STORMWATER MANAGEMENT REPORT

FOR: K & R CONSTRUCTION COMPANY, LLC

PROPOSED OFFICE/STORAGE YARD

84 BOSTON ROAD

NEWBURY, MA

TAX MAP 36 LOT No. 23A

PREPARED BY:

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SEPTEMBER 28, 2020

1.0 INTRODUCTION

1.1 Project Description

K & R Construction Company LLC proposes to construct an office building and storage yard for their construction operations at 84 Boston Road in Newbury, MA. A stormwater management system will be constructed to support the development. Private utilities including electric will also support the development. Access to the site will be provided via Boston Road.

1.2 Existing Site Characteristics

The subject parcel is described as Tax Map 36, Lot No. 23A on the Town of Newbury, MA Assessor's Map and is bordered by Boston Road to the east and Sled Road to the north. The project parcel is 2.28 acres in size. Elevations on the site range from 32.00' at various spots onsite to 12.00' at the wetlands at the rear of the site. These elevations are based upon 1988 NAVD.

The entire property is undisturbed natural woodland. Wetlands are present along the northwesterly portion of the property. See the accompanying plan for a more detailed description of the existing site conditions and topography.

The lot consists of one soil group: Rock outcrop-Buxton complex, 716 (Hydrologic Soil Group D). 3 test pits were performed onsite for drainage in March 2020. See Appendix E for the NRCS soil map.

1.3 Proposed Site Features

The proposed facility includes a 7,400 square foot building with 2 paved access driveways, paved parking and access on 3 sides of the building, and a gravel storage area to the rear and side of the building. Electrical service will be provided to the building.

In order to address stormwater management regulations, a constructed wetland is proposed to store and treat runoff. No infiltration of stormwater runoff is proposed given the soil conditions and presence of ledge.

2.0 WATERSHED ANALYSIS AND METHODOLOGY

The stormwater runoff management system was analyzed using the storm events of the 2-year, 10-year and 100-year frequency. The analysis was performed using HydroCAD, version 10.00. Using USDA NRCS TR-20 and TR-55 methods of estimating runoff, the program uses the measured characteristics of the site and computes runoff produced by simulated rainfall events. The results are then used to design runoff control structures.

Existing drainage area boundaries were developed using an onsite topographic survey performed by Millennium Engineering, Inc. Proposed site development boundaries were developed from proposed grades and ground cover designed to minimize site storm water management structure requirements.

Hydrologic soil groups and curve numbers were estimated for existing and proposed developed conditions using available NRCS Soil Maps, current vegetation, and terrain.

3.0 DRAINAGE ANALYSIS

The purpose of the drainage analysis is two-fold. The first is to analyze and quantify the pre-development runoff flows through the site. The second purpose is to evaluate the impact of the proposed development on drainage patterns and flows, both within and outside the site, and to design a stormwater management system to adequately convey post-development runoff.

The design of the stormwater management system has the following goals:

1.) Minimize or eliminate erosion and sedimentation during construction as well as after development.

2.) To ensure that post-development flows do not have an adverse affect on downstream drainage structures and landowners.

3.) To design a stormwater and treatment system which will carry the surface runoff and satisfy goals one and two.

To determine the hydrological effect of the proposed development on the watershed, the existing conditions must first be analyzed.

4.0 WATERSHED DESCRIPTION: EXISTING CONDITIONS

Depending on the soil classification, type of ground cover present and the direction of the flow of runoff, the existing site is divided into watershed areas. Watershed area 100 consists of the majority of the site and it feeds the bordering vegetated wetlands at the rear of the site. Area 200 consists of the southeast corner of the property and it feeds the bordering vegetated wetlands offsite to the south. See the attached plans (Watersheds and HydroCad Data, sheet 1 of 2) for the watershed area boundaries and the pre-development time of concentration flow paths.

4.1 WATERSHED ANALYSIS: EXISTING CONDITIONS

The existing conditions were modeled using the tabular hydrograph method with a Type III synthetic storm distribution for the 2, 10 and 100-year storm recurrence intervals. Runoff hydrographs were produced to estimate existing peak discharge.

Flows for the three storm simulations are as follows:

Existing (Pre-development) Peak Runoff Rates (c.f.s.)

Subcatchment	Size	2 Yr	10 Yr	100 Yr
	(Acres)	Storm	Storm	Storm
100	1.99	2.4	5.1	12.2
200	0.79	1.0	2.0	4.6
		2 Yr	10 Yr	100 Yr
BV Wetland "D"		2.4	5.1	12.2
BV Wetland "I"		1.0	2.0	4.6

The pre-development drainage calculations can be found in Appendix C.

5.0 WATERSHED DESCRIPTION: POST-DEVELOPMENT CONDITIONS

To determine the post development runoff, new watersheds, runoff curve numbers and times of concentration were generated reflecting the changes in the topography and surface cover. The post-development watersheds are shown on the attached plans (Watersheds and HydroCad Data, sheet 2 of 2). Watershed areas 1S-5S consist of the proposed building and paved/gravel areas and they feed the constructed wetland via a catch basin and pipe network. Area 100 consists of the areas outside the limits of work and it feeds the bordering vegetated wetlands at the rear of the site. Area 200 consists of the very front of the site and the southeast corner of the property and it feeds the bordering vegetated wetlands offsite to the south.

5.1 WATERSHED ANALYSIS: POST-DEVELOPMENT CONDITIONS

The proposed developed conditions were modeled using the tabular hydrograph method with a Type III synthetic storm distribution for the 2, 10 and 100-year storm recurrence intervals. Runoff hydrographs were produced to estimate the post-development peak discharge.

Flows for the three storm simulations are as follows:

Post-Developed Peak Runoff Rates (c.f.s.)

Subcatchment	Size (Acres)	2 Yr Storm	10 Yr Storm	100 Yr Storm
1S	0.20	0.5	0.8	1.5
2S	0.36	0.8	1.4	2.7
3S	0.41	1.1	1.7	3.2
4S	0.47	1.2	1.9	3.6
5S	0.13	0.2	0.4	0.9
100	0.78	1.1	2.2	5.2
200	0.45	0.8	1.5	3.2
		2 Yr	10 Yr	100 Yr
BV Wetland "D"		2.4	4.1	11.6
BV Wetland "I"		0.8	1.5	3.2

The post-development drainage calculations can be found in Appendix D.

6.0 STORMWATER STANDARDS CALCULATIONS

The Stormwater Management Plan developed for this project incorporates water quantity and quality controls that will protect surface and groundwater resources and adjacent properties from potential impacts due to increased impervious areas on the site. The following provides a brief discussion on how the proposed project will meet the ten established performance standards of the DEP Stormwater Management Policy.

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

No proposed site stormwater conveyance systems will discharge untreated stormwater directly to wetlands or surrounding areas. Stormwater runoff from the roofs and proposed paved area will discharge into the proposed constructed wetland.

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

Stormwater runoff peak discharge rates from the proposed development are less than existing conditions for the 2-yr, 10-yr, and 100-yr 24-hour Type III storm events.

3. Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall

approximate the annual recharge from pre-development conditions based on soil type. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

Required Recharge volume, Rv (D soil) = F * impervious area
= 0.10 in * 53,920 s.f.
= 449 c.f.

Site conditions make it very difficult to meet the recharge requirements. Poor soil conditions (C & D soils) and ledge exist throughout the site, which doesn't allow for the use of infiltration BMPs.

4. Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This Standard is met when:

a. Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan, and thereafter are implemented and maintained;
b. Structural stormwater best management practices are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and
c. Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.

The Massachusetts DEP requires water quality calculations based on 0.5 inch of runoff for the total impervious area associated with the proposed development. The following calculation identifies the water quality volume required.

Total Impervious Area = 53,920 s.f.
53,920 s.f. * .5" / 12 (to convert to ft) = 2,247 c.f. of runoff to be treated for water quality.

Volume of Constructed Wetland = 8,805 c.f.

The proposed development's drainage system must meet the MA Office of Coastal Zone management (CZM)/MA Department of Environmental Protection (DEP) Stormwater Management policy standard of removing 80% of the average annual load of Total Suspended Solids (TSS). The stormwater management system for this development will include the use of a sediment forebay for pre-treatment, and a constructed wetland for treatment prior to discharge into the resource areas. The following demonstrates that the proposed storm water management system for the development satisfies the requirement for treatment of 80% of total Suspended Solids:

Deep Sump Catch Basin	25%
Constructed Wetland	80%

TSS removed from all impervious areas = (1.00)*(25%) TSS removed + (.75 TSS Remaining) * (80%)

Weighted TSS Removal Rate for Entire Site = 85%

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

This project does not qualify as a land use with higher potential pollutant loads.

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

This project does not fall within a critical area.

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

The proposed development is not considered a redevelopment project and does not meet the requirements of definition for this standard.

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

The proposed development design includes erosion and sediment controls to minimize the potential for sedimentation in down gradient resource areas. Reference is made to the project plans for additional information.

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

An O&M plan has been developed and is included in this report.

10. All illicit discharges to the stormwater management system are prohibited.

No illicit discharges exist on the site.

7.0 CONCLUSIONS

The results of this report indicate the proposed stormwater management system for the proposed development is capable of storing and treating the runoff for the 2-year, 10-year and 100-year storm events.

The peak fiow rates in this analysis have been conservatively estimated for both the pre- and post-development conditions. Based on the results of the analyses described herein, the proposed development will not increase in the existing the runoff rate leaving the site. The proposed storm water management facilities shown on the Site Plan will produce no adverse storm water runoff impacts under the storms analyzed.

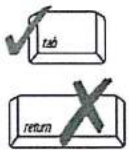
8.0 APPENDIX A – STORMWATER REPORT CHECKLIST

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

Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

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

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

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

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

[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.

B. Stormwater Checklist and Certification

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

Checklist for Stormwater Report

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.

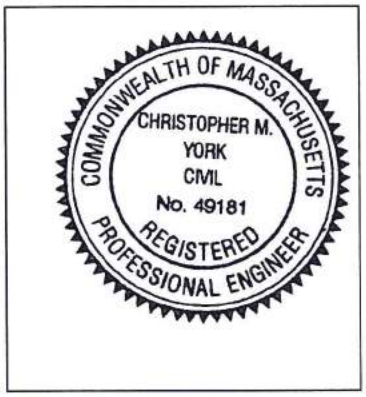
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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



Christ M. Y- 9-28-20
Signature and Date

Checklist

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

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist (continued)

Checklist for Stormwater Report

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

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

Standard 1: No New Untreated Discharges

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

Checklist (continued)

Checklist for Stormwater Report

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☐ Soil Analysis provided.

☐ Required Recharge Volume calculation provided.

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

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

☐ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

- ☒ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

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

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

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

Checklist (continued)

Checklist for Stormwater Report

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

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

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

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

Checklist (continued)

Checklist for Stormwater Report

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 (continued)

Checklist for Stormwater Report

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 (continued)

Checklist for Stormwater Report

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.

9.0 APPENDIX B – LONG-TERM POLLUTION PREVENTION PLAN AND OPERATION & MAINTENANCE PLAN

LONG-TERM POLLUTION PREVENTION PLAN

AND

OPERATION & MAINTENANCE PLAN

For

K & R CONSTRUCTION COMPANY LLC
P.O. BOX 163
BOXFORD, MA 01921

A PROPOSED OFFICE/STORAGE YARD

PREPARED BY:

MILLENNIUM ENGINEERING, INC.
62 ELM STREET
SALISBURY, MA 01952
(978) 463–8980

SEPTEMBER 28, 2020

This long-term Stormwater Management System Operations and Maintenance (O&M) Plan, filed with the Town of Newbury, shall be implemented for the proposed development at 84 Boston Road to ensure that the stormwater management system functions as designed. The Owner holds the primary responsibility for overseeing and implementing the O&M Plan and assigning a Property Manager who will be responsible for the proper operation and maintenance of the stormwater structures. In case of transfer of property ownership, future property owners shall be notified of the presence of the stormwater management system and the requirements for proper implementation of the O&M Plan. Included in the manual is a Stormwater Management O&M Plan identifying the key components of the stormwater system and a log for tracking inspections and maintenance.

The stormwater management system protects and enhances the stormwater runoff water quality through the removal of sediment and pollutants, and source control significantly reduces the amount of pollutants entering the system. Preventive maintenance of the system will include a comprehensive source reduction program of regular vacuuming and litter removal, and prohibitions on the use of pesticides.

The purpose of the Stormwater Operations and Maintenance (O&M) plan is to ensure inspection of the system, removal of accumulated sediments, oils, and debris, and implementation of corrective action and record keeping activities.

The ongoing responsibility is the Owner, its successors and assigns. Adequate maintenance is defined in this document as good working condition.

Contact information is provided below:

Responsibility for Operations and Maintenance
Kevin Whitney
P.O. Box 163
Boxford, MA 01921
(978) 356-4188

Illicit Discharge Compliance Statement

I, _____,verify that all illicit discharges to the stormwater management system are prohibited and no illicit discharges exist on the site.

EROSION AND SEDIMENT CONTROL BMPs

Minimize Disturbed Area and Protect Natural Features and Soil

Topsoil

Topsoil stripped from the immediate construction area can be temporarily stockpiled on site providing that the perimeter of the stockpiles is properly staked with silt fence at the toe of slope. The stockpiles shall be in areas that will not interfere with construction and at least 15 feet away from areas of concentrated flows or pavement. The area shall be inspected weekly for erosion and immediately after storm events. Areas on or around the stockpile that have eroded shall be stabilized immediately with erosion controls.

Stabilize Soils

Temporary Stabilization

- All vegetated areas which do not exhibit a minimum of 85% vegetative growth by Oct. 15th, or which are disturbed after Oct. 15th, shall be stabilized by seeding and installing erosion control blankets on slopes greater than 3:1, and seeding and placing 3 to 4 tons of mulch per acre, secured with anchored netting, elsewhere. The placement of erosion control blankets or mulch and netting shall not occur over accumulated snow or on frozen ground and shall be completed in advance of thaw or spring melt events.
- All ditches or swales which do not exhibit a minimum of 85% vegetative growth by Oct. 15th, or which are disturbed after Oct. 15th, shall be stabilized with stone or erosion control blankets appropriate for the design flow conditions.
- After November 15th, incomplete road surfaces, where work has stopped for the winter season, shall be protected with a minimum of 3 inches of crushed gravel.

Protect Slopes

Geotextile erosion control blankets shall be used to provide stabilization for slopes exceeding 3:1. Prepare soil before installing erosion control blanket, including any necessary application of lime, fertilizer, and seed. Begin at the top of the slope by anchoring the blanket in a 6" deep x 6" wide trench with approximately 12" extended beyond the upslope portion of the trench. Anchor the blanket with a row of staples/stakes approximately 12" apart in the bottom of the trench. Backfill and compact the trench after stapling. Apply seed to compacted soil and fold remaining 12" portion of back over seed and compacted soil. Secure over compacted soil with a row of staples/stakes spaced approximately 12" apart across the width of the blanket. Roll erosion control blanket either down or horizontally across the slope. Blanket will unroll with appropriate side against the soil surface. All blankets must be securely fastened to soil surface by placing staples/stakes in appropriate locations as shown in the staple pattern guide. When using the dot system, staples/stakes should be placed through each of the colored dots corresponding to the appropriate staple pattern. The edges of parallel blankets must be stapled with approximately 2"-5" overlap. Consecutive blankets spliced down the slope must be placed end over end (shingle style) with an approximate 3" overlap. Staple through

overlapped area, approximately 12" apart across entire blanket's width. In loose soil conditions, the use of staple or stake lengths greater than 6" may be necessary to properly anchor the blanket.

Establish Perimeter Controls and Sediment Barriers

Silt fence shall be installed along the property lines/edge of wetlands. The silt fence shall be installed before construction begins. Wooden posts shall be doubled and coupled at filter cloth seams. Filter cloth shall be fastened securely to support netting with ties spaced every 24" at top, midsection, and bottom. When two sections of filter cloth adjoin each other, they shall be overlapped by 6 inches, folded and stapled. Silt fence shall be removed upon completion of the project and stabilization of all soil.

Maintenance:
1. Silt fence shall be inspected immediately after each rainfall and at least daily during prolonged rainfall. Any repairs that are required shall be made immediately.
2. If the fabric on the silt fence shall decompose or become ineffective during the expected life of the fence, the fabric shall be replaced promptly.
3. Sediment deposits shall be inspected after every storm event. The deposits shall be removed when they reach approximately one-half the height of the barrier.
4. Sediment deposits that are removed or left in place after the fabric has been removed shall be graded to conform with the existing topography and vegetated.

Establish Stabilized Construction Entrance

A stabilized construction entrance shall be installed before construction begins on the site. The stone anti-tracking pad shall remain in place until the subgrade of pavement is installed.

1. Stone shall be 3-4" stone, reclaimed stone, or recycled concrete equivalent.
2. The length of the stabilized entrance shall not be less than 50'.
3. The thickness of the stone for the stabilized entrance shall not be less than 12".
4. Geotextile filter cloth shall be placed over the entire area prior to placing the stone.
5. All surface water that is flowing to or diverted toward the construction entrance shall be piped beneath the entrance. If piping is impractical, a berm with 5:1 slopes that can be crossed by vehicles may be substituted for the pipe.
6. The entrance shall be maintained in a condition that will prevent tracking or flowing of sediment onto public rights-of-way. This may require periodic top-dressing with additional stone as conditions demand and repair and/or cleanout of any measures used to trap sediment. All sediment spilled, washed, or tracked onto public rights-of-way must be removed promptly.
7. Wheels shall be cleaned to remove mud prior to entrance onto public rights-of way. When washing is required, it shall be done on an area stabilized with stone which drains into an approved sediment trapping device.

Catch Basin Inlet Protection

Inlet protection devices intercept and/or filter sediment before it can be transported from a site into the storm drain system and discharged into a lake, river, stream, wetland, or other waterbody. These devices also keep sediment from filling or clogging storm drain pipes, ditches, and downgradient sediment traps or ponds. A siltsack or approved equal shall be used for catch basin inlet protection. It should be inspected weekly. When the restraint cord is no longer visible, siltsack is full and shall be emptied.

POST-CONSTRUCTION BMPs

Snow and Snow Melt Management

Proper management of snow and snow melt, snow removal and storage, use of deicing compounds, and other practices can minimize major runoff and pollutant loading impacts. Snow will be stored at the rear of the site behind the last building. Use of alternative deicing compounds, such as calcium chloride and calcium magnesium acetate, will be investigated for use. Professional services will be used for snow management.

Catch Basins

Catch basins are incorporated in the proposed development's stormwater management plan. The sump provides for settlement of suspended solids and a hood is provided to remove floatables and trapped hydrocarbons. It is not anticipated that the proposed paved areas will become an area of high sediment loading. The sump should be inspected and cleaned at least two times per year; the more frequent the cleaning, the less likely sediment will be resuspended and subsequently discharged. Catch basin sediments and debris shall be disposed of at an approved DEP landfill. The owner shall be responsible for the catch basin cleaning operations.

Sediment Forebay

A sediment forebay is included in the stormwater management plan as pretreatment for the proposed constructed wetland. The forebay will be portioned from the wetland by use of a stone filter berm. The forebay and riprap shall be inspected monthly during construction and cleaned upon completion of the project. The forebay shall be inspected at least two times per year and cleaned as needed by a landscaping contractor hired by the Owner. Sediments removed during cleaning shall be disposed of at an approved DEP landfill.

Constructed Wetland

A constructed wetland is included in the stormwater management plan design for the proposed development. The applicant of the project, through his contractor, will incorporate this sediment control feature into the project during construction activities. Upon completion of the development, the owner shall retain the services of a landscaping contractor for proper maintenance and upkeep of the wetland. To ensure proper performance and system longevity, the following maintenance schedule is recommended:

a.) Sediment and debris removal: Wetland should be inspected twice a year by a certified wetland scientist, during both growing and non-growing seasons, in the first 3 years after construction. Observations during the inspections should include:
    i.) Types and distribution of dominant wetland plants in the wetland;
    ii.) The presence and distribution of planted wetland species versus the presence and distribution of natural wetland species and any signs that natural species are overtaking planted species;
    iii.) Accumulation of sediment in the forebay and micropool. Any sediment and debris should be removed manually before the vegetation is adversely impacted;
b.) Wetland protection: Efforts should be made, through snow and snow melt management, local bylaws and public education, to protect the wetlands from damages of snow removal and off street parking.

FINAL STABILIZATION

Permanent Seeding

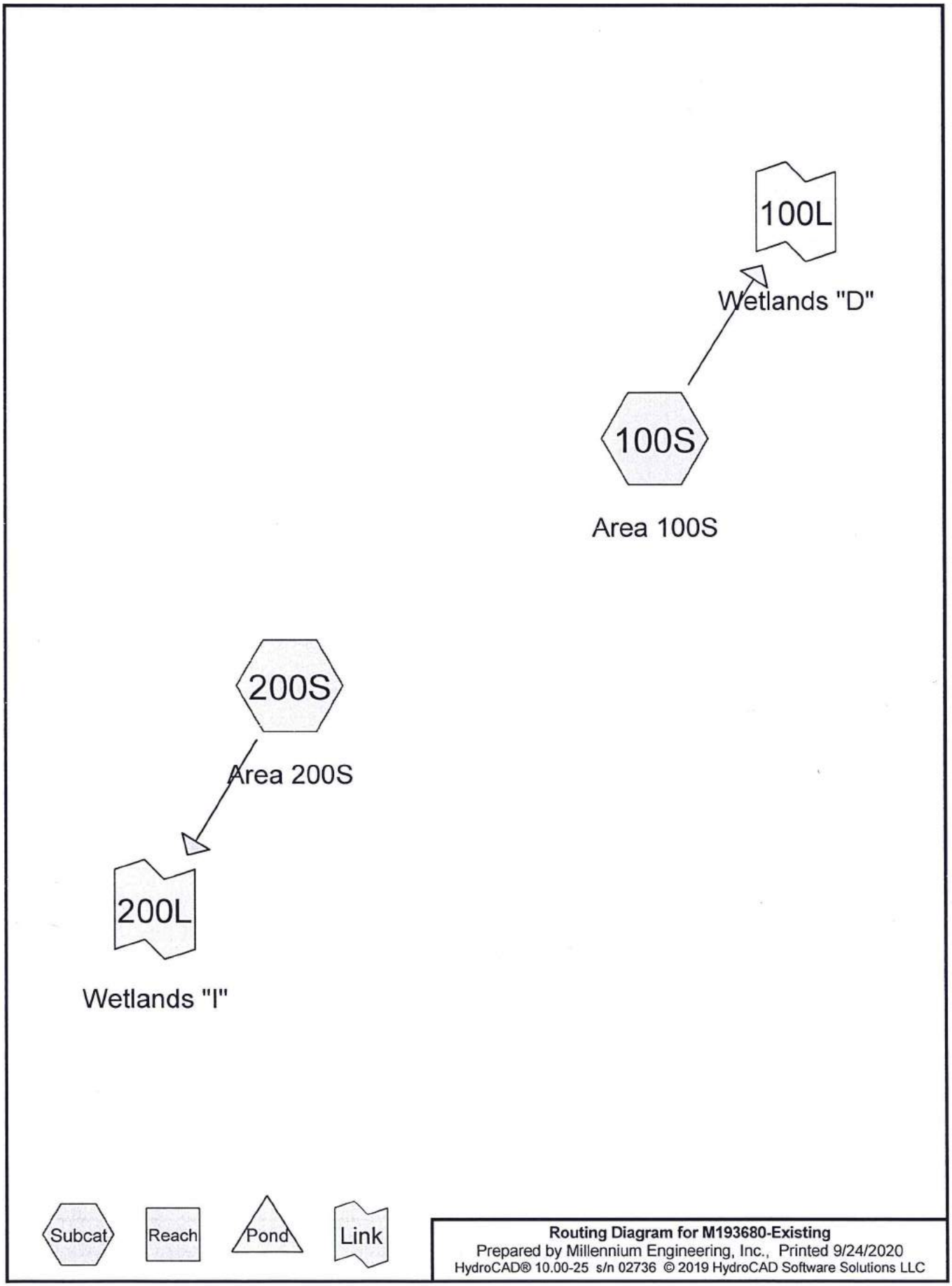
Loam and hydroseed any disturbed surfaces after the final design grades have been achieved. A minimum of 6" of loam shall be installed. Seed mix shall be a maximum of 10% rye grass and a minimum of 90% permanent bluegrass and/or fescue. Lime shall be applied at a rate of 2 tons/acre.

Construction debris, trash and temporary BMPs (including silt fences, material storage areas, and inlet protection) will also be removed and any areas disturbed during removal will be seeded immediately.

POST-CONSTRUCTION INSPECTION & MAINTENANCE LOG

Activity	*Date*	*Inspected By*	*Findings*
Street Sweeping (1x per year)			
Catch Basin Cleaning (2x per year)			
Forebay Sediment Removal Incl. rip rap and pipe (2x per year)			
Constructed Wetland Cleaning (2x per year)			
Rip-rap Outlets & Emergency Spillway Protection (2x per year)			
Outlet Structure Inspection & Sediment Removal (2x per year)			
Vegetation and Landscaping (2x per year)			
Roof Drain Cleanouts (2x per year)			

10.0 APPENDIX C – PRE-DEVELOPMENT DRAINAGE CALCULATIONS



Routing Diagram for M193680-Existing
Prepared by Millennium Engineering, Inc., Printed 9/24/2020

Summary for Subcatchment 100S: Area 100S

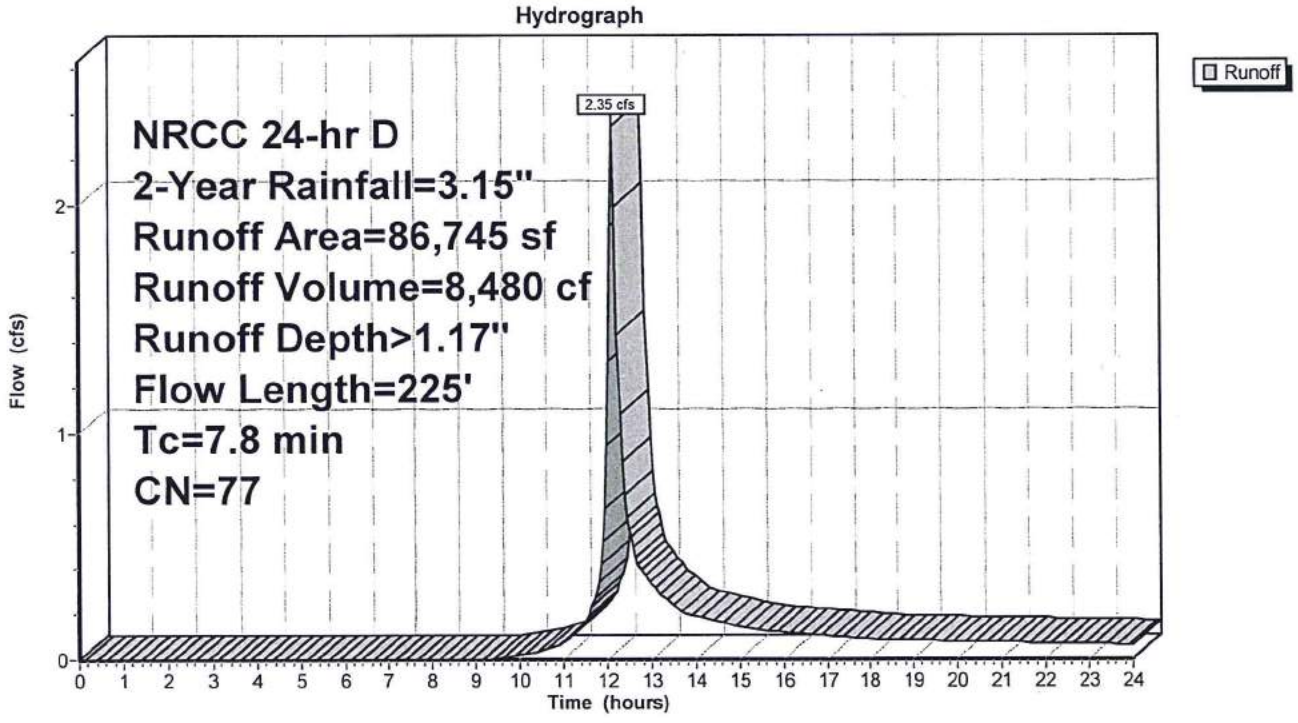
Runoff = 2.35 cfs @ 12.15 hrs, Volume= 8,480 cf, Depth> 1.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
1,785	98	Paved roads w/curbs & sewers, HSG D
84,960	77	Woods, Good, HSG D
86,745	77	Weighted Average
84,960		97.94% Pervious Area
1,785		2.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.1400	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
2.0	175	0.0850	1.46		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
7.8	225	Total			

Subcatchment 100S: Area 100S

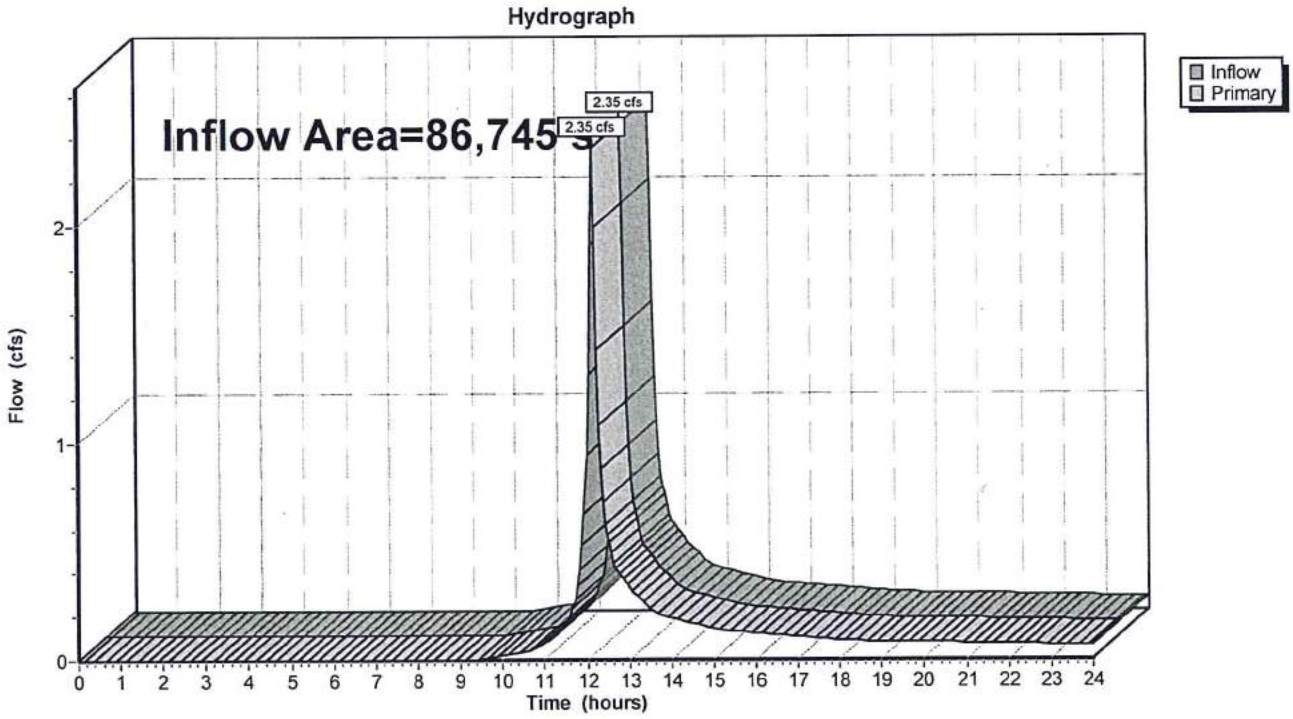


Summary for Link 100L: Wetlands "D"

Inflow Area = 86,745 sf, 2.06% Impervious, Inflow Depth > 1.17" for 2-Year event
Inflow = 2.35 cfs @ 12.15 hrs, Volume= 8,480 cf
Primary = 2.35 cfs @ 12.15 hrs, Volume= 8,480 cf, Atten= 0%, Lag= 0.0 min

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

Link 100L: Wetlands "D"



Summary for Subcatchment 200S: Area 200S

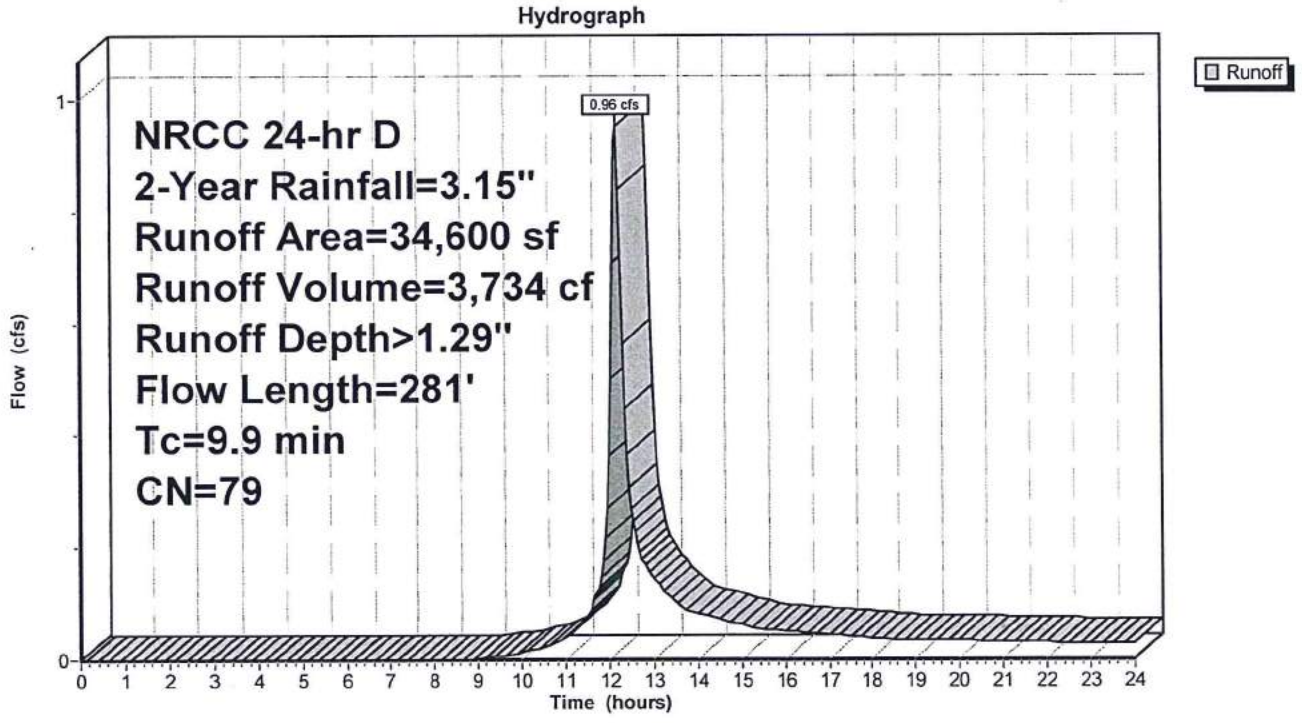
Runoff = 0.96 cfs @ 12.18 hrs, Volume= 3,734 cf, Depth> 1.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
3,090	98	Paved roads w/curbs & sewers, HSG D
31,510	77	Woods, Good, HSG D
34,600	79	Weighted Average
31,510		91.07% Pervious Area
3,090		8.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.1400	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.1	231	0.0350	0.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.9	281	Total			

Subcatchment 200S: Area 200S

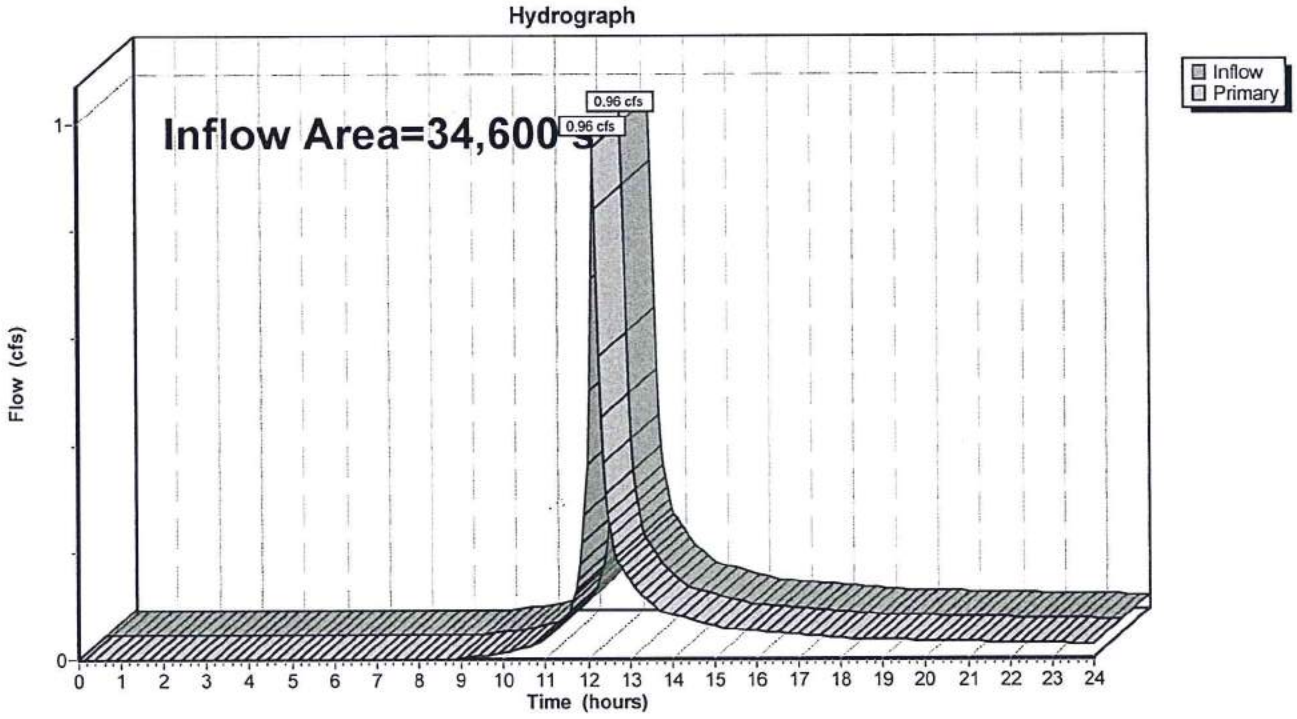


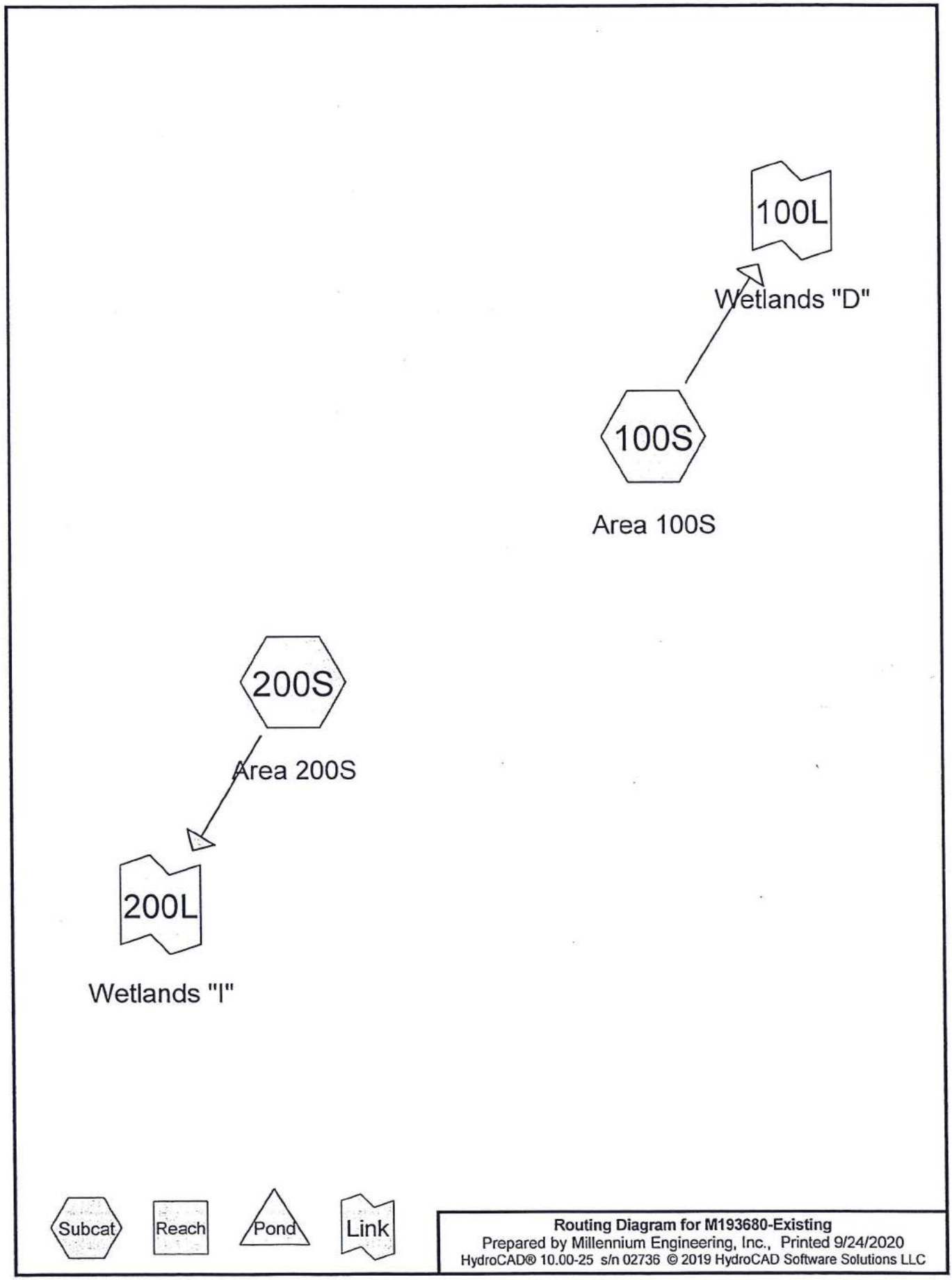
Summary for Link 200L: Wetlands "I"

Inflow Area = 34,600 sf, 8.93% Impervious, Inflow Depth > 1.29" for 2-Year event
Inflow = 0.96 cfs @ 12.18 hrs, Volume= 3,734 cf
Primary = 0.96 cfs @ 12.18 hrs, Volume= 3,734 cf, Atten= 0%, Lag= 0.0 min

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

Link 200L: Wetlands "I"





Routing Diagram for M193680-Existing
Prepared by Millennium Engineering, Inc., Printed 9/24/2020

Summary for Subcatchment 100S: Area 100S

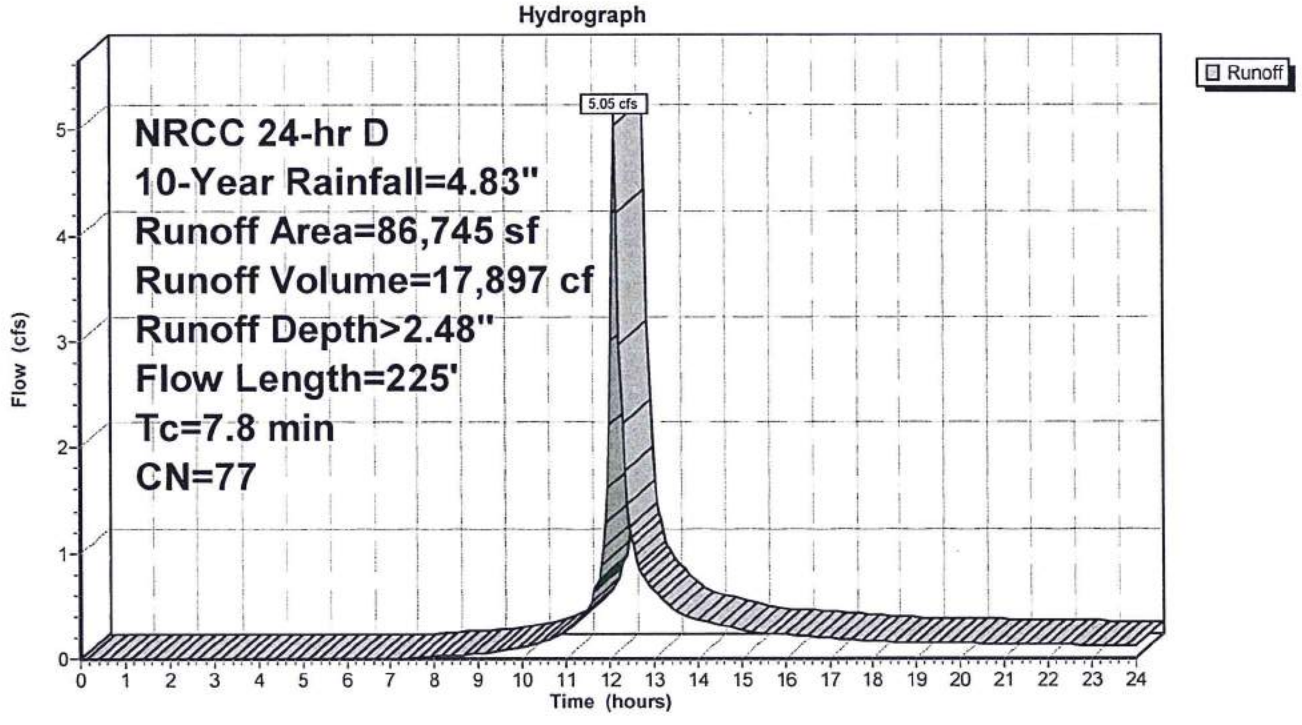
Runoff = 5.05 cfs @ 12.15 hrs, Volume= 17,897 cf, Depth> 2.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
1,785	98	Paved roads w/curbs & sewers, HSG D
84,960	77	Woods, Good, HSG D
86,745	77	Weighted Average
84,960		97.94% Pervious Area
1,785		2.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.1400	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
2.0	175	0.0850	1.46		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
7.8	225	Total			

Subcatchment 100S: Area 100S

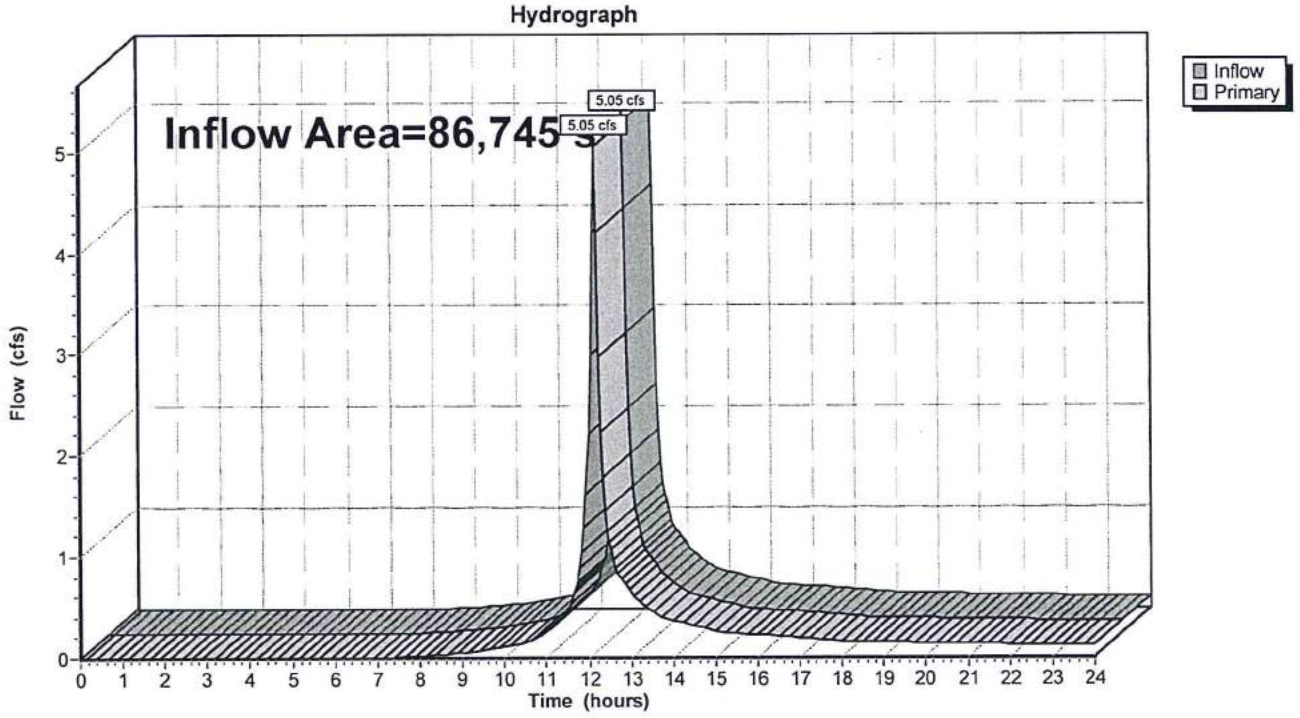


Summary for Link 100L: Wetlands "D"

Inflow Area = 86,745 sf, 2.06% Impervious, Inflow Depth > 2.48" for 10-Year event
Inflow = 5.05 cfs @ 12.15 hrs, Volume= 17,897 cf
Primary = 5.05 cfs @ 12.15 hrs, Volume= 17,897 cf, Atten= 0%, Lag= 0.0 min

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

Link 100L: Wetlands "D"



Summary for Subcatchment 200S: Area 200S

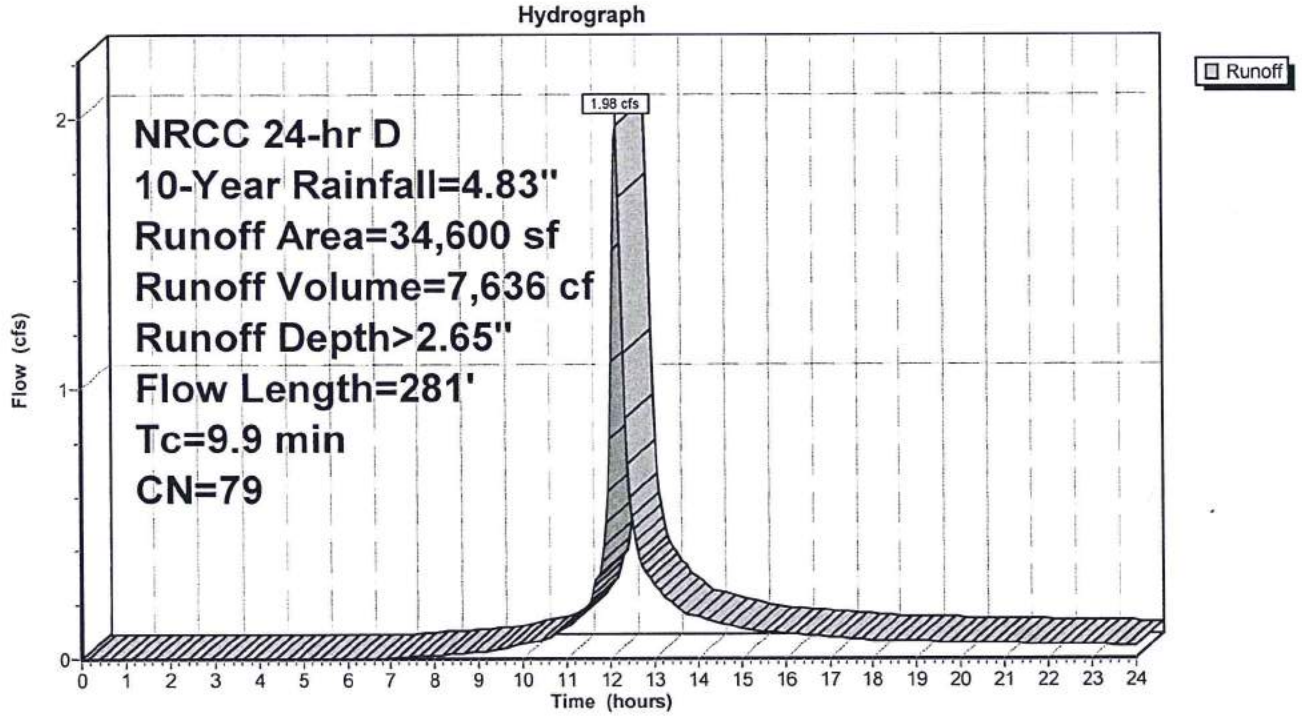
Runoff = 1.98 cfs @ 12.17 hrs, Volume= 7,636 cf, Depth> 2.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
3,090	98	Paved roads w/curbs & sewers, HSG D
31,510	77	Woods, Good, HSG D
34,600	79	Weighted Average
31,510		91.07% Pervious Area
3,090		8.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.1400	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.1	231	0.0350	0.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.9	281	Total			

Subcatchment 200S: Area 200S

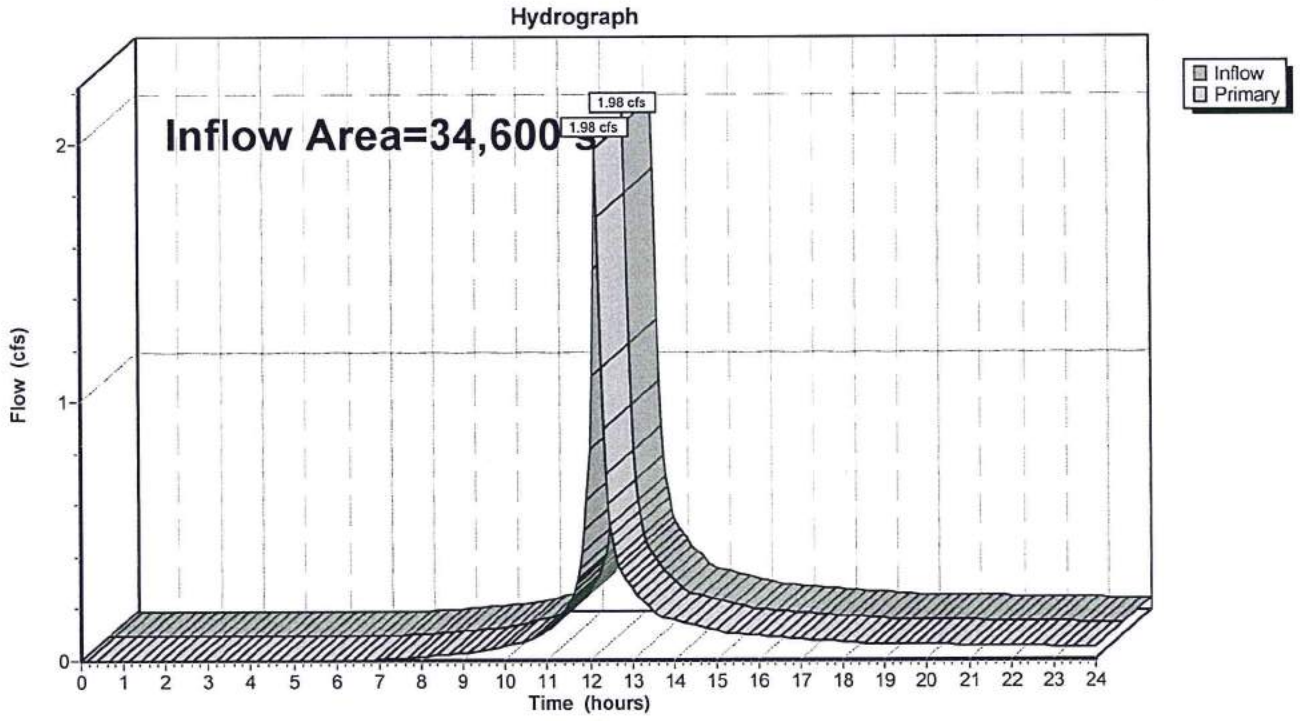


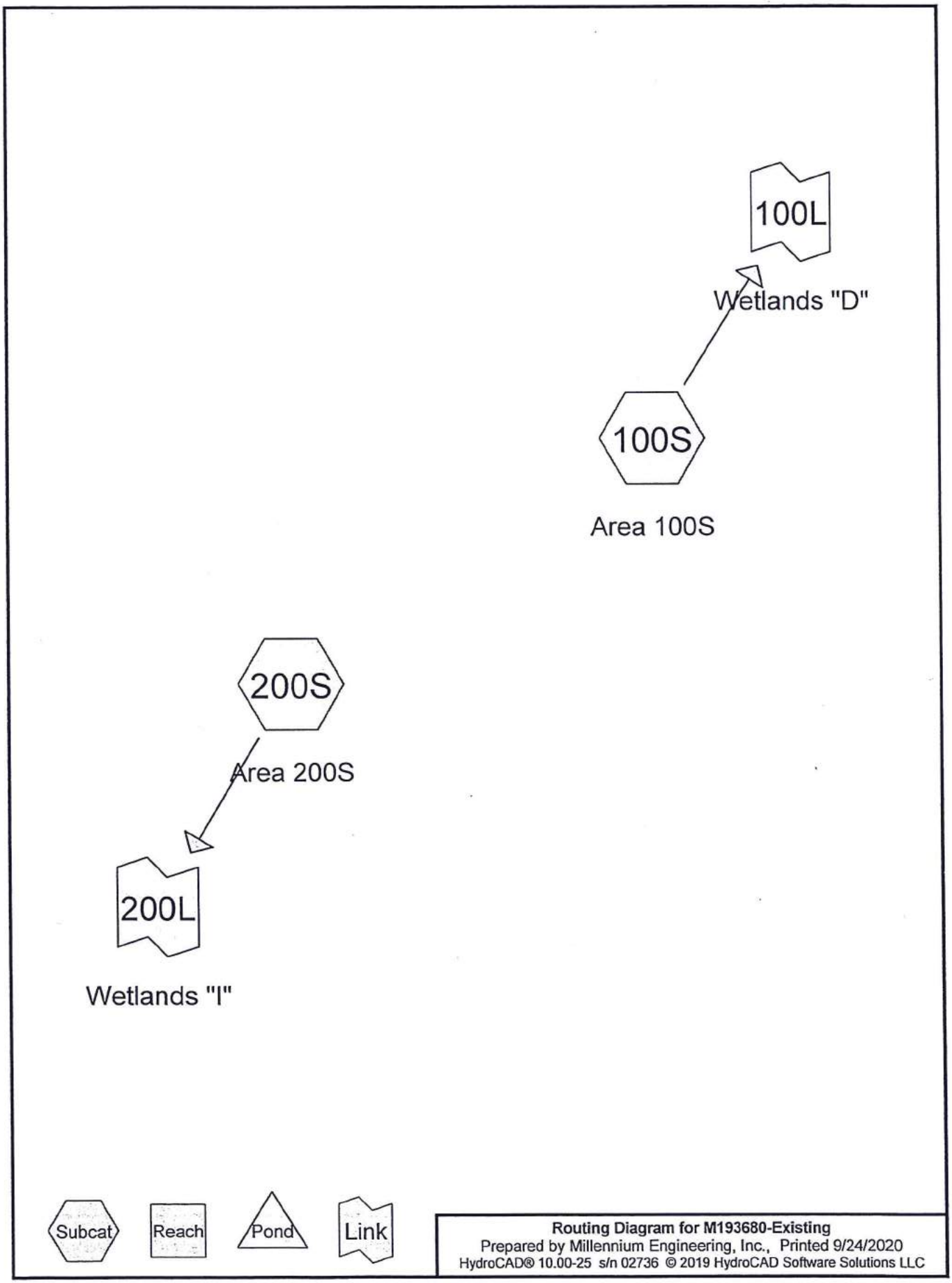
Summary for Link 200L: Wetlands "I"

Inflow Area = 34,600 sf, 8.93% Impervious, Inflow Depth > 2.65" for 10-Year event
Inflow = 1.98 cfs @ 12.17 hrs, Volume= 7,636 cf
Primary = 1.98 cfs @ 12.17 hrs, Volume= 7,636 cf, Atten= 0%, Lag= 0.0 min

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

Link 200L: Wetlands "I"





Routing Diagram for M193680-Existing
Prepared by Millennium Engineering, Inc., Printed 9/24/2020
HydroCAD® 10.00-25 s/n 02736 © 2019 HydroCAD Software Solutions LLC

Summary for Subcatchment 100S: Area 100S

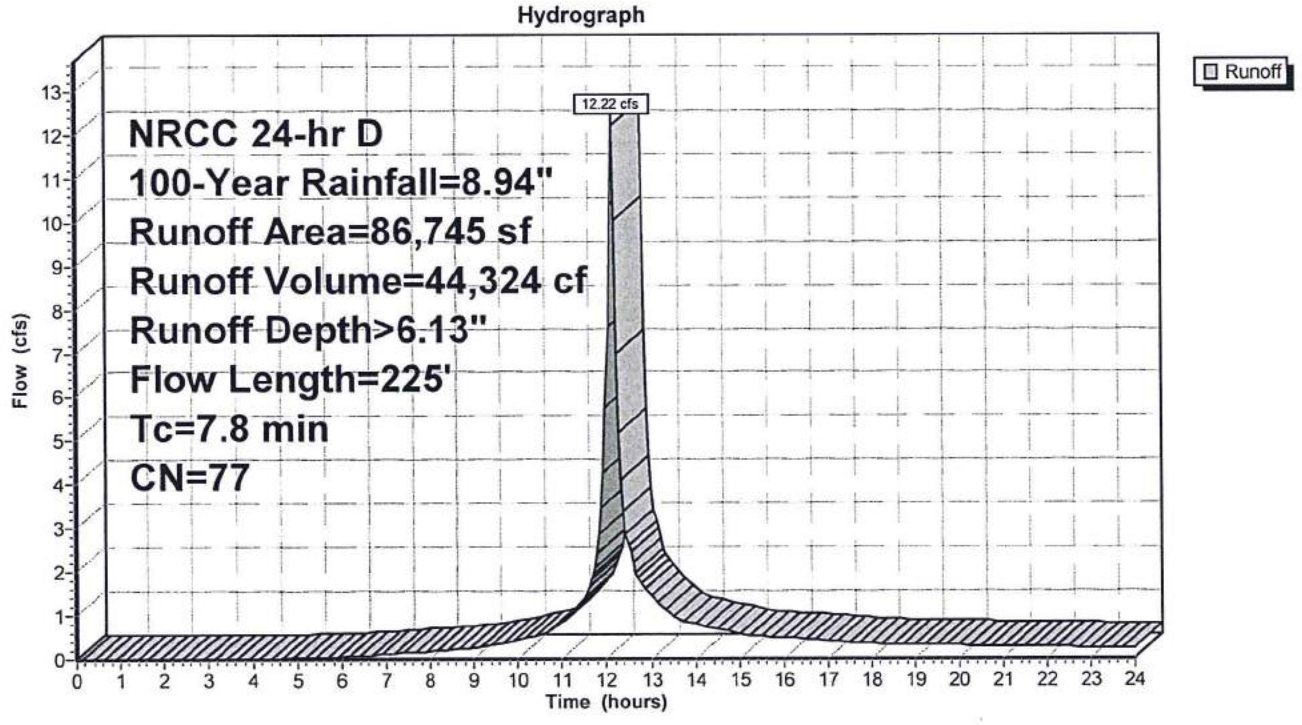
Runoff = 12.22 cfs @ 12.15 hrs, Volume= 44,324 cf, Depth> 6.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
1,785	98	Paved roads w/curbs & sewers, HSG D
84,960	77	Woods, Good, HSG D
86,745	77	Weighted Average
84,960		97.94% Pervious Area
1,785		2.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.1400	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
2.0	175	0.0850	1.46		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
7.8	225	Total			

Subcatchment 100S: Area 100S

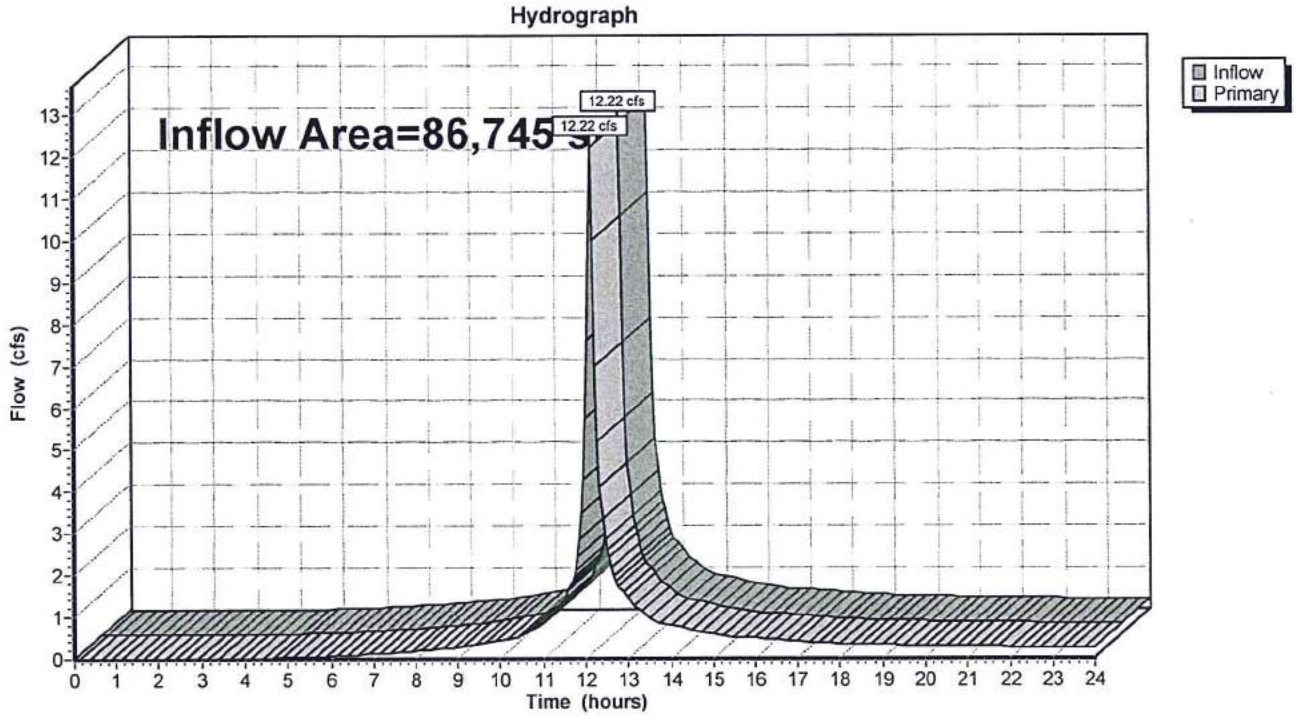


Summary for Link 100L: Wetlands "D"

Inflow Area = 86,745 sf, 2.06% Impervious, Inflow Depth > 6.13" for 100-Year event
Inflow = 12.22 cfs @ 12.15 hrs, Volume= 44,324 cf
Primary = 12.22 cfs @ 12.15 hrs, Volume= 44,324 cf, Atten= 0%, Lag= 0.0 min

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

Link 100L: Wetlands "D"



Summary for Subcatchment 200S: Area 200S

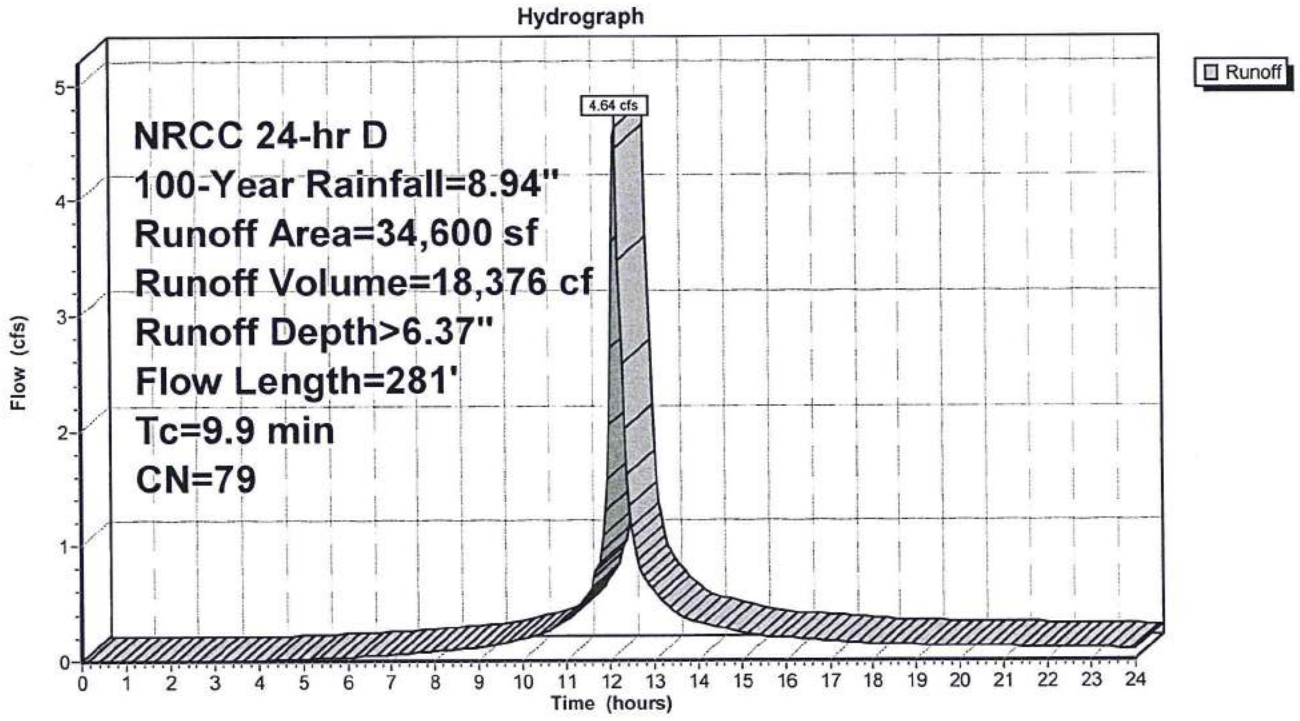
Runoff = 4.64 cfs @ 12.17 hrs, Volume= 18,376 cf, Depth> 6.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
3,090	98	Paved roads w/curbs & sewers, HSG D
31,510	77	Woods, Good, HSG D
34,600	79	Weighted Average
31,510		91.07% Pervious Area
3,090		8.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.1400	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
4.1	231	0.0350	0.94		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
9.9	281	Total			

Subcatchment 200S: Area 200S

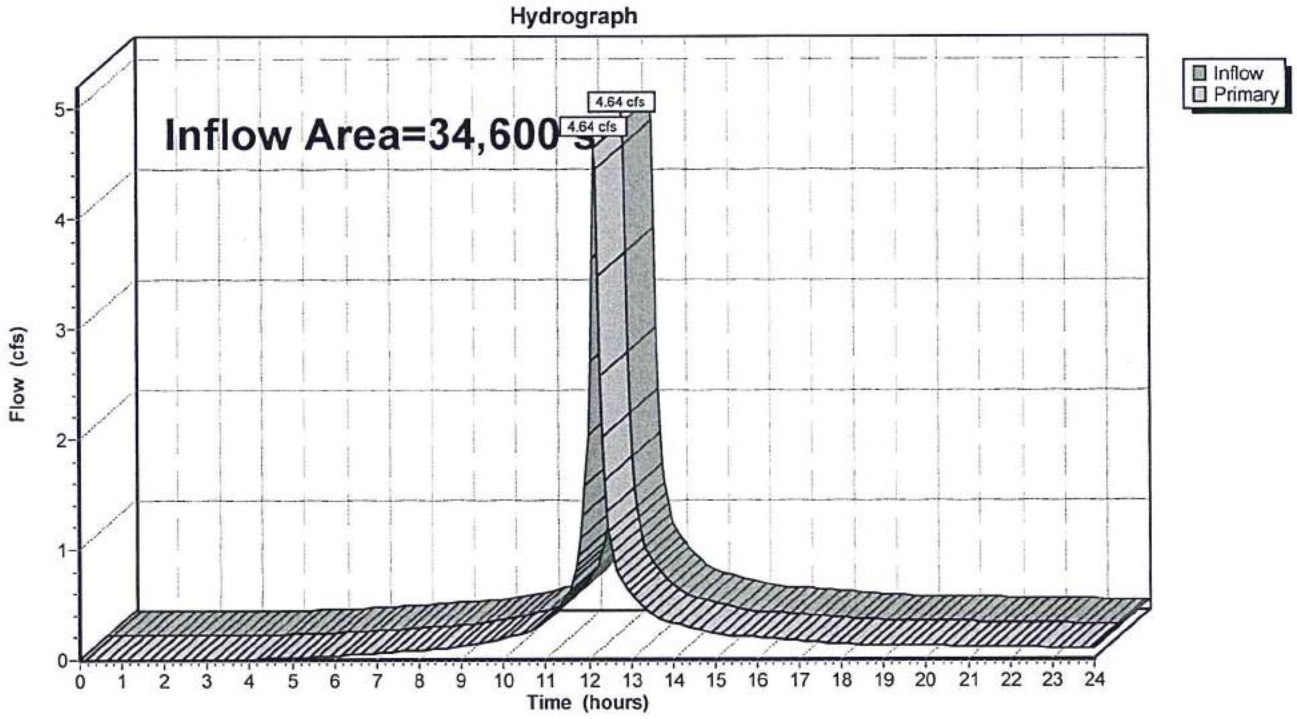


Summary for Link 200L: Wetlands "I"

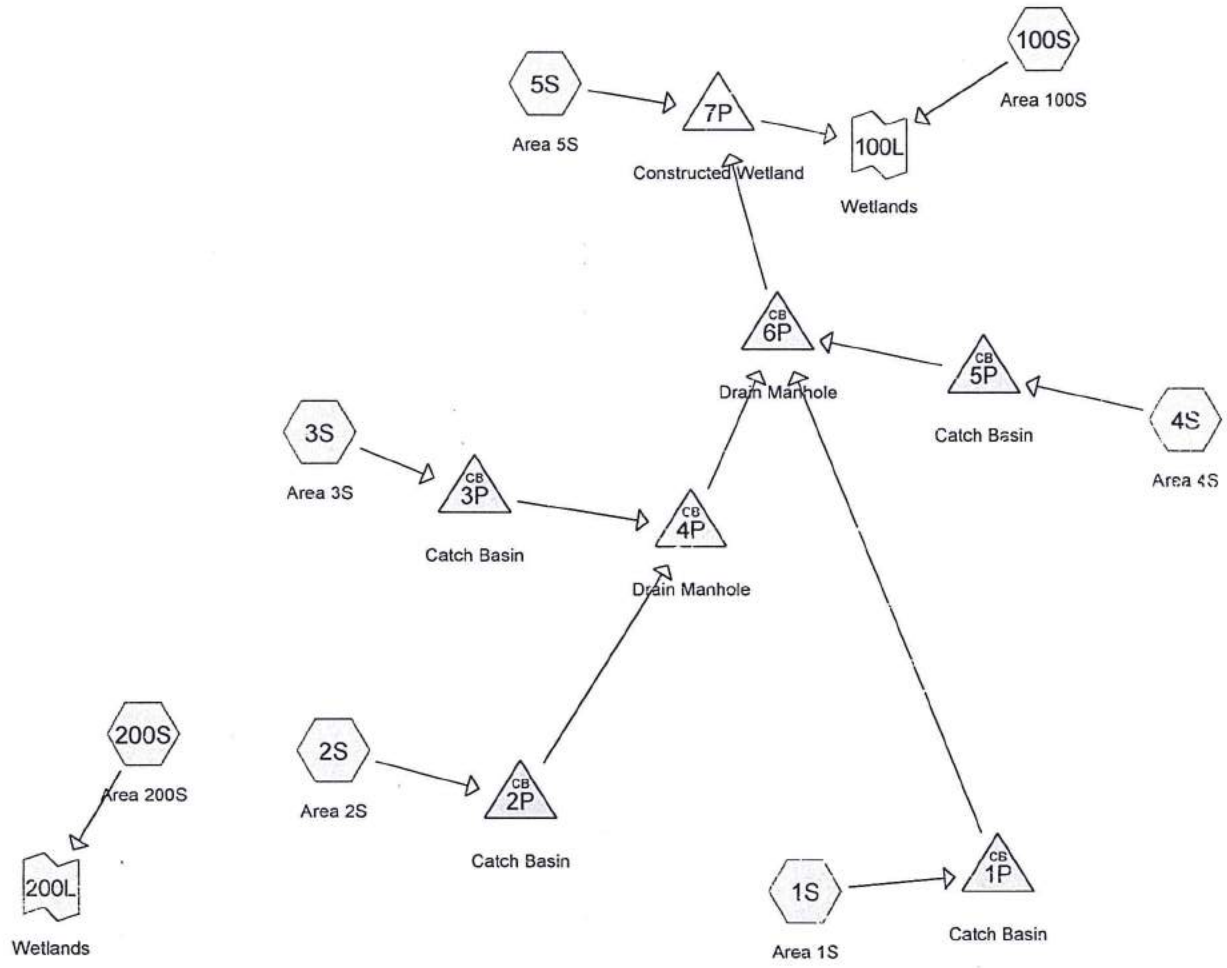
Inflow Area = 34,600 sf, 8.93% Impervious, Inflow Depth > 6.37" for 100-Year event
Inflow = 4.64 cfs @ 12.17 hrs, Volume= 18,376 cf
Primary = 4.64 cfs @ 12.17 hrs, Volume= 18,376 cf, Atten= 0%, Lag= 0.0 min

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

Link 200L: Wetlands "I"



11.0 APPENDIX D – POST-DEVELOPMENT DRAINAGE CALCULATIONS



Subcat Reach Pond Link

Routing Diagram for M193680-Proposed
Prepared by Millennium Engineering, Inc., Printed 9/24/2020

Summary for Subcatchment 1S: Area 1S

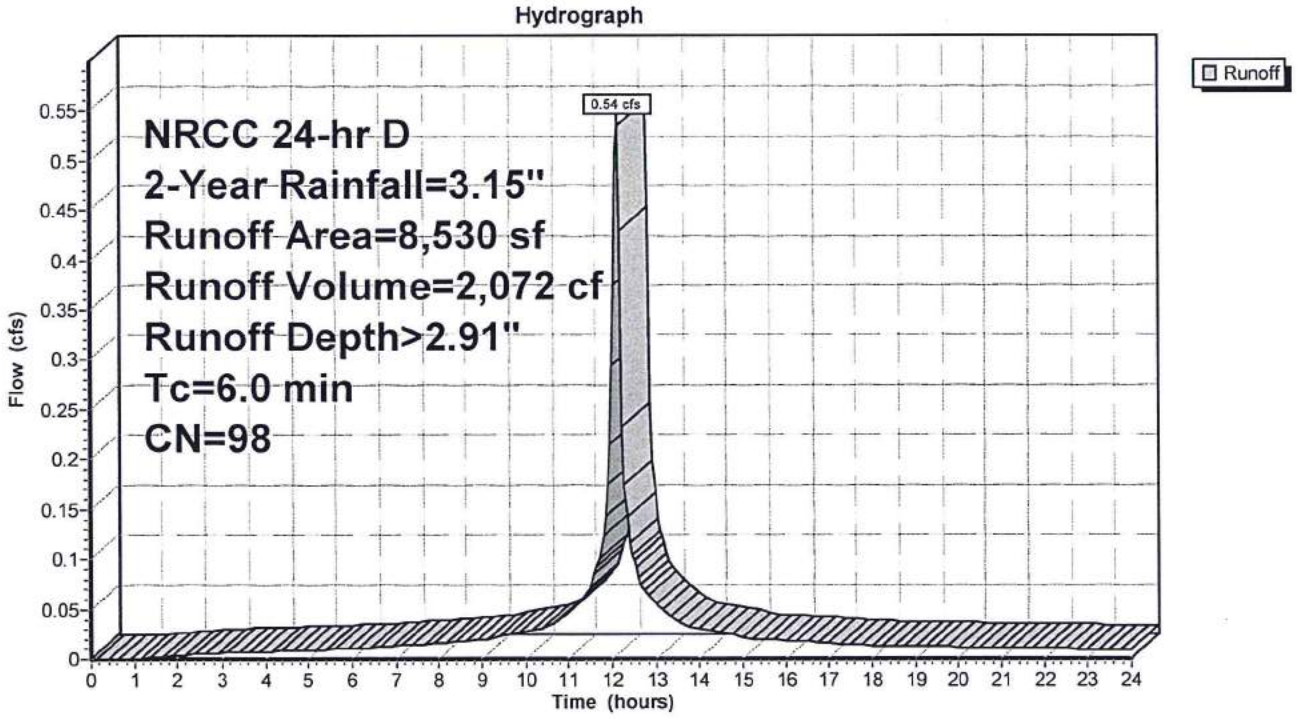
Runoff = 0.54 cfs @ 12.13 hrs, Volume= 2,072 cf, Depth> 2.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
3,700	98	Roofs, HSG D
4,830	98	Paved parking, HSG D
8,530	98	Weighted Average
8,530		100.00% Impervious Area

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

Subcatchment 1S: Area 1S



Summary for Pond 1P: Catch Basin

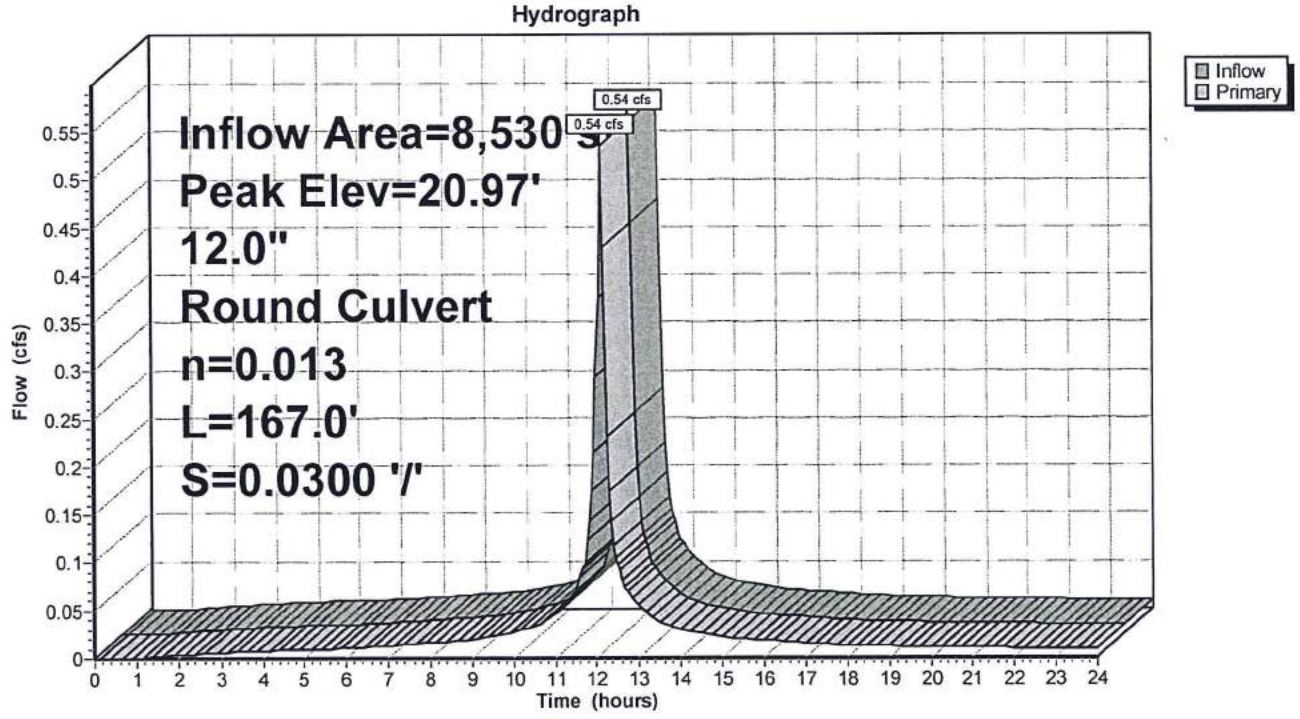
Inflow Area = 8,530 sf,100.00% Impervious, Inflow Depth > 2.91" for 2-Year event
Inflow = 0.54 cfs @ 12.13 hrs, Volume= 2,072 cf
Outflow = 0.54 cfs @ 12.13 hrs, Volume= 2,072 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.54 cfs @ 12.13 hrs, Volume= 2,072 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 20.97' @ 12.13 hrs
Flood Elev= 24.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	20.60'	**12.0" Round Culvert** L= 167.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 20.60' / 15.59' S= 0.0300 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.51 cfs @ 12.13 hrs HW=20.96' (Free Discharge)
1=Culvert (Inlet Controls 0.51 cfs @ 2.03 fps)

Pond 1P: Catch Basin



Summary for Subcatchment 2S: Area 2S

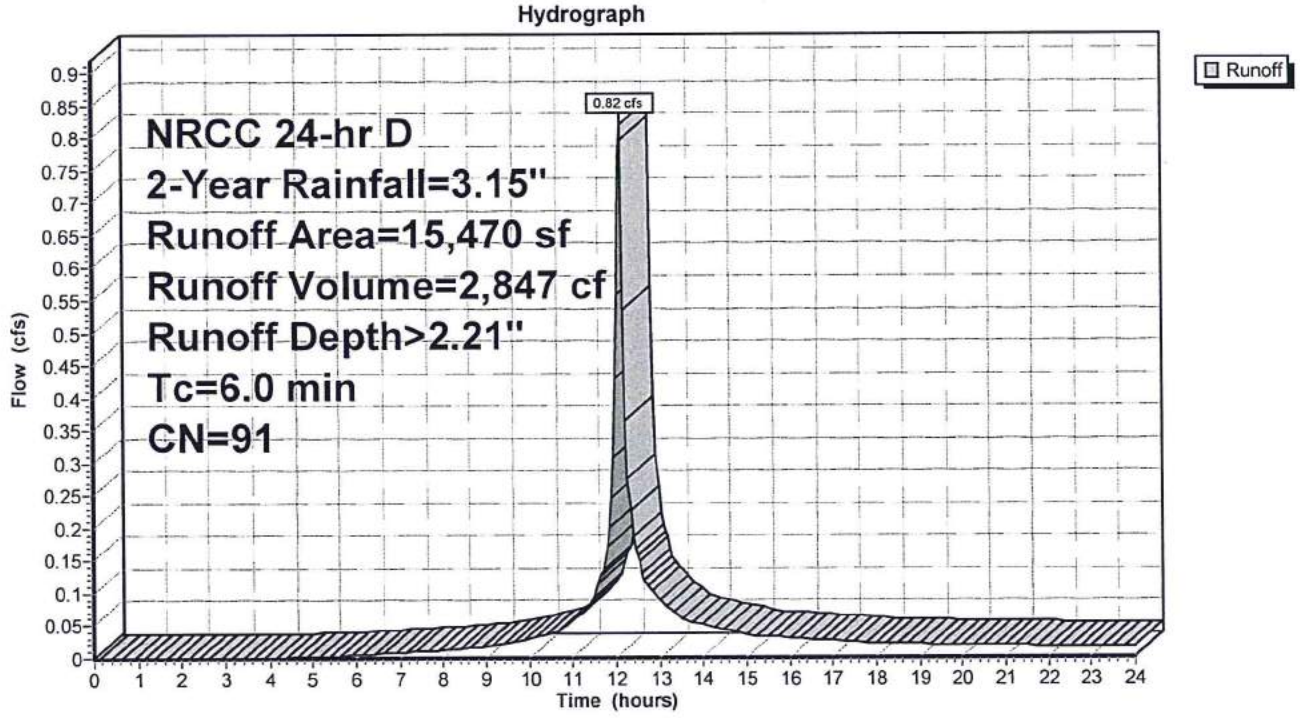
Runoff = 0.82 cfs @ 12.13 hrs, Volume= 2,847 cf, Depth> 2.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
1,810	98	Paved parking, HSG D
8,510	96	Gravel surface, HSG D
5,150	80	>75% Grass cover, Good, HSG D
15,470	91	Weighted Average
13,660		88.30% Pervious Area
1,810		11.70% Impervious Area

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

Subcatchment 2S: Area 2S



Summary for Pond 2P: Catch Basin

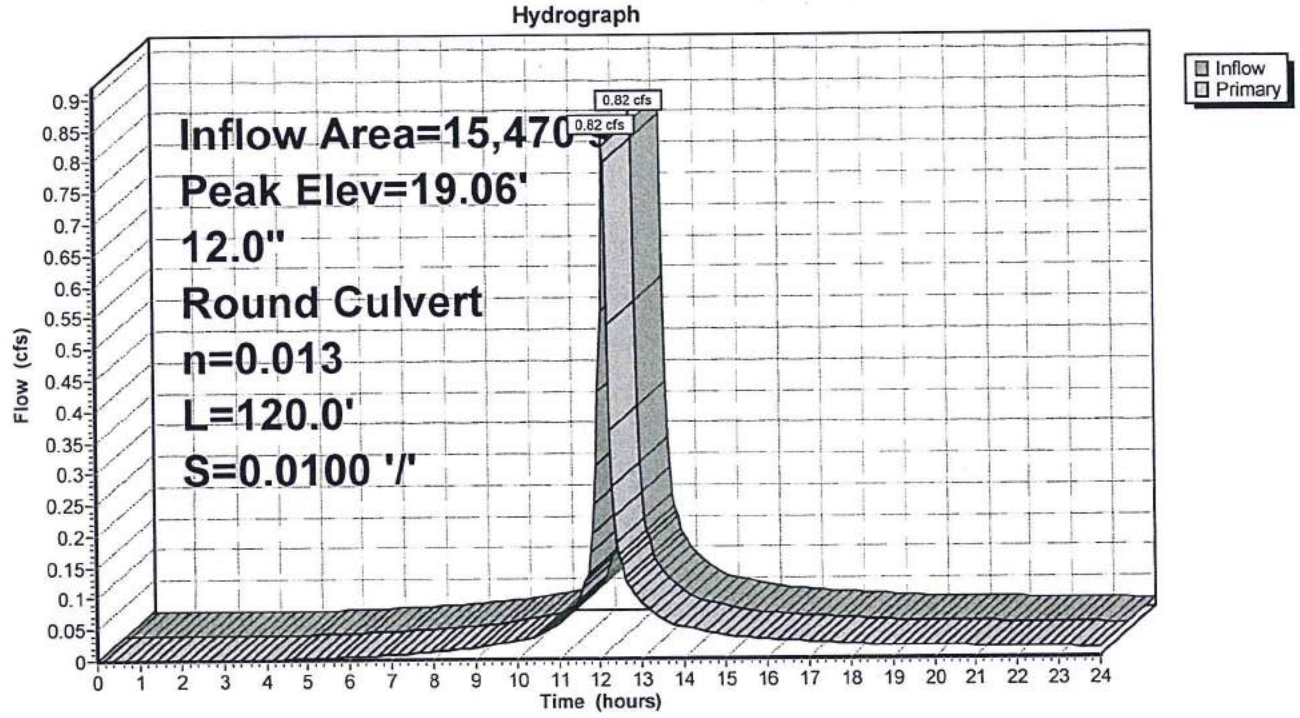
Inflow Area = 15,470 sf, 11.70% Impervious, Inflow Depth > 2.21" for 2-Year event
Inflow = 0.82 cfs @ 12.13 hrs, Volume= 2,847 cf
Outflow = 0.82 cfs @ 12.13 hrs, Volume= 2,847 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.82 cfs @ 12.13 hrs, Volume= 2,847 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 19.06' @ 12.13 hrs
Flood Elev= 22.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	18.60'	**12.0" Round Culvert** L= 120.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 18.60' / 17.40' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.79 cfs @ 12.13 hrs HW=19.05' (Free Discharge)
1=Culvert (Inlet Controls 0.79 cfs @ 2.29 fps)

Pond 2P: Catch Basin



Summary for Subcatchment 3S: Area 3S

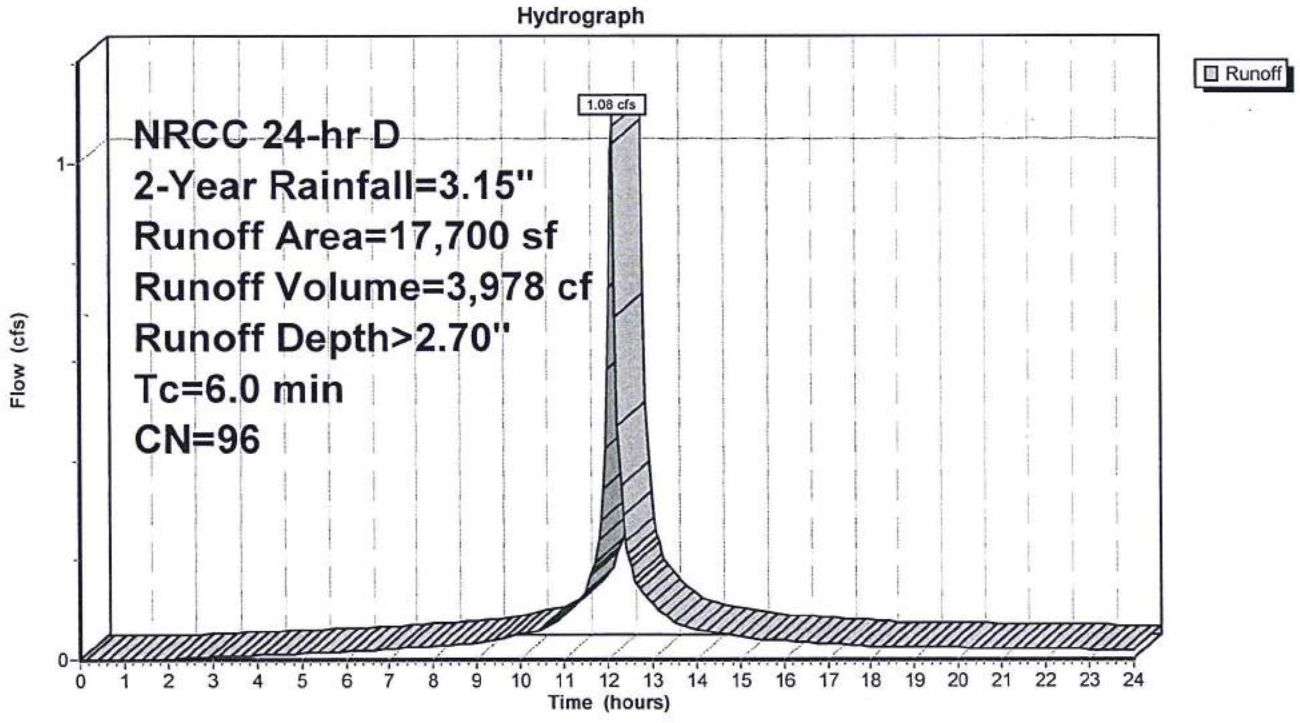
Runoff = 1.08 cfs @ 12.13 hrs, Volume= 3,978 cf, Depth> 2.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
3,700	98	Roofs, HSG D
4,120	98	Paved parking, HSG D
8,560	96	Gravel surface, HSG D
1,320	80	>75% Grass cover, Good, HSG D
17,700	96	Weighted Average
9,880		55.82% Pervious Area
7,820		44.18% Impervious Area

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

Subcatchment 3S: Area 3S



Summary for Pond 3P: Catch Basin

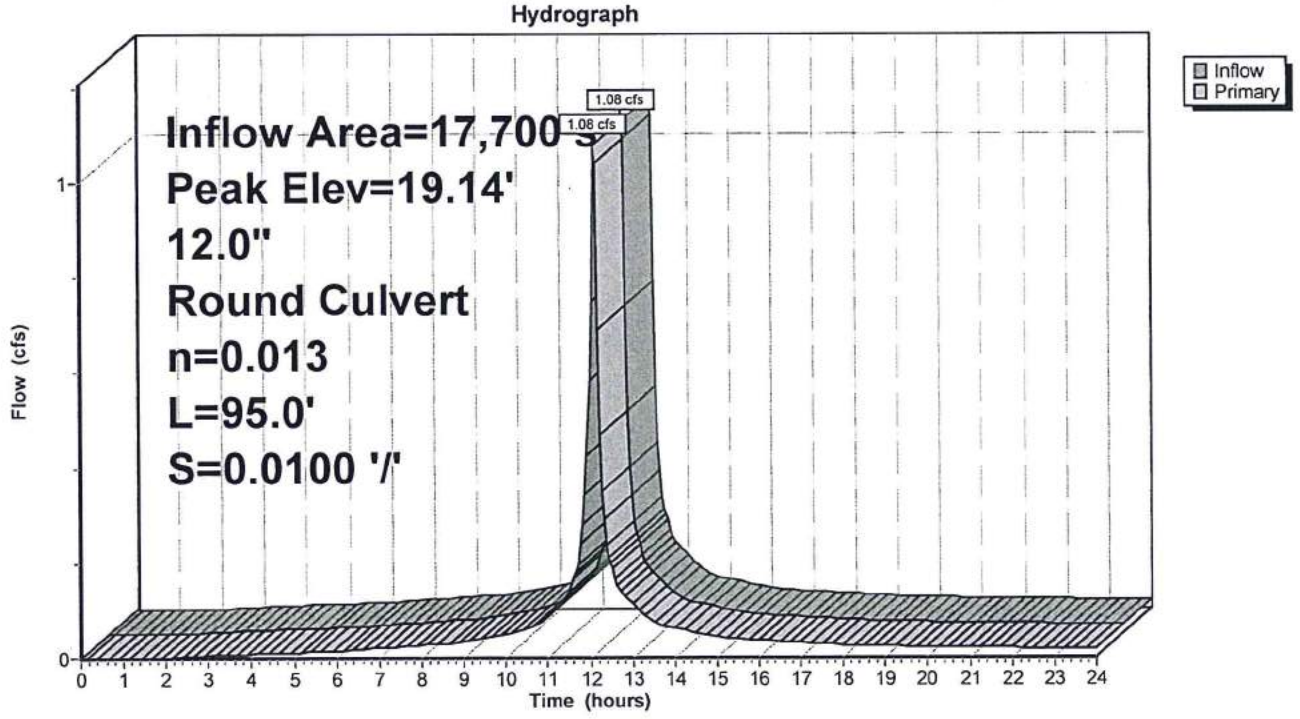
Inflow Area = 17,700 sf, 44.18% Impervious, Inflow Depth > 2.70" for 2-Year event
Inflow = 1.08 cfs @ 12.13 hrs, Volume= 3,978 cf
Outflow = 1.08 cfs @ 12.13 hrs, Volume= 3,978 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.08 cfs @ 12.13 hrs, Volume= 3,978 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 19.14' @ 12.13 hrs
Flood Elev= 22.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	18.60'	**12.0" Round Culvert** L= 95.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 18.60' / 17.65' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.03 cfs @ 12.13 hrs HW=19.12' (Free Discharge)
1=Culvert (Inlet Controls 1.03 cfs @ 2.47 fps)

Pond 3P: Catch Basin



Summary for Pond 4P: Drain Manhole

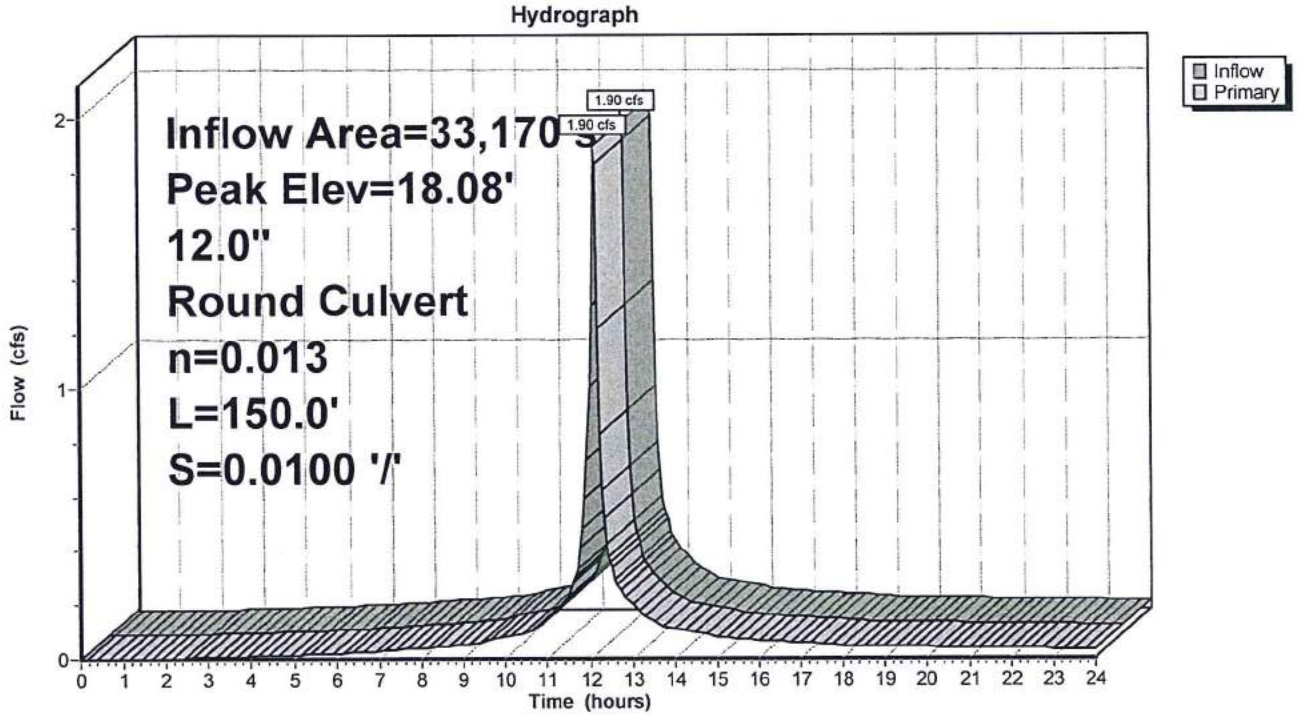
Inflow Area = 33,170 sf, 29.03% Impervious, Inflow Depth > 2.47" for 2-Year event
Inflow = 1.90 cfs @ 12.13 hrs, Volume= 6,825 cf
Outflow = 1.90 cfs @ 12.13 hrs, Volume= 6,825 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.90 cfs @ 12.13 hrs, Volume= 6,825 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 18.08' @ 12.13 hrs
Flood Elev= 24.30'

Device	Routing	Invert	Outlet Devices
#1	Primary	17.32'	**12.0" Round Culvert** L= 150.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 17.32' / 15.82' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.82 cfs @ 12.13 hrs HW=18.06' (Free Discharge)
1=Culvert (Inlet Controls 1.82 cfs @ 2.92 fps)

Pond 4P: Drain Manhole



Summary for Subcatchment 4S: Area 4S

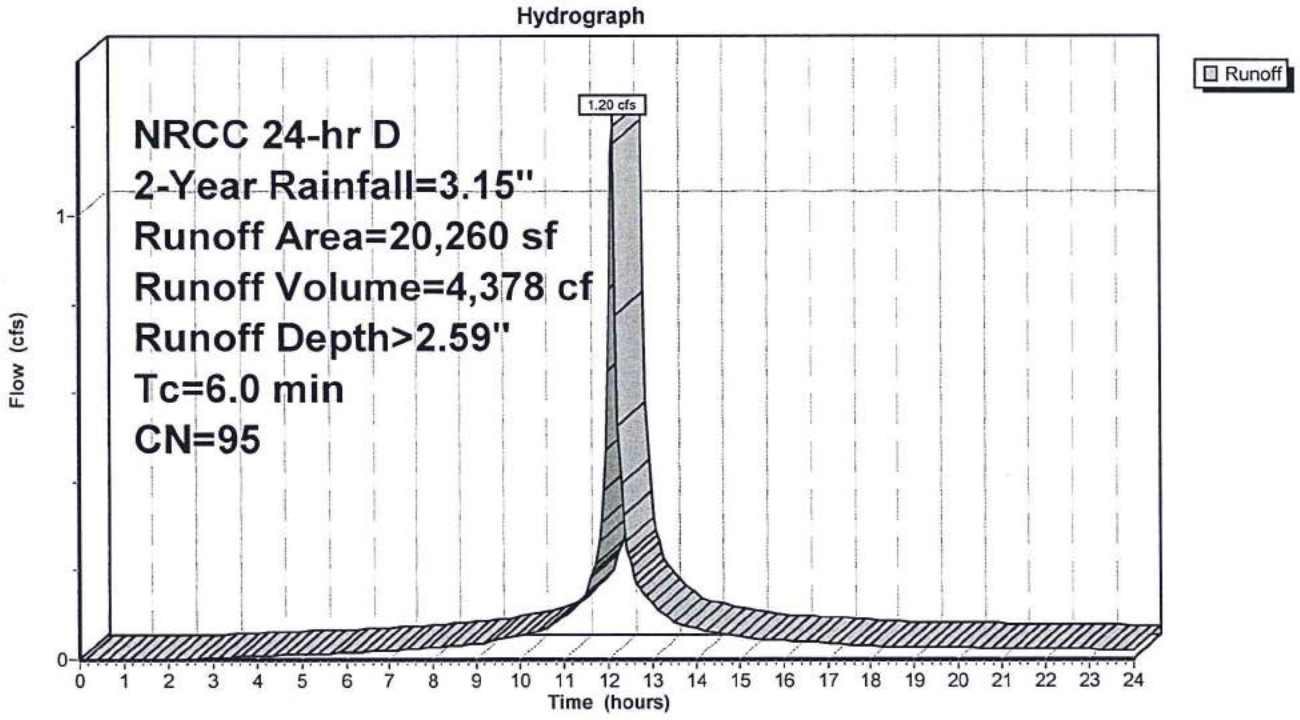
Runoff = 1.20 cfs @ 12.13 hrs, Volume= 4,378 cf, Depth> 2.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
4,180	98	Paved parking, HSG D
14,510	96	Gravel surface, HSG D
1,570	80	>75% Grass cover, Good, HSG D
20,260	95	Weighted Average
16,080		79.37% Pervious Area
4,180		20.63% Impervious Area

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

Subcatchment 4S: Area 4S



Summary for Pond 5P: Catch Basin

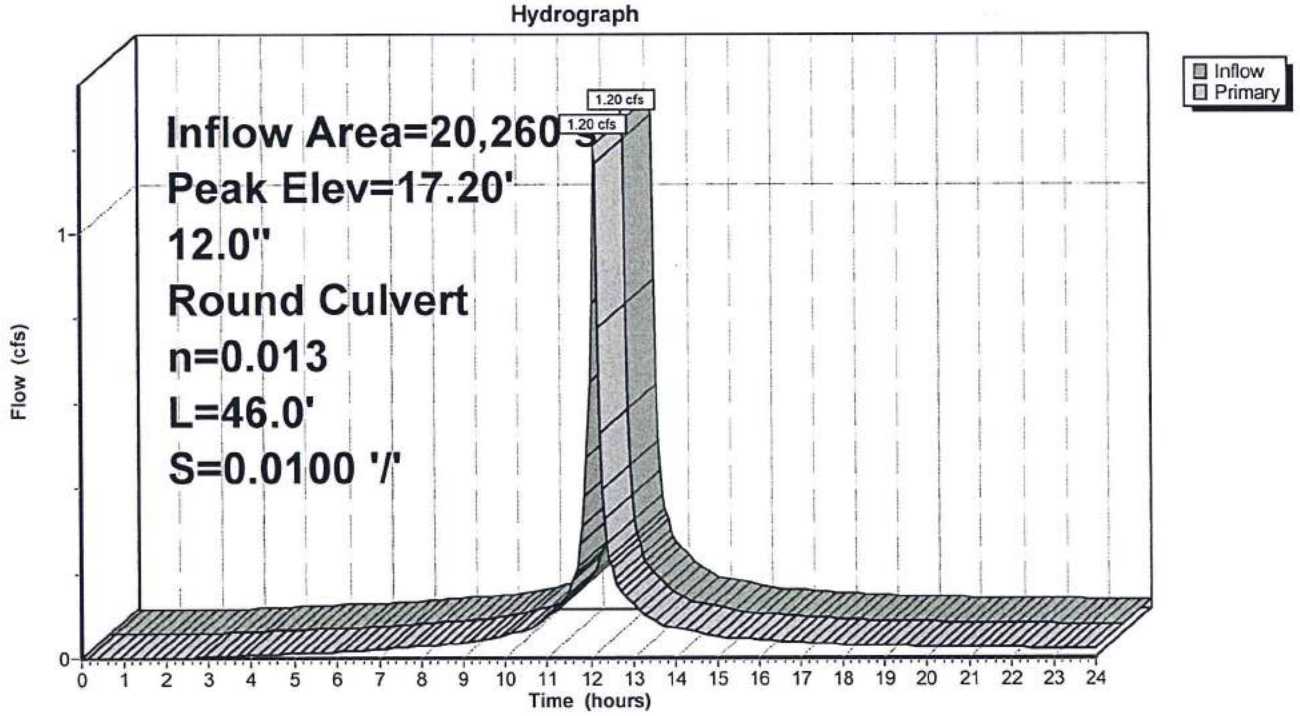
Inflow Area = 20,260 sf, 20.63% Impervious, Inflow Depth > 2.59" for 2-Year event
Inflow = 1.20 cfs @ 12.13 hrs, Volume= 4,378 cf
Outflow = 1.20 cfs @ 12.13 hrs, Volume= 4,378 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.20 cfs @ 12.13 hrs, Volume= 4,378 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 17.20' @ 12.13 hrs
Flood Elev= 20.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	16.60'	**12.0" Round Culvert** L= 46.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 16.60' / 16.14' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.15 cfs @ 12.13 hrs HW=17.18' (Free Discharge)
1=Culvert (Barrel Controls 1.15 cfs @ 3.52 fps)

Pond 5P: Catch Basin



Summary for Pond 6P: Drain Manhole

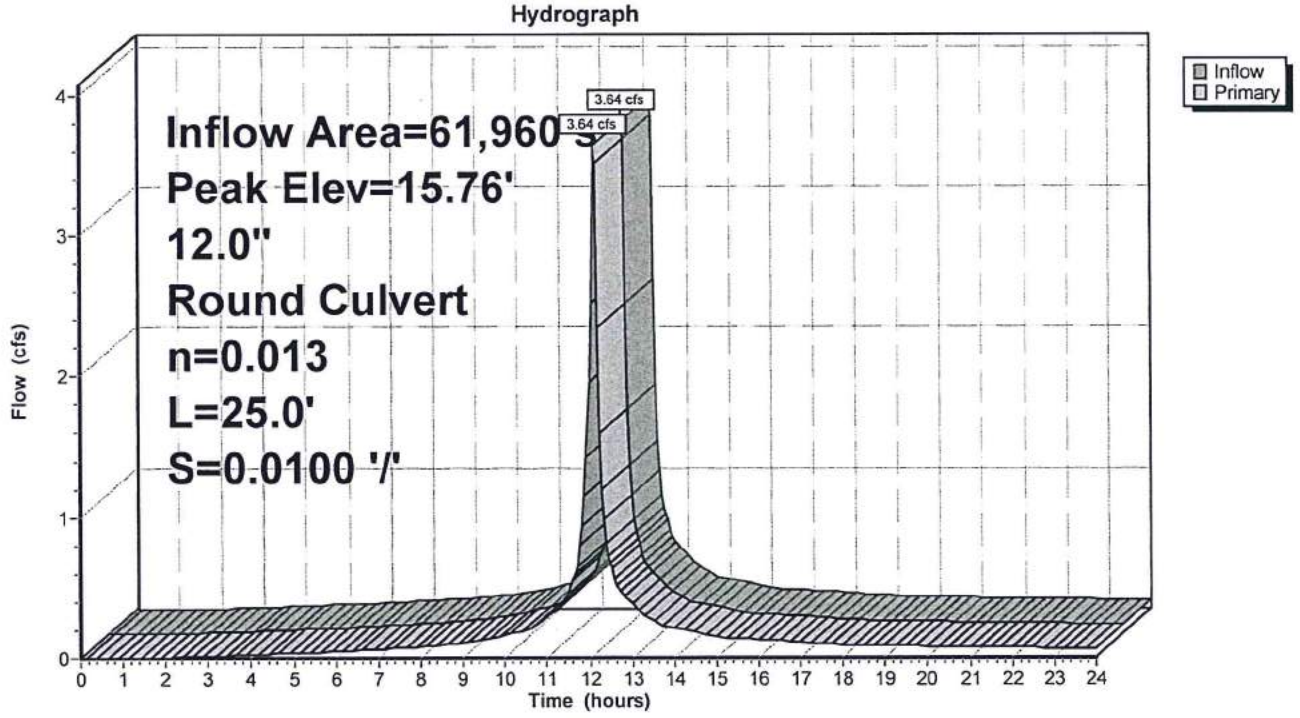
Inflow Area = 61,960 sf, 36.06% Impervious, Inflow Depth > 2.57" for 2-Year event
Inflow = 3.64 cfs @ 12.13 hrs, Volume= 13,274 cf
Outflow = 3.64 cfs @ 12.13 hrs, Volume= 13,274 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.64 cfs @ 12.13 hrs, Volume= 13,274 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 15.76' @ 12.13 hrs
Flood Elev= 21.70'

Device	Routing	Invert	Outlet Devices
#1	Primary	14.25'	**12.0" Round Culvert** L= 25.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 14.25' / 14.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=3.49 cfs @ 12.13 hrs HW=15.70' (Free Discharge)
↳**1=Culvert** (Barrel Controls 3.49 cfs @ 4.44 fps)

Pond 6P: Drain Manhole



Summary for Subcatchment 5S: Area 5S

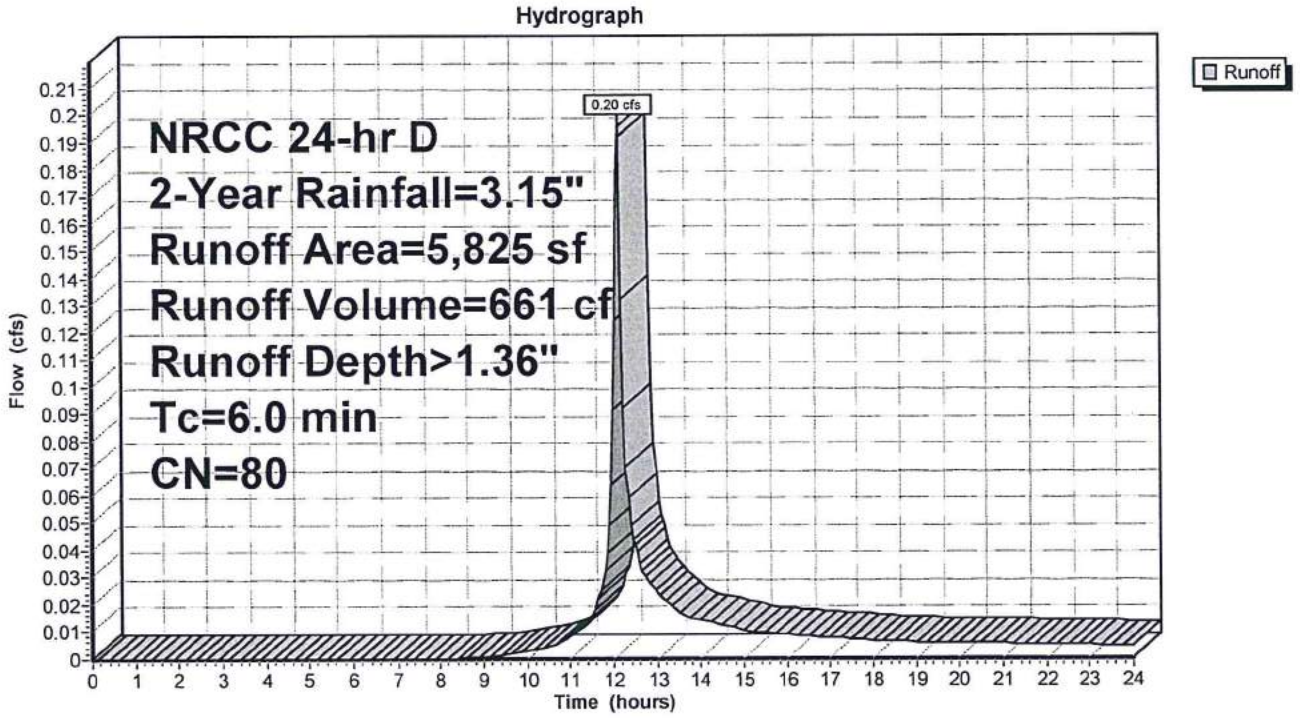
Runoff = 0.20 cfs @ 12.13 hrs, Volume= 661 cf, Depth> 1.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
5,825	80	>75% Grass cover, Good, HSG D
5,825		100.00% Pervious Area

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

Subcatchment 5S: Area 5S



Summary for Pond 7P: Constructed Wetland

Inflow Area = 67,785 sf, 32.96% Impervious, Inflow Depth > 2.47" for 2-Year event
Inflow = 3.83 cfs @ 12.13 hrs, Volume= 13,935 cf
Outflow = 1.51 cfs @ 12.27 hrs, Volume= 13,681 cf, Atten= 61%, Lag= 8.7 min
Primary = 1.51 cfs @ 12.27 hrs, Volume= 13,681 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 13.28' @ 12.27 hrs Surf.Area= 2,605 sf Storage= 2,696 cf
Flood Elev= 15.00' Surf.Area= 4,755 sf Storage= 8,805 cf

Plug-Flow detention time= 36.8 min calculated for 13,652 cf (98% of inflow)
Center-of-Mass det. time= 25.5 min (818.6 - 793.1)

Volume	Invert	Avail.Storage	Storage Description
#1	12.00'	8,805 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

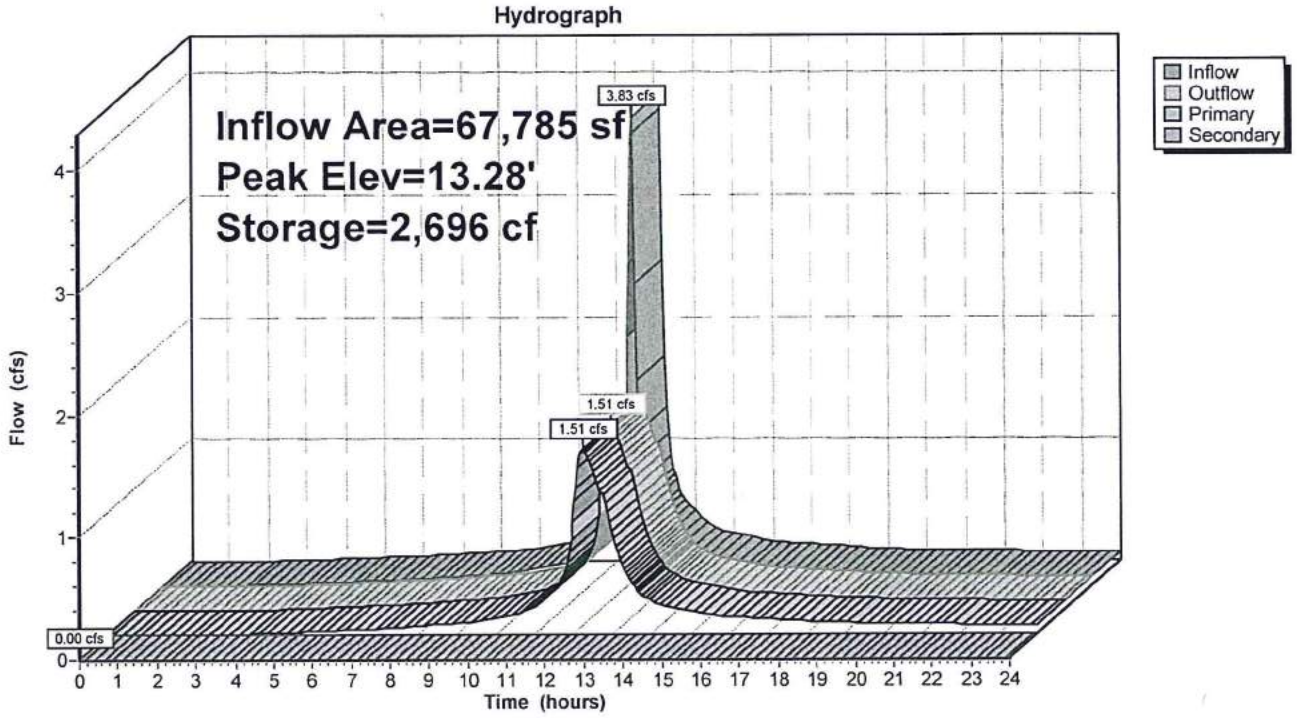
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
12.00	1,655	0	0
13.00	2,365	2,010	2,010
14.00	3,235	2,800	4,810
15.00	4,755	3,995	8,805

Device	Routing	Invert	Outlet Devices
#1	Primary	12.00'	**8.0" Round Culvert** L= 30.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 12.00' / 11.70' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf
#2	Primary	13.50'	**8.0" Round Culvert** L= 25.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 13.50' / 13.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf
#3	Secondary	14.50'	**9.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=1.51 cfs @ 12.27 hrs HW=13.27' (Free Discharge)
↑—**1=Culvert** (Barrel Controls 1.51 cfs @ 4.32 fps)
└—**2=Culvert** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.00' (Free Discharge)
↑—**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 7P: Constructed Wetland



Summary for Subcatchment 100S: Area 100S

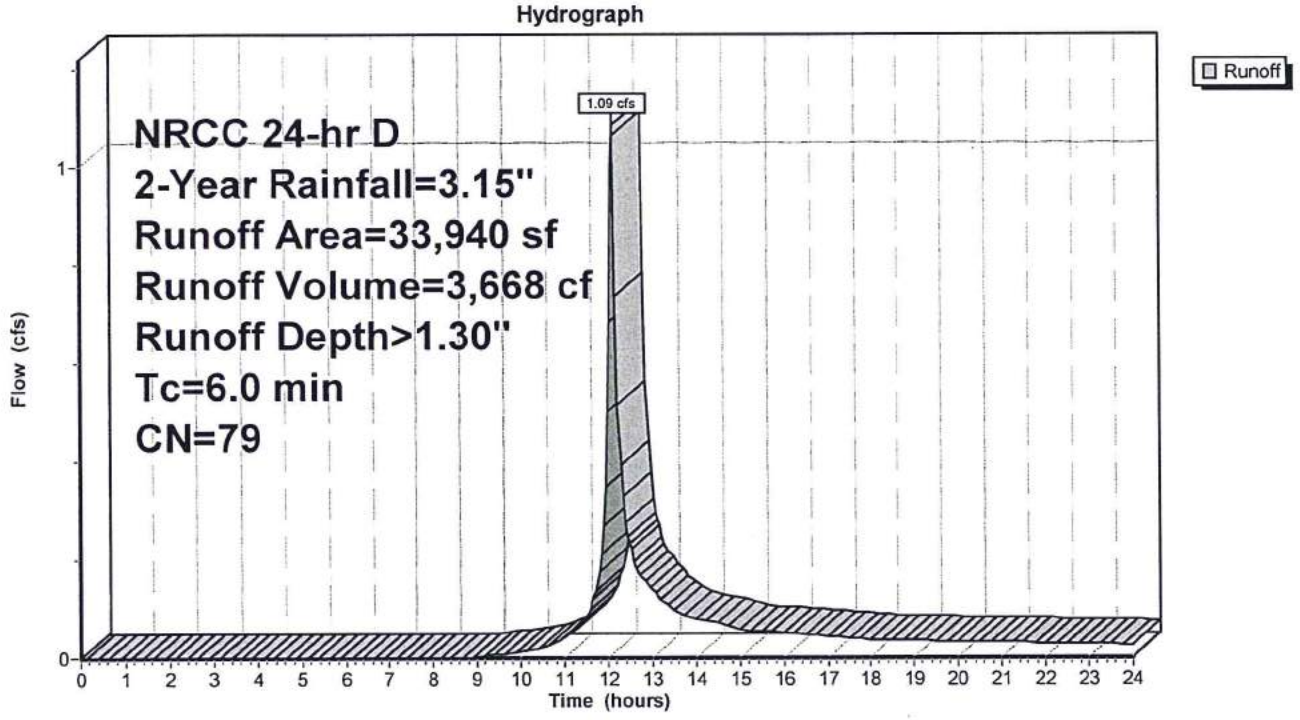
Runoff = 1.09 cfs @ 12.13 hrs, Volume= 3,668 cf, Depth> 1.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
1,825	98	Paved roads w/curbs & sewers, HSG D
11,115	80	>75% Grass cover, Good, HSG D
21,000	77	Woods, Good, HSG D
33,940	79	Weighted Average
32,115		94.62% Pervious Area
1,825		5.38% Impervious Area

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

Subcatchment 100S: Area 100S

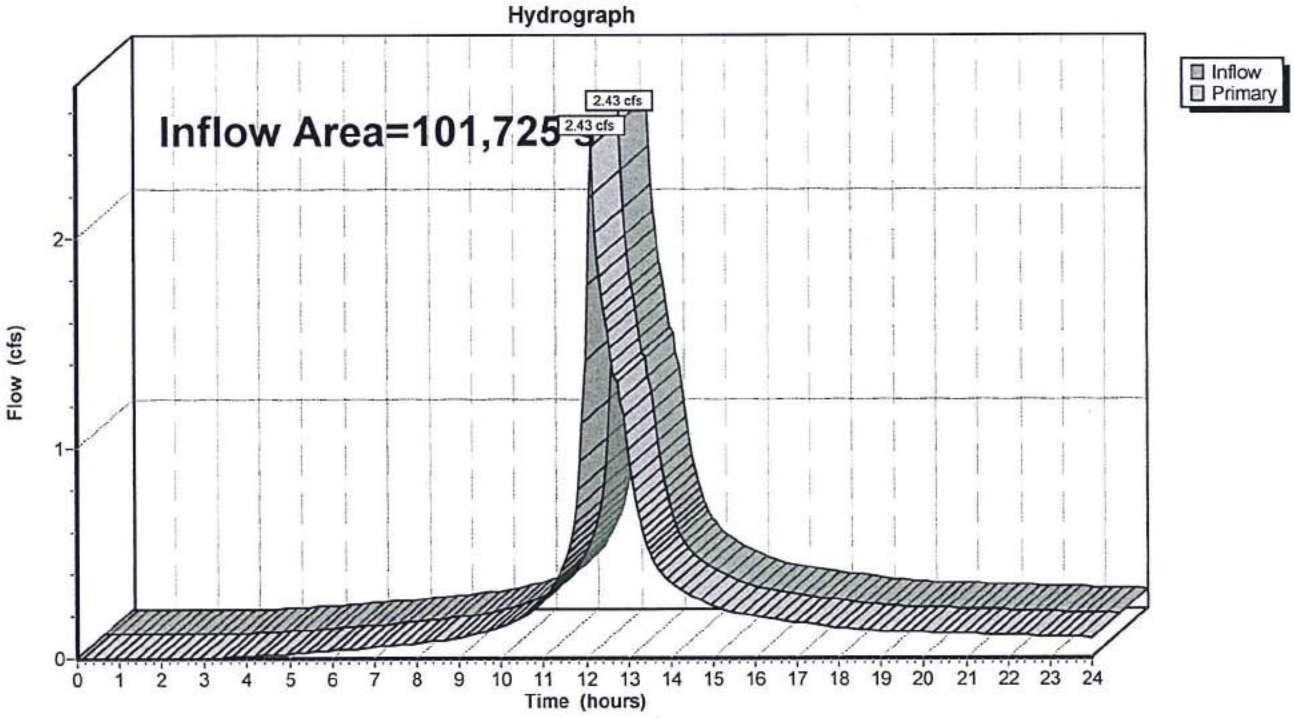


Summary for Link 100L: Wetlands

Inflow Area = 101,725 sf, 23.76% Impervious, Inflow Depth > 2.05" for 2-Year event
Inflow = 2.43 cfs @ 12.15 hrs, Volume= 17,349 cf
Primary = 2.43 cfs @ 12.15 hrs, Volume= 17,349 cf, Atten= 0%, Lag= 0.0 min

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

Link 100L: Wetlands



Summary for Subcatchment 200S: Area 200S

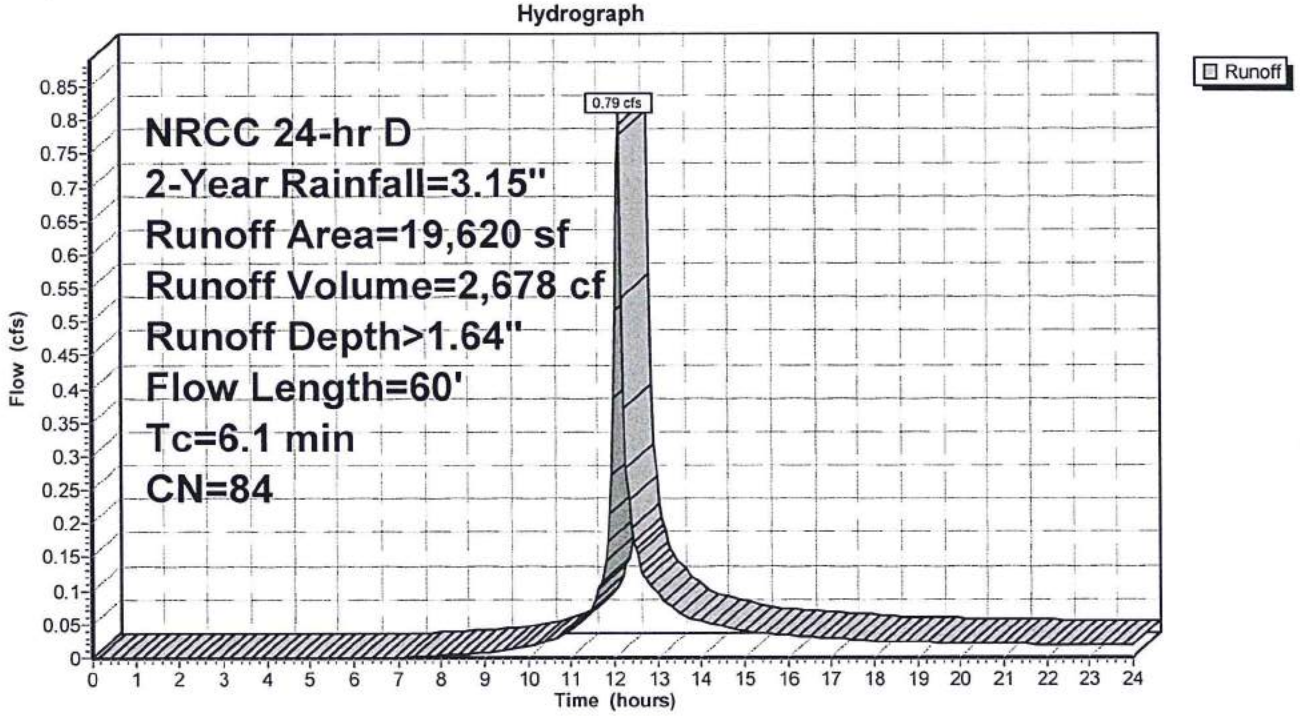
Runoff = 0.79 cfs @ 12.13 hrs, Volume= 2,678 cf, Depth> 1.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
5,900	98	Paved roads w/curbs & sewers, HSG D
6,600	80	>75% Grass cover, Good, HSG D
7,120	77	Woods, Good, HSG D
19,620	84	Weighted Average
13,720		69.93% Pervious Area
5,900		30.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.1400	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
0.3	10	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
6.1	60	Total			

Subcatchment 200S: Area 200S

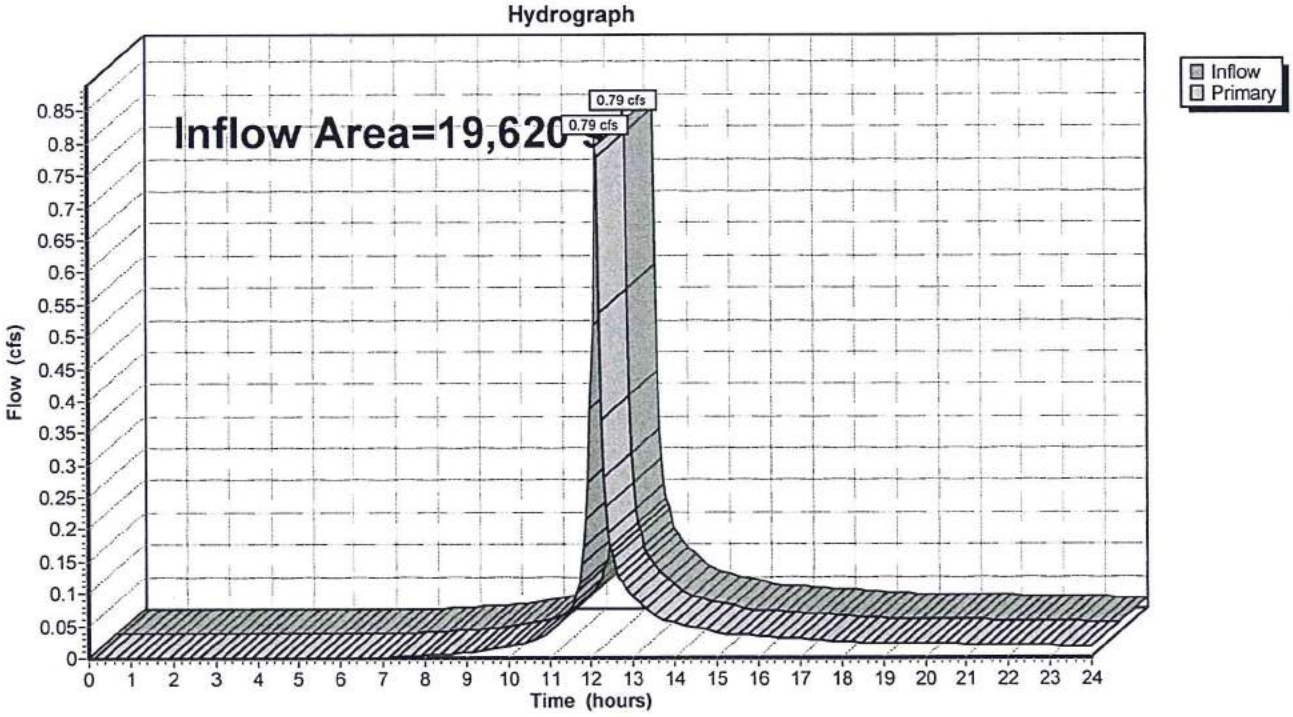


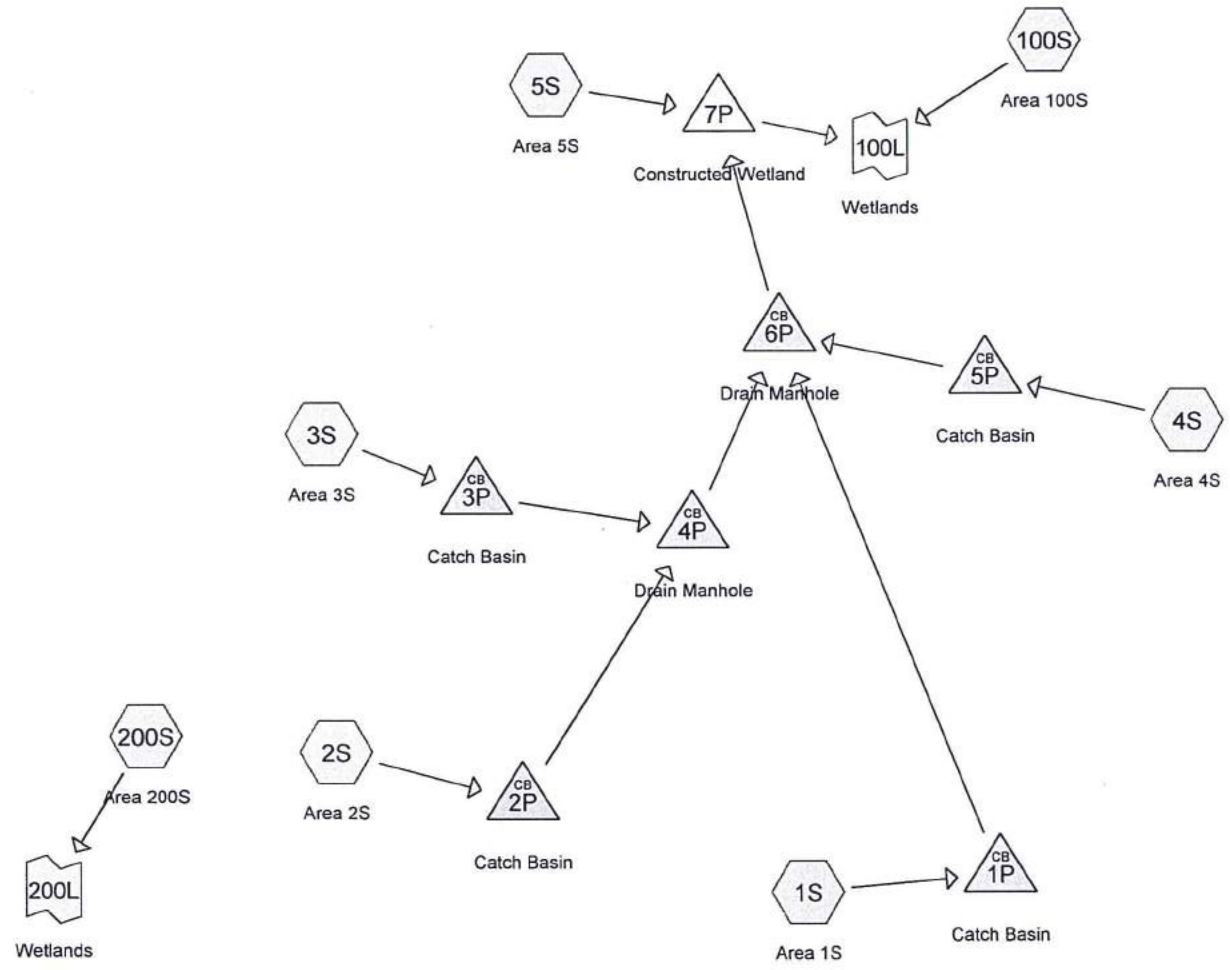
Summary for Link 200L: Wetlands

Inflow Area = 19,620 sf, 30.07% Impervious, Inflow Depth > 1.64" for 2-Year event
Inflow = 0.79 cfs @ 12.13 hrs, Volume= 2,678 cf
Primary = 0.79 cfs @ 12.13 hrs, Volume= 2,678 cf, Atten= 0%, Lag= 0.0 min

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

Link 200L: Wetlands





Subcat Reach Pond Link

Routing Diagram for M193680-Proposed
Prepared by Millennium Engineering, Inc., Printed 9/24/2020

Summary for Subcatchment 1S: Area 1S

Runoff = 0.83 cfs @ 12.13 hrs, Volume= 3,262 cf, Depth> 4.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
3,700	98	Roofs, HSG D
4,830	98	Paved parking, HSG D
8,530	98	Weighted Average
8,530		100.00% Impervious Area

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

Summary for Subcatchment 2S: Area 2S

Runoff = 1.37 cfs @ 12.13 hrs, Volume= 4,915 cf, Depth> 3.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
1,810	98	Paved parking, HSG D
8,510	96	Gravel surface, HSG D
5,150	80	>75% Grass cover, Good, HSG D
15,470	91	Weighted Average
13,660		88.30% Pervious Area
1,810		11.70% Impervious Area

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

Summary for Subcatchment 3S: Area 3S

Runoff = 1.69 cfs @ 12.13 hrs, Volume= 6,429 cf, Depth> 4.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
3,700	98	Roofs, HSG D
4,120	98	Paved parking, HSG D
8,560	96	Gravel surface, HSG D
1,320	80	>75% Grass cover, Good, HSG D
17,700	96	Weighted Average
9,880		55.82% Pervious Area
7,820		44.18% Impervious Area

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

Summary for Subcatchment 4S: Area 4S

Runoff = 1.91 cfs @ 12.13 hrs, Volume= 7,169 cf, Depth> 4.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
4,180	98	Paved parking, HSG D
14,510	96	Gravel surface, HSG D
1,570	80	>75% Grass cover, Good, HSG D
20,260	95	Weighted Average
16,080		79.37% Pervious Area
4,180		20.63% Impervious Area

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

Summary for Subcatchment 5S: Area 5S

Runoff = 0.39 cfs @ 12.13 hrs, Volume= 1,331 cf, Depth> 2.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
5,825	80	>75% Grass cover, Good, HSG D
5,825		100.00% Pervious Area

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

Summary for Subcatchment 100S: Area 100S

Runoff = 2.22 cfs @ 12.13 hrs, Volume= 7,500 cf, Depth> 2.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
1,825	98	Paved roads w/curbs & sewers, HSG D
11,115	80	>75% Grass cover, Good, HSG D
21,000	77	Woods, Good, HSG D
33,940	79	Weighted Average
32,115		94.62% Pervious Area
1,825		5.38% Impervious Area

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

Summary for Subcatchment 200S: Area 200S

Runoff = 1.48 cfs @ 12.13 hrs, Volume= 5,086 cf, Depth> 3.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
5,900	98	Paved roads w/curbs & sewers, HSG D
6,600	80	>75% Grass cover, Good, HSG D
7,120	77	Woods, Good, HSG D
19,620	84	Weighted Average
13,720		69.93% Pervious Area
5,900		30.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.8	50	0.1400	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
0.3	10	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
6.1	60	Total			

Summary for Pond 1P: Catch Basin

Inflow Area = 8,530 sf,100.00% Impervious, Inflow Depth > 4.59" for 10-Year event
Inflow = 0.83 cfs @ 12.13 hrs, Volume= 3,262 cf
Outflow = 0.83 cfs @ 12.13 hrs, Volume= 3,262 cf, Atten= 0%, Lag= 0.0 min
Primary = 0.83 cfs @ 12.13 hrs, Volume= 3,262 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Peak Elev= 21.06' @ 12.13 hrs
Flood Elev= 24.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	20.60'	**12.0" Round Culvert** L= 167.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 20.60' / 15.59' S= 0.0300 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.79 cfs @ 12.13 hrs HW=21.05' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 0.79 cfs @ 2.29 fps)

Summary for Pond 2P: Catch Basin

Inflow Area = 15,470 sf, 11.70% Impervious, Inflow Depth > 3.81" for 10-Year event
Inflow = 1.37 cfs @ 12.13 hrs, Volume= 4,915 cf
Outflow = 1.37 cfs @ 12.13 hrs, Volume= 4,915 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.37 cfs @ 12.13 hrs, Volume= 4,915 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 19.22' @ 12.13 hrs
Flood Elev= 22.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	18.60'	**12.0" Round Culvert** L= 120.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 18.60' / 17.40' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.32 cfs @ 12.13 hrs HW=19.20' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 1.32 cfs @ 2.65 fps)

Summary for Pond 3P: Catch Basin

Inflow Area = 17,700 sf, 44.18% Impervious, Inflow Depth > 4.36" for 10-Year event
Inflow = 1.69 cfs @ 12.13 hrs, Volume= 6,429 cf
Outflow = 1.69 cfs @ 12.13 hrs, Volume= 6,429 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.69 cfs @ 12.13 hrs, Volume= 6,429 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 19.30' @ 12.13 hrs
Flood Elev= 22.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	18.60'	**12.0" Round Culvert** L= 95.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 18.60' / 17.65' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.62 cfs @ 12.13 hrs HW=19.29' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 1.62 cfs @ 2.82 fps)

Summary for Pond 4P: Drain Manhole

Inflow Area = 33,170 sf, 29.03% Impervious, Inflow Depth > 4.10" for 10-Year event
Inflow = 3.06 cfs @ 12.13 hrs, Volume= 11,344 cf
Outflow = 3.06 cfs @ 12.13 hrs, Volume= 11,344 cf, Atten= 0%, Lag= 0.0 min
Primary = 3.06 cfs @ 12.13 hrs, Volume= 11,344 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 18.47' @ 12.13 hrs
Flood Elev= 24.30'

Device	Routing	Invert	Outlet Devices
#1	Primary	17.32'	**12.0" Round Culvert** L= 150.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 17.32' / 15.82' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=2.94 cfs @ 12.13 hrs HW=18.42' (Free Discharge)
1=Culvert (Inlet Controls 2.94 cfs @ 3.74 fps)

Summary for Pond 5P: Catch Basin

Inflow Area = 20,260 sf, 20.63% Impervious, Inflow Depth > 4.25" for 10-Year event
Inflow = 1.91 cfs @ 12.13 hrs, Volume= 7,169 cf
Outflow = 1.91 cfs @ 12.13 hrs, Volume= 7,169 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.91 cfs @ 12.13 hrs, Volume= 7,169 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 17.40' @ 12.13 hrs
Flood Elev= 20.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	16.60'	**12.0" Round Culvert** L= 46.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 16.60' / 16.14' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.83 cfs @ 12.13 hrs HW=17.37' (Free Discharge)
1=Culvert (Barrel Controls 1.83 cfs @ 3.89 fps)

Summary for Pond 6P: Drain Manhole

Inflow Area = 61,960 sf, 36.06% Impervious, Inflow Depth > 4.22" for 10-Year event
Inflow = 5.80 cfs @ 12.13 hrs, Volume= 21,776 cf
Outflow = 5.80 cfs @ 12.13 hrs, Volume= 21,776 cf, Atten= 0%, Lag= 0.0 min
Primary = 5.80 cfs @ 12.13 hrs, Volume= 21,776 cf

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 17.06' @ 12.13 hrs
Flood Elev= 21.70'

Device	Routing	Invert	Outlet Devices
#1	Primary	14.25'	**12.0" Round Culvert** L= 25.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 14.25' / 14.00' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=5.56 cfs @ 12.13 hrs HW=16.91' (Free Discharge)
↑—**1=Culvert** (Inlet Controls 5.56 cfs @ 7.08 fps)

Summary for Pond 7P: Constructed Wetland

Inflow Area =	67,785 sf,	32.96% Impervious,	Inflow Depth >	4.09"	for 10-Year event
Inflow =	6.20 cfs @	12.13 hrs, Volume=	23,106 cf		
Outflow =	2.45 cfs @	12.27 hrs, Volume=	22,784 cf,	Atten= 60%,	Lag= 8.7 min
Primary =	2.45 cfs @	12.27 hrs, Volume=	22,784 cf		
Secondary =	0.00 cfs @	0.00 hrs, Volume=	0 cf		

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 13.91' @ 12.27 hrs Surf.Area= 3,154 sf Storage= 4,512 cf
Flood Elev= 15.00' Surf.Area= 4,755 sf Storage= 8,805 cf

Plug-Flow detention time= 33.7 min calculated for 22,737 cf (98% of inflow)
Center-of-Mass det. time= 24.7 min (803.5 - 778.8)

Volume	Invert	Avail.Storage	Storage Description
#1	12.00'	8,805 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
12.00	1,655	0	0
13.00	2,365	2,010	2,010
14.00	3,235	2,800	4,810
15.00	4,755	3,995	8,805

Device	Routing	Invert	Outlet Devices
#1	Primary	12.00'	**8.0" Round Culvert** L= 30.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 12.00' / 11.70' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf
#2	Primary	13.50'	**8.0" Round Culvert** L= 25.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 13.50' / 13.00' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf
#3	Secondary	14.50'	**9.0' long x 15.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Primary OutFlow Max=2.43 cfs @ 12.27 hrs HW=13.90' (Free Discharge)
└─**1=Culvert** (Barrel Controls 1.96 cfs @ 5.63 fps)
└─**2=Culvert** (Inlet Controls 0.47 cfs @ 2.15 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=12.00' (Free Discharge)
└─**3=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Link 100L: Wetlands

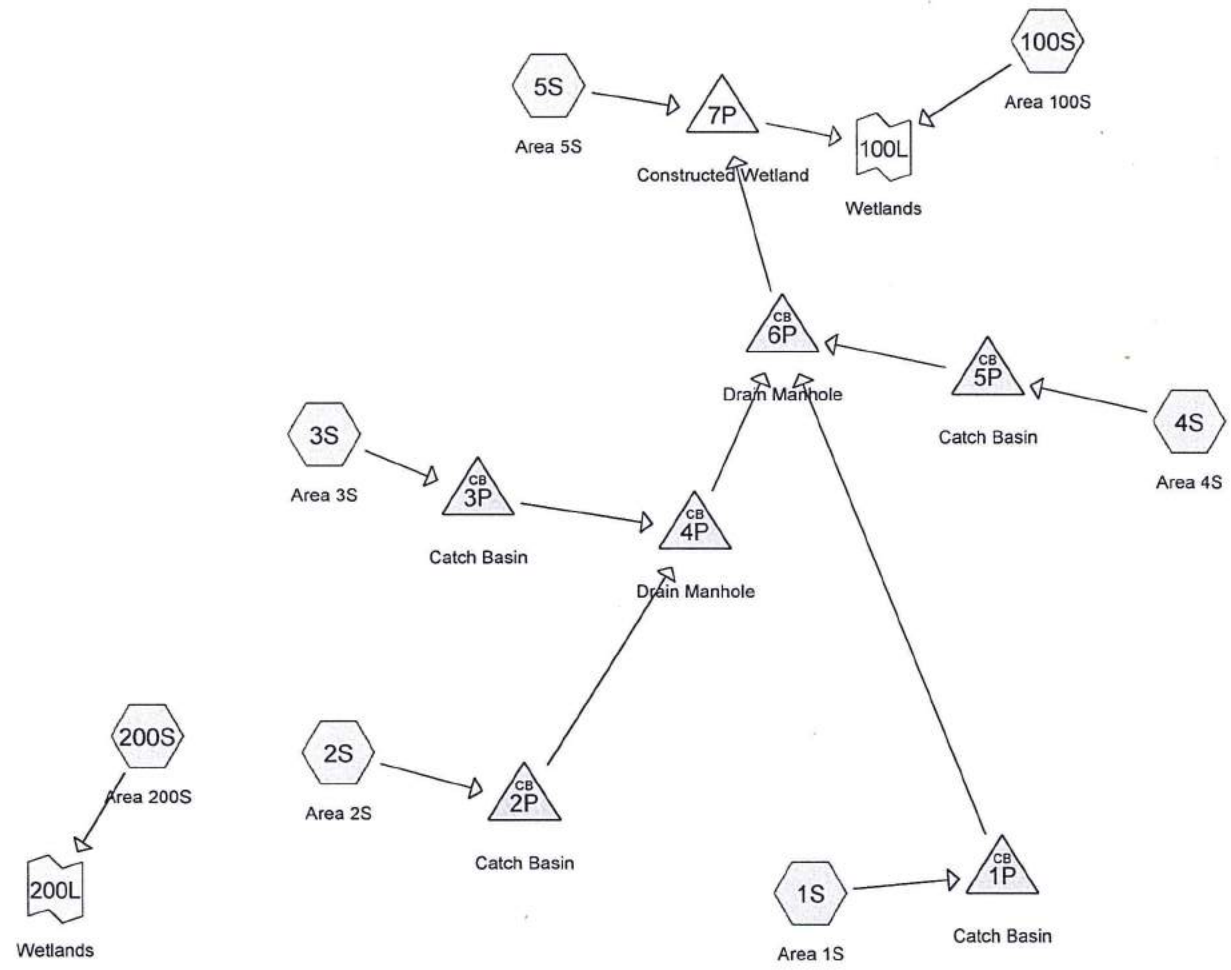
Inflow Area = 101,725 sf, 23.76% Impervious, Inflow Depth > 3.57" for 10-Year event
Inflow = 4.09 cfs @ 12.15 hrs, Volume= 30,285 cf
Primary = 4.09 cfs @ 12.15 hrs, Volume= 30,285 cf, Atten= 0%, Lag= 0.0 min

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

Summary for Link 200L: Wetlands

Inflow Area = 19,620 sf, 30.07% Impervious, Inflow Depth > 3.11" for 10-Year event
Inflow = 1.48 cfs @ 12.13 hrs, Volume= 5,086 cf
Primary = 1.48 cfs @ 12.13 hrs, Volume= 5,086 cf, Atten= 0%, Lag= 0.0 min

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



Subcat Reach Pond Link

Routing Diagram for M193680-Proposed
Prepared by Millennium Engineering, Inc., Printed 9/24/2020

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: Area 1S Runoff Area=8,530 sf 100.00% Impervious Runoff Depth>8.69"
Tc=6.0 min CN=98 Runoff=1.54 cfs 6,178 cf

Subcatchment 2S: Area 2S Runoff Area=15,470 sf 11.70% Impervious Runoff Depth>7.84"
Tc=6.0 min CN=91 Runoff=2.70 cfs 10,113 cf

Subcatchment 3S: Area 3S Runoff Area=17,700 sf 44.18% Impervious Runoff Depth>8.45"
Tc=6.0 min CN=96 Runoff=3.17 cfs 12,464 cf

Subcatchment 4S: Area 4S Runoff Area=20,260 sf 20.63% Impervious Runoff Depth>8.33"
Tc=6.0 min CN=95 Runoff=3.62 cfs 14,063 cf

Subcatchment 5S: Area 5S Runoff Area=5,825 sf 0.00% Impervious Runoff Depth>6.50"
Tc=6.0 min CN=80 Runoff=0.90 cfs 3,157 cf

Subcatchment 100S: Area 100S Runoff Area=33,940 sf 5.38% Impervious Runoff Depth>6.38"
Tc=6.0 min CN=79 Runoff=5.18 cfs 18,046 cf

Subcatchment 200S: Area 200S Runoff Area=19,620 sf 30.07% Impervious Runoff Depth>6.99"
Flow Length=60' Tc=6.1 min CN=84 Runoff=3.20 cfs 11,432 cf

Pond 1P: Catch Basin Peak Elev=21.27' Inflow=1.54 cfs 6,178 cf
12.0" Round Culvert n=0.013 L=167.0' S=0.0300 '/' Outflow=1.54 cfs 6,178 cf

Pond 2P: Catch Basin Peak Elev=19.60' Inflow=2.70 cfs 10,113 cf
12.0" Round Culvert n=0.013 L=120.0' S=0.0100 '/' Outflow=2.70 cfs 10,113 cf

Pond 3P: Catch Basin Peak Elev=19.79' Inflow=3.17 cfs 12,464 cf
12.0" Round Culvert n=0.013 L=95.0' S=0.0100 '/' Outflow=3.17 cfs 12,464 cf

Pond 4P: Drain Manhole Peak Elev=22.14' Inflow=5.87 cfs 22,577 cf
12.0" Round Culvert n=0.013 L=150.0' S=0.0100 '/' Outflow=5.87 cfs 22,577 cf

Pond 5P: Catch Basin Peak Elev=18.10' Inflow=3.62 cfs 14,063 cf
12.0" Round Culvert n=0.013 L=46.0' S=0.0100 '/' Outflow=3.62 cfs 14,063 cf

Pond 6P: Drain Manhole Peak Elev=23.14' Inflow=11.03 cfs 42,817 cf
12.0" Round Culvert n=0.013 L=25.0' S=0.0100 '/' Outflow=11.03 cfs 42,817 cf

Pond 7P: Constructed Wetland Peak Elev=14.80' Storage=7,894 cf Inflow=11.93 cfs 45,974 cf
Primary=4.13 cfs 43,373 cf Secondary=4.01 cfs 2,145 cf Outflow=8.14 cfs 45,518 cf

Link 100L: Wetlands Inflow=11.63 cfs 63,564 cf
Primary=11.63 cfs 63,564 cf

Link 200L: Wetlands Inflow=3.20 cfs 11,432 cf
Primary=3.20 cfs 11,432 cf

Total Runoff Area = 121,345 sf Runoff Volume = 75,452 cf Average Runoff Depth = 7.46"
75.22% Pervious = 91,280 sf 24.78% Impervious = 30,065 sf

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
31,580	80	>75% Grass cover, Good, HSG D (2S, 3S, 4S, 5S, 100S, 200S)
31,580	96	Gravel surface, HSG D (2S, 3S, 4S)
14,940	98	Paved parking, HSG D (1S, 2S, 3S, 4S)
7,725	98	Paved roads w/curbs & sewers, HSG D (100S, 200S)
7,400	98	Roofs, HSG D (1S, 3S)
28,120	77	Woods, Good, HSG D (100S, 200S)
121,345	**88**	**TOTAL AREA**

12.0 APPENDIX E – NRCS SOIL MAP

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

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

Custom Soil Resource Report for Essex County, Massachusetts, Northern Part

84 Boston Road

April 28, 2020

Preface

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

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

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

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

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

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

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Contents

How Soil Surveys Are Made

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

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

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

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

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

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

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

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

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

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

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

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

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

Custom Soil Resource Report
Soil Map

Map Scale: 1:1,460 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

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

MAP LEGEND

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

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

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

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

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

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

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

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

Soil Survey Area: Essex County, Massachusetts, Northern Part
Survey Area Data: Version 15, Sep 12, 2019

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

Date(s) aerial images were photographed: Dec 31, 2009—Sep 12, 2016

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
12A	Maybid silt loam, 0 to 3 percent slopes	0.0	0.4%
716C	Rock outcrop-Buxton complex, 3 to 15 percent slopes	4.3	99.6%
Totals for Area of Interest		**4.3**	**100.0%**

Map Unit Descriptions

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

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

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

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

onsite investigation is needed to define and locate the soils and miscellaneous areas.

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

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

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

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

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

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

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

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

Essex County, Massachusetts, Northern Part

12A—Maybid silt loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: vjhj
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Maybid and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Maybid

Setting

Landform: Depressions, depressions
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Soft silty and clayey glaciolacustrine deposits and/or firm silty marine deposits

Typical profile

H1 - 0 to 7 inches: silt loam
H2 - 7 to 19 inches: silty clay
H3 - 19 to 60 inches: silty clay

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water storage in profile: Moderate (about 8.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: C/D
Hydric soil rating: Yes

Minor Components

Scantic

Percent of map unit: 12 percent
Landform: Depressions
Hydric soil rating: Yes

Swansea

Percent of map unit: 3 percent
Landform: Bogs
Hydric soil rating: Yes

716C—Rock outcrop-Buxton complex, 3 to 15 percent slopes

Map Unit Setting

National map unit symbol: vjr0
Elevation: 10 to 900 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 125 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Rock outcrop: 50 percent
Buxton and similar soils: 35 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rock Outcrop

Setting

Parent material: Mica schist

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 0 inches to lithic bedrock

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydric soil rating: Unranked

Description of Buxton

Setting

Landform: Valleys, valleys
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Soft fine-loamy glaciolacustrine deposits over hard fine-loamy glaciolacustrine deposits

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 30 inches: silt loam
H3 - 30 to 60 inches: silty clay

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: About 12 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: High (about 9.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Hydric soil rating: No

Minor Components

Suffield

Percent of map unit: 10 percent
Hydric soil rating: No

Scantic

Percent of map unit: 5 percent
Landform: Depressions
Hydric soil rating: Yes

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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

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

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

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

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

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

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

Custom Soil Resource Report
Map—Hydrologic Soil Group

Map Scale: 1:1,460 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

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

MAP LEGEND

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

Soils

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

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

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

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

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

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

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

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Table—Hydrologic Soil Group

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Totals for Area of Interest			**4.3**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

13.0 APPENDIX F – WATERSHED PLANS