TOWN OF TOPSFIELD, MA

FEBRUARY 2024

Stormwater Management Plan

20974A

Boston Street Water Tank

WRIGHT-PIERCE
Engineering a Better Environment

Boston Street Water Tank

Stormwater Management Plan

Town of Topsfield, MA

FEBRUARY 2024

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Section 1 Introduction

The subject of this analysis involves the Boston Street Water Storage Tank Replacement project located in Topsfield, MA. The project proposes demolition of the existing 500,000-gallon concrete water tank and replacement with an 800,000-gallon tank, in a different location. The existing storage tank is located at 288R Boston Street, along the northwest (NW) side of Boston Street. The proposed tank will be located at 279 Boston Street on the southeast (SE) side of Boston Street, adjacent to the existing Water Treatment Plant.

The proposed improvements include construction of a 60-foot diameter concrete water tank with a 15-foot wide access track, slope stabilization and water piping modifications. The proposed water tank will be located at the edge of an existing driveway and built into a slope, requiring some tree clearing, excavation and filling. Post construction, the site grading will only be altered in the vicinity of the tank and embankments will be sloped at a 2H:1V and stabilized with riprap to minimize the limit of disturbance. Stormwater originating from the roof of the tank will initially flow through the 15-foot wide grassed access track. Following this, runoff that hasn't infiltrated will flow toward a stormwater detention/infiltration trench sited at the toe of the riprap slope. Flows exceeding the capacity of the storage will continue toward the rear of the site, flowing into existing vegetated buffers. Stormwater originating from the remainder of the site will continue to follow existing drainage paths.

The project also includes demolition of the existing 60-foot diameter concrete water tank, salvage of water valves/tank appurtenances and restoration of the surrounding area with loam and seed.

1.1 Stormwater Management Plan Approach

This Stormwater Management Plan (SWMP) was prepared in accordance with the Massachusetts Stormwater Management Manual and the Massachusetts Department of Environmental Protection's (DEP) Stormwater Checklist, which has been included in Appendix A. The following sections will address each stormwater standard to document compliance of the proposed project.

1.2 Organization of the SWMP

This SWMP was prepared to comply with the requirements for the ten stormwater Standards as outlined in the Massachusetts Stormwater Handbook.

Standard	Description	Report Section
1	No New Untreated Discharges	2
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Section 2 No New Untreated Discharges

2.1 Existing Conditions

The existing site has been previously developed with the construction of the Water Treatment Plant, Department of Public Works building, booster pump station and a salt shed. The proposed work area is partially wooded and is generally sloping from southwest to northeast with stormwater flowing to a large, wooded parcel to the east. The soils on-site are of the Hydrologic Soil Group (HSG) C and are characterized as Paxon 306B/D. Review of FEMA Flood maps indicate that the property is not within a 100-year flood plain.

2.2 New Stormwater Conveyances

The stormwater management plan has been designed to meet the requirements of the Massachusetts Stormwater Management Policy. As such, there are no untreated stormwater discharges from new impervious surfaces as part of this project. All stormwater from the proposed tank roof will receive treatment via vegetated buffers.

Section 3 Peak Rate Attenuation

Standard 2 of the Massachusetts Stormwater Standards requires new development projects be designed so that post-development peak discharge rates do not exceed pre-development discharge rates. Pre- and post-development hydrologic models have been created to quantify peak flow rates leaving the site. The hydrologic analysis was performed using the SCS TR-20 methodology and HydroCAD version 10 computer modeling software was utilized to perform the computations. The rainfall data used to conduct the analysis was obtained from the Northeast Regional Climate Center (NRCC) and Natural Resources Conservation Service (NRCS) joint website "precip.net," which provides extreme precipitation data for New York and New England. The TR-20 analysis relies heavily on in-situ HSG classification, land cover type and time of concentration calculations.

3.1 Watershed Characteristics

To quantify runoff from the site, an analysis of the site's topography was performed. The subject property has multiple sub-watersheds flowing in different directions requiring two sub-catchment areas to be analyzed. Sub-catchment 1 has a localized watershed area of approximately 58,292 square feet. The natural drainage path conveys flow toward the rear of the property and into an adjacent wooded parcel. Sub-catchment 2 has a localized watershed area of approximately 97,384 square feet. The natural drainage path of this catchment area conveys flows toward the front of the site.

3.2 Soils

Soils data for the proposed project area was obtained through the Natural Resource Conservation Service (NRCS) Soil Survey Geographic (SSURGO) database. Based on the information obtained, the watershed area is comprised of Paxon 306b and Paxon 306d soils, which fall within HSG Type C.

3.3 Land Cover

Land cover classifications for the project site were selected and quantified based on measurements taken from aerial imagery. Each land cover designation was assigned a runoff curve number (CN), and a weighted curve number was calculated for entry into the HydroCAD model. A summary of the existing and proposed watershed characteristics are included in Table 3-1 and 3-2.

Table 3-1 Pre-Development Watershed Characteristics

Catchment Area	Total Area (SF)	HSG C – Grass (SF)	HSG C – Woods (SF)	Impervious Area (SF)	Gravel (SF)	Riprap (SF)	Composite CN	TC (min)
Sub-catchment 1 (SP1)	58,292	20,592	29,109	7,328	570	693	75	20.7
Sub-catchment 2 (SP2)	97,348	32,780	31,585	32,983	0	0	81	15.4

Table 3-2 Post-Development Watershed Characteristics

Catchment Area	Total Area (SF)	HSG C – Grass (SF)	HSG C – Woods (SF)	Impervious Area (SF)	Gravel (SF)	Riprap (SF)	Composite CN	TC (min)
Sub-catchment 1 (SP1)	58,292	22,289	21,943	9,905	838	3,317	77	19.7
Sub-catchment 2 (SP2)	97,348	35,238	29,127	32,983	0	0	81	15.4

3.4 Time of Concentration

The time of concentration (Tc) for each watershed area was calculated using the lag CN method. This method determines the T_c based on the length and slope of the longest flow path for a given catchment area. For the purposes of the model, a minimum Tc of 6 minutes was used.

3.5 Stormwater Quantity Results

The site has been analyzed for pre- and post-development runoff corresponding to the 2, 10 and 100-year, 24-hour storms. Peak discharge rates from the edge of the site are summarized in Table 3-3 and the HydroCAD results have been included in Appendix B.

Table 3-3 Pre- and Post-Development Peak Discharge Rates (cfs)

Development Scenario	2-Year, 24-Hour (3.20 Inch Rainfall Depth)	10-Year, 24-Hour (4.88 Inch Rainfall Depth)	100-Year, 24-Hour (8.97 Inch Rainfall Depth)
S1 Pre-Development (SP1)	0.9	2.0	4.6
S1 Post-Development (SP1)	0.9	1.9	4.2
S2 Pre-Development (SP2)	2.6	4.7	9.6
S2 Post-Development (SP2)	2.6	4.7	9.6

Based on the results of the TR-20 analysis, a decrease in peak rate of discharge was noted for the 2-year, 10-year and 100-year, 24-hour storms. It should be noted that this analysis does not include demolition of the existing tank because it flows in a different direction. However, the existing tank site and proposed tank site both flow to the Ipswich River. If the hydrologic modeling was extended to include both sites, the peak discharge rate entering the Ipswich River would likely see a greater reduction for the pre-development to post-development condition.

Section 4 Recharge

4.1 Groundwater Recharge

Standard 3 of the Massachusetts Stormwater Standards requires the loss of annual groundwater recharge to be eliminated or minimized using infiltration measures. The Topsfield zoning bylaws indicate the recharge volume may be reduced where clean rooftop runoff is directed to pervious areas. The entirety of the proposed impervious surface is the tank roof, which is considered a clean source of runoff. Runoff originating from the tank roof will flow across the 15-wide, grassed access way surrounding the tank. Following this, runoff that hasn't infiltrated will flow toward a stormwater detention/infiltration trench sited at the toe of the riprap slope. Flows exceeding the capacity of the storage will continue toward the rear of the site, which is a large, wooded parcel, allowing for additional infiltration. Based on review of the Bylaws and discussion with Town administrators, it is understood that this arrangement satisfies the intent of the standard.

Section 5 Water Quality

5.1 Water Quality Provisions

Standard 4 of the Massachusetts Stormwater Standards requires systems to be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS) for the required water quality volume. The Topsfield bylaws indicate the water quality volume may be reduced where clean rooftop runoff is directed to pervious areas. The entirety of the proposed impervious surface is the tank roof, which is considered a clean source of runoff. Runoff originating from the tank roof will initially flow through a 15' wide grassed accessway. Following this, runoff that hasn't infiltrated will flow toward a stormwater detention/infiltration trench sited at the toe of the riprap slope. Flows exceeding the capacity of the storage will continue toward the rear of the site, which is a large, wooded parcel, allowing for additional TSS removal via existing vegetated buffers. Based on our review of the Bylaws and discussions with Town administrators, it is understood that this arrangement satisfies the intent of the standard.

5.2 Long Term Pollution Prevention Plan

Standard 4 of the Massachusetts Stormwater Standards also requires a Long-Term Pollution Prevention Plan to be submitted. This plan, included in Appendix D, addresses information related to proper procedure for the following items:

- Good housekeeping;
- Storage of materials;
- Street Sweeping;
- Vehicle Washing;
- Routine Inspections of Stormwater BMP's
- Spill prevention and response;
- Landscaping maintenance;
- Storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management;
- Operation and maintenance of waste management systems;
- Proper storage of deicing chemicals and snow;

Section 6 Land Uses with Higher Potential Pollutant Loads

The Massachusetts Department of Environmental Protection has identified certain land uses which generate higher concentrations of pollutants than found in typical runoff. The construction of the Boston Street Water Tank is not a land use which would trigger higher potential pollutant loads.

Section 7 Critical Areas

The proposed project does not result in stormwater discharges to an area deemed as Critical in the Massachusetts Stormwater Handbook.

Section 8 Re-development and Other Projects

The proposed project does not qualify as re-development.

Section 9 Construction Period Pollution Prevention & Erosion/Sedimentation Control Plan

Per the MassDEP stormwater standards, projects that disturb one acre of land or more are required to obtain coverage under the NPDES Construction General Permit issued by EPA and prepare a Stormwater Pollution Prevention Plan (SWPPP). The following plan is meant to serve as a combined Construction Period Pollution Prevention & Erosion/Sedimentation Control Plan as well as the SWPPP.

The objective of this document is to provide a general outline of the measures required to prevent erosion and pollution associated with the construction of the Boston Street Water Storage Tank project located in Topsfield, MA. The selected contractor(s) will be responsible for following and implementing the measures described in this plan. In addition, the contractor will be required to develop and submit a SWPPP prior to the start of construction to document exactly how they intend to address these requirements. Prior to the start of any earthwork on the site, the sedimentation and erosion control barriers will be installed. Section 9.2 provides a listing of controls and a sequence of construction.

1. Site Description and Overview:
    a. The proposed improvements include construction of a 60-foot diameter concrete water tank with a 15-foot wide access track, slope stabilization and water piping modifications. The proposed water tank will be located at the edge of an existing driveway and built into a slope, requiring some tree clearing, excavation and filling. Post construction, the site grading will only be altered in the vicinity of the tank and embankments will be sloped at a 2H:1V and stabilized with riprap to minimize the limit of disturbance. Stormwater originating from the roof of the tank will flow through vegetated buffers to receive stormwater treatment. Stormwater originating from the remainder of the site will continue to follow existing drainage paths. The project also includes demolition of the existing 60-foot diameter concrete water tank, salvage of water valves/tank appurtenances and restoration of the surrounding area with loam and seed. The proposed work area is mostly wooded and is underlain by type C soils.

2. Location and description of Resource Areas:
    a. Watercourses and Water bodies: The proposed development is not immediately adjacent to any rivers or waterbodies. Flow leaving the site is tributary to a wooded parcel which eventually flows toward the Ipswich River.

    b. Wetlands: No wetlands were identified within or adjacent to the proposed work area.

3. Existing soils and the volume and nature of imported soil materials: Discussion of existing soil types and classifications has been included in section 3.2 of this report. The proposed site has been designed to reuse excess material to the extent feasible. The only materials that will be imported to the site would be screened gravel for use as structural fill, roadway base and subbase on an as needed basis when existing material cannot be used.

4. Drainage patterns, watersheds, and sub-watersheds: Detailed discussion of existing drainage patterns, watersheds and stormwater calculations have been included in section 3 of this report. In general, the site

slopes from west to east with portions of runoff flowing into a wooded parcel to the east of the work area. In the post-development state, runoff from proposed impervious surfaces will be directed to vegetated buffers for stormwater treatment.

5. A description of construction and waste materials to be stored on-site: All waste generated by construction activities will be stored in dumpsters and disposed of regularly. The contractor will be required to address handling of waste in the SWPPP. The contractor's SWPPP will address practices to minimize exposure of materials to stormwater as well as spill response procedures. The contractor will also provide detailed descriptions of their proposed storage areas and methods of handling construction debris.

6. Location of all erosion and sediment control measures with a narrative of construction sequencing: Discussion of proposed erosion and sediment control measures can be found on the construction plans. Notes and details have been included on the design drawings for convenience to the contractor. The E&SC measures shown on the plan are meant to be the minimum required, however the contractor will be required to implement measures as required to control erosion and sedimentation to the standards discussed in this plan.

7. Construction period stormwater handling: During construction, the contractor will be required to implement erosion and sedimentation control measures prior to the start of work. Temporary erosion and sediment control measures are discussed on plan sheet C-501. This sheet details requirements for the maximum amount of disturbed area, temporary stabilization measures and seasonal variances in these requirements.

8. Post-construction stormwater handling: After construction, stormwater will be controlled via vegetated buffers and existing drainage paths. In order for these systems to function properly, they will need to be inspected and maintained regularly in accordance with the maintenance schedule outlined in the Operation and Maintenance Plan.

9.1 Inspection and Maintenance of Stormwater Controls

Stormwater controls must be maintained in good operating condition until all disturbed soils are permanently stabilized. To ensure this, the erosion and sedimentation controls shall be inspected by the Resident Engineer once every two weeks and after every rainfall event of 0.5 inches or greater.

The following standard maintenance practices will apply to the erosion and sedimentation controls for the project:

- All erosion and sediment control measures will be properly maintained. If repairs or other maintenance is necessary, it will be initiated by the Contractor within 24 hours of report;
- Silt fence will be inspected for depth of sediment, tears, to see if the fabric is securely attached to the fence posts, and to see that the fence posts are firmly in the ground;
- Built up sediment will be removed from silt fence when it has reached one-half the height of the fence and at end of the job;
- Dust will be controlled by periodic driveway sweeping during the progress of the work;

- Erosion control measures will be maintained for disturbed areas of the site that have not been stabilized;
- Erosion control measures will be installed and maintained for the construction staging area, fueling area, stockpiles, and material storage areas until those areas have been stabilized after construction; and,
- Temporary and permanent seeding and planting will be inspected for bare spots, washouts, and healthy growth.

If the inspections reveal the need for additional control devices to prevent erosion and sedimentation, the Contractor will promptly install additional protection devices as required. Control devices in need of repair will be repaired promptly after identification. A stockpile of 100 linear feet of silt fence will be maintained on the site and under cover for emergency repairs and routine maintenance.

The Owner (or their representative) will be responsible for preparing an inspection and maintenance report (Attached in Appendix E) following each inspection and filing completed reports after maintenance action has taken place by the Contractor. The Contractor's superintendent will be responsible for maintenance and repair activities and completing and signing the maintenance action part of inspection and maintenance reports.

9.2 Stormwater Controls During the Construction Period

The contractor will be required to implement BMPs as necessary to control stormwater and erosion for a 100-year, 24-hour storm. Temporary BMPs include a stabilized construction entrance, silt fence, composite silt socks, temporary sediment basins, stone check dams and erosion control matting. Specific details noting installation requirements are included on plan sheet C-504 Erosion Control Notes and Details and in specification section 02270 Temporary Erosion Controls.

PROJECT SCHEDULE: Prior to the start of construction, the selected contractor will be required to submit a construction schedule outlining the sequencing/phasing of the work. The project construction phasing will generally proceed in the following sequence:

1. Field location and flagging of the limits of work and any critical resource areas.
2. Installation of sedimentation/erosion control barriers at the down gradient limit of work. This includes, but is not limited to installation of silt fence, silt sacks, stabilized construction entrances, temporary and/or permanent sediment basins and check dams.
3. Establish storage/stockpiling areas. Clearing and Grubbing.
4. Excavation, site preparation and installation of stormwater BMPs.
5. Installation of site piping, concrete pads and fine grading of the site.
6. Tank construction, electrical duct bank installation and paving.
7. Loaming, seeding, and mulching of disturbed areas as construction in those areas is completed.

8. Inspection of seeding success and removal of sedimentation/erosion control barriers once permanent stabilization has become established pursuant to the specifications and satisfaction of the Resident Engineer.

EROSION AND SEDIMENT CONTROLS:
Various erosion and sedimentation control measures will be utilized to prevent or minimize soil erosion and sedimentation of on-site stormwater systems adjacent to wetlands. Refer to plan sheet C-102 for locations and C-504 for details of temporary erosion and sedimentation control measures.

Sedimentation controls mainly include silt sacs (temporary sediment traps), silt fence and silt booms. Anti-tracking aprons (stabilized construction entrances) shall also be utilized as shown on project plans. These measures will be installed as detailed on the site plans. Land disturbance is required to be kept to a minimum to reduce soil erosion and sedimentation. Whenever possible, work shall be phased to avoid disturbances of more than one acre at a time.

Contractor Staging Area: Contractor staging and/or stockpiles may be placed on-site in the designated area, or at alternate locations as approved by the Engineer and Owner. The maximum permissible slope of a stockpile will be 2H:1V. The area selected for stockpiling shall be dry and stable and the location approved by the Engineer and Owner. Stockpiles will be required to be stabilized or covered and stockpiles not used within 30 days shall be seeded or mulched immediately after the formation of the stockpile.

Dust Control: Dust Control Measures will be implemented in accordance with the project specifications if determined to be necessary. Off-site vehicle tracking of sediment and the generation of dust shall be minimized. The volume of water sprayed to prevent dust shall be minimized to prevent the runoff of water, and any water running off shall contain no visible oil sheen, floating solids, discoloration, or cause foaming in the receiving water.

Restoration and Stabilization: Disturbed areas will be stabilized with mulch or temporary seeding in accordance with the requirements and timeframes noted on the site plans and in accordance with the specifications. At a minimum, any disturbed area left exposed for a period greater than 14 days will be stabilized. Stabilization should occur within seven days after suspension of work in the disturbed areas. Site restoration will include installation of pavement, aprons, walkways, loam, seed, and other restoration as shown on the site plans and detailed in the project specifications.

Maintenance: During construction, various measures will be used to conserve soil and minimize erosion until disturbed areas are stabilized. The selected contractor will be responsible for inspecting, maintaining, and periodically cleaning all E&SC measures in accordance with the site plans and specifications. Some of the maintenance tasks are listed below:

- Remove sediment when deposits reach one half the height of a silt fence. Replace silt sacks or temporary sediment traps in accordance with manufacturer's recommendations.
- Construction Entrances: Maintain in a condition to prevent tracking of debris onto paved surfaces. This may include the need for periodic top dressing with additional stone as conditions warrant.
- Concrete washout areas: Remove hardened concrete when materials have accumulated to half the height of the container or washout area.

- Sediment/Dewatering Basins: Accumulated sediment shall be removed from systems periodically to promote proper function and shall be inspected frequently.
- All erosion and sedimentation controls shall be inspected every 7 days and immediately following any significant rain event.

Temporary stabilization measures shall be instituted to minimize effects of sedimentation and erosion during construction. Temporary Erosion Controls will be established at the site in accordance with specification section 02270 included in Appendix F.

Permanent stabilization measures shall be employed to minimize effects of sedimentation and erosion after the completion of construction. Detailed information is included in Specification Section 02485 – Loaming and Seeding attached in Appendix F.

Housekeeping: The contractor will be required to follow good housekeeping practices, material management and spill prevention practices that will minimize the risk of spills or accidental exposure of materials to stormwater runoff or wetland areas. These minimum practices are outlined below:

- Contractor shall make an effort to store only enough products on-site required to do the job.
- All materials stored on-site will be stored in a neat, orderly manner in their appropriate containers and, if possible, under a roof, plastic, or other waterproof enclosure.
- Products will be kept in their original containers with the original manufacturer's label intact.
- Original labels and material safety data sheets will be retained.
- Substances will not be mixed unless in accordance with the manufacturer's recommendations.
- Whenever possible, all of a product will be used up before properly disposing of the container.
- Contractor shall take measures to ensure that no litter, debris, building materials or similar materials are discharged to the waters of the State.
- The contractor will inspect periodically to ensure proper use and disposal of materials.
- Care will be taken in the selection of the location and method of storage of any petroleum products, hazardous material, or similar, to minimize the potential for accidental spillage, leakage, or release to the environment.
- All onsite vehicles will be monitored for leaks and receive regular preventive maintenance to reduce the chance of leakage.

Spill Prevention and Response Practices: In addition to good house keeping and material management practices discussed above, the following general practices will be followed for spill prevention, response, and cleanup:

- Materials and equipment required for spill response will be maintained onsite. Equipment and materials may include, but are not limited to gloves, safety glasses, speedi-dri, spill "pigs", sorbent materials, poly sheeting, and miscellaneous containers.
- Adequate personnel will be trained in spill response procedures.
- The contractor shall designate a specific person to be responsible for spill prevention and response.
- All spills will be properly reported and cleaned up immediately after discovery.

Section 10 Operation/Maintenance Plan

The stormwater BMP's used in the construction of the Boston Street Water Tank project require a long-term operation and maintenance plan to ensure proper function. The following sections address the maintenance requirements of the proposed BMP and establish the responsibility for ensuring each task is completed.

10.1 Responsible Party

The BMP's are not part of the public stormwater system and will therefore be maintained by the water treatment plant operator. Contact info for the responsible party is listed below:

Topsfield Water Department
279 Boston Street, Topsfield, MA
(978) 887-1500

10.2 Description of Stormwater BMPS

Post-construction stormwater management will be achieved by directing runoff from the tank roof to vegetated buffers. Review of the Topsfield Bylaws indicate that stormwater treatment requirements are reduced for runoff from clean rooftop sources. The only new impervious surface proposed as part of this project is the roof of the water storage tank. As such, the site's stormwater management is achieved through the use of vegetated buffers.

10.3 Maintenance Requirements

Maintenance requirements specific to the site's stormwater controls have been established in accordance with the Massachusetts Stormwater Handbook. Table 10-1 details the long-term maintenance requirements for each BMP.

Table 10-1 Long Term Maintenance Schedule

BMP	Activity	Frequency
Riprap	Clean out vegetation and organic matter	As needed.
Vegetated Filter Strips	Regularly mow grass	As needed.
	Remove sediment buildup.	As needed.

Additional information related to the extent of each maintenance activity can be found in the Massachusetts Stormwater Handbook. All maintenance activities shall be documented by filling out the Inspection Maintenance Checklist and tracked on the Stormwater Maintenance Log which can be found in Appendix E.

Section 11 Prohibition of Illicit Discharges

Standard 10 of the Massachusetts Stormwater Standards prohibits all illicit discharges to the stormwater management system. In order to comply with this standard, appropriate disposal methods have been designed for all sanitary and process related waste. The proposed design does not contain any cross connections between sanitary and storm water conveyances or any opportunity for illicit discharges to enter the stormwater system. In addition, spill containment has been designed to capture any spills from chemical deliveries. The project site will be monitored during and after construction to verify that there is no opportunity for illicit discharges. The Boston Street Water Storage Tank project will specifically prohibit the discharge of any illicit substance to the stormwater management system. Measures to prevent any possible future illicit discharges have been implemented as part of the Operation and Maintenance Plan.

Stamp of signing professional Engineer

James Cray, PE

Registered Professional Engineer

02/23/2024

Date

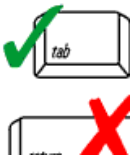
Appendix A – Stormwater Checklist

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

Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

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

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

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

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

[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.

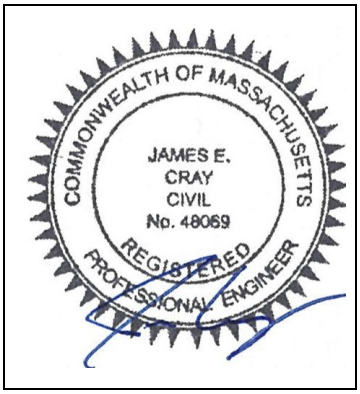
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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



02/23/2024

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): Vegetated filter strips

Standard 1: No New Untreated Discharges

☒ No new untreated discharges

☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth

☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☐ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☐ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☐ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

☐ Site is comprised solely of C and D soils and/or bedrock at the land surface

☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000

☐ Solid Waste Landfill pursuant to 310 CMR 19.000

☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☐ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

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

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

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

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

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

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

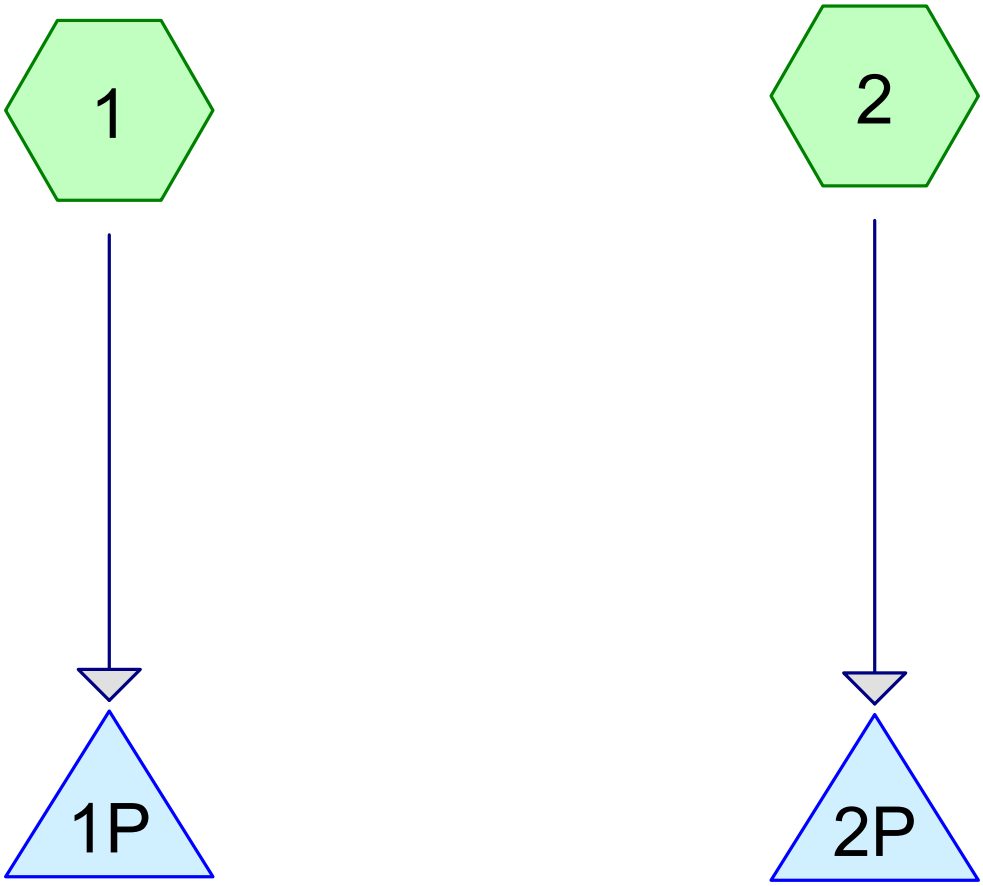
Standard 10: Prohibition of Illicit Discharges

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

☒ An Illicit Discharge Compliance Statement is attached;

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

Appendix B – HydroCAD Model Results



Subcat Reach Pond Link

Routing Diagram for Pre Development
Prepared by {enter your company name here}, Printed 2/21/2024

Project Notes

Defined 7 rainfall events from Topsfield Rainfall IDF
Copied 7 events from Topsfield Rainfall 24-hr S1 storm

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.225	74	>75% Grass cover, Good, HSG C (1, 2)
0.013	96	Gravel surface, HSG C (1)
0.925	98	Impervious (1, 2)
0.016	72	Riprap (1)
1.393	70	Woods, Good, HSG C (1, 2)
3.573	**79**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
2.632	HSG C	1, 2
0.000	HSG D	
0.941	Other	1, 2
3.573		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	1.225	0.000	0.000	1.225	>75% Grass cover, Good	1, 2
0.000	0.000	0.013	0.000	0.000	0.013	Gravel surface	1
0.000	0.000	0.000	0.000	0.925	0.925	Impervious	1, 2
0.000	0.000	0.000	0.000	0.016	0.016	Riprap	1
0.000	0.000	1.393	0.000	0.000	1.393	Woods, Good	1, 2
0.000	**0.000**	**2.632**	**0.000**	**0.941**	**3.573**	**TOTAL AREA**	

Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 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 1: Runoff Area=58,292 sf 12.57% Impervious Runoff Depth=1.09"
Flow Length=439' Tc=20.7 min CN=75 Runoff=0.9 cfs 0.122 af

Subcatchment 2: Runoff Area=97,348 sf 33.88% Impervious Runoff Depth=1.47"
Flow Length=636' Tc=15.4 min CN=81 Runoff=2.6 cfs 0.274 af

Pond 1P: SP-1 Inflow=0.9 cfs 0.122 af
Primary=0.9 cfs 0.122 af

Pond 2P: SP-2 Inflow=2.6 cfs 0.274 af
Primary=2.6 cfs 0.274 af

Total Runoff Area = 3.573 ac Runoff Volume = 0.396 af Average Runoff Depth = 1.33"
74.10% Pervious = 2.648 ac 25.90% Impervious = 0.925 ac

Summary for Subcatchment 1:

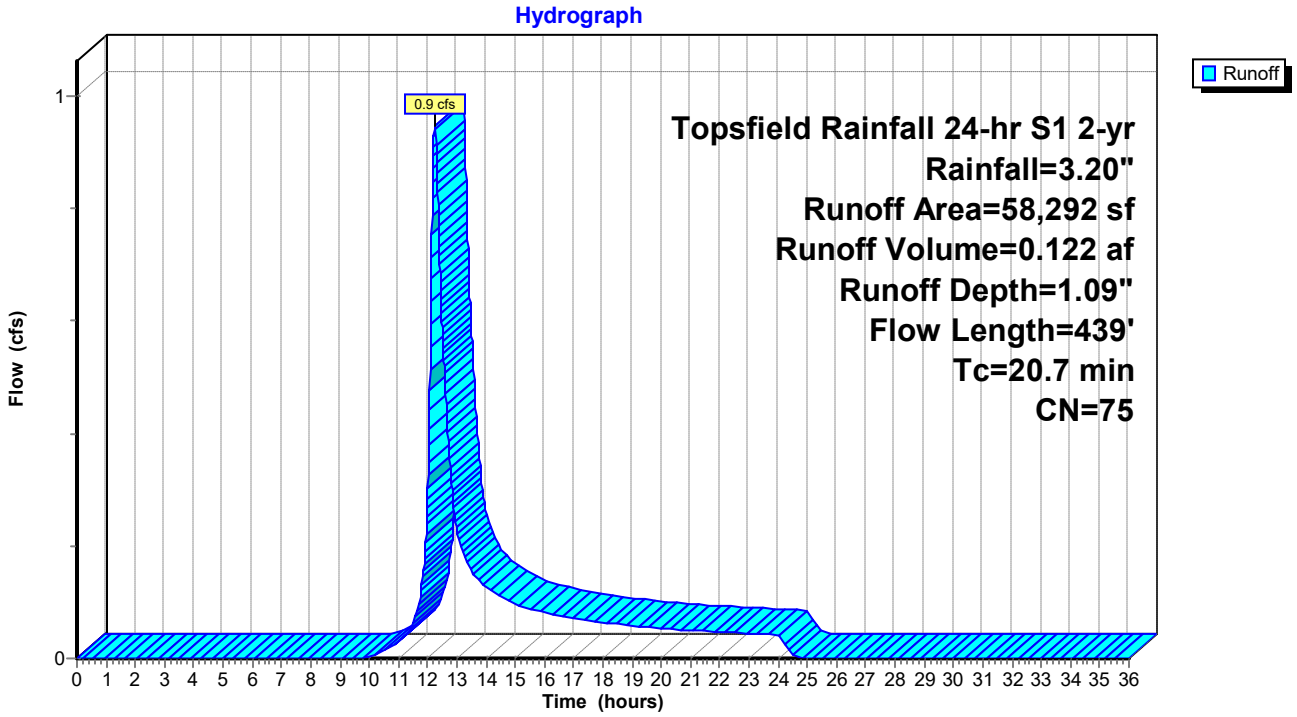
Runoff = 0.9 cfs @ 12.25 hrs, Volume= 0.122 af, Depth= 1.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Topsfield Rainfall 24-hr S1 2-yr Rainfall=3.20"

	Area (sf)	CN	Description
	29,109	70	Woods, Good, HSG C
	20,592	74	>75% Grass cover, Good, HSG C
*	7,328	98	Impervious
	570	96	Gravel surface, HSG C
*	693	72	Riprap
	58,292	75	Weighted Average
	50,964		87.43% Pervious Area
	7,328		12.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	38	0.1320	0.14		**Sheet Flow, Wooded sheet flow** Woods: Light underbrush n= 0.400 P2= 3.20"
1.1	77	0.0160	1.19		**Sheet Flow, Paved Sheet Flow** Smooth surfaces n= 0.011 P2= 3.20"
10.9	135	0.0710	0.21		**Sheet Flow, Grassed Sheet Flow** Grass: Dense n= 0.240 P2= 3.20"
0.5	48	0.0630	1.76		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.5	141	0.0710	0.67		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
20.7	439	Total			

Subcatchment 1:



Summary for Subcatchment 2:

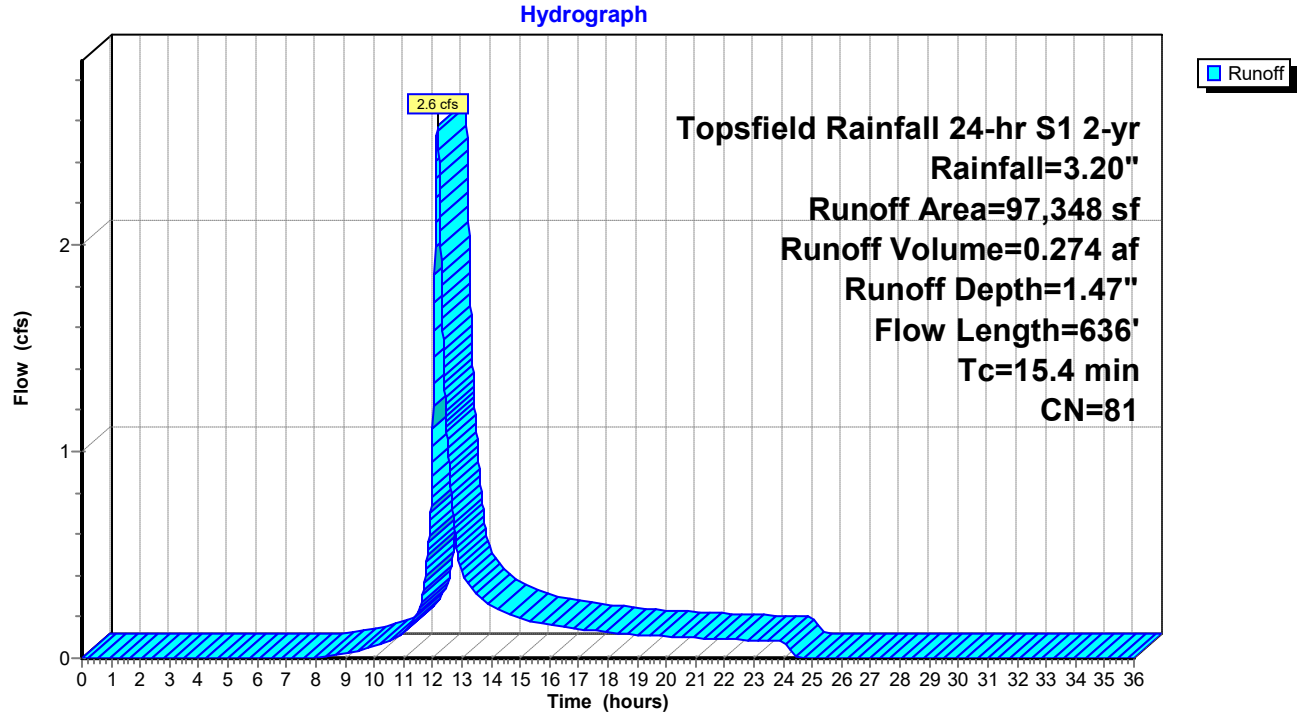
Runoff = 2.6 cfs @ 12.17 hrs, Volume= 0.274 af, Depth= 1.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Topsfield Rainfall 24-hr S1 2-yr Rainfall=3.20"

	Area (sf)	CN	Description
	31,585	70	Woods, Good, HSG C
	32,780	74	>75% Grass cover, Good, HSG C
*	32,983	98	Impervious
	97,348	81	Weighted Average
	64,365		66.12% Pervious Area
	32,983		33.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	53	0.0800	0.07		**Sheet Flow, Wooded Sheet Flow** Woods: Dense underbrush n= 0.800 P2= 3.20"
1.4	197	0.0590	2.43		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.1	386	0.0770	5.63		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
15.4	636	Total			

Subcatchment 2:



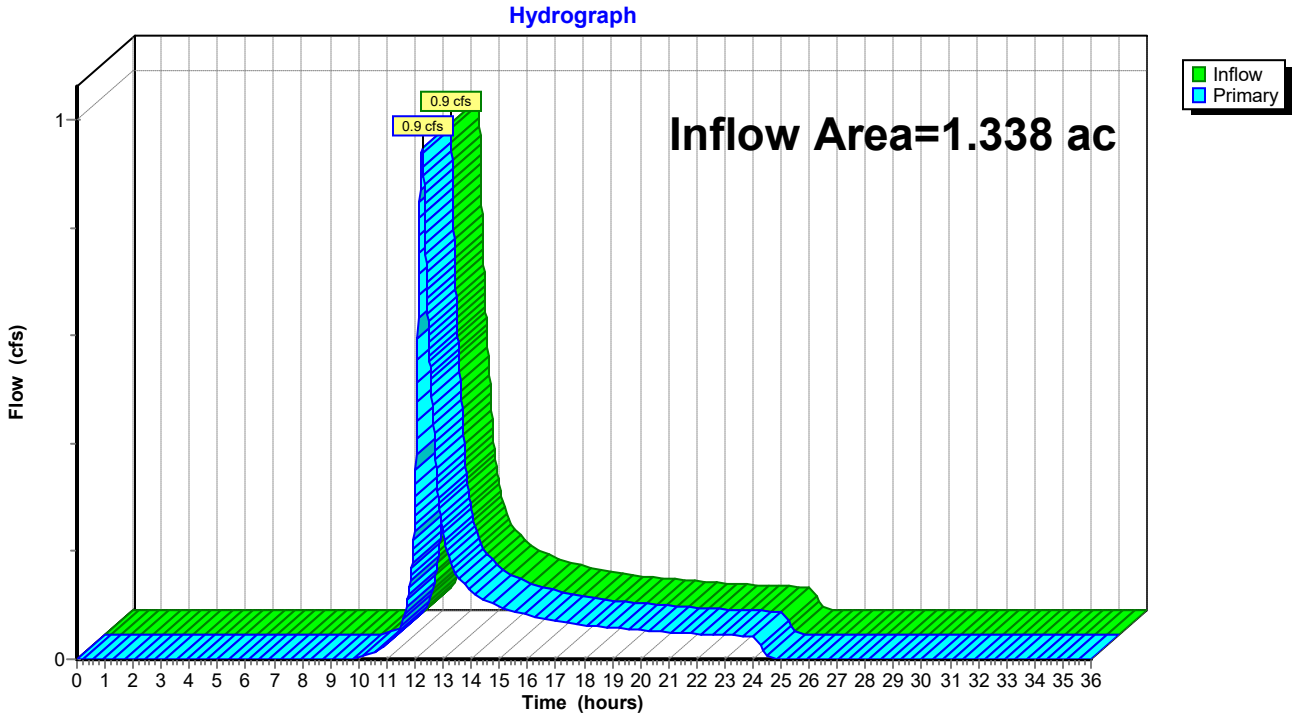
Summary for Pond 1P: SP-1

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

Inflow Area = 1.338 ac, 12.57% Impervious, Inflow Depth = 1.09" for 2-yr event
Inflow = 0.9 cfs @ 12.25 hrs, Volume= 0.122 af
Primary = 0.9 cfs @ 12.25 hrs, Volume= 0.122 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Pond 1P: SP-1



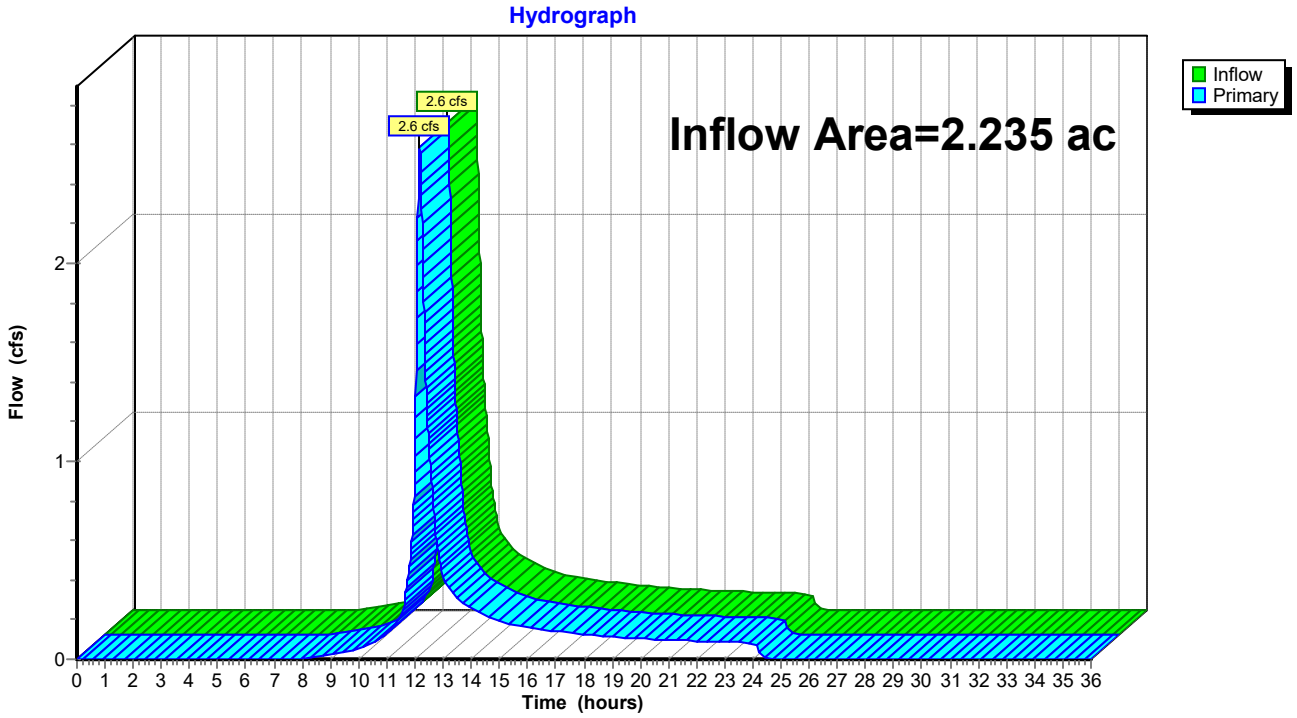
Summary for Pond 2P: SP-2

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

Inflow Area = 2.235 ac, 33.88% Impervious, Inflow Depth = 1.47" for 2-yr event
Inflow = 2.6 cfs @ 12.17 hrs, Volume= 0.274 af
Primary = 2.6 cfs @ 12.17 hrs, Volume= 0.274 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Pond 2P: SP-2



Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 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 1: Runoff Area=58,292 sf 12.57% Impervious Runoff Depth=2.35"
Flow Length=439' Tc=20.7 min CN=75 Runoff=2.0 cfs 0.262 af

Subcatchment 2: Runoff Area=97,348 sf 33.88% Impervious Runoff Depth=2.88"
Flow Length=636' Tc=15.4 min CN=81 Runoff=4.7 cfs 0.536 af

Pond 1P: SP-1 Inflow=2.0 cfs 0.262 af
Primary=2.0 cfs 0.262 af

Pond 2P: SP-2 Inflow=4.7 cfs 0.536 af
Primary=4.7 cfs 0.536 af

Total Runoff Area = 3.573 ac Runoff Volume = 0.799 af Average Runoff Depth = 2.68"
74.10% Pervious = 2.648 ac 25.90% Impervious = 0.925 ac

Summary for Subcatchment 1:

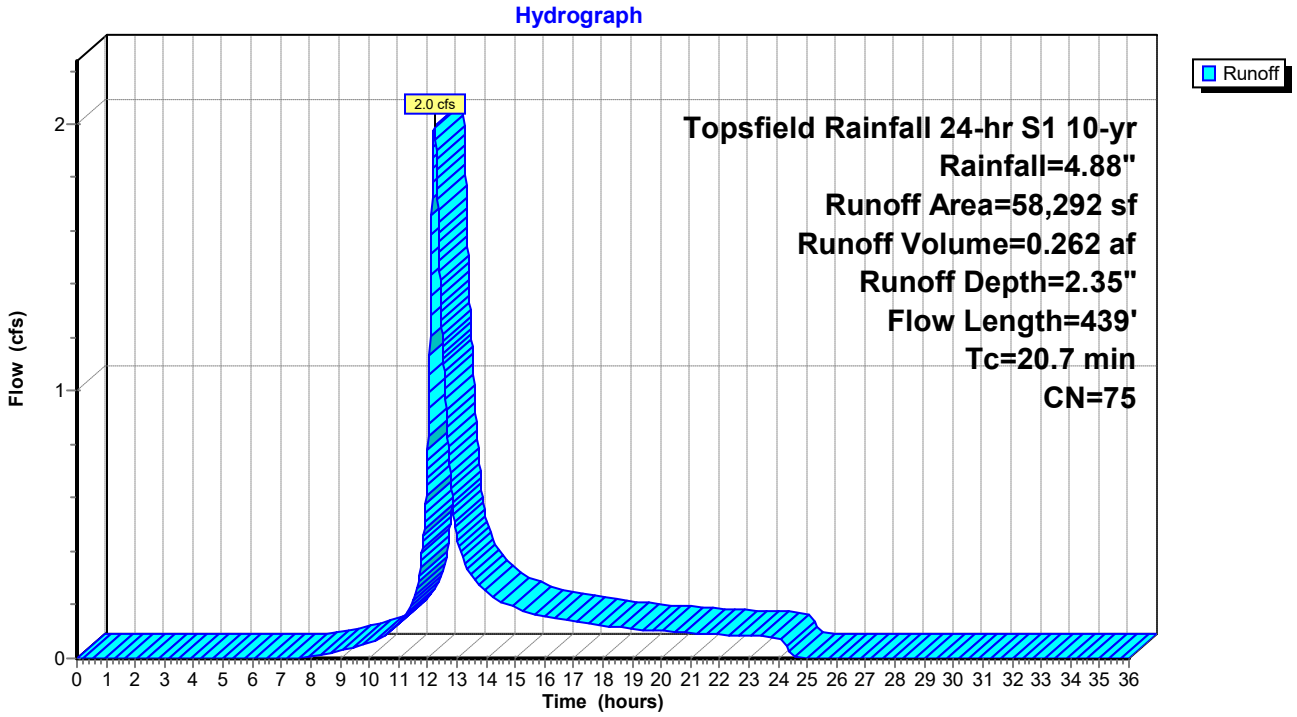
Runoff = 2.0 cfs @ 12.24 hrs, Volume= 0.262 af, Depth= 2.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Topsfield Rainfall 24-hr S1 10-yr Rainfall=4.88"

	Area (sf)	CN	Description
	29,109	70	Woods, Good, HSG C
	20,592	74	>75% Grass cover, Good, HSG C
*	7,328	98	Impervious
	570	96	Gravel surface, HSG C
*	693	72	Riprap
	58,292	75	Weighted Average
	50,964		87.43% Pervious Area
	7,328		12.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	38	0.1320	0.14		**Sheet Flow, Wooded sheet flow** Woods: Light underbrush n= 0.400 P2= 3.20"
1.1	77	0.0160	1.19		**Sheet Flow, Paved Sheet Flow** Smooth surfaces n= 0.011 P2= 3.20"
10.9	135	0.0710	0.21		**Sheet Flow, Grassed Sheet Flow** Grass: Dense n= 0.240 P2= 3.20"
0.5	48	0.0630	1.76		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.5	141	0.0710	0.67		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
20.7	439	Total			

Subcatchment 1:



Summary for Subcatchment 2:

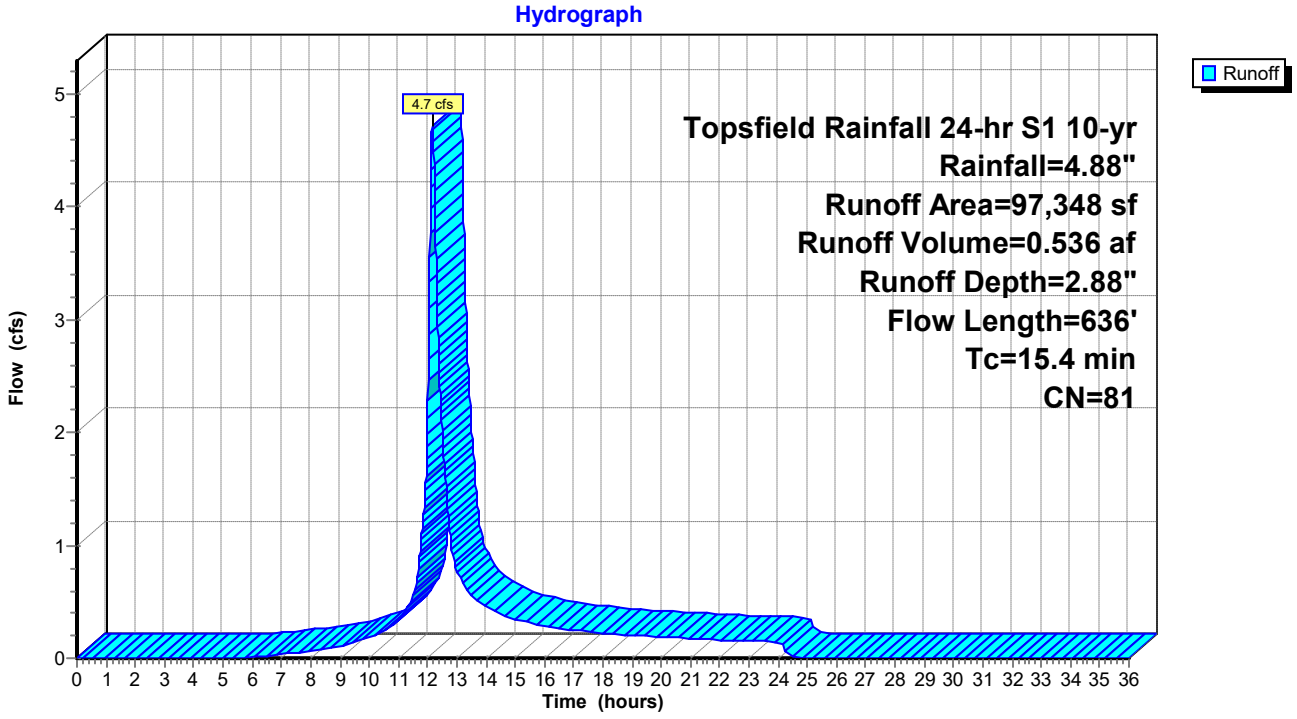
Runoff = 4.7 cfs @ 12.16 hrs, Volume= 0.536 af, Depth= 2.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Topsfield Rainfall 24-hr S1 10-yr Rainfall=4.88"

	Area (sf)	CN	Description
	31,585	70	Woods, Good, HSG C
	32,780	74	>75% Grass cover, Good, HSG C
*	32,983	98	Impervious
	97,348	81	Weighted Average
	64,365		66.12% Pervious Area
	32,983		33.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	53	0.0800	0.07		**Sheet Flow, Wooded Sheet Flow** Woods: Dense underbrush n= 0.800 P2= 3.20"
1.4	197	0.0590	2.43		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.1	386	0.0770	5.63		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
15.4	636	Total			

Subcatchment 2:



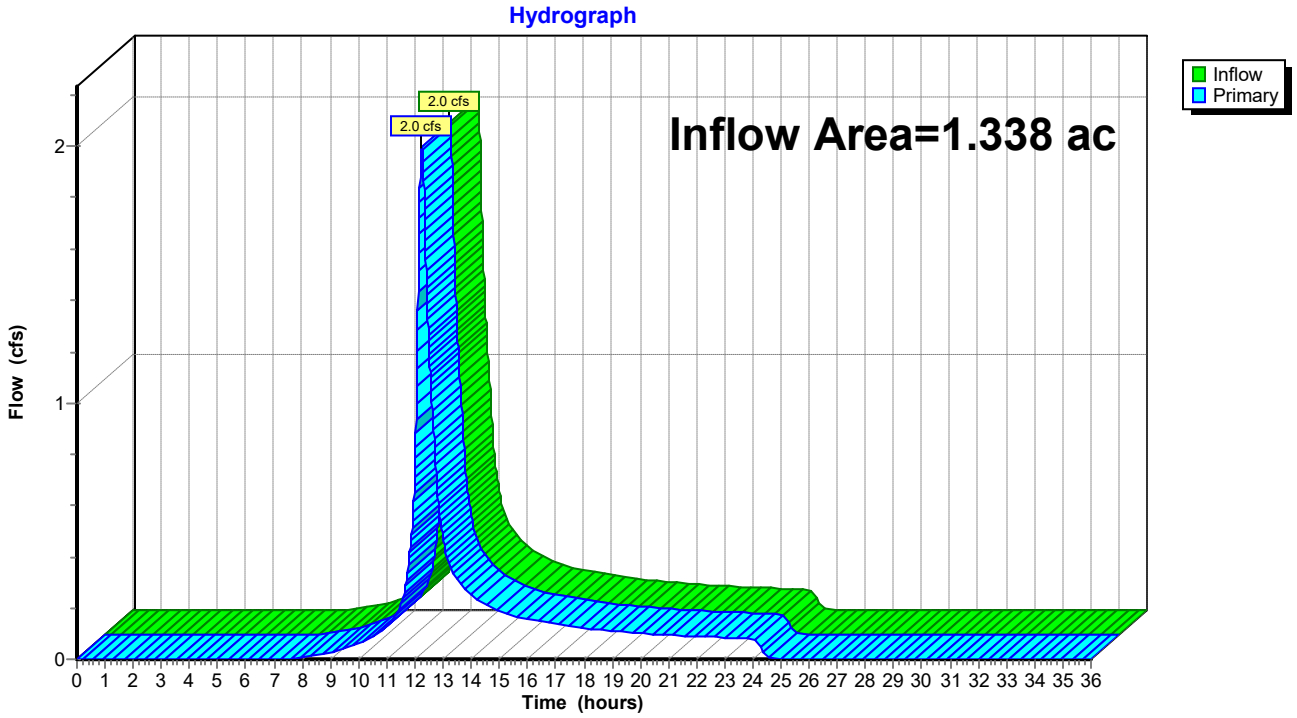
Summary for Pond 1P: SP-1

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

Inflow Area = 1.338 ac, 12.57% Impervious, Inflow Depth = 2.35" for 10-yr event
Inflow = 2.0 cfs @ 12.24 hrs, Volume= 0.262 af
Primary = 2.0 cfs @ 12.24 hrs, Volume= 0.262 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Pond 1P: SP-1



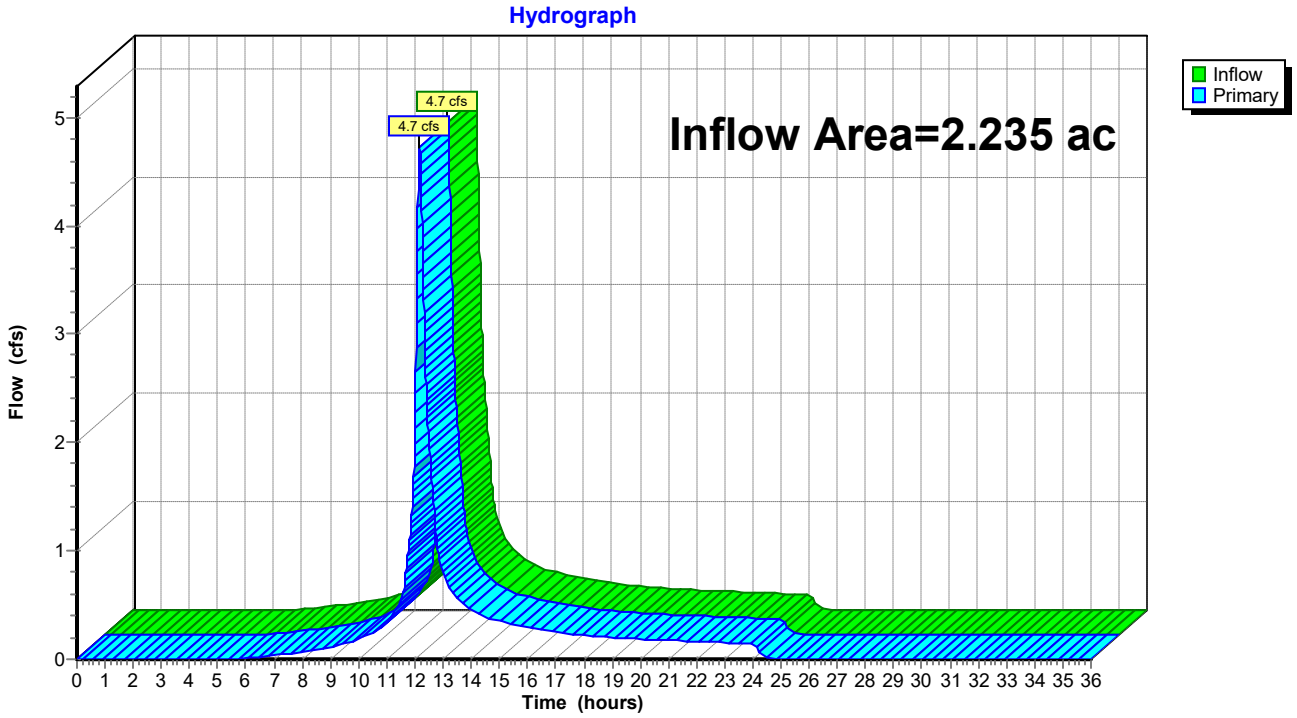
Summary for Pond 2P: SP-2

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

Inflow Area = 2.235 ac, 33.88% Impervious, Inflow Depth = 2.88" for 10-yr event
Inflow = 4.7 cfs @ 12.16 hrs, Volume= 0.536 af
Primary = 4.7 cfs @ 12.16 hrs, Volume= 0.536 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Pond 2P: SP-2



Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 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 1: Runoff Area=58,292 sf 12.57% Impervious Runoff Depth=5.92"
Flow Length=439' Tc=20.7 min CN=75 Runoff=4.6 cfs 0.661 af

Subcatchment 2: Runoff Area=97,348 sf 33.88% Impervious Runoff Depth=6.66"
Flow Length=636' Tc=15.4 min CN=81 Runoff=9.6 cfs 1.241 af

Pond 1P: SP-1 Inflow=4.6 cfs 0.661 af
Primary=4.6 cfs 0.661 af

Pond 2P: SP-2 Inflow=9.6 cfs 1.241 af
Primary=9.6 cfs 1.241 af

Total Runoff Area = 3.573 ac Runoff Volume = 1.901 af Average Runoff Depth = 6.39"
74.10% Pervious = 2.648 ac 25.90% Impervious = 0.925 ac

Summary for Subcatchment 1:

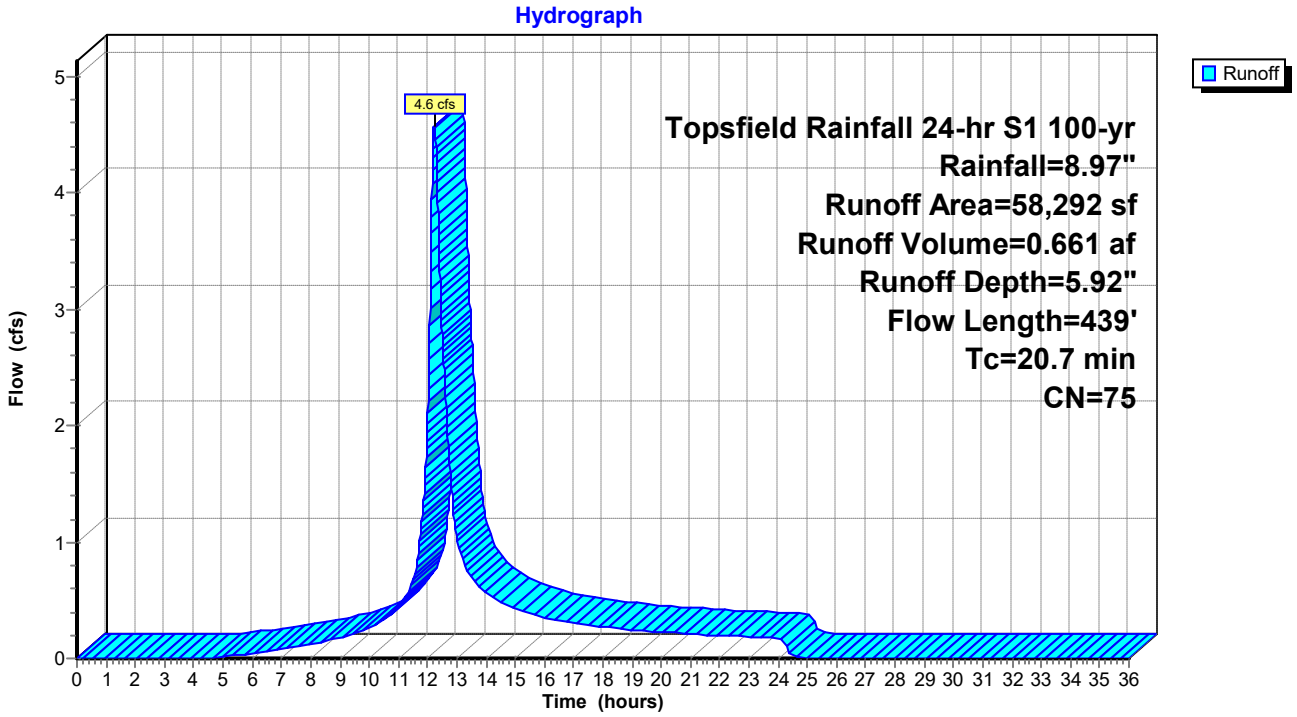
Runoff = 4.6 cfs @ 12.23 hrs, Volume= 0.661 af, Depth= 5.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Topsfield Rainfall 24-hr S1 100-yr Rainfall=8.97"

	Area (sf)	CN	Description
	29,109	70	Woods, Good, HSG C
	20,592	74	>75% Grass cover, Good, HSG C
*	7,328	98	Impervious
	570	96	Gravel surface, HSG C
*	693	72	Riprap
	58,292	75	Weighted Average
	50,964		87.43% Pervious Area
	7,328		12.57% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.7	38	0.1320	0.14		**Sheet Flow, Wooded sheet flow** Woods: Light underbrush n= 0.400 P2= 3.20"
1.1	77	0.0160	1.19		**Sheet Flow, Paved Sheet Flow** Smooth surfaces n= 0.011 P2= 3.20"
10.9	135	0.0710	0.21		**Sheet Flow, Grassed Sheet Flow** Grass: Dense n= 0.240 P2= 3.20"
0.5	48	0.0630	1.76		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.5	141	0.0710	0.67		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
20.7	439	Total			

Subcatchment 1:



Summary for Subcatchment 2:

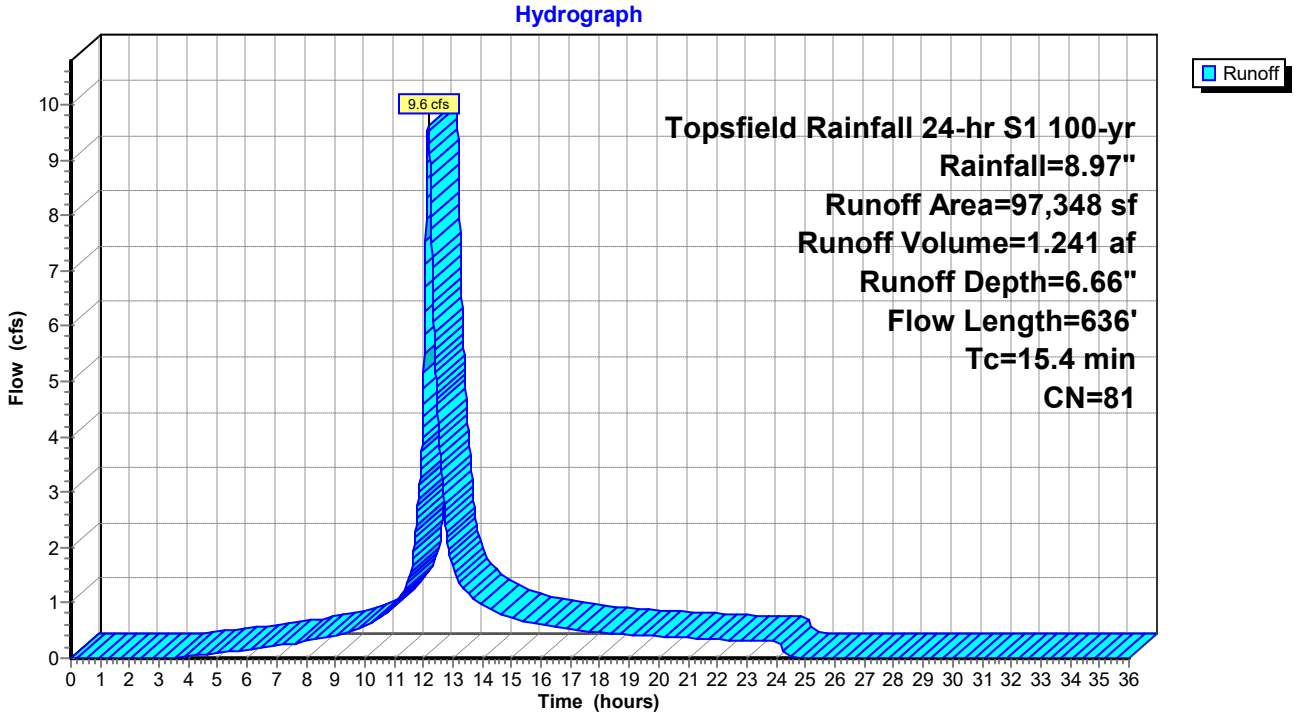
Runoff = 9.6 cfs @ 12.16 hrs, Volume= 1.241 af, Depth= 6.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Topsfield Rainfall 24-hr S1 100-yr Rainfall=8.97"

	Area (sf)	CN	Description
	31,585	70	Woods, Good, HSG C
	32,780	74	>75% Grass cover, Good, HSG C
*	32,983	98	Impervious
	97,348	81	Weighted Average
	64,365		66.12% Pervious Area
	32,983		33.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	53	0.0800	0.07		**Sheet Flow, Wooded Sheet Flow** Woods: Dense underbrush n= 0.800 P2= 3.20"
1.4	197	0.0590	2.43		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.1	386	0.0770	5.63		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
15.4	636	Total			

Subcatchment 2:



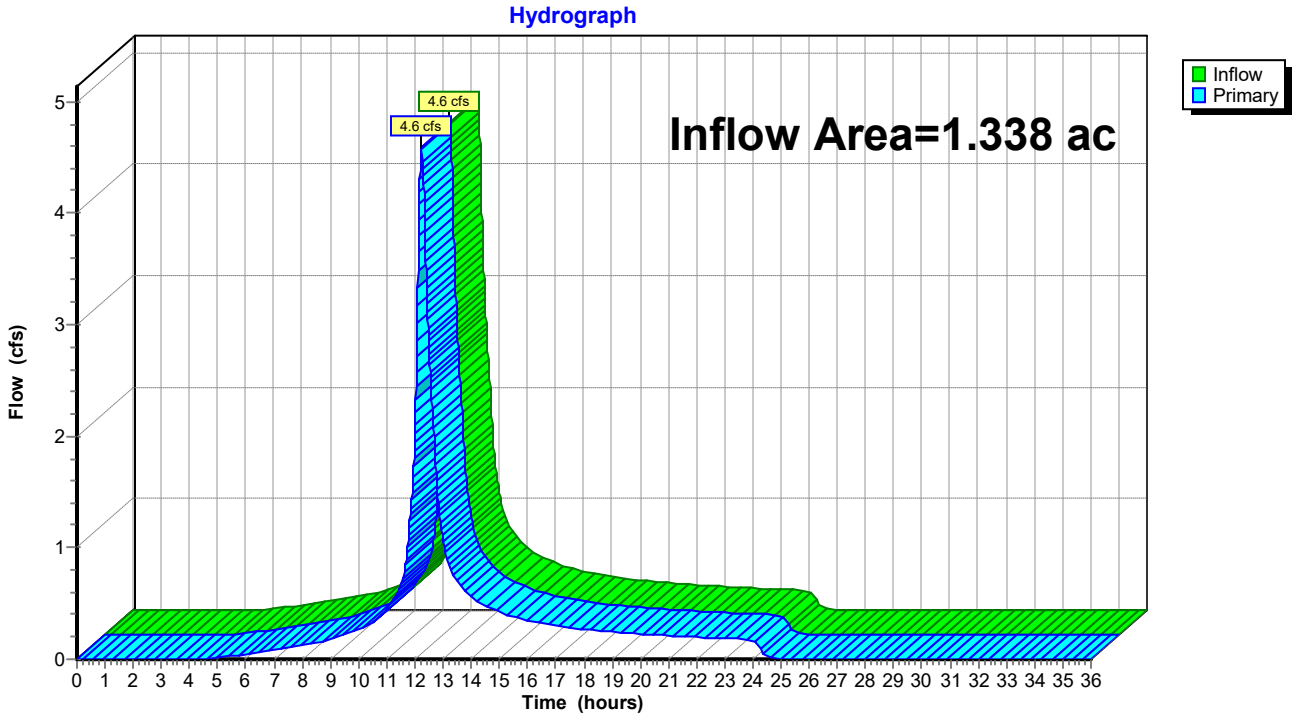
Summary for Pond 1P: SP-1

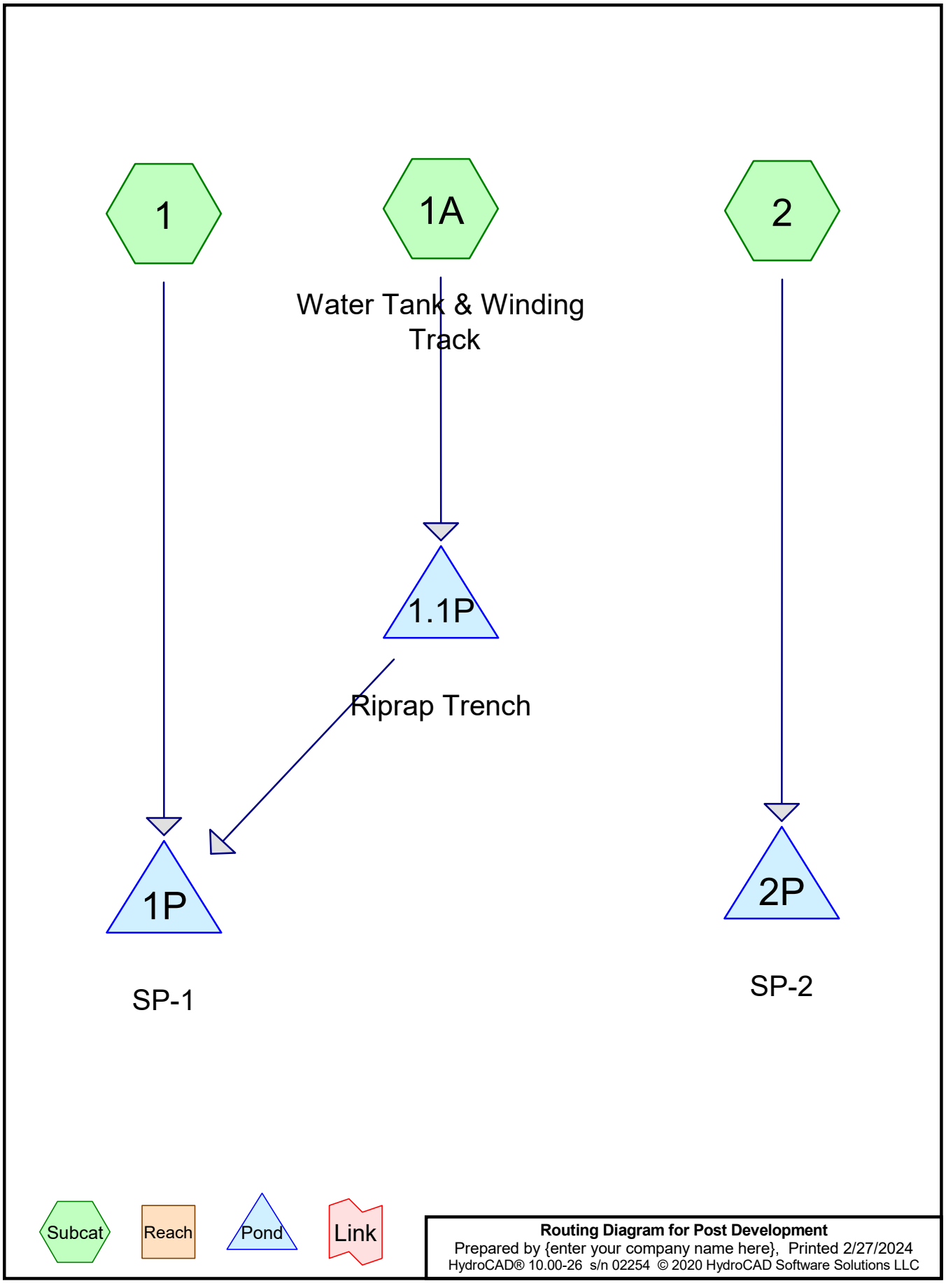
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.338 ac, 12.57% Impervious, Inflow Depth = 5.92" for 100-yr event
Inflow = 4.6 cfs @ 12.23 hrs, Volume= 0.661 af
Primary = 4.6 cfs @ 12.23 hrs, Volume= 0.661 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Pond 1P: SP-1




1
1A
2
Water Tank & Winding Track
1.1P
Riprap Trench
1P
2P
SP-1
SP-2
Subcat
Reach
Pond
Link
Routing Diagram for Post Development
Prepared by {enter your company name here}, Printed 2/27/2024
HydroCAD® 10.00-26 s/n 02254 © 2020 HydroCAD Software Solutions LLC

Project Notes

Defined 7 rainfall events from Topsfield Rainfall IDF
Copied 7 events from Topsfield Rainfall 24-hr S1 storm

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.321	74	>75% Grass cover, Good, HSG C (1, 1A, 2)
0.019	96	Gravel surface, HSG C (1)
0.911	98	Impervious (1, 2)
0.076	72	Riprap (1, 1A)
0.074	98	Roofs, HSG C (1A)
1.172	70	Woods, Good, HSG C (1, 2)
3.573	**79**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
2.586	HSG C	1, 1A, 2
0.000	HSG D	
0.987	Other	1, 1A, 2
3.573		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	1.321	0.000	0.000	1.321	>75% Grass cover, Good	1, 1A, 2
0.000	0.000	0.019	0.000	0.000	0.019	Gravel surface	1
0.000	0.000	0.000	0.000	0.911	0.911	Impervious	1, 2
0.000	0.000	0.000	0.000	0.076	0.076	Riprap	1, 1A
0.000	0.000	0.074	0.000	0.000	0.074	Roofs	1A
0.000	0.000	1.172	0.000	0.000	1.172	Woods, Good	1, 2
0.000	**0.000**	**2.586**	**0.000**	**0.987**	**3.573**	**TOTAL AREA**	

Time span=0.00-36.00 hrs, dt=0.02 hrs, 1801 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 1: Runoff Area=48,998 sf 13.65% Impervious Runoff Depth=1.15"
Flow Length=461' Tc=19.7 min CN=76 Runoff=0.9 cfs 0.108 af

Subcatchment 1A: Water Tank & Winding Runoff Area=9,294 sf 34.61% Impervious Runoff Depth=1.54"
Flow Length=34' Slope=0.0400 '/' Tc=6.0 min CN=82 Runoff=0.4 cfs 0.027 af

Subcatchment 2: Runoff Area=97,348 sf 33.88% Impervious Runoff Depth=1.47"
Flow Length=636' Tc=15.4 min CN=81 Runoff=2.6 cfs 0.274 af

Pond 1.1P: Riprap Trench Peak Elev=211.00' Storage=469 cf Inflow=0.4 cfs 0.027 af
Outflow=0.1 cfs 0.023 af

Pond 1P: SP-1 Inflow=0.9 cfs 0.131 af
Primary=0.9 cfs 0.131 af

Pond 2P: SP-2 Inflow=2.6 cfs 0.274 af
Primary=2.6 cfs 0.274 af

Total Runoff Area = 3.573 ac Runoff Volume = 0.409 af Average Runoff Depth = 1.37"
72.44% Pervious = 2.588 ac 27.56% Impervious = 0.985 ac

Summary for Subcatchment 1:

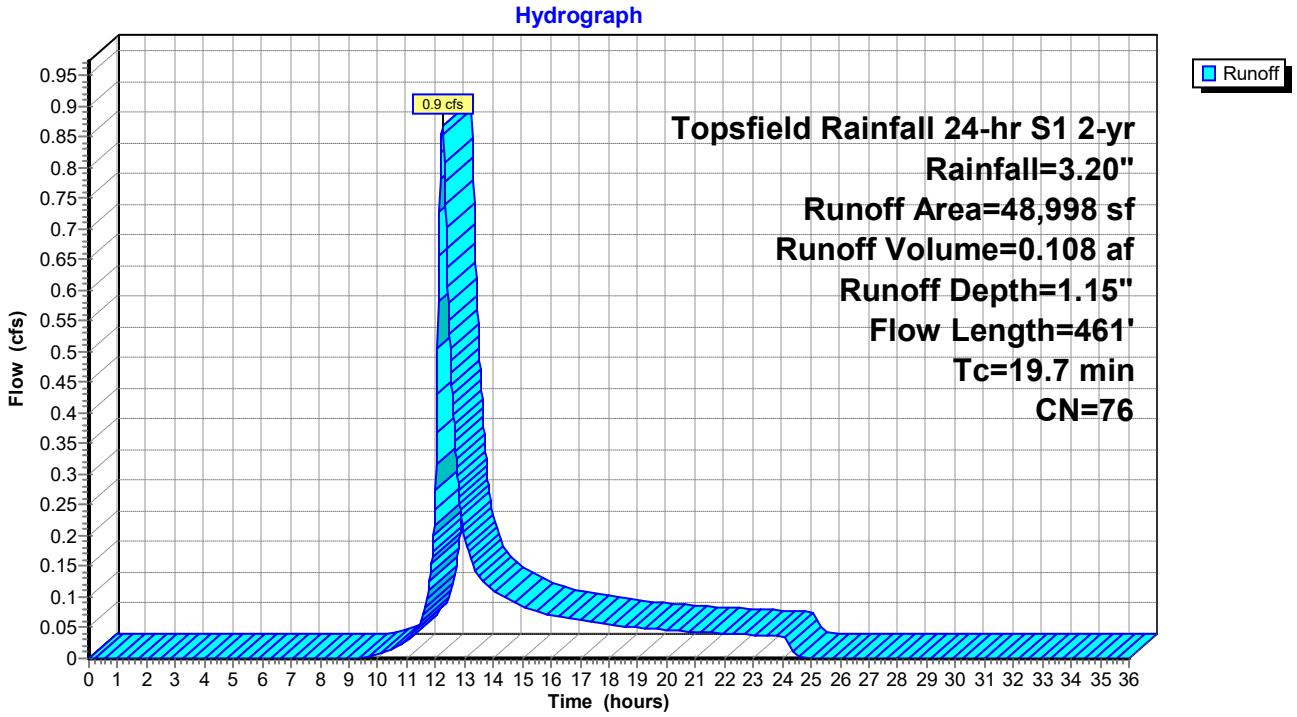
Runoff = 0.9 cfs @ 12.23 hrs, Volume= 0.108 af, Depth= 1.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Topsfield Rainfall 24-hr S1 2-yr Rainfall=3.20"

	Area (sf)	CN	Description
	21,943	70	Woods, Good, HSG C
	18,836	74	>75% Grass cover, Good, HSG C
*	6,688	98	Impervious
	838	96	Gravel surface, HSG C
*	693	72	Riprap
	48,998	76	Weighted Average
	42,310		86.35% Pervious Area
	6,688		13.65% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	30	0.0670	0.10		**Sheet Flow, Wooded sheet flow** Woods: Light underbrush n= 0.400 P2= 3.20"
1.2	90	0.0170	1.26		**Sheet Flow, Paved Sheet Flow** Smooth surfaces n= 0.011 P2= 3.20"
9.2	130	0.1000	0.23		**Sheet Flow, Grass Sheet Flow** Grass: Dense n= 0.240 P2= 3.20"
0.5	65	0.0920	2.12		**Shallow Concentrated Flow, Grassed SCF** Short Grass Pasture Kv= 7.0 fps
3.7	146	0.0680	0.65		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
19.7	461	Total			

Subcatchment 1:



Summary for Subcatchment 1A: Water Tank & Winding Track

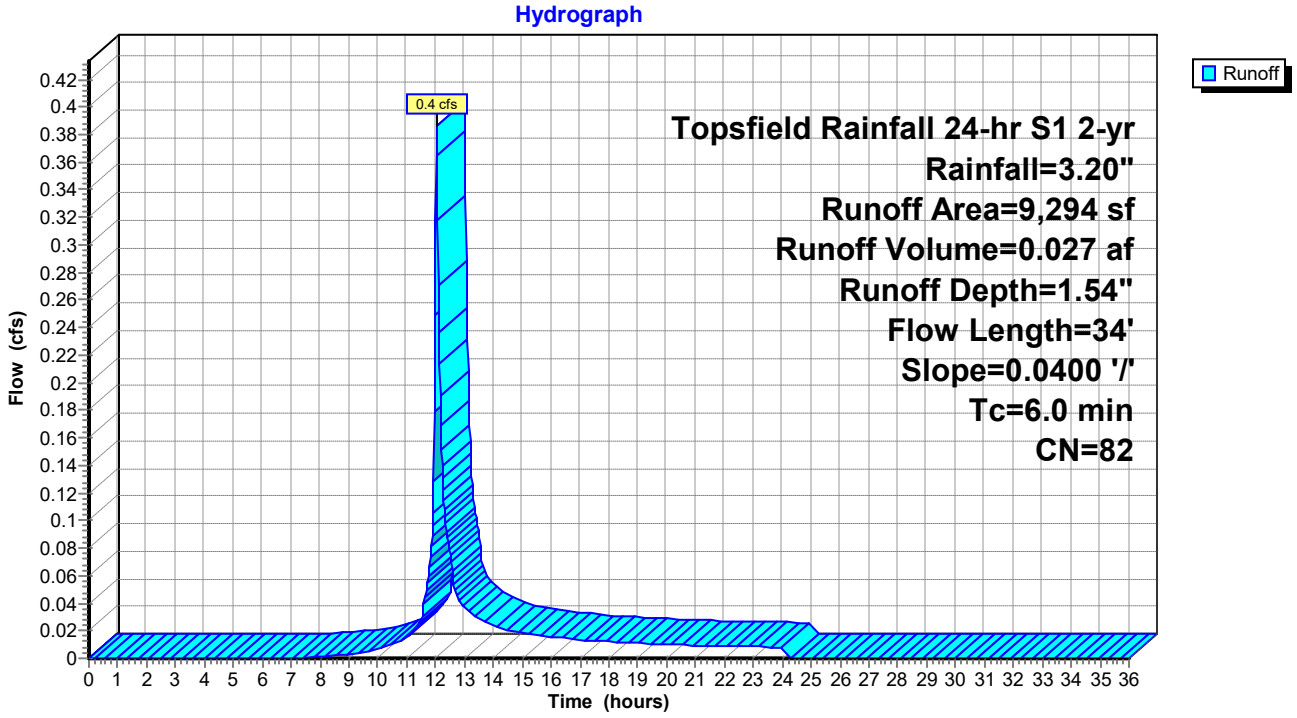
Runoff = 0.4 cfs @ 12.04 hrs, Volume= 0.027 af, Depth= 1.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Topsfield Rainfall 24-hr S1 2-yr Rainfall=3.20"

	Area (sf)	CN	Description
	3,217	98	Roofs, HSG C
	3,453	74	>75% Grass cover, Good, HSG C
*	2,624	72	Riprap
	9,294	82	Weighted Average
	6,077		65.39% Pervious Area
	3,217		34.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	34	0.0400	1.46		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
0.4	34	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 1A: Water Tank & Winding Track



Summary for Subcatchment 2:

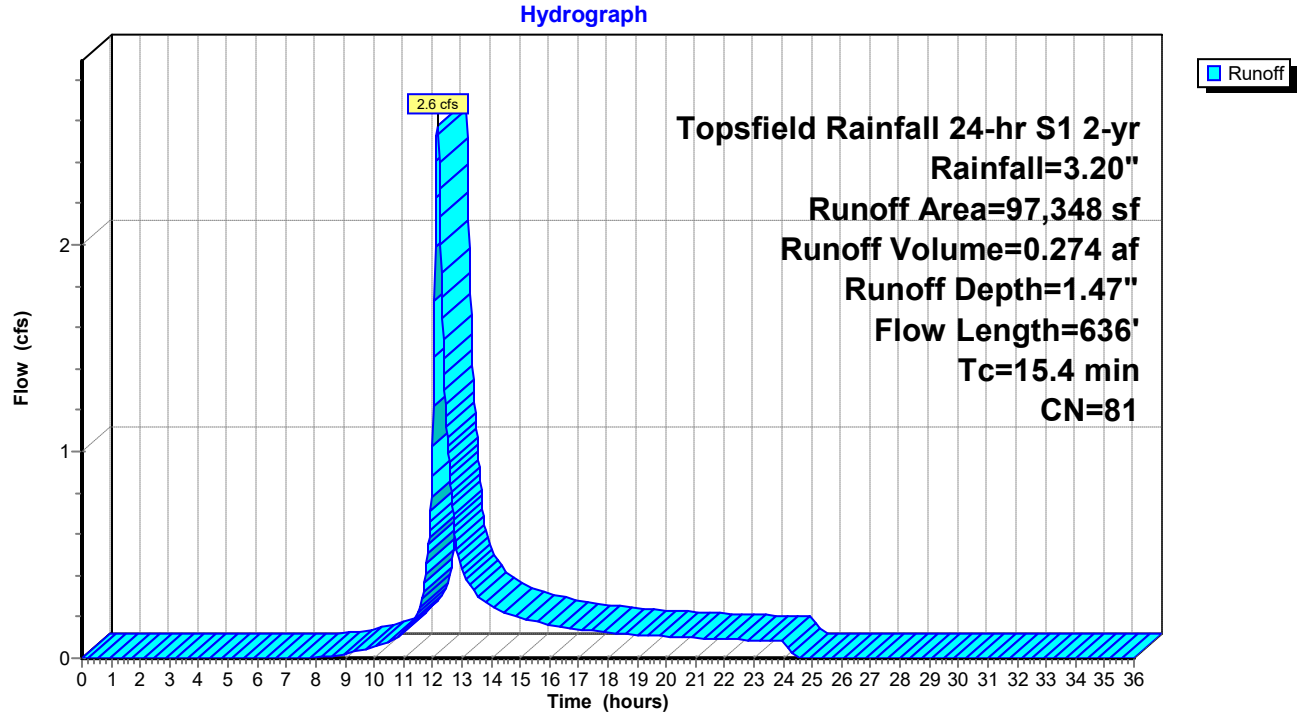
Runoff = 2.6 cfs @ 12.17 hrs, Volume= 0.274 af, Depth= 1.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Topsfield Rainfall 24-hr S1 2-yr Rainfall=3.20"

	Area (sf)	CN	Description
	29,127	70	Woods, Good, HSG C
	35,238	74	>75% Grass cover, Good, HSG C
*	32,983	98	Impervious
	97,348	81	Weighted Average
	64,365		66.12% Pervious Area
	32,983		33.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	53	0.0800	0.07		**Sheet Flow, Wooded Sheet Flow** Woods: Dense underbrush n= 0.800 P2= 3.20"
1.4	197	0.0590	2.43		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.1	386	0.0770	5.63		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
15.4	636	Total			

Subcatchment 2:



Summary for Pond 1.1P: Riprap Trench

Inflow Area = 0.213 ac, 34.61% Impervious, Inflow Depth = 1.54" for 2-yr event
Inflow = 0.4 cfs @ 12.04 hrs, Volume= 0.027 af
Outflow = 0.1 cfs @ 12.61 hrs, Volume= 0.023 af, Atten= 85%, Lag= 34.2 min
Primary = 0.1 cfs @ 12.61 hrs, Volume= 0.023 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Peak Elev= 211.00' @ 12.61 hrs Surf.Area= 380,319 sf Storage= 469 cf

Plug-Flow detention time= 178.5 min calculated for 0.023 af (86% of inflow)
Center-of-Mass det. time= 109.0 min (972.6 - 863.6)

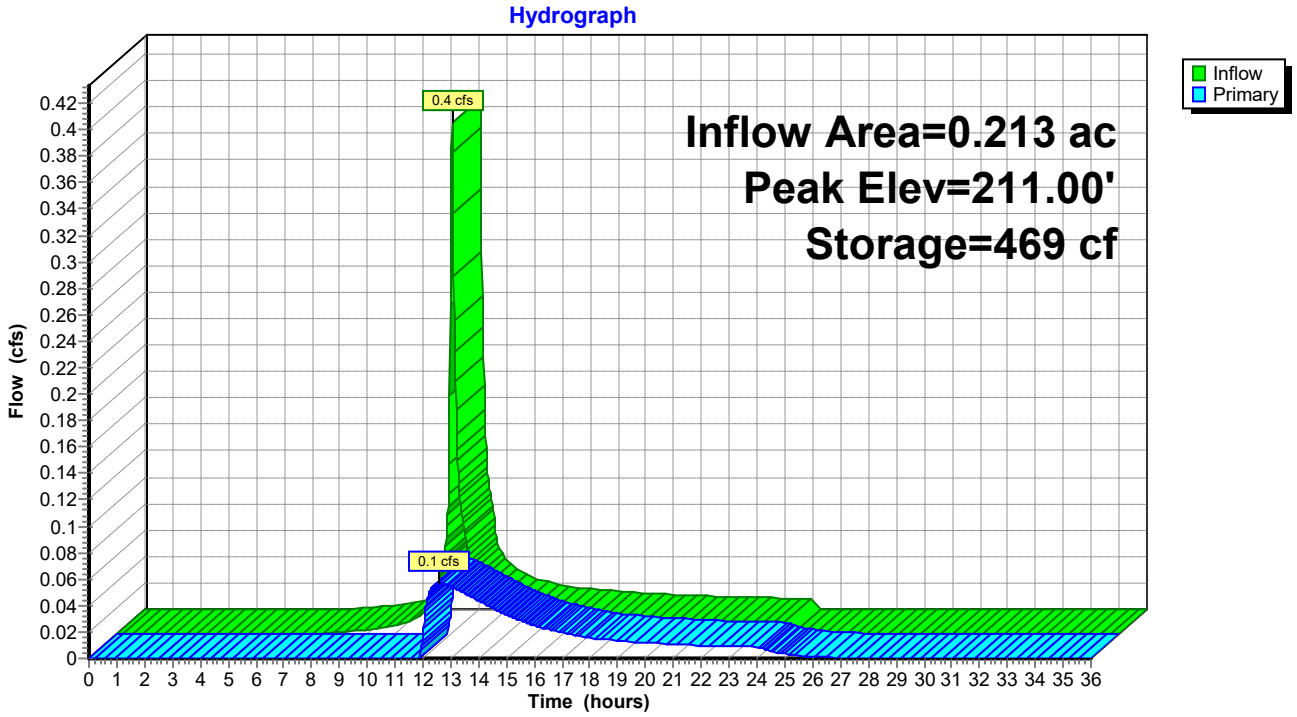
Volume	Invert	Avail.Storage	Storage Description
#1	209.50'	4,398,181 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 10,995,452 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
209.50	300	0	0
211.00	300	450	450
211.01	1,000,000	5,001	5,451
222.00	1,000,000	10,990,000	10,995,452

Device	Routing	Invert	Outlet Devices
#1	Primary	211.00'	**100.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=0.1 cfs @ 12.61 hrs HW=211.00' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.1 cfs @ 0.15 fps)

Pond 1.1P: Riprap Trench



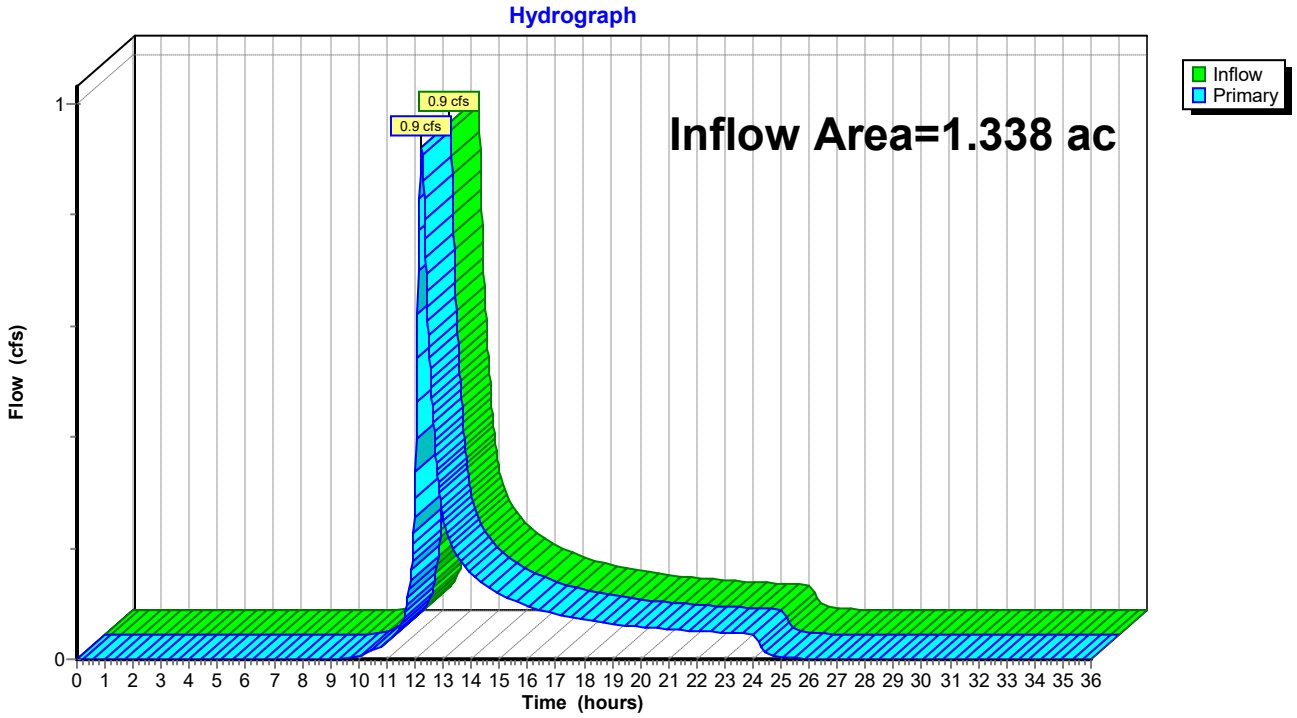
Summary for Pond 1P: SP-1

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

Inflow Area = 1.338 ac, 16.99% Impervious, Inflow Depth = 1.18" for 2-yr event
Inflow = 0.9 cfs @ 12.24 hrs, Volume= 0.131 af
Primary = 0.9 cfs @ 12.24 hrs, Volume= 0.131 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs

Pond 1P: SP-1



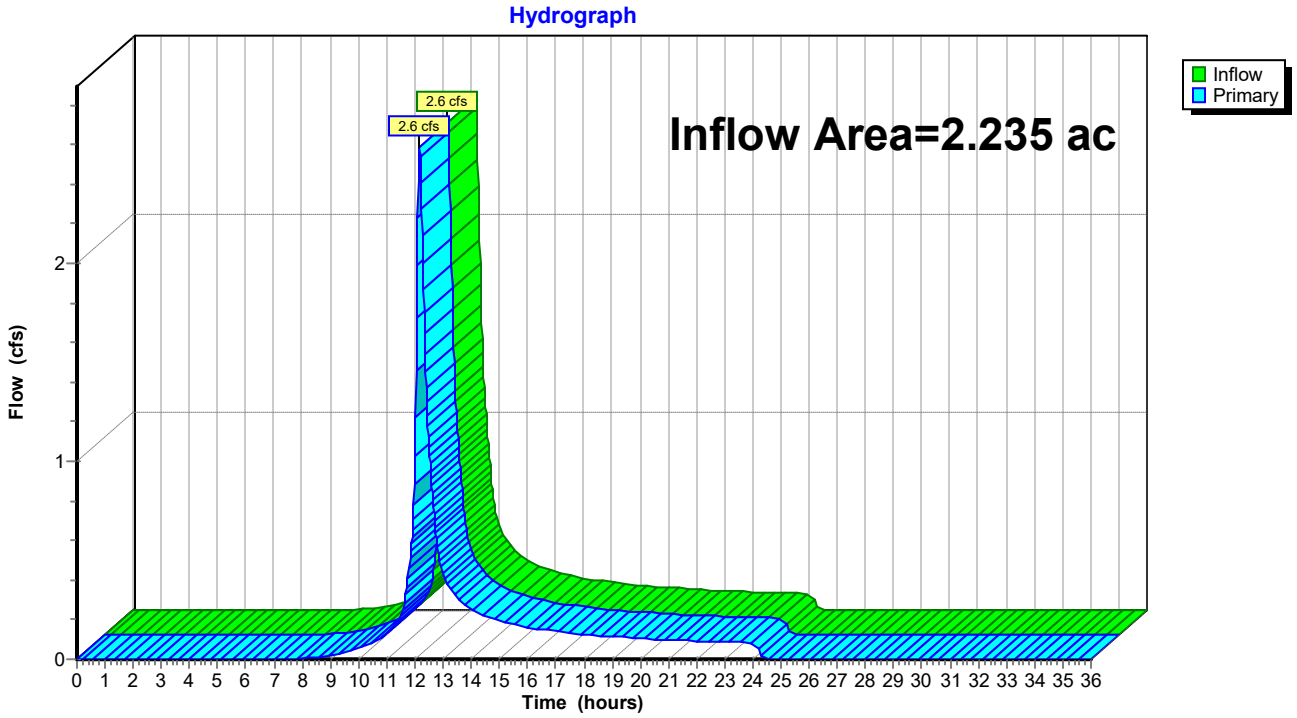
Summary for Pond 2P: SP-2

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

Inflow Area = 2.235 ac, 33.88% Impervious, Inflow Depth = 1.47" for 2-yr event
Inflow = 2.6 cfs @ 12.17 hrs, Volume= 0.274 af
Primary = 2.6 cfs @ 12.17 hrs, Volume= 0.274 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs

Pond 2P: SP-2



Time span=0.00-36.00 hrs, dt=0.02 hrs, 1801 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 1: Runoff Area=48,998 sf 13.65% Impervious Runoff Depth=2.44"
Flow Length=461' Tc=19.7 min CN=76 Runoff=1.8 cfs 0.228 af

Subcatchment 1A: Water Tank & Winding Runoff Area=9,294 sf 34.61% Impervious Runoff Depth=2.97"
Flow Length=34' Slope=0.0400 '/' Tc=6.0 min CN=82 Runoff=0.7 cfs 0.053 af

Subcatchment 2: Runoff Area=97,348 sf 33.88% Impervious Runoff Depth=2.88"
Flow Length=636' Tc=15.4 min CN=81 Runoff=4.7 cfs 0.536 af

Pond 1.1P: Riprap Trench Peak Elev=211.01' Storage=885 cf Inflow=0.7 cfs 0.053 af
Outflow=0.1 cfs 0.049 af

Pond 1P: SP-1 Inflow=1.9 cfs 0.277 af
Primary=1.9 cfs 0.277 af

Pond 2P: SP-2 Inflow=4.7 cfs 0.536 af
Primary=4.7 cfs 0.536 af

Total Runoff Area = 3.573 ac Runoff Volume = 0.818 af Average Runoff Depth = 2.75"
72.44% Pervious = 2.588 ac 27.56% Impervious = 0.985 ac

Summary for Subcatchment 1:

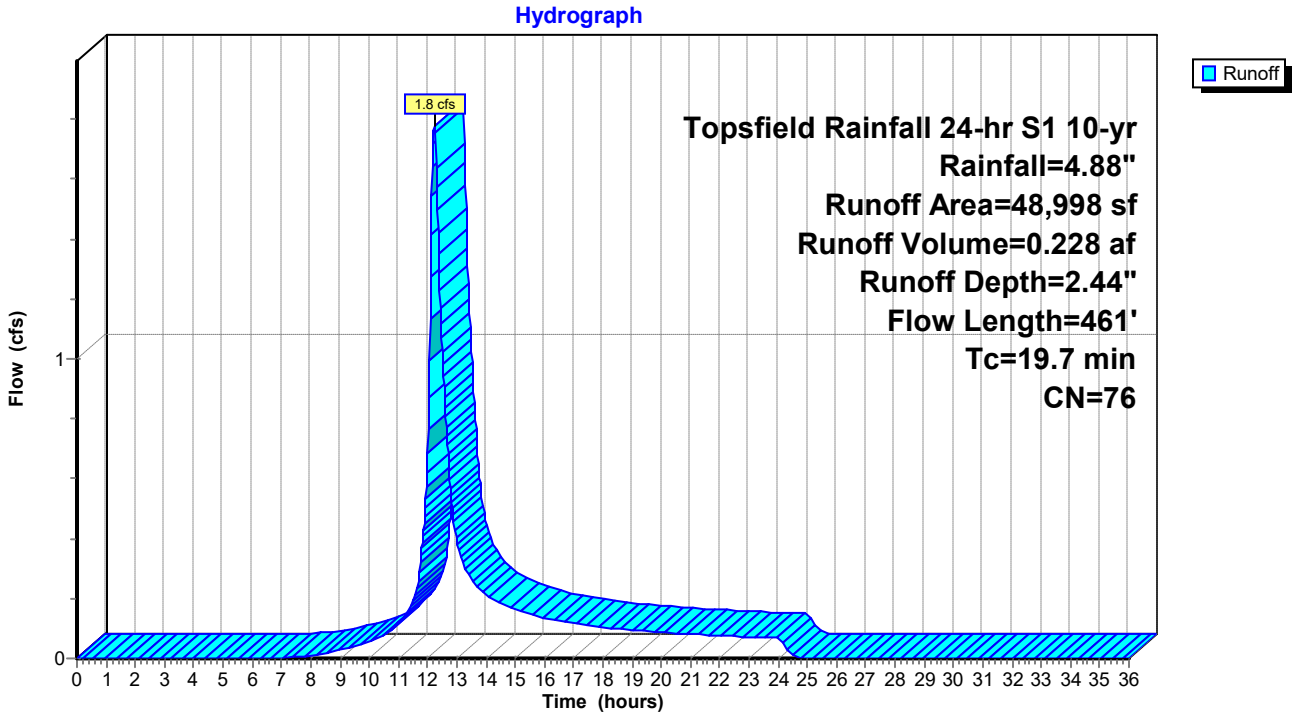
Runoff = 1.8 cfs @ 12.23 hrs, Volume= 0.228 af, Depth= 2.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Topsfield Rainfall 24-hr S1 10-yr Rainfall=4.88"

	Area (sf)	CN	Description
	21,943	70	Woods, Good, HSG C
	18,836	74	>75% Grass cover, Good, HSG C
*	6,688	98	Impervious
	838	96	Gravel surface, HSG C
*	693	72	Riprap
	48,998	76	Weighted Average
	42,310		86.35% Pervious Area
	6,688		13.65% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	30	0.0670	0.10		**Sheet Flow, Wooded sheet flow** Woods: Light underbrush n= 0.400 P2= 3.20"
1.2	90	0.0170	1.26		**Sheet Flow, Paved Sheet Flow** Smooth surfaces n= 0.011 P2= 3.20"
9.2	130	0.1000	0.23		**Sheet Flow, Grass Sheet Flow** Grass: Dense n= 0.240 P2= 3.20"
0.5	65	0.0920	2.12		**Shallow Concentrated Flow, Grassed SCF** Short Grass Pasture Kv= 7.0 fps
3.7	146	0.0680	0.65		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
19.7	461	Total			

Subcatchment 1:



Summary for Subcatchment 1A: Water Tank & Winding Track

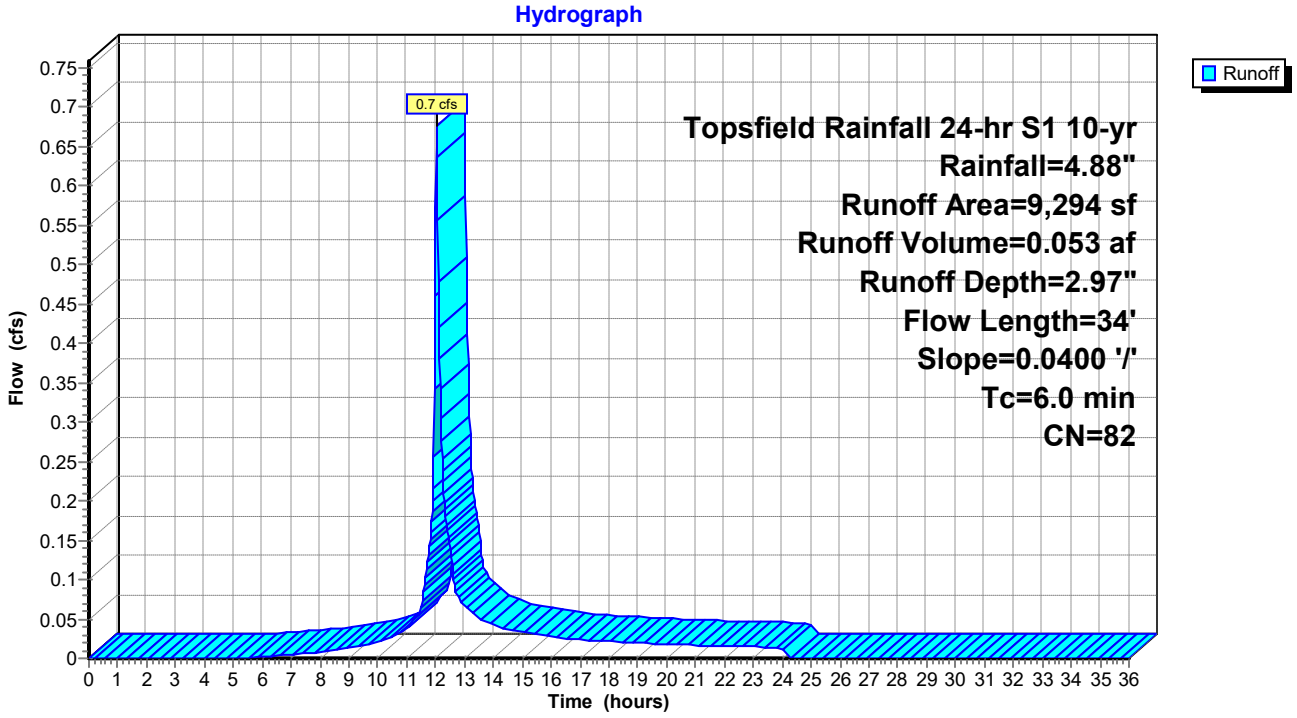
Runoff = 0.7 cfs @ 12.04 hrs, Volume= 0.053 af, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Topsfield Rainfall 24-hr S1 10-yr Rainfall=4.88"

	Area (sf)	CN	Description
	3,217	98	Roofs, HSG C
	3,453	74	>75% Grass cover, Good, HSG C
*	2,624	72	Riprap
	9,294	82	Weighted Average
	6,077		65.39% Pervious Area
	3,217		34.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	34	0.0400	1.46		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
0.4	34	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 1A: Water Tank & Winding Track



Summary for Subcatchment 2:

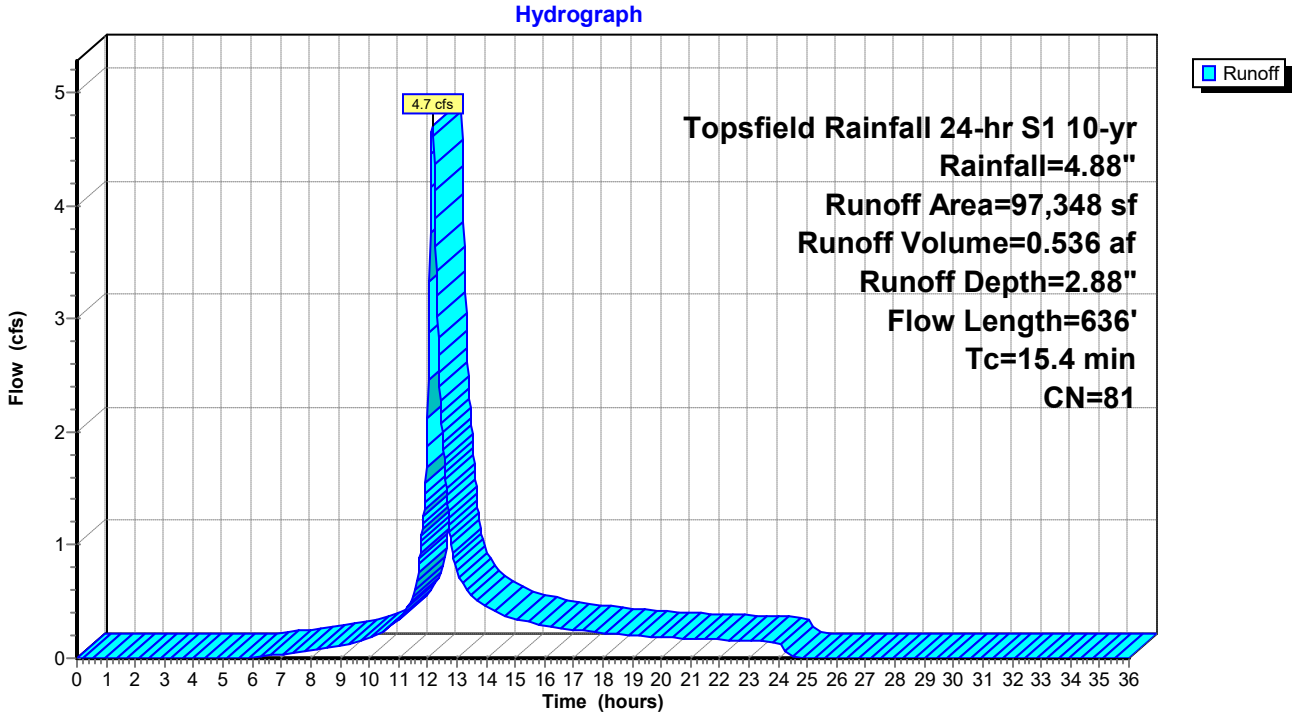
Runoff = 4.7 cfs @ 12.16 hrs, Volume= 0.536 af, Depth= 2.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Topsfield Rainfall 24-hr S1 10-yr Rainfall=4.88"

	Area (sf)	CN	Description
	29,127	70	Woods, Good, HSG C
	35,238	74	>75% Grass cover, Good, HSG C
*	32,983	98	Impervious
	97,348	81	Weighted Average
	64,365		66.12% Pervious Area
	32,983		33.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	53	0.0800	0.07		**Sheet Flow, Wooded Sheet Flow** Woods: Dense underbrush n= 0.800 P2= 3.20"
1.4	197	0.0590	2.43		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.1	386	0.0770	5.63		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
15.4	636	Total			

Subcatchment 2:



Summary for Pond 1.1P: Riprap Trench

Inflow Area = 0.213 ac, 34.61% Impervious, Inflow Depth = 2.97" for 10-yr event
Inflow = 0.7 cfs @ 12.04 hrs, Volume= 0.053 af
Outflow = 0.1 cfs @ 12.59 hrs, Volume= 0.049 af, Atten= 84%, Lag= 33.2 min
Primary = 0.1 cfs @ 12.59 hrs, Volume= 0.049 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Peak Elev= 211.01' @ 12.59 hrs Surf.Area= 593,798 sf Storage= 885 cf

Plug-Flow detention time= 151.9 min calculated for 0.049 af (93% of inflow)
Center-of-Mass det. time= 111.2 min (951.9 - 840.7)

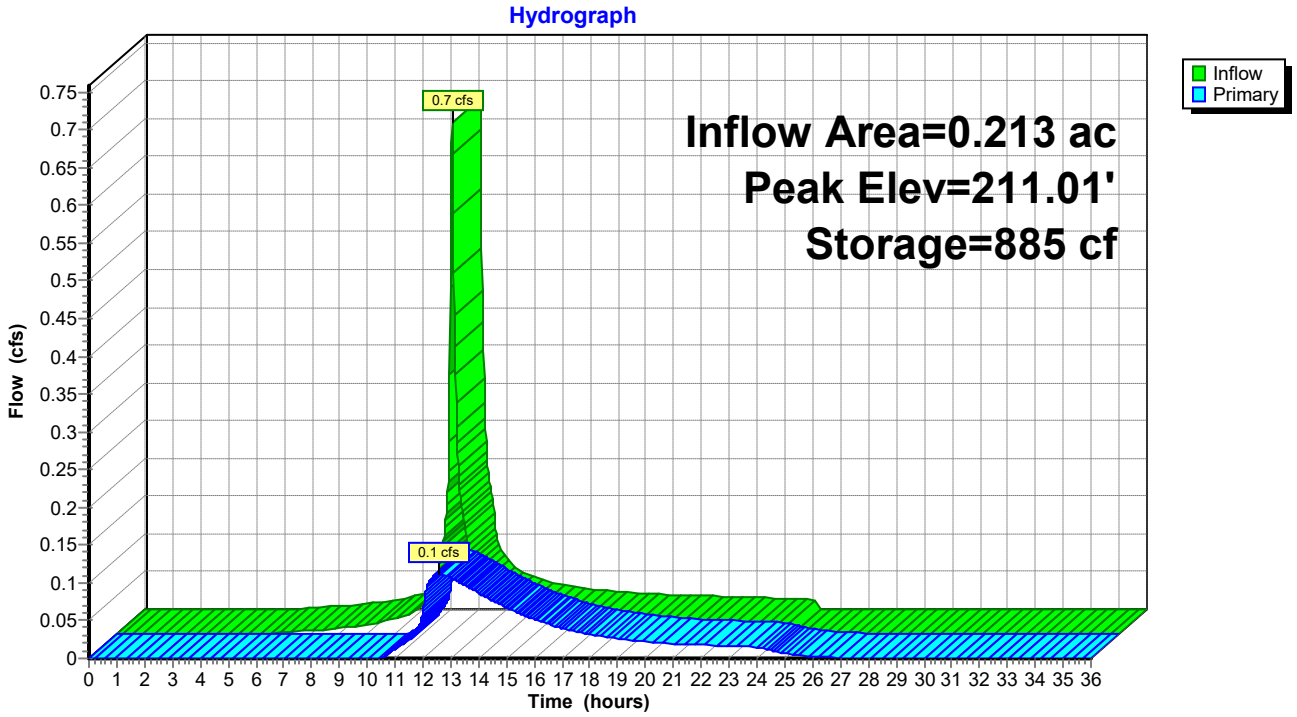
Volume	Invert	Avail.Storage	Storage Description
#1	209.50'	4,398,181 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 10,995,452 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
209.50	300	0	0
211.00	300	450	450
211.01	1,000,000	5,001	5,451
222.00	1,000,000	10,990,000	10,995,452

Device	Routing	Invert	Outlet Devices
#1	Primary	211.00'	**100.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=0.1 cfs @ 12.59 hrs HW=211.01' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.1 cfs @ 0.19 fps)

Pond 1.1P: Riprap Trench



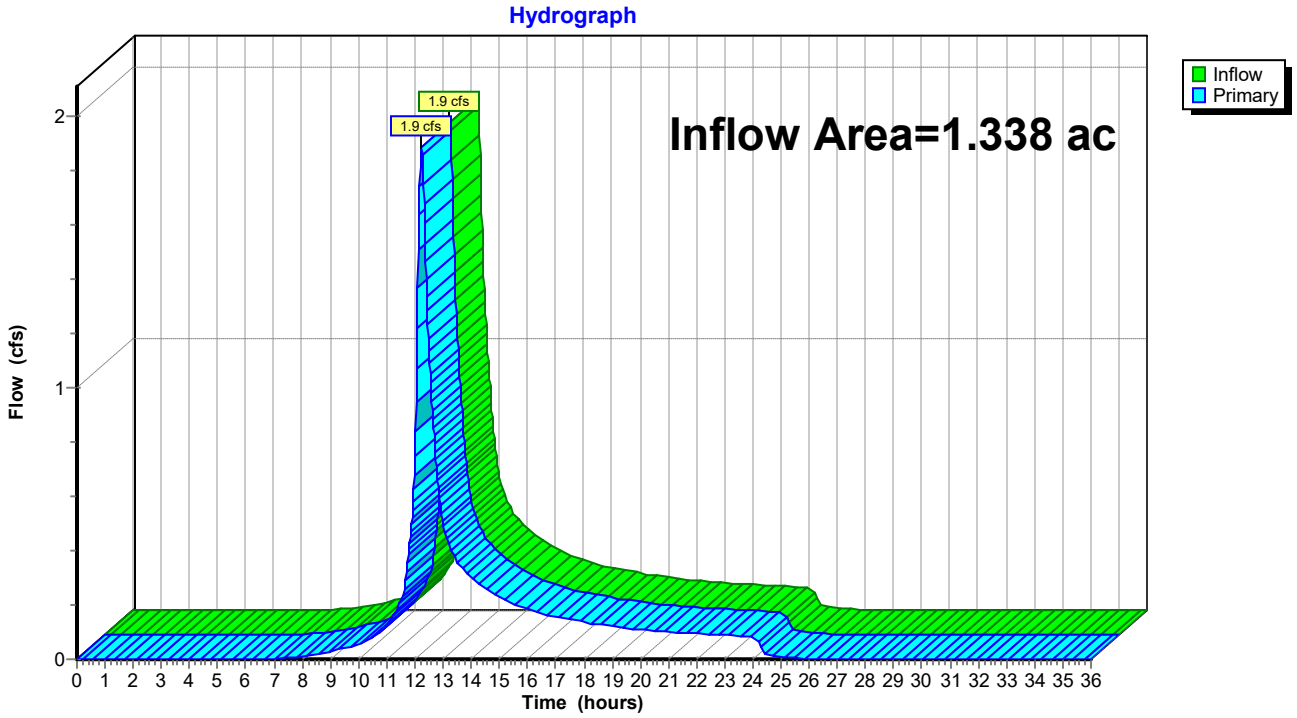
Summary for Pond 1P: SP-1

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

Inflow Area = 1.338 ac, 16.99% Impervious, Inflow Depth = 2.49" for 10-yr event
Inflow = 1.9 cfs @ 12.23 hrs, Volume= 0.277 af
Primary = 1.9 cfs @ 12.23 hrs, Volume= 0.277 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs

Pond 1P: SP-1



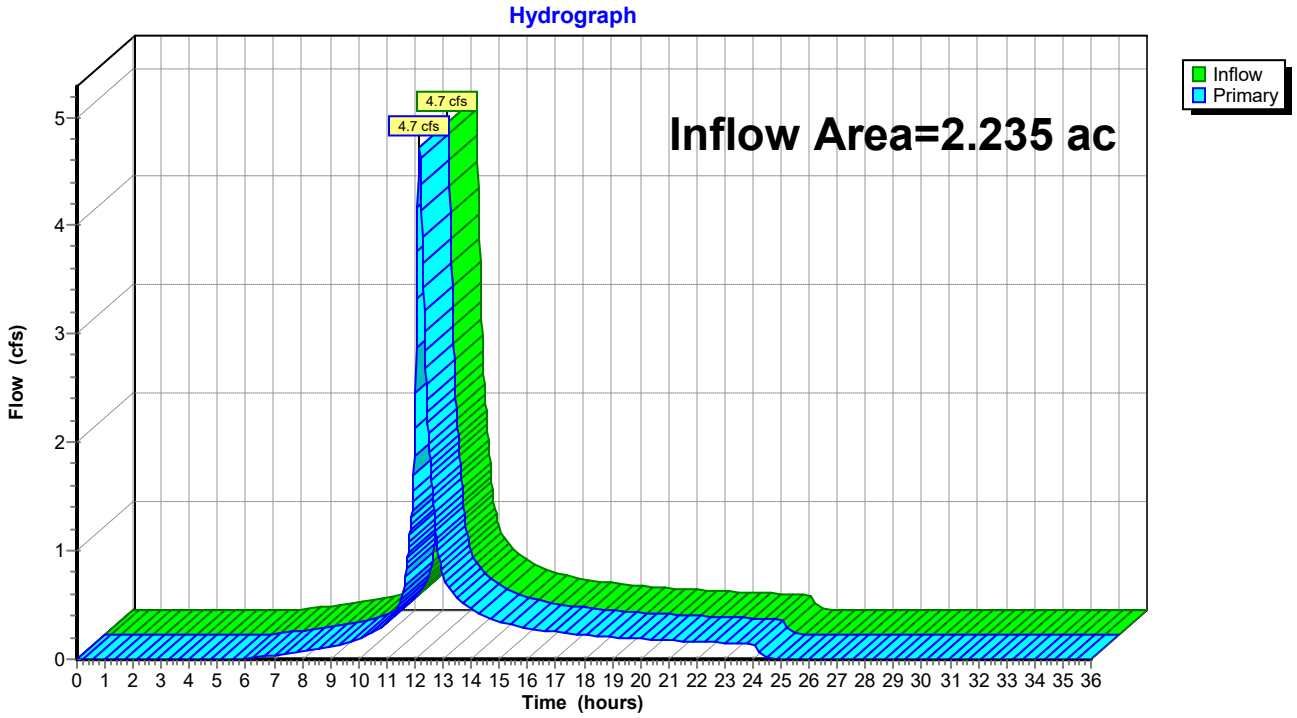
Summary for Pond 2P: SP-2

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

Inflow Area = 2.235 ac, 33.88% Impervious, Inflow Depth = 2.88" for 10-yr event
Inflow = 4.7 cfs @ 12.16 hrs, Volume= 0.536 af
Primary = 4.7 cfs @ 12.16 hrs, Volume= 0.536 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs

Pond 2P: SP-2



Time span=0.00-36.00 hrs, dt=0.02 hrs, 1801 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 1: Runoff Area=48,998 sf 13.65% Impervious Runoff Depth=6.05"
Flow Length=461' Tc=19.7 min CN=76 Runoff=4.0 cfs 0.567 af

Subcatchment 1A: Water Tank & Winding Runoff Area=9,294 sf 34.61% Impervious Runoff Depth=6.79"
Flow Length=34' Slope=0.0400 '/' Tc=6.0 min CN=82 Runoff=1.3 cfs 0.121 af

Subcatchment 2: Runoff Area=97,348 sf 33.88% Impervious Runoff Depth=6.66"
Flow Length=636' Tc=15.4 min CN=81 Runoff=9.6 cfs 1.241 af

Pond 1.1P: Riprap Trench Peak Elev=211.01' Storage=1,885 cf Inflow=1.3 cfs 0.121 af
Outflow=0.2 cfs 0.117 af

Pond 1P: SP-1 Inflow=4.2 cfs 0.684 af
Primary=4.2 cfs 0.684 af

Pond 2P: SP-2 Inflow=9.6 cfs 1.241 af
Primary=9.6 cfs 1.241 af

Total Runoff Area = 3.573 ac Runoff Volume = 1.928 af Average Runoff Depth = 6.48"
72.44% Pervious = 2.588 ac 27.56% Impervious = 0.985 ac

Summary for Subcatchment 1:

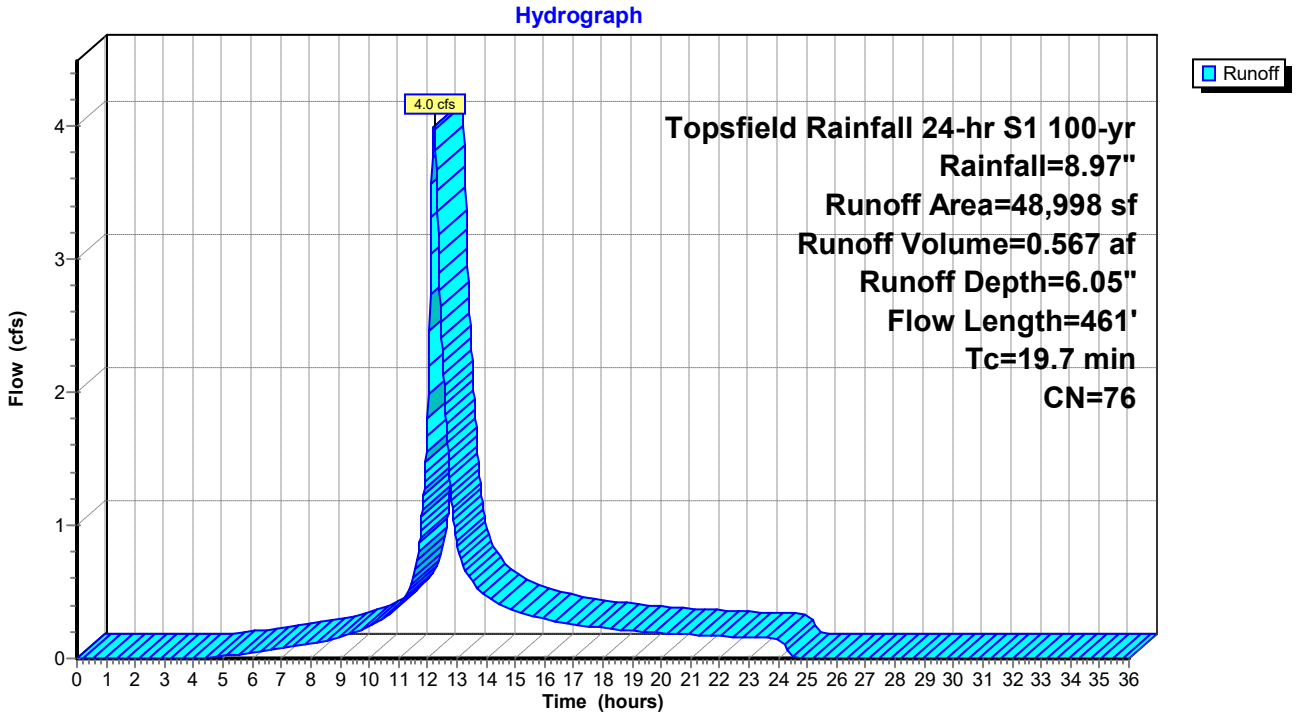
Runoff = 4.0 cfs @ 12.22 hrs, Volume= 0.567 af, Depth= 6.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Topsfield Rainfall 24-hr S1 100-yr Rainfall=8.97"

	Area (sf)	CN	Description
	21,943	70	Woods, Good, HSG C
	18,836	74	>75% Grass cover, Good, HSG C
*	6,688	98	Impervious
	838	96	Gravel surface, HSG C
*	693	72	Riprap
	48,998	76	Weighted Average
	42,310		86.35% Pervious Area
	6,688		13.65% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.1	30	0.0670	0.10		**Sheet Flow, Wooded sheet flow** Woods: Light underbrush n= 0.400 P2= 3.20"
1.2	90	0.0170	1.26		**Sheet Flow, Paved Sheet Flow** Smooth surfaces n= 0.011 P2= 3.20"
9.2	130	0.1000	0.23		**Sheet Flow, Grass Sheet Flow** Grass: Dense n= 0.240 P2= 3.20"
0.5	65	0.0920	2.12		**Shallow Concentrated Flow, Grassed SCF** Short Grass Pasture Kv= 7.0 fps
3.7	146	0.0680	0.65		**Shallow Concentrated Flow,** Forest w/Heavy Litter Kv= 2.5 fps
19.7	461	Total			

Subcatchment 1:



Summary for Subcatchment 1A: Water Tank & Winding Track

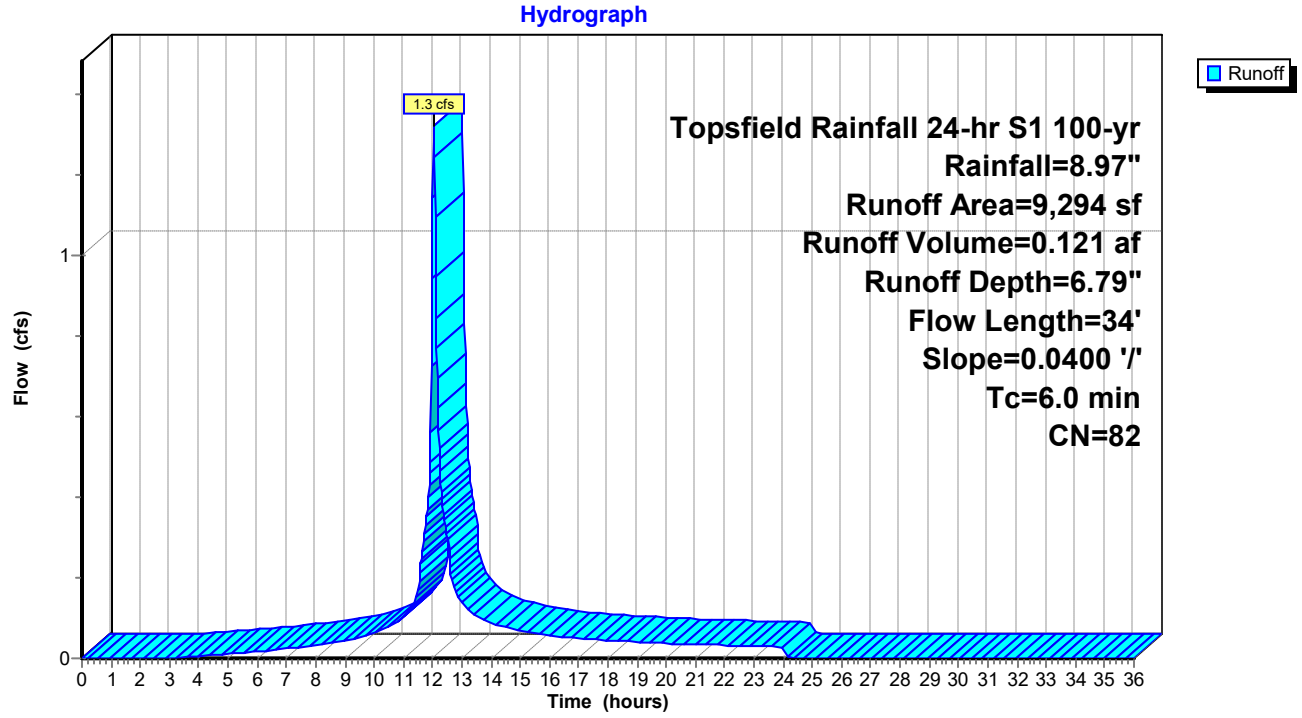
Runoff = 1.3 cfs @ 12.04 hrs, Volume= 0.121 af, Depth= 6.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Topsfield Rainfall 24-hr S1 100-yr Rainfall=8.97"

	Area (sf)	CN	Description
	3,217	98	Roofs, HSG C
	3,453	74	>75% Grass cover, Good, HSG C
*	2,624	72	Riprap
	9,294	82	Weighted Average
	6,077		65.39% Pervious Area
	3,217		34.61% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	34	0.0400	1.46		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
0.4	34	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 1A: Water Tank & Winding Track



Summary for Subcatchment 2:

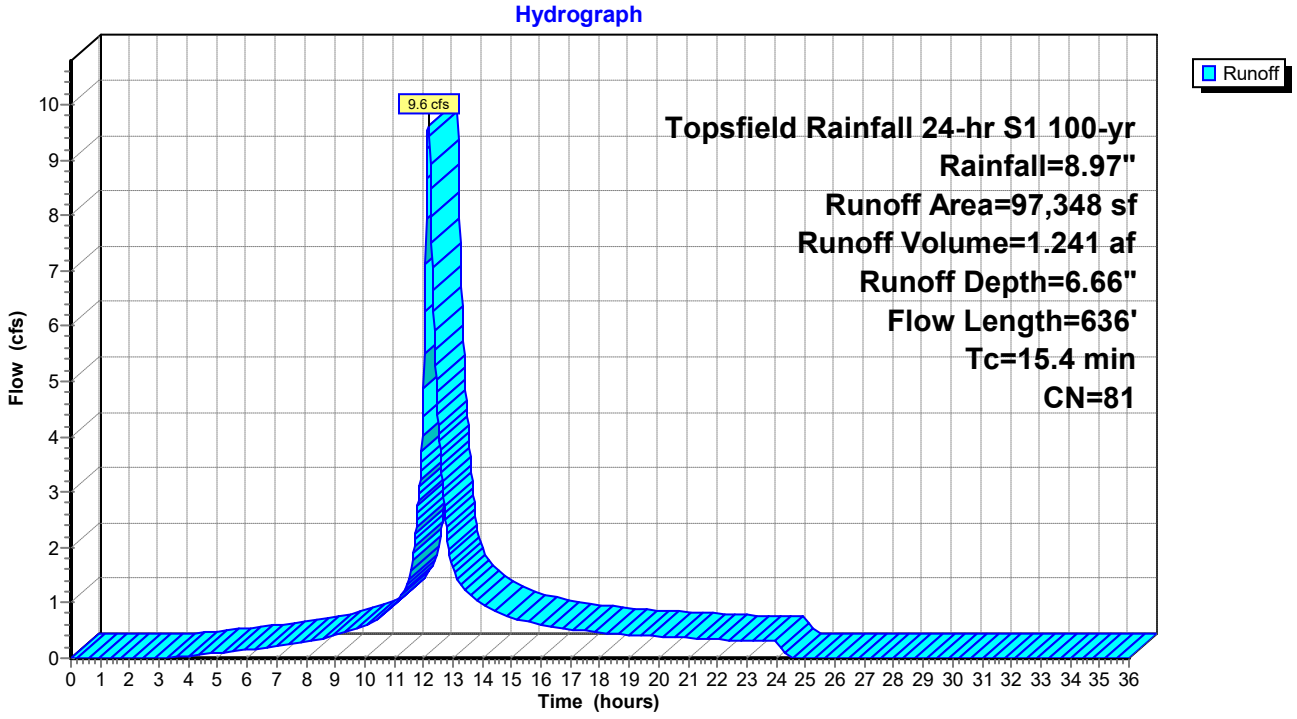
Runoff = 9.6 cfs @ 12.16 hrs, Volume= 1.241 af, Depth= 6.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Topsfield Rainfall 24-hr S1 100-yr Rainfall=8.97"

	Area (sf)	CN	Description
	29,127	70	Woods, Good, HSG C
	35,238	74	>75% Grass cover, Good, HSG C
*	32,983	98	Impervious
	97,348	81	Weighted Average
	64,365		66.12% Pervious Area
	32,983		33.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.9	53	0.0800	0.07		**Sheet Flow, Wooded Sheet Flow** Woods: Dense underbrush n= 0.800 P2= 3.20"
1.4	197	0.0590	2.43		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.20"
1.1	386	0.0770	5.63		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
15.4	636	Total			

Subcatchment 2:



Summary for Pond 1.1P: Riprap Trench

Inflow Area = 0.213 ac, 34.61% Impervious, Inflow Depth = 6.79" for 100-yr event
Inflow = 1.3 cfs @ 12.04 hrs, Volume= 0.121 af
Outflow = 0.2 cfs @ 12.61 hrs, Volume= 0.117 af, Atten= 84%, Lag= 34.4 min
Primary = 0.2 cfs @ 12.61 hrs, Volume= 0.117 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs
Peak Elev= 211.01' @ 12.61 hrs Surf.Area= 923,114 sf Storage= 1,885 cf

Plug-Flow detention time= 140.6 min calculated for 0.117 af (97% of inflow)
Center-of-Mass det. time= 121.1 min (931.9 - 810.8)

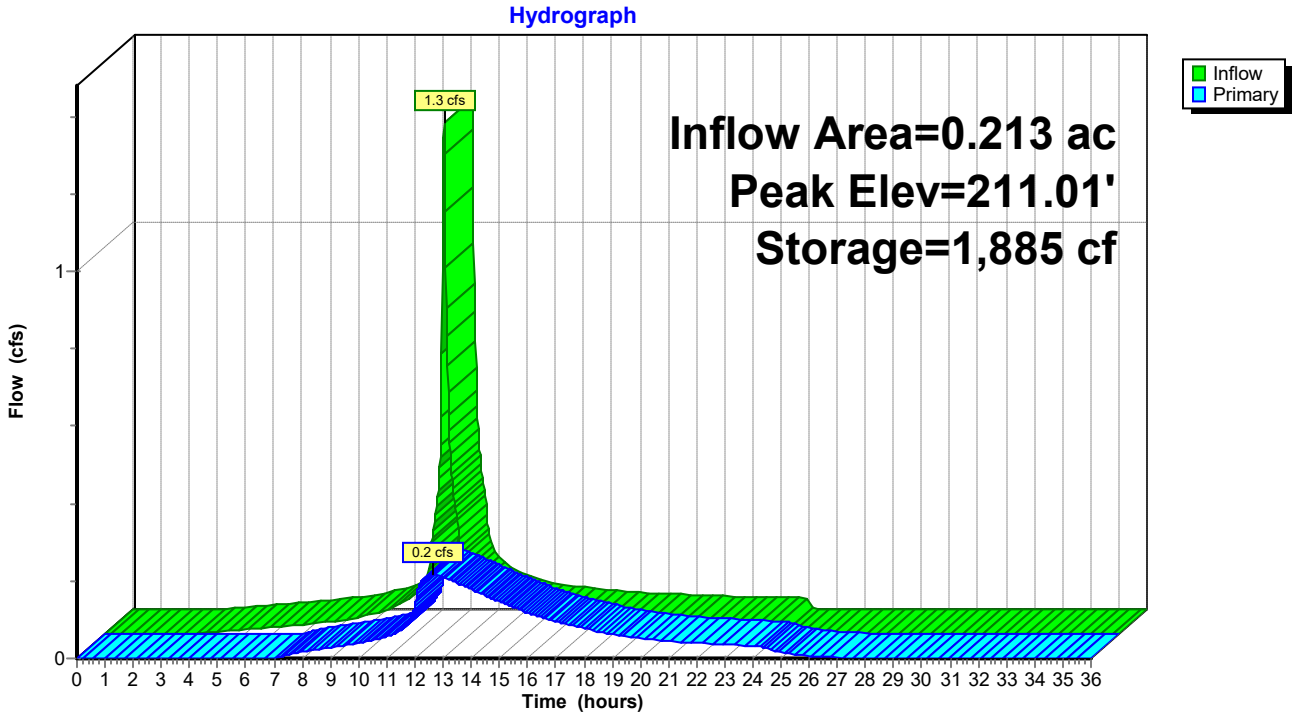
Volume	Invert	Avail.Storage	Storage Description
#1	209.50'	4,398,181 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 10,995,452 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
209.50	300	0	0
211.00	300	450	450
211.01	1,000,000	5,001	5,451
222.00	1,000,000	10,990,000	10,995,452

Device	Routing	Invert	Outlet Devices
#1	Primary	211.00'	**100.0' long x 3.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=0.2 cfs @ 12.61 hrs HW=211.01' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.2 cfs @ 0.23 fps)

Pond 1.1P: Riprap Trench



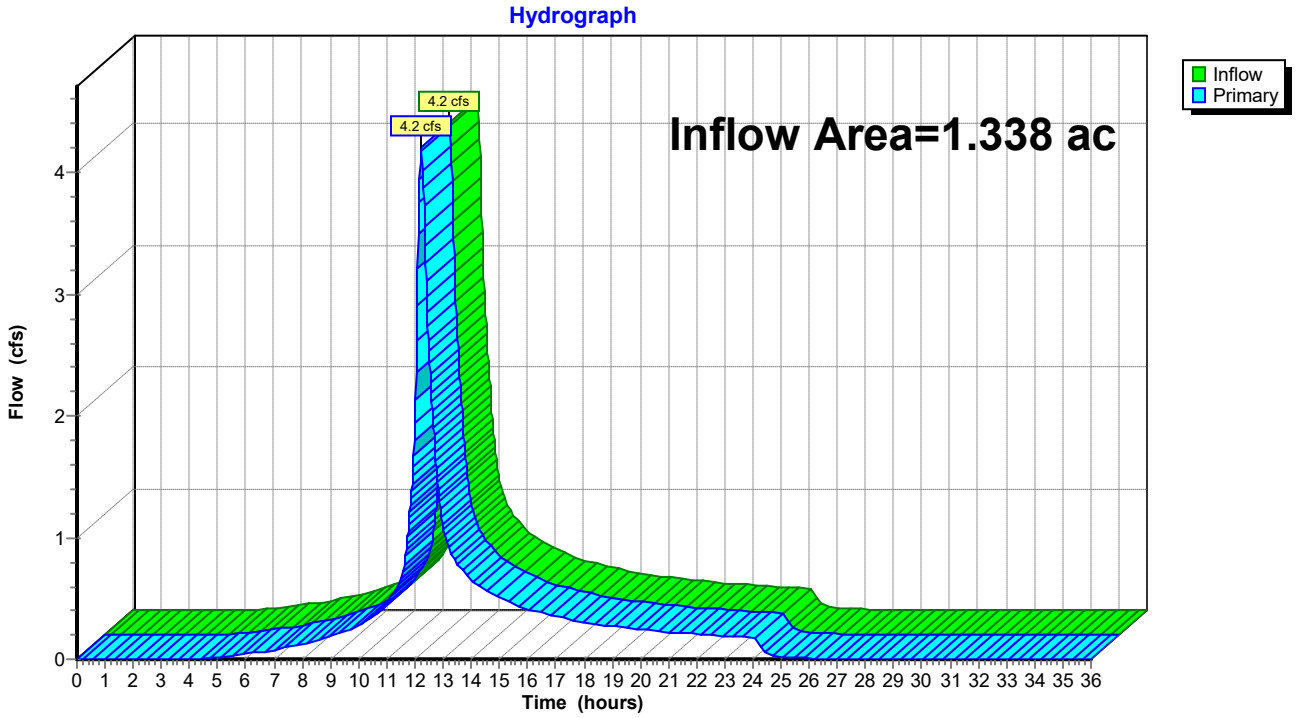
Summary for Pond 1P: SP-1

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

Inflow Area = 1.338 ac, 16.99% Impervious, Inflow Depth = 6.13" for 100-yr event
Inflow = 4.2 cfs @ 12.22 hrs, Volume= 0.684 af
Primary = 4.2 cfs @ 12.22 hrs, Volume= 0.684 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs

Pond 1P: SP-1



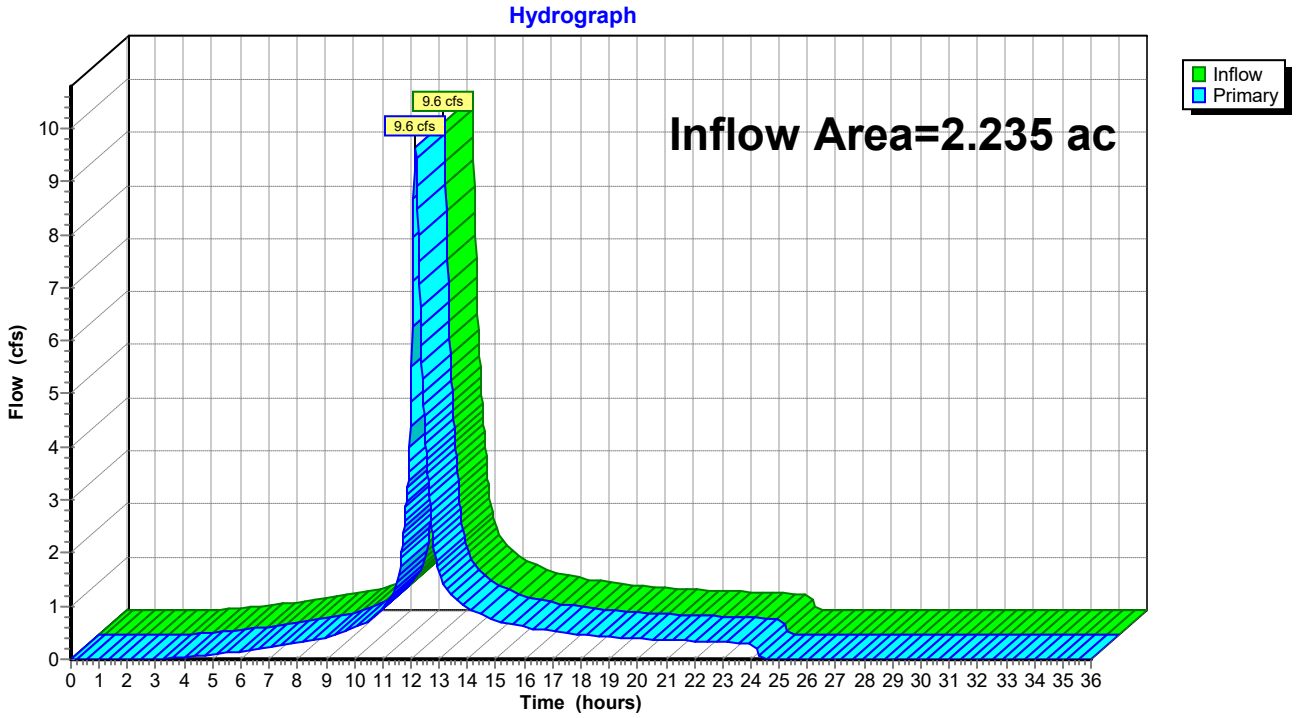
Summary for Pond 2P: SP-2

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

Inflow Area = 2.235 ac, 33.88% Impervious, Inflow Depth = 6.66" for 100-yr event
Inflow = 9.6 cfs @ 12.16 hrs, Volume= 1.241 af
Primary = 9.6 cfs @ 12.16 hrs, Volume= 1.241 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.02 hrs

Pond 2P: SP-2



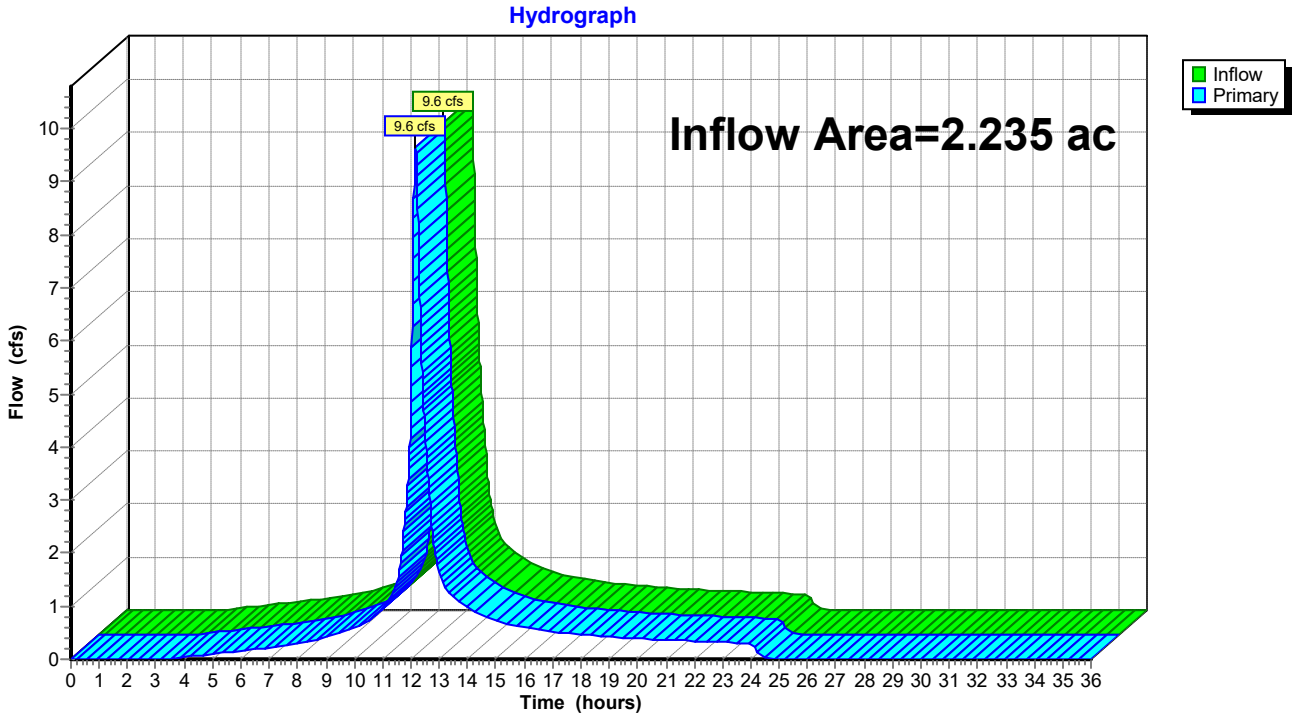
Summary for Pond 2P: SP-2

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

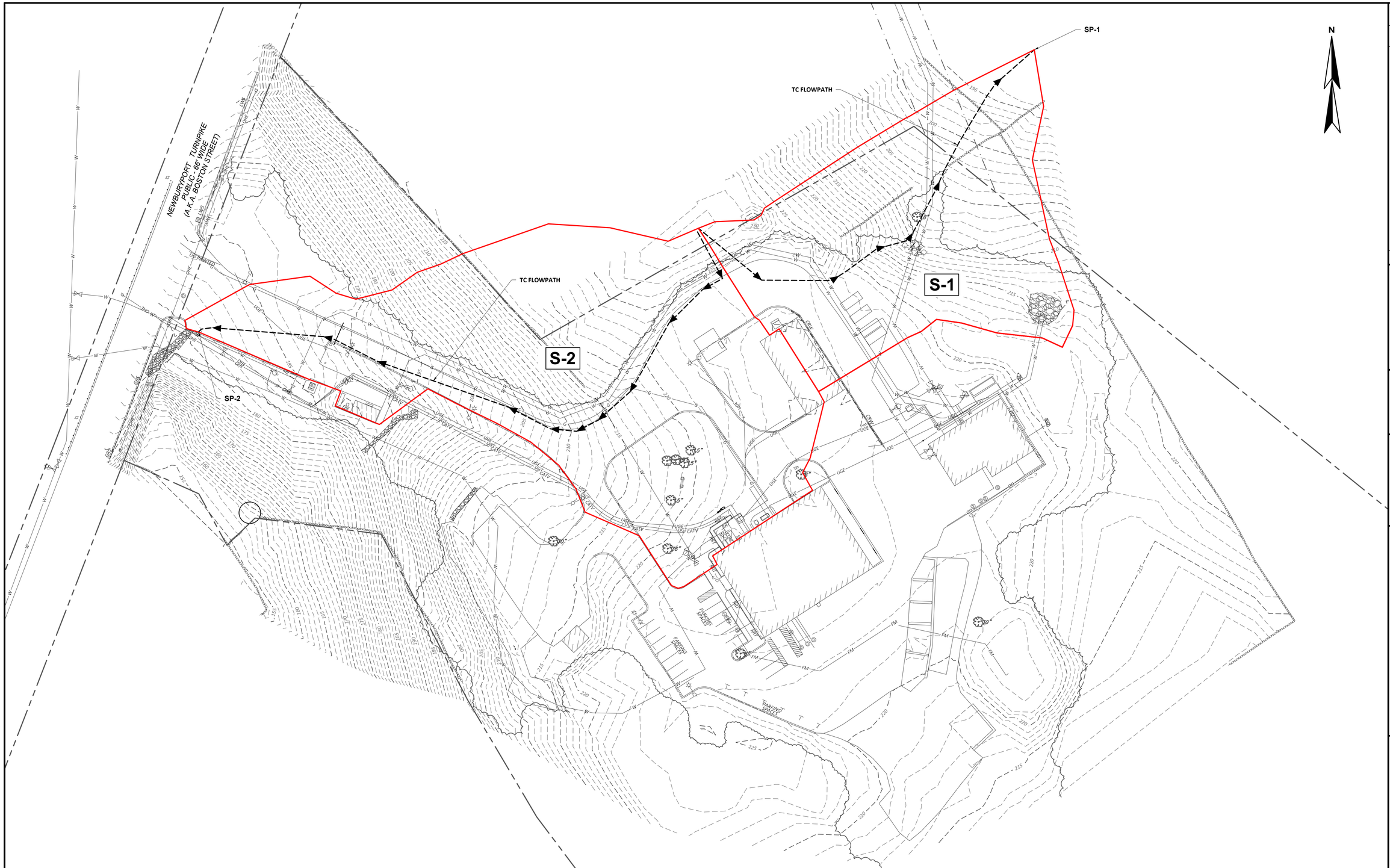
Inflow Area = 2.235 ac, 33.88% Impervious, Inflow Depth = 6.66" for 100-yr event
Inflow = 9.6 cfs @ 12.16 hrs, Volume= 1.241 af
Primary = 9.6 cfs @ 12.16 hrs, Volume= 1.241 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Pond 2P: SP-2



Appendix C – Stormwater Figures



CATCHMENT AREA	TOTAL AREA (SF)	HSG C - GRASS AREA (SF)	HSG C - WOODS AREA (SF)	IMPERVIOUS AREA (SF)	GRAVEL (SF)	RIPRAP (SF)	COMPOSITE CN	TC (MIN)
SUB-CATCHMENT 1 (SP1)	58,292	20,592	29,109	7,328	570	693	75	20.7
SUB-CATCHMENT 2 (SP2)	97,348	32,780	31,585	32,983	0	0	81	15.4

PRE-DEVELOPMENT PLAN
SCALE: 1"=40'

0 40 80

NO	REVISIONS	APP'D	DATE
1			
2			
3			
4			
5			

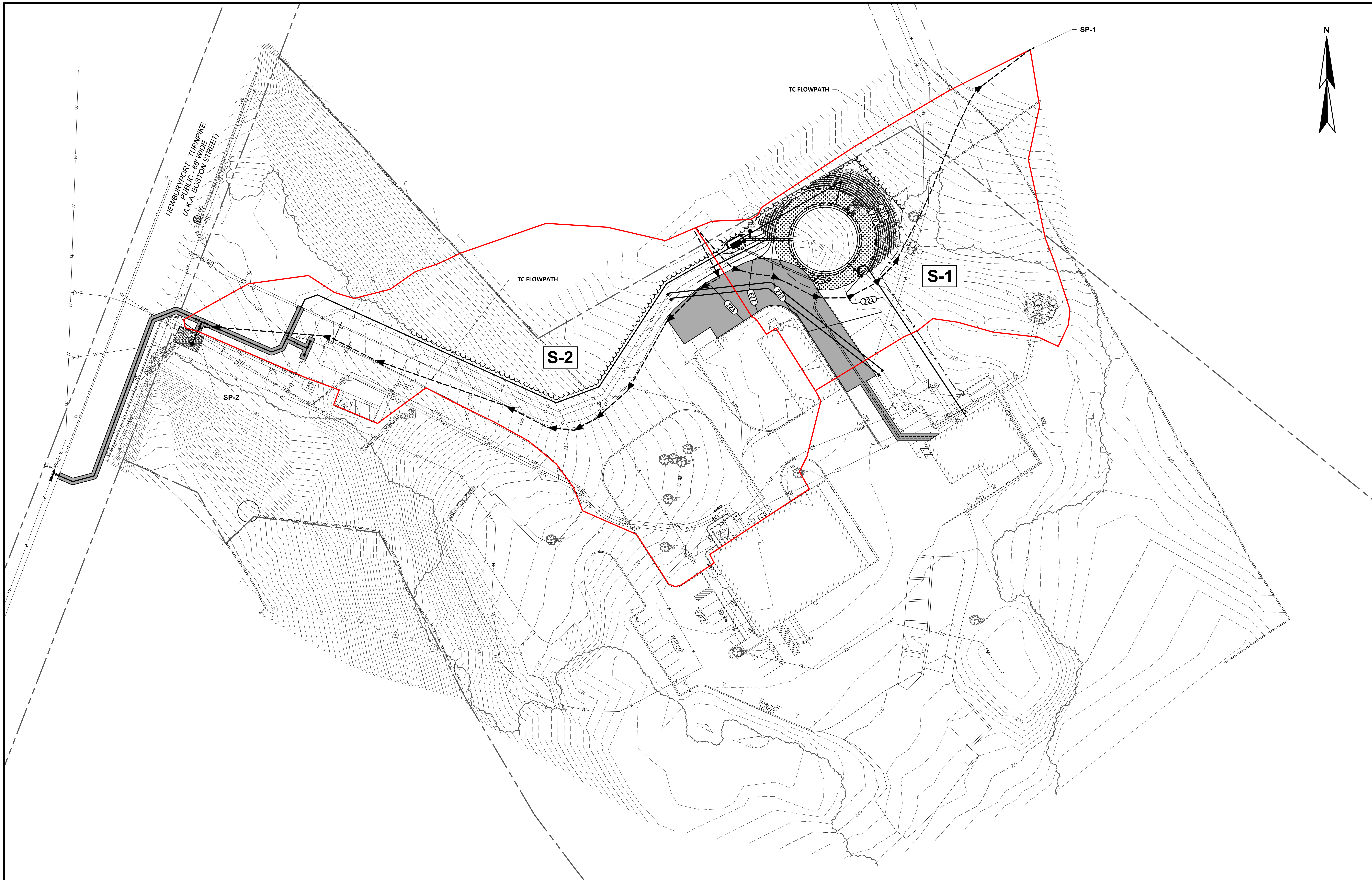
PROJECT NO: 20974
DESIGNED: C.DAIGLE
CAD COORD: S.COCHRAN
CAD: D.METZ
CHECKED: J.CRAY
DATE: 02-2024
APPROVED: J.CRAY
DATE: 02-2024
SUBMISSION: PERMIT SUBMITTAL

WRIGHT-PIERCE
978.416.8000 | www.wright-pierce.com
600 FEDERAL STREET, SUITE 2151, ANDOVER, MA 01810

TOWN OF TOPSFIELD, MASSACHUSSETTS
BOSTON STREET
WATER STORAGE TANK
REPLACEMENT

FIGURE 1 - PRE-DEVELOPMENT

DRAWING
PD-1



CATCHMENT AREA	TOTAL AREA (SF)	HSG C - GRASS AREA (SF)	HSG C - WOODS AREA (SF)	IMPERVIOUS AREA (SF)	GRAVEL (SF)	RIPRAP (SF)	COMPOSITE CN	TC (MIN)
SUB-CATCHMENT 1 (SP1)	58,292	22,289	21,943	9,905	838	3,317	77	19.7
SUB-CATCHMENT 2 (SP2)	97,348	35,238	29,127	32,983	0	0	81	15.4

0 40 80

POST-DEVELOPMENT PLAN

SCALE: 1"=40'

NO	REVISIONS	APP'D	DATE
1			
2			
3			
4			
5			

PROJECT NO: 20974
DESIGNED: C.DAIGLE
CAD COORD: S.COCHRAN
CAD: D.METZ
CHECKED: J.CRAY
DATE: 02-2024
APPROVED: J.CRAY
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600 FEDERAL STREET, SUITE 2151, ANDOVER, MA 01810

TOWN OF TOPSFIELD, MASSACHUSETTS
BOSTON STREET
WATER STORAGE TANK
REPLACEMENT

FIGURE 2 - POST DEVELOPMENT

DRAWING
PD-2

Appendix D – Long Term Pollution Prevention Plan

LONG TERM POLLUTION PREVENTION PLAN

Boston Street Water Storage Tank
Topsfield, MA

In compliance with Standard 4 of the Massachusetts Stormwater Standards, a Long-Term Pollution Prevention Plan has been created for the Boston Street Water Storage Tank project. The following management measures will address proper procedures for a variety of activities that could take place on the site.

1. **Housekeeping:**
   Proper housekeeping is the first step to reduce the potential for pollution. This entails keeping up with disposal of any waste generated by the site and using proper disposal methods. The plant operator is encouraged to reduce the storage of materials outdoors and to maintain an orderly site.

2. **Storing Materials and Waste Products:**
   Proper storage of materials and waste is important to reduce potential for pollution. Chemicals, paint, fuel, and any other pollutants shall not be stored outdoors. The Water Treatment plant staff are encouraged to use proper housekeeping measures to reduce the chance of a spill indoors or outdoors. Spill kits shall always be available on site in the event of a spill and shall be kept in a convenient and accessible location.

3. **Routine Inspection and Maintenance of Stormwater BMPs:**
   Inspection and maintenance of stormwater BMP's is critical to ensure proper function. Inspection and maintenance tasks shall be carried out in accordance with the schedule outlined in the Operation and Maintenance Plan developed for the site.

4. **Spill Prevention and Response:**
   Spills shall be prevented to the maximum extent feasible through use of approved materials for transport and transfer of fuels and chemicals. Construction equipment and fuel/chemical delivery equipment shall be inspected prior to entering the site to identify any deficiencies. Defective equipment shall not be allowed onsite at any time. In order to prepare for a spill, spill containment and cleanup kits, appropriate for the materials used on site shall be present and accessible at all times. Plant operators and chemical delivery personnel shall be trained on spill prevention and response specific to materials used onsite.

   Spill Response: In the event of a spill, the following procedures shall be followed:
   - Stop operations
   - Identify the product - check container design, warning labels, markings, etc.

- Prevent personnel from approaching the site and keep them at a distance sufficiently removed that they will not be injured by, or cause, a fire or explosion.
- Stop the flow at the source.
- Obtain a spill kit and try to prevent the spread of the spill.
- Assess the extent of the spill and determine if MassDEP should be called for emergency response.
- Report the spill to the plant operator and provide basic information such as location of spill and amount.
- Report the spill to federal and local authorities as necessary.

Emergency Contact Information:

Agency	Phone Number
Topsfield Water Department	(978) 887-1500
Fire or Police Department (Emergency)	911
Fire Department (Non-Emergency)	(978) 887-5148
Police (Non-Emergency)	(978) 887-6533
MassDEP Emergency Response	(888) 304-1133
MassDEP Spill Reporting	(617) 292-5500

5. Landscaping Maintenance:

This management measure seeks to control the storm water impacts of landscaping and lawn care practices to reduce nutrient loadings and the amount of storm water runoff generated from lawns. These practices can benefit the environment by reducing water use; decreasing energy use and minimizing runoff that transports sediment and pollutants. The following lawn and landscaping management practices will be encouraged:

a. Mow lawns at the highest recommended height;
b. Minimize lawn size and maintain existing native vegetation;
c. Water only when necessary;

6. Pet Waste Management:

Significant loading of pet waste has the potential to impact water quality of waterways if not managed properly. Pet waste is not anticipated to be a problem for this site as it will not be a permanent residence for pets. If pets are allowed on site, owners shall be required to pick up any waste and dispose of it in a proper manner.

7. Operation and Management of Sanitary Waste:

The proposed is not anticipated to generate any sanitary waste.

8. **Proper Management of Snow and deicing Chemicals:**
   Proper management of snow is an important task to ensure proper function of stormwater BMP's. Snow storage shall not be permitted within stormwater BMP's. Sand storage shall only be permitted in a stabilized container to prevent discharge to wetlands or waterbodies.

Operation and Maintenance Plan

The stormwater BMP's used in the construction of the Boston Street Water Tank project require a long-term operation and maintenance plan to ensure proper function. The following sections address the maintenance requirements of the proposed BMP and establish the responsibility for ensuring each task is completed.

1.1 Responsible Party

The BMP's are not part of the public stormwater system and will therefore be maintained by the water treatment plant operator. Contact info for the responsible party is listed below:

Topsfield Water Department
279 Boston Street, Topsfield, MA
(978) 887-1500

1.2 Description of Stormwater BMPS

Post-construction stormwater management will be achieved by directing runoff from the tank roof to vegetated buffers. Review of the Topsfield Bylaws indicate that stormwater treatment requirements are reduced for runoff from clean rooftop sources. The only new impervious surface proposed as part of this project is the roof of the water storage tank. As such, the site's stormwater management is achieved through the use of vegetated buffers.

1.3 Maintenance Requirements

Maintenance requirements specific to the site's stormwater controls have been established in accordance with the Massachusetts Stormwater Handbook. Table 10-1 details the long-term maintenance requirements for each BMP.

Table 10-1 Long Term Maintenance Schedule

BMP	Activity	Frequency
Riprap	Clean out vegetation and organic matter	As needed.
Vegetated Filter Strips	Regularly mow grass	As needed.
	Remove sediment buildup.	As needed.

Additional information related to the extent of each maintenance activity can be found in the Massachusetts Stormwater Handbook. All maintenance activities shall be documented by filling out the Inspection Maintenance Checklist and tracked on the Stormwater Maintenance Log which can be found in Appendix E.

Appendix E – Inspection, Maintenance and O&M Forms

Inspection and Maintenance Checklist

Category: **Stormwater BMP** Type:

Location: _____

Date: _____ Time: _____Inspector: _____Weather:_____

Recent Large Rainfall Event □ Yes □ No Rainfall Depth: _____ Event Date:_____

□ **UNIT AREA**

Area Accessible: □ Yes □ No Comment: _____
Sink Holes: □ Yes □ No Comment: _____
Corrective Action Needed: _____
Corrective Action Taken: _____Date:_____

□ **FLOATABLE DEBRIS/ORGANIC MATTER**

Floatables present? □Yes □No If yes, to what extent? _____
Corrective Action Needed: _____
Corrective Action Taken: _____Date:_____

□ **SEDIMENT MEASUREMENT**

Sediment Depth: _____ Note: if the sediment depth is 2 feet or more, removal is necessary.
Corrective Action Needed: _____
Corrective Action Taken: _____Date:_____

NOTES:

Describe any incidents of non-compliance not listed above:

Note: Any maintenance performed as a result of this inspection should be recorded on the maintenance log.

Inspector Signature: _____ Date: _____

Stormwater BMP Maintenance Log

Date	Initials	BMP	Sediment Depth Measured	Volume of Sediment Removed	Site Activity and Comments

Appendix F – Temporary & Permanent Stabilization Specifications

SECTION 02270

TEMPORARY EROSION CONTROL

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. The work under this section shall include provision of all labor, equipment, materials and maintenance of temporary erosion control devices as specified herein, and as directed by the Engineer.
2. Erosion control measures shall be provided as necessary to correct conditions that develop prior to the completion of permanent erosion control devices or as required to control erosion that occurs during normal construction operations.
3. Construction operations shall comply with all federal, state and local regulations pertaining to erosion control.
4. Erosion control measures shall be in accordance with the Massachusetts Department of Environmental Protection's – Stormwater Management Standards – (referred to hereafter as MassDEP SMS) and "Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas," *Franklin, Hampden, Hampshire Conservation Districts, 2003.*
5. After awarded the Contract, prior to commencement of construction activities, meet with the Engineer to discuss erosion control requirements and develop a mutual understanding relative to details of erosion control.

B. Design Criteria:

1. Conduct all construction in a manner and sequence that causes the least practical disturbance of the physical environment.
2. Stabilize disturbed earth surfaces in the shortest time and employ such temporary erosion control devices as may be necessary until such time as adequate soil stabilization has been achieved.

1.2 REQUIREMENTS SPECIFIED ELSEWHERE

A. Additional Requirements are specified elsewhere including, but not necessarily limited to, General Conditions, Supplementary Conditions, and Division 1.

1.3 SUBMITTALS

A. The Contractor shall furnish the Engineer, in writing, his work plan giving proposed locations for storage of topsoil and excavated material before beginning construction. A schedule of work shall accompany the work plan. Acceptance of this plan will not relieve the Contractor of the responsibility of completion of the work as specified.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Compost Filter Tube:

1. The purpose of this item is to provide a linear, compost-filled tube for filtering suspended sediments from storm water flow.

2. Compost tubes shall be installed onsite using blown-in-place methods.
3. Tubes for compost filters shall be a minimum of 12 inches (300 mm), a maximum of 18 inches (450mm) in diameter. Tube material shall be a knitted mesh with 1/8" - 3/8" (3-10 mm) openings and made of biodegradable (cotton or jute) materials. Photodegradable fabric may be used; however, photodegradable fabric must be removed and disposed of by the contractor, at his expense, at the end of the contract. Additional tubes shall be used at the direction of the Engineer.
4. Stakes for anchors, if required, shall be nominal 2 x 2 stakes.
5. Compost shall have the following physical and chemical properties:

Compost Parameters	Test Method & Name Reported As	Requirement
pH	TMECC 04.11-A Electrometric pH 1:5 Slurry Method pH Units	6.0-8.5
Soluble Salts	TMECC 04.10-A Electrical Conductivity 1:5 Slurry Method dS/m (mmhos/cm)	0 - 5
Moisture Content	TMECC 03.09-A Total Solids & Moisture at 70+/- 5 deg C % Wet Weight Basis	30 – 60 %
Organic Matter Content	TMECC 05.07-A Matter Method. Loss on Ignition Organic Matter Method % Dry Weight Basis	25 - 65 %
Maturity Percent Emergence %Relative Seedling Vigor %Relative to positive control	TMECC 05.05-A Biological Assays. Seedling Emergence and Relative Growth	100% 100%
Stability (respirometry)	TMECC 05.08-B Carbon Dioxide Evolution Rate mg CO_2-C/g OM per day mg CO_2-C/g TS per day	< 8
Particle Size	TMECC 02.12-B Sample Sieving for Aggregate Size Classification % Dry Weight Basis	Inches & Percentage Passing 3" (75 mm) 98% to 100% 1" (25 mm) 90% to 100% ¾" (19 mm) 70% to 100% ¼" (6.4 mm) 30% to 75% Maximum particle size: 4" (100 mm)
Physical Contaminants (man made inert)	TMECC 02.02-C % dry weight basis	< 1%
Pathogen	TMECC 07.01-B Fecal Coliform Bacteria <1000 MPN/gram dry wt.	Pass
Pathogen	TMECC 07.01-B Salmonella <3 MPN/4 grams dry wt.	Pass

6. Compost shall have the following biological properties:

Property	Test Method	Requirement Low-High
Active Bacterial (mg/g)	DIC/ Epifluorescence Microscopy	Range 15 – 30
Total Bacterial (mg/g)	DIC/ Epifluorescence Microscopy	Range 150 – 300+
Active Fungal (mg/g)	DIC/ Epifluorescence Microscopy	Range 2 - 10
Total Fungal (mg/g)	DIC/ Epifluorescence Microscopy	Range 150 – 200+

7. Acceptable Providers:
   a. Groundscapes Express (Wrentham, MA)

b. Massachusetts Environmental Products (Bridgewater, MA)
c. Approved equivalent

B. Mulches:
1. Temporary and permanent vegetated erosion control to prevent sheet flow, stabilize soil and prevent sediment loss.
a. Acceptable Products:
i. EarthBlanket, Groundscapes Express (Wrentham, MA)
ii. Curlex Double Net, American Excelsior Company (Norwalk, OH)
iii. Approved equivalent.

C. Permanent Seed:
1. Seed mix appropriate to the predominant soil conditions as specified in the MADEP SMS and/or "Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas," and subject to approval by the Engineer.

D. Temporary Seeding:
1. Use species appropriate for soil conditions and season as specified in the MADEP SMS and/or "Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas," and subject to approval by the Engineer.

E. Water:
1. The Contractor shall provide water and equipment to control dust, as directed by the Engineer.

F. Filter Fabric:
Filter fabric shall conform to the requirements of AASHTO M288, Class 2.

G. Silt Sacks:
1. Silt Sacks (or equivalent) shall be placed in downgradient catch basins to prevent sediment from entering the drainage system. Silt sacks shall have overflows. Silt sacks shall be periodically cleaned while in use and must be cleaned prior to and after precipitation events. Applicants are advised they may be required to respond immediately for repair and maintenance at the request of the City within two (2) hours of notification. Silt sacks shall meet the following minimum requirements:
a. Grab Tensile Strength: 300 lb
b. Grab Tensile Elongation: 20%
c. Puncture (ASTM D-4833): 120 lb
d. Mullen Burst (ASTM D-3786): 800 psi
e. Trapezoid Tear (ASTM D-4533): 120 lb
f. UV Resistance (ASTM D-4355): 80%
g. Apparent Opening Size: 40 US sieve
h. Flow rate: 40 gpm/SF
i. Permittivity: 0.55/sec

H. Silt Fence:
1. Silt Fence shall be one of the commercially available brands, meeting the following requirements:

Geotextile Mechanical Property	Test Method	Minimum Permissible Value

Grab Tensile Strength (both directions)	ASTM D-4632	124 pounds
Puncture Strength	ASTM D-4833	60 pounds
Apparent Opening Size	ASTM D-4751	#30
Flow Rate	ASTM D-4491	8 gal/min/ft^2

2.2 CONSTRUCTION REQUIREMENTS

A. Temporary Erosion Checks:
   1. Temporary erosion checks shall be constructed in ditches and other locations as necessary.
   2. Baled hay, sand bags or siltation fence may be used in an arrangement to fit local conditions.

B. Temporary Berms:
   1. Temporary barriers shall be constructed along the toe of embankments when necessary to prevent erosion and sedimentation.

C. Temporary Seeding:
   1. Areas to remain exposed for a time exceeding 3 weeks shall receive temporary seeding as indicated below:

Season	Seed	Rate
Summer (5/15 - 8/15)	Sudangrass	40 lbs/acre
Late Summer/Early Fall (8/15 - 9/15)	Oats	80 lbs/acre
	Annual Ryegrass	40 lbs/acre
Fall (9/15 - 10/1)	Winter Rye	112 lbs/acre
Winter (10/1 - 4/1)	Mulch w/Dormant Seed	80 lbs/acre*
Spring (4/1 - 7/1)	Oats	80 lbs/acre
	Annual Ryegrass	40 lbs/acre

* seed rate only

D. Silt Fence shall be supported by posts and installed per the manufacturer's recommendations.
   1. A trench 6-inches in width and 6-inches in depth should be excavated to toe in the bottom of the silt fence. The trench should be backfilled after the silt fence is installed.

E. Mulch All Areas Receiving Seeding:

   Use either wood cellulose fiber mulch (750 lbs/acre); or straw mulch with chemical tack (as per manufacturers specifications). Wetting for small areas may be permitted. Biodegradable netting is recommended in areas to be exposed to drainage flow.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Temporary Erosion Checks:
   1. Temporary erosion checks shall be constructed in ditches and at other locations designated by the Engineer. The Engineer may modify the Contractor's arrangement of silt fences, bales and bags to fit local conditions.
   2. Baled hay, silt fences, or sandbags, or some combination, may be used in other areas as necessary to inhibit soil erosion.
   3. Siltation fence shall be located and installed as shown on plans or as required to comply with all Federal, State and Local Regulations.

B. Maintenance:
   1. Erosion control features shall be installed prior to excavation wherever appropriate. Temporary erosion control features shall remain in place and shall be maintained until a satisfactory growth of grass is established. The Contractor shall be responsible for maintaining erosion control features throughout the life of the construction contract. Maintenance will include periodic inspections by the Owner or Engineer for effectiveness of location, installation and condition with corrective action taken by the Contractor as appropriate.

C. Removing and Disposing of Materials:
   1. When no longer needed, material and devices for temporary erosion control shall be removed and disposed of as approved by the Engineer.
   2. When removed, such devices may be reused in other locations provided they are in good condition and suitable to perform the erosion control for which they are intended.
   3. When dispersed over adjacent areas, the material shall be scattered to the extent that it causes no unsightly conditions nor creates future maintenance problems.

END OF SECTION

SECTION 02480

LANDSCAPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. Perform the following items of work as required to complete the work of this section as shown on the Drawings and as specified hereunder:
   a. Spread stockpiled topsoil and furnish and spread any additional topsoil, required to meet the requirements of this section.
   b. Furnish and sow grass seed/or sod in all areas within the work area to the extent indicated on the Drawings, and in existing grass areas which have been damaged or disturbed by the work of this Contract.
   c. Furnish and install plant materials in all areas within the work area as indicated on the Drawings.
   d. Provide maintenance services as specified hereunder.

B. Examine all other sections of the Specifications and all Drawings for the relationship of the work under this section and the work of other trades. Cooperate with all trades in performing the work under this section.

1.2 REQUIREMENTS SPECIFIED ELSEWHERE

A. Additional Requirements are specified elsewhere including, but not necessarily limited to, General Conditions, Supplementary Conditions, and Division 1.

1.3 SUBMITTALS AND TESTING

A. Seed:

1. Furnish the Engineer with duplicate signed copies of a statement from the vendor, certifying that each container of seed delivered to the project site is fully labeled in accordance with the Federal Seed Act and is at least equal to the specification requirements.
2. This certification shall appear in, or with, all copies of invoices for the seed.
3. Each lot of seed shall be subject to sampling and testing, at the discretion of the Engineer, in accordance with the latest rules and regulations under the Federal Seed Act.

B. Topsoil:

1. Inform the Engineer, within 30 days after the award of the Contract, of the sources from which the topsoil is to be furnished. It is the intent of this section that all topsoil which can be recovered from the site shall be used. Furnish additional topsoil as required.
2. Obtain representative soil samples, taken from several locations in the area under consideration for topsoil removal, to the full stripping depth.
3. Have soil samples tested by an independent soils testing laboratory, approved by the Engineer, at the Contractor's expense.

4. Have soil samples tested for physical properties and pH (or lime requirement), for organic matter, available phosphoric acid, and available potash, in accordance with standard practices of soil testing for agricultural use.
5. Approval, by the Engineer, to use topsoil for use in the work will be dependent upon the results of the soils tests.

C. Lime and Fertilizer:
1. Furnish the Engineer with duplicate copies of invoices for all lime and fertilizer used on the project showing the total minimum carbonates and minimum percentages of the material furnished that pass the 90 and 20 mesh sieves and the grade furnished.
2. Each lot of lime and fertilizer shall be subject to sampling and testing at the discretion of the Engineer.
3. Sampling and testing shall be in accordance with the official methods of the Association of Official Agricultural Chemists.
4. Upon completion of the project, a final check may be made comparing the total quantities of fertilizer and lime used to the total area seeded. If the minimum rates of application have not been met, the Engineer may require the Contractor to distribute additional quantities of these materials to meet the minimum rates.

1.4 DELIVERY, STORAGE AND HANDLING

A. Seed:
1. Furnish all seed in sealed standard containers, unless exception is granted in writing by the Engineer.
2. Containers shall be labeled in accordance with the United States Department of Agriculture's rules and regulations under the Federal Seed Act in effect at the time of purchase.

B. Fertilizer:
1. Furnish all fertilizer in unopened original containers.
2. Containers shall be labeled with the manufacturer's statement of analysis.

1.5 JOB CONDITIONS

A. Topsoil:
1. Do not place or spread topsoil when the subgrade is frozen, excessively wet or dry, or in any condition otherwise detrimental, in the opinion of the Engineer, to the proposed planting or to proper grading.

B. Seeding and Planting:
1. Work Seasons - Perform seeding and planting work only between the dates of 1 May to 20 June and 15 August to 1 October, except as otherwise directed in writing by the Engineer. Regardless of the time of seeding, the Contractor shall be responsible for each seeded area until it is accepted.
2. Weather Conditions:
   a. Do not perform seeding work when weather conditions are such that beneficial results are not likely to be obtained, such as drought, excessive moisture, or high winds.
   b. Stop the seeding work when, in the opinion of the Engineer, weather conditions are not favorable.

c. Resume the work only when, in the opinion of the Engineer, conditions become favorable, or when approved alternate or corrective measures and procedures are placed into effect.

PART 2 - PRODUCTS

2.1 MATERIALS FOR GRADING AND SEEDING

A. Topsoil:
1. Fertile, friable, natural topsoil typical of the locality, without admixture of subsoil, refuse or other foreign materials and obtained from a well-drained site. Mixture of sand, silt, and clay particles in equal proportions.
2. Free of stumps, roots, heavy of stiff clay, stones larger than 1-inch in diameter, lumps, coarse sand, weeds, sticks, brush or other deleterious matter.
3. Not less than 4 percent nor more than 20 percent organic matter.
4. Topsoil depth shall be 4-inches, unless otherwise indicated.

B. Fertilizer:
1. Fertilizer shall be used to counteract soil deficiencies as indicated by the soil analysis and as approved by the Engineer. It should be a complete fertilizer, a standard product complying with the state and federal fertilizer laws, part of the elements of which are derived from organic sources, containing the following percentages by weight:

Nitrogen	10N - Minimum 75 percent organic
Phosphorus	6 P -
Potash	4 K -

The fertilizer shall be delivered to the site in the original unopened containers bearing the manufacturer's guaranteed statement of analysis, or a manufacturer's certificate of compliance covering analysis shall be furnished to the Engineer. The fertilizer shall be spread at the rate of 17 to 20 lbs/1000 sq-ft.

C. Lime:
1. Provide lime which is ground limestone containing not less than 85 percent of total carbonate and of such fineness that 90 percent will pass a No. 20 sieve and 50 percent will pass a No. 100 sieve.
2. Coarser materials will be acceptable provided the specified rates of application are increased proportionately on the basis of quantities passing a No. 100 sieve. No additional payment will be made to the Contractor for the increased quantity.

D. Soil Enrichers:
1. They shall be one of the following materials:
   a. Peat Moss - Finely shredded and consisting of not less than 90 percent organic matter.
   b. Sawdust - rotten.
2. They shall be natural and suited to horticultural use. They shall not contain lumps, roots or other foreign matter over two inches in diameter. They shall be free from noxious weeds, seeds and other elements harmful to lawns. They shall be subject to inspection approval by the Engineer at the source and upon

delivery and shall contain not more than 35 percent moisture by weight at the time of incorporation into the soil.

E. Mulch for Hydro Seeding:
   1. Mulch material shall meet the following requirements:
      a. Hay or straw - Hay or straw mulch shall consist of long fibered hay or straw, reasonably free from noxious weeds or other undesirable material. No material shall be used which is so wet, decayed, or compacted as to inhibit even and uniform spreading. No chopped hay, grass clippings or other short fibered material shall be used unless directed.
      b. Wood cellulose fiber - Wood cellulose fiber mulch shall consist of natural wood cellulose fiber containing no materials which will inhibit seed germination or plant growth. Sufficient non-toxic water soluble green dye shall be added to provide a definite color contrast to the ground surface to aid in even distribution. Wood fiber mulch shall be supplied in uniform packages not exceeding 100 pounds each. Each package shall be marked to show the air dry weight.

F. Mulch Binder for Hydroseeding:
   1. Material for mulch binder shall be emulsified asphalt.
      a. Emulsified asphalt mulch binder shall be a type acceptable to the Engineer and may be diluted with water to assure even distribution.

G. Grass Seed Mixture
   1. Fresh, clean, new crop seed. Seed may be mixed by an approved method on the site, or may be mixed by the dealer. If the seed is mixed on the site, each variety shall be delivered in the original containers which shall bear the dealer's guaranteed statement of the composition of the mixture and the percentage of purity of each variety. The Dealers Guarantee Statement shall be delivered to the Engineer.
   2. Grass seed shall be composed of the following varieties which shall be mixed in the proportions and shall test to 80 percent minimum purity, and 80 percent germination.

      Percent Proportion by Weight:

      a. Park Mixture:
         i. Creeping red fescue 50 percent
         ii. Kentucky Bluegrass 30 percent
         iii. Annual Rye Grass 20 percent
         iv. Add 1 pound White or Dutch Clover per acre.
         v. No weed seeds allowed
      b. Roadside Mixture (Slopes):
         i. Creeping Red Fescue 40 percent
         ii. Kentucky Bluegrass 25 percent
         iii. Kentucky 31 Fescue 30 percent
         iv. White Clover 5 percent
         v. Add 1 pound White or Dutch Clover per acre.
         vi. No weed seeds allowed
      c. Lawn Areas:
         i. Kentucky 31 Fescue 25 percent

ii.	Chewing Fescue	15 percent
iii.	Creeping Red Fescue	15 percent
iv.	Pennfine Perennial Rye	25 percent
v.	Lynn Perennial Rye	10 percent
vi.	Common Annual Rye	10 percent
vii.	No weed seeds allowed	

H. Sod:
1. Preferable two year growth, at least 85 percent weed-free, solid landscaping sod composed of perennial fescues, Kentucky bluegrass's. Submit one 12 by 12 inch piece of sod, with source location, for approval of the Engineer, before ordering sod for the work.

2.2 MATERIALS FOR PLANTING

A. Water:
1. The Contractor shall arrange and pay for water required for the planting. Water shall be clean and suitable for domestic consumption.

B. Manure:
1. Manure shall be well rotted, unleached, horse or cow manure or a combination of both. It shall be free from any chemicals used to hasten decomposition artificially, or any other injurious substance.
2. Manure shall be at least nine months old and not more than two years old, free from sawdust, hay, tanbark or wood shavings, or refuse of any kind. Manure shall consist of not more than 25 percent straw or other acceptable material.

C. Stakes shall be white cedar or approved equal, of size and length as shown on the Drawings.

D. Hose for guying shall be new black or green two-ply fiber garden hose, not less than 1/2 inch inside diameter. Seconds rejected by the factory are acceptable.

E. Burlap for wrapping shall be first quality burlap at least eight ounces in weight and six inches in width.

F. Wire for tree guys shall be galvanized annealed steel wire, No. 14 gauge, as detailed.

G. Tree paint shall be waterproof, adhesive and elastic, free from kerosene, coal tar creosote or any other material injurious to the life of the trees. Tree paint shall contain an antiseptic.

H. Pine bark mulch shall be clean, shredded, free of weeds, seeds, insects and extraneous materials.

I. Plant Materials:
1. Plant materials shall conform to American Standard for Nursery Stock (April 15, 1951), sponsored by the American Association of Nurserymen, Inc., Standard Plant Names (1942) shall be the authority for plant names. Plant materials shall be of standard quality true to name and type and first class representatives of their species or variety.
2. All plants shall conform to the varieties specified in the Plant List. No substitutions will be permitted unless approved in writing by the Engineer. Each bundle of plants and all separate plants shall be properly identified by name on legible, waterproof labels, securely attached thereto before delivery to the site.

3. Plant materials shall be free of damage as a result of handling and transportation.
4. All plant material shall be certified by the supplier to be free of disease and infestation.
5. All plants shall be subject to approval at their source prior to shipment. The Contractor shall accompany the Engineer to inspect the materials, and shall request such inspection at least one week in advance.
6. All plants shall be typical of their species or variety and shall have a normal habit of growth. They shall be first quality, sound, healthy, vigorous, well branched and densely foliated. They shall be free of disease, insect pests, eggs or larvae, and shall have healthy, well furnished root systems. Plants lacking compactness or proper proportions, and plants injured by too close planting in nursery rows will not be accepted.
7. All plants shall conform to the measurements specified in the Plant List. Measurements specified shall be the minimum acceptable for each variety. Plants that meet these requirements specified, but do not possess a normal balance between height and spread, will not be accepted. Plants shall not be pruned prior to delivery.
8. All plants and all tree trunks shall be measured when the branches are in their normal position. Dimensions noted for height and spread refer to the main body of the plant, and not from branch tip to branch tip. Height is defined as the approximate dimension from ground to top of last year's growth. Top spread is defined as the approximate spread to top or principal width. The height of tree trunks need not be specified if the required height can be obtained by pruning the lower branches without leaving unsightly scars or otherwise damaging the trunk. Shade trees shall be free of branches up to five feet, with a single leader, well branched and reasonably straight stems. No trees which have had their leaders cut, or are so damaged that cutting is necessary, will be accepted. Trees which had their tops cut off some years previous will only be acceptable if the scar has not decayed. No trees with cut off tops will be accepted unless corrective surgery has been performed so as to effect a complete healing of the stem.
9. Caliper of trees shall be measured one foot above ground.
10. Plants larger in size than those specified in the Plant List may be provided if approved by the Owner or the Engineer, but the use of larger plants shall not increase the cost of the Contract. If the use of larger plants is approved, the ball of earth or spread of roots shall be increased in proportion to the size of the plant. If plants required to be bare rooted are furnished in sizes greater than specified, they shall be balled and burlapped.
11. All trees shall have straight trunks with single leader intact. There shall be no abrasion of the bark and no fresh cuts of limbs over 1-1/4 inch which have not completely callused over.
12. All plants shall be grown in nurseries and cultivated, sprayed, pruned, and fertilized annually in accordance with good horticultural practice. All plants shall have been grown under climatic conditions similar to those in the locality

of the project, or shall have been acclimated to the conditions of the locality for at least two years.

13. All plants shall be freshly dug; neither heeled in plants nor plants from cold storage will be accepted. All plants shall have been transplated or root pruned at least once in the past three years. Balled and burlapped plants shall come from soil which will hold a firm ball.
14. Plants marked "B&B" in the Plant List shall be adequately balled and burlapped with firm natural balls of soil, of diameter of sufficient depth to include all the roots. No plant required to be balled and burlapped shall be accepted if the ball is cracked or broken either before or during the process of planting, or when burlap, stakes, ropes or platform required in this connection have been removed.
15. All plants shall be handled so that the roots are adequately protected at all times. During shipment all plants shall be properly protected by a tarpaulin or other suitable covering.
16. No plants shall be so bound with rope or wire at any time so as to damage the bark, break branches, or destroy its natural shape. All balled and burlapped plants which cannot be planted immediately on delivery shall be set on the ground and well protected with soil or other acceptable material including watering. Until planted, all material shall be properly maintained.

2.3 STORAGE OF MATERIAL

A. Materials such as fertilizers, ground limestone, etc. shall be stored in weatherproof storage areas and in such a manner that their effectiveness will not be impaired.

PART 3 - EXECUTION

3.1 PREPARATION

A. Equipment:
   1. Provide all equipment necessary for the proper preparation of the ground surface and for the handling and placing of all required materials.
   2. Demonstrate to the Engineer that the equipment will apply materials at the specified rates.

B. Subsoil Preparation:
   1. Before spreading topsoil, the subgrade shall be raked by approved means. Remove all stones greater than four inches and all debris or rubbish to a depth of six inches. Such materials shall be removed from the site.

C. Screening:
   1. All topsoil shall be screened clear of all stones greater than one inch, sticks, plants, and all other foreign materials before being spread.
   2. During the screening of topsoil, commercial fertilizers and lime as required by the soil analysis shall be mixed with the topsoil so that they are evenly distributed throughout the screened topsoil.
   3. At the completion of this operation, topsoil is referred to as improved topsoil for the purpose of this specification and the Drawings.

3.2 SEED AND SOD BED PREPARATION

A. Spread improved topsoil uniformly over subgrade and all areas where the existing

grade has been changed and areas disturbed by construction operations except for those areas indicated on the site plans to be paved. No subsoil, topsoil, or improved topsoil shall be handled in any way when in a wet or frozen condition.

B. Fine rake surface to receive seed or sod.

C. After natural settlement and a light rolling, the completed work shall conform to the lines, grades, pitches, and spot elevations shown on the plans.

D. Seeding may be done immediately thereafter, provided the seed bed has remained in a good friable condition and has not become wet.

3.3 SEASON

A. Do all seeding work within the dates herein specified.

B. If special conditions exist which may warrant a variance in the above dates, submit a written request to the Engineer stating the conditions and proposed variance. Permission for the variance will be given if, in the opinion of the Engineer, the variance is warranted.

C. If seeding is authorized between May 15 and August 15, annual rye shall be sown separately in addition to the specified seed mix. Sow at the rate of six to eight pounds per 1000 square feet.

3.4 SEEDING AND SODDING

A. Immediately before seeding and sodding, the ground shall be restored as necessary to a loose friable condition by discing or other approved method to a depth of not less than two inches. The surface shall be cleared of all debris and of all stones one inch or more in diameter.

B. Seed all areas to be seeded with the specified grass seed, sowing evenly with an approved mechanical seeder at the rate specified in the seed mix schedule. Sow one half the seed in one direction and the other half at right angles to the first seeding. Cultipacker or approved similar equipment may be used to cover the seed and to firm the seed bed in one operation. In areas inaccessible to Cultipacker, the seeded ground shall be lightly raked and rolled in two directions with a water ballast roller. Extreme care shall be taken during seeding and raking to insure that no change shall occur in the finished grades and that the seed is not raked from one spot to another.

C. The hydraulic spray method of sowing seed may be used where approved by the Engineer. This work shall be done with an approved machine operated by a competent crew. Seed and fertilizing materials shall be mixed with water in the tank of the machine and kept thoroughly agitated so the materials are uniformly mixed and suspended in the water at all times during operation. The spraying equipment must be designed and operated to distribute seed and fertilizing materials evenly and uniformly on the designated areas at the required rates. If the Engineer finds the application uneven or otherwise unsatisfactory, the Engineer may require the hydraulic spray method to be abandoned and the balance of the work done as specified herein. Seed must be lightly raked into the surface of the soil unless seeding is to be followed within 24 hours by mulching.

1. Applying Mulch - At the option of the Contractor, any of the following types of mulch material may be applied.

   a. Hay or straw mulch shall be spread evenly and uniformly over the designated areas. Unless other directed, mulch shall be applied to a

thickness of 1". Too heavy application of mulch shall be avoided and lumps and thick spots shall be thinned. Unless otherwise authorized, the mulch shall be anchored in place by uniformly applying an asphalt mulch binder. Application of a concentrated stream of mulch binder will not be allowed. Asphalt mulch binder may be omitted when authorized by the Engineer and when there is a danger of the asphalt contaminating the surface of nearby structures, houses, vehicles, or other objects. Other methods of anchoring mulch may be used subject to the approval of the Engineer.

b. Wood fiber mulch shall be applied as a water-borne slurry. The wood fiber and water shall be thoroughly mixed and sprayed on the area to be covered so as to form a uniform mat of mulch at the rate of not less than 30 pounds per 1,000 square feet unit of area. Wood fiber mulch may be mixed with the proper quantities of seed, fertilizer and lime as required in this section, or may be applied separately after seeding has been carried out. In the latter case, it must be applied within 24 hours after seeding.

2. Maintenance - The Contractor shall maintain the mulch by repairing any damaged mulch and by correcting any shifting of the mulch due to wind, water or other causes, until an acceptable growth of grass has been achieved, regardless of the acceptance status of the seeding. The Contractor shall supply additional mulch necessary as a result of damage or seed failure. Repairs to mulched areas and furnishing of additional mulch shall be incidental to this item. If wood fiber is used, any reseeding will require additional wood fiber mulch.

D. Do not perform broadcast seeding work during windy weather.

E. Compacting:

1. Compact the entire area immediately after the seeding operations have been completed.
2. Compact by means of a cultipacker, roller, or other equipment approved by the Engineer weighing 60 to 90 pounds per linear foot of roller.
3. If the soil is of such type that a smooth or corrugated roller cannot be operated satisfactorily, use a pneumatic roller (not wobbly wheel) that has tires of sufficient size to obtain complete coverage of the soil.
4. When using a cultipacker or similar equipment, perform the final rolling at right angles to the prevailing slopes to prevent water erosion, or at right angles to the prevailing wind to prevent dust.

F. Thoroughly wet soil surfaces before sodding. Place sod pieces tightly together, tamping gently into position as the work progresses. After each area of sodding is completed, roll the entire surface in two directions with a water ballast roller, and soak the newly sodded areas.

G. After the grass has started, all of the areas greater than five square feet which fail to show a uniform stand of grass for any reason whatsoever shall be reseeded repeatedly until all areas are covered with a satisfactory growth of grass.

H. At the time of the first cutting, set mower blades two inches high. All lawns shall receive at least two mowings before acceptance. Schedule for mowing shall be coordinated with the Engineer.

I. Maintenance shall also include all temporary protection fences, barriers and signs and all other work incidental to proper maintenance.

J. Maintain grass areas until a full stand of grass is indicated, which will be a minimum of 45 days after all seeding or sodding work is completed, and shall not necessarily relate to Substantial Completion of the General Contract.

K. Protection and maintenance of grass areas shall consist of watering, weeding, cutting, repair of any erosion and reseeding as necessary to establish a uniform stand of the specified grasses, and shall continue until Acceptance by the Engineer of the work of this section. It shall also include the furnishing and applying of such pesticides as are necessary to keep grass areas free of insects and disease. All pesticides shall be approved by Engineer prior to use.

3.5 SEEDING AND SODDING INSPECTION FOR PROVISIONAL ACCEPTANCE

A. The Engineer shall inspect all work for Provisional Acceptance upon written request of the Contractor. The request shall be received at least ten calendar days before the anticipated date of inspection.

B. Upon completion and reinspection of all repairs or renewals necessary in the judgment of the Engineer, the Engineer shall certify in writing to the Owner as to the Provisional Acceptance of the work of this section.

C. Upon approval of the Provisional Acceptance by the Owner, the Owner will assume maintenance of the lawn areas.

3.6 GUARANTEE

A. The Contractor shall submit a written guarantee to the Engineer, after Provisional Acceptance of grass, covering reseeding of grass areas which do not survive through one full growing season after the date of Provisional Acceptance, at no cost to the Owner.

3.7 CLEAN-UP

A. Any soil or similar material which has been brought on to paved areas by hauling operations or otherwise shall be removed promptly, keeping these areas clean at all time.

B. Upon completion of work under this section all excess stones, debris, and soil resulting from work under this section, which have not previously been cleaned up, shall be removed from the project site.

3.8 PLANTING METHOD

A. The Contractor shall excavate plant pits, furnish and place all plants, and then maintain them in a satisfactory manner until final acceptance.

B. All pits shall be of size and shape as shown on the Drawings.

C. For tree and shrub planting, soil used for backfilling shall be improved topsoil as recommended by soil analysis, with the following additions:

1. For deciduous plants use a mixture of four parts topsoil and one part of manure.
2. For evergreen plants use a mixture of four parts topsoil and one part of peat moss as specified under Soil Enrichers.

D. Plant pits within or near paved areas shall be prepared prior to the laying of the pavement. Where tree pits in paved areas are to be covered with mulch, trees shall

be placed at sufficient depth below finished grade to allow for the depth of the mulch.

E. Plants shall be set plumb and straight, and at such a level that after settlement, a normal or natural relationship of the crown of the plant with the ground surface is established. Each plant shall be planted in the center of the pit. When balled, burlapped and platformed plants are set, the platform shall first be removed from the pit and the soil shall be carefully tamped under and around the base of each ball to fill all voids. All burlap, ropes, and wires shall be removed from the sides and tops of balls, but no burlap shall be pulled out from under the balls, except for plastic burlap, which shall be completely removed from the pit.

F. All seals shall remain unbroken and visible on plant material until final inspection by Engineer. The Contractor shall remove all seals immediately after final inspection.

3.9 PLANTING SEASON

A. Do all planting work within the dates herein specified.

3.10 PRUNING, PAINTING, SPRAYING

A. Pruning:
   1. Each tree and shrub planted shall be pruned to preserve the natural character of the plant and in a manner appropriate to the particular requirements of the landscape design. In general, approximately one third of the wood shall be removed by thinning or shortening branches, but no leaders shall be cut.
   2. All pruning shall be done with sharp tools. All pruning cuts shall be made flush and clean, especially where lower branches have been removed from collected trees.

B. Painting:
   1. Pruning cuts over one-half inch in diameter shall be painted with tree paint specified under "Materials" on all exposed cambium as well as other exposed living tissues.

3.11 STAKING

A. All staking shall be done immediately after wrapping. Stakes shall be driven perpendicular into the ground around the periphery of the ball of the tree. Plants shall stand plumb after staking.

3.12 WATERING

A. Plantings shall be watered in a satisfactory manner during and immediately after planting, not less than twice per week, until provisional acceptance.

B. Suitable water for maintaining plants shall be provided by the Owner. The Contractor shall furnish the hose and hose connections from the outlets where water is furnished. Contractor is responsible for all watering until provisional acceptance.

3.13 MAINTENANCE

A. Maintenance shall begin immediately after each plant is planted. Plants shall be watered, mulched, weeded, fertilized, cultivated and otherwise maintained and protected until provisional acceptance.

B. Guys shall be tightened and repaired. Defective work shall be corrected as soon as possible after defects become apparent, and weather and season permit.

3.14 TREE SURGERY

A. Existing trees shall be trimmed of all dead and diseased limbs at the direction of the Engineer. All cuts shall be made close to the trunk and those over one inch in diameter shall be covered with an acceptable tree paint manufactured for this specific purpose. In the case of important large trees where a small amount of cavity work would prolong their lives, such work should be done. The services of a qualified tree surgeon are recommended.

3.15 INSPECTION AND PROVISIONAL ACCEPTANCE

A. The Engineer will inspect all planting work for provisional acceptance upon request of the Contractor.

B. The Contractor shall furnish full and complete written instructions for maintenance of the planting to the Owner at the time of provisional acceptance.

C. After all necessary corrective work has been completed and maintenance instructions have been received by the Owner, the Engineer will certify in writing the provisional acceptance of the planting.

3.16 GUARANTEE PERIOD

A. All plants shall be guaranteed by the Contractor for a period of not less than one full year from time of provisional acceptance.

B. At the issuance of provisional acceptance, the Owner shall take over maintenance of the planting. Nevertheless, the guarantee of all plant material will remain with the Contractor. The Contractor shall ascertain that the Owner properly waters and maintains all planting during the one year guarantee period.

C. At the end of the guarantee period, any plant that is missing, dead, not true to name or size as specified, or not in satisfactory growth, as determined by the Engineer, shall be replaced. In case of reasonable doubt or question regarding the condition and satisfactory establishment of a rejected plant, the Engineer may allow such a plant to remain through another complete growing season, at which time the rejected plant, if found to be dead, in an unhealthy or badly impaired condition, shall be replaced at once. The Contractor will not be required to replace an inspected and accepted plant more than once.

D. Replacements shall be plants of the same kind and size as specified in the Plant List. They shall be furnished and planted as specified herein. The cost of replacement shall be borne by the Contractor, except where it can be definitely shown that loss resulted from Owner's failure to maintain planting as instructed.

3.17 FINAL INSPECTION AND FINAL ACCEPTANCE

A. At the end of the guarantee period, inspection will be made by the Engineer, at the request of the Contractor.

B. After all necessary corrective work has been completed, the Engineer will certify in writing the final acceptance of the planting.

3.18 CLEAN UP

A. Upon completion of work under this section, all excess stones, debris and soil resulting from planting work shall be removed from project site. The site shall be restored to a better condition than was present prior to construction.

END OF SECTION

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