Pit No.	Source	Depth (Ft)	Laboratory No.	Identification Tests								Proctor / CBR / Permeability Tests								Laboratory Log and Soil Description
				As Received Moisture Content %	LL %	PL %	Gravel %	Sand %	Fines %	Org. %	G_s	Dry unit wt. pcf	Test Moisture Content %	γ_d MAX (pcf) / W_{opt} (%)	γ_d MAX (pcf) / W_{opt} (%) (Corr.)	Target Test Setup as % of Proctor	CBR @ 0.1"	CBR @ 0.2"	Permeability cm/sec	
				D2216	D4318		D6913			D2974	D854			D1557						
TP-2	Natural Sand	3-4.5	21-S-2918				0.0	93.8	6.2											Light Brown sand
TP-3	Existing Fill	1-2.5	21-S-2919				2.2	95.5	2.3											Brown sand
TP-5	Natural Sand	2-4	21-S-2920				26.9	61.2	11.9											Brown loamy sand

Date Received: 07.21.21 Reviewed By: Date Reviewed: 07.28.21

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.8	30.2	62.8	5.2	1.0

Test Results (D7928 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.375"	100.0		
#4	100.0		
#10	99.2		
#20	93.6		
#40	69.0		
#60	37.8		
#100	17.8		
#200	6.2		
0.0492 mm.	5.1		
0.0351 mm.	3.8		
0.0249 mm.	3.1		
0.0129 mm.	2.2		
0.0092 mm.	1.8		
0.0065 mm.	1.7		
0.0046 mm.	1.5		
0.0032 mm.	1.3		
0.0013 mm.	0.8		

* (no specification provided)

Material Description

Light Brown sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP-SM **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 0.7234 D_{85}= 0.6122 D_{60}= 0.3635
D_{50}= 0.3088 D_{30}= 0.2125 D_{15}= 0.1346
D_{10}= 0.1053 C_u= 3.45 C_c= 1.18

Remarks

Date Received: 07.21.21 **Date Tested:** 07.26.21

Tested By: JM / RR / MS

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Test Pits **Depth:** 3-4.5' **Date Sampled:**
Sample Number: TP-2

Thielsch Engineering Inc.

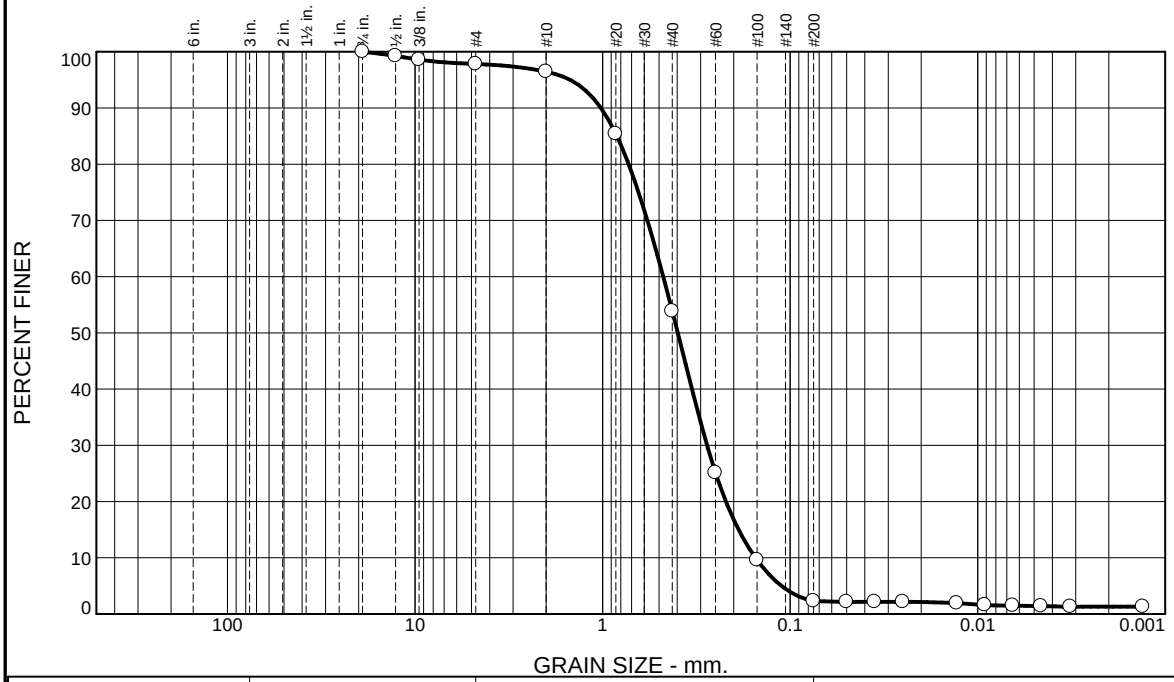
Cranston, RI

Client: Northeast Geotechnical Inc.

Project: Ayer Commons
65 Fitchburg Road, Ayer, MA

Project No: O438.00 **Figure** 21-S-2918

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	2.2	1.3	42.6	51.6	1.0	1.3

Test Results (D7928 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
0.75"	100.0		
0.5"	99.3		
0.375"	98.6		
#4	97.8		
#10	96.5		
#20	85.4		
#40	53.9		
#60	25.1		
#100	9.6		
#200	2.3		
0.0500 mm.	2.2		
0.0354 mm.	2.2		
0.0250 mm.	2.2		
0.0129 mm.	1.9		
0.0092 mm.	1.6		
0.0065 mm.	1.5		
0.0046 mm.	1.4		
0.0032 mm.	1.3		
0.0013 mm.	1.3		

* (no specification provided)

Material Description

Brown sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SP **AASHTO (M 145)=** A-3

Coefficients

D_{90}= 1.0212 D_{85}= 0.8391 D_{60}= 0.4747
D_{50}= 0.3971 D_{30}= 0.2771 D_{15}= 0.1884
D_{10}= 0.1530 C_u= 3.10 C_c= 1.06

Remarks

Date Received: 07.21.21 **Date Tested:** 07.26.21

Tested By: JM / RR / MS

Checked By: Steven Accetta

Title: Laboratory Coordinator

Source of Sample: Test Pits **Depth:** 1-2.5' **Date Sampled:**
Sample Number: TP-3

Thielsch Engineering Inc.

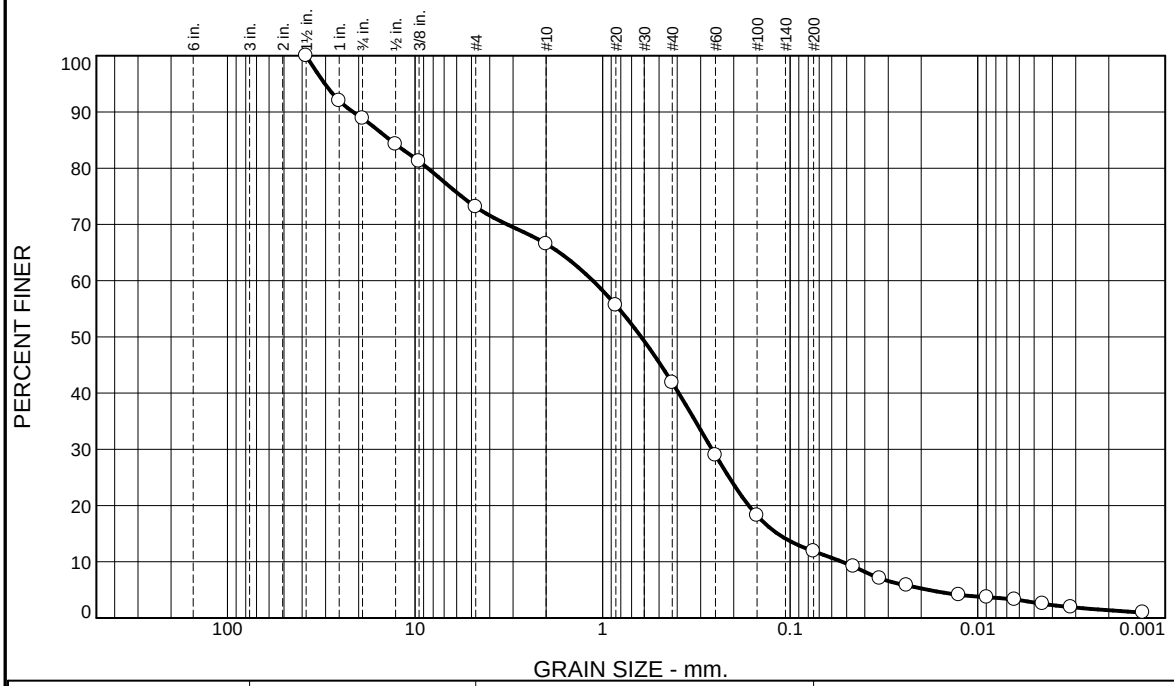
Cranston, RI

Client: Northeast Geotechnical Inc.

Project: Ayer Commons
65 Fitchburg Road, Ayer, MA

Project No: O438.00 **Figure** 21-S-2919

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	11.1	15.8	6.6	24.7	29.9	10.5	1.4

Test Results (D7928 & ASTM D 1140)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1-1/2"	100.0		
1"	92.0		
3/4"	88.9		
1/2"	84.3		
3/8"	81.2		
#4	73.1		
#10	66.5		
#20	55.6		
#40	41.8		
#60	29.0		
#100	18.2		
#200	11.9		
0.0460 mm.	9.2		
0.0333 mm.	7.1		
0.0239 mm.	5.8		
0.0126 mm.	4.1		
0.0089 mm.	3.7		
0.0063 mm.	3.3		
0.0045 mm.	2.5		
0.0032 mm.	1.9		
0.0013 mm.	1.0		

* (no specification provided)

Material Description

Brown loamy sand

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SW-SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 21.3837 D_{85}= 13.5661 D_{60}= 1.1273
D_{50}= 0.6230 D_{30}= 0.2608 D_{15}= 0.1165
D_{10}= 0.0527 C_u= 21.38 C_c= 1.14

Remarks

Date Received: 07.21.21 **Date Tested:** 07.26.21

Tested By: JM / RR / MS

Checked By: Steven Accetta

Title: Laboratory Coordinator

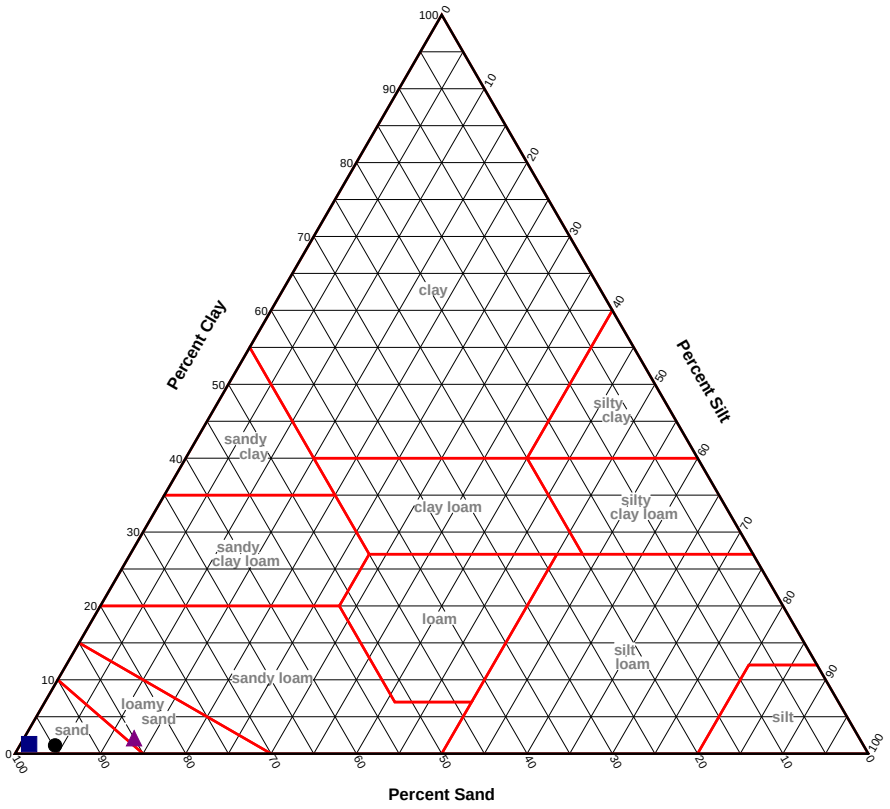
Source of Sample: Test Pits **Depth:** 2-4' **Date Sampled:**
Sample Number: TP-5

Thielsch Engineering Inc.

Cranston, RI

Client: Northeast Geotechnical Inc.
Project: Ayer Commons
65 Fitchburg Road, Ayer, MA
Project No: O438.00 **Figure** 21-S-2920

USDA Soil Classification



SOIL DATA

	Source	Sample No.	Depth	Percentages From Material Passing a #10 Sieve			Classification
				Sand	Silt	Clay	
●	Test Pits	TP-2	3-4.5'	94.7	4.3	1.0	Sand
■	Test Pits	TP-3	1-2.5'	97.7	0.9	1.3	Sand
▲	Test Pits	TP-5	2-4'	85.0	12.9	2.1	Loamy sand

Thielsch Engineering Inc.

Cranston, RI

Client: Northeast Geotechnical Inc.

Project: Ayer Commons
65 Fitchburg Road, Ayer, MA

Project No.: O438.00 **Figure** 2918 to 2920

Checked By: sa

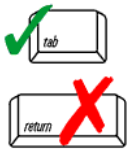
STORMWATER REPORT CHECKLIST

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.

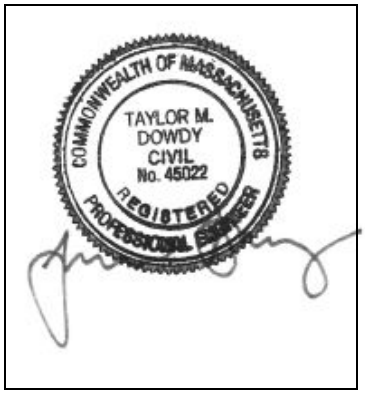
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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



Taylor M. Dowdy, P.E. 06/14/2022
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.

Pond 1P Mounding - Input Values

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)	
11.6	0	0	219	0	0	0	
11.65	0.01	0	219	0.01	0.01	0	48085 Impervious Surface (sft)
11.7	0.01	0	219	0.01	0.01	0	(see HydroCAD)
11.75	0.01	0	219	0.01	0.01	0	0.05519 Required recharge volume (acre-ft)
11.8	0.01	0	219	0.01	0.01	0	(0.60" for HSG-A)
11.85	0.02	0	219	0.02	0.02	0	0.009 Average infiltration rate (cfs)
11.9	0.02	0	219	0.02	0.02	0	
11.95	0.03	0	219	0.03	0.03	0	798.65 Average infiltration rate (cft/day)
12	0.05	0	219	0.05	0.05	0	
12.05	0.07	0	219	0.07	0.07	0	12962.5 System bottom area (sft)
12.1	0.09	0	219	0.09	0.09	0	(85'x152.5')
12.15	0.12	0	219	0.12	0.12	0	
12.2	0.16	0	219	0.16	0.16	0	0.062 Recharge/infiltration rate (ft/day)
12.25	0.21	0	219	0.21	0.21	0	
--- Full tabular hydrograph data not shown for brevity; refer to HydroCAD output ---							11.65 Infiltration start time
23.5	0.01	0	219	0	0	0	
23.55	0.01	0	219	0.03	0.03	0	24.15 Infiltration end time
23.6	0.01	0	219	0	0	0	
23.65	0.01	0	219	0.03	0.03	0	12.5 Time (hrs)
23.7	0.01	0	219	0	0	0	
23.75	0.01	0	219	0.03	0.03	0	0.521 Time (days)
23.8	0.01	0	219	0	0	0	
23.85	0.01	0	219	0.03	0.03	0	39 Hydraulic conductivity (ft/day)
23.9	0.01	0	219	0	0	0	("Medium Sand" per DEP Brainshark table)
23.95	0.01	0	219	0.03	0.03	0	0.222 Specific yield
24	0.01	0	219	0	0	0	("Sand" per DEP Brainshark table)
24.05	0.01	0	219	0.02	0.02	0	22 Initial saturated thickness (ft)
24.1	0	0	219	0	0	0	
24.15	0	0	219	0.01	0.01	0	Legend:
24.2	0	0	219	0	0	0	= user-supplied values
							= input values in Results sheet

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
0.0620	***R***	**Recharge (infiltration) rate (feet/day)**
0.222	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
39.00	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
85.000	**x**	**1/2 length of basin (x direction, in feet)**
152.500	**y**	**1/2 width of basin (y direction, in feet)**
0.521	**t**	**duration of infiltration period (days)**
22.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

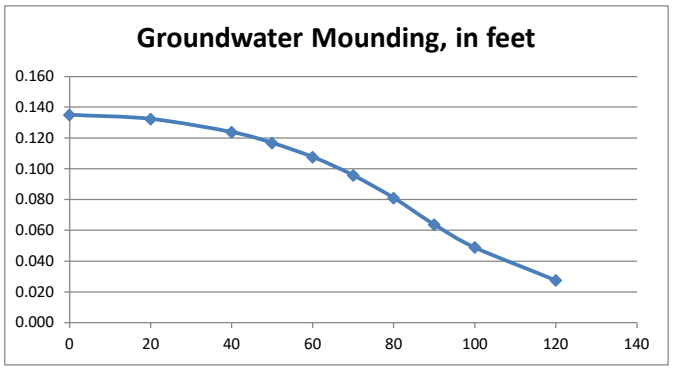
hours	days
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

22.135	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.135	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
0.135	**0**
0.132	**20**
0.124	**40**
0.117	**50**
0.108	**60**
0.096	**70**
0.081	**80**
0.064	**90**
0.049	**100**
0.028	**120**

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

Pond 2P Mounding - Input Values

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)	
11.6	0	0	218	0	0	0	
11.65	0.01	0	218	0.01	0.01	0	
11.7	0.02	0	218	0.02	0.02	0	
11.75	0.03	0	218	0.03	0.03	0	
11.8	0.05	0	218	0.05	0.05	0	
11.85	0.07	0	218	0.07	0.07	0	
11.9	0.1	0	218	0.1	0.1	0	
11.95	0.15	1	218	0.14	0.14	0	
12	0.26	12	218.01	0.14	0.14	0	
12.05	0.46	52	218.05	0.14	0.14	0	
12.1	0.58	119	218.12	0.14	0.14	0	
12.15	0.51	192	218.19	0.14	0.14	0	
12.2	0.41	249	218.25	0.14	0.14	0	
12.25	0.36	293	218.29	0.14	0.14	0	
--- Full tabular hydrograph data not shown for brevity; refer to HydroCAD output ---							
23.5	0.01	0	218	0	0	0	
23.55	0.01	0	218	0.03	0.03	0	
23.6	0.01	0	218	0	0	0	
23.65	0.01	0	218	0.03	0.03	0	
23.7	0.01	0	218	0	0	0	
23.75	0.01	0	218	0.03	0.03	0	
23.8	0.01	0	218	0	0	0	
23.85	0.01	0	218	0.02	0.02	0	
23.9	0.01	0	218	0	0	0	
23.95	0.01	0	218	0.02	0.02	0	
24	0.01	0	218	0	0	0	
24.05	0.01	0	218	0.02	0.02	0	
24.1	0	0	218	0	0	0	
24.15	0	0	218	0.01	0.01	0	
24.2	0	0	218	0	0	0	

42351	Impervious Surface (sft)
(see HydroCAD)	
0.04861	Required recharge volume (acre-ft)
(0.60" for HSG-A)	
0.008	Average infiltration rate (cfs)
708.11	Average infiltration rate (cft/day)
2492.05	System bottom area (sft)
(21.7'x115')	
0.284	Recharge/infiltration rate (ft/day)
11.65	Infiltration start time
24.15	Infiltration end time
12.5	Time (hrs)
0.521	Time (days)
39	Hydraulic conductivity (ft/day)
("Medium Sand" per DEP Brainshark table)	
0.222	Specific yield
("Sand" per DEP Brainshark table)	
19	Initial saturated thickness (ft)

Legend:

= user-supplied values

= input values in Results sheet

Hantush Groundwater Mounding Analysis
Ayer Commons, Ayer MA

INFILTRATION POND 2P

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values		
0.2840	***R***	**Recharge (infiltration) rate (feet/day)**
0.222	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
39.00	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
21.670	**x**	**1/2 length of basin (x direction, in feet)**
115.000	**y**	**1/2 width of basin (y direction, in feet)**
0.521	**t**	**duration of infiltration period (days)**
19.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

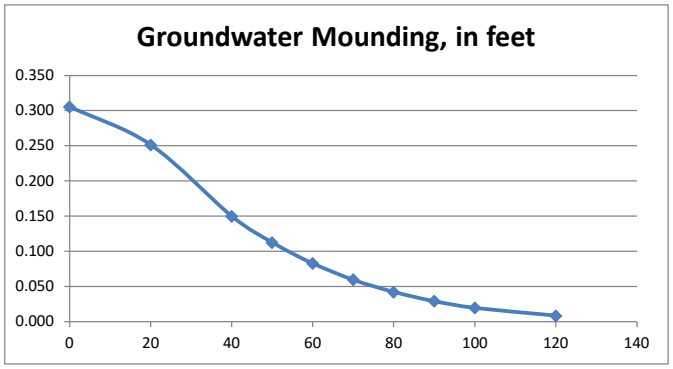
hours	days
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

19.306	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.306	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	Distance from center of basin in x direction, in feet
0.306	**0**
0.251	**20**
0.150	**40**
0.113	**50**
0.083	**60**
0.060	**70**
0.042	**80**
0.029	**90**
0.020	**100**
0.009	**120**

Re-Calculate Now



Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

Pond 3P Mounding - Input Values

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)	
11.65	0	0	215	0	0	0	
11.7	0.01	0	215	0.01	0.01	0	
11.75	0.02	0	215	0.02	0.02	0	
11.8	0.03	0	215	0.03	0.03	0	
11.85	0.05	0	215	0.05	0.05	0	
11.9	0.07	0	215	0.07	0.07	0	
11.95	0.11	0	215	0.11	0.11	0	
12	0.19	0	215	0.19	0.19	0	
12.05	0.34	7	215	0.26	0.26	0	
12.1	0.43	31	215.02	0.26	0.26	0	
12.15	0.39	58	215.03	0.26	0.26	0	
12.2	0.31	75	215.04	0.26	0.26	0	
12.25	0.28	82	215.04	0.26	0.26	0	
12.3	0.25	83	215.05	0.26	0.26	0	
--- Full tabular hydrograph data not shown for brevity; refer to HydroCAD output ---							
23.45	0.01	0	215	0	0	0	
23.5	0.01	0	215	0.02	0.02	0	
23.55	0.01	0	215	0	0	0	
23.6	0.01	0	215	0.02	0.02	0	
23.65	0.01	0	215	0	0	0	
23.7	0.01	0	215	0.02	0.02	0	
23.75	0.01	0	215	0	0	0	
23.8	0.01	0	215	0.02	0.02	0	
23.85	0.01	0	215	0	0	0	
23.9	0.01	0	215	0.02	0.02	0	
23.95	0.01	0	215	0	0	0	
24	0.01	0	215	0.02	0.02	0	
24.05	0.01	0	215	0	0	0	
24.1	0	0	215	0.01	0.01	0	
24.15	0	0	215	0	0	0	

32637	Impervious Surface (sft)
(see HydroCAD)	
0.037	Required recharge volume (acre-ft)
(0.60" for HSG-A)	
0.006	Average infiltration rate (cfs)
547.42	Average infiltration rate (cft/day)
4592.15	System bottom area (sft)
(31.7'x145')	
0.119	Recharge/infiltration rate (ft/day)
11.7	Infiltration start time
24.1	Infiltration end time
12.4	Time (hrs)
0.517	Time (days)
39	Hydraulic conductivity (ft/day)
("Medium Sand" per DEP Brainshark table)	
0.222	Specific yield
("Sand" per DEP Brainshark table)	
17	Initial saturated thickness (ft)
Legend:	
	= user-supplied values
	= input values in Results sheet

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
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Input Values		use consistent units (e.g. feet & days **or** inches & hours)
0.1190	***R***	**Recharge (infiltration) rate (feet/day)**
0.222	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
39.00	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
31.670	**x**	**1/2 length of basin (x direction, in feet)**
145.000	**y**	**1/2 width of basin (y direction, in feet)**
0.517	**t**	**duration of infiltration period (days)**
17.000	**hi(0)**	**initial thickness of saturated zone (feet)**

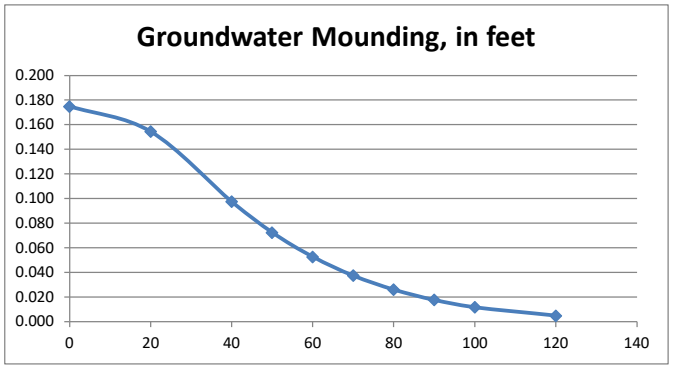
Conversion Table	
inch/hour	**feet/day**
0.67	1.33
2.00	4.00
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

17.175	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.175	**Δh(max)**	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
0.175	**0**
0.154	**20**
0.098	**40**
0.073	**50**
0.053	**60**
0.038	**70**
0.026	**80**
0.018	**90**
0.012	**100**
0.005	**120**

Re-Calculate Now



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