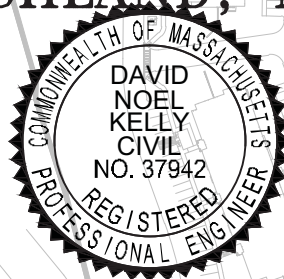


STORMWATER MANAGEMENT REPORT

09/28/15

ASHLAND RAIL TRANSIT APARTMENTS
ASHLAND, MA



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PREPARED FOR:

CAMPANELLI II ACQUISITIONS, LLC
C/O CAMPANELLI COMPANIES
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INTRODUCTION

The purpose of this report is to analyze the pre-development and post-development drainage conditions for the proposed project and to demonstrate that the project will have no negative impacts on the surrounding properties and resource areas. The design incorporates multiple management practices. The project as designed is compliant with the Massachusetts Department of Environmental Protection Stormwater Management Standards, The town of Ashland Conservation Commission Stormwater Management By-Law and Regulations, and the Town of Ashland Wetlands Protection By-Law and Regulations.

PROJECT DESCRIPTION

The project consists of a 398 unit Apartment Complex to be constructed on approximately 30 Acres of the 200 plus Acre mixed use development known as Ashland Station. The proposed project will replace the previously approved “Jefferson at Ashland Station” that consisted of 500 Units on approximately the same 30 Acres.

The proposed development will include 9 3.5 story Apartment Buildings, 21 detached garage buildings with 168 car spaces, 548 surface parking stalls, a clubhouse amenity facility, a playground, a dog run, and a recycle center.

Utilities including natural gas, electricity, and sewer will be serviced from the existing MTBA access road. A state of the art drainage system will be installed to match existing drainage patterns and decrease

RELATION TO PREVIOUS PROJECTS

As stated in the introduction the current project replaces the 500 unit Jefferson At Ashland Station. The primary difference of this 398 unit proposal is that the current proposal does not propose to utilize a park wide storm water management system. The current design will utilize on site best management practices.

In order to prepare this storm water management report we have reviewed “Stormwater Management Report, Jefferson at Ashland Station, An Apartment Community, by Allen & Major Associates, Inc., for JPI Development L.P. last dated April 2007. This report will be referenced as the (“2007 SWM Report”)

This report chose three analysis points that are similar to those reviewed in the referenced report. These include runoff that enters High Street and eventually enters the Sudbury River to the North of the site (Sudbury River), runoff that flows across MTBA road and enters the existing wetland system located north of the project and just south and east of the MTBA parking lot (Northerly Wetlands), and runoff that crosses MBTA road and enters the wetland system just to the south and east of proposed site and south of the Nyanza Superfund Site(Easterly Wetlands)

EXISTING SITE

The 30+/- Acre site is located on the west side of MBTA Road Exhibit and located in the Rail Transit Overlay Overlay District “E”. The site currently consists of wooded areas with elevations ranging from 258 to 358.

A review of the NRCS soils maps show that the majority of the site consists Paxton fine Sandy Loam that is rate as hydrologic soil group(HSG) D. The area of the site closest to MTBA roadway consists of Narragansett Silt Loam that is HSG A. In addition to reviewing the soils maps the test holes, borings, and percolation testing provided in the 2007 SWM has also been reviewed. The

soil testing is consistent with the NRCS mapping. The NRCS mapping and relevant portions of the 2007 SWM geotechnical information can be viewed in **Attachment E**.

As stated above the existing stormwater catchment areas and design points have been chosen based on the 2007 SWM Report. Approximately 67 Acres have been analyzed for pre and post runoff conditions. Three Design Points have been chosen. Approximately 19.5 Acres currently runs off the North and West of the Site toward High Street and eventually enters the Sudbury River to the North and West of the Site. 33.2 Acres currently drains across MBTA road, enters the wetland area North of the site and South East of the MBTA parking lot. This wetland drains to Chemical Brook, a stone ditch that runs along the rail road tracks, and exists Ashland Station through an existing 36" pipe that goes under the CSX railway. Approximately 13.7 Acres Cross MTBA Raodway and enter the wetlands system located to the South and East. Runoff that enters this wetland travels around the Nyanza Superfund Site, and ultimately crosses Megunko Road, combines with Chemical Brook and enters the 36" culvert that crosses the CSX rail line.

See **Attachment A** for existing conditions drainage maps and runoff calculations.

PROPOSED SITE

The proposed project will entail constructing 398 Apartment units in 9 3.5 Apartment Buildings, 21 detached garage buildings with 168 car spaces, 548 surface parking stalls, a clubhouse amenity facility, a playground, a dog run, and a recycle center. A stormwater management system has been designed to comply with Massachusetts Department of Environmental Protection Standards for stormwater management.

The Stormwater management system will incorporate many Best Management Practices (BMPs), which will include multiple deep sump catch basins, 2 proprietary water quality devices, 9 subsurface recharge chambers, 1 stormwater management pond, an operations and maintenance program designed to treat, recharge, and detain all of the runoff generated from the proposed development of the site.

See Proposed Conditions Drainage Exhibit in **Attachment B**.

STORMWATER MANAGEMENT STANDARDS

The following is a discussion of the Massachusetts Stormwater Management Standards

STANDARD 1: NO NEW UNTREATED DISCHARGES

The proposed project has been designed for no new untreated discharges from the site. The proposed pavement areas will be treated by proprietary water quality devices or biofilter swales.

STANDARD 2: PEAK RATE ATTENUATION

Existing and developed sites were modeled using Hydraflow Hydrographs 10 computer program by AutoCAD Civil 3D 2013. This computer software uses the TR55/TR20 tabular method of computing peak flows, hydrograph addition, and pond routing. The curve numbers for the existing conditions analysis were determined using soil survey maps which show hydrologic group A and D soils. See soil survey map in **Attachment F**.

As can be seen from the summary chart below, the peak flows from the design storm on the site will be reduced as a result of this project. Peak flow mitigation is provided within the stormwater management pond

The entire TR55 analysis is included in **Attachment A** (existing conditions) **and B** (proposed conditions) of this report.

Peak Runoff Chart (To High Street and The Sudbury River)

<u>Storm</u>	<u>Existing</u>	<u>Proposed</u>	<u>Difference</u>
(yr, inches)	(cfs)	(cfs)	(cfs)
2,3.1	17.68	11.13	-6.55
10,4.5	33.15	21.65	-11.5
25,5.3	45.86	28.01	-17.85
50,5.9	52.35	32.89	-19.46
100,6.5	61.55	37.84	-23.71

Peak Runoff Chart (To Northerly Wetlands)

<u>Storm</u>	<u>Existing</u>	<u>Proposed</u>	<u>Difference</u>
(yr, inches)	(cfs)	(cfs)	(cfs)
2,3.1	10.12	5.31	-4.81
10,4.5	27.66	23.49	-4.17
25,5.3	44.74	39.08	-5.66
50,5.9	54.05	51.49	-2.56
100,6.5	67.68	64.52	-3.16

Peak Runoff Chart (To Easterly Wetlands)

<u>Storm</u>	<u>Existing</u>	<u>Proposed</u>	<u>Difference</u>
(yr, inches)	(cfs)	(cfs)	(cfs)
2,3.1	0.836	0.956	0.12
10,4.5	4.195	4.632	0.437
25,5.3	8.745	8.186	-0.559
50,5.9	11.50	11.41	-0.09
100,6.5	15.86	15.02	-0.84

STANDARD 3: RECHARGE

The project site contains hydrologic group A and B soils according to the NRCS soil maps and confirmed by on site soil testing by others. Based on DEP guidelines for recharge, the required recharge volume for hydrologic group A soils is 0.6” and the required recharge volume for Group D soil is 0.1”. The project complies with the DEP guidelines for the Static Method that requires the total required recharge volume be provided below the lowest overflow and drain down within 72 hours after a rain event.

The total impervious area on the proposed site is 543,985 s.f. and will require 11,024 cu.ft. of recharge volume.

The dedicated recharge volume has been provided in the 9 subsurface recharge basins and one recharge pond totaling 12,543 cu.ft of dedicated recharge volume.

See **Attachment C** for detailed calculations and recharge volumes

STANDARD 4: STORMWATER QUALITY

Stormwater runoff from the site will be enhanced by means of a number of Best Management Practices (BMP's), which have been designed to comply with the DEP Stormwater Management Guidelines. In order to achieve a Total Suspended Solids (TSS) removal rate of 80%, the following BMP's will be incorporated:

- o Pavement sweeping and maintenance program
- o 2 ea. Proprietary Water Quality Devices
- o Deep Sump Catch Basins
- o Constructed Wetland Water Quality Pond with Sediment Forebay.
- o Infiltration basins including 9 subsurface and one surface basin.

The total TSS removal is expected to be greater than 80%. See TSS Removal in **Attachment E**.

STANDARD 5: Land Uses with Higher Potential Pollutant Loads (LUHPPL's)

The proposed project is considered a land use with higher potential pollutant loads due to 1,000 average daily traffic trips. The proposed use is not an industrial use and is not subject to a NPDES Multi-Sector General Permit.

STANDARD 6: CRITICAL AREAS

The site is not in an active public water supply, surface water protection area, nor groundwater protection area, and is not in an area of critical environmental concern.

STANDARD 7: REDEVELOPMENT

The proposed project constitutes both redevelopment and new development.

STANDARD 8: CONSTRUCTION PERIOD POLLUTION PREVENTION AND EROSION CONTROL

A construction phasing plan will be established when a site contractor is consulted. At that time a construction phasing plan and the associated Stormwater Pollution Prevention Plan will be prepared and submitted to the Town of Framingham and the EPA.

STANDARD 9: OPERATIONS AND MAINTENANCE PLAN

The Stormwater Management System Operation and Maintenance Plan and Long Term Pollution Prevention Plan, Operations and Maintenance Log, and BMP Location Map are provided in **Attachment D**.

STANDARD 10: ILLICIT DISCHARGES

An Illicit Discharge Statement is attached and can be found in the Table of Contents. The Long Term Pollution Prevention Plan can be found in **Attachment D**.

HYDROLOGY AND HYDRAULICS:

Hydraulics:

The on-site drainage systems were designed by means of the Rational Method. The drainage system was designed based on a 25-year recurrence interval.

The Rational Method is based on the following formula:

$$Q=CiA$$

Where:

Q = Peak Rate of Runoff in Cubic Feet per Second

C = Coefficient of Runoff

i = Rainfall Intensity in Inches per Hour

(A value 7.0 inches per hour was used per TP-40)

A = Drainage Area in Acres

The values that have been used in the Rational Method formula to calculate the peak rate of runoff for this project are as follows:

C= Runoff Coefficients:

For our analysis, we used the following runoff coefficients:
C = 0.90 for paved areas and
C = 0.40 for grass, woods, and landscaping areas.

Tc = Time of Concentration

Considering the fact that almost the whole site is paved, a Time of Concentration of 5 minutes has been used to determine rainfall intensity. This will give conservative estimates for peak runoff.

A = Drainage Area
Drainage divide lines were determined by using Site Topographic Maps and the proposed grading plan prepared by this office. Existing watershed boundaries were verified by existing topographic information and by field inspection.

Storm drains were designed using the Manning formula.

$$Q = \frac{1.49R^{2/3} A S^{1/2}}{n}$$

Where

Q = Capacity of Pipe flowing full in cubic feet per second.

R = Hydraulic radius

n = Manning's Resistance Coefficient

(For our computation, we used n = .011 for HDPE)

A = Cross sectional area of the pipe in square feet

S = Slope of the pipe in feet per feet

The entire Rational Method and Manning's Calculation is included in **Attachment D**.

CONCLUSION

An extensive stormwater management system has been designed for the project. The stormwater management system has been designed to comply with current (DEP) standards and will incorporate a number of Best

Management Practices (“BMP’s”) that will ensure that the runoff will be treated prior to leaving the site.

The construction of the stormwater management system will ensure that stormwater runoff from this site will be of high quality and that there will be no adverse impacts on surrounding properties or resource areas.



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 8²
- Operation and Maintenance Plan required by Standard 9

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

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

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

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

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



Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

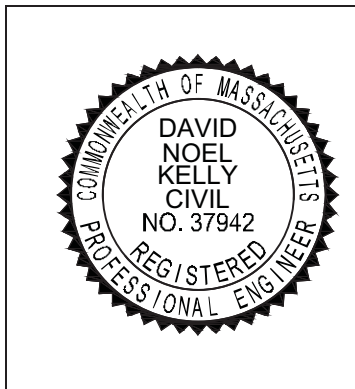
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the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

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



David Noel Kelly
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Signature and Date

Checklist

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

- New development
- Redevelopment
- Mix of New Development and Redevelopment



Checklist for Stormwater Report

Checklist (continued)

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

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

Standard 1: No New Untreated Discharges

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



Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

- Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.
- Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.
- Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

- Soil Analysis provided.
- Required Recharge Volume calculation provided.
- Required Recharge volume reduced through use of the LID site Design Credits.
- Sizing the infiltration, BMPs is based on the following method: Check the method used.
 - Static
 - Simple Dynamic
 - Dynamic Field¹
- Runoff from all impervious areas at the site discharging to the infiltration BMP.
- Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.
- Recharge BMPs have been sized to infiltrate the Required Recharge Volume.
- Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:
 - Site is comprised solely of C and D soils and/or bedrock at the land surface
 - M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
 - Solid Waste Landfill pursuant to 310 CMR 19.000
 - Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.
- Calculations showing that the infiltration BMPs will drain in 72 hours are provided.
- Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

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



Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

- The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.
- Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

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

- Good housekeeping practices;
 - Provisions for storing materials and waste products inside or under cover;
 - Vehicle washing controls;
 - Requirements for routine inspections and maintenance of stormwater BMPs;
 - Spill prevention and response plans;
 - Provisions for maintenance of lawns, gardens, and other landscaped areas;
 - Requirements for storage and use of fertilizers, herbicides, and pesticides;
 - Pet waste management provisions;
 - Provisions for operation and management of septic systems;
 - Provisions for solid waste management;
 - Snow disposal and plowing plans relative to Wetland Resource Areas;
 - Winter Road Salt and/or Sand Use and Storage restrictions;
 - Street sweeping schedules;
 - Provisions for prevention of illicit discharges to the stormwater management system;
 - Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
 - Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
 - List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.
- A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.
 - Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:
 - is within the Zone II or Interim Wellhead Protection Area
 - is near or to other critical areas
 - is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
 - involves runoff from land uses with higher potential pollutant loads.
 - The Required Water Quality Volume is reduced through use of the LID site Design Credits.
 - Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.



Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

- The BMP is sized (and calculations provided) based on:
 - The ½" or 1" Water Quality Volume or
 - The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.
- The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.
- A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

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

- The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.
- The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted **prior to** the discharge of stormwater to the post-construction stormwater BMPs.
- The NPDES Multi-Sector General Permit does **not** cover the land use.
- LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.
- All exposure has been eliminated.
- All exposure has **not** been eliminated and all BMPs selected are on MassDEP LUHPPL list.
- The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

- The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.
- Critical areas and BMPs are identified in the Stormwater Report.



Checklist for Stormwater Report

Checklist (continued)

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

- The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:
 - Limited Project
 - Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
 - Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
 - Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
 - Bike Path and/or Foot Path
 - Redevelopment Project
 - Redevelopment portion of mix of new and redevelopment.
- Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.
- The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

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

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

- Narrative;
 - Construction Period Operation and Maintenance Plan;
 - Names of Persons or Entity Responsible for Plan Compliance;
 - Construction Period Pollution Prevention Measures;
 - Erosion and Sedimentation Control Plan Drawings;
 - Detail drawings and specifications for erosion control BMPs, including sizing calculations;
 - Vegetation Planning;
 - Site Development Plan;
 - Construction Sequencing Plan;
 - Sequencing of Erosion and Sedimentation Controls;
 - Operation and Maintenance of Erosion and Sedimentation Controls;
 - Inspection Schedule;
 - Maintenance Schedule;
 - Inspection and Maintenance Log Form.
- A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.



Checklist for Stormwater Report

Checklist (continued)

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

- The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has **not** been included in the Stormwater Report but will be submitted **before** land disturbance begins.
- The project is **not** covered by a NPDES Construction General Permit.
- The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.
- The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

- The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:
 - Name of the stormwater management system owners;
 - Party responsible for operation and maintenance;
 - Schedule for implementation of routine and non-routine maintenance tasks;
 - Plan showing the location of all stormwater BMPs maintenance access areas;
 - Description and delineation of public safety features;
 - Estimated operation and maintenance budget; and
 - Operation and Maintenance Log Form.
- The responsible party is **not** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:
 - A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
 - A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

- The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;
- An Illicit Discharge Compliance Statement is attached;
- NO Illicit Discharge Compliance Statement is attached but will be submitted **prior to** the discharge of any stormwater to post-construction BMPs.

ILLICIT DISCHARGE STATEMENT

This statement has been prepared to comply with Stormwater Management Standard #10 as referenced in the Massachusetts Stormwater Handbook, Volume One, Chapter One, Page 25. This handbook has been issued by the Massachusetts Department of Environmental Protection for compliance with revised Regulations for Wetlands 310 CMR 10.00.

As detailed in the Site Development Plans accompanying this application this project will not involve any illicit discharge to the stormwater management system. Furthermore, to the best of my knowledge there are no illicit discharges to the stormwater management system of the existing site.

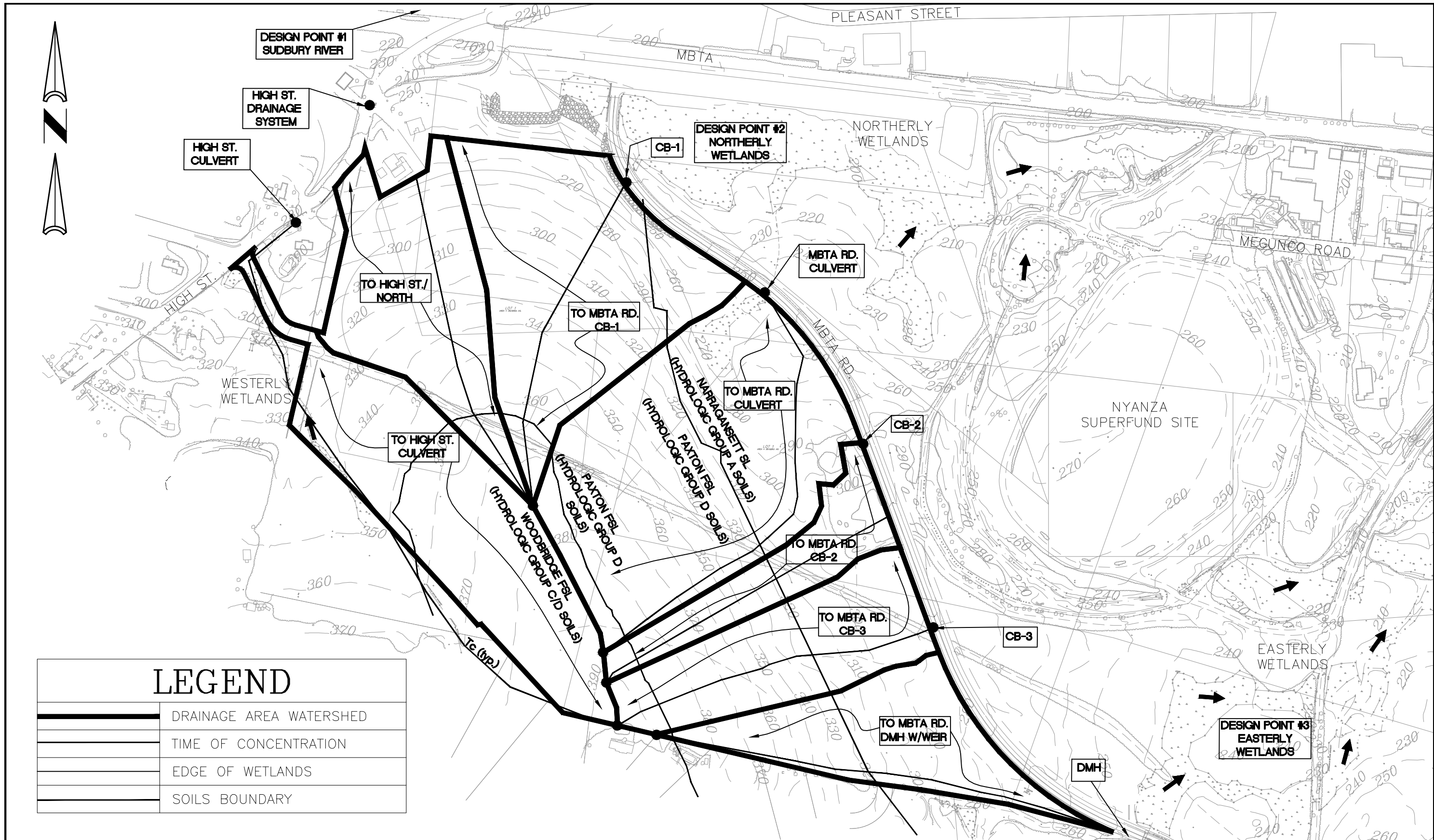
Owner and Responsible Party for Operating and
Managing the site:

Campanelli Acquisitions II, LLC
PO Box 850985
Braintree, MA
781-849-1440

_____ Date

KELLY ENGINEERING GROUP, INC.
Zero Campanelli Drive-Braintree-MA 02184 Phone 781 843 4333

Attachment A
Existing Conditions

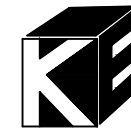


LEGEND	
	DRAINAGE AREA WATERSHED
	TIME OF CONCENTRATION
	EDGE OF WETLANDS
	SOILS BOUNDARY

CAMPANELLI COMPANIES
ASHLAND
ASHLAND, MA

SCALE: 1" = 300'
 DATE: 09/28/15
 2015-042-EXDR00

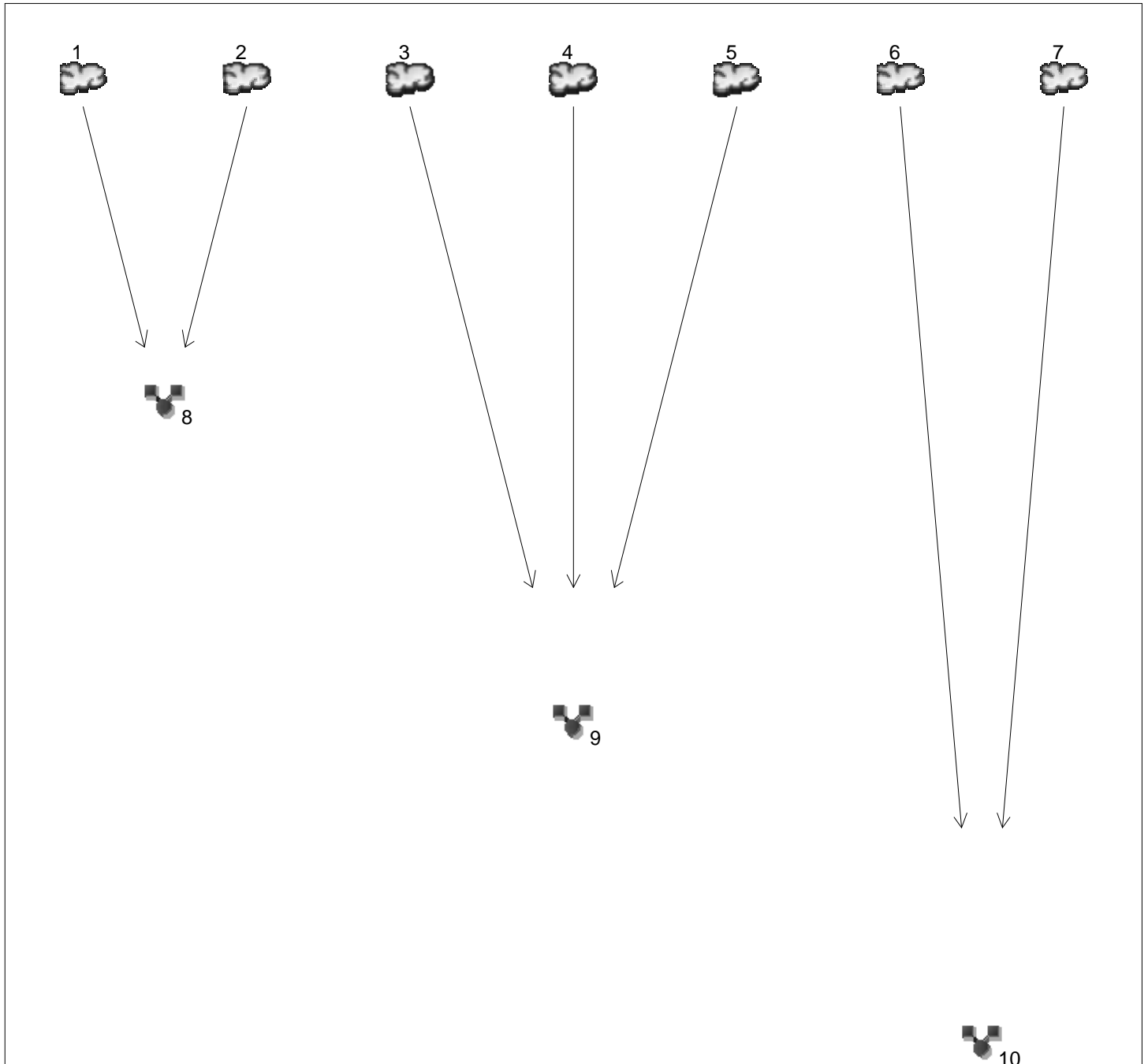
**EXISTING
 DRAINAGE
 EXHIBIT**



KELLY ENGINEERING GROUP, INC.
 CIVIL ENGINEERING CONSULTANTS
 0 CAMPANELLI DRIVE · BRAINTREE MA · 02184
 PHONE: 781 843 4333 FAX: 781 843 0028

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10



Legend

Hyd. Origin	Description
1	SCS Runoff TO HIGH ST. CULVERT
2	SCS Runoff HIGH ST. DRAINAGE SYSTEM
3	SCS Runoff MBTA RD. CB-1
4	SCS Runoff MBTA RD. CULVERT
5	SCS Runoff MBTA RD. CB-2
6	SCS Runoff MBTA RD. CB-3
7	SCS Runoff MBTA RD. DMH
8	Combine TO SUDBURY RIVER
9	Combine TO NORTHERLY WETLANDS
10	Combine TO EASTERLY WETLANDS

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	9.883	-----	-----	18.55	25.66	29.30	34.46	TO HIGH ST. CULVERT
2	SCS Runoff	-----	-----	8.087	-----	-----	15.12	20.90	23.85	28.04	HIGH ST. DRAINAGE SYSTEM
3	SCS Runoff	-----	-----	8.421	-----	-----	17.80	25.83	30.00	35.98	MBTA RD. CB-1
4	SCS Runoff	-----	-----	2.248	-----	-----	9.233	16.75	20.94	27.24	MBTA RD. CULVERT
5	SCS Runoff	-----	-----	0.116	-----	-----	1.104	2.440	3.256	4.523	MBTA RD. CB-2
6	SCS Runoff	-----	-----	0.836	-----	-----	3.664	6.797	8.555	11.19	MBTA RD. CB-3
7	SCS Runoff	-----	-----	0.047	-----	-----	0.742	2.184	3.164	4.773	MBTA RD. DMH
8	Combine	1, 2,	-----	17.68	-----	-----	33.15	45.86	52.35	61.55	TO SUDBURY RIVER
9	Combine	3, 4, 5,	-----	10.12	-----	-----	27.66	44.74	54.05	67.68	TO NORTHERLY WETLANDS
10	Combine	6, 7,	-----	0.836	-----	-----	4.195	8.745	11.50	15.86	TO EASTERLY WETLANDS

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	9.883	2	738	50,247	-----	-----	-----	TO HIGH ST. CULVERT
2	SCS Runoff	8.087	2	734	36,717	-----	-----	-----	HIGH ST. DRAINAGE SYSTEM
3	SCS Runoff	8.421	2	736	40,663	-----	-----	-----	MBTA RD. CB-1
4	SCS Runoff	2.248	2	746	18,620	-----	-----	-----	MBTA RD. CULVERT
5	SCS Runoff	0.116	2	758	2,134	-----	-----	-----	MBTA RD. CB-2
6	SCS Runoff	0.836	2	748	7,360	-----	-----	-----	MBTA RD. CB-3
7	SCS Runoff	0.047	2	916	1,298	-----	-----	-----	MBTA RD. DMH
8	Combine	17.68	2	736	86,964	1, 2,	-----	-----	TO SUDBURY RIVER
9	Combine	10.12	2	738	61,417	3, 4, 5,	-----	-----	TO NORTHERLY WETLANDS
10	Combine	0.836	2	748	8,659	6, 7,	-----	-----	TO EASTERLY WETLANDS
Pre-Existing Conditions.gpw					Return Period: 2 Year			Wednesday, 09 / 23 / 2015	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	18.55	2	738	91,662	-----	-----	-----	TO HIGH ST. CULVERT
2	SCS Runoff	15.12	2	734	66,981	-----	-----	-----	HIGH ST. DRAINAGE SYSTEM
3	SCS Runoff	17.80	2	734	80,365	-----	-----	-----	MBTA RD. CB-1
4	SCS Runoff	9.233	2	738	51,260	-----	-----	-----	MBTA RD. CULVERT
5	SCS Runoff	1.104	2	744	7,855	-----	-----	-----	MBTA RD. CB-2
6	SCS Runoff	3.664	2	738	20,864	-----	-----	-----	MBTA RD. CB-3
7	SCS Runoff	0.742	2	750	7,715	-----	-----	-----	MBTA RD. DMH
8	Combine	33.15	2	736	158,642	1, 2,	-----	-----	TO SUDBURY RIVER
9	Combine	27.66	2	736	139,479	3, 4, 5,	-----	-----	TO NORTHERLY WETLANDS
10	Combine	4.195	2	742	28,579	6, 7,	-----	-----	TO EASTERLY WETLANDS
Pre-Existing Conditions.gpw					Return Period: 10 Year			Wednesday, 09 / 23 / 2015	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	25.66	2	738	126,320	-----	-----	-----	TO HIGH ST. CULVERT
2	SCS Runoff	20.90	2	734	92,307	-----	-----	-----	HIGH ST. DRAINAGE SYSTEM
3	SCS Runoff	25.83	2	734	114,793	-----	-----	-----	MBTA RD. CB-1
4	SCS Runoff	16.75	2	736	83,455	-----	-----	-----	MBTA RD. CULVERT
5	SCS Runoff	2.440	2	740	14,035	-----	-----	-----	MBTA RD. CB-2
6	SCS Runoff	6.797	2	736	34,315	-----	-----	-----	MBTA RD. CB-3
7	SCS Runoff	2.184	2	744	15,538	-----	-----	-----	MBTA RD. DMH
8	Combine	45.86	2	736	218,627	1, 2,	-----	-----	TO SUDBURY RIVER
9	Combine	44.74	2	734	212,283	3, 4, 5,	-----	-----	TO NORTHERLY WETLANDS
10	Combine	8.745	2	738	49,853	6, 7,	-----	-----	TO EASTERLY WETLANDS
Pre-Existing Conditions.gpw					Return Period: 25 Year			Wednesday, 09 / 23 / 2015	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	29.30	2	738	144,257	-----	-----	-----	TO HIGH ST. CULVERT
2	SCS Runoff	23.85	2	734	105,414	-----	-----	-----	HIGH ST. DRAINAGE SYSTEM
3	SCS Runoff	30.00	2	734	132,889	-----	-----	-----	MBTA RD. CB-1
4	SCS Runoff	20.94	2	736	101,328	-----	-----	-----	MBTA RD. CULVERT
5	SCS Runoff	3.256	2	738	17,587	-----	-----	-----	MBTA RD. CB-2
6	SCS Runoff	8.555	2	736	41,813	-----	-----	-----	MBTA RD. CB-3
7	SCS Runoff	3.164	2	742	20,217	-----	-----	-----	MBTA RD. DMH
8	Combine	52.35	2	736	249,672	1, 2,	-----	-----	TO SUDBURY RIVER
9	Combine	54.05	2	734	251,804	3, 4, 5,	-----	-----	TO NORTHERLY WETLANDS
10	Combine	11.50	2	736	62,030	6, 7,	-----	-----	TO EASTERLY WETLANDS
Pre-Existing Conditions.gpw					Return Period: 50 Year			Wednesday, 09 / 23 / 2015	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description	
1	SCS Runoff	34.46	2	738	169,887	-----	-----	-----	TO HIGH ST. CULVERT	
2	SCS Runoff	28.04	2	732	124,143	-----	-----	-----	HIGH ST. DRAINAGE SYSTEM	
3	SCS Runoff	35.98	2	734	158,992	-----	-----	-----	MBTA RD. CB-1	
4	SCS Runoff	27.24	2	734	127,996	-----	-----	-----	MBTA RD. CULVERT	
5	SCS Runoff	4.523	2	736	22,999	-----	-----	-----	MBTA RD. CB-2	
6	SCS Runoff	11.19	2	734	53,026	-----	-----	-----	MBTA RD. CB-3	
7	SCS Runoff	4.773	2	740	27,516	-----	-----	-----	MBTA RD. DMH	
8	Combine	61.55	2	736	294,029	1, 2,	-----	-----	TO SUDBURY RIVER	
9	Combine	67.68	2	734	309,987	3, 4, 5,	-----	-----	TO NORTHERLY WETLANDS	
10	Combine	15.86	2	736	80,542	6, 7,	-----	-----	TO EASTERLY WETLANDS	
Pre-Existing Conditions.gpw					Return Period: 100 Year			Wednesday, 09 / 23 / 2015		

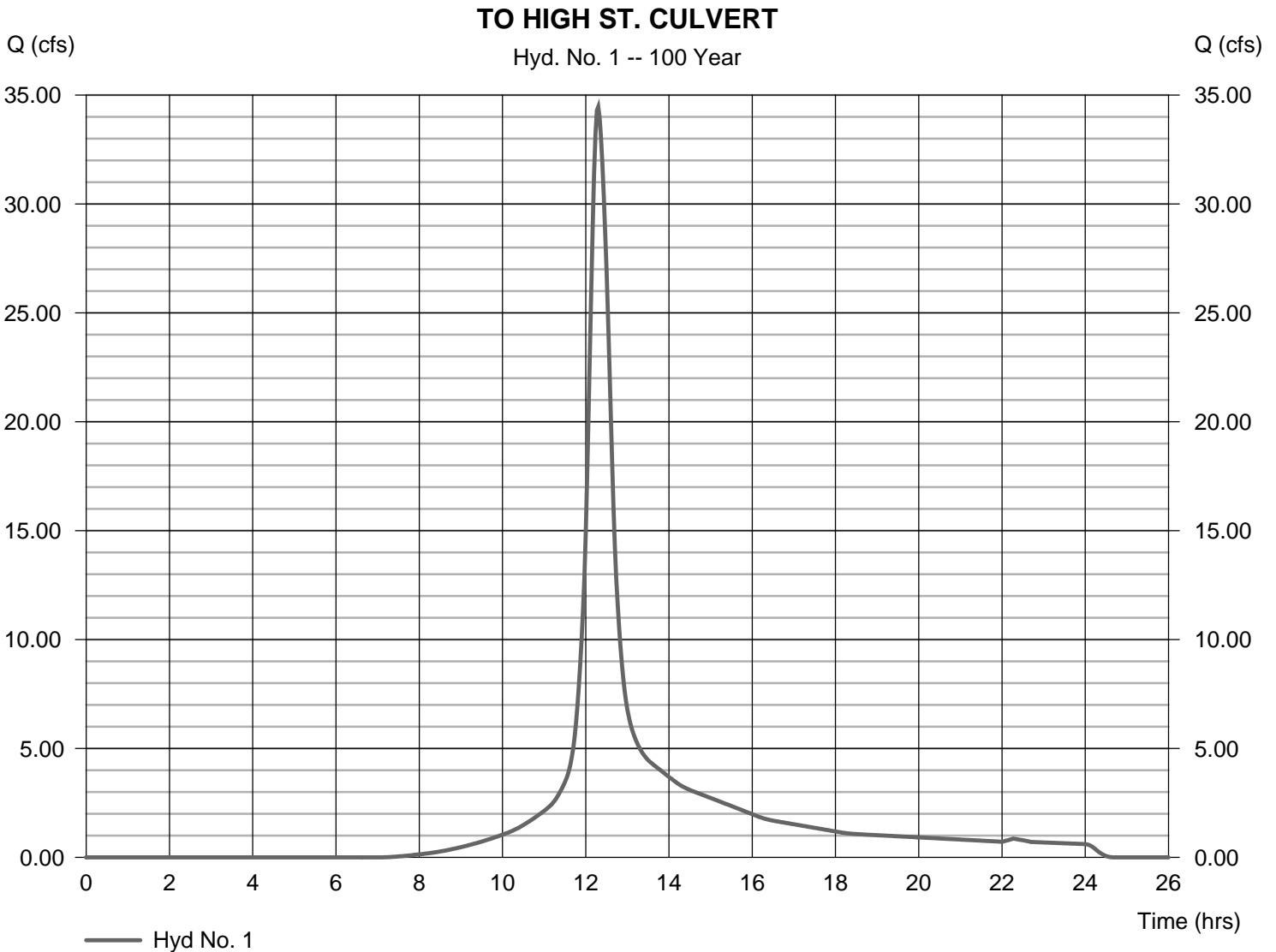
Hydrograph Report

Hyd. No. 1

TO HIGH ST. CULVERT

Hydrograph type = SCS Runoff
Storm frequency = 100 yrs
Time interval = 2 min
Drainage area = 11.604 ac
Basin Slope = 0.0 %
Tc method = TR55
Total precip. = 6.70 in
Storm duration = 24 hrs

Peak discharge = 34.46 cfs
Time to peak = 12.30 hrs
Hyd. volume = 169,887 cuft
Curve number = 77
Hydraulic length = 0 ft
Time of conc. (Tc) = 24.70 min
Distribution = Type III
Shape factor = 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No. 1

TO HIGH ST. CULVERT

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.600	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.10	0.00	0.00	
Land slope (%)	= 3.00	0.00	0.00	
Travel Time (min)	= 14.74	+ 0.00	+ 0.00	= 14.74
Shallow Concentrated Flow				
Flow length (ft)	= 520.00	1650.00	0.00	
Watercourse slope (%)	= 4.00	5.50	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=3.23	3.78	0.00	
Travel Time (min)	= 2.69	+ 7.27	+ 0.00	= 9.95
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	(0)0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				24.70 min

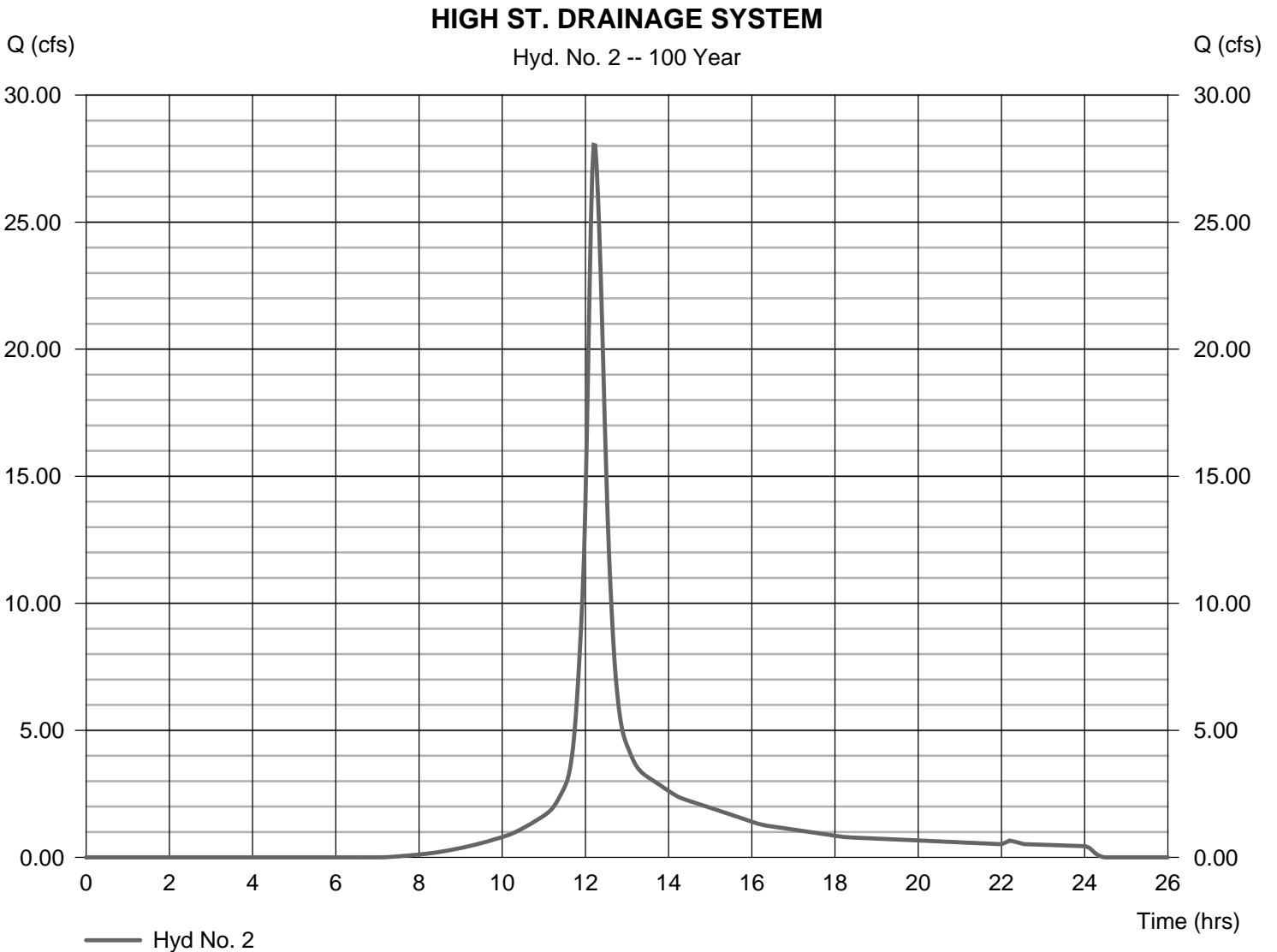
Hydrograph Report

Hyd. No. 2

HIGH ST. DRAINAGE SYSTEM

Hydrograph type = SCS Runoff
Storm frequency = 100 yrs
Time interval = 2 min
Drainage area = 8.347 ac
Basin Slope = 0.0 %
Tc method = TR55
Total precip. = 6.70 in
Storm duration = 24 hrs

Peak discharge = 28.04 cfs
Time to peak = 12.20 hrs
Hyd. volume = 124,143 cuft
Curve number = 77
Hydraulic length = 0 ft
Time of conc. (Tc) = 18.50 min
Distribution = Type III
Shape factor = 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No. 2

HIGH ST. DRAINAGE SYSTEM

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.600	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.10	0.00	0.00	
Land slope (%)	= 3.00	0.00	0.00	
Travel Time (min)	= 14.74	+ 0.00	+ 0.00	= 14.74
Shallow Concentrated Flow				
Flow length (ft)	= 1100.00	0.00	0.00	
Watercourse slope (%)	= 9.00	0.00	0.00	
Surface description	= Unpaved	Unpaved	Unpaved	
Average velocity (ft/s)	=4.84	0.00	0.00	
Travel Time (min)	= 3.79	+ 0.00	+ 0.00	= 3.79
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	{0}0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				18.50 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

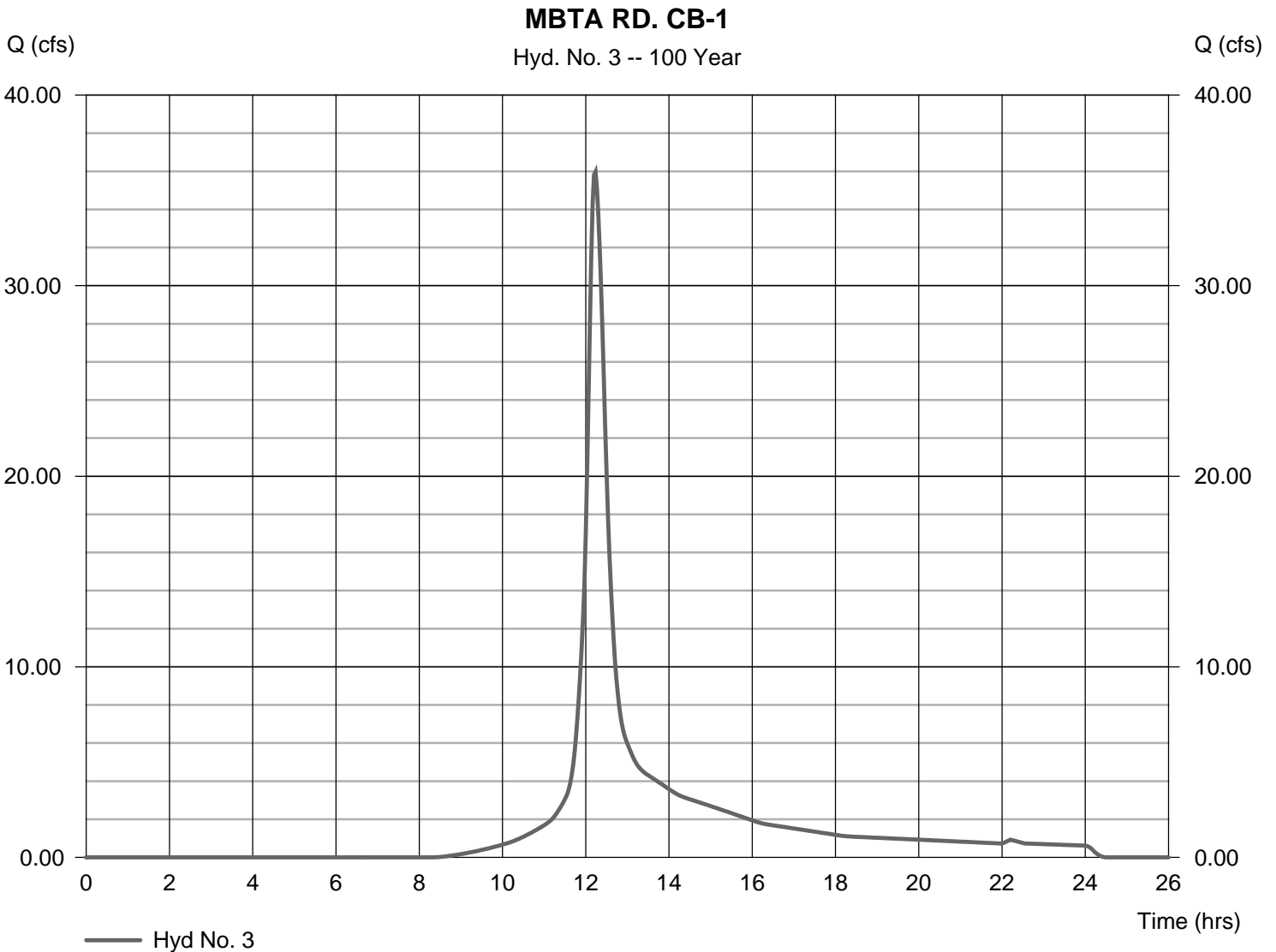
Wednesday, 09 / 23 / 2015

Hyd. No. 3

MBTA RD. CB-1

Hydrograph type = SCS Runoff
Storm frequency = 100 yrs
Time interval = 2 min
Drainage area = 12.467 ac
Basin Slope = 0.0 %
Tc method = TR55
Total precip. = 6.70 in
Storm duration = 24 hrs

Peak discharge = 35.98 cfs
Time to peak = 12.23 hrs
Hyd. volume = 158,992 cuft
Curve number = 71.4
Hydraulic length = 0 ft
Time of conc. (Tc) = 18.10 min
Distribution = Type III
Shape factor = 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No. 3

MBTA RD. CB-1

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.600	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.10	0.00	0.00	
Land slope (%)	= 3.00	0.00	0.00	
Travel Time (min)	= 14.74	+ 0.00	+ 0.00	= 14.74
Shallow Concentrated Flow				
Flow length (ft)	= 520.00	560.00	0.00	
Watercourse slope (%)	= 6.70	21.00	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=4.18	7.39	0.00	
Travel Time (min)	= 2.08	+ 1.26	+ 0.00	= 3.34
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	{0}0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				18.10 min

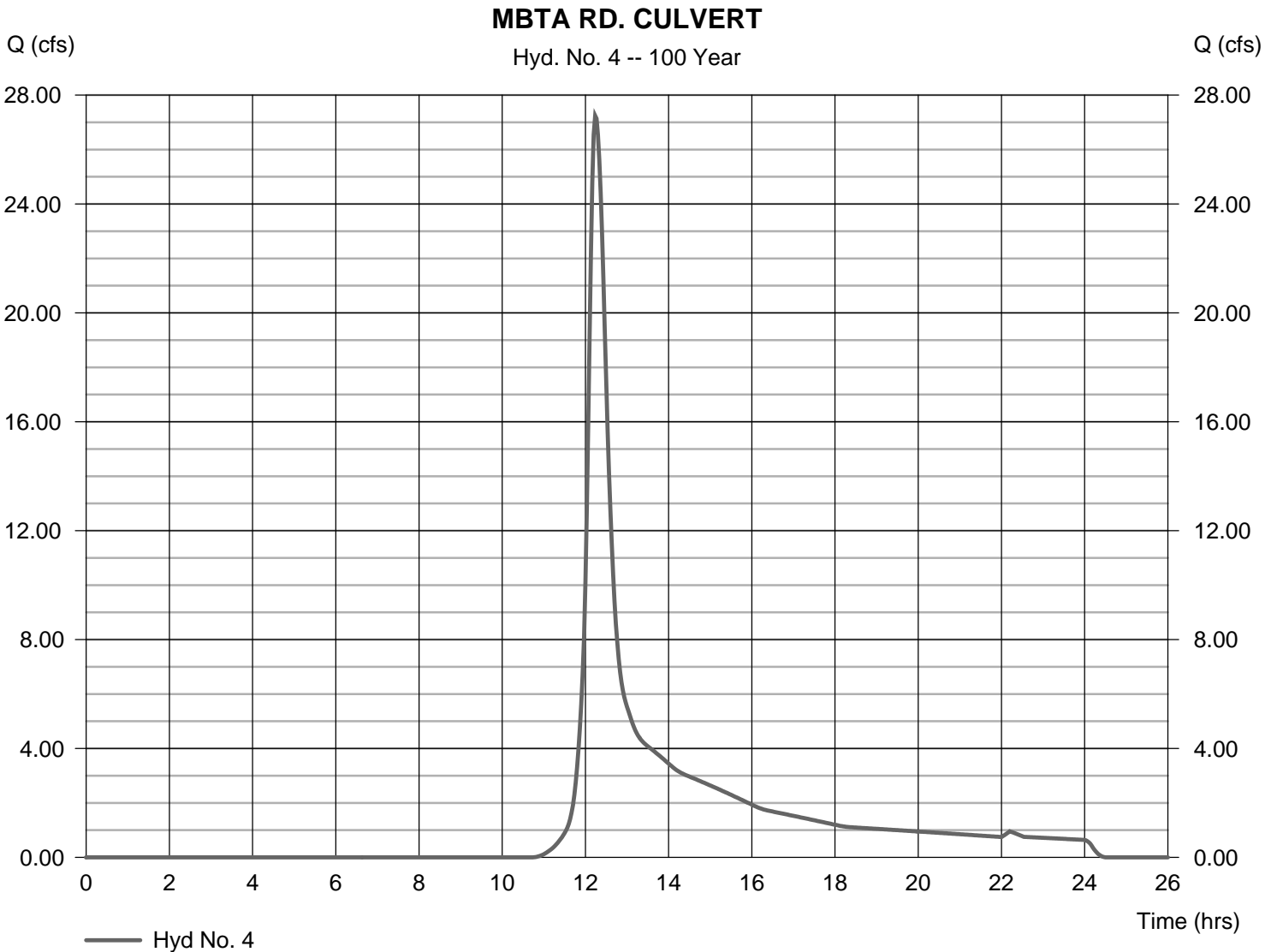
Hydrograph Report

Hyd. No. 4

MBTA RD. CULVERT

Hydrograph type = SCS Runoff
Storm frequency = 100 yrs
Time interval = 2 min
Drainage area = 16.735 ac
Basin Slope = 0.0 %
Tc method = TR55
Total precip. = 6.70 in
Storm duration = 24 hrs

Peak discharge = 27.24 cfs
Time to peak = 12.23 hrs
Hyd. volume = 127,996 cuft
Curve number = 56.9
Hydraulic length = 0 ft
Time of conc. (Tc) = 19.30 min
Distribution = Type III
Shape factor = 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No. 4

MBTA RD. CULVERT

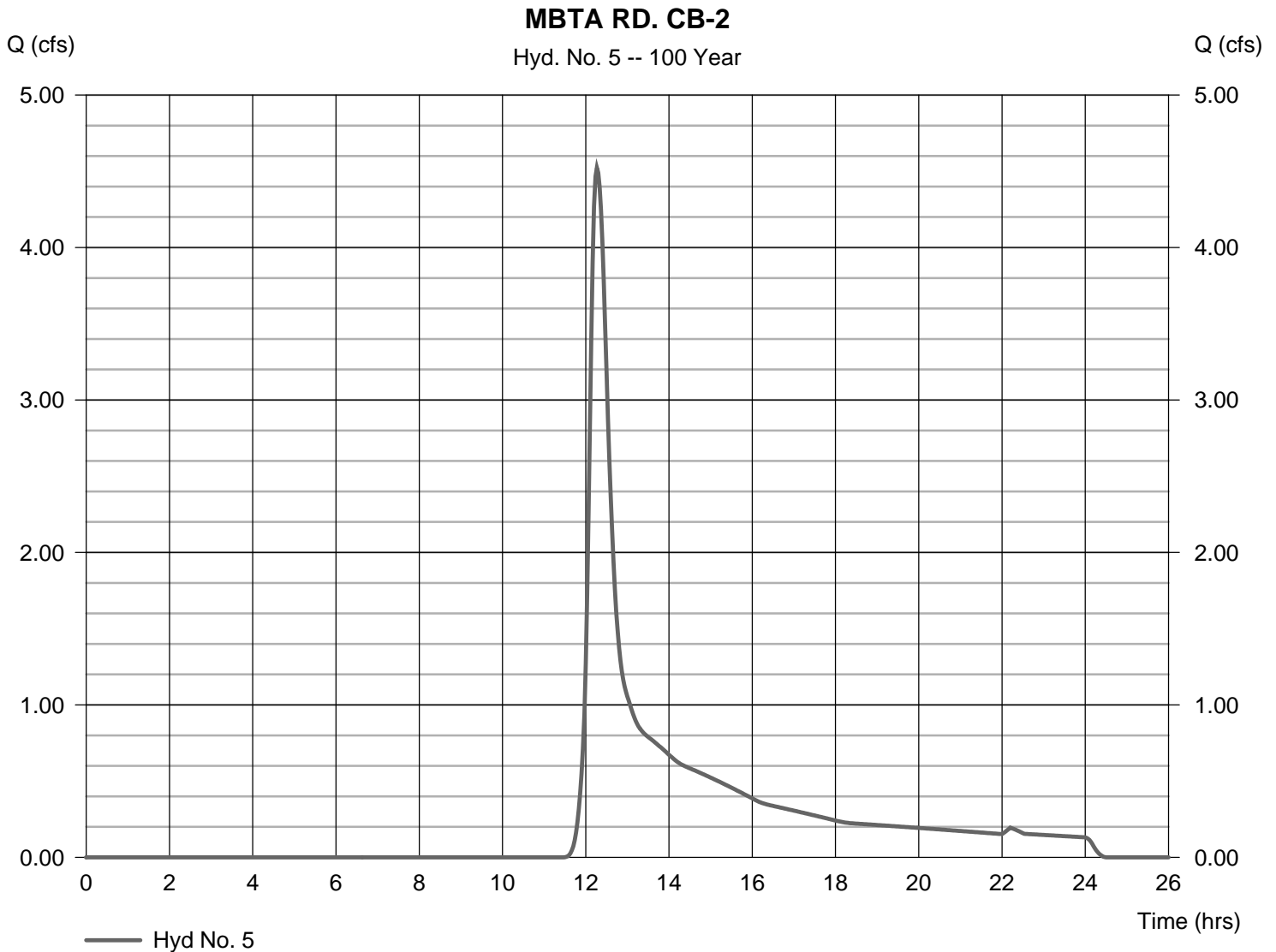
<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.600	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.10	0.00	0.00	
Land slope (%)	= 3.00	0.00	0.00	
Travel Time (min)	= 14.74	+ 0.00	+ 0.00	= 14.74
Shallow Concentrated Flow				
Flow length (ft)	= 720.00	760.00	0.00	
Watercourse slope (%)	= 11.80	6.70	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=5.54	5.26	0.00	
Travel Time (min)	= 2.17	+ 2.41	+ 0.00	= 4.57
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	{0}0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				19.30 min

Hydrograph Report

Hyd. No. 5

MBTA RD. CB-2

Hydrograph type	= SCS Runoff	Peak discharge	= 4.523 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.27 hrs
Time interval	= 2 min	Hyd. volume	= 22,999 cuft
Drainage area	= 4.035 ac	Curve number	= 50.8
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 19.70 min
Total precip.	= 6.70 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No. 5

MBTA RD. CB-2

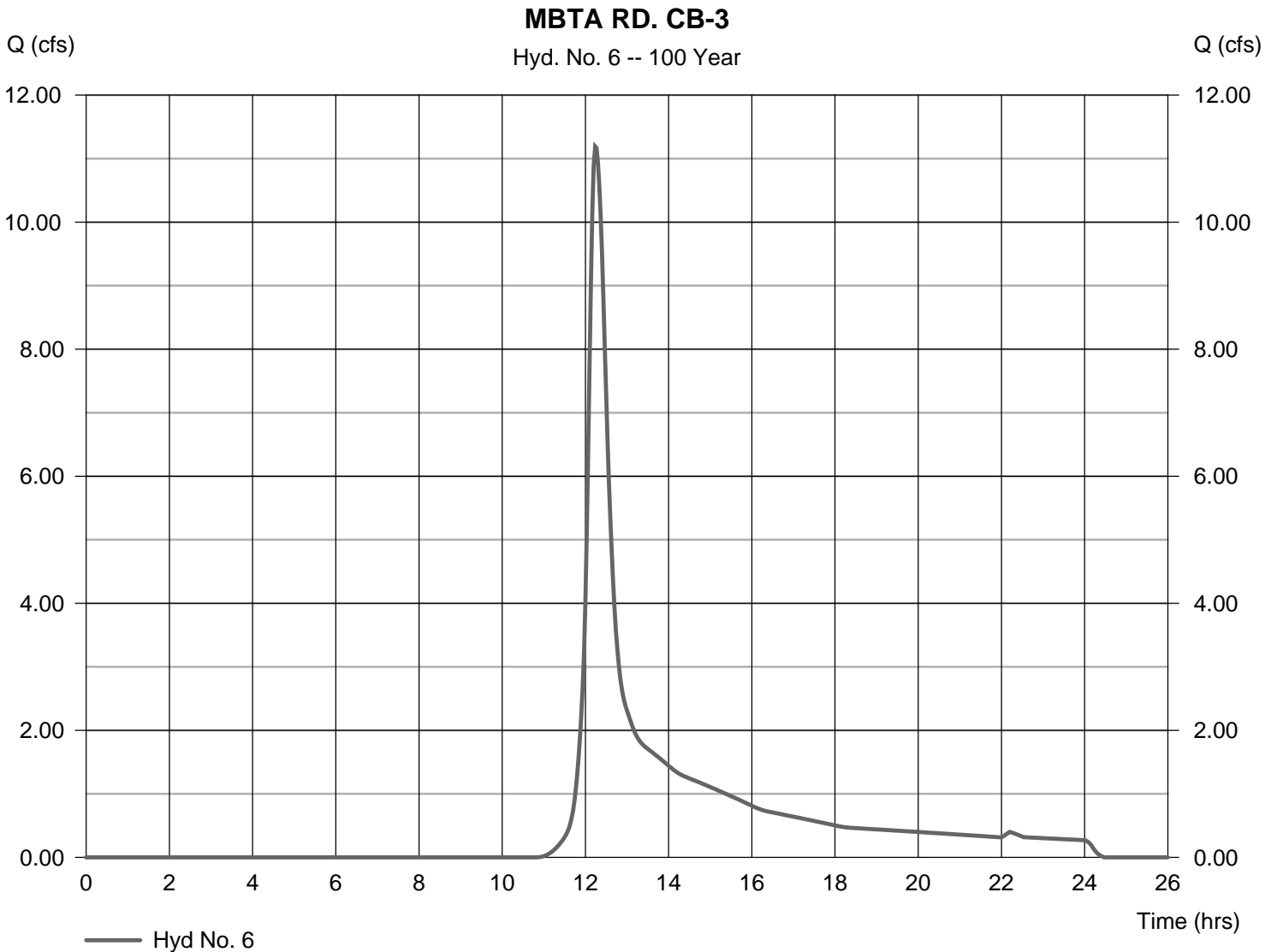
<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.600	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.10	0.00	0.00	
Land slope (%)	= 3.00	0.00	0.00	
Travel Time (min)	= 14.74	+ 0.00	+ 0.00	= 14.74
Shallow Concentrated Flow				
Flow length (ft)	= 750.00	515.00	0.00	
Watercourse slope (%)	= 12.00	3.80	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=5.59	3.15	0.00	
Travel Time (min)	= 2.24	+ 2.73	+ 0.00	= 4.97
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	{0}0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				19.70 min

Hydrograph Report

Hyd. No. 6

MBTA RD. CB-3

Hydrograph type	= SCS Runoff	Peak discharge	= 11.19 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.23 hrs
Time interval	= 2 min	Hyd. volume	= 53,026 cuft
Drainage area	= 7.180 ac	Curve number	= 56.1
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 18.10 min
Total precip.	= 6.70 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No. 6

MBTA RD. CB-3

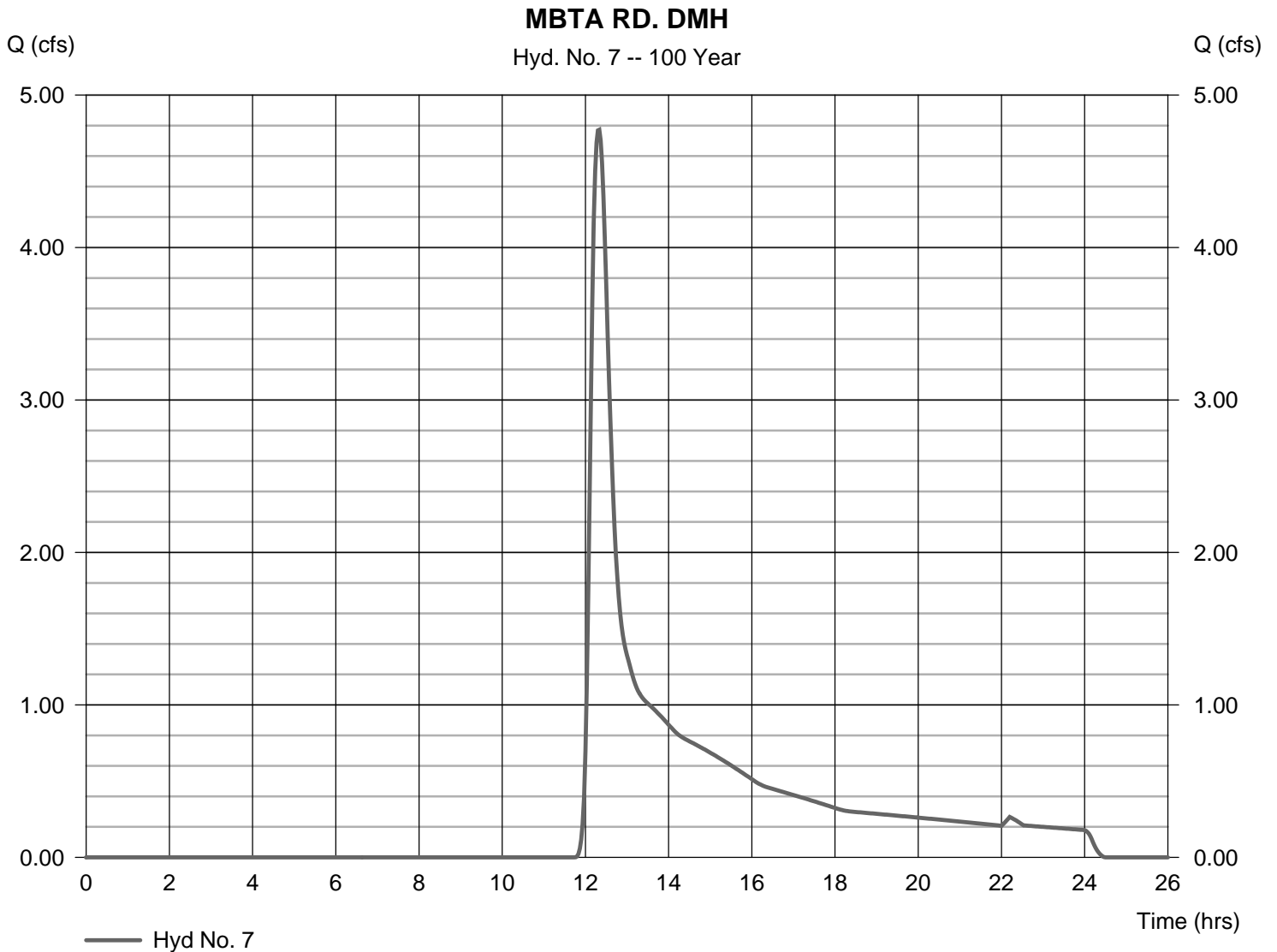
<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.600	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.10	0.00	0.00	
Land slope (%)	= 3.00	0.00	0.00	
Travel Time (min)	= 14.74	+ 0.00	+ 0.00	= 14.74
Shallow Concentrated Flow				
Flow length (ft)	= 1030.00	0.00	0.00	
Watercourse slope (%)	= 10.00	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=5.10	0.00	0.00	
Travel Time (min)	= 3.36	+ 0.00	+ 0.00	= 3.36
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	{0}0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				18.10 min

Hydrograph Report

Hyd. No. 7

MBTA RD. DMH

Hydrograph type	= SCS Runoff	Peak discharge	= 4.773 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.33 hrs
Time interval	= 2 min	Hyd. volume	= 27,516 cuft
Drainage area	= 6.527 ac	Curve number	= 45.8
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 19.60 min
Total precip.	= 6.70 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No. 7

MBTA RD. DMH

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.600	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.10	0.00	0.00	
Land slope (%)	= 3.00	0.00	0.00	
Travel Time (min)	= 14.74	+ 0.00	+ 0.00	= 14.74
Shallow Concentrated Flow				
Flow length (ft)	= 860.00	610.00	0.00	
Watercourse slope (%)	= 11.00	8.20	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=5.35	4.62	0.00	
Travel Time (min)	= 2.68	+ 2.20	+ 0.00	= 4.88
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	{0}0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				19.60 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

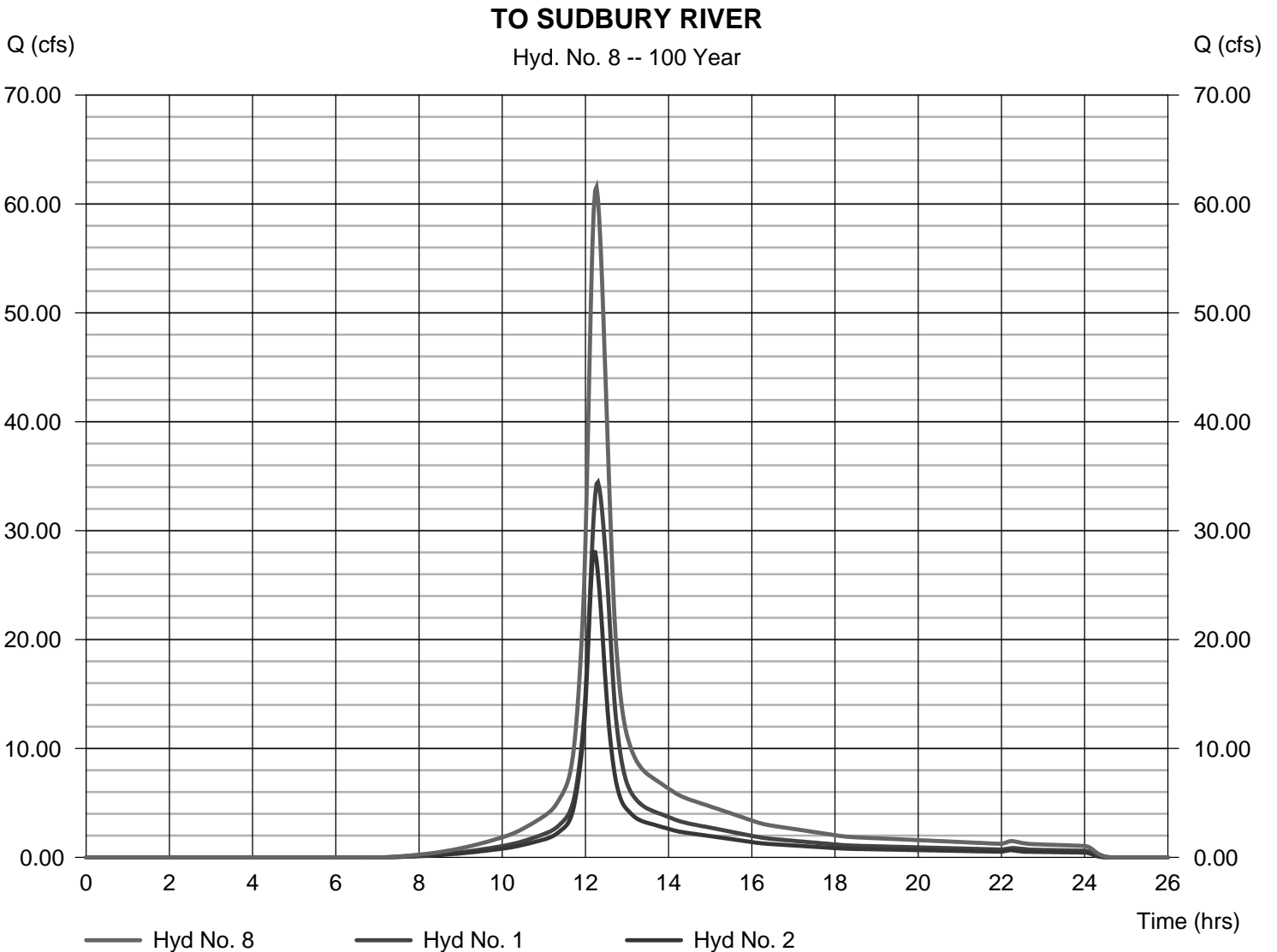
Wednesday, 09 / 23 / 2015

Hyd. No. 8

TO SUDBURY RIVER

Hydrograph type = Combine
Storm frequency = 100 yrs
Time interval = 2 min
Inflow hyds. = 1, 2

Peak discharge = 61.55 cfs
Time to peak = 12.27 hrs
Hyd. volume = 294,029 cuft
Contrib. drain. area = 19.951 ac



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

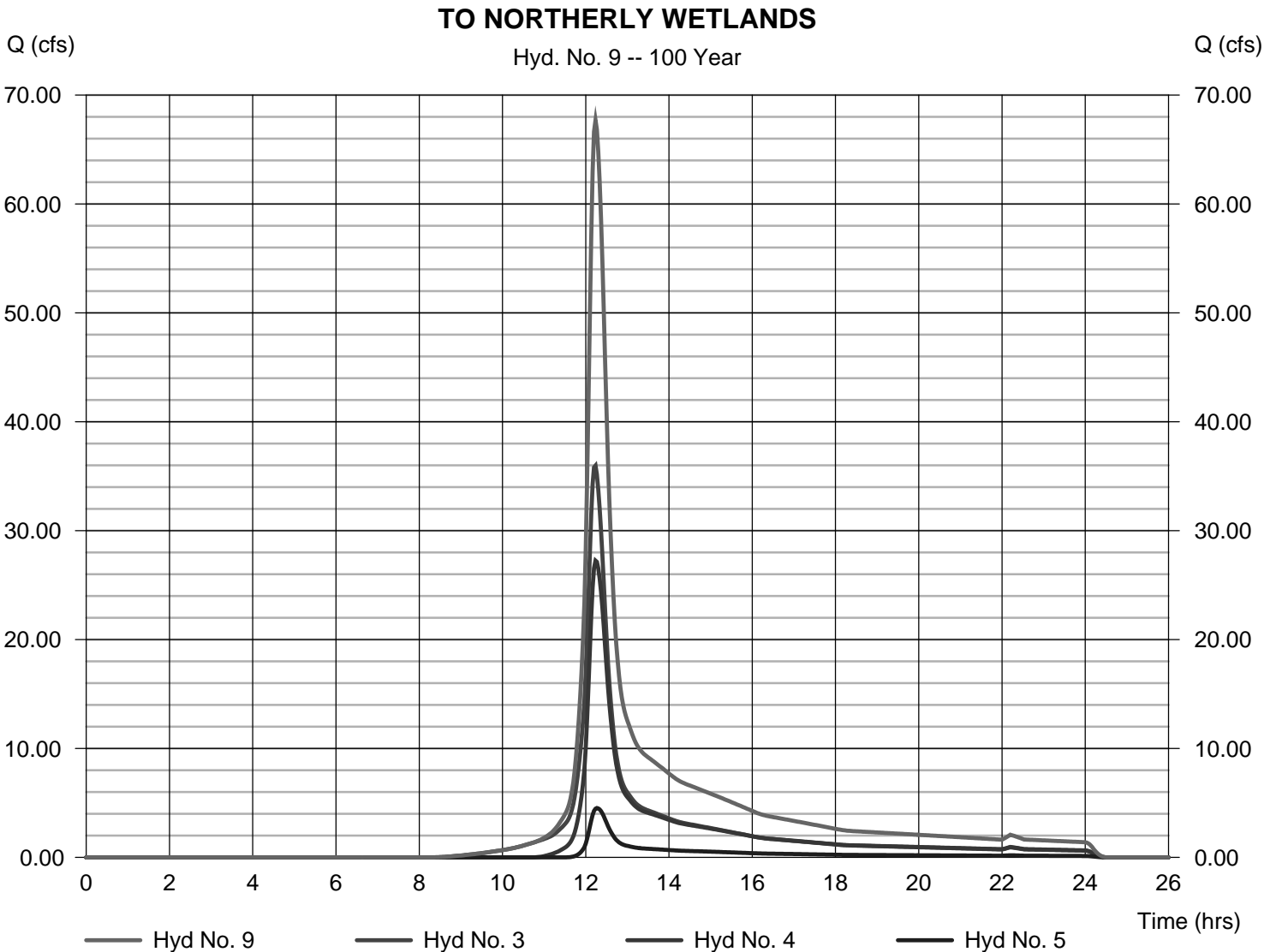
Wednesday, 09 / 23 / 2015

Hyd. No. 9

TO NORTHERLY WETLANDS

Hydrograph type = Combine
Storm frequency = 100 yrs
Time interval = 2 min
Inflow hyds. = 3, 4, 5

Peak discharge = 67.68 cfs
Time to peak = 12.23 hrs
Hyd. volume = 309,987 cuft
Contrib. drain. area = 33.237 ac

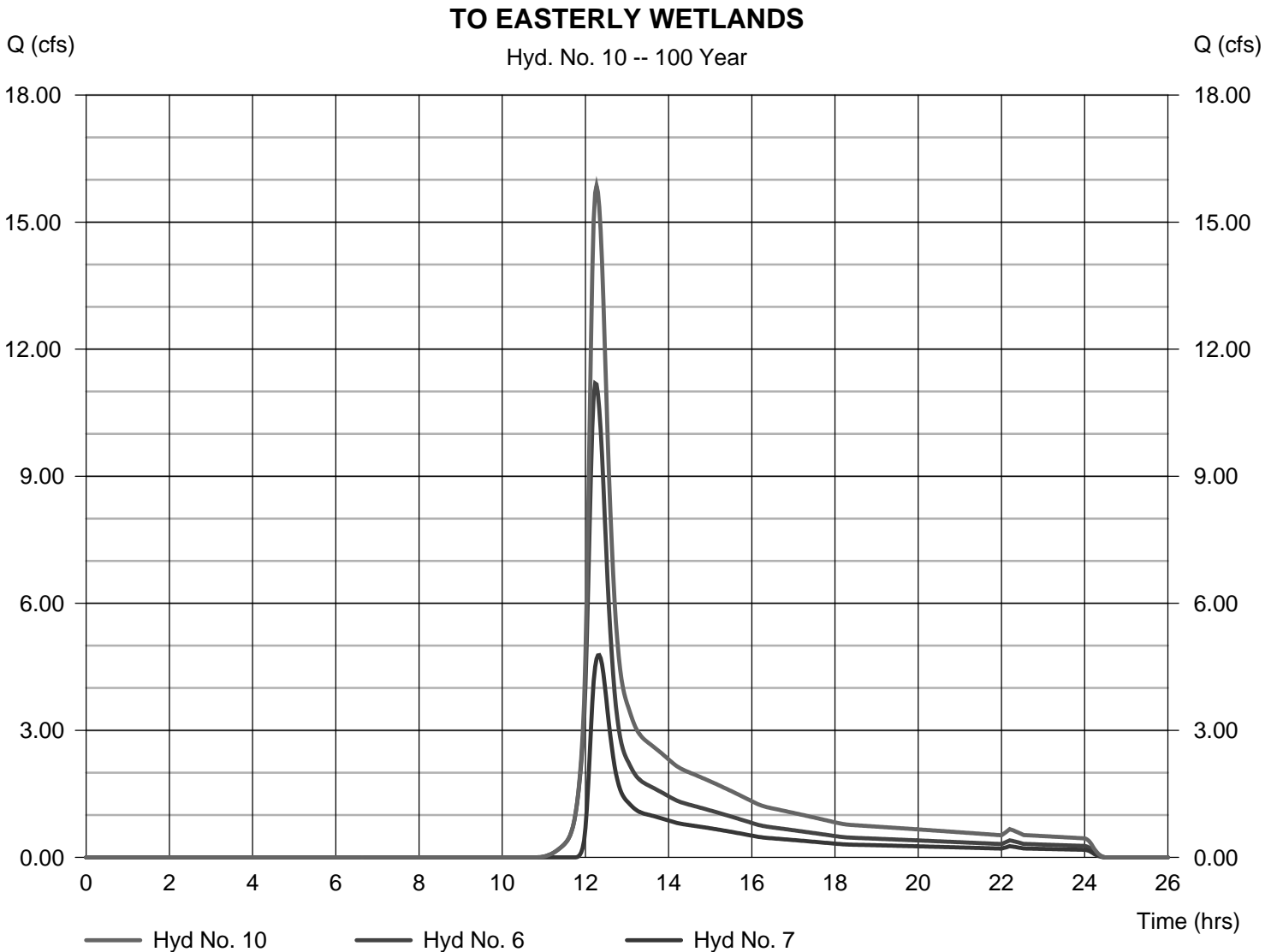


Hydrograph Report

Hyd. No. 10

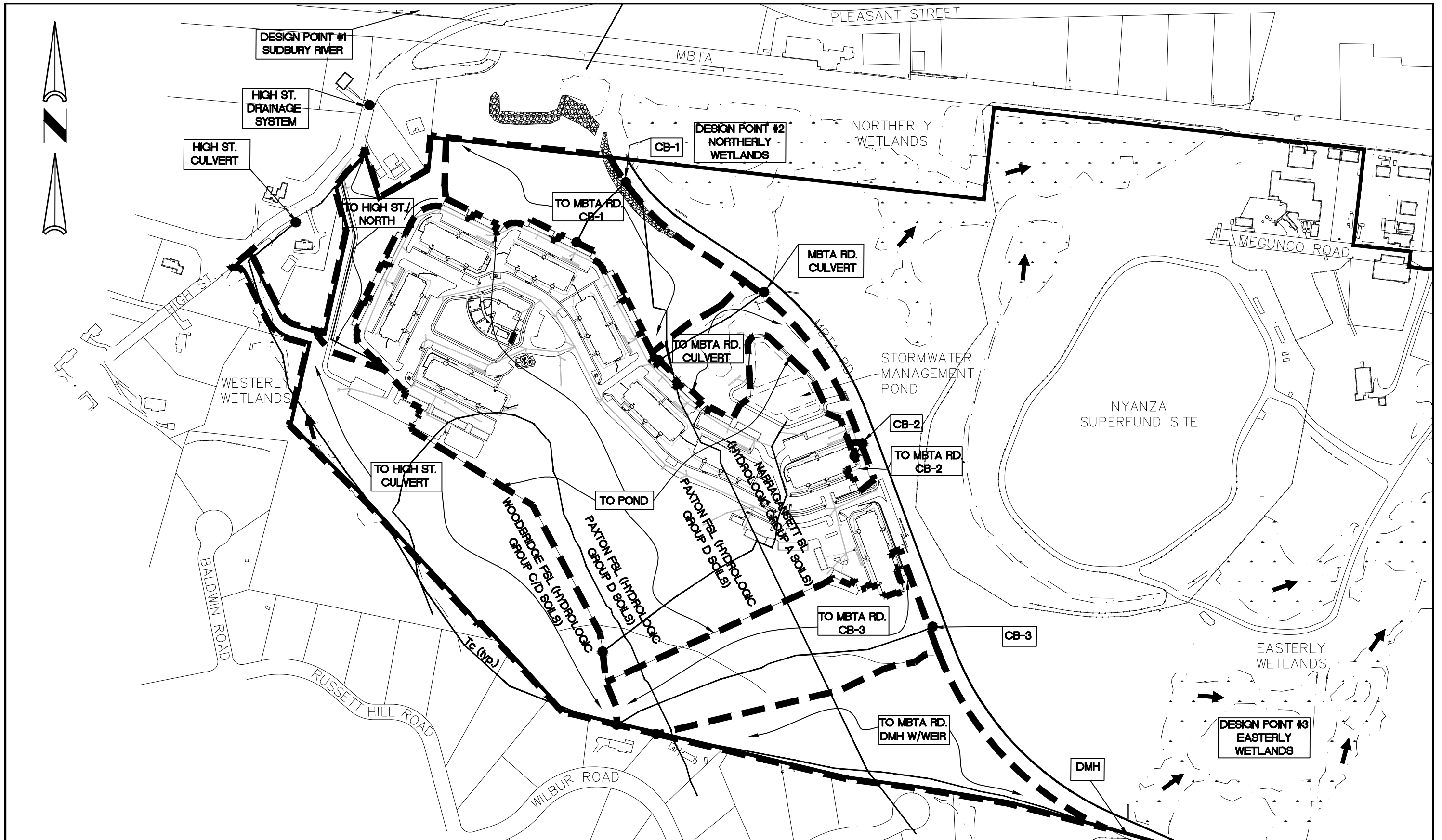
TO EASTERLY WETLANDS

Hydrograph type	= Combine	Peak discharge	= 15.86 cfs
Storm frequency	= 100 yrs	Time to peak	= 12.27 hrs
Time interval	= 2 min	Hyd. volume	= 80,542 cuft
Inflow hyds.	= 6, 7	Contrib. drain. area	= 13.707 ac



KELLY ENGINEERING GROUP, INC.
Zero Campanelli Drive-Braintree-MA 02184 Phone 781 843 4333

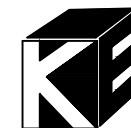
Attachment B
Proposed Conditions



**ASHLAND RAIL
TRANSIT APARTMENTS
ASHLAND, MA**

SCALE: 1" = 300'
DATE: 09/28/15
2015-042-PRDR00

**PROPOSED
DRAINAGE
EXHIBIT**



KELLY ENGINEERING GROUP, INC.
CIVIL ENGINEERING CONSULTANTS
0 CAMPANELLI DRIVE · BRAINTREE MA · 02184
PHONE: 781 843 4333 FAX: 781 843 0028

Runoff Curve Number and Runoff

Name: Campanelli Ashland By: bgl Date: 09/28/15
 Location : MBTA Road, Ashland MA
 Description: Proposed Conditions - To High St. Culvert

Circle One: Pre or Post

Runoff Curve Number (CN):

Surface Description	Soil Name; hydrologic group; hydrologic condition	CN	s.f.	Product of CN x Area
Woods	Hydrologic Group A; Good Condition	30	0	0
Woods	Hydrologic Group D; Good Condition	77	431352	3.3E+07
Grass	Hydrologic Group A; Good Condition	39	0	0
Grass	Hydrologic Group D; Good Condition	80	23971	1917680
Roof		98	0	0
Paved		98	18253	1788794
Totals =			473576.00	3.7E+07
Acres =			10.871809	

CN or C (weighted) = total product/total area = **78.0**

Reference: *Urban Hydrology for Small Watersheds*
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Number and Runoff

Name: Campanelli Ashland **By:** bgl **Date:** 09/28/15
Location : MBTA Road, Ashland MA
Description: Proposed Conditions - To High St. Drainage System

Circle One: Pre or Post

Runoff Curve Number (CN):

Surface Description	Soil Name; hydrologic group; hydrologic condition	CN	s.f.	Product of CN x Area
Woods	Hydrologic Group A; Good Condition	30	0	0
Woods	Hydrologic Group D; Good Condition	77	56257	4331789
Grass	Hydrologic Group A; Good Condition	39	0	0
Grass	Hydrologic Group D; Good Condition	80	49116	3929280
Roof		98	0	0
Paved		98	8590	841820
Totals =			113963.00	9102889
Acres =			2.61623049	

CN or C (weighted) = total product/total area = **79.9**

Reference: *Urban Hydrology for Small Watersheds
 Technical Release 55, Soil Conservation Service
 U.S. Department of Agriculture, June 1986*

Runoff Curve Number and Runoff

Name: Campanelli Ashland **By:** bgl **Date:** 09/28/15
Location : MBTA Road, Ashland MA
Description: Proposed Conditions - To MBTA Rd. CB-1

Circle One: Pre or Post

Runoff Curve Number (CN):

Surface Description	Soil Name; hydrologic group; hydrologic condition	CN	s.f.	Product of CN x Area
Woods	Hydrologic Group A; Good Condition	30	64282	1928460
Woods	Hydrologic Group D; Good Condition	77	119413	9194801
Grass	Hydrologic Group A; Good Condition	39	0	0
Grass	Hydrologic Group D; Good Condition	80	80122	6409760
Roof		98	0	0
Paved		98	0	0
Totals =			263817.00	1.8E+07
Acres =			6.05640496	

CN or C (weighted) = total product/total area = **66.5**

Reference: *Urban Hydrology for Small Watersheds
 Technical Release 55, Soil Conservation Service
 U.S. Department of Agriculture, June 1986*

Runoff Curve Number and Runoff

Name: Campanelli Ashland **By:** bgl **Date:** 09/28/15
Location : MBTA Road, Ashland MA
Description: Proposed Conditions - To MBTA Rd. Culvert

Circle One: Pre or Post

Runoff Curve Number (CN):

Surface Description	Soil Name; hydrologic group; hydrologic condition	CN	s.f.	Product of CN x Area
Woods	Hydrologic Group A; Good Condition	30	78082	2342460
Woods	Hydrologic Group D; Good Condition	77	1651	127127
Grass	Hydrologic Group A; Good Condition	39	39847	1554033
Grass	Hydrologic Group D; Good Condition	80	1805	144400
Roof		98	0	0
Paved		98	0	0
Totals =			121385.00	4168020
Acres =			2.78661616	

CN or C (weighted) = total product/total area = **34.3**

Reference: *Urban Hydrology for Small Watersheds
 Technical Release 55, Soil Conservation Service
 U.S. Department of Agriculture, June 1986*

Runoff Curve Number and Runoff

Name: Campanelli Ashland By: bgl Date: 09/28/15
 Location : MBTA Road, Ashland MA
 Description: Proposed Conditions - To MBTA Rd. CB-2

Circle One: Pre or Post

Runoff Curve Number (CN):

Surface Description	Soil Name; hydrologic group; hydrologic condition	CN	s.f.	Product of CN x Area
Woods	Hydrologic Group A; Good Condition	30	0	0
Woods	Hydrologic Group D; Good Condition	77	0	0
Grass	Hydrologic Group A; Good Condition	39	7321	285519
Grass	Hydrologic Group D; Good Condition	80	0	0
Roof		98	0	0
Paved		98	0	0
Totals =			7321.00	285519
Acres =			0.16806703	

CN or C (weighted) = total product/total area = **39.0**

Reference: *Urban Hydrology for Small Watersheds
 Technical Release 55, Soil Conservation Service
 U.S. Department of Agriculture, June 1986*

Runoff Curve Number and Runoff

Name: Campanelli Ashland **By:** bgl **Date:** 09/28/15
Location : MBTA Road, Ashland MA
Description: Proposed Conditions - To MBTA Rd. CB-3

Circle One: Pre or **Post**

Runoff Curve Number (CN):

Surface Description	Soil Name; hydrologic group; hydrologic condition	CN	s.f.	Product of CN x Area
Woods	Hydrologic Group A; Good Condition	30	108960	3268800
Woods	Hydrologic Group D; Good Condition	77	173431	1.3E+07
Grass	Hydrologic Group A; Good Condition	39	9709	378651
Grass	Hydrologic Group D; Good Condition	80	0	0
Roof		98	0	0
Paved		98	0	0
Totals =			292100.00	1.7E+07
Acres =			6.7056933	

CN or C (weighted) = total product/total area = **58.2**

Reference: *Urban Hydrology for Small Watersheds
 Technical Release 55, Soil Conservation Service
 U.S. Department of Agriculture, June 1986*

Runoff Curve Number and Runoff

Name: Campanelli Ashland By: bgl Date: 09/28/15
 Location : MBTA Road, Ashland MA
 Description: Proposed Conditions - To MBTA Rd. DMH

Circle One: Pre or Post

Runoff Curve Number (CN):

Surface Description	Soil Name; hydrologic group; hydrologic condition	CN	s.f.	Product of CN x Area
Woods	Hydrologic Group A; Good Condition	30	188792	5663760
Woods	Hydrologic Group D; Good Condition	77	95535	7356195
Grass	Hydrologic Group A; Good Condition	39	0	0
Grass	Hydrologic Group D; Good Condition	80	0	0
Roof		98	0	0
Paved		98	0	0
Totals =			284327.00	1.3E+07
Acres =			6.52724977	

CN or C (weighted) = total product/total area = **45.8**

Reference: *Urban Hydrology for Small Watersheds*
Technical Release 55, Soil Conservation Service
U.S. Department of Agriculture, June 1986

Runoff Curve Number and Runoff

Name: Campanelli Ashland **By:** bgl **Date:** 09/28/15
Location : MBTA Road, Ashland MA
Description: Proposed Conditions - To Pond

Circle One: Pre or Post

Runoff Curve Number (CN):

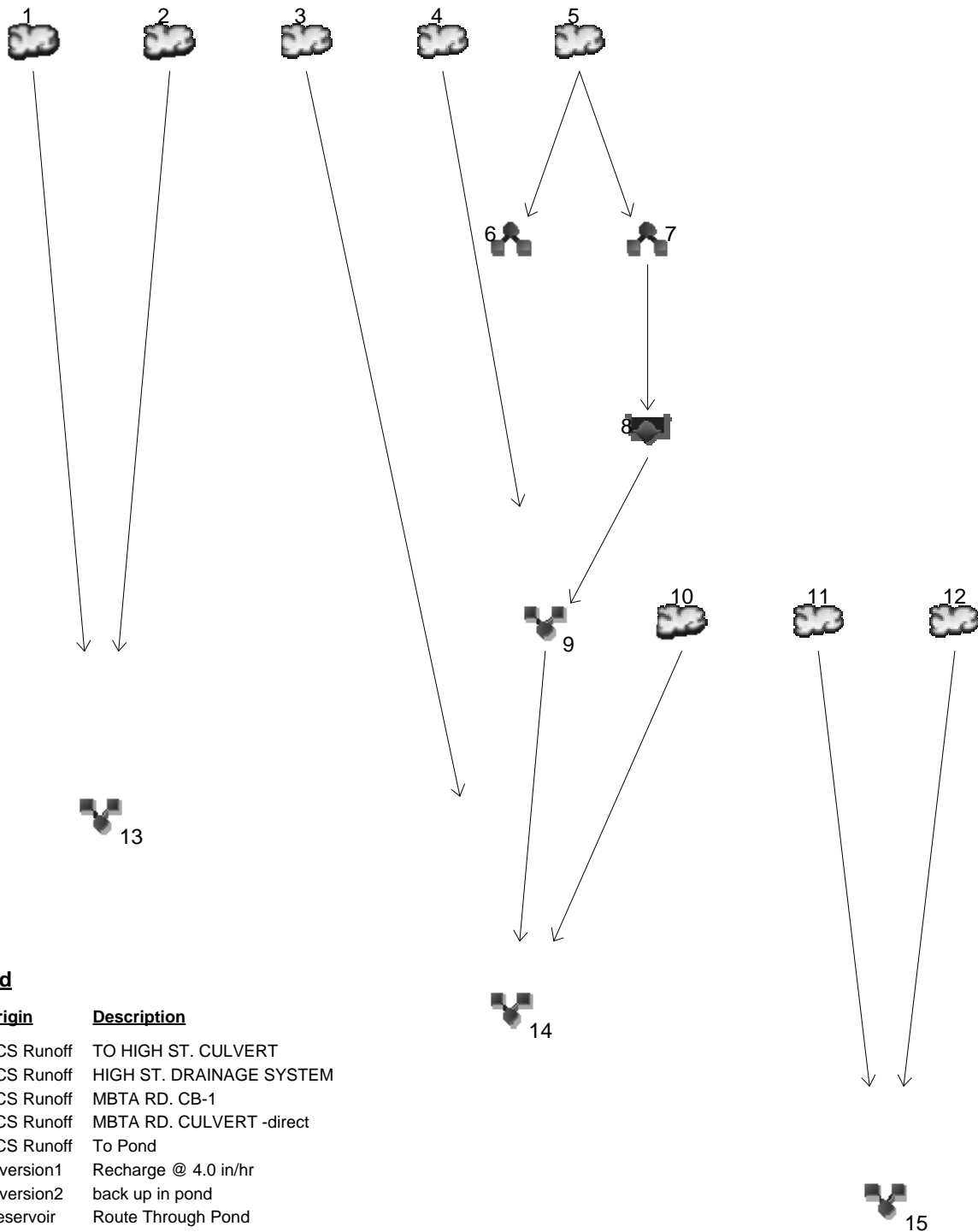
Surface Description	Soil Name; hydrologic group; hydrologic condition	CN	s.f.	Product of CN x Area
Woods	Hydrologic Group A; Good Condition	30	11652	349560
Woods	Hydrologic Group D; Good Condition	77	373465	2.9E+07
Grass	Hydrologic Group A; Good Condition	39	139645	5446155
Grass	Hydrologic Group D; Good Condition	80	323439	2.6E+07
Roof		98	194558	1.9E+07
Paved		98	322584	3.2E+07
Totals =			1365343.00	1.1E+08
Acres =			31.3439624	

CN or C (weighted) = total product/total area = **81.4**

Reference: *Urban Hydrology for Small Watersheds
 Technical Release 55, Soil Conservation Service
 U.S. Department of Agriculture, June 1986*

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10



Legend

Hyd. Origin	Description
1	SCS Runoff TO HIGH ST. CULVERT
2	SCS Runoff HIGH ST. DRAINAGE SYSTEM
3	SCS Runoff MBTA RD. CB-1
4	SCS Runoff MBTA RD. CULVERT -direct
5	SCS Runoff To Pond
6	Diversion1 Recharge @ 4.0 in/hr
7	Diversion2 back up in pond
8	Reservoir Route Through Pond
9	Combine Total to MBTA Culvert
10	SCS Runoff MBTA RD. CB-2
11	SCS Runoff MBTA RD. CB-3
12	SCS Runoff MBTA RD. DMH
13	Combine TO SUDBURY RIVER
14	Combine TO NORTHERLY WETLANDS
15	Combine TO EASTERLY WETLANDS

Project: Post-Proposed Conditions.gpw

Sunday, 09 / 27 / 2015

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)								Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	SCS Runoff	-----	-----	9.204	-----	-----	18.05	23.42	27.53	31.68	TO HIGH ST. CULVERT
2	SCS Runoff	-----	-----	3.609	-----	-----	6.822	8.745	10.21	11.68	HIGH ST. DRAINAGE SYSTEM
3	SCS Runoff	-----	-----	2.624	-----	-----	7.111	10.09	12.45	14.89	MBTA RD. CB-1
4	SCS Runoff	-----	-----	0.000	-----	-----	0.012	0.039	0.079	0.242	MBTA RD. CULVERT -direct
5	SCS Runoff	-----	-----	36.26	-----	-----	66.50	84.53	98.27	112.09	To Pond
6	Diversion1	5	-----	1.050	-----	-----	1.050	1.050	1.050	1.050	Recharge @ 4.0 in/hr
7	Diversion2	5	-----	35.21	-----	-----	65.45	83.48	97.22	111.04	back up in pond
8	Reservoir	7	-----	4.727	-----	-----	21.04	34.84	45.76	57.14	Route Through Pond
9	Combine	4, 8	-----	4.727	-----	-----	21.04	34.84	45.83	57.37	Total to MBTA Culvert
10	SCS Runoff	-----	-----	0.000	-----	-----	0.002	0.011	0.024	0.044	MBTA RD. CB-2
11	SCS Runoff	-----	-----	0.956	-----	-----	4.156	6.644	8.688	10.90	MBTA RD. CB-3
12	SCS Runoff	-----	-----	0.035	-----	-----	0.742	1.833	2.956	4.292	MBTA RD. DMH
13	Combine	1, 2,	-----	11.13	-----	-----	21.65	28.01	32.89	37.84	TO SUDBURY RIVER
14	Combine	3, 9, 10,	-----	5.310	-----	-----	23.49	39.08	51.49	64.52	TO NORTHERLY WETLANDS
15	Combine	11, 12,	-----	0.956	-----	-----	4.632	8.186	11.41	15.02	TO EASTERLY WETLANDS

Proj. file: Post-Proposed Conditions.gpw

Sunday, 09 / 27 / 2015

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description	
1	SCS Runoff	9.204	2	738	46,632	-----	-----	-----	TO HIGH ST. CULVERT	
2	SCS Runoff	3.609	2	726	12,526	-----	-----	-----	HIGH ST. DRAINAGE SYSTEM	
3	SCS Runoff	2.624	2	734	13,162	-----	-----	-----	MBTA RD. CB-1	
4	SCS Runoff	0.000	2	n/a	0	-----	-----	-----	MBTA RD. CULVERT -direct	
5	SCS Runoff	36.26	2	734	161,276	-----	-----	-----	To Pond	
6	Diversion1	1.050	2	710	49,761	5	-----	-----	Recharge @ 4.0 in/hr	
7	Diversion2	35.21	2	734	111,515	5	-----	-----	back up in pond	
8	Reservoir	4.727	2	786	75,861	7	271.36	71,433	Route Through Pond	
9	Combine	4.727	2	786	75,861	4, 8	-----	-----	Total to MBTA Culvert	
10	SCS Runoff	0.000	2	n/a	0	-----	-----	-----	MBTA RD. CB-2	
11	SCS Runoff	0.956	2	746	7,616	-----	-----	-----	MBTA RD. CB-3	
12	SCS Runoff	0.035	2	930	1,013	-----	-----	-----	MBTA RD. DMH	
13	Combine	11.13	2	736	59,158	1, 2,	-----	-----	TO SUDBURY RIVER	
14	Combine	5.310	2	778	89,023	3, 9, 10,	-----	-----	TO NORTHERLY WETLANDS	
15	Combine	0.956	2	746	8,629	11, 12,	-----	-----	TO EASTERLY WETLANDS	
Post-Proposed Conditions.gpw					Return Period: 2 Year			Sunday, 09 / 27 / 2015		

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	18.05	2	738	89,057	-----	-----	-----	TO HIGH ST. CULVERT
2	SCS Runoff	6.822	2	726	23,294	-----	-----	-----	HIGH ST. DRAINAGE SYSTEM
3	SCS Runoff	7.111	2	732	30,649	-----	-----	-----	MBTA RD. CB-1
4	SCS Runoff	0.012	2	1326	228	-----	-----	-----	MBTA RD. CULVERT -direct
5	SCS Runoff	66.50	2	734	293,891	-----	-----	-----	To Pond
6	Diversion1	1.050	2	732	58,441	5	-----	-----	Recharge @ 4.0 in/hr
7	Diversion2	65.45	2	734	235,451	5	-----	-----	back up in pond
8	Reservoir	21.04	2	758	199,779	7	272.48	120,493	Route Through Pond
9	Combine	21.04	2	758	200,007	4, 8	-----	-----	Total to MBTA Culvert
10	SCS Runoff	0.002	2	888	66	-----	-----	-----	MBTA RD. CB-2
11	SCS Runoff	4.156	2	738	22,299	-----	-----	-----	MBTA RD. CB-3
12	SCS Runoff	0.742	2	750	7,715	-----	-----	-----	MBTA RD. DMH
13	Combine	21.65	2	736	112,351	1, 2,	-----	-----	TO SUDBURY RIVER
14	Combine	23.49	2	756	230,722	3, 9, 10,	-----	-----	TO NORTHERLY WETLANDS
15	Combine	4.632	2	740	30,013	11, 12,	-----	-----	TO EASTERLY WETLANDS
Post-Proposed Conditions.gpw					Return Period: 10 Year			Sunday, 09 / 27 / 2015	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	23.42	2	738	115,288	-----	-----	-----	TO HIGH ST. CULVERT
2	SCS Runoff	8.745	2	726	29,881	-----	-----	-----	HIGH ST. DRAINAGE SYSTEM
3	SCS Runoff	10.09	2	732	42,328	-----	-----	-----	MBTA RD. CB-1
4	SCS Runoff	0.039	2	898	1,059	-----	-----	-----	MBTA RD. CULVERT -direct
5	SCS Runoff	84.53	2	732	374,376	-----	-----	-----	To Pond
6	Diversion1	1.050	2	726	60,972	5	-----	-----	Recharge @ 4.0 in/hr
7	Diversion2	83.48	2	732	313,404	5	-----	-----	back up in pond
8	Reservoir	34.84	2	754	277,725	7	273.04	145,174	Route Through Pond
9	Combine	34.84	2	754	278,784	4, 8	-----	-----	Total to MBTA Culvert
10	SCS Runoff	0.011	2	752	157	-----	-----	-----	MBTA RD. CB-2
11	SCS Runoff	6.644	2	736	32,897	-----	-----	-----	MBTA RD. CB-3
12	SCS Runoff	1.833	2	744	13,797	-----	-----	-----	MBTA RD. DMH
13	Combine	28.01	2	736	145,169	1, 2,	-----	-----	TO SUDBURY RIVER
14	Combine	39.08	2	752	321,269	3, 9, 10,	-----	-----	TO NORTHERLY WETLANDS
15	Combine	8.186	2	738	46,694	11, 12,	-----	-----	TO EASTERLY WETLANDS
Post-Proposed Conditions.gpw					Return Period: 25 Year			Sunday, 09 / 27 / 2015	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	27.53	2	738	135,585	-----	-----	-----	TO HIGH ST. CULVERT
2	SCS Runoff	10.21	2	726	34,955	-----	-----	-----	HIGH ST. DRAINAGE SYSTEM
3	SCS Runoff	12.45	2	732	51,666	-----	-----	-----	MBTA RD. CB-1
4	SCS Runoff	0.079	2	820	2,041	-----	-----	-----	MBTA RD. CULVERT -direct
5	SCS Runoff	98.27	2	732	436,170	-----	-----	-----	To Pond
6	Diversion1	1.050	2	724	62,681	5	-----	-----	Recharge @ 4.0 in/hr
7	Diversion2	97.22	2	732	373,489	5	-----	-----	back up in pond
8	Reservoir	45.76	2	752	337,807	7	273.45	163,075	Route Through Pond
9	Combine	45.83	2	752	339,848	4, 8	-----	-----	Total to MBTA Culvert
10	SCS Runoff	0.024	2	748	248	-----	-----	-----	MBTA RD. CB-2
11	SCS Runoff	8.688	2	736	41,646	-----	-----	-----	MBTA RD. CB-3
12	SCS Runoff	2.956	2	742	19,247	-----	-----	-----	MBTA RD. DMH
13	Combine	32.89	2	734	170,541	1, 2,	-----	-----	TO SUDBURY RIVER
14	Combine	51.49	2	750	391,762	3, 9, 10,	-----	-----	TO NORTHERLY WETLANDS
15	Combine	11.41	2	736	60,892	11, 12,	-----	-----	TO EASTERLY WETLANDS
Post-Proposed Conditions.gpw					Return Period: 50 Year			Sunday, 09 / 27 / 2015	

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

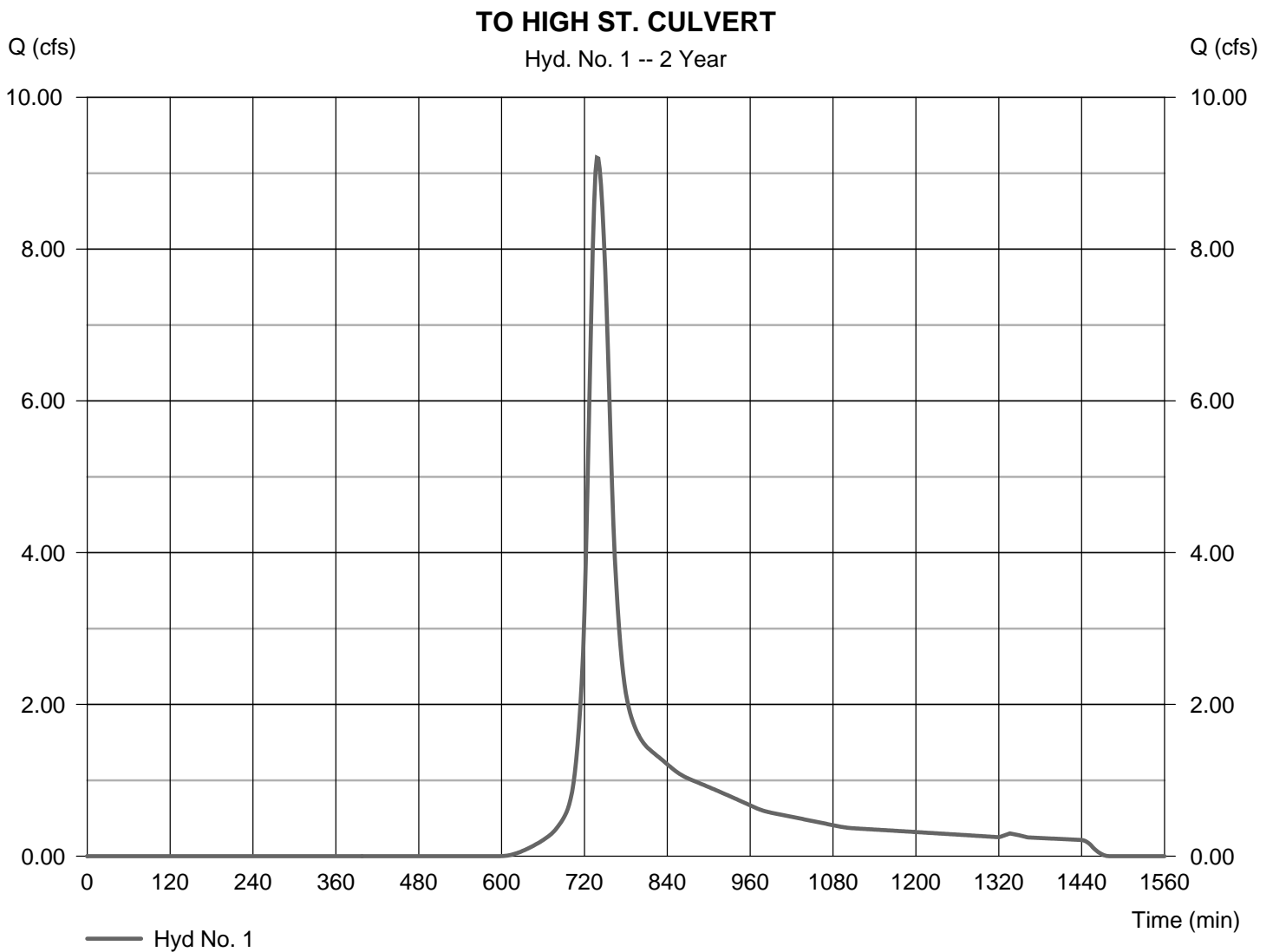
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	SCS Runoff	31.68	2	738	156,294	-----	-----	-----	TO HIGH ST. CULVERT
2	SCS Runoff	11.68	2	726	40,118	-----	-----	-----	HIGH ST. DRAINAGE SYSTEM
3	SCS Runoff	14.89	2	732	61,405	-----	-----	-----	MBTA RD. CB-1
4	SCS Runoff	0.242	2	746	3,302	-----	-----	-----	MBTA RD. CULVERT -direct
5	SCS Runoff	112.09	2	732	498,897	-----	-----	-----	To Pond
6	Diversion1	1.050	2	722	64,295	5	-----	-----	Recharge @ 4.0 in/hr
7	Diversion2	111.04	2	732	434,602	5	-----	-----	back up in pond
8	Reservoir	57.14	2	750	398,917	7	273.84	180,057	Route Through Pond
9	Combine	57.37	2	750	402,219	4, 8	-----	-----	Total to MBTA Culvert
10	SCS Runoff	0.044	2	744	355	-----	-----	-----	MBTA RD. CB-2
11	SCS Runoff	10.90	2	734	50,968	-----	-----	-----	MBTA RD. CB-3
12	SCS Runoff	4.292	2	740	25,348	-----	-----	-----	MBTA RD. DMH
13	Combine	37.84	2	734	196,412	1, 2,	-----	-----	TO SUDBURY RIVER
14	Combine	64.52	2	748	463,979	3, 9, 10,	-----	-----	TO NORTHERLY WETLANDS
15	Combine	15.02	2	736	76,317	11, 12,	-----	-----	TO EASTERLY WETLANDS
Post-Proposed Conditions.gpw					Return Period: 100 Year			Sunday, 09 / 27 / 2015	

Hydrograph Report

Hyd. No. 1

TO HIGH ST. CULVERT

Hydrograph type	= SCS Runoff	Peak discharge	= 9.204 cfs
Storm frequency	= 2 yrs	Time to peak	= 738 min
Time interval	= 2 min	Hyd. volume	= 46,632 cuft
Drainage area	= 10.870 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 24.69 min
Total precip.	= 3.10 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 1

TO HIGH ST. CULVERT

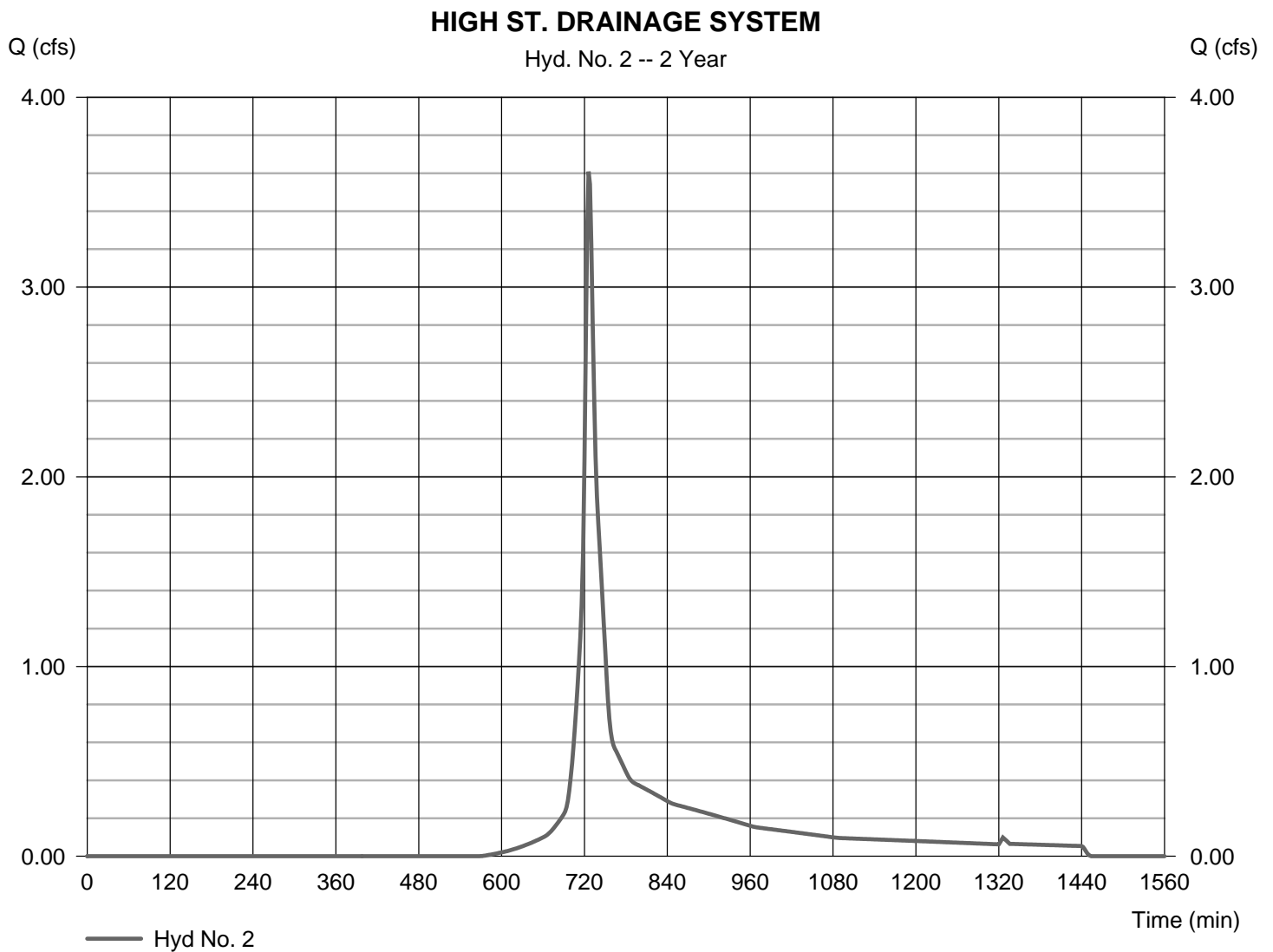
<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.600	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.10	0.00	0.00	
Land slope (%)	= 3.00	0.00	0.00	
Travel Time (min)	= 14.74	+ 0.00	+ 0.00	= 14.74
Shallow Concentrated Flow				
Flow length (ft)	= 520.00	1650.00	0.00	
Watercourse slope (%)	= 4.00	5.50	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=3.23	3.78	0.00	
Travel Time (min)	= 2.69	+ 7.27	+ 0.00	= 9.95
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	({0})0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				24.69 min

Hydrograph Report

Hyd. No. 2

HIGH ST. DRAINAGE SYSTEM

Hydrograph type	= SCS Runoff	Peak discharge	= 3.609 cfs
Storm frequency	= 2 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 12,526 cuft
Drainage area	= 2.616 ac	Curve number	= 79.9
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 6.90 min
Total precip.	= 3.10 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 2

HIGH ST. DRAINAGE SYSTEM

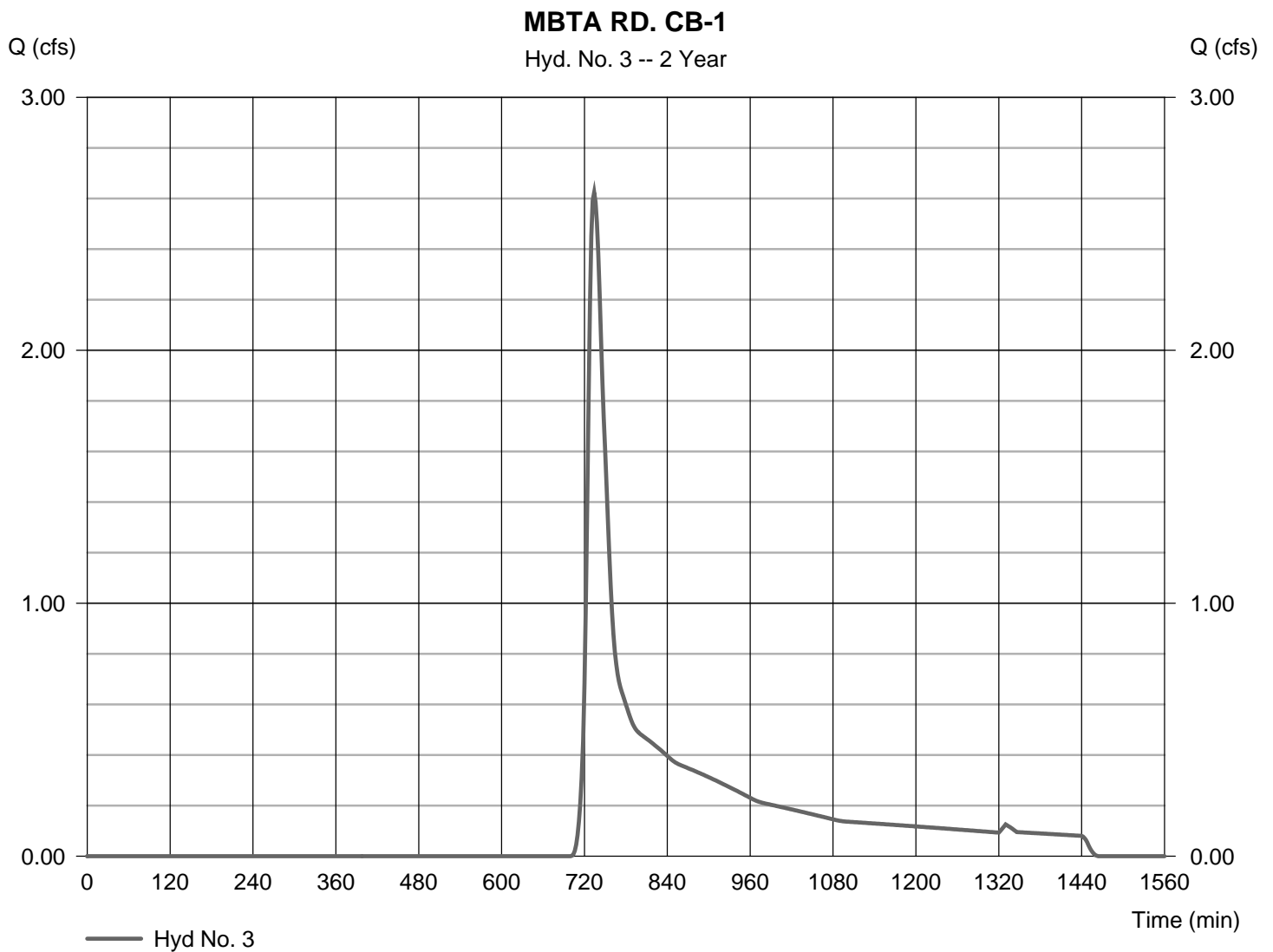
<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.150	0.150	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.10	0.00	0.00	
Land slope (%)	= 3.00	0.00	0.00	
Travel Time (min)	= 4.86	+	0.00	+
			0.00	= 4.86
Shallow Concentrated Flow				
Flow length (ft)	= 117.00	545.00	0.00	
Watercourse slope (%)	= 13.60	10.60	0.00	
Surface description	= Unpaved	Unpaved	Unpaved	
Average velocity (ft/s)	=5.95	5.25	0.00	
Travel Time (min)	= 0.33	+	1.73	+
			0.00	= 2.06
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00			
		0.00		
			0.00	
Flow length (ft)	({0})0.0	0.0	0.0	
Travel Time (min)	= 0.00	+	0.00	+
			0.00	= 0.00
Total Travel Time, Tc				6.90 min

Hydrograph Report

Hyd. No. 3

MBTA RD. CB-1

Hydrograph type	= SCS Runoff	Peak discharge	= 2.624 cfs
Storm frequency	= 2 yrs	Time to peak	= 734 min
Time interval	= 2 min	Hyd. volume	= 13,162 cuft
Drainage area	= 6.056 ac	Curve number	= 66.5
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.60 min
Total precip.	= 3.10 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 3

MBTA RD. CB-1

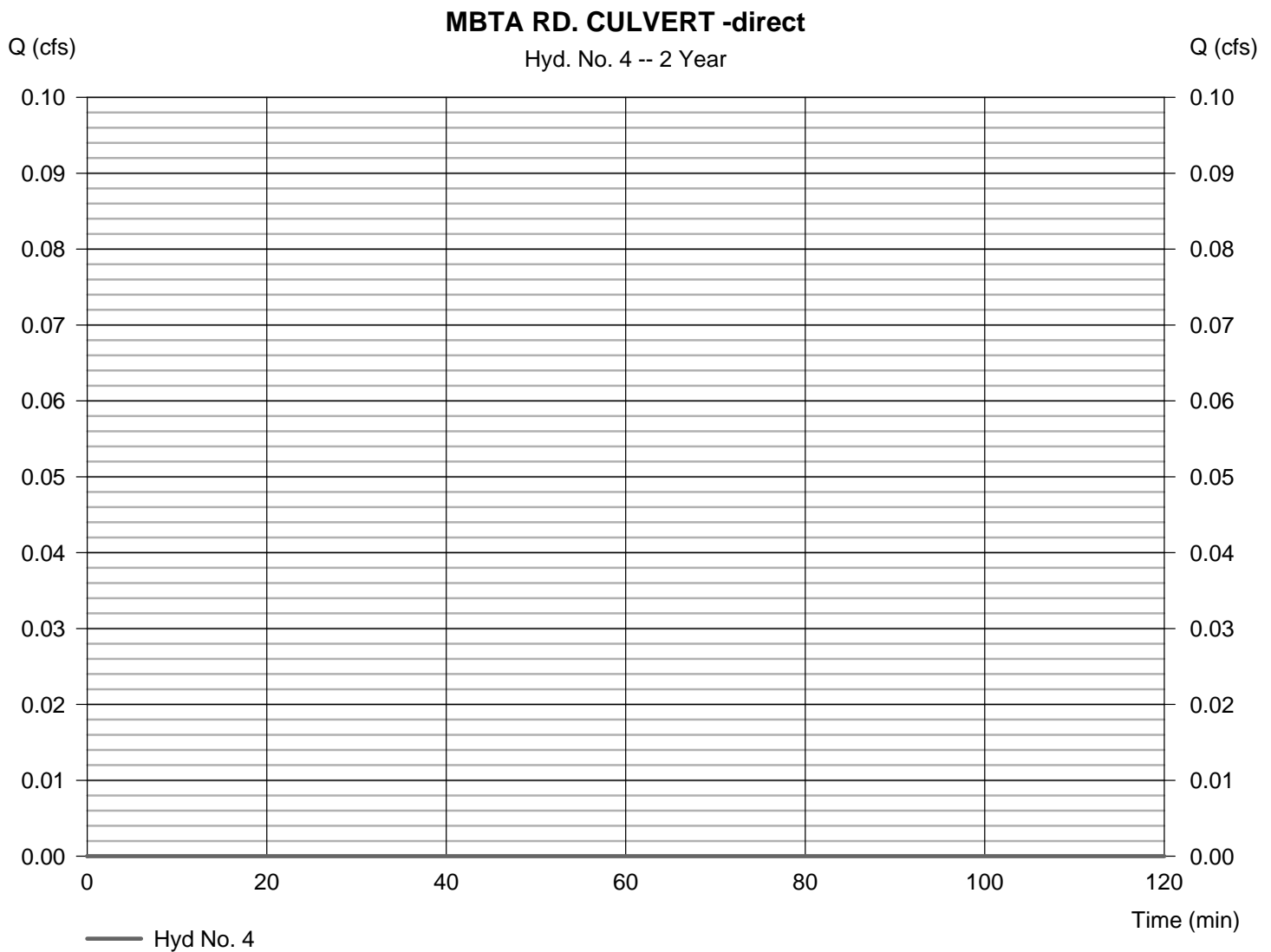
<u>Description</u>	<u>A</u>		<u>B</u>		<u>C</u>		<u>Totals</u>
Sheet Flow							
Manning's n-value	= 0.150		0.150		0.600		
Flow length (ft)	= 10.0		72.0		41.0		
Two-year 24-hr precip. (in)	= 3.10		3.10		3.10		
Land slope (%)	= 2.00		50.00		17.00		
Travel Time (min)	= 1.58	+	2.11	+	6.28	=	9.97
Shallow Concentrated Flow							
Flow length (ft)	= 2133.00		0.00		0.00		
Watercourse slope (%)	= 37.00		0.00		0.00		
Surface description	= Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=9.81		0.00		0.00		
Travel Time (min)	= 3.62	+	0.00	+	0.00	=	3.62
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00		0.00		0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00
Total Travel Time, Tc							13.60 min

Hydrograph Report

Hyd. No. 4

MBTA RD. CULVERT -direct

Hydrograph type	= SCS Runoff	Peak discharge	= 0.000 cfs
Storm frequency	= 2 yrs	Time to peak	= n/a
Time interval	= 2 min	Hyd. volume	= 0 cuft
Drainage area	= 2.787 ac	Curve number	= 34.3
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.36 min
Total precip.	= 3.10 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 4

MBTA RD. CULVERT -direct

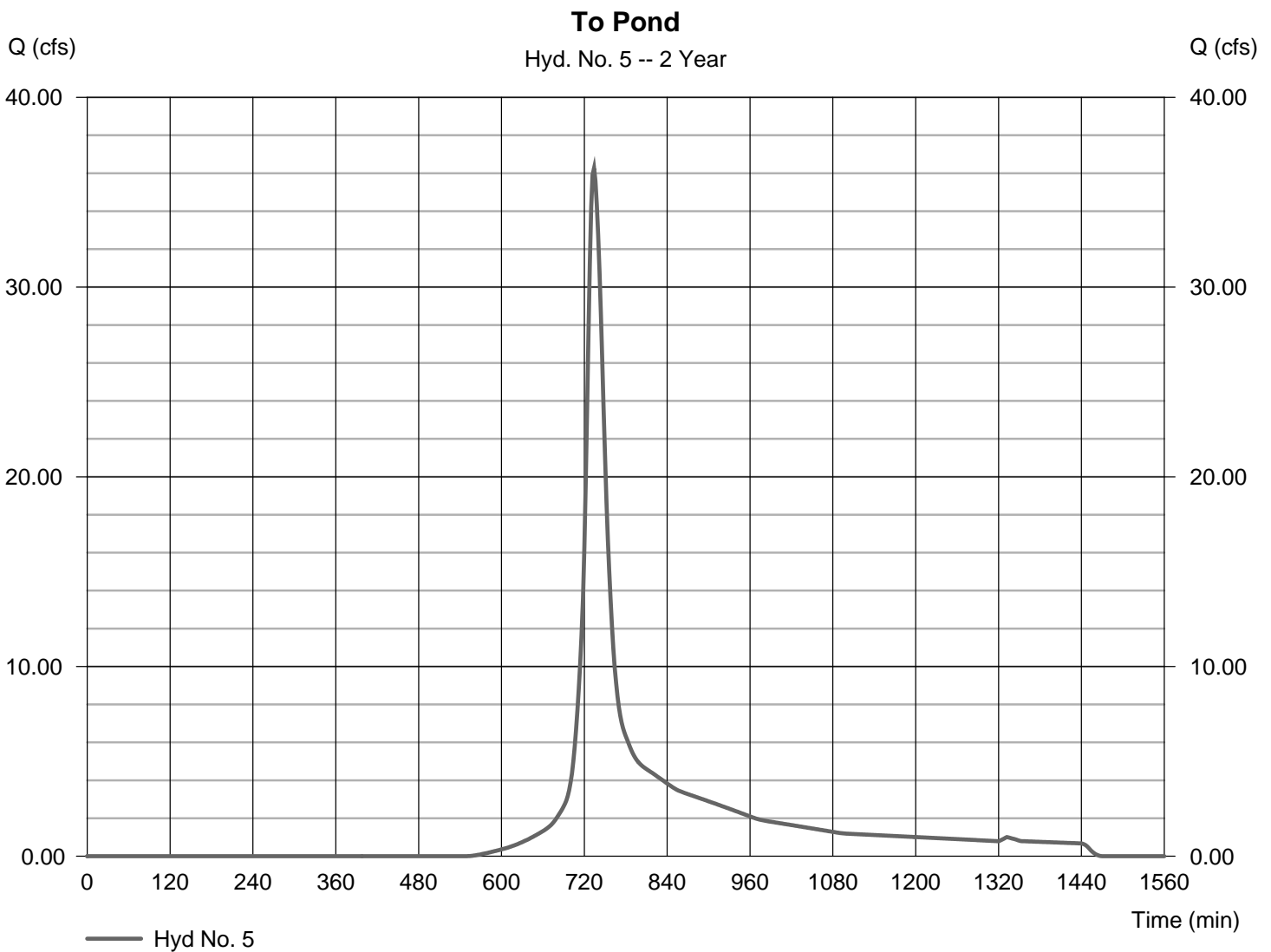
<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.600	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.10	0.00	0.00	
Land slope (%)	= 26.00	0.00	0.00	
Travel Time (min)	= 6.21	+ 0.00	+ 0.00	= 6.21
Shallow Concentrated Flow				
Flow length (ft)	= 88.00	279.00	0.00	
Watercourse slope (%)	= 33.00	5.30	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=9.27	4.68	0.00	
Travel Time (min)	= 0.16	+ 0.99	+ 0.00	= 1.15
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	({0})0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				7.36 min

Hydrograph Report

Hyd. No. 5

To Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 36.26 cfs
Storm frequency	= 2 yrs	Time to peak	= 734 min
Time interval	= 2 min	Hyd. volume	= 161,276 cuft
Drainage area	= 31.343 ac	Curve number	= 81.4
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 19.52 min
Total precip.	= 3.10 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 5

To Pond

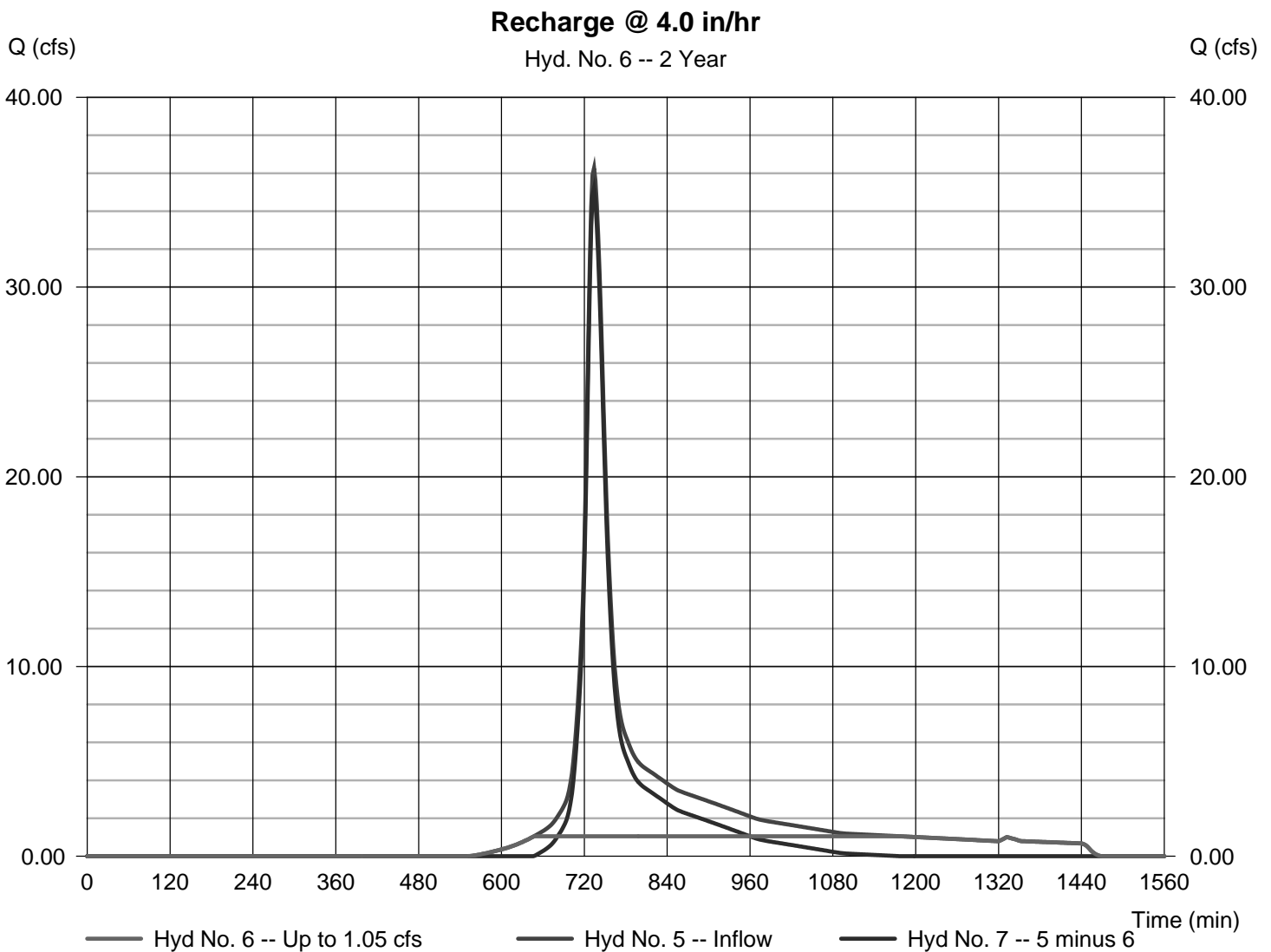
<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.600	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.10	0.00	0.00	
Land slope (%)	= 2.00	0.00	0.00	
Travel Time (min)	= 17.33	+ 0.00	+ 0.00	= 17.33
Shallow Concentrated Flow				
Flow length (ft)	= 251.00	235.00	140.00	
Watercourse slope (%)	= 7.00	17.00	25.00	
Surface description	= Unpaved	Unpaved	Unpaved	
Average velocity (ft/s)	=4.27	6.65	8.07	
Travel Time (min)	= 0.98	+ 0.59	+ 0.29	= 1.86
Channel Flow				
X sectional flow area (sqft)	= 3.14	0.00	0.00	
Wetted perimeter (ft)	= 3.00	0.00	0.00	
Channel slope (%)	= 2.50	0.00	0.00	
Manning's n-value	= 0.011	0.015	0.015	
Velocity (ft/s)	=22.08	0.00	0.00	
Flow length (ft)	(({0})442.0	0.0	0.0	
Travel Time (min)	= 0.33	+ 0.00	+ 0.00	= 0.33
Total Travel Time, Tc				19.52 min

Hydrograph Report

Hyd. No. 6

Recharge @ 4.0 in/hr

Hydrograph type	= Diversion1	Peak discharge	= 1.050 cfs
Storm frequency	= 2 yrs	Time to peak	= 710 min
Time interval	= 2 min	Hyd. volume	= 49,761 cuft
Inflow hydrograph	= 5 - To Pond	2nd diverted hyd.	= 7
Diversion method	= Constant Q	Constant Q	= 1.05 cfs

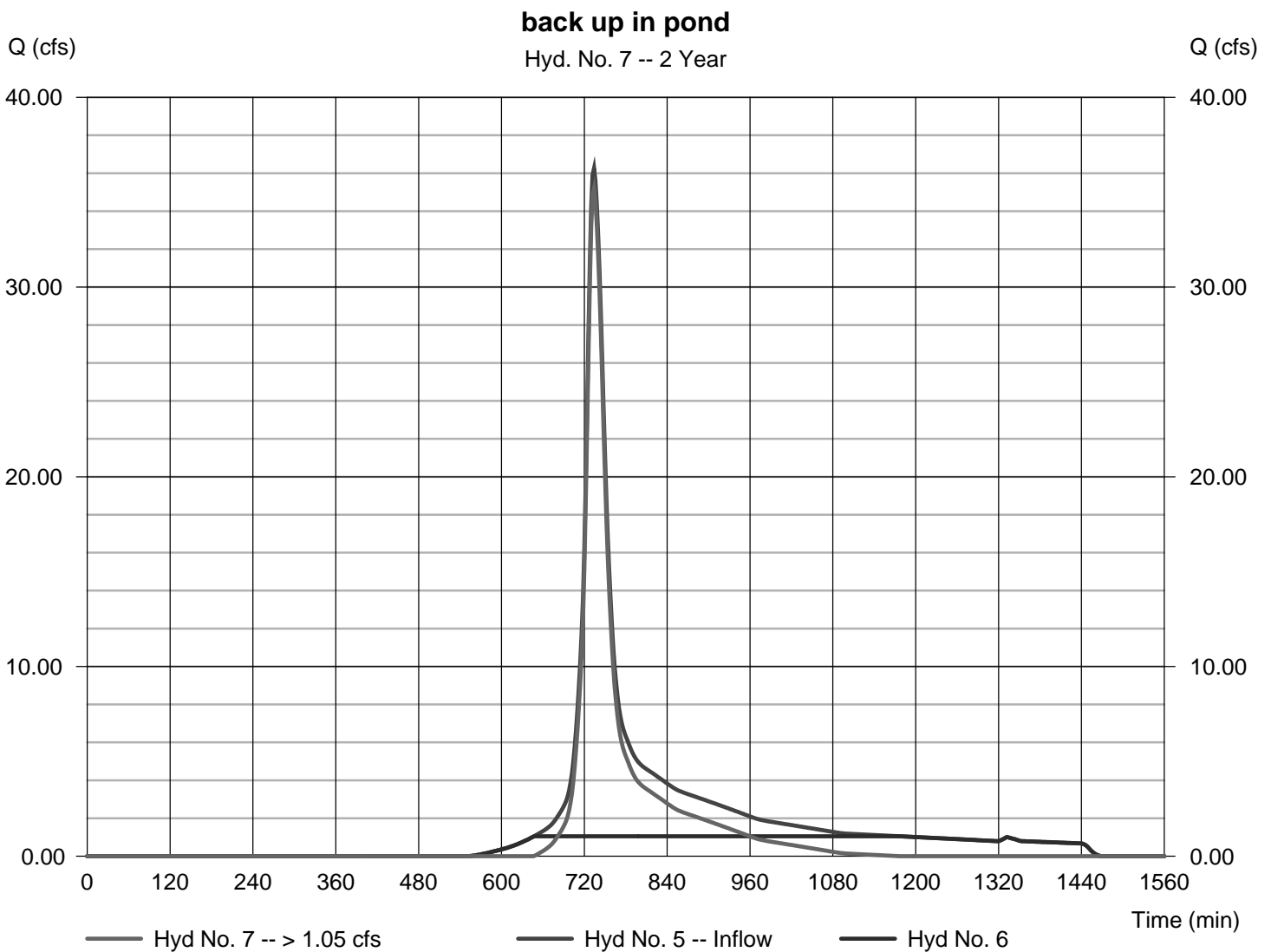


Hydrograph Report

Hyd. No. 7

back up in pond

Hydrograph type	= Diversion2	Peak discharge	= 35.21 cfs
Storm frequency	= 2 yrs	Time to peak	= 734 min
Time interval	= 2 min	Hyd. volume	= 111,515 cuft
Inflow hydrograph	= 5 - To Pond	2nd diverted hyd.	= 6
Diversion method	= Constant Q	Constant Q	= 1.05 cfs



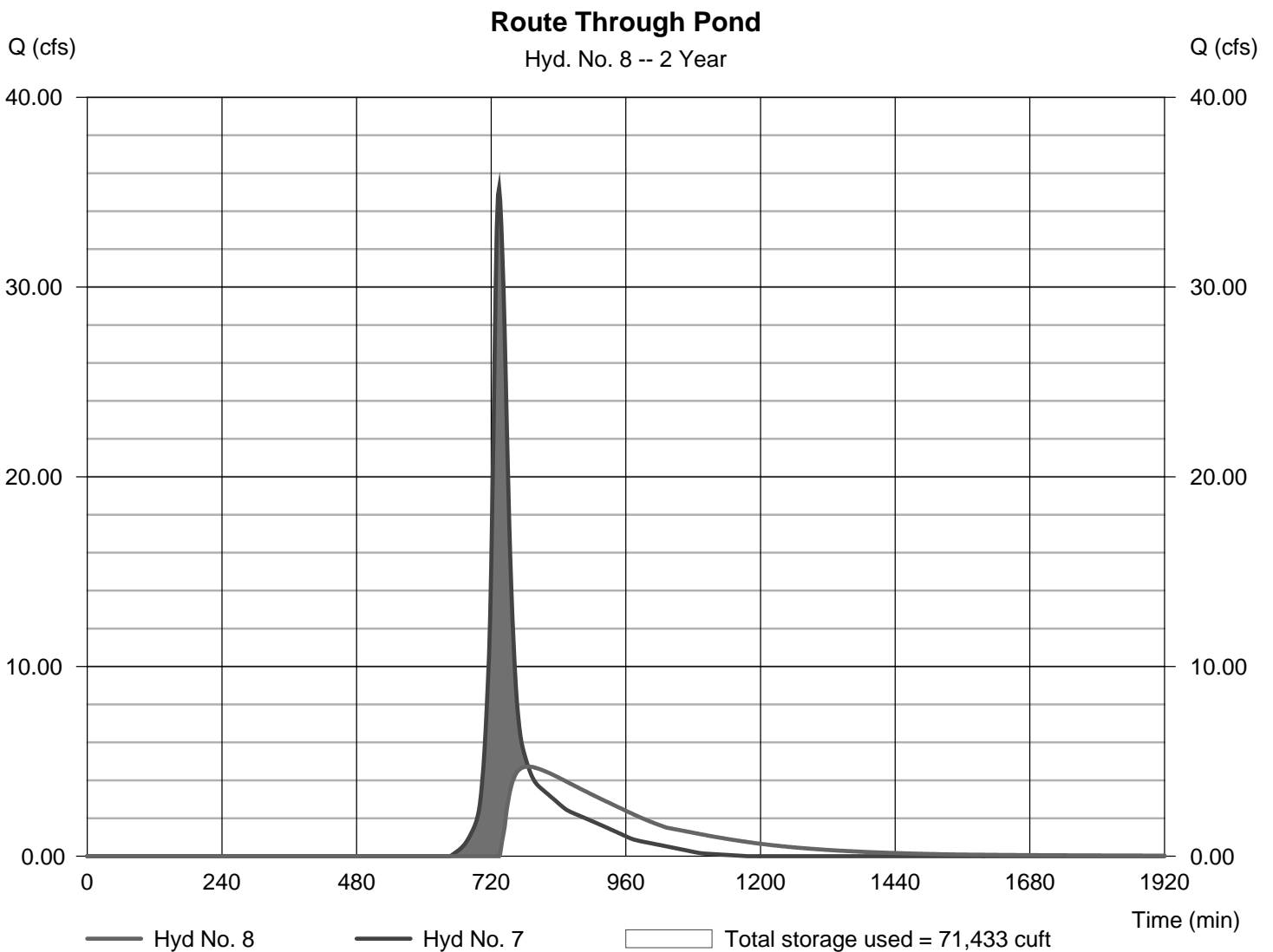
Hydrograph Report

Hyd. No. 8

Route Through Pond

Hydrograph type	= Reservoir	Peak discharge	= 4.727 cfs
Storm frequency	= 2 yrs	Time to peak	= 786 min
Time interval	= 2 min	Hyd. volume	= 75,861 cuft
Inflow hyd. No.	= 7 - back up in pond	Max. Elevation	= 271.36 ft
Reservoir name	= Detention	Max. Storage	= 71,433 cuft

Storage Indication method used.



Pond Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2013 by Autodesk, Inc. v10

Sunday, 09 / 27 / 2015

Pond No. 1 - Detention

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 268.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	268.00	11,426	0	0
0.80	268.80	12,609	9,609	9,609
2.40	270.40	16,375	23,119	32,729
2.60	270.60	39,500	5,420	38,148
6.00	274.00	48,396	149,153	187,301

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 10.00	12.00	0.00	0.00
Span (in)	= 10.00	12.00	0.00	0.00
No. Barrels	= 2	2	0	0
Invert El. (ft)	= 268.80	270.50	0.00	0.00
Length (ft)	= 1.00	0.00	0.00	0.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	4.00	0.00	0.00
Crest El. (ft)	= 271.00	272.00	0.00	0.00
Weir Coeff.	= 3.03	3.33	3.33	3.33
Weir Type	= 100 degV	Rect	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 0.000 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

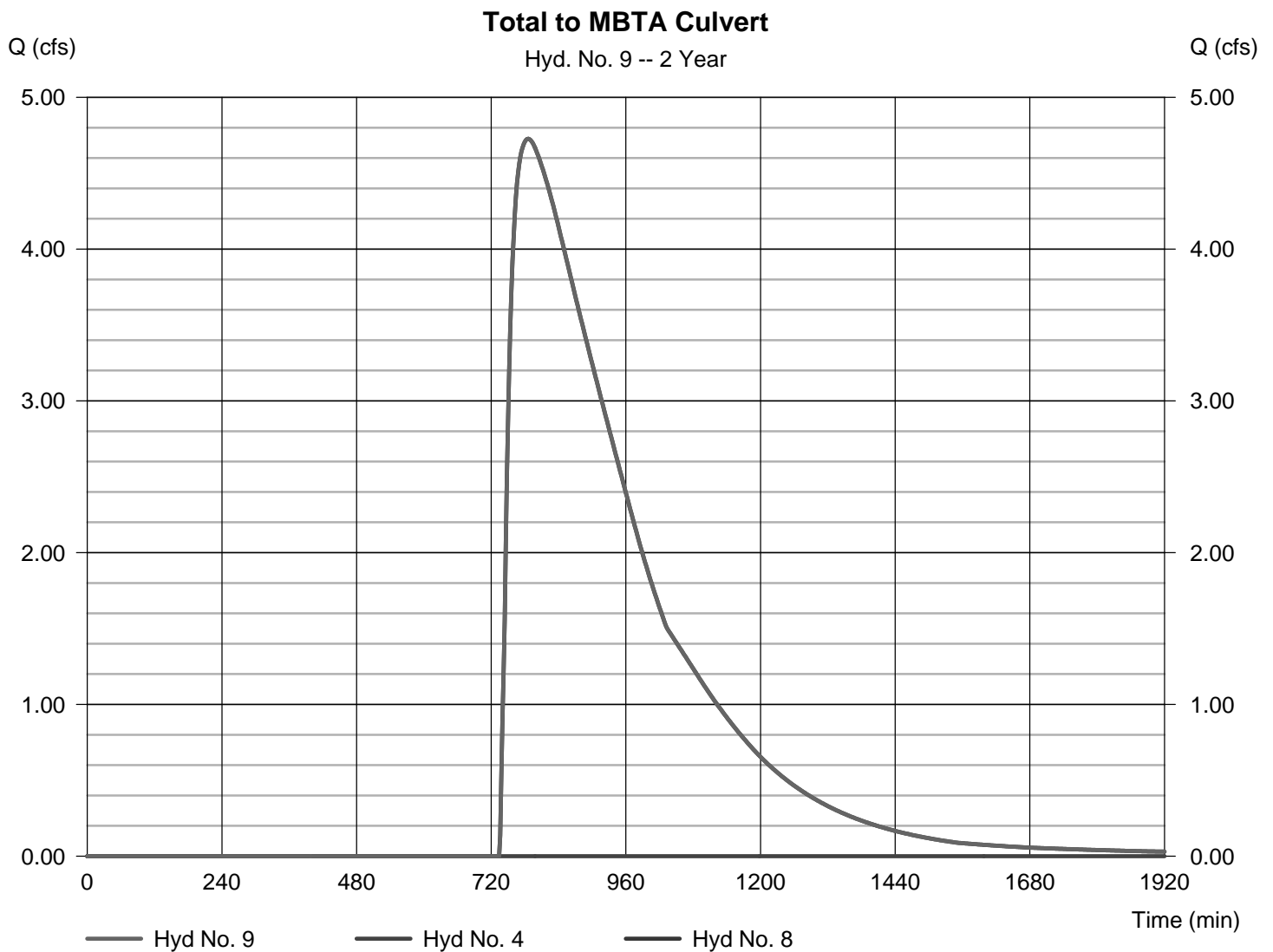
Stage ft	Storage cuft	Elevation ft	Civ A cfs	Civ B cfs	Civ C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	268.00	0.00	0.00	---	---	---	0.00	---	---	---	---	0.000
0.80	9,609	268.80	0.00	0.00	---	---	---	0.00	---	---	---	---	0.000
2.40	32,729	270.40	0.00	0.00	---	---	---	0.00	---	---	---	---	0.000
2.60	38,148	270.60	0.00	0.09 ic	---	---	---	0.00	---	---	---	---	0.088
6.00	187,301	274.00	11.43 ic	13.10 ic	---	---	11.42 s	37.67	---	---	---	---	62.19

Hydrograph Report

Hyd. No. 9

Total to MBTA Culvert

Hydrograph type	= Combine	Peak discharge	= 4.727 cfs
Storm frequency	= 2 yrs	Time to peak	= 786 min
Time interval	= 2 min	Hyd. volume	= 75,861 cuft
Inflow hyds.	= 4, 8	Contrib. drain. area	= 2.787 ac

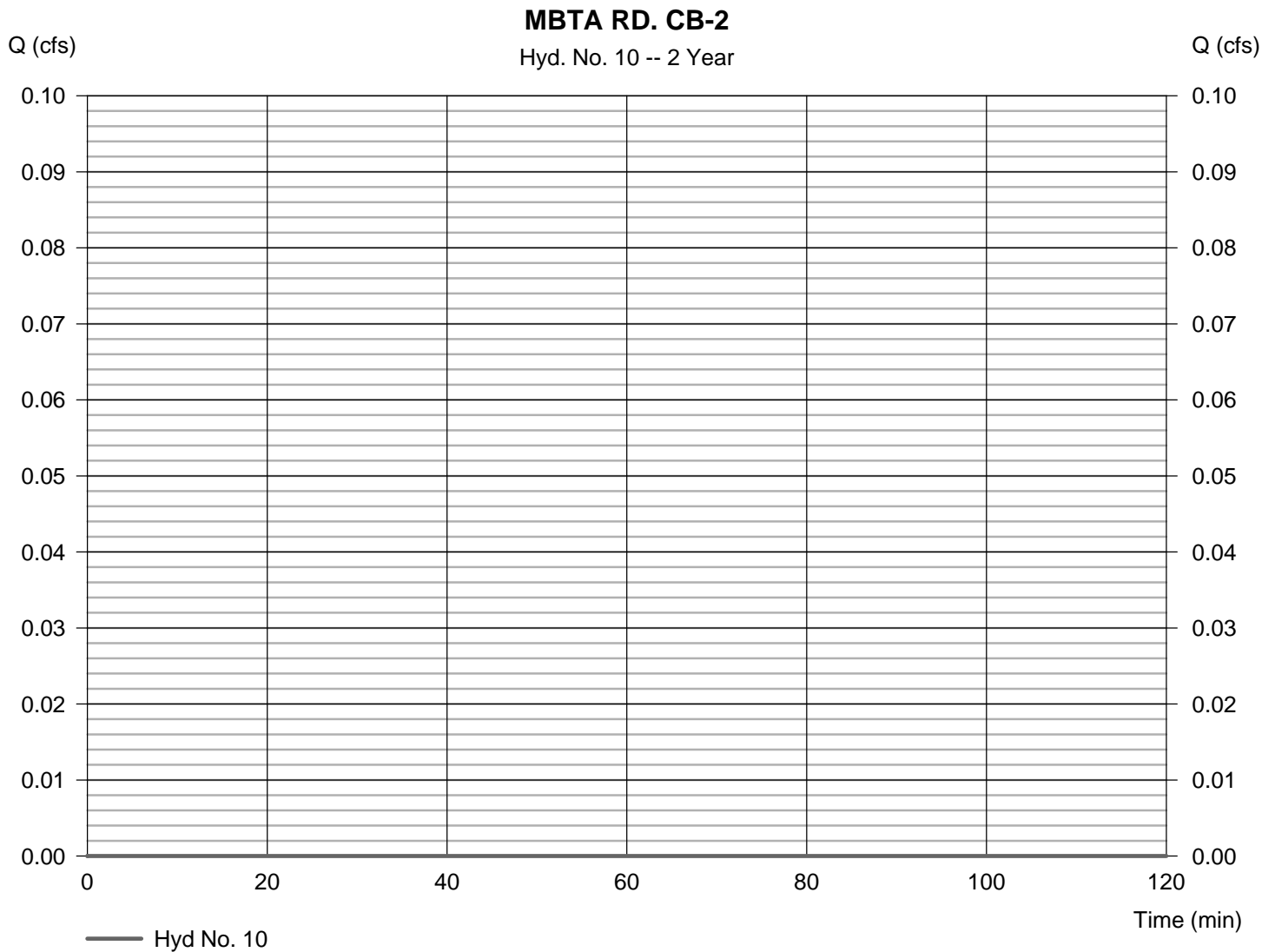


Hydrograph Report

Hyd. No. 10

MBTA RD. CB-2

Hydrograph type	= SCS Runoff	Peak discharge	= 0.000 cfs
Storm frequency	= 2 yrs	Time to peak	= n/a
Time interval	= 2 min	Hyd. volume	= 0 cuft
Drainage area	= 0.168 ac	Curve number	= 39
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.60 min
Total precip.	= 3.10 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 10

MBTA RD. CB-2

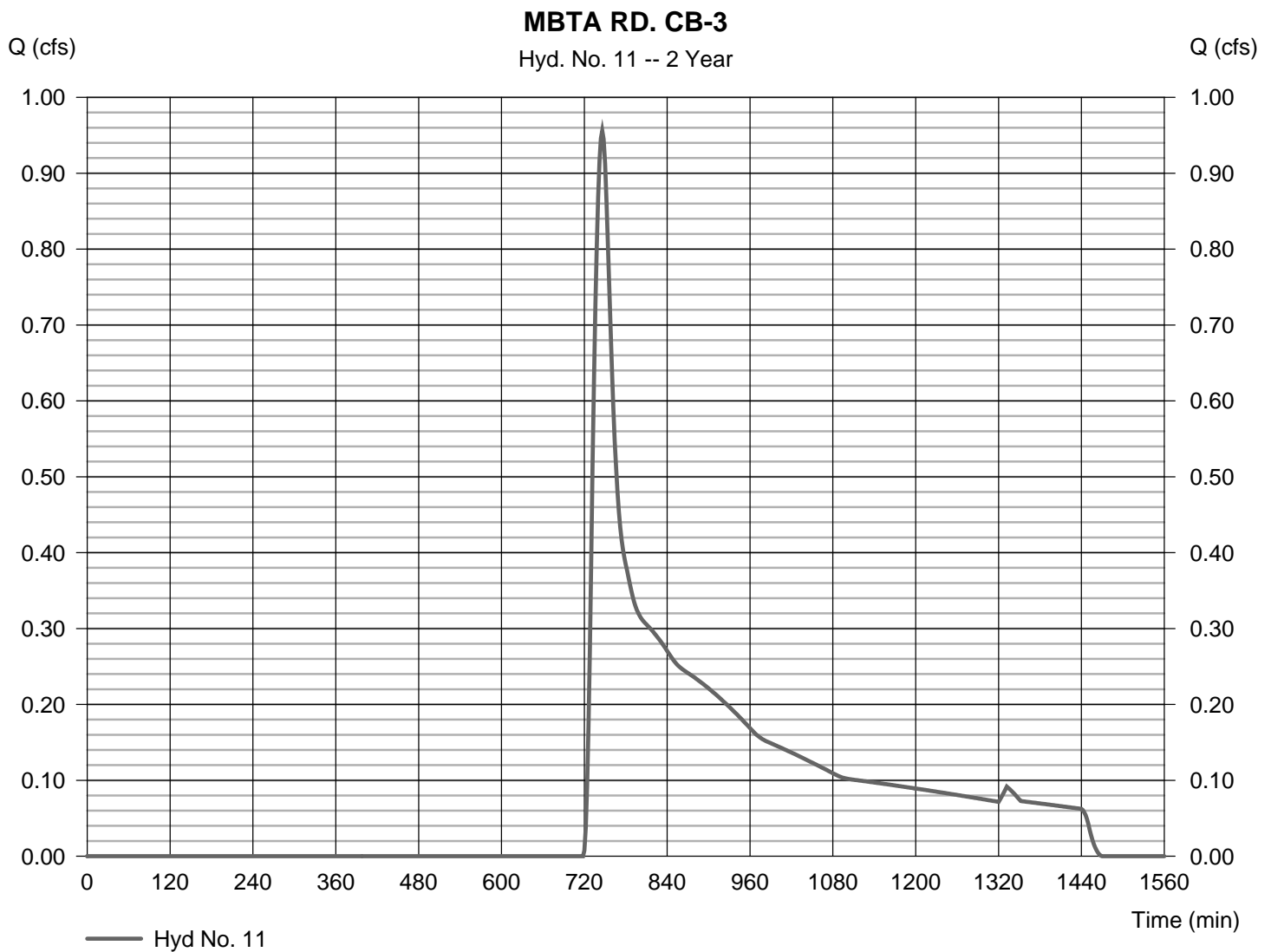
<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.600	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.10	0.00	0.00	
Land slope (%)	= 5.40	0.00	0.00	
Travel Time (min)	= 11.65	+ 0.00	+ 0.00	= 11.65
Shallow Concentrated Flow				
Flow length (ft)	= 750.00	515.00	0.00	
Watercourse slope (%)	= 12.00	3.80	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=5.59	3.15	0.00	
Travel Time (min)	= 2.24	+ 2.73	+ 0.00	= 4.97
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				16.60 min

Hydrograph Report

Hyd. No. 11

MBTA RD. CB-3

Hydrograph type	= SCS Runoff	Peak discharge	= 0.956 cfs
Storm frequency	= 2 yrs	Time to peak	= 746 min
Time interval	= 2 min	Hyd. volume	= 7,616 cuft
Drainage area	= 6.706 ac	Curve number	= 58.2
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 18.10 min
Total precip.	= 3.10 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 11

MBTA RD. CB-3

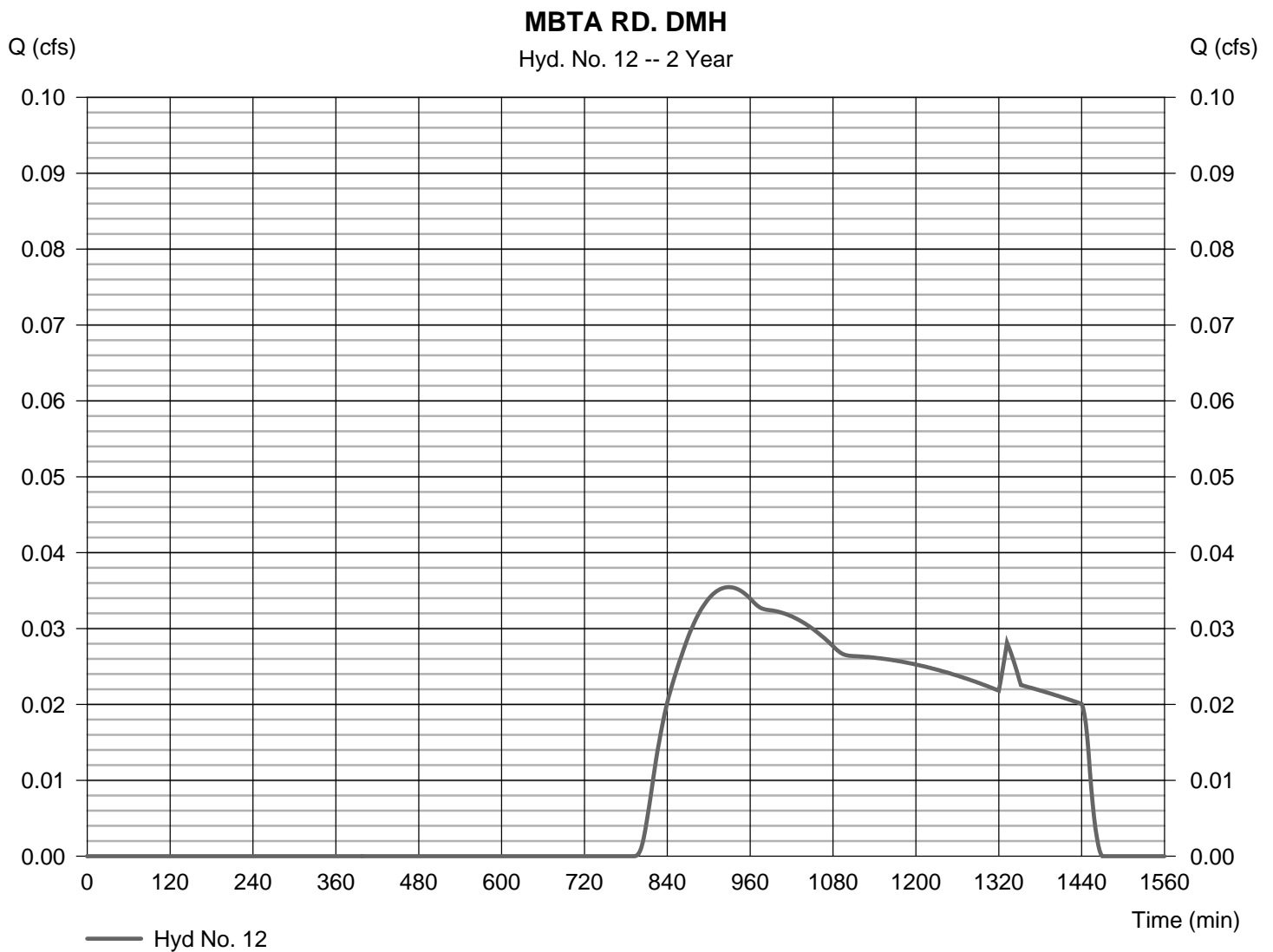
<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.600	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.10	0.00	0.00	
Land slope (%)	= 3.00	0.00	0.00	
Travel Time (min)	= 14.74	+ 0.00	+ 0.00	= 14.74
Shallow Concentrated Flow				
Flow length (ft)	= 1030.00	0.00	0.00	
Watercourse slope (%)	= 10.00	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	=5.10	0.00	0.00	
Travel Time (min)	= 3.36	+ 0.00	+ 0.00	= 3.36
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				18.10 min

Hydrograph Report

Hyd. No. 12

MBTA RD. DMH

Hydrograph type	= SCS Runoff	Peak discharge	= 0.035 cfs
Storm frequency	= 2 yrs	Time to peak	= 930 min
Time interval	= 2 min	Hyd. volume	= 1,013 cuft
Drainage area	= 6.527 ac	Curve number	= 45.8
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 19.60 min
Total precip.	= 3.10 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



TR55 Tc Worksheet

Hyd. No. 12

MBTA RD. DMH

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.600	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.10	0.00	0.00	
Land slope (%)	= 3.00	0.00	0.00	
Travel Time (min)	= 14.74	+ 0.00	+ 0.00	= 14.74
Shallow Concentrated Flow				
Flow length (ft)	= 860.00	610.00	0.00	
Watercourse slope (%)	= 11.00	8.20	0.00	
Surface description	= Unpaved	Unpaved	Paved	
Average velocity (ft/s)	=5.35	4.62	0.00	
Travel Time (min)	= 2.68	+ 2.20	+ 0.00	= 4.88
Channel Flow				
X sectional flow area (sqft)	= 0.00	0.00	0.00	
Wetted perimeter (ft)	= 0.00	0.00	0.00	
Channel slope (%)	= 0.00	0.00	0.00	
Manning's n-value	= 0.015	0.015	0.015	
Velocity (ft/s)	=0.00	0.00	0.00	
Flow length (ft)	0.0	0.0	0.0	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				19.60 min

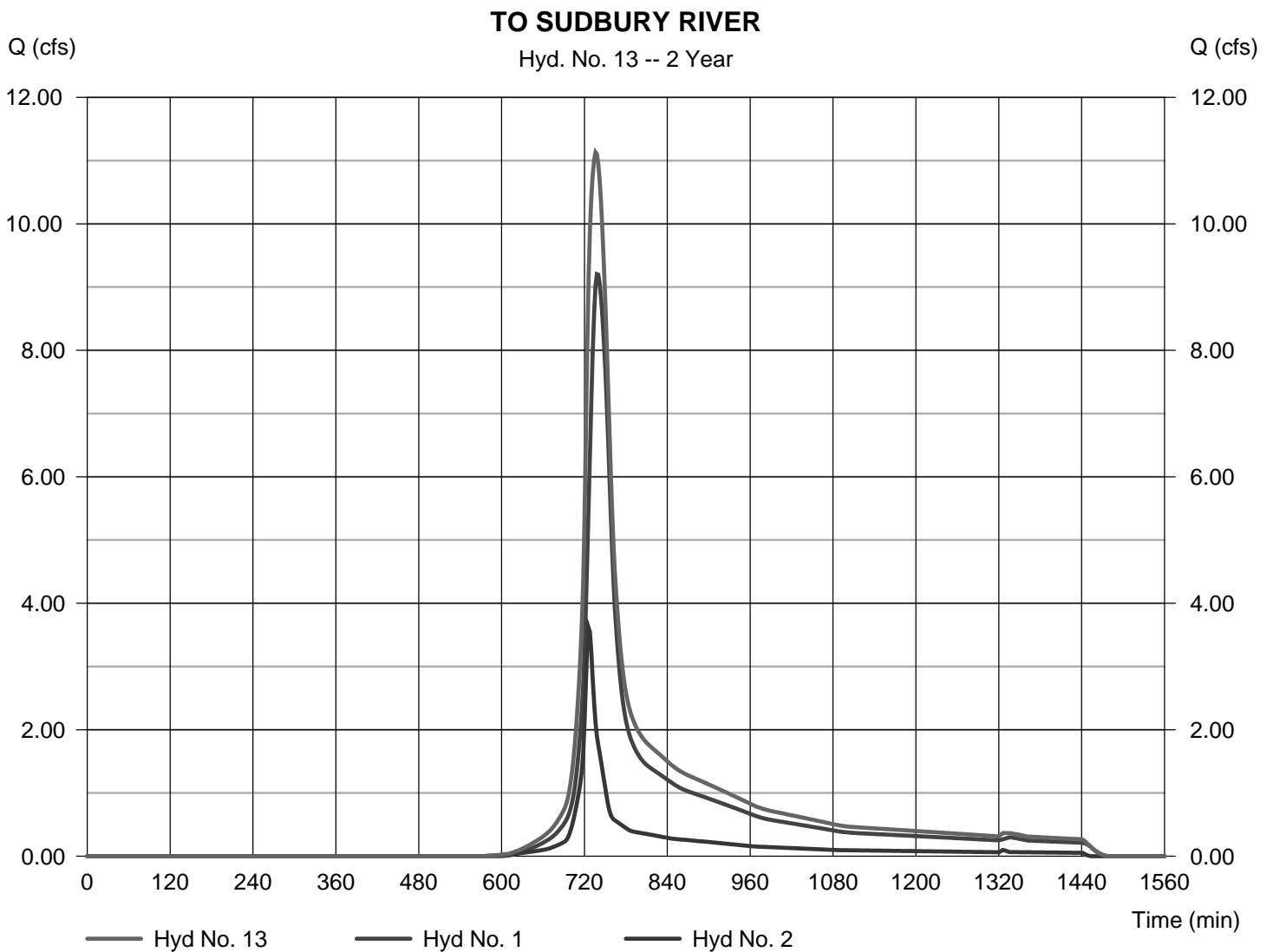
Hydrograph Report

Hyd. No. 13

TO SUDBURY RIVER

Hydrograph type = Combine
Storm frequency = 2 yrs
Time interval = 2 min
Inflow hyds. = 1, 2

Peak discharge = 11.13 cfs
Time to peak = 736 min
Hyd. volume = 59,158 cuft
Contrib. drain. area = 13.486 ac



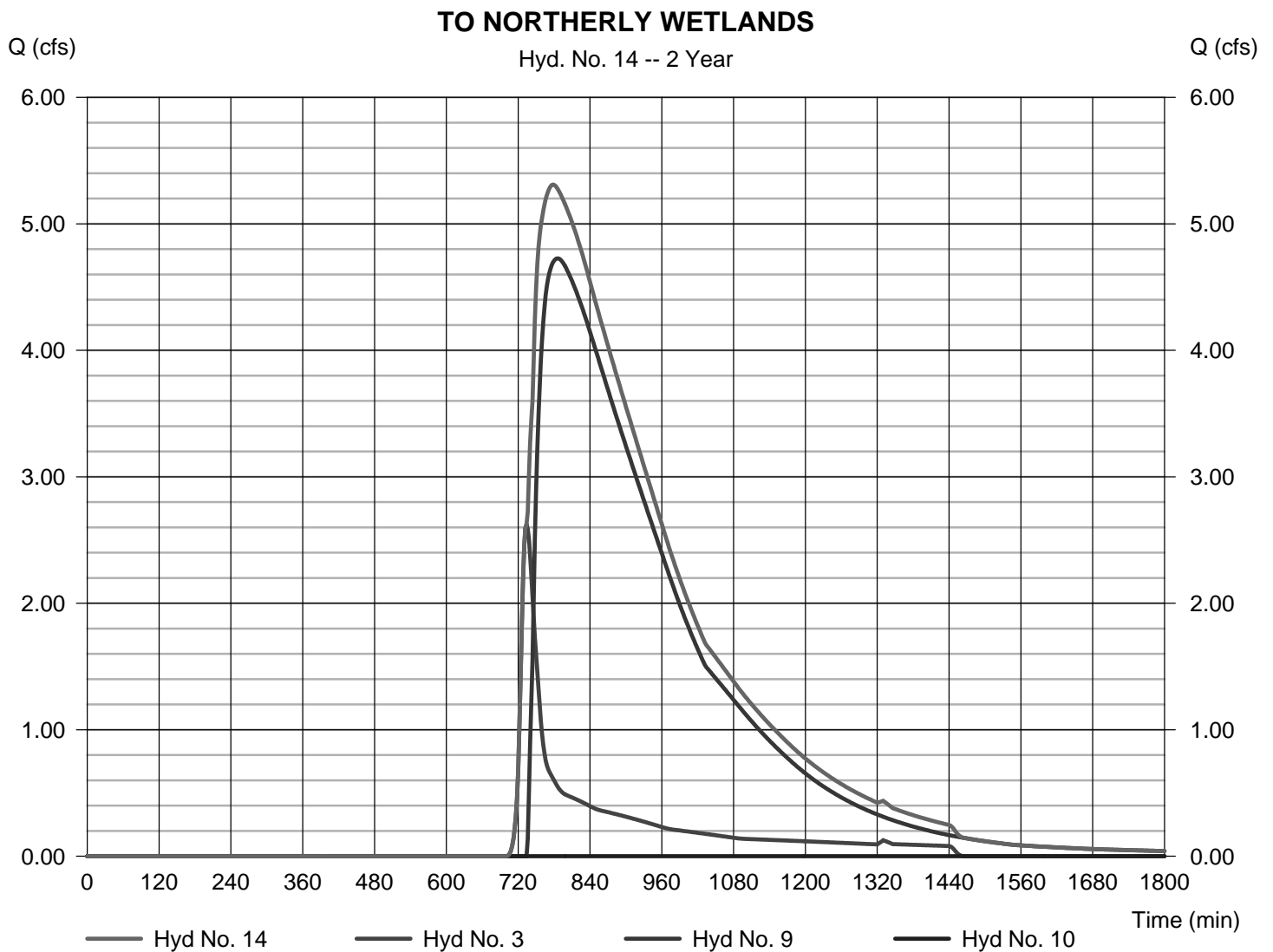
Hydrograph Report

Hyd. No. 14

TO NORTHERLY WETLANDS

Hydrograph type = Combine
Storm frequency = 2 yrs
Time interval = 2 min
Inflow hyds. = 3, 9, 10

Peak discharge = 5.310 cfs
Time to peak = 778 min
Hyd. volume = 89,023 cuft
Contrib. drain. area = 6.224 ac

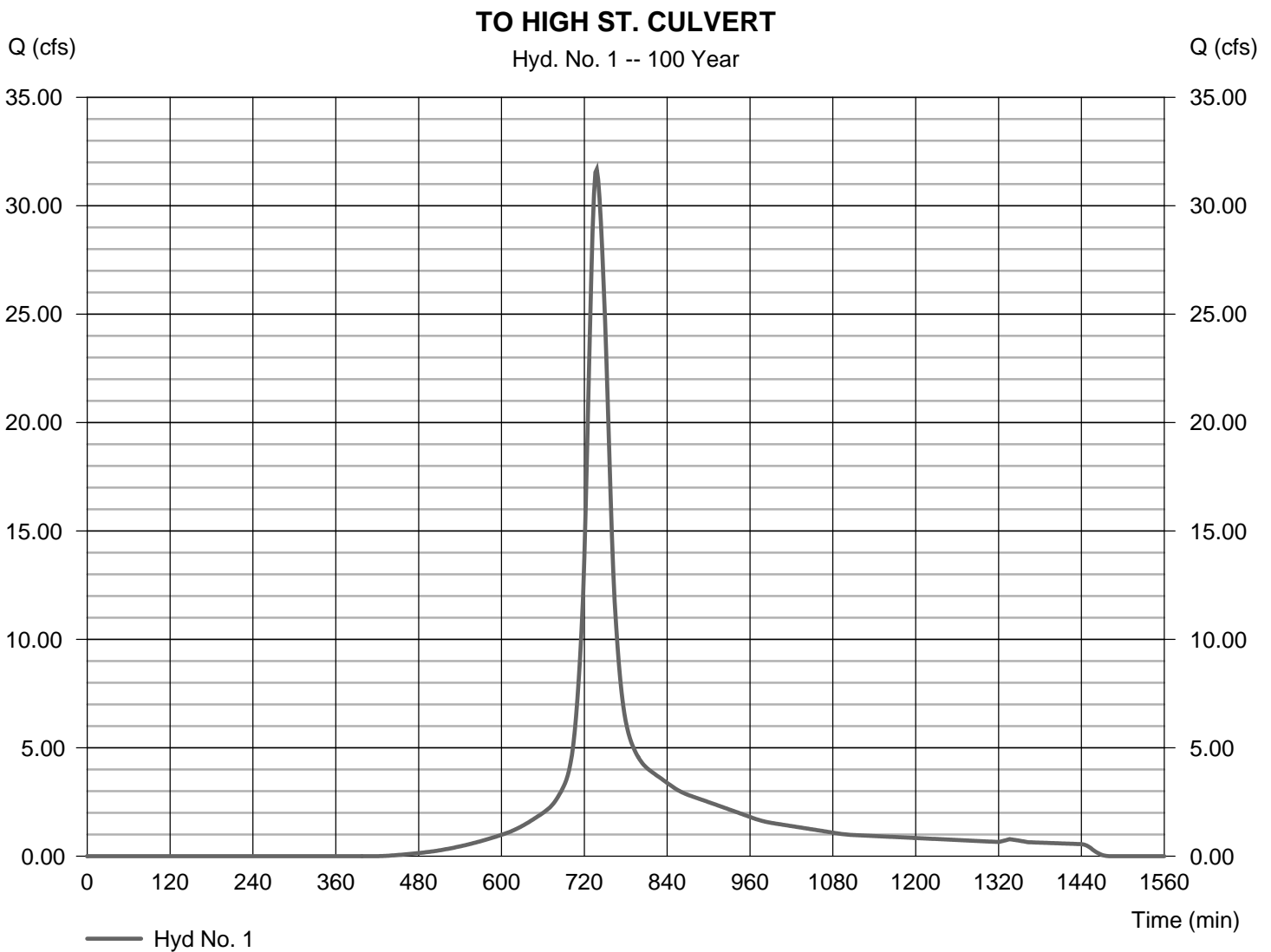


Hydrograph Report

Hyd. No. 1

TO HIGH ST. CULVERT

Hydrograph type	= SCS Runoff	Peak discharge	= 31.68 cfs
Storm frequency	= 100 yrs	Time to peak	= 738 min
Time interval	= 2 min	Hyd. volume	= 156,294 cuft
Drainage area	= 10.870 ac	Curve number	= 78
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 24.69 min
Total precip.	= 6.50 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

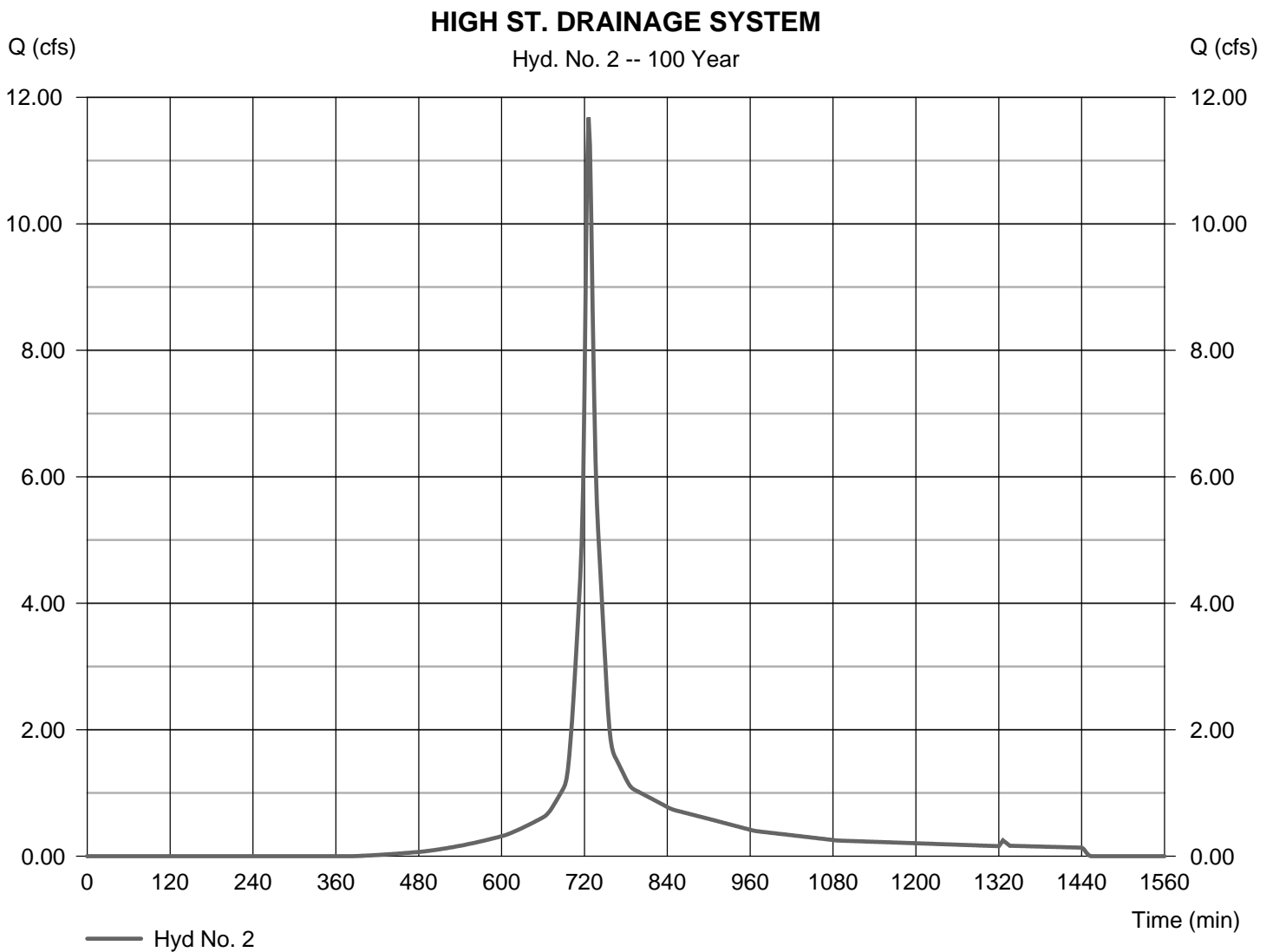


Hydrograph Report

Hyd. No. 2

HIGH ST. DRAINAGE SYSTEM

Hydrograph type	= SCS Runoff	Peak discharge	= 11.68 cfs
Storm frequency	= 100 yrs	Time to peak	= 726 min
Time interval	= 2 min	Hyd. volume	= 40,118 cuft
Drainage area	= 2.616 ac	Curve number	= 79.9
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 6.90 min
Total precip.	= 6.50 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

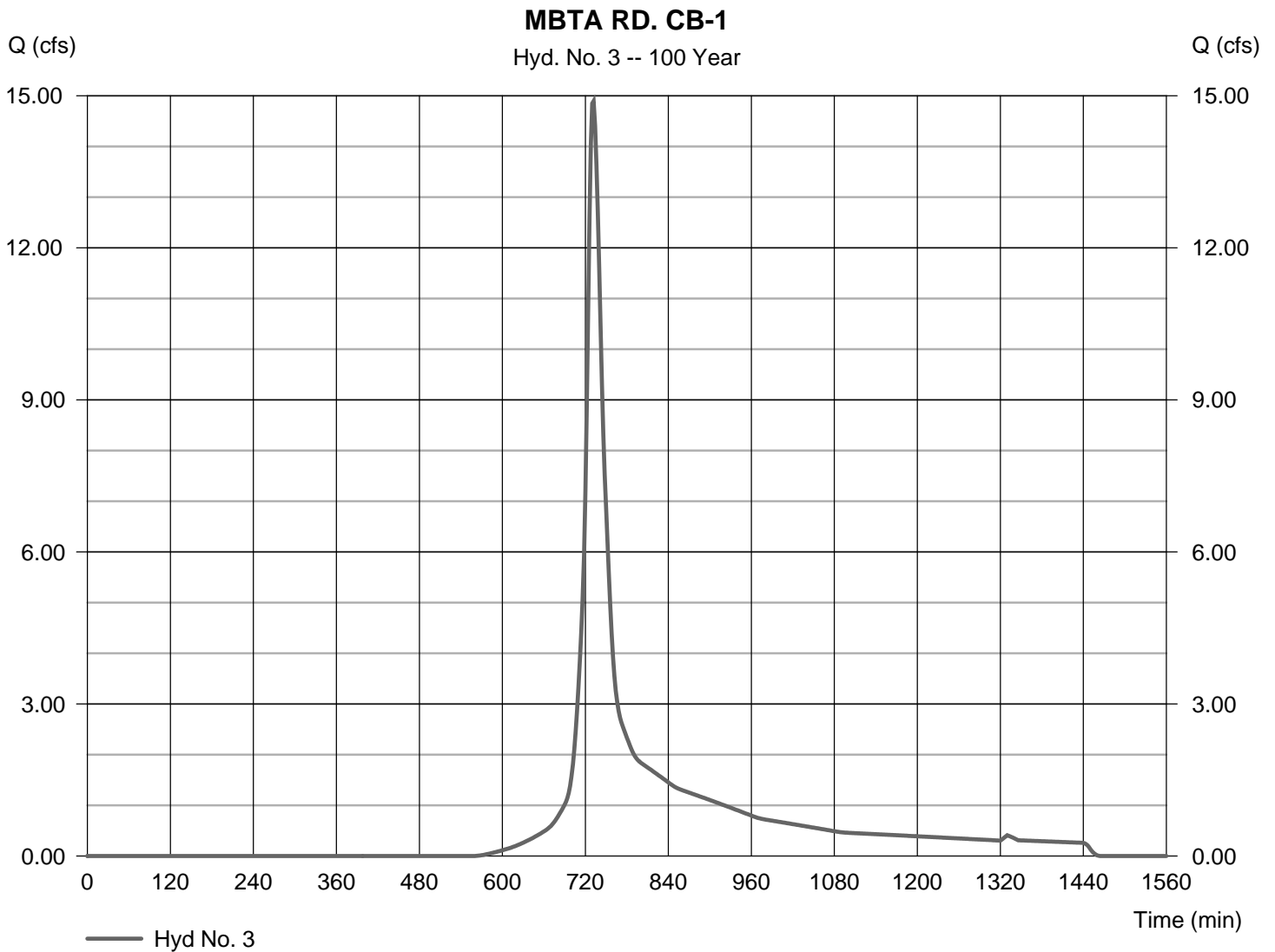


Hydrograph Report

Hyd. No. 3

MBTA RD. CB-1

Hydrograph type	= SCS Runoff	Peak discharge	= 14.89 cfs
Storm frequency	= 100 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 61,405 cuft
Drainage area	= 6.056 ac	Curve number	= 66.5
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 13.60 min
Total precip.	= 6.50 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

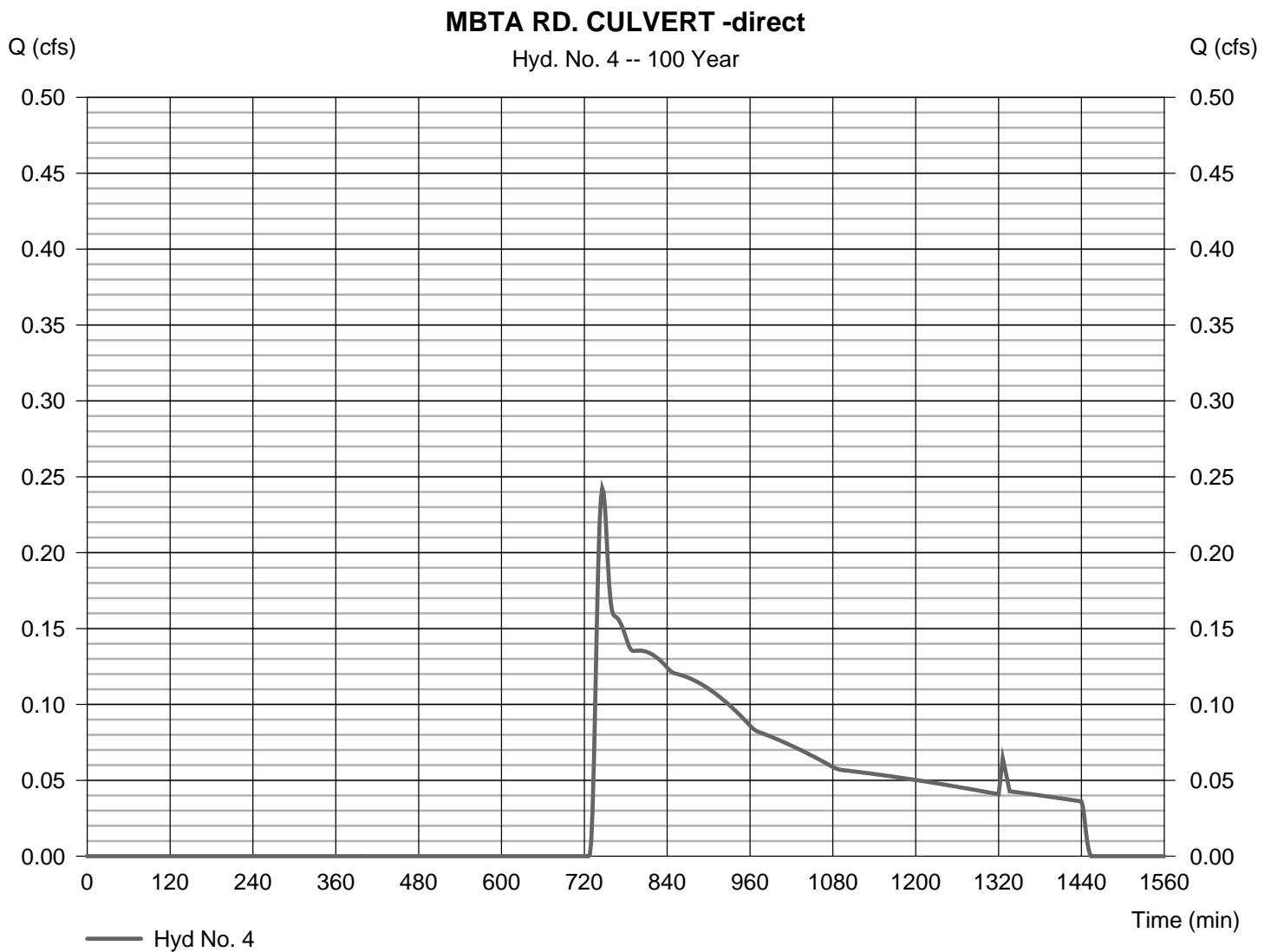


Hydrograph Report

Hyd. No. 4

MBTA RD. CULVERT -direct

Hydrograph type	= SCS Runoff	Peak discharge	= 0.242 cfs
Storm frequency	= 100 yrs	Time to peak	= 746 min
Time interval	= 2 min	Hyd. volume	= 3,302 cuft
Drainage area	= 2.787 ac	Curve number	= 34.3
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 7.36 min
Total precip.	= 6.50 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

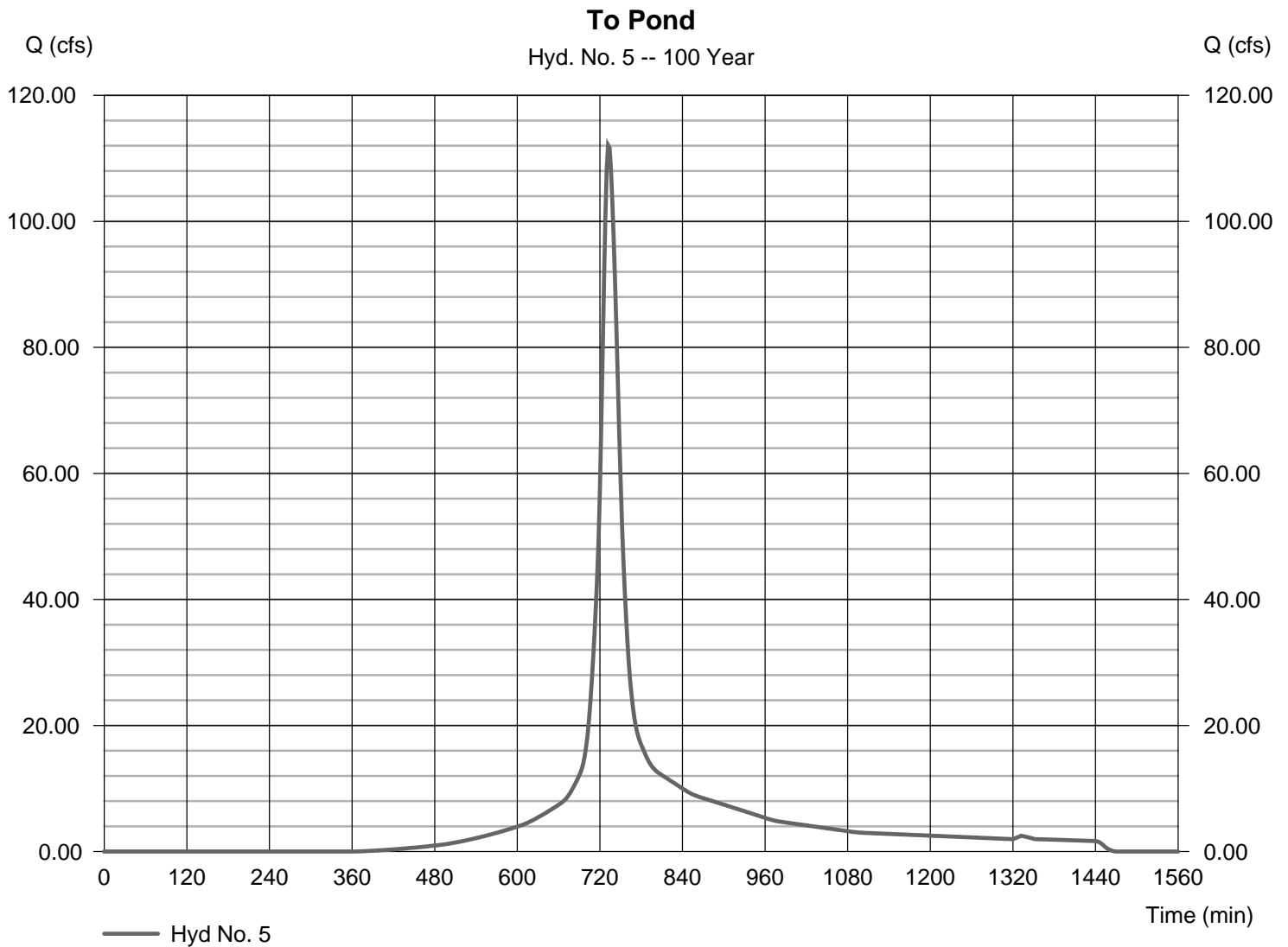


Hydrograph Report

Hyd. No. 5

To Pond

Hydrograph type	= SCS Runoff	Peak discharge	= 112.09 cfs
Storm frequency	= 100 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 498,897 cuft
Drainage area	= 31.343 ac	Curve number	= 81.4
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 19.52 min
Total precip.	= 6.50 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



Hydrograph Report

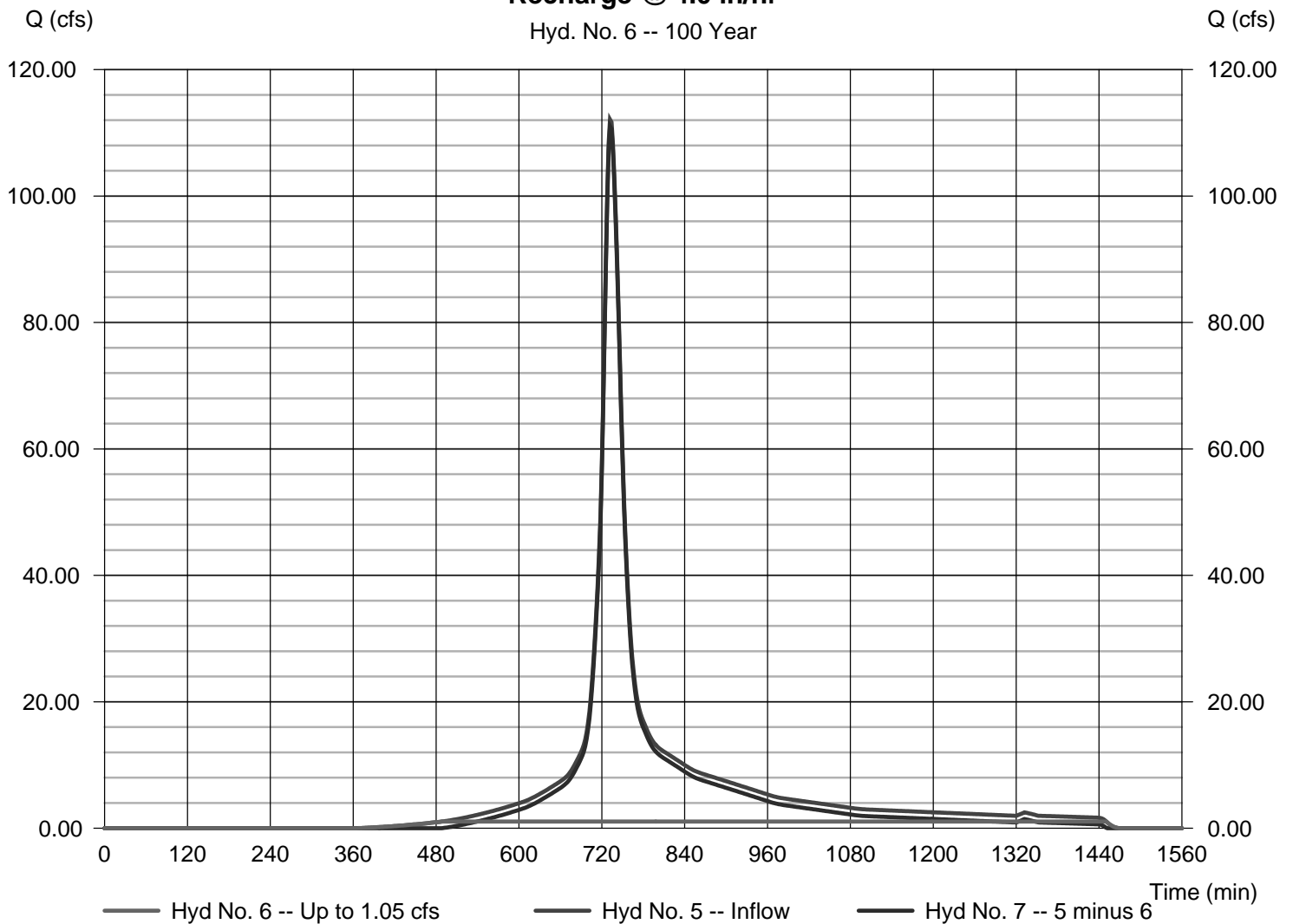
Hyd. No. 6

Recharge @ 4.0 in/hr

Hydrograph type	= Diversion1	Peak discharge	= 1.050 cfs
Storm frequency	= 100 yrs	Time to peak	= 722 min
Time interval	= 2 min	Hyd. volume	= 64,295 cuft
Inflow hydrograph	= 5 - To Pond	2nd diverted hyd.	= 7
Diversion method	= Constant Q	Constant Q	= 1.05 cfs

Recharge @ 4.0 in/hr

Hyd. No. 6 -- 100 Year

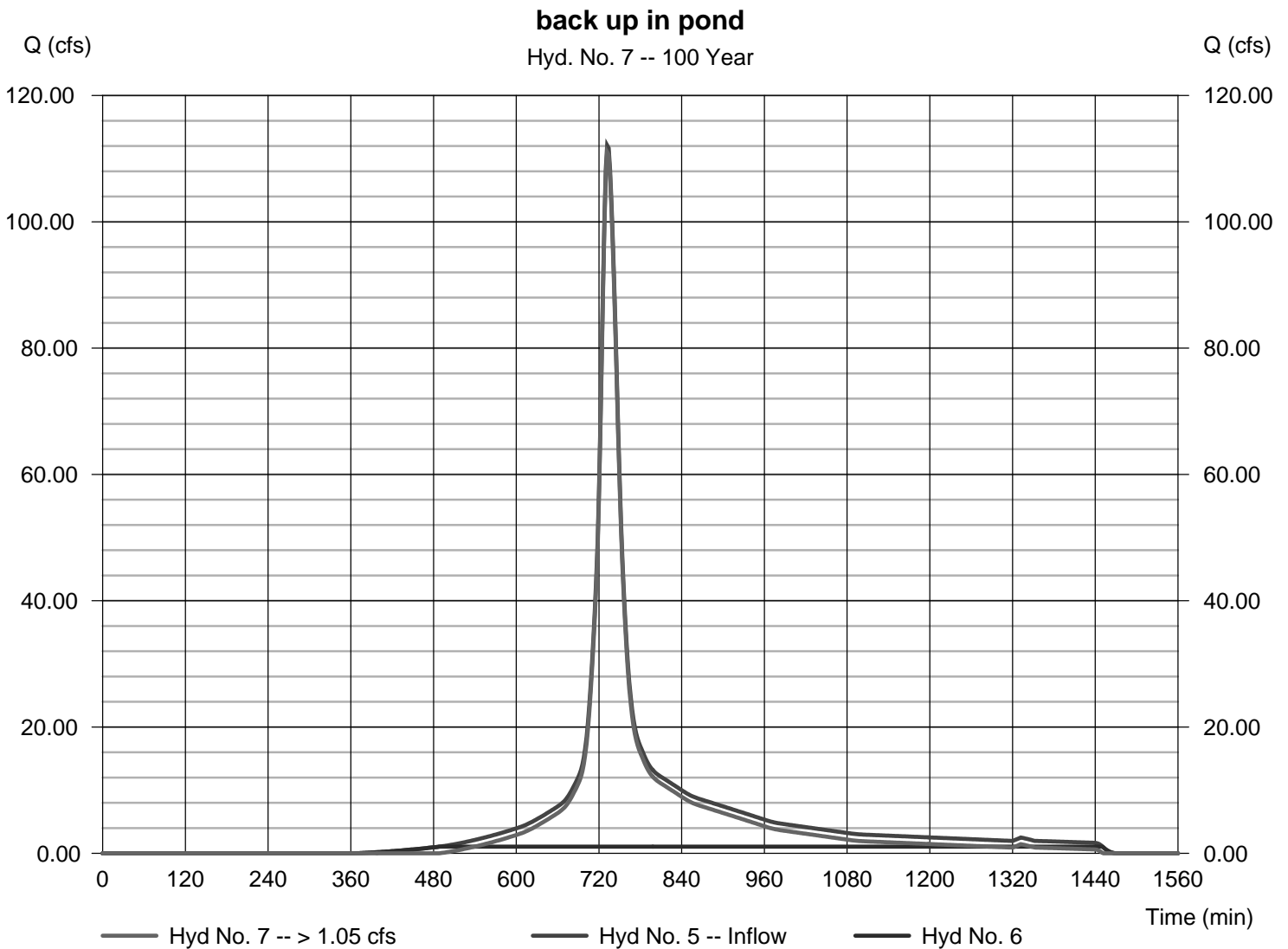


Hydrograph Report

Hyd. No. 7

back up in pond

Hydrograph type	= Diversion2	Peak discharge	= 111.04 cfs
Storm frequency	= 100 yrs	Time to peak	= 732 min
Time interval	= 2 min	Hyd. volume	= 434,602 cuft
Inflow hydrograph	= 5 - To Pond	2nd diverted hyd.	= 6
Diversion method	= Constant Q	Constant Q	= 1.05 cfs



Hydrograph Report

Hyd. No. 8

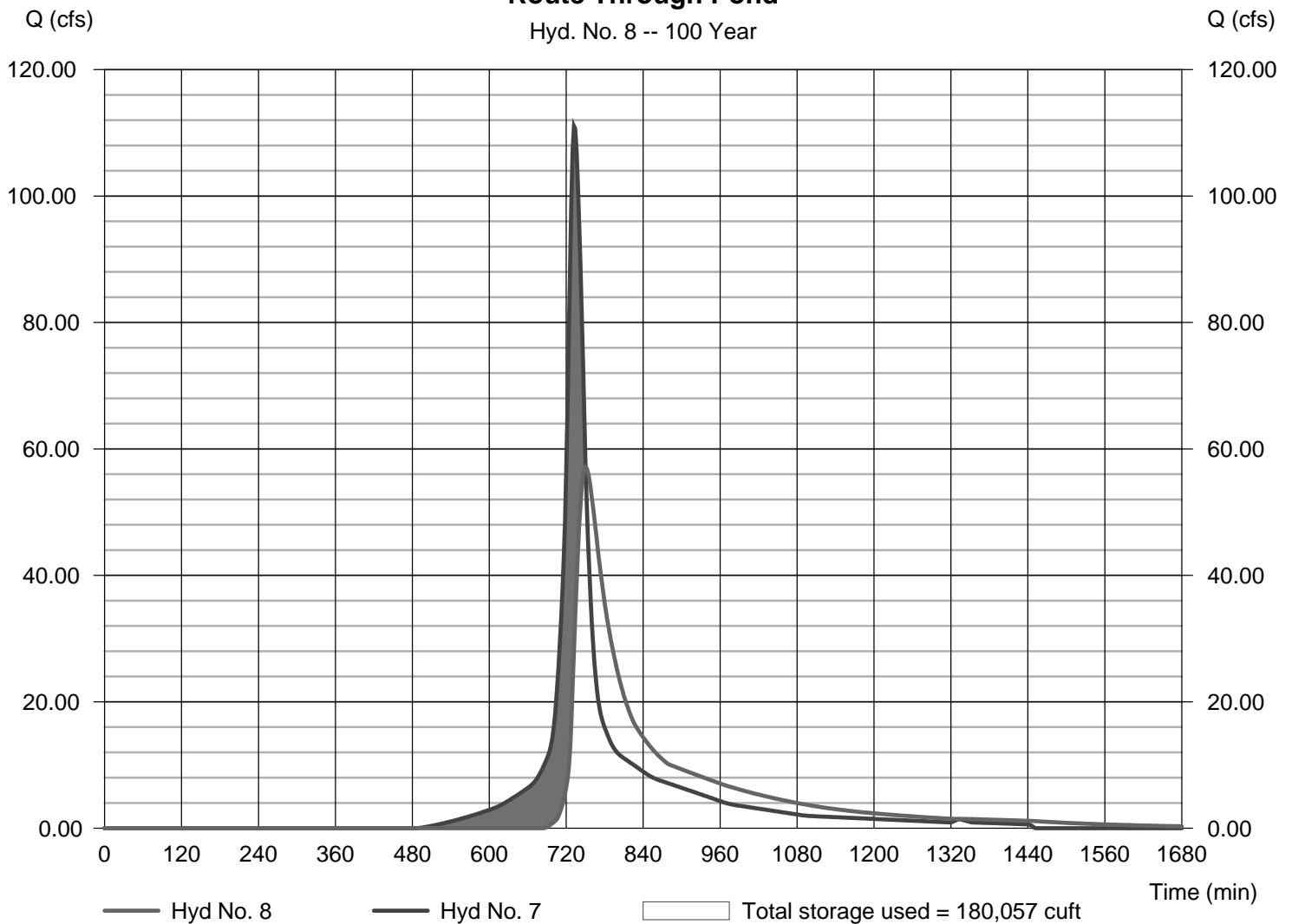
Route Through Pond

Hydrograph type	= Reservoir	Peak discharge	= 57.14 cfs
Storm frequency	= 100 yrs	Time to peak	= 750 min
Time interval	= 2 min	Hyd. volume	= 398,917 cuft
Inflow hyd. No.	= 7 - back up in pond	Max. Elevation	= 273.84 ft
Reservoir name	= Detention	Max. Storage	= 180,057 cuft

Storage Indication method used.

Route Through Pond

Hyd. No. 8 -- 100 Year

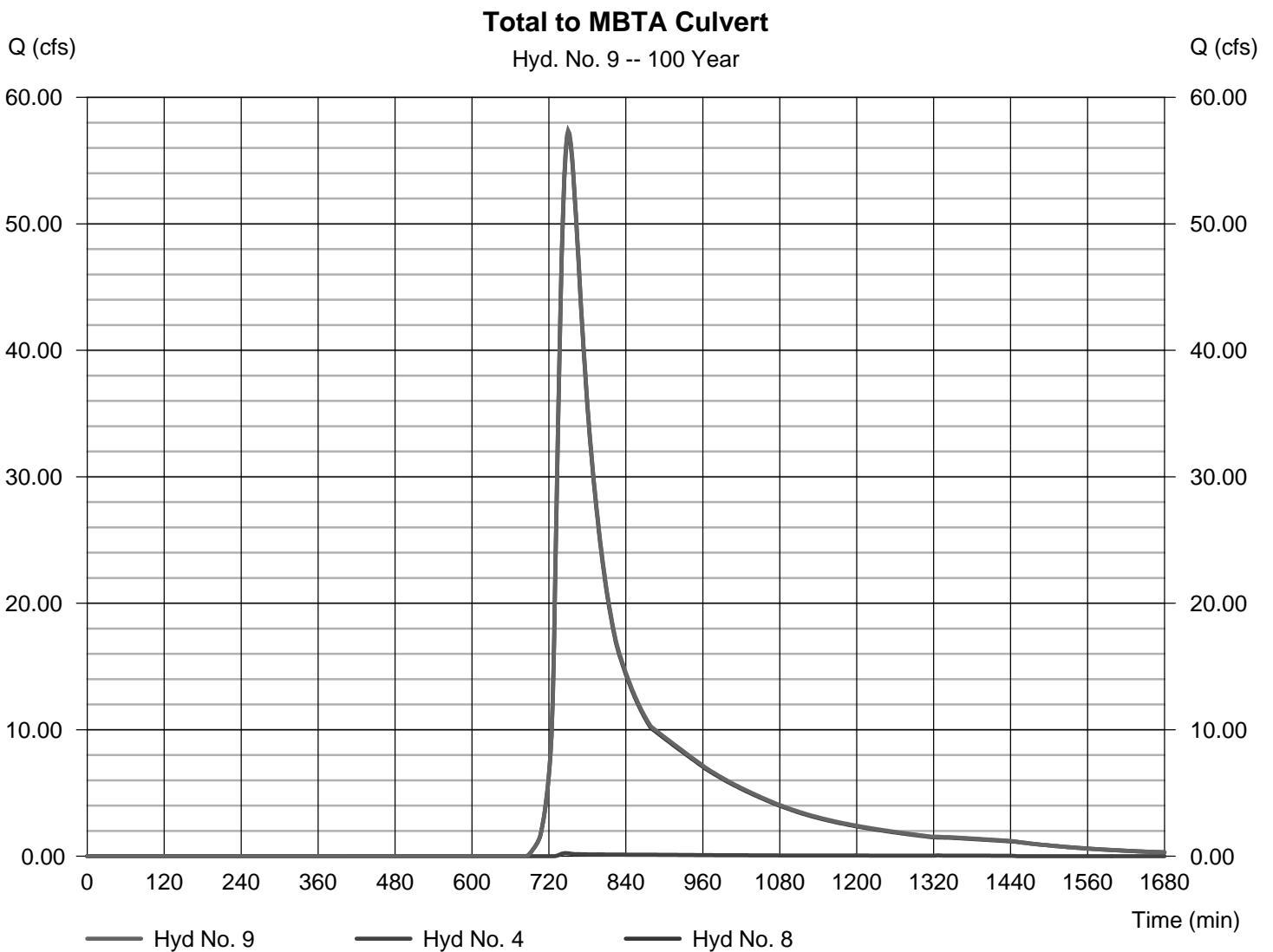


Hydrograph Report

Hyd. No. 9

Total to MBTA Culvert

Hydrograph type	= Combine	Peak discharge	= 57.37 cfs
Storm frequency	= 100 yrs	Time to peak	= 750 min
Time interval	= 2 min	Hyd. volume	= 402,219 cuft
Inflow hyds.	= 4, 8	Contrib. drain. area	= 2.787 ac

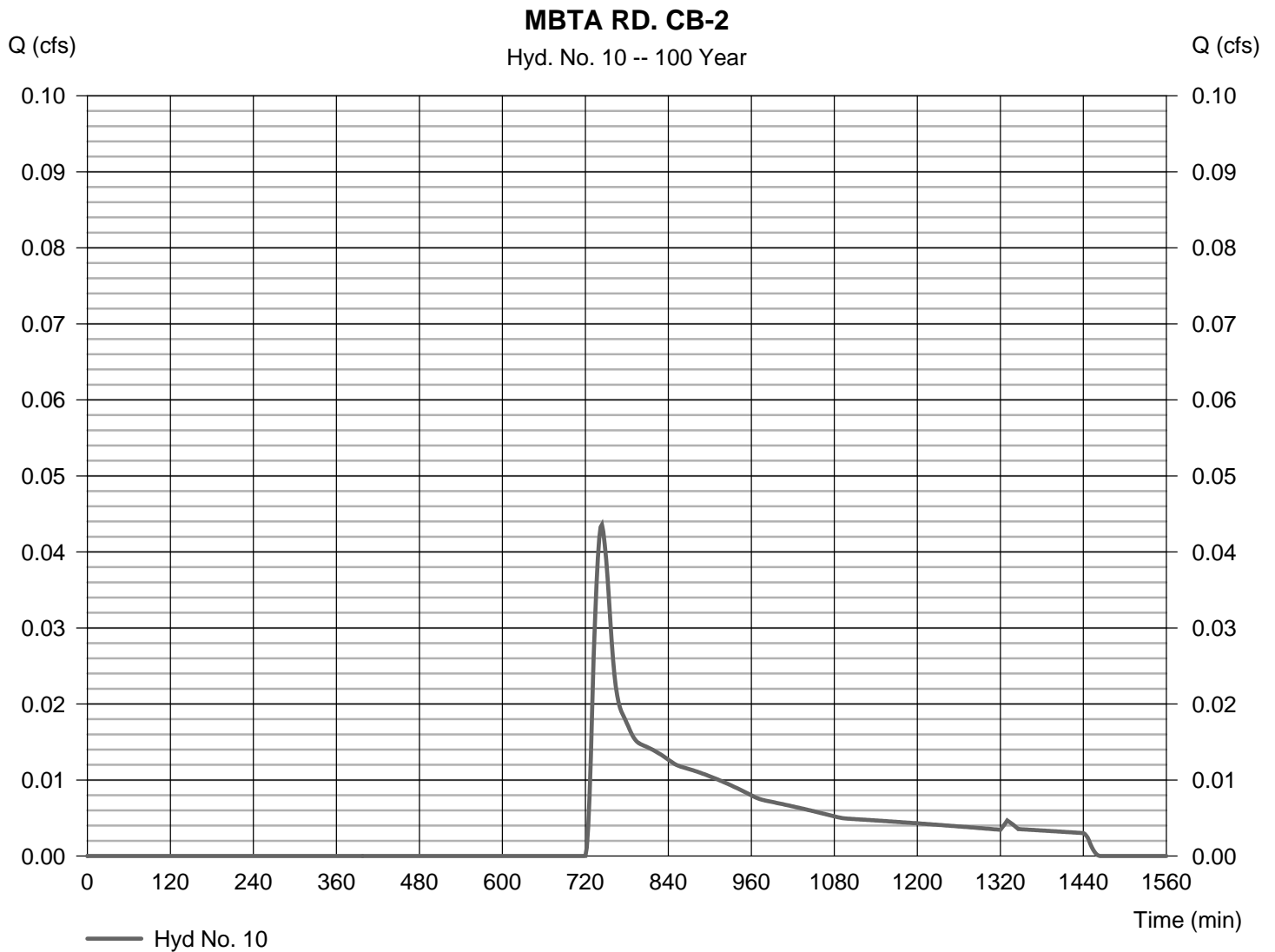


Hydrograph Report

Hyd. No. 10

MBTA RD. CB-2

Hydrograph type	= SCS Runoff	Peak discharge	= 0.044 cfs
Storm frequency	= 100 yrs	Time to peak	= 744 min
Time interval	= 2 min	Hyd. volume	= 355 cuft
Drainage area	= 0.168 ac	Curve number	= 39
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 16.60 min
Total precip.	= 6.50 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

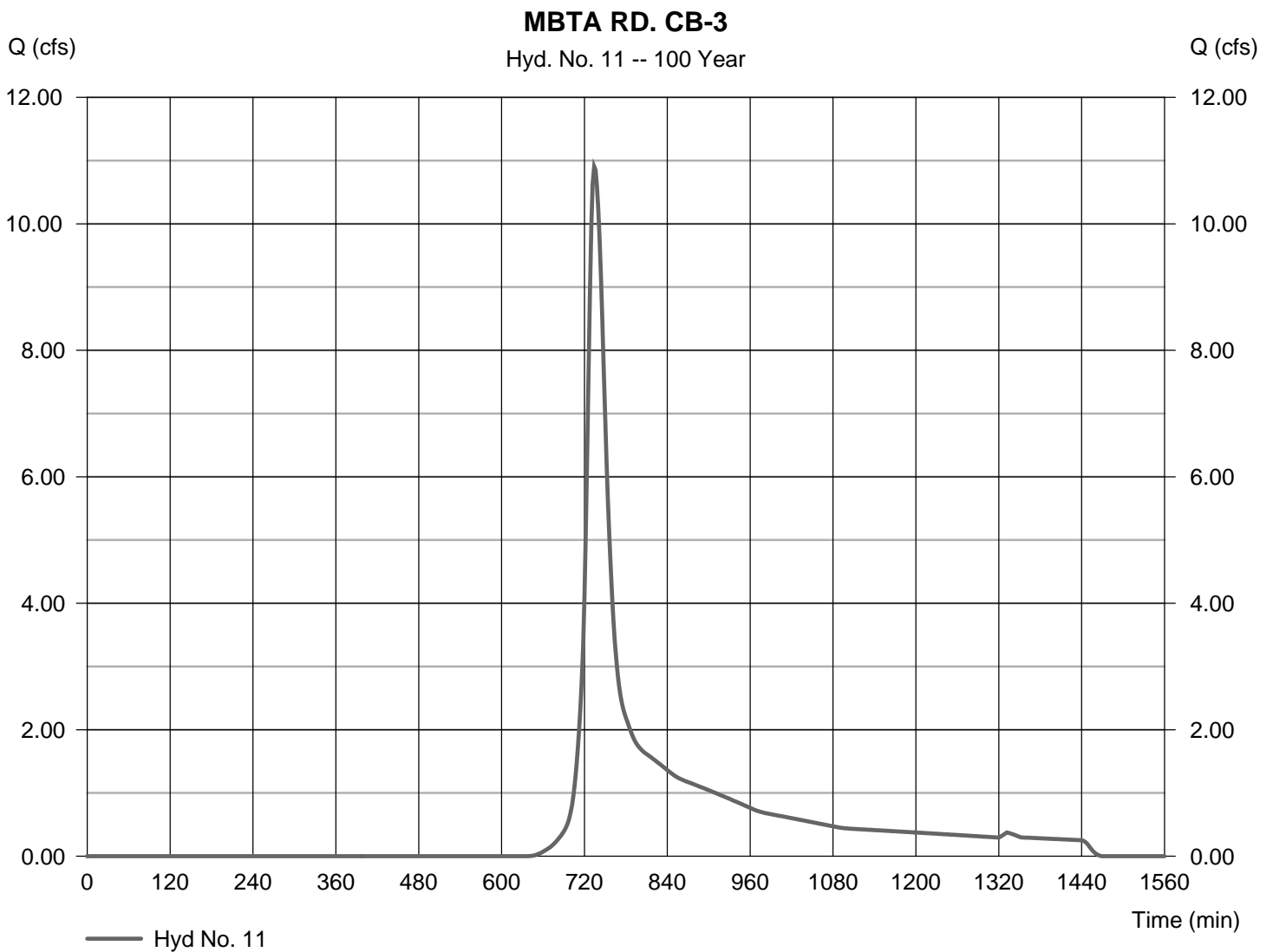


Hydrograph Report

Hyd. No. 11

MBTA RD. CB-3

Hydrograph type	= SCS Runoff	Peak discharge	= 10.90 cfs
Storm frequency	= 100 yrs	Time to peak	= 734 min
Time interval	= 2 min	Hyd. volume	= 50,968 cuft
Drainage area	= 6.706 ac	Curve number	= 58.2
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 18.10 min
Total precip.	= 6.50 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

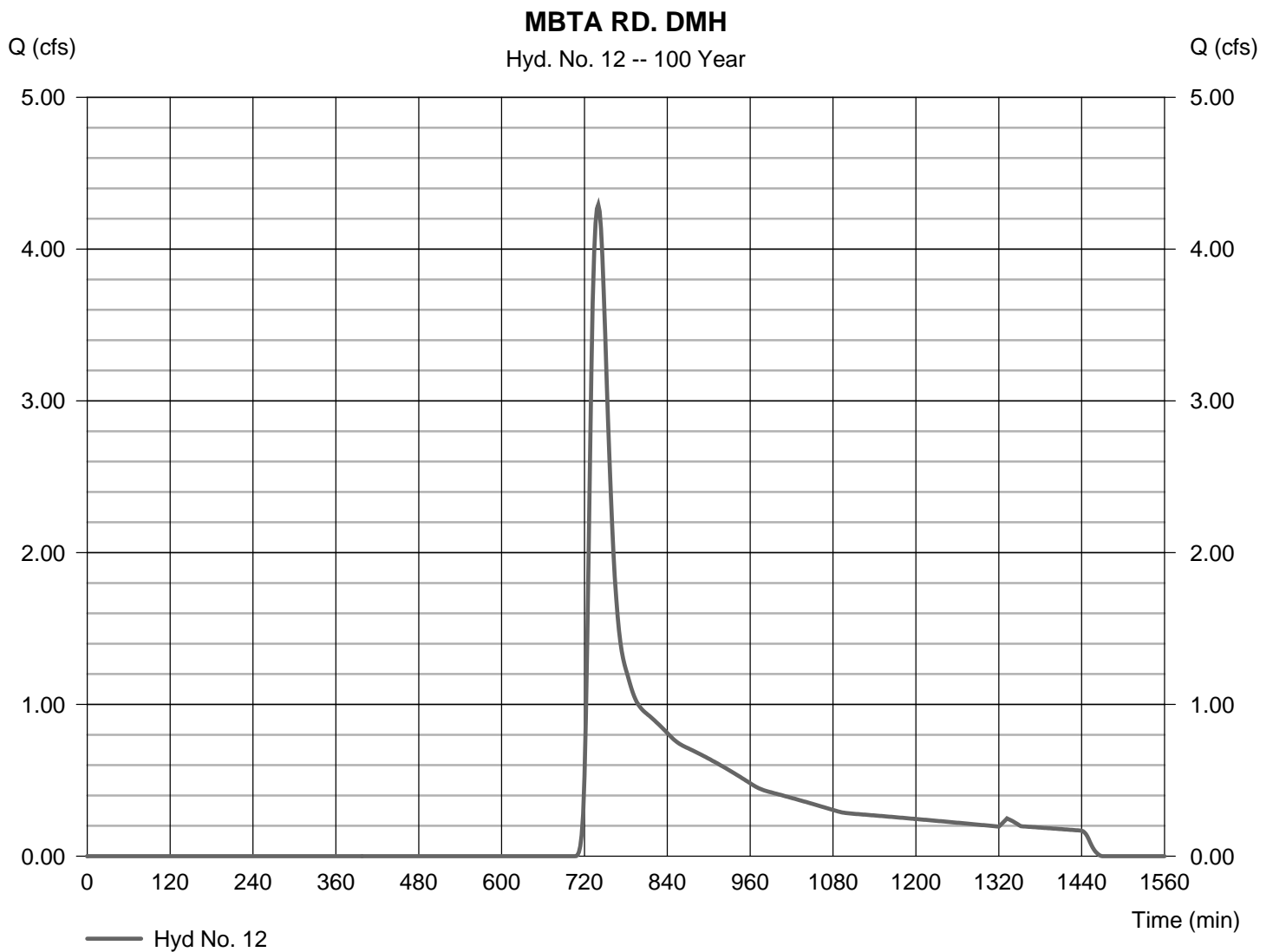


Hydrograph Report

Hyd. No. 12

MBTA RD. DMH

Hydrograph type	= SCS Runoff	Peak discharge	= 4.292 cfs
Storm frequency	= 100 yrs	Time to peak	= 740 min
Time interval	= 2 min	Hyd. volume	= 25,348 cuft
Drainage area	= 6.527 ac	Curve number	= 45.8
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 19.60 min
Total precip.	= 6.50 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484



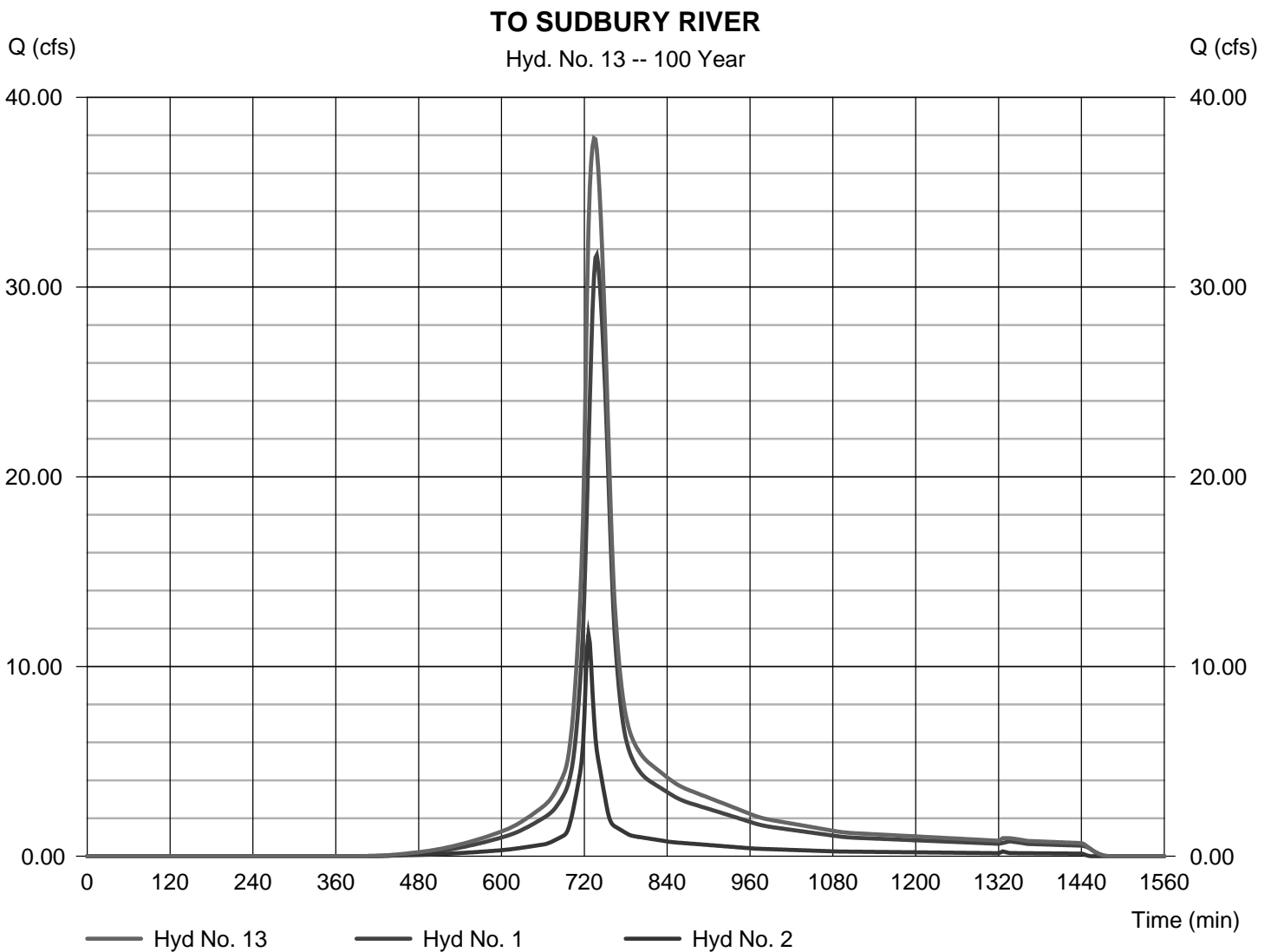
Hydrograph Report

Hyd. No. 13

TO SUDBURY RIVER

Hydrograph type = Combine
Storm frequency = 100 yrs
Time interval = 2 min
Inflow hyds. = 1, 2

Peak discharge = 37.84 cfs
Time to peak = 734 min
Hyd. volume = 196,412 cuft
Contrib. drain. area = 13.486 ac



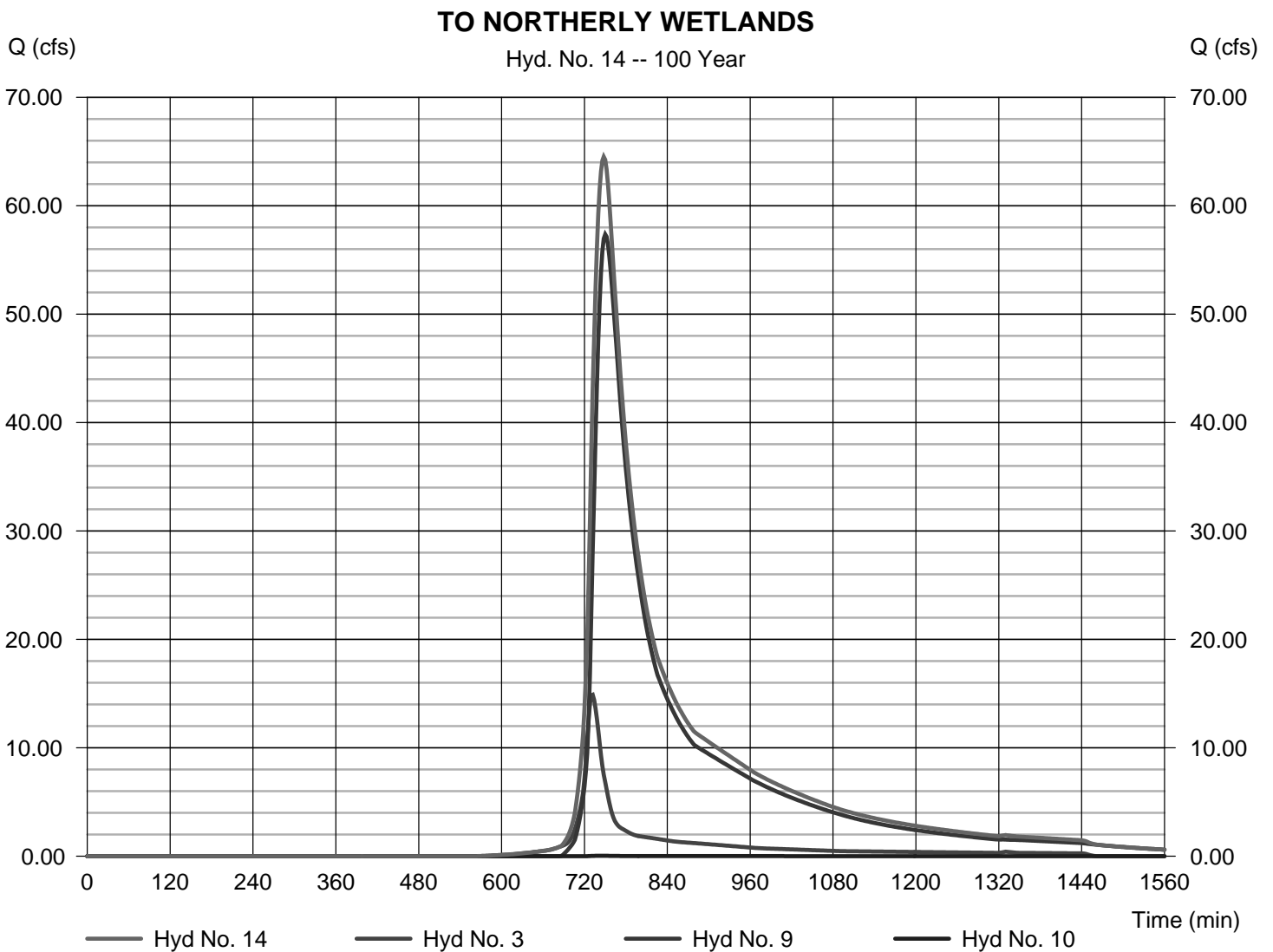
Hydrograph Report

Hyd. No. 14

TO NORTHERLY WETLANDS

Hydrograph type = Combine
Storm frequency = 100 yrs
Time interval = 2 min
Inflow hyds. = 3, 9, 10

Peak discharge = 64.52 cfs
Time to peak = 748 min
Hyd. volume = 463,979 cuft
Contrib. drain. area = 6.224 ac



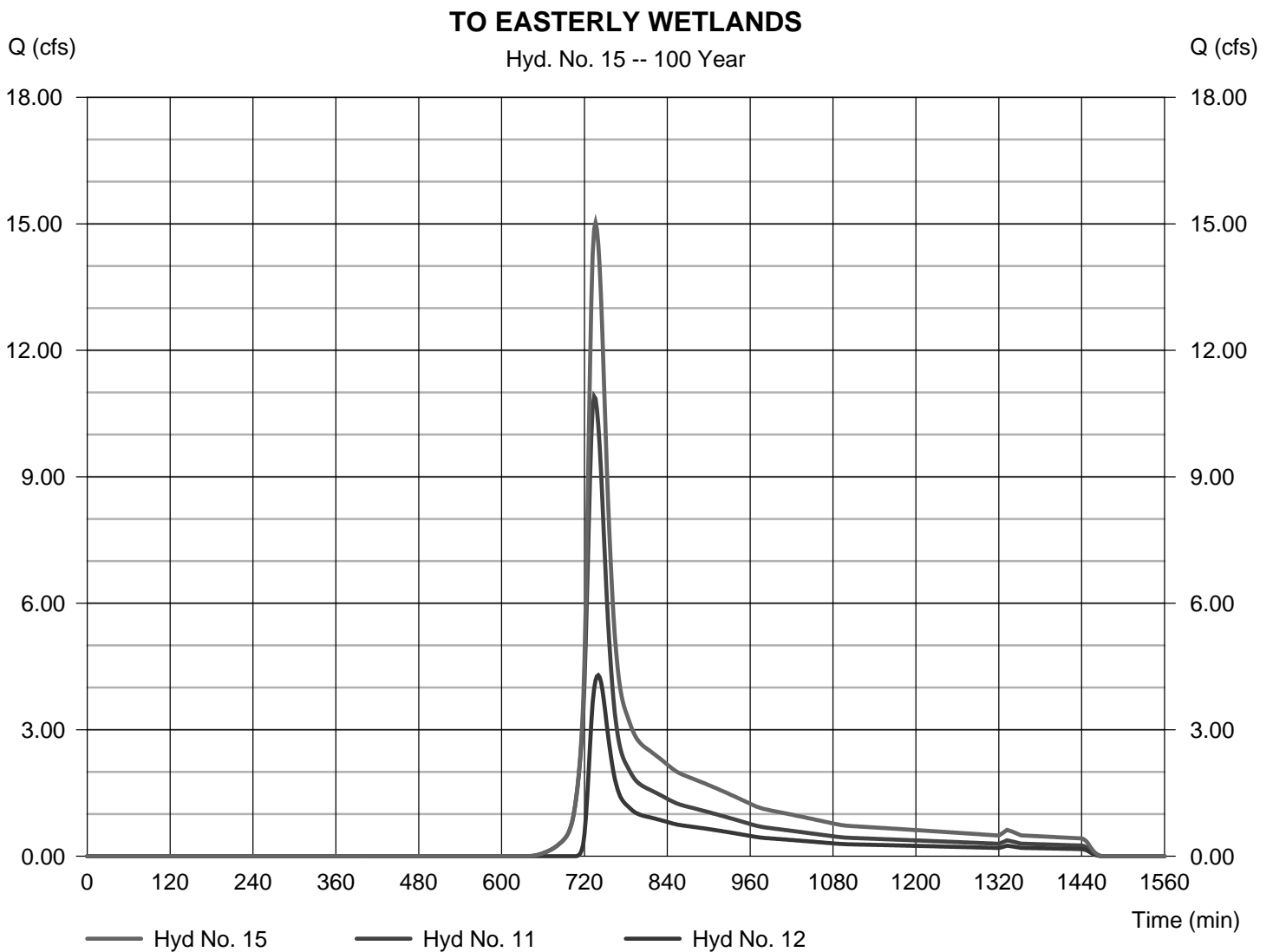
Hydrograph Report

Hyd. No. 15

TO EASTERLY WETLANDS

Hydrograph type = Combine
Storm frequency = 100 yrs
Time interval = 2 min
Inflow hyds. = 11, 12

Peak discharge = 15.02 cfs
Time to peak = 736 min
Hyd. volume = 76,317 cuft
Contrib. drain. area = 13.233 ac



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	0.0000	0.0000	0.0000	-----
2	42.4120	9.2500	0.7886	-----
3	0.0000	0.0000	0.0000	-----
5	56.7673	11.0000	0.7948	-----
10	67.9290	12.0000	0.8012	-----
25	85.5668	13.2500	0.8118	-----
50	97.8027	13.7500	0.8148	-----
100	112.8269	14.5000	0.8222	-----

File name: Sample.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	5.22	4.12	3.43	2.96	2.61	2.35	2.14	1.96	1.82	1.70	1.59	1.50
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.27	5.05	4.26	3.70	3.29	2.97	2.71	2.49	2.32	2.16	2.03	1.92
10	7.02	5.71	4.84	4.23	3.76	3.40	3.11	2.87	2.66	2.49	2.34	2.21
25	8.10	6.65	5.68	4.98	4.44	4.02	3.68	3.39	3.16	2.95	2.78	2.62
50	8.98	7.40	6.34	5.56	4.97	4.50	4.12	3.81	3.54	3.31	3.11	2.94
100	9.81	8.13	6.98	6.14	5.49	4.98	4.56	4.22	3.92	3.67	3.45	3.26

Tc = time in minutes. Values may exceed 60.

Precip. file name: Sample.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	2.50	3.10	0.00	3.30	4.50	5.30	5.90	6.50
SCS 6-Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-1st	0.00	0.00	0.00	2.75	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	2.75	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	2.80	0.00	0.00	0.00	0.00

KELLY ENGINEERING GROUP, INC.
Zero Campanelli Drive-Braintree-MA 02184 Phone 781 843 4333

Attachment C
Recharge Systems

Required Recharge Volume

Total Impervious Area on site = 543,985 s.f.

155,778 s.f. within Group A Soils

388,207 s.f. within Group D Soils

Group A Required Volume = $.6 * 155,778 * 1/12 = 7,789$ cu ft.

Group D Required Volume = $.1 * 388,207 * 1/12 = 3,235$ cu .ft.

Total Volume Required = 11,024 cu. ft.

Provided:

- 1) 9 ea. Cultec subsurface recharge systems. Each system has 16 chambers.
6 Systems in D soils with a dedicated recharge volume of 265 cu.ft. = 1,590 cu.ft.
3 Systems in A soils with a dedicated recharge volume of 448 cu.ft = 1,344 cu.ft

Total in Recharge Chambers: = 2,934

See attached Cultec Calculator and details for additional information.

- 2) Volume in Stormwater Management Pond = 9,609 cu. ft.

See attached Stage Storage calculation:

Total Provided = 12,543cu.ft.

Drain Down Time: 72 hour drain down time is required

Group D soils = .09 in/hr

Group A soils = 4.0 in/hr

Cultech Systems:

Each system is 62.5' x 8.33' = 521 s.f.

Group D soils: 521 s.f. *.09 in/hr *1/12 = 3.91 cu.ft./hr

265 cu.ft /3.91 cu.ft/hr = 67 hours

Group A soils: 521 s.f. * 4.0 in/hr *1/12 = 173.7

447 cu.ft/ 173.7 = 2.6 hours

Recharge Pond:

12,609 s.f * 4 in/hr *1/12 = 4,203 cu.ft/ hr = 1.17 CFS

12,609 cu.ft/ 4,203 cu.ft./hr = 3.0 hours

Prepared For:

Name	
Company Name	
Street Address	
City	
State	Zip
Phone	
Fax	
Email	

Project Information:

Name	Ashland
Street Address	
City	
State	Zip
Date:	(mm/dd)

Engineer:

Name	
Company Name	
Street Address	
City	
State	Zip
Phone	
Fax	
Email	

Calculations Performed By:

Name	
Company Name	
Street Address	
City	
State	Zip
Phone	
Fax	
Email	

Input Given Parameters

Unit of Measure	English
Select Model	Contactor 100HD
Stone Porosity	40.0%
Number of Header Systems	1 Header
Stone Depth Above Chamber	6 inches
Stone Depth Below Chamber	6 inches
Workable Bed Depth	10.00 feet
Max. Bed Width	10.00 feet
Storage Volume Required	500.00 cu. feet



Chamber Specifications

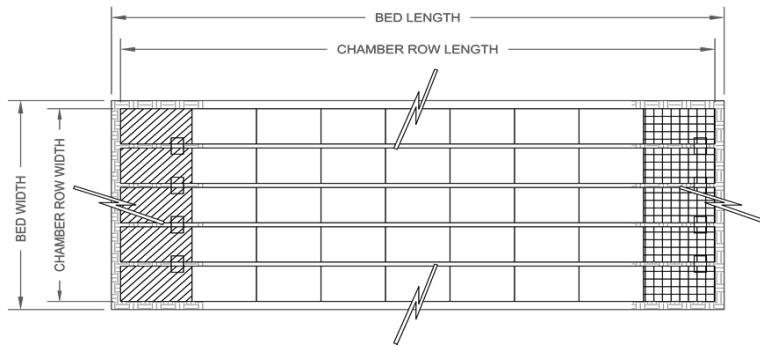
Height	12.5	inches
Width	36.00	inches
Length	8.00	feet
Installed Length	7.50	feet
Bare Chamber Volume	14.00	cu. feet
Installed Chamber Volume	28.81	cu. feet
Bed Depth	2.96	feet
Bed Width	8.33	feet
Storage Volume Provided	560.88	cu. feet

Image for visual reference only. May not reflect selected model.

Materials List

Contactor 100HD Stormwater System by CULTEC, Inc.			
Approx. Unit Count - not for construction	17	pieces	
Actual Number of Chambers Required	16	pieces	
Starter Chambers	2	pieces	
Intermediate Chambers	0	pieces	
End Chambers	14	pieces	
			HVLV SFCx2 1 pieces
			CULTEC No. 410™ Filter Fabric 162.67 sq. yards
			CULTEC No. 20L Polyethylene Liner 8.33 feet
			Stone 31.02 cu. yards
			Volume of Excavation 57.07 cu. yards

Bed Detail



Number of Rows Wide	2	pieces
Number of Chambers Long	8	pieces
Chamber Row Width	6.33	feet
Chamber Row Length	60.50	feet
Bed Width	8.33	feet
Bed Length	62.50	feet
Bed Area Required	520.83	sq. feet

Bed detail for reference only. Not project specific. Not to scale. Use CULTEC StormGenie to output project specific detail.

Project Name: Name

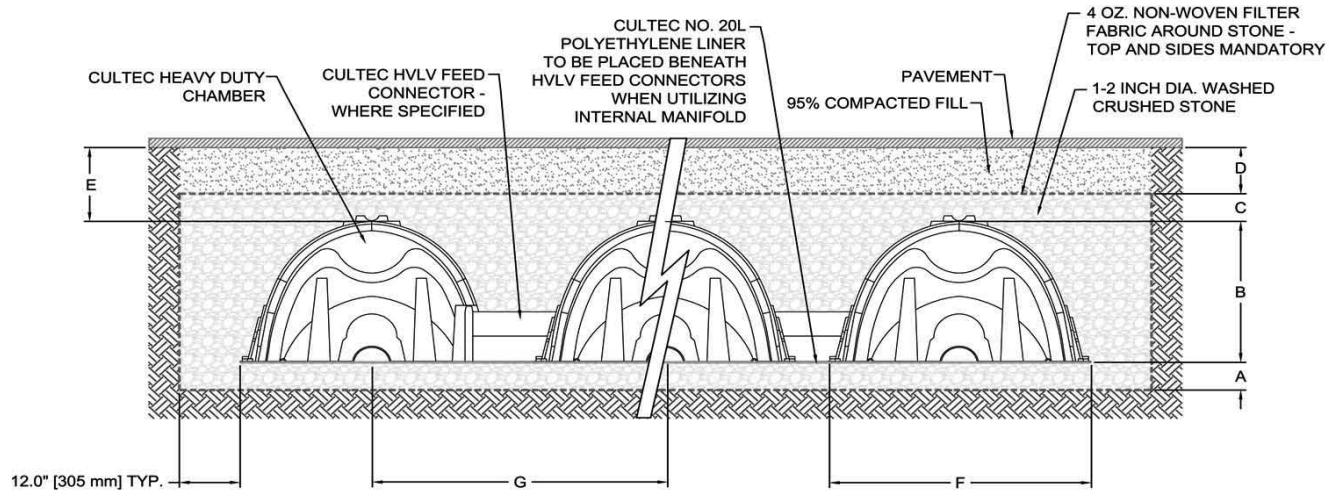
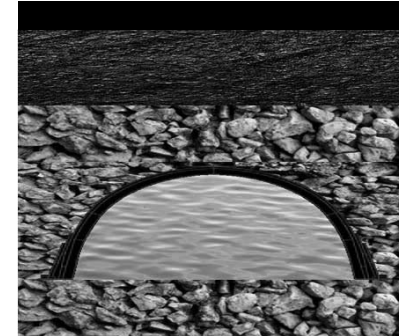
Date: (mm/dd)

Cross Section Detail



Conceptual graphic only. Not job specific.

Contactor 100HD		
Pavement	3	inches
95% Compacted Fill	8	inches
Stone Above	6	inches
Chamber Height	12.5	inches
Stone Below	6	inches
Effective Depth	24.5	inches
Bed Depth	35.5	inches



A	Depth of Stone Base	6.0	inches
B	Chamber Height	12.5	inches
C	Depth of Stone Above Units	6.0	inches
D	Depth of 95% Compacted Fill	8.0	inches
E	Max. Depth of Cover Allowed Above Crown of Chamber	14.0	feet
F	Chamber Width	36.0	inches
G	Center to Center Spacing	3.33	feet

Breakdown of Storage Provided by Contactor 100HD Stormwater System		
Chambers	225.79	cu. feet
Feed Connectors	0.10	cu. feet
Stone	334.99	cu. feet
Total Storage Provided	560.88	cu. feet



Number of chambers -
Stone Void -
Base of Stone Elevation -
Stone Border

16
0.40
1.00
136.00
0.90

Given: 6" stone base
6" stone above units
40" center to center

Length
Width

CULTEC Contactor 100HD Incremental Storage Volumes

Height of System (in)	Chamber Ht (in)	Incremental Chamber (ft ³)	cumulative storage per chamber alone (ft3)	cumulative storage per chamber alone (m3)	Incremental Stone (ft ³)	Incremental Chamber & Stone (ft ³)	Cumulative Storage per Chamber (ft ³)	Cumulative Storage for System (ft ³)	Elevation	Stone Border	Cummulative stone border	Total System
24.5		0.000			0.83	0.83	28.81	461.02	3.04	4.08	99.96	560.98
23.5		0.000			0.83	0.83	27.98	447.69	2.96	4.08	95.88	543.57
22.5		0.000			0.83	0.83	27.15	434.35	2.88	4.08	91.8	526.15
21.5		0.000			0.83	0.83	26.31	421.02	2.79	4.08	87.72	508.74
20.5		0.000			0.83	0.83	25.48	407.69	2.71	4.08	83.64	491.33
19.5		0.000			0.83	0.83	24.65	394.35	2.63	4.08	79.56	473.91
18.5	12.5	0.000			0.42	0.42	23.81	381.02	2.54	2.04	75.48	456.50
18	12	0.068	13.995	0.396	0.81	0.87	23.40	374.35	2.50	4.08	73.44	447.79
17	11	0.503	13.928	0.394	0.63	1.13	22.52	360.37	2.42	4.08	69.36	429.73
16	10	0.825	13.425	0.380	0.50	1.33	21.39	342.21	2.33	4.08	65.28	407.49
15	9	1.043	12.600	0.357	0.42	1.46	20.06	320.96	2.25	4.08	61.2	382.16
14	8	1.193	11.558	0.327	0.36	1.55	18.60	297.62	2.17	4.08	57.12	354.74
13	7	1.305	10.365	0.294	0.31	1.62	17.05	272.84	2.08	4.08	53.04	325.88
12	6	1.380	9.060	0.257	0.28	1.66	15.44	246.98	2.00	4.08	48.96	295.94
11	5	1.440	7.680	0.217	0.26	1.70	13.77	220.39	1.92	4.08	44.88	265.27
10	4	1.523	6.240	0.177	0.22	1.75	12.08	193.24	1.83	4.08	40.8	234.04
9	3	1.523	4.718	0.134	0.22	1.75	10.33	165.29	1.75	4.08	36.72	202.01
8	2	1.523	3.195	0.090	0.22	1.75	8.58	137.34	1.67	4.08	32.64	169.98
7	1	1.673	1.673	0.047	0.16	1.84	6.84	109.39	1.58	4.08	28.56	137.95
6		0.000			0.83	0.83	5.00	80.00	1.50	4.08	24.48	104.48
5		0.000			0.83	0.83	4.17	66.67	1.42	4.08	20.4	87.07
4		0.000			0.83	0.83	3.33	53.33	1.33	4.08	16.32	69.65
3		0.000			0.83	0.83	2.50	40.00	1.25	4.08	12.24	52.24
2		0.000			0.83	0.83	1.67	26.67	1.17	4.08	8.16	34.83
1		0.000			0.83	0.83	0.83	13.33	1.08	4.08	4.08	17.41
TOTALS		13.995			14.82	28.81	28.81	461.02		4.08		560.98

Dedicated storage for blds 4-9

Dedicated storage for blds 1-3

Pond Report

Pond No. 1 - Detention

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Begining Elevation = 268.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	268.00	11,426	0	0
0.80	268.80	12,609	9,609	9,609
2.40	270.40	16,375	23,119	32,729
2.60	270.60	39,500	5,420	38,148
6.00	274.00	48,396	149,153	187,301

dedicated to recharge

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 10.00	12.00	0.00	0.00
Span (in)	= 10.00	12.00	0.00	0.00
No. Barrels	= 2	2	0	0
Invert El. (ft)	= 268.80	270.50	0.00	0.00
Length (ft)	= 1.00	0.00	0.00	0.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	4.00	0.00	0.00
Crest El. (ft)	= 271.00	272.00	0.00	0.00
Weir Coeff.	= 3.03	3.33	3.33	3.33
Weir Type	= 100 degV	Rect	---	---
Multi-Stage	= Yes	No	No	No
Exfil.(in/hr)	= 0.000 (by Contour)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	268.00	0.00	0.00	---	---	---	0.00	---	---	---	---	0.000
0.80	9,609	268.80	0.00	0.00	---	---	---	0.00	---	---	---	---	0.000
2.40	32,729	270.40	0.00	0.00	---	---	---	0.00	---	---	---	---	0.000
2.60	38,148	270.60	0.00	0.09 ic	---	---	---	0.00	---	---	---	---	0.088
6.00	187,301	274.00	11.43 ic	13.10 ic	---	---	11.42 s	37.67	---	---	---	---	62.19

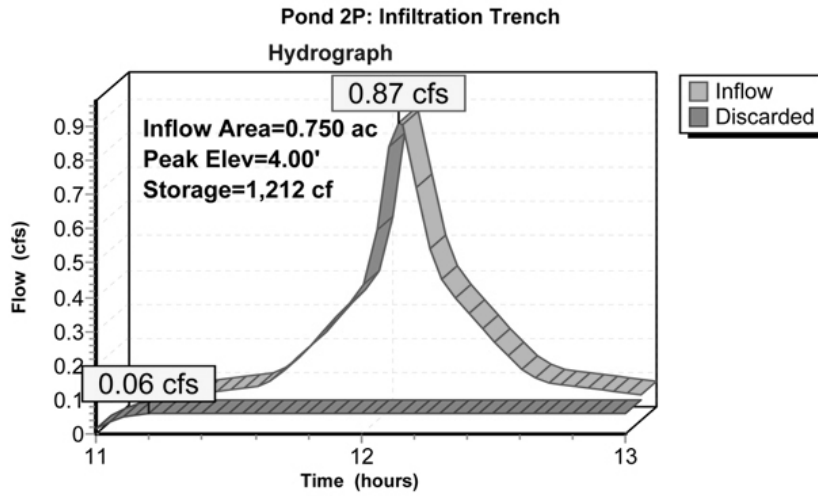


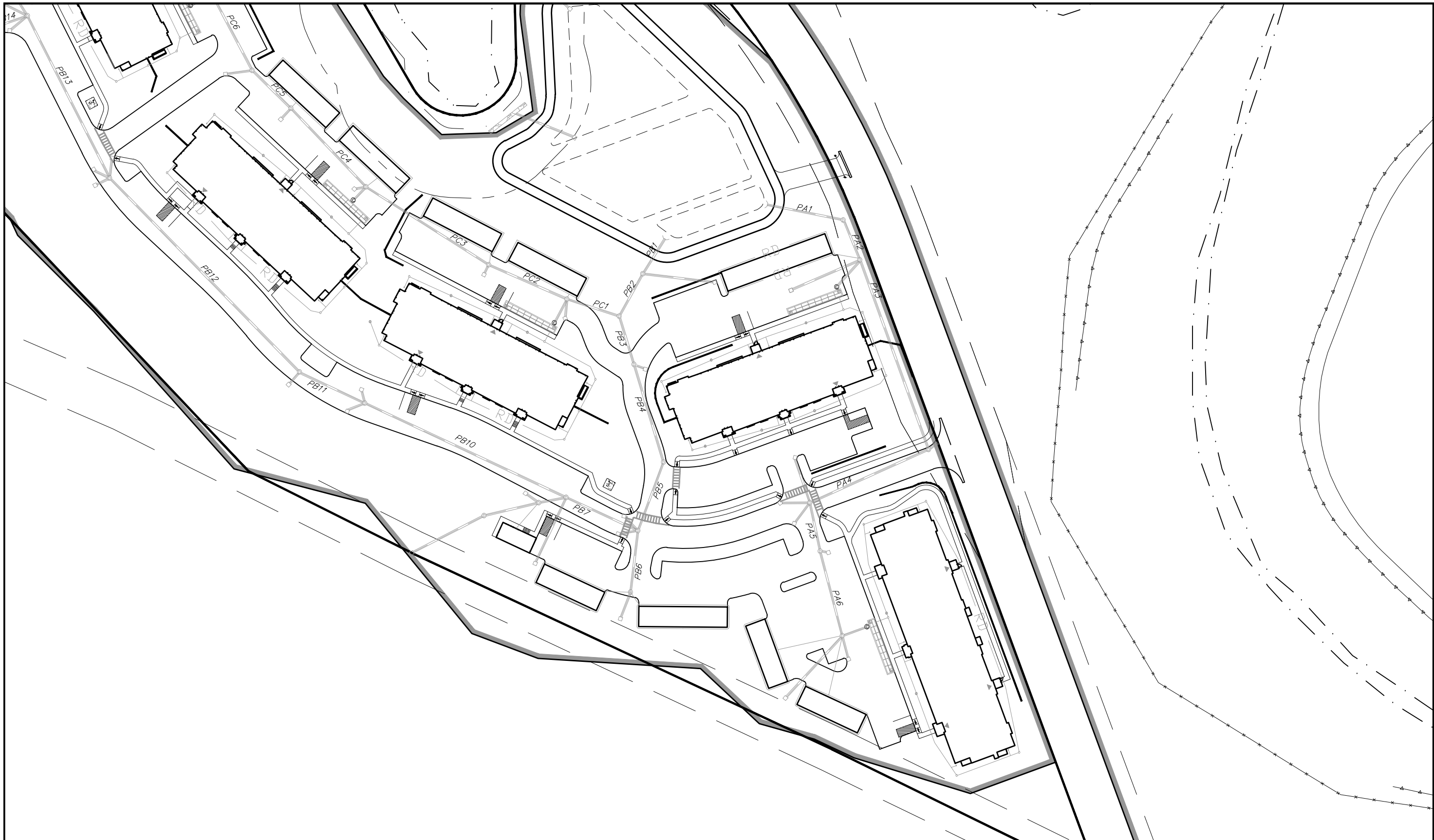
Table 2.3.3. 1982 Rawls Rates¹⁸

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

¹⁸ Rawls, Brakensiek and Saxton, 1982

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Zero Campanelli Drive-Braintree-MA 02184 Phone 781 843 4333

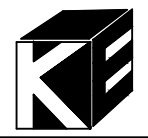
Attachment D
Pipe Sizing



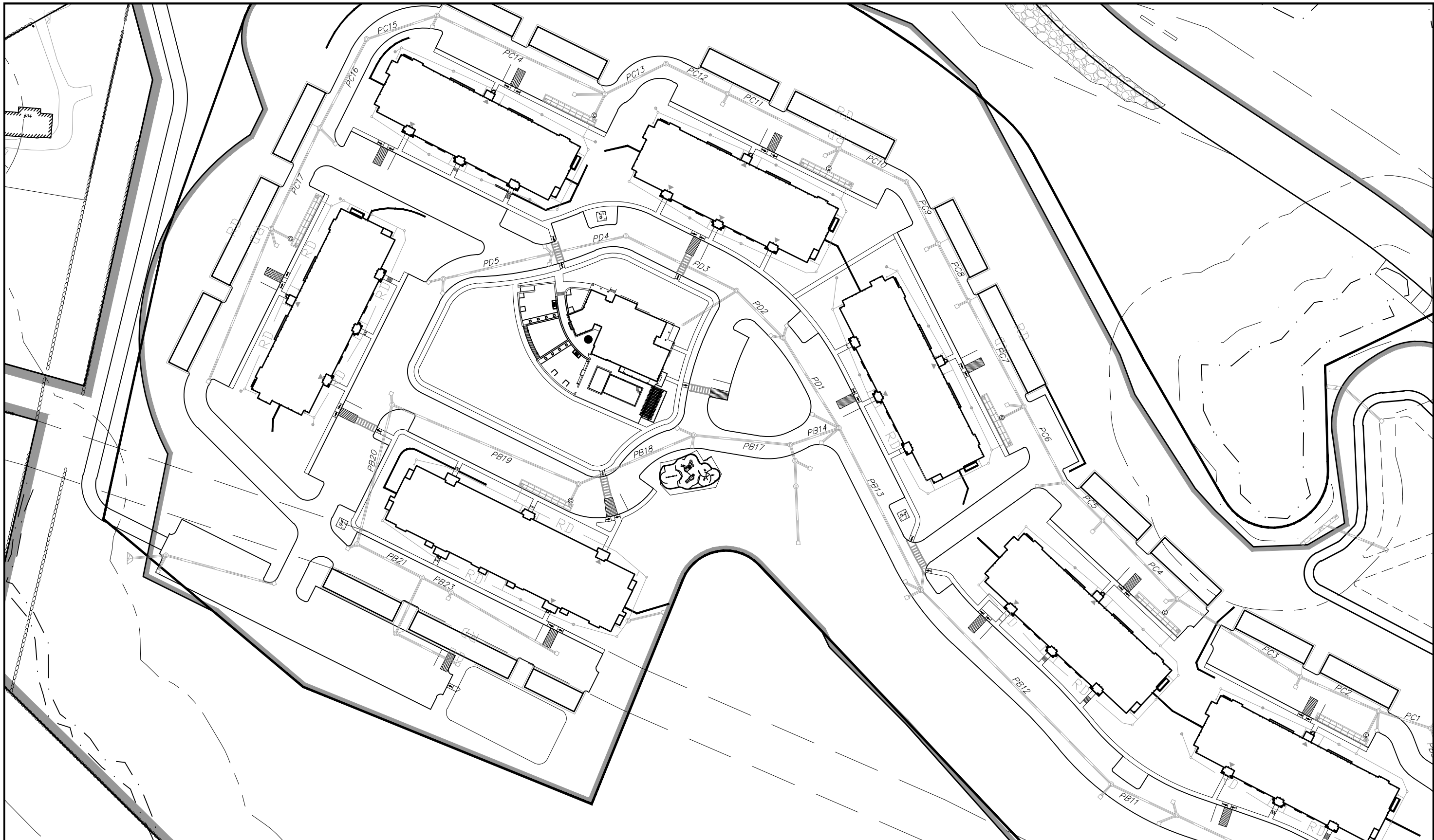
**ASHLAND RAIL TRANSIT APARTMENTS
 MBTA ACCESS ROAD
 ASHLAND, MA**

SCALE: 1" = 100'
DATE: 09/28/15
 2015-042-PRDR00

**PIPE
 SIZING
 EXHIBIT**



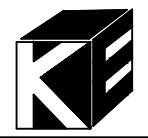
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 PHONE: 781 843 4333 FAX: 781 843 0028



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 MBTA ACCESS ROAD
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PIPE
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Rational Method Calculations

i=6.5 in/hr (25 year storm)

Pipe Run A DMH A1 - A6

	PA1	PA2	PA3	PA4	PA5	PA6
Node Area (s.f.)	0	34,229	14,237	21,668	17,462	164,459
Green area	0	7234	7234	5722	2,130	123,439
Impervious area	0	26,995	7,003	15,946	15,332	41,020
C	0.00	0.79	0.65	0.77	0.84	0.52
Node Area (AC)		0.79	0.33	0.50	0.40	3.78
Q=CIA (Node)		4.06	1.37	2.48	2.19	12.88
Total Area (s.f.)	252055	252055	217826	203589	181921	164459
Total Area (AC)	5.79	5.79	5.00	4.67	4.18	3.78
Q=CIA (Total)	22.98	22.98	18.92	17.55	15.06	12.88

Pipe Run D DMH D1 - D5

	PD1	PD2	PD3	PD4	PD5
Node Area (s.f.)	21,566	35,005	0	15,658	10,717
Green area	3519	13036	0	21969	3,796
Impervious area	18,047	21,969	0	10,506	6,921
C	0.82	0.71	0.00	1.17	0.72
Node Area (AC)	0.50	0.80	0.00	0.36	0.25
Q=CIA (Node)	2.63	3.73	0.00	2.72	1.16
Total Area (s.f.)	82946	61380	26375	26375	10717
Total Area (AC)	1.90	1.41	0.61	0.61	0.25
Q=CIA (Total)	10.24	7.61	3.88	3.88	1.16

Pipe Run C DMH C1 - C17

	PC1	PC2	PC3	PC4	PC5	PC6	PC7	PC8	PC9	PC10	PC11	PC12	PC13	PC14	PC15	PC16	PC17
Node Area (s.f.)	32,905	9,008	35,579	6,382	12,738	34,105	5,708	6,648	0	37,589	8436	0	49306	3643	0	19379	52,444
Green area	9876	2227	9971	807	4,925	11,747	0	858	0	11487	0	0	17269	0	0	4691	14,589
Impervious area	23,029	6,781	25,608	5,575	7,813	22,358	5,708	5,790	0	26,102	8,436	0	32,037	3,643	0	14,688	37,855
C	0.75	0.78	0.76	0.84	0.71	0.73	0.90	0.84	0.00	0.75	0.90	0.00	0.72	0.90	0.00	0.78	0.76
Node Area (AC)	0.76	0.21	0.82	0.15	0.29	0.78	0.13	0.15	0.00	0.86	0.19	0.00	1.13	0.08	0.00	0.44	1.20
Q=CIA (Node)	3.68	1.04	4.03	0.80	1.34	3.70	0.77	0.83	0.00	4.19	1.13	0.00	5.33	0.49	0.00	2.25	5.95
Total Area (s.f.)	313870	280965	271957	236378	229996	217258	183153	177445	170797	170797	133208	124772	124772	75466	71823	71823	52444
Total Area (AC)	7.21	6.45	6.24	5.43	5.28	4.99	4.20	4.07	3.92	3.92	3.06	2.86	2.86	1.73	1.65	1.65	1.20
Q=CIA (Total)	35.55	31.87	30.83	26.79	26.00	24.65	20.95	20.18	19.35	19.35	15.16	14.03	14.03	8.70	8.21	8.21	5.95

Pipe Run B DMH B1 - B24

	PB1	**PB2	PB3	PB4	PB5	PB7	PB10	PB11	PB12	*PB13	PB14	PB17	PB18	PB19	PB20	PB21	PB23
Node Area (s.f.)	2,995	0	14,995	0	78901	157207	26605	104531	40428	13270	34,453	40068	40247	13301	9288	32851	26409
Green area	0	0	9873	0	61485	156487	8904	104531	28016	7833	34,453	22392	20001	2621	1775	32851	11627
Impervious area	2,995	0	5,122	0	17,416	720	17,701	0	12,412	5,437	0	17,676	20,246	10,680	7,513	0	14,782
C	0.90	0.00	0.57	0.00	0.51	0.40	0.73	0.40	0.55	0.60	0.40	0.62	0.65	0.80	0.80	0.40	0.68
Node Area (AC)	0.07	0.00	0.34	0.00	1.81	3.61	0.61	2.40	0.93	0.30	0.79	0.92	0.92	0.31	0.21	0.75	0.61
Q=CIA (Node)	0.40	0.00	1.28	0.00	6.01	9.44	2.91	6.24	3.34	1.20	2.06	3.71	3.91	1.59	1.11	1.96	2.68
Total Area (s.f.)	1032365	1029370	715500	700505	700505	621604	464397	437792	333261	292833	196617	162164	122096	81849	68548	59260	26409
Total Area (AC)	23.70	23.63	16.43	16.08	16.08	14.27	10.66	10.05	7.65	6.72	4.51	3.72	2.80	1.88	1.57	1.36	0.61
Q=CIA (Total)	93.63	93.23	57.67	56.40	56.40	50.39	40.95	38.04	31.80	28.46	17.02	14.97	11.26	7.35	5.75	4.64	2.68

*PB13 - Flow from PD1 enters network

**PB2 - Flow from PC1 enters network

Note PB1 = pipe out from Drain Manhole #B1

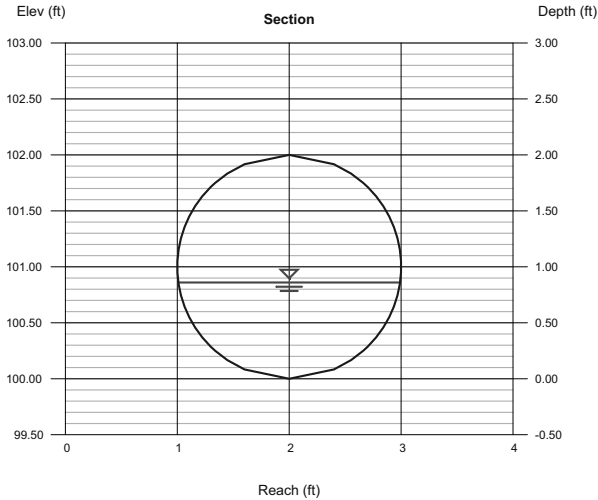
Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Tuesday, Sep 29 2015

PA1

Circular		Highlighted	
Diameter (ft)	= 2.00	Depth (ft)	= 0.86
		Q (cfs)	= 22.98
		Area (sqft)	= 1.30
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 17.67
Slope (%)	= 5.00	Wetted Perim (ft)	= 2.87
N-Value	= 0.011	Crit Depth, Yc (ft)	= 1.71
		Top Width (ft)	= 1.98
		EGL (ft)	= 5.71
Calculations			
Compute by:	Known Q		
Known Q (cfs)	= 22.98		



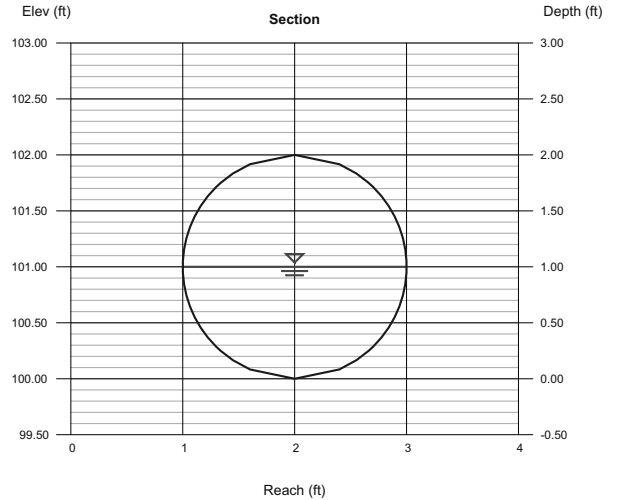
Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Tuesday, Sep 29 2015

PA2

Circular		Highlighted	
Diameter (ft)	= 2.00	Depth (ft)	= 1.00
		Q (cfs)	= 22.98
		Area (sqft)	= 1.58
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 14.55
Slope (%)	= 3.00	Wetted Perim (ft)	= 3.15
N-Value	= 0.011	Crit Depth, Yc (ft)	= 1.71
		Top Width (ft)	= 2.00
		EGL (ft)	= 4.29
Calculations			
Compute by:	Known Q		
Known Q (cfs)	= 22.98		



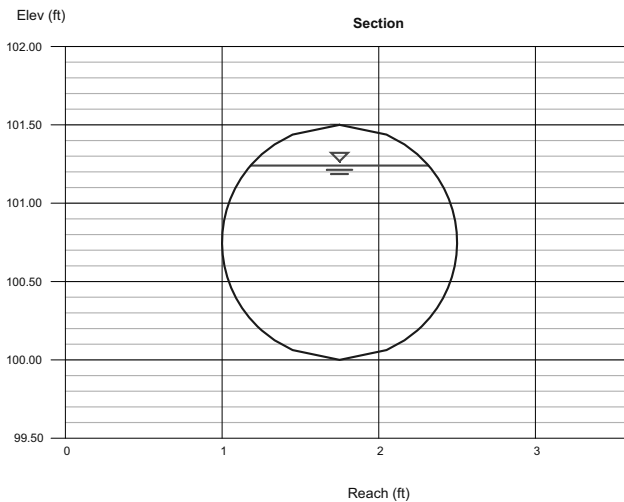
Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Tuesday, Sep 29 2015

PA3

Circular		Highlighted	
Diameter (ft)	= 1.50	Depth (ft)	= 1.24
		Q (cfs)	= 18.92
		Area (sqft)	= 1.56
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 12.10
Slope (%)	= 2.30	Wetted Perim (ft)	= 3.43
N-Value	= 0.011	Crit Depth, Yc (ft)	= 1.46
		Top Width (ft)	= 1.13
		EGL (ft)	= 3.52
Calculations			
Compute by:	Known Q		
Known Q (cfs)	= 18.92		



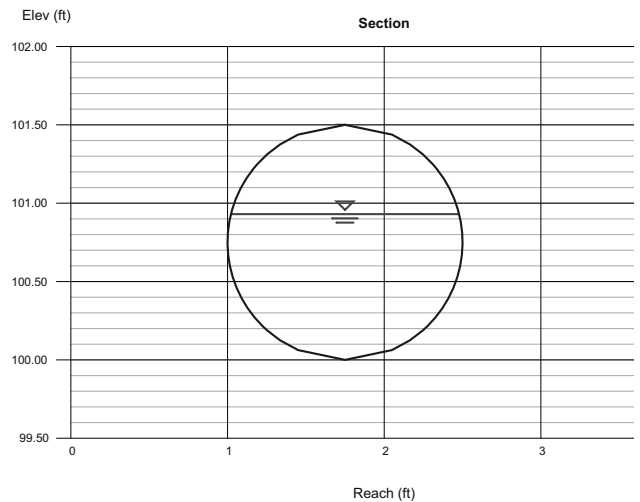
Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Tuesday, Sep 29 2015

PA4

Circular		Highlighted	
Diameter (ft)	= 1.50	Depth (ft)	= 0.93
		Q (cfs)	= 17.55
		Area (sqft)	= 1.15
Invert Elev (ft)	= 100.00	Velocity (ft/s)	= 15.22
Slope (%)	= 4.10	Wetted Perim (ft)	= 2.72
N-Value	= 0.011	Crit Depth, Yc (ft)	= 1.45
		Top Width (ft)	= 1.46
		EGL (ft)	= 4.53
Calculations			
Compute by:	Known Q		
Known Q (cfs)	= 17.55		



Channel Report

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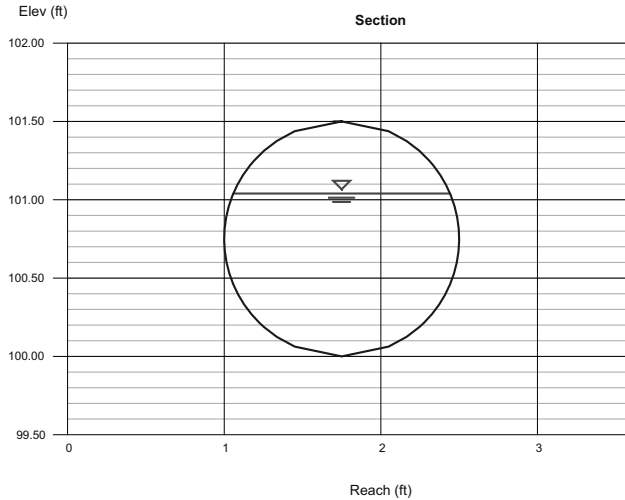
Tuesday, Sep 29 2015

PA5

Circular
 Diameter (ft) = 1.50
 Invert Elev (ft) = 100.00
 Slope (%) = 2.20
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 15.06

Highlighted
 Depth (ft) = 1.04
 Q (cfs) = 15.06
 Area (sqft) = 1.31
 Velocity (ft/s) = 11.50
 Wetted Perim (ft) = 2.95
 Crit Depth, Yc (ft) = 1.41
 Top Width (ft) = 1.38
 EGL (ft) = 3.10



Channel Report

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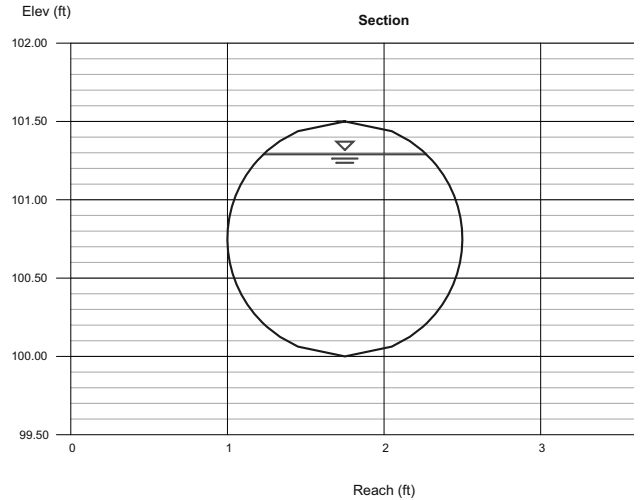
Tuesday, Sep 29 2015

PA6

Circular
 Diameter (ft) = 1.50
 Invert Elev (ft) = 100.00
 Slope (%) = 1.00
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 12.88

Highlighted
 Depth (ft) = 1.29
 Q (cfs) = 12.88
 Area (sqft) = 1.62
 Velocity (ft/s) = 7.97
 Wetted Perim (ft) = 3.56
 Crit Depth, Yc (ft) = 1.35
 Top Width (ft) = 1.04
 EGL (ft) = 2.28



Channel Report

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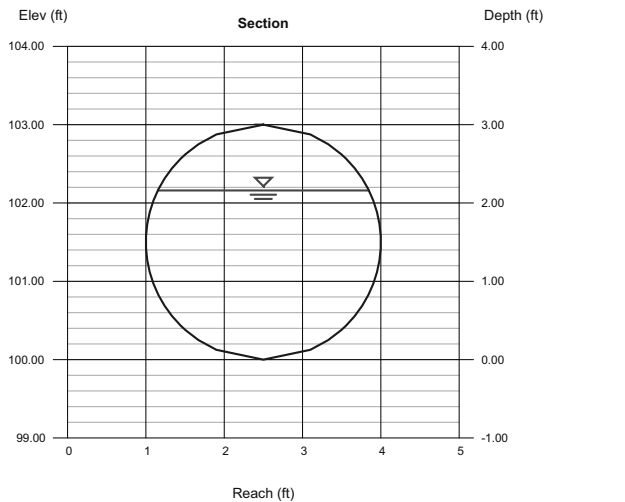
Monday, Sep 28 2015

PB1

Circular
 Diameter (ft) = 3.00
 Invert Elev (ft) = 100.00
 Slope (%) = 2.00
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 96.63

Highlighted
 Depth (ft) = 2.16
 Q (cfs) = 96.63
 Area (sqft) = 5.46
 Velocity (ft/s) = 17.69
 Wetted Perim (ft) = 6.09
 Crit Depth, Yc (ft) = 2.89
 Top Width (ft) = 2.69
 EGL (ft) = 7.03



Channel Report

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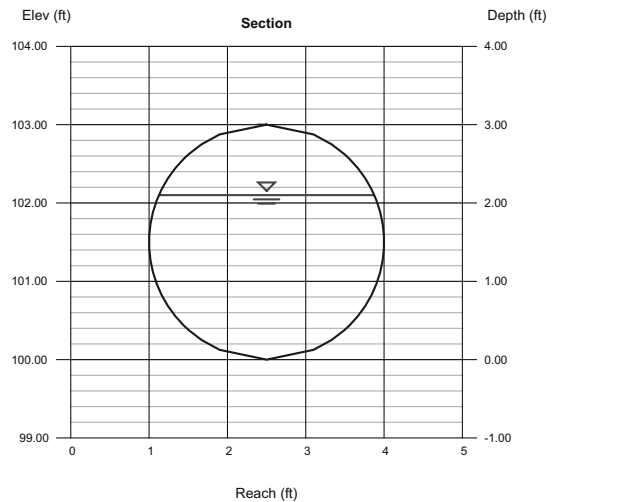
Monday, Sep 28 2015

PB2

Circular
 Diameter (ft) = 3.00
 Invert Elev (ft) = 100.00
 Slope (%) = 2.00
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 93.23

Highlighted
 Depth (ft) = 2.10
 Q (cfs) = 93.23
 Area (sqft) = 5.30
 Velocity (ft/s) = 17.61
 Wetted Perim (ft) = 5.95
 Crit Depth, Yc (ft) = 2.87
 Top Width (ft) = 2.75
 EGL (ft) = 6.92



Channel Report

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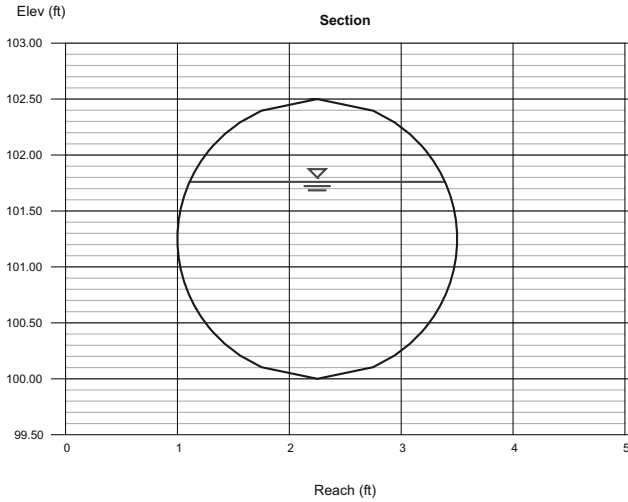
Monday, Sep 28 2015

PB3

Circular
 Diameter (ft) = 2.50
 Invert Elev (ft) = 100.00
 Slope (%) = 2.00
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 57.67

Highlighted
 Depth (ft) = 1.76
 Q (cfs) = 57.67
 Area (sqft) = 3.70
 Velocity (ft/s) = 15.57
 Wetted Perim (ft) = 4.99
 Crit Depth, Yc (ft) = 2.38
 Top Width (ft) = 2.28
 EGL (ft) = 5.53



Channel Report

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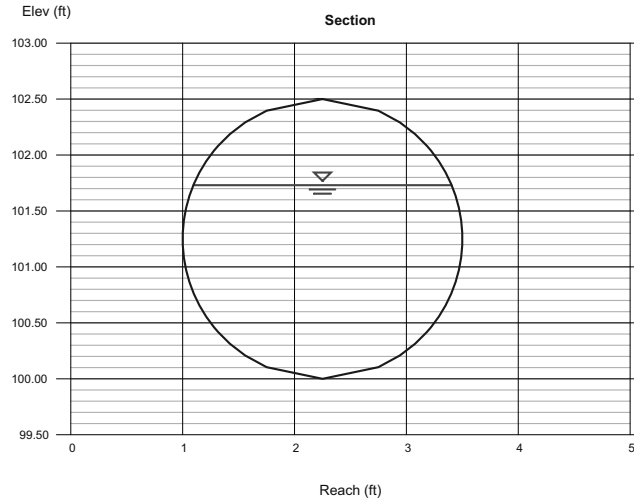
Monday, Sep 28 2015

PB4

Circular
 Diameter (ft) = 2.50
 Invert Elev (ft) = 100.00
 Slope (%) = 2.00
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 56.40

Highlighted
 Depth (ft) = 1.73
 Q (cfs) = 56.40
 Area (sqft) = 3.62
 Velocity (ft/s) = 15.56
 Wetted Perim (ft) = 4.91
 Crit Depth, Yc (ft) = 2.37
 Top Width (ft) = 2.31
 EGL (ft) = 5.49



Channel Report

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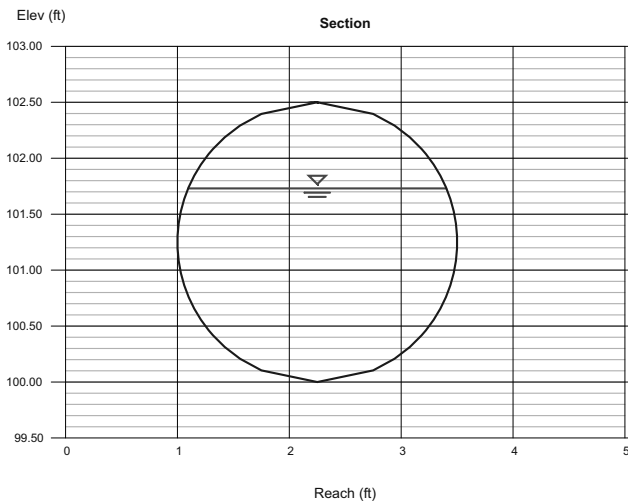
Monday, Sep 28 2015

PB5

Circular
 Diameter (ft) = 2.50
 Invert Elev (ft) = 100.00
 Slope (%) = 2.00
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 56.40

Highlighted
 Depth (ft) = 1.73
 Q (cfs) = 56.40
 Area (sqft) = 3.62
 Velocity (ft/s) = 15.56
 Wetted Perim (ft) = 4.91
 Crit Depth, Yc (ft) = 2.37
 Top Width (ft) = 2.31
 EGL (ft) = 5.49



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

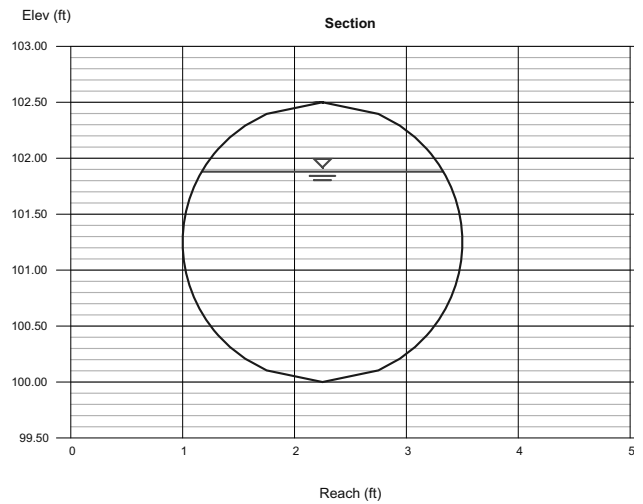
Monday, Sep 28 2015

PB7

Circular
 Diameter (ft) = 2.50
 Invert Elev (ft) = 100.00
 Slope (%) = 1.30
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 50.39

Highlighted
 Depth (ft) = 1.88
 Q (cfs) = 50.39
 Area (sqft) = 3.96
 Velocity (ft/s) = 12.72
 Wetted Perim (ft) = 5.25
 Crit Depth, Yc (ft) = 2.31
 Top Width (ft) = 2.16
 EGL (ft) = 4.39



Channel Report

Hydraulix Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

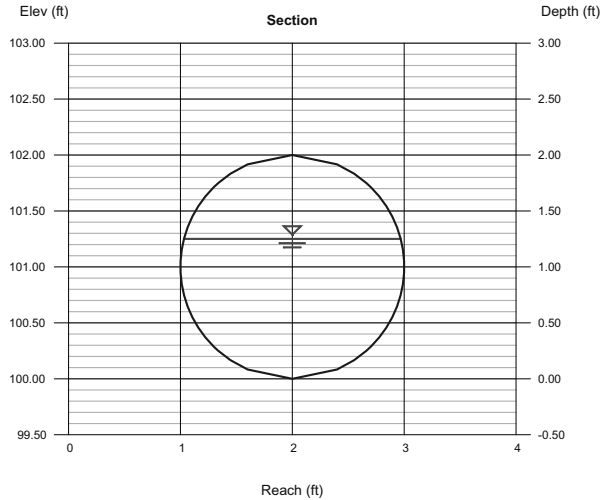
Monday, Sep 28 2015

PB10

Circular
 Diameter (ft) = 2.00
 Invert Elev (ft) = 100.00
 Slope (%) = 4.60
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 40.95

Highlighted
 Depth (ft) = 1.25
 Q (cfs) = 40.95
 Area (sqft) = 2.07
 Velocity (ft/s) = 19.80
 Wetted Perim (ft) = 3.65
 Crit Depth, Yc (ft) = 1.96
 Top Width (ft) = 1.94
 EGL (ft) = 7.34



Channel Report

Hydraulix Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

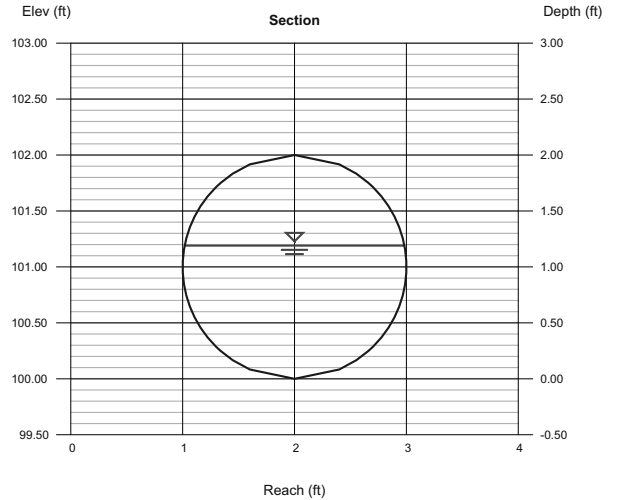
Monday, Sep 28 2015

PB11

Circular
 Diameter (ft) = 2.00
 Invert Elev (ft) = 100.00
 Slope (%) = 4.60
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 38.04

Highlighted
 Depth (ft) = 1.19
 Q (cfs) = 38.04
 Area (sqft) = 1.95
 Velocity (ft/s) = 19.46
 Wetted Perim (ft) = 3.53
 Crit Depth, Yc (ft) = 1.95
 Top Width (ft) = 1.96
 EGL (ft) = 7.08



Channel Report

Hydraulix Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

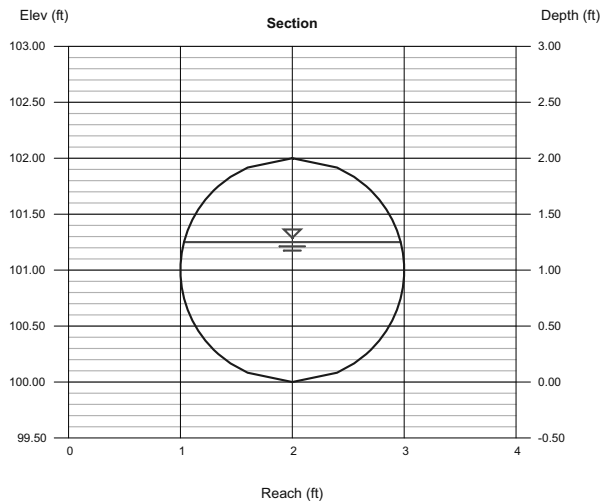
Monday, Sep 28 2015

PB12

Circular
 Diameter (ft) = 2.00
 Invert Elev (ft) = 100.00
 Slope (%) = 2.80
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 31.80

Highlighted
 Depth (ft) = 1.25
 Q (cfs) = 31.80
 Area (sqft) = 2.07
 Velocity (ft/s) = 15.37
 Wetted Perim (ft) = 3.65
 Crit Depth, Yc (ft) = 1.89
 Top Width (ft) = 1.94
 EGL (ft) = 4.92



Channel Report

Hydraulix Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

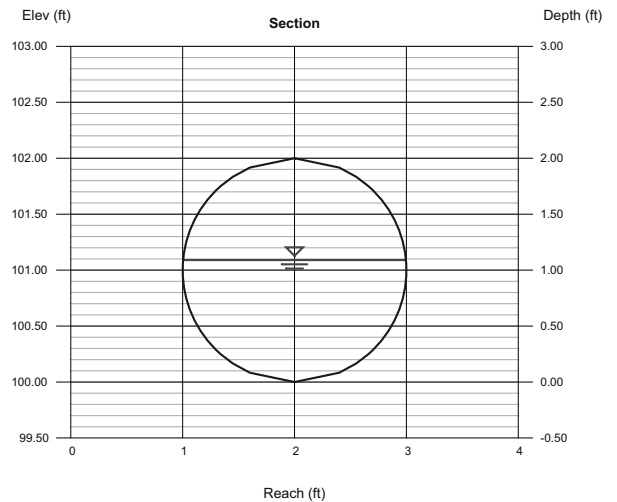
Monday, Sep 28 2015

PB13

Circular
 Diameter (ft) = 2.00
 Invert Elev (ft) = 100.00
 Slope (%) = 3.40
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 28.46

Highlighted
 Depth (ft) = 1.09
 Q (cfs) = 28.46
 Area (sqft) = 1.76
 Velocity (ft/s) = 16.18
 Wetted Perim (ft) = 3.33
 Crit Depth, Yc (ft) = 1.84
 Top Width (ft) = 1.99
 EGL (ft) = 5.16



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

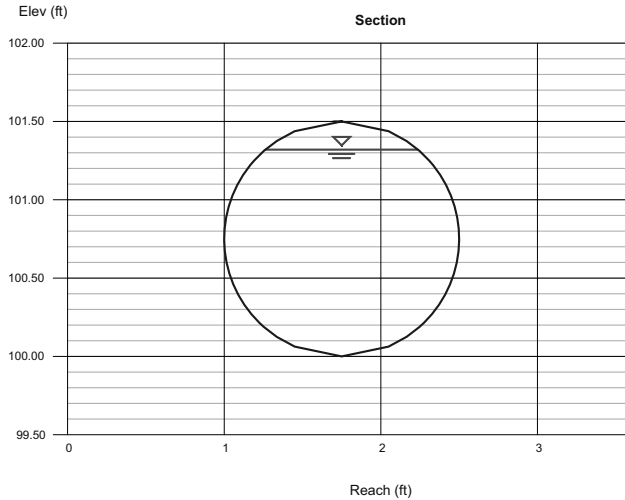
Tuesday, Sep 29 2015

PB14

Circular
 Diameter (ft) = 1.50
 Invert Elev (ft) = 100.00
 Slope (%) = 1.70
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 17.03

Highlighted
 Depth (ft) = 1.32
 Q (cfs) = 17.03
 Area (sqft) = 1.65
 Velocity (ft/s) = 10.34
 Wetted Perim (ft) = 3.65
 Crit Depth, Yc (ft) = 1.44
 Top Width (ft) = 0.97
 EGL (ft) = 2.98



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

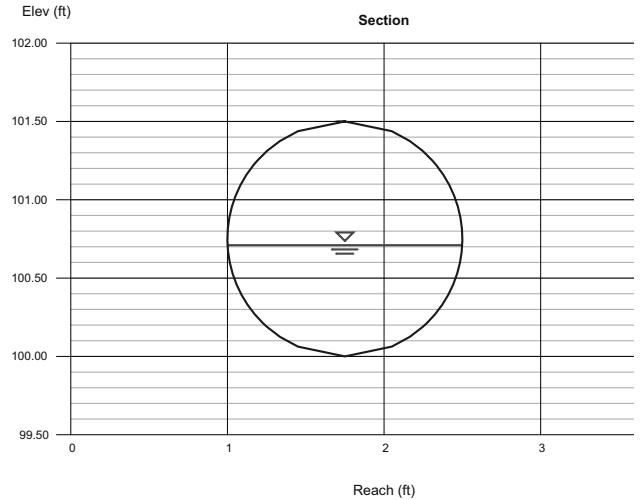
Tuesday, Sep 29 2015

PB17

Circular
 Diameter (ft) = 1.50
 Invert Elev (ft) = 100.00
 Slope (%) = 7.10
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 14.97

Highlighted
 Depth (ft) = 0.71
 Q (cfs) = 14.97
 Area (sqft) = 0.83
 Velocity (ft/s) = 18.11
 Wetted Perim (ft) = 2.28
 Crit Depth, Yc (ft) = 1.41
 Top Width (ft) = 1.50
 EGL (ft) = 5.81



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

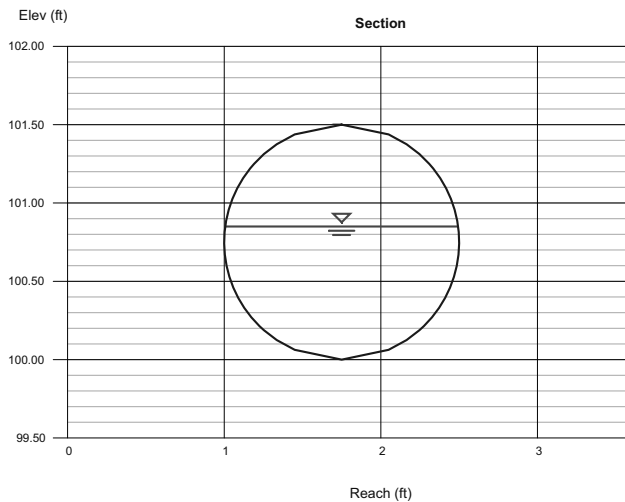
Tuesday, Sep 29 2015

PB18

Circular
 Diameter (ft) = 1.50
 Invert Elev (ft) = 100.00
 Slope (%) = 2.20
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 11.26

Highlighted
 Depth (ft) = 0.85
 Q (cfs) = 11.26
 Area (sqft) = 1.03
 Velocity (ft/s) = 10.89
 Wetted Perim (ft) = 2.56
 Crit Depth, Yc (ft) = 1.29
 Top Width (ft) = 1.49
 EGL (ft) = 2.69



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

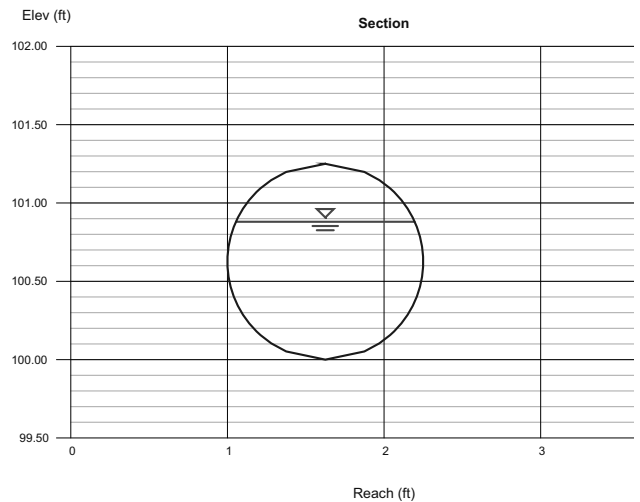
Tuesday, Sep 29 2015

PB19

Circular
 Diameter (ft) = 1.25
 Invert Elev (ft) = 100.00
 Slope (%) = 1.30
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 7.35

Highlighted
 Depth (ft) = 0.88
 Q (cfs) = 7.350
 Area (sqft) = 0.93
 Velocity (ft/s) = 7.94
 Wetted Perim (ft) = 2.49
 Crit Depth, Yc (ft) = 1.08
 Top Width (ft) = 1.14
 EGL (ft) = 1.86



Channel Report

Hydraulow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

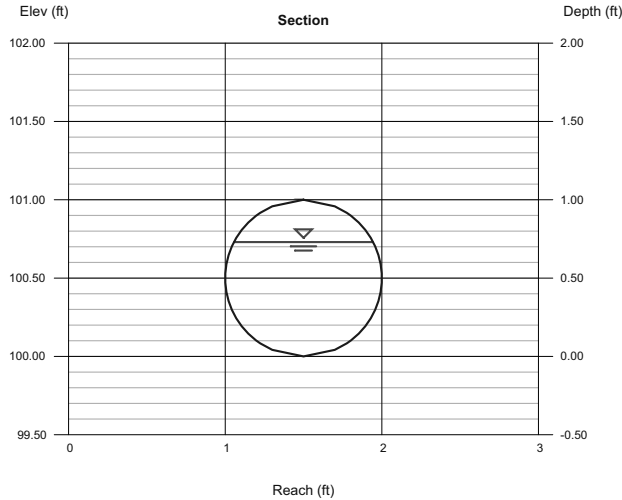
Tuesday, Sep 29 2015

PB20

Circular
 Diameter (ft) = 1.00
 Invert Elev (ft) = 100.00
 Slope (%) = 2.40
 N-Value = 0.011

Highlighted
 Depth (ft) = 0.73
 Q (cfs) = 5.750
 Area (sqft) = 0.61
 Velocity (ft/s) = 9.35
 Wetted Perim (ft) = 2.05
 Crit Depth, Yc (ft) = 0.95
 Top Width (ft) = 0.89
 EGL (ft) = 2.09

Calculations
 Compute by: Known Q
 Known Q (cfs) = 5.75



Channel Report

Hydraulow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

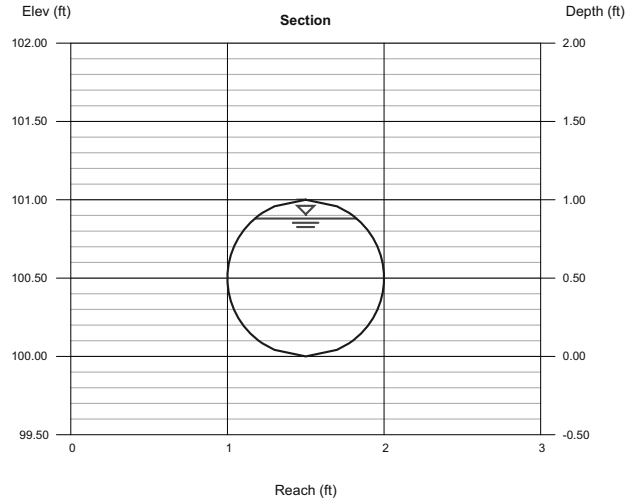
Tuesday, Sep 29 2015

PB21

Circular
 Diameter (ft) = 1.00
 Invert Elev (ft) = 100.00
 Slope (%) = 1.10
 N-Value = 0.011

Highlighted
 Depth (ft) = 0.88
 Q (cfs) = 4.640
 Area (sqft) = 0.73
 Velocity (ft/s) = 6.34
 Wetted Perim (ft) = 2.44
 Crit Depth, Yc (ft) = 0.90
 Top Width (ft) = 0.65
 EGL (ft) = 1.50

Calculations
 Compute by: Known Q
 Known Q (cfs) = 4.64



Channel Report

Hydraulow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

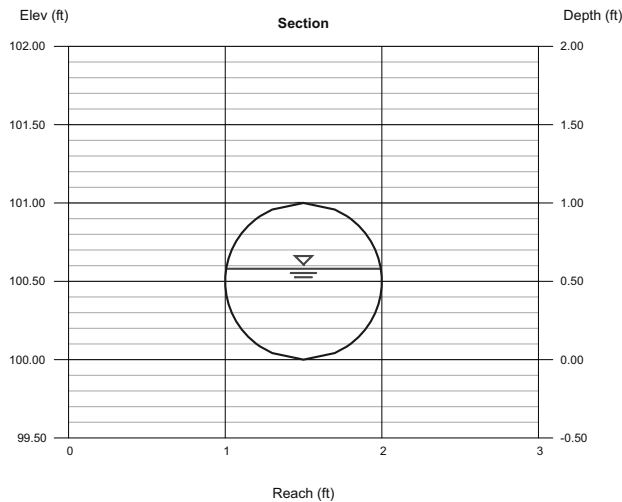
Tuesday, Sep 29 2015

PB23

Circular
 Diameter (ft) = 1.00
 Invert Elev (ft) = 100.00
 Slope (%) = 1.00
 N-Value = 0.011

Highlighted
 Depth (ft) = 0.58
 Q (cfs) = 2.680
 Area (sqft) = 0.47
 Velocity (ft/s) = 5.65
 Wetted Perim (ft) = 1.73
 Crit Depth, Yc (ft) = 0.71
 Top Width (ft) = 0.99
 EGL (ft) = 1.08

Calculations
 Compute by: Known Q
 Known Q (cfs) = 2.68



Channel Report

Hydraulow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

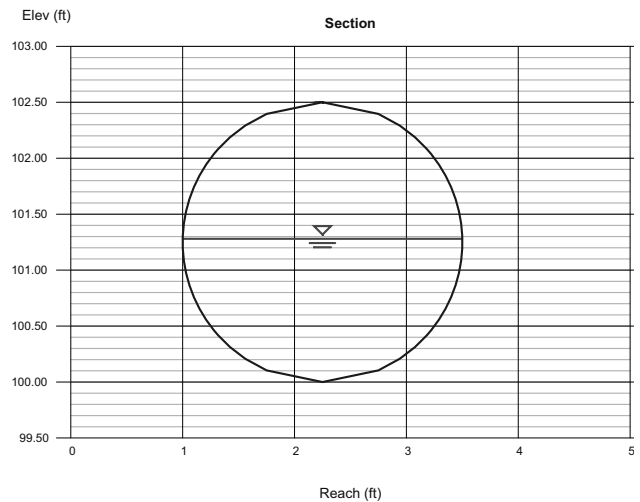
Tuesday, Sep 29 2015

PC1

Circular
 Diameter (ft) = 2.50
 Invert Elev (ft) = 100.00
 Slope (%) = 2.00
 N-Value = 0.011

Highlighted
 Depth (ft) = 1.28
 Q (cfs) = 35.55
 Area (sqft) = 2.53
 Velocity (ft/s) = 14.05
 Wetted Perim (ft) = 3.99
 Crit Depth, Yc (ft) = 2.03
 Top Width (ft) = 2.50
 EGL (ft) = 4.35

Calculations
 Compute by: Known Q
 Known Q (cfs) = 35.55



Channel Report

Hydraulow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

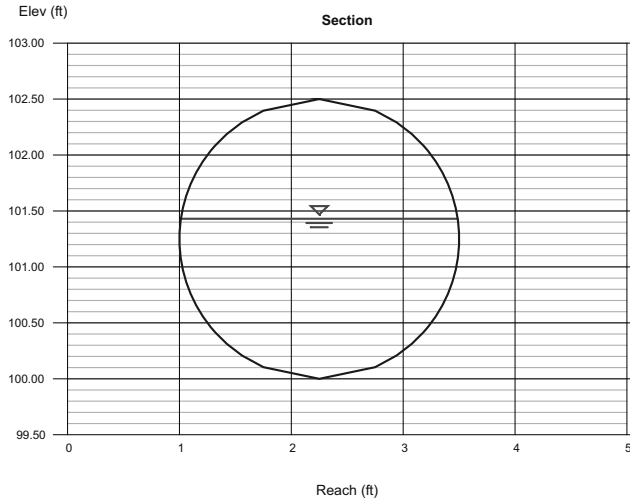
Tuesday, Sep 29 2015

PC2

Circular
 Diameter (ft) = 2.50
 Invert Elev (ft) = 100.00
 Slope (%) = 1.10
 N-Value = 0.011

Highlighted
 Depth (ft) = 1.43
 Q (cfs) = 31.87
 Area (sqft) = 2.92
 Velocity (ft/s) = 10.92
 Wetted Perim (ft) = 4.30
 Crit Depth, Yc (ft) = 1.92
 Top Width (ft) = 2.47
 EGL (ft) = 3.29

Calculations
 Compute by: Known Q
 Known Q (cfs) = 31.87



Channel Report

Hydraulow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

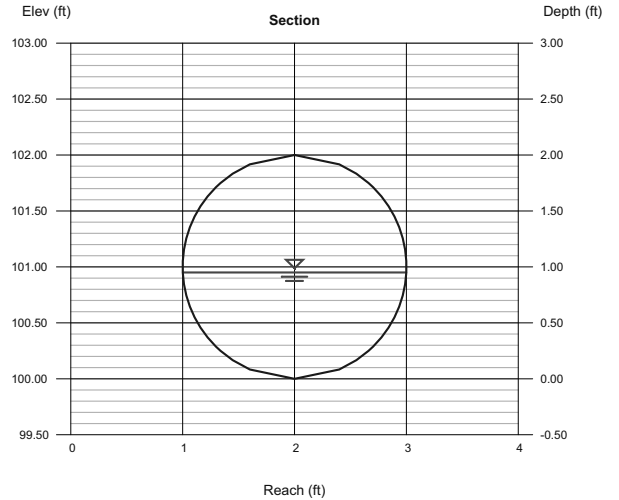
Tuesday, Sep 29 2015

PC3

Circular
 Diameter (ft) = 2.00
 Invert Elev (ft) = 100.00
 Slope (%) = 6.40
 N-Value = 0.011

Highlighted
 Depth (ft) = 0.95
 Q (cfs) = 30.83
 Area (sqft) = 1.48
 Velocity (ft/s) = 20.84
 Wetted Perim (ft) = 3.05
 Crit Depth, Yc (ft) = 1.88
 Top Width (ft) = 2.00
 EGL (ft) = 7.70

Calculations
 Compute by: Known Q
 Known Q (cfs) = 30.83



Channel Report

Hydraulow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

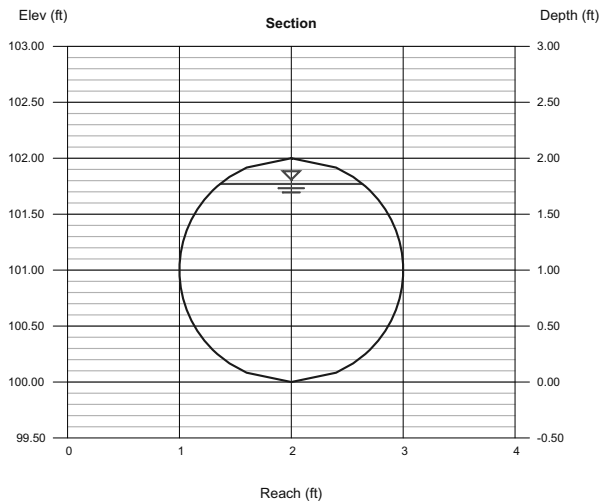
Tuesday, Sep 29 2015

PC4

Circular
 Diameter (ft) = 2.00
 Invert Elev (ft) = 100.00
 Slope (%) = 0.90
 N-Value = 0.011

Highlighted
 Depth (ft) = 1.77
 Q (cfs) = 26.79
 Area (sqft) = 2.94
 Velocity (ft/s) = 9.11
 Wetted Perim (ft) = 4.90
 Crit Depth, Yc (ft) = 1.81
 Top Width (ft) = 1.28
 EGL (ft) = 3.06

Calculations
 Compute by: Known Q
 Known Q (cfs) = 26.79



Channel Report

Hydraulow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

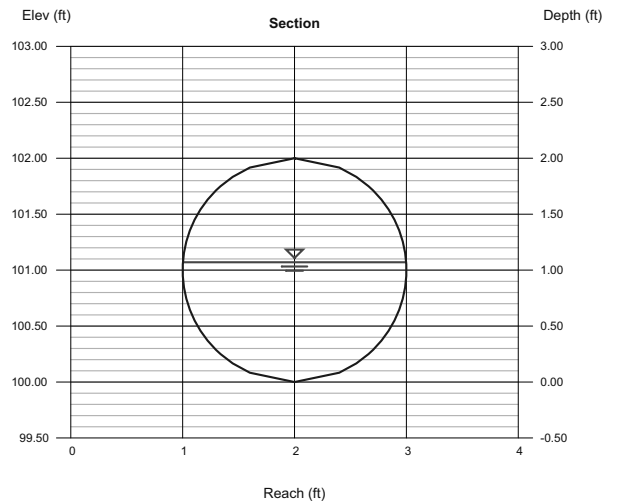
Tuesday, Sep 29 2015

PC5

Circular
 Diameter (ft) = 2.00
 Invert Elev (ft) = 100.00
 Slope (%) = 3.00
 N-Value = 0.011

Highlighted
 Depth (ft) = 1.07
 Q (cfs) = 26.00
 Area (sqft) = 1.72
 Velocity (ft/s) = 15.13
 Wetted Perim (ft) = 3.29
 Crit Depth, Yc (ft) = 1.79
 Top Width (ft) = 1.99
 EGL (ft) = 4.63

Calculations
 Compute by: Known Q
 Known Q (cfs) = 26.00



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

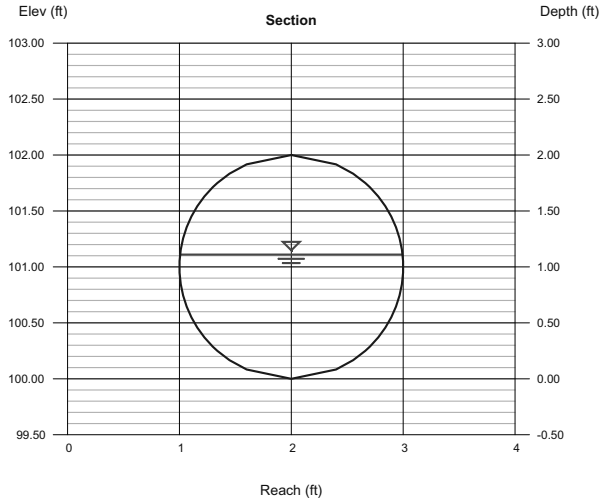
Tuesday, Sep 29 2015

PC6

Circular
 Diameter (ft) = 2.00
 Invert Elev (ft) = 100.00
 Slope (%) = 2.40
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 24.65

Highlighted
 Depth (ft) = 1.11
 Q (cfs) = 24.65
 Area (sqft) = 1.80
 Velocity (ft/s) = 13.71
 Wetted Perim (ft) = 3.37
 Crit Depth, Yc (ft) = 1.76
 Top Width (ft) = 1.99
 EGL (ft) = 4.03



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

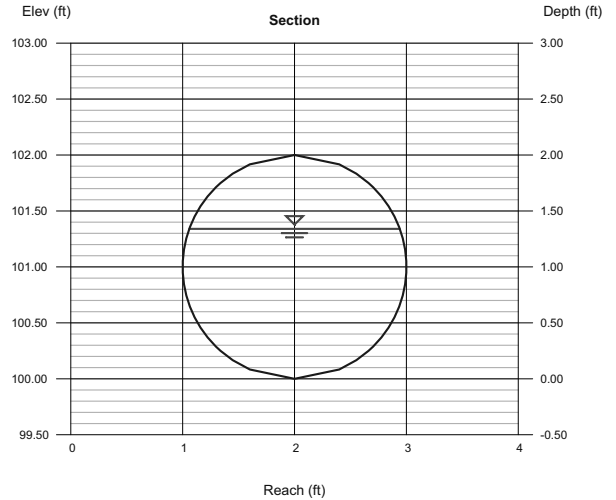
Tuesday, Sep 29 2015

PC7

Circular
 Diameter (ft) = 2.00
 Invert Elev (ft) = 100.00
 Slope (%) = 1.00
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 20.95

Highlighted
 Depth (ft) = 1.34
 Q (cfs) = 20.95
 Area (sqft) = 2.24
 Velocity (ft/s) = 9.35
 Wetted Perim (ft) = 3.84
 Crit Depth, Yc (ft) = 1.64
 Top Width (ft) = 1.88
 EGL (ft) = 2.70



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

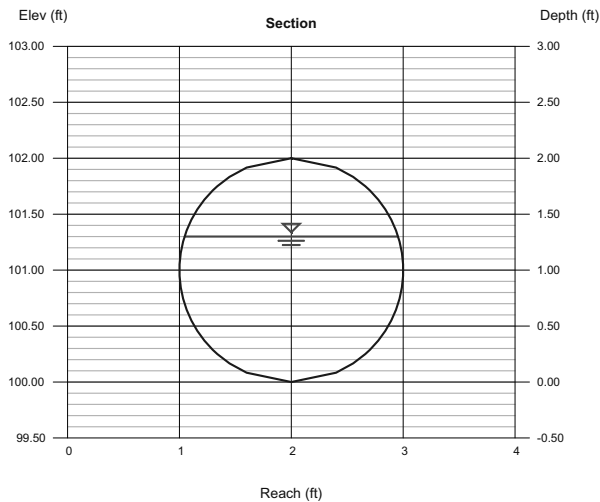
Tuesday, Sep 29 2015

PC8

Circular
 Diameter (ft) = 2.00
 Invert Elev (ft) = 100.00
 Slope (%) = 1.00
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 20.18

Highlighted
 Depth (ft) = 1.30
 Q (cfs) = 20.18
 Area (sqft) = 2.17
 Velocity (ft/s) = 9.30
 Wetted Perim (ft) = 3.76
 Crit Depth, Yc (ft) = 1.62
 Top Width (ft) = 1.91
 EGL (ft) = 2.64



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

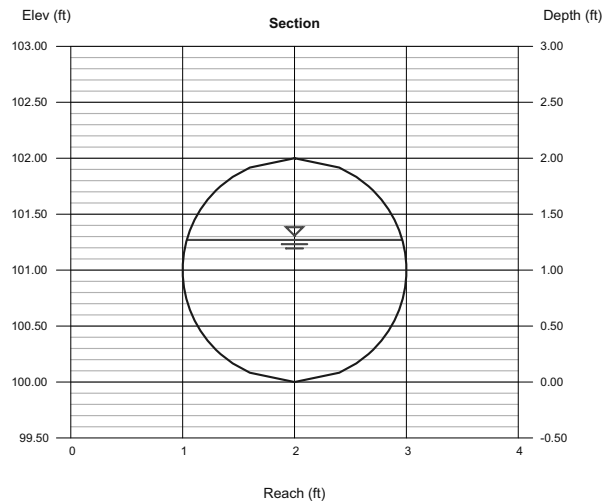
Tuesday, Sep 29 2015

PC9

Circular
 Diameter (ft) = 2.00
 Invert Elev (ft) = 100.00
 Slope (%) = 1.00
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 19.35

Highlighted
 Depth (ft) = 1.27
 Q (cfs) = 19.35
 Area (sqft) = 2.11
 Velocity (ft/s) = 9.19
 Wetted Perim (ft) = 3.69
 Crit Depth, Yc (ft) = 1.59
 Top Width (ft) = 1.93
 EGL (ft) = 2.58



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

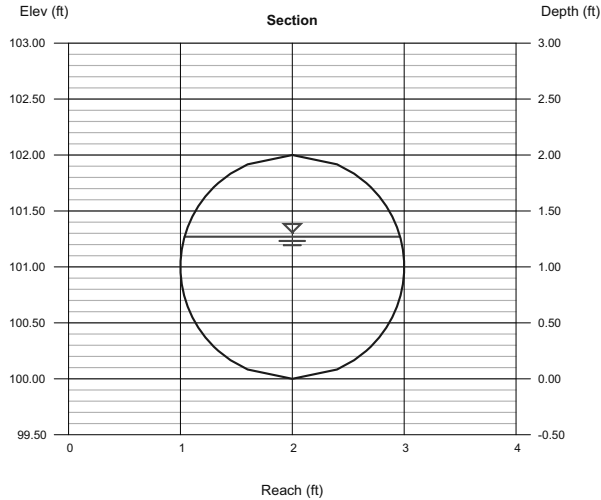
Tuesday, Sep 29 2015

PC10

Circular
 Diameter (ft) = 2.00
 Invert Elev (ft) = 100.00
 Slope (%) = 1.00
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 19.35

Highlighted
 Depth (ft) = 1.27
 Q (cfs) = 19.35
 Area (sqft) = 2.11
 Velocity (ft/s) = 9.19
 Wetted Perim (ft) = 3.69
 Crit Depth, Yc (ft) = 1.59
 Top Width (ft) = 1.93
 EGL (ft) = 2.58



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

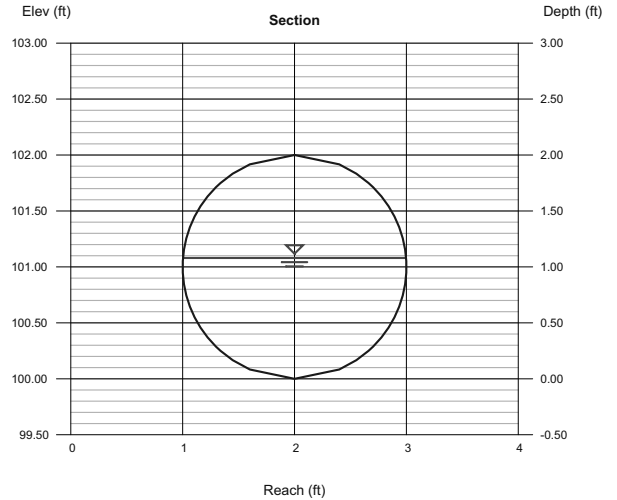
Tuesday, Sep 29 2015

PC11

Circular
 Diameter (ft) = 2.00
 Invert Elev (ft) = 100.00
 Slope (%) = 1.00
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 15.16

Highlighted
 Depth (ft) = 1.08
 Q (cfs) = 15.16
 Area (sqft) = 1.74
 Velocity (ft/s) = 8.72
 Wetted Perim (ft) = 3.31
 Crit Depth, Yc (ft) = 1.41
 Top Width (ft) = 1.99
 EGL (ft) = 2.26



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

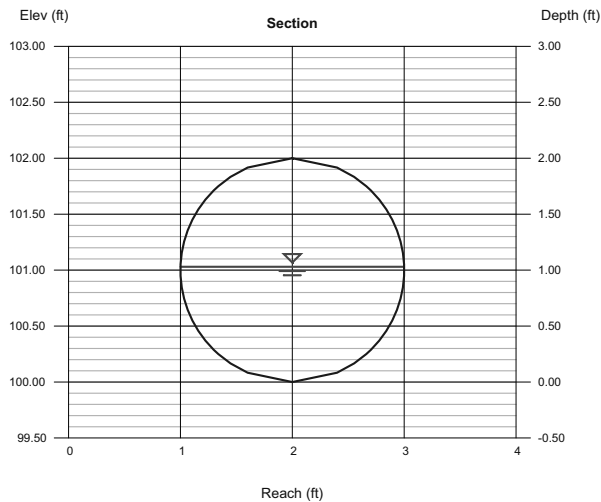
Tuesday, Sep 29 2015

PC12

Circular
 Diameter (ft) = 2.00
 Invert Elev (ft) = 100.00
 Slope (%) = 1.00
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 14.03

Highlighted
 Depth (ft) = 1.03
 Q (cfs) = 14.03
 Area (sqft) = 1.64
 Velocity (ft/s) = 8.56
 Wetted Perim (ft) = 3.21
 Crit Depth, Yc (ft) = 1.35
 Top Width (ft) = 2.00
 EGL (ft) = 2.17



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

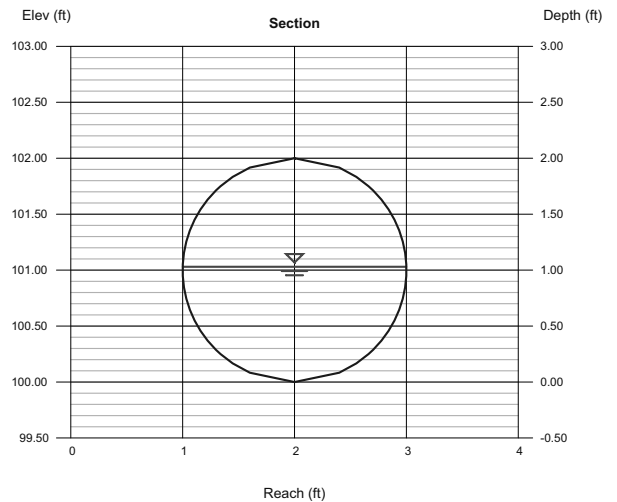
Tuesday, Sep 29 2015

PC13

Circular
 Diameter (ft) = 2.00
 Invert Elev (ft) = 100.00
 Slope (%) = 1.00
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 14.03

Highlighted
 Depth (ft) = 1.03
 Q (cfs) = 14.03
 Area (sqft) = 1.64
 Velocity (ft/s) = 8.56
 Wetted Perim (ft) = 3.21
 Crit Depth, Yc (ft) = 1.35
 Top Width (ft) = 2.00
 EGL (ft) = 2.17



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

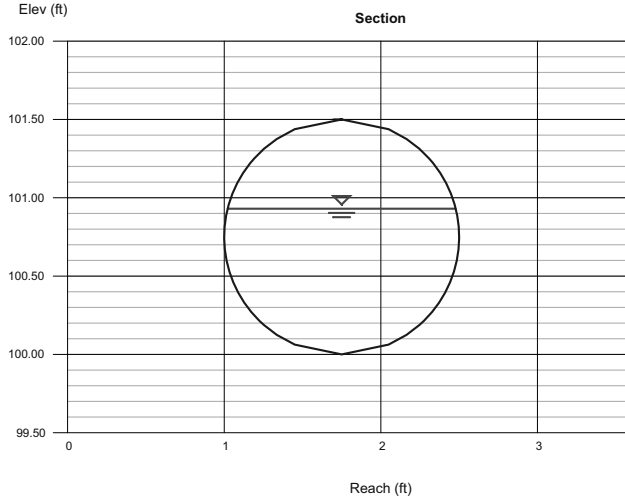
Tuesday, Sep 29 2015

PC14

Circular
 Diameter (ft) = 1.50
 Invert Elev (ft) = 100.00
 Slope (%) = 1.00
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 8.70

Highlighted
 Depth (ft) = 0.93
 Q (cfs) = 8.700
 Area (sqft) = 1.15
 Velocity (ft/s) = 7.55
 Wetted Perim (ft) = 2.72
 Crit Depth, Yc (ft) = 1.15
 Top Width (ft) = 1.46
 EGL (ft) = 1.82



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

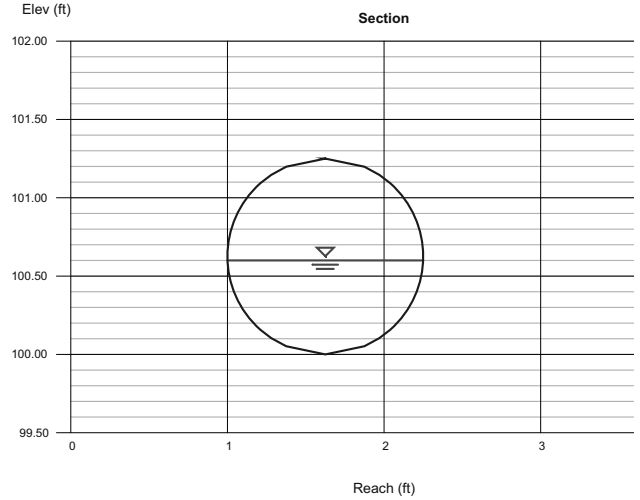
Tuesday, Sep 29 2015

PC15

Circular
 Diameter (ft) = 1.25
 Invert Elev (ft) = 100.00
 Slope (%) = 5.60
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 8.21

Highlighted
 Depth (ft) = 0.60
 Q (cfs) = 8.210
 Area (sqft) = 0.59
 Velocity (ft/s) = 14.02
 Wetted Perim (ft) = 1.92
 Crit Depth, Yc (ft) = 1.13
 Top Width (ft) = 1.25
 EGL (ft) = 3.66



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

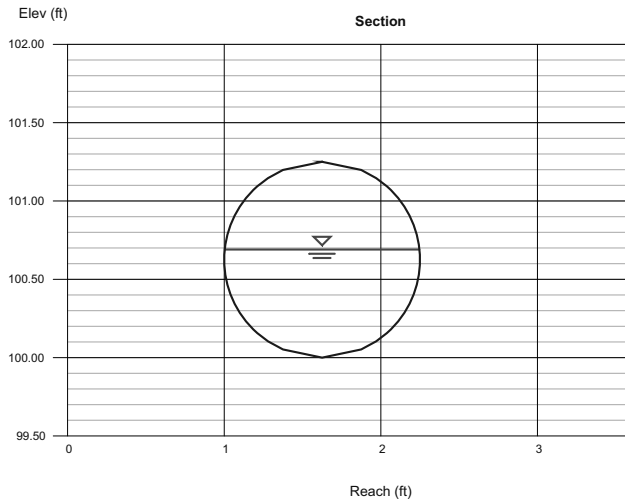
Tuesday, Sep 29 2015

PC16

Circular
 Diameter (ft) = 1.25
 Invert Elev (ft) = 100.00
 Slope (%) = 3.40
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 8.21

Highlighted
 Depth (ft) = 0.69
 Q (cfs) = 8.210
 Area (sqft) = 0.69
 Velocity (ft/s) = 11.82
 Wetted Perim (ft) = 2.09
 Crit Depth, Yc (ft) = 1.13
 Top Width (ft) = 1.24
 EGL (ft) = 2.86



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

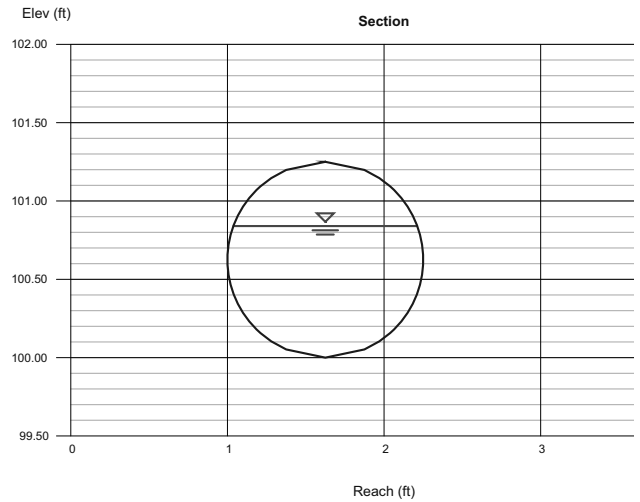
Tuesday, Sep 29 2015

PC17

Circular
 Diameter (ft) = 1.25
 Invert Elev (ft) = 100.00
 Slope (%) = 1.00
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 5.95

Highlighted
 Depth (ft) = 0.84
 Q (cfs) = 5.950
 Area (sqft) = 0.88
 Velocity (ft/s) = 6.77
 Wetted Perim (ft) = 2.41
 Crit Depth, Yc (ft) = 0.99
 Top Width (ft) = 1.17
 EGL (ft) = 1.55



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

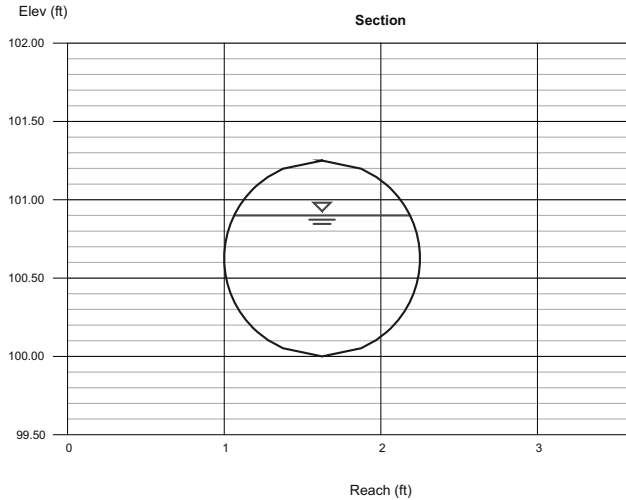
Tuesday, Sep 29 2015

PD1

Circular
 Diameter (ft) = 1.25
 Invert Elev (ft) = 100.00
 Slope (%) = 2.40
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 10.24

Highlighted
 Depth (ft) = 0.90
 Q (cfs) = 10.24
 Area (sqft) = 0.95
 Velocity (ft/s) = 10.80
 Wetted Perim (ft) = 2.54
 Crit Depth, Yc (ft) = 1.19
 Top Width (ft) = 1.12
 EGL (ft) = 2.71



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

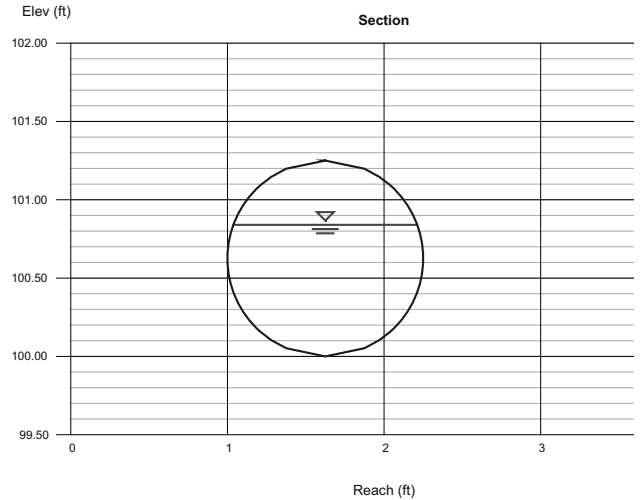
Tuesday, Sep 29 2015

PD2

Circular
 Diameter (ft) = 1.25
 Invert Elev (ft) = 100.00
 Slope (%) = 1.60
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 7.61

Highlighted
 Depth (ft) = 0.84
 Q (cfs) = 7.610
 Area (sqft) = 0.88
 Velocity (ft/s) = 8.66
 Wetted Perim (ft) = 2.41
 Crit Depth, Yc (ft) = 1.10
 Top Width (ft) = 1.17
 EGL (ft) = 2.01



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

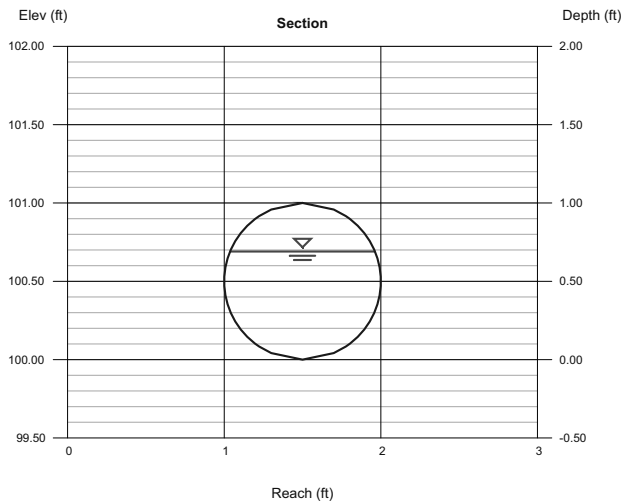
Tuesday, Sep 29 2015

PD3

Circular
 Diameter (ft) = 1.00
 Invert Elev (ft) = 100.00
 Slope (%) = 1.30
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 3.88

Highlighted
 Depth (ft) = 0.69
 Q (cfs) = 3.880
 Area (sqft) = 0.58
 Velocity (ft/s) = 6.69
 Wetted Perim (ft) = 1.96
 Crit Depth, Yc (ft) = 0.84
 Top Width (ft) = 0.92
 EGL (ft) = 1.39



Channel Report

Hydraflow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

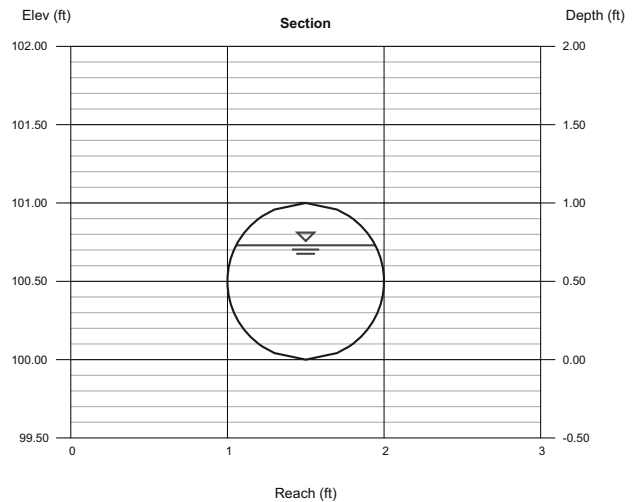
Tuesday, Sep 29 2015

PD4

Circular
 Diameter (ft) = 1.00
 Invert Elev (ft) = 100.00
 Slope (%) = 1.10
 N-Value = 0.011

Calculations
 Compute by: Known Q
 Known Q (cfs) = 3.88

Highlighted
 Depth (ft) = 0.73
 Q (cfs) = 3.880
 Area (sqft) = 0.61
 Velocity (ft/s) = 6.31
 Wetted Perim (ft) = 2.05
 Crit Depth, Yc (ft) = 0.84
 Top Width (ft) = 0.89
 EGL (ft) = 1.35



Channel Report

Hydrow Express Extension for Autodesk® AutoCAD® Civil 3D® by Autodesk, Inc.

Tuesday, Sep 29 2015

PD5

Circular

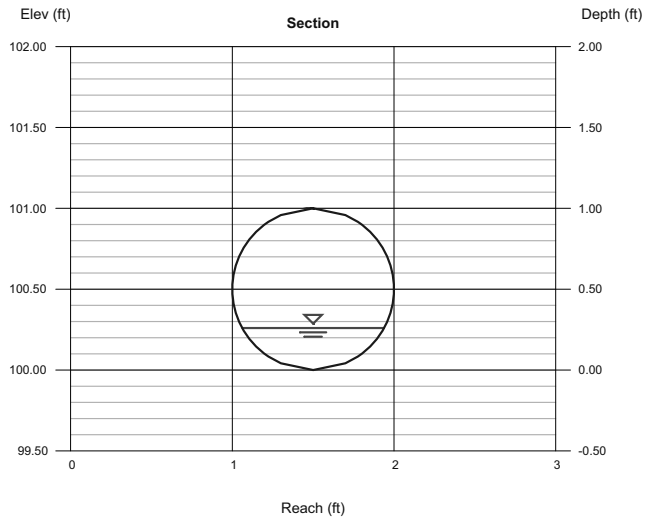
Diameter (ft) = 1.00
Invert Elev (ft) = 100.00
Slope (%) = 3.60
N-Value = 0.011

Calculations

Compute by: Known Q
Known Q (cfs) = 1.16

Highlighted

Depth (ft) = 0.26
Q (cfs) = 1.160
Area (sqft) = 0.16
Velocity (ft/s) = 7.07
Wetted Perim (ft) = 1.07
Crit Depth, Yc (ft) = 0.46
Top Width (ft) = 0.88
EGL (ft) = 1.04



KELLY ENGINEERING GROUP, INC.
Zero Campanelli Drive-Braintree-MA 02184 Phone 781 843 4333

Attachment E
TSS Removal

INSTRUCTIONS:

1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: Stormwater Management Pond

TSS Removal Calculation Worksheet

B	C	D	E	F
BMP ¹	TSS Removal Rate ¹	Starting TSS Load*	Amount Removed (C*D)	Remaining Load (D-E)
Street Sweeping - 5%	0.05	1.00	0.05	0.95
Deep Sump and Hooded Catch Basin	0.25	0.95	0.24	0.71
Constructed Stormwater Wetland	0.80	0.71	0.57	0.14
Infiltration Basin	0.80	0.14	0.11	0.03
	0.00	0.03	0.00	0.03

Total TSS Removal =

97%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: 2015-042
 Prepared By: Kelly Engineering Group, Inc.
 Date: 9/25/2015

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
 1. From MassDEP Stormwater Handbook Vol. 1

1" WATER QUALITY VOLUME (STORMWATER MANAGEMENT POND)

Paved area(including sidewalks) = 322,584 s.f.

Required Water Quality Volume = 322,584 s.f. x 1"/12 = **26,882 cu.ft.**

Volume provided in Sediment Forebay = 3,600 cu. ft.

Volume provided in Water Quality Forebay = 24,243 cu. ft.

Total Provided Water Quality Volume = **27,843 cu. ft.**

***See Calculations by Contech for Water Quality Volume for other paved not routed to stormwater pond.**

Pond Report

Pond No. 2 - Water Quality

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 269.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	269.00	14,943	0	0
1.00	270.00	16,573	15,749	15,749
1.50	270.50	17,409	8,494	24,243

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .000	.000	.000	n/a
Orifice Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 0.00	0.00	0.00	0.00
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No
Exfil.(in/hr)	= 0.000 (by Wet area)			
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	269.00	---	---	---	---	---	---	---	---	---	---	0.000
1.00	15,749	270.00	---	---	---	---	---	---	---	---	---	---	0.000
1.50	24,243	270.50	---	---	---	---	---	---	---	---	---	---	0.000

Pond Report

Pond No. 3 - Sediment Forebay

Pond Data

Contours -User-defined contour areas. Conic method used for volume calculation. Beginning Elevation = 270.00 ft

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	270.00	3,146	0	0
1.00	271.00	4,075	3,600	3,600

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	0.00	0.00	0.00
Span (in)	= 0.00	0.00	0.00	0.00
No. Barrels	= 0	0	0	0
Invert El. (ft)	= 0.00	0.00	0.00	0.00
Length (ft)	= 0.00	0.00	0.00	0.00
Slope (%)	= 0.00	0.00	0.00	n/a
N-Value	= .000	.000	.000	n/a
Orifice Coeff.	= 0.00	0.00	0.00	0.00
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 0.00	0.00	0.00	0.00
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No
Exfil.(in/hr)	= 0.000	(by Wet area)		
TW Elev. (ft)	= 0.00			

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	270.00	---	---	---	---	---	---	---	---	---	---	0.000
1.00	3,600	271.00	---	---	---	---	---	---	---	---	---	---	0.000

**CDS ESTIMATED NET ANNUAL TSS REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD**



**ASHLAND RAIL TRANSIT APARTMENTS
ASHLAND, MA
for SYSTEM: WQD 2**

Area	0.26	acres	CDS Model	
Weighted C	0.90		2015-4	
Tc	6	minutes	CDS Treatment Capacity	1.4 cfs

<u>Rainfall Intensity¹</u> <u>(in/hr)</u>	<u>Percent Rainfall Volume¹</u>	<u>Cumulative Rainfall Volume</u>	<u>Total Flowrate (cfs)</u>	<u>Treated Flowrate (cfs)</u>	<u>Removal Efficiency (%)</u>	<u>Incremental Removal (%)</u>
0.02	10.2%	10.2%	0.00	0.00	97.0	9.9
0.04	9.6%	19.8%	0.01	0.01	96.8	9.3
0.06	9.4%	29.3%	0.01	0.01	96.5	9.1
0.08	7.7%	37.0%	0.02	0.02	96.3	7.4
0.10	8.6%	45.6%	0.02	0.02	96.1	8.2
0.12	6.3%	51.9%	0.03	0.03	95.9	6.0
0.14	4.7%	56.5%	0.03	0.03	95.6	4.5
0.16	4.6%	61.2%	0.04	0.04	95.4	4.4
0.18	3.5%	64.7%	0.04	0.04	95.2	3.4
0.20	4.3%	69.1%	0.05	0.05	94.9	4.1
0.25	8.0%	77.1%	0.06	0.06	94.4	7.5
0.30	5.6%	82.7%	0.07	0.07	93.8	5.2
0.35	4.4%	87.0%	0.08	0.08	93.2	4.1
0.40	2.5%	89.5%	0.09	0.09	92.7	2.3
0.45	2.5%	92.1%	0.11	0.11	92.1	2.3
0.50	1.4%	93.5%	0.12	0.12	91.5	1.3
0.75	5.0%	98.5%	0.18	0.18	88.7	4.5
1.00	1.0%	99.5%	0.23	0.23	85.8	0.9
1.50	0.0%	99.5%	0.35	0.35	80.1	0.0
2.00	0.0%	99.5%	0.47	0.47	74.4	0.0
3.00	0.5%	100.0%	0.70	0.70	63.1	0.3

	Removal Efficiency Adjustment ² =	6.5%
	Predicted % Annual Rainfall Treated =	93.5%
	Predicted Net Annual Load Removal Efficiency =	88.4%

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
 2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

**CDS ESTIMATED NET ANNUAL TSS REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD**



**ASHLAND RAIL TRANSIT APARTMENTS
ASHLAND, MA
for SYSTEM: WQD 1**

Area	0.36	acres	CDS Model	
Weighted C	0.90		2015-4	
Tc	6	minutes	CDS Treatment Capacity	1.4
				cfs

<u>Rainfall Intensity¹</u> <u>(in/hr)</u>	<u>Percent Rainfall Volume¹</u>	<u>Cumulative Rainfall Volume</u>	<u>Total Flowrate (cfs)</u>	<u>Treated Flowrate (cfs)</u>	<u>Removal Efficiency (%)</u>	<u>Incremental Removal (%)</u>
0.02	10.2%	10.2%	0.01	0.01	96.9	9.9
0.04	9.6%	19.8%	0.01	0.01	96.6	9.3
0.06	9.4%	29.3%	0.02	0.02	96.3	9.1
0.08	7.7%	37.0%	0.03	0.03	96.0	7.4
0.10	8.6%	45.6%	0.03	0.03	95.6	8.2
0.12	6.3%	51.9%	0.04	0.04	95.3	6.0
0.14	4.7%	56.5%	0.05	0.05	95.0	4.4
0.16	4.6%	61.2%	0.05	0.05	94.7	4.4
0.18	3.5%	64.7%	0.06	0.06	94.4	3.3
0.20	4.3%	69.1%	0.06	0.06	94.1	4.1
0.25	8.0%	77.1%	0.08	0.08	93.3	7.5
0.30	5.6%	82.7%	0.10	0.10	92.5	5.2
0.35	4.4%	87.0%	0.11	0.11	91.7	4.0
0.40	2.5%	89.5%	0.13	0.13	90.9	2.3
0.45	2.5%	92.1%	0.15	0.15	90.1	2.3
0.50	1.4%	93.5%	0.16	0.16	89.3	1.2
0.75	5.0%	98.5%	0.24	0.24	85.4	4.3
1.00	1.0%	99.5%	0.32	0.32	81.5	0.8
1.50	0.0%	99.5%	0.49	0.49	73.6	0.0
2.00	0.0%	99.5%	0.65	0.65	65.7	0.0
3.00	0.5%	100.0%	0.97	0.97	49.9	0.2

	Removal Efficiency Adjustment ² =	6.5%
	Predicted % Annual Rainfall Treated =	93.5%
	Predicted Net Annual Load Removal Efficiency =	87.5%

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
 2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

Project: Ashland Rail Transit Apartments
Location: Ashland, MA
Prepared For: Kelly Engineering Group



Purpose: To calculate the water quality flow rate (WQF) over a given site area. In this situation the WQF is derived from the first 1.0" of runoff.

Reference: Massachusetts Dept. of Environmental Protection Wetlands Program / United States Department of Agriculture Natural Resources Conservation Service TR-55 Manual

Given:

Structure Name	Impv. (acres)	A (miles ²)	t _c (min)	t _c (hr)	WQV (in)
WQD1	0.36	0.0005658	6.0	0.100	1.00
WQD2	0.26	0.0004062	6.0	0.100	1.00

Procedure:

Determine unit peak discharge using Figure 1 or 2. Figure 2 is in tabular form so is preferred. Using the t_c, read the unit peak discharge (qu) from Figure 1 or Table in Figure 2. qu is expressed in the following units: cfs/mi²/watershed inches (csm/in).

Structure Name	qu (csm/in.)
WQD1	774.00
WQD2	774.00

1. Compute Q Rate using the following equation:

$$Q_1 = (qu) (A) (WQV)$$

where:

Q₁ = flow rate associated with first 1.0" of runoff

qu = the unit peak discharge, in csm/in.

A = impervious surface drainage area (in square miles)

WQV = water quality volume in watershed inches (1.0" in this case)

Structure Name	Q ₁ (cfs)
WQD1	0.44
WQD2	0.31

**ASHLAND RAIL TRANSIT APARTMENTS
STORMWATER MANAGEMENT SYSTEM
OPERATION AND MAINTENANCE PLAN
&
LONG-TERM POLLUTION PREVENTION PLAN
09/28/15**

Prepared by:

KELLY ENGINEERING GROUP, INC.
Zero Campanelli Drive
Braintree, Massachusetts 02184

OWNER AND RESPONSIBLE PARTY:
Campanelli Acquisitions II, LLC
PO Box 850985
Braintree, MA 02185

Note: If ownership of this property changes then the new owner becomes the responsible party.
The Owner may assign responsibility to a tenant on the property.

Introduction

Considerable time, effort and cost has been spent in the design and construction of the stormwater management system for this development. The stormwater management system consists of a number of Best Management Practices (BMP's). These BMP's combine to ensure that storm runoff from the site will not damage the sensitive environmental resources surrounding the site. In order to ensure that these BMP's operate as designed it is very important that the procedures in this operation and maintenance plan be followed. Most of these operation procedures require observation and measurement; however, at certain times more extensive maintenance measures may be needed. The following is an itemization of each of these BMP's and their maintenance needs.

The party responsible for maintenance should contract with a maintenance organization capable of performing the more extensive measures such as pumping of catch basin sumps, etc.

BMP No. 1 – Paved Road Surface/Parking Lot Area:

- Regularly pick up and remove litter from the parking lot area, landscaped islands and perimeter landscaped areas and water quality areas.
- The paved area is to be swept a minimum of two times per year, at least once during April and again during September with a high efficiency vacuum sweeper or a regenerative air sweeper. If a mechanical sweeper is used, the paved area is to be swept a minimum of once a month.

BMP No. 2 - Deep Sump Catch Basins:

- Basins are to be inspected 4 times per year.
 1. Verify that tees are secure and free-flowing.
 2. Measure depth of sediment below water line.
- Basins are to be cleaned whenever sediment and hydrocarbons are observed. Basins are to be cleaned a minimum of twice per year. One of these cleanings shall occur before April 15th of each year and one shall occur before September 15th of each year. Basins may be cleaned either using a clamshell or a vacuum pump.
- All liquid shall be pumped from the sump of each basin at least once per year.
- All sediments and hydrocarbons should be properly handled and disposed of, in accordance with local, state and federal guidelines and regulations.

Note: See catch basin detail for explanation of terms.

BMP No. 3 – Contech Water Quality Inlets:

- Basins are to be inspected 4 times per year by owner or designee.
 1. Verify that tees are secure and free-flowing.
 2. Measure depth of sediment below water line.
- Basins are to be cleaned whenever 18" of sediment and hydrocarbons are observed. Basins are to be cleaned a minimum of twice per year. One of these cleanings shall occur before April 15th of each year and one shall occur before September 15th of each year. Basins may be cleaned either using a clamshell or a vacuum pump.

- All liquid shall be pumped from the sump of each basin at least once per year.
- All sediments and hydrocarbons shall be properly handled and disposed of, in accordance with local, state and federal guidelines and regulations.

If any problems are encountered with the Contech Units, contact the manufacturer.

BMP No. 4 - Subsurface Recharge:

- The inlet pipe and observation basin shall be inspected 4 times a year. Any accumulated debris shall be removed.
- Inspect recharge facilities following a rainfall event greater than 2.5 inches in a 24 hour period.
- If standing water is observed for more than 48 hours following a storm event, immediately retain a qualified professional to assess whether infiltration function has been lost and develop recommended corrective actions.

BMP No. 5 – Constructed Stormwater Wetland & Level Spreaders:

- On a regular basis, as required by growing conditions, those portions of the side slopes that are planted with grass shall be mowed and otherwise maintained in such a manner as to maintain a dense cover of grass.

Any area of erosion or other conditions of slope instability shall be corrected at the time they occur.

- Inlet and outlet structures.

On a regular basis, the inlet pipe and outlet structure shall be checked for debris and removed as necessary to ensure unobstructed flow of water through the water quality pond. Impoundment embankments and outlet structures should be inspected at least once annually by a qualified professional for structural integrity and for any conditions which could adversely affect their function.

- Recharge Pond.

Inspect recharge pond once per year and following a rainfall event greater than 2.5 inches in a 24 hour period. Remove sediment annually. If standing water is observed for more than 48 hours following a storm event, immediately retain a qualified professional to assess whether infiltration function has been lost and develop recommended corrective actions.

Snow Removal:

- There shall be no plowing or stock piling of snow within all resource areas and any area subject to the jurisdiction of local and state regulations without the prior written permission from state or local approving authority.
- Road salts and de-icing materials shall be stored on impervious pads and covered to protect from wind and precipitation.
- No de-icing materials shall be stored nor used within all resource areas and any area subject to the jurisdiction of local and state regulations without the prior written permission from state or local approving authority.
- No de-icing materials shall be stored within Zone I, Zone II, Zone A, and 200 feet from a river or estuary.

Storage and Use of Chemicals:

- No pesticides, herbicides, nor insecticides shall be stored nor used within all resource areas and any area subject to the jurisdiction of local and state regulations without the prior written permission from state or local approving authority.
- Chemical storage on site shall be limited. Any chemicals that must be stored shall be stored in a secure area in accordance with Local and State regulations.

Hazardous Waste:

- Containment – In the event of a discharge or spill of oil or another hazardous material, outlets to stormwater management systems shall be plugged so that hazardous material do not enter resource areas.
- Reporting - In the event of a discharge or spill of oil or another hazardous material, responsible facility personnel, oil spill and/or hazardous material removal organizations, federal, state, and local regulatory agencies, the Town of Ashland Board of Health, fire and police departments, and the EPA National Response Center 1-800-424-8802 shall be rapidly notified.
- Hazardous Waste – All hazardous waste materials will be disposed of in the manner specified by local, state and/or federal regulations and by the manufacturer of such products.
- There shall be no illicit discharges to the stormwater management system.

Material and Waste Storage, Handling and Management:

- All waste materials will be collected and stored in a securely lidded metal dumpster from a solid waste management company licensed to do business by the state and the town. The dumpster will comply with all local and state solid waste management regulations.

Training for Long Term Pollution Prevention Plan:

- All staff or personnel involved and responsible for implementing the Stormwater Management System Operations and Maintenance Plan and the Long-Term Pollution Prevention Plan shall be properly trained as required under the DEP Stormwater Management Regulations. Training shall be documented with records kept with other stormwater maintenance records.

Operation and maintenance of septic systems:

- Septic systems shall be properly maintained according to manufacturer's specifications.

Pet Waste Management:

- Pooper-scooper laws for pets shall be followed.
- Never dump pet waste into storm drains, catch basins, or the drainage system.
- Pet waste shall be scooped up and disposed of properly in the garbage.

Lawn and Garden activities:

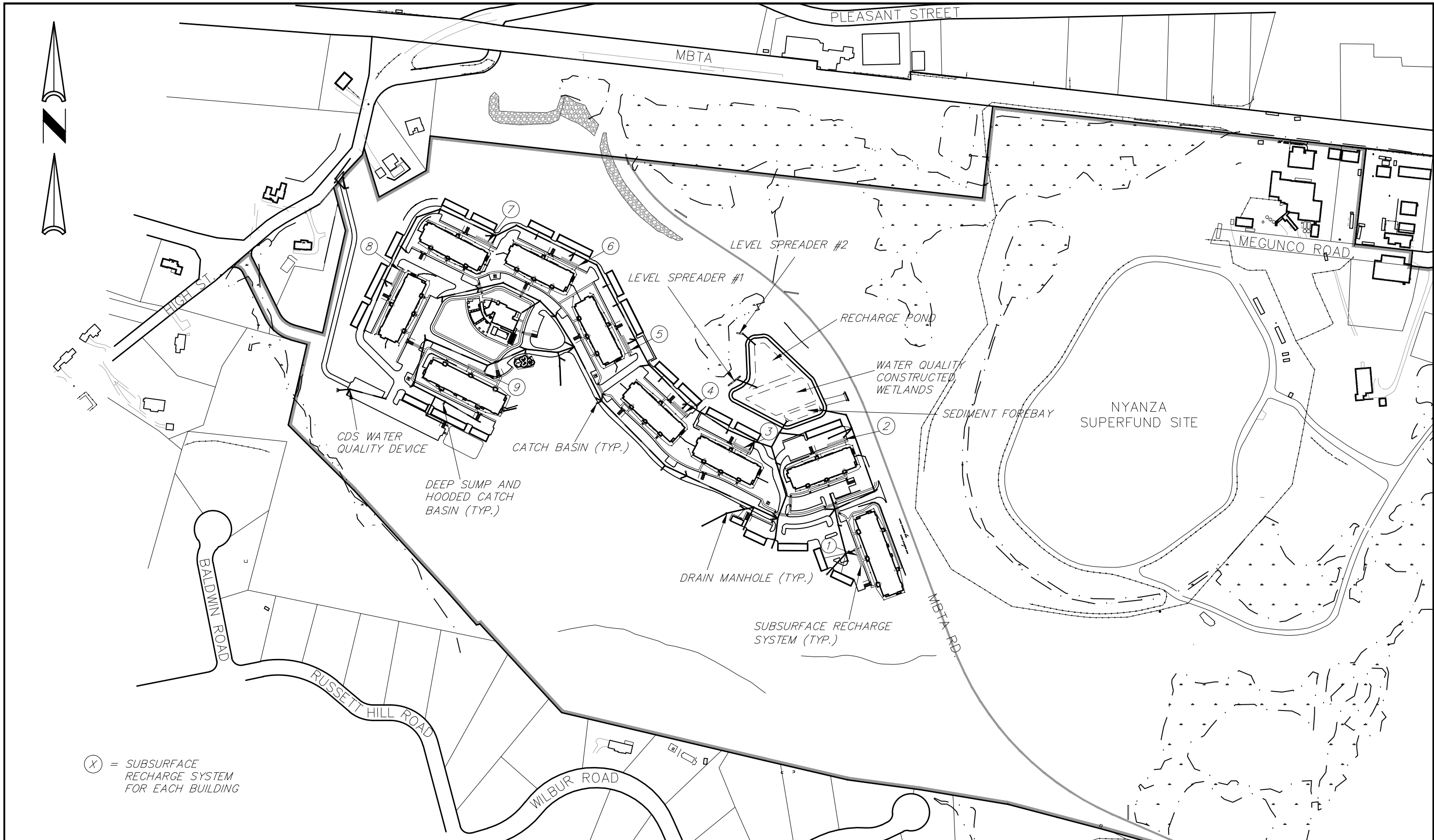
- There shall be no exterior storage of fertilizers, pesticides, herbicides, or insecticides. No pesticides, herbicides, nor insecticides shall be stored nor used within any resource areas its buffers, and any area subject to the jurisdiction of local and state regulations without the prior written permission from state or local approving authority.
- Fertilizers and pesticides shall be applied properly, sparingly, and outside any resource areas and its

buffers.

To reduce the impact of fertilizers, consider the following tips;

- Don't fertilize before a rain storm.
- Consider using organic fertilizers. They release nutrients more slowly.
- Test soils before applying fertilizers. Some soils may not need fertilizers. A standard soil test costs \$9.00. (Call the UMass Extension Soil Testing Lab at 413-545-2311 or download a soil test order form at <http://www.umass.edu/plsoils/soiltest/>.)

Ashland Rail Transit Apartments							
PROJECT LOCATION: Ashland Rail Transit Apartments, Ashland, MA							
STORMWATER ANAGEMENT BEST MANAGEMENT PRACTICES - INSPECTION SCHEDULE AND EVALUATION CHECKLIST							
Best Management Practice	Inspection Frequency (1)	Date I	Inspector	Minimum Maintenance and Key Items to Check (1)	Cleaning/Repair Needed yes__ no__ (list items)	Date of Cleaning /Repair	Perform ed By
Street Sweeping	4x per year			Vacuum sweeper			
Deep Sump and Hooded Catch Basins	4x per year			Remove sediment 1x per year or if >6"			
Detention Pond Sediment Forebay Constructed Wetland Recharge ponds Level Spreaders	2x per year first year, annually thereafter			Inspect inlets, vegetated, overflow discharge pipes, drain time less than 4 days			
CDS water Quality device	2x per year			Per manufacturer Requirements			
Subsurface Recharge Systems	2x per year			Inspect after 2.5" rain in 24 hours, drain time less than 3 days			
(1) Refer to the Operation and Maintenance Plan for recommendations regarding frequency of inspections and maintenance of specific BMP's.							
recommendations regarding frequency for inspection and maintenance of specific BMPs.							
Stormwater Control Manager/Environmental Monitor:				Stamp/Signature			

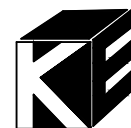


(X) = SUBSURFACE RECHARGE SYSTEM FOR EACH BUILDING

**ASHLAND RAIL
TRANSIT APARTMENTS
ASHLAND, MA**

SCALE: 1" = 300'
DATE: 09/28/15
2015-042-BMP00

**BMP
LOCATION
MAP**



KELLY ENGINEERING GROUP, INC.
CIVIL ENGINEERING CONSULTANTS
0 CAMPANELLI DRIVE • BRAINTREE MA • 02184
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KELLY ENGINEERING GROUP, INC.
Zero Campanelli Drive-Braintree-MA 02184 Phone 781 843 4333

Attachment F
Miscellaneous

Attention must be given to ensure consistency in units. In particular, the Target Depth Factors must be converted to feet.

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

Table 2.3.2: Recharge Target Depth by Hydrologic Soil Group

When a site contains multiple Hydrologic Soil Groups, determine the *Required Recharge Volume* for each impervious area by Hydrologic Soil Group and then add the volumes together.

Example: Assume a ten (10) acre site. 5.0 acres are proposed to be developed for a retail use. A section of the entrance roadway is to be bridged over a stream that is classified as land under water. As such, the bridging is subject to the Wetlands Protection Act Regulations, and the Stormwater Management Standards apply to stormwater runoff from all proposed roads, parking areas, and rooftops. Of the 5.0 acres proposed to be developed, 2 acres of impervious surfaces are proposed atop Hydrologic Soil Group (HSG) “A” soils, 1 acre of impervious surfaces atop HSG “B” soil, 1.5 acres of impervious surfaces atop HSG “C” soil, and 0.5 acres are proposed to be landscaped area. The remaining 5.0 acres, located on HSG “A” soil, are proposed to remain forested. Determine the *Required Recharge Volume*.

Solution: The *Required Recharge Volume* is determined only for the impervious surfaces. The 5.0-acre forested area and the 0.5-acre landscaped area are not impervious areas. Although converted from forest, landscaped area is pervious area for purposes of Standard 3. Use *Equation (1)* to determine the *Required Recharge Volume* for each Hydrologic Soil Group covered by impervious area. Add together the *Required Recharge Volumes* determined for each HSG.

$$Rv = F \times \text{impervious area}$$

$$Rv = [(F_{\text{HSG "A"}}) (\text{Area}_1)] + [(F_{\text{HSG "B"}}) (\text{Area}_2)] + [(F_{\text{HSG "C"}}) (\text{Area}_3)] + [(F_{\text{HSG "D"}}) (\text{Area}_4)] \text{ Equation (2)}$$

$$Rv = [(0.6\text{-in}/12)(2 \text{ acres})] + [(0.35\text{-in}/12)(1 \text{ acre})] + [(0.25\text{-in}/12)(1.5 \text{ acres})] + [(0.1\text{-in}/12)(0 \text{ acres})]$$

$$Rv = 0.1605 \text{ acre-feet}$$

$$Rv = 0.1605 \text{ acre-feet} \times 43560 \text{ square feet/acre-feet} = 6,991 \text{ cubic feet or } 258.9 \text{ cubic yards}$$

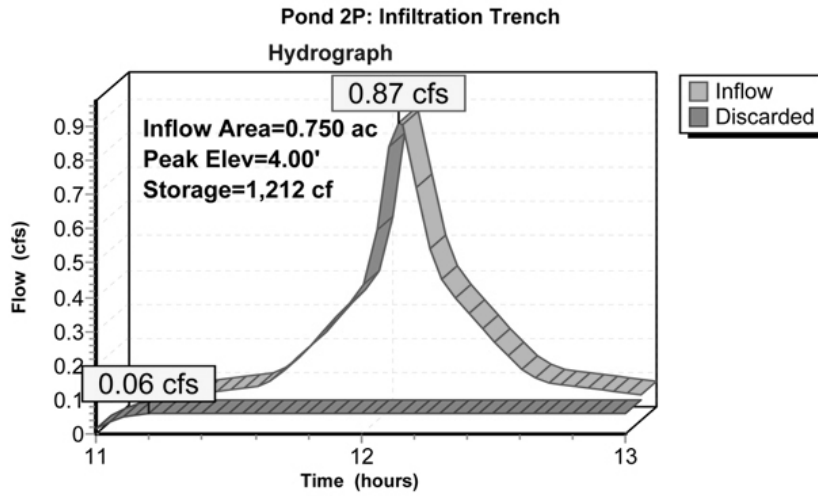
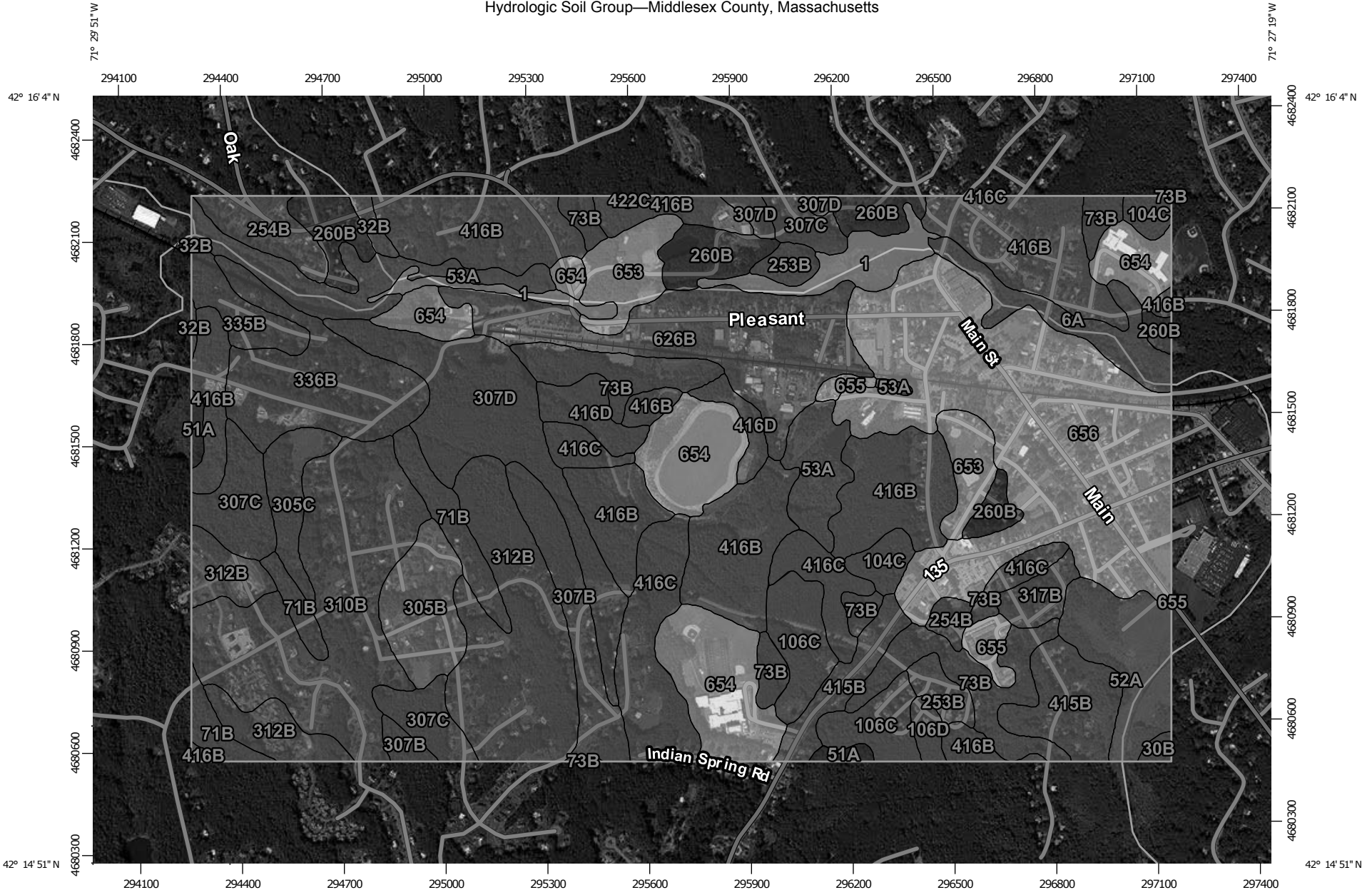


Table 2.3.3. 1982 Rawls Rates¹⁸

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

¹⁸ Rawls, Brakensiek and Saxton, 1982

Hydrologic Soil Group—Middlesex County, Massachusetts



Map Scale: 1:15,900 if printed on A landscape (11" x 8.5") sheet.


0 200 400 800 1200 Meters

0 500 1000 2000 3000 Feet

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









MAP LEGEND

Area of Interest (AOI)









 Area of Interest (AOI)

Soils

Soil Rating Polygons





 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Lines


 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Points






 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available


Water Features

 Streams and Canals

Transportation

 Rails
 Interstate Highways
 US Routes
 Major Roads
 Local Roads

Background

 Aerial Photography

MAP INFORMATION

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

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

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
 Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Middlesex County, Massachusetts
 Survey Area Data: Version 14, Sep 19, 2014

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

Date(s) aerial images were photographed: Sep 12, 2014—Sep 28, 2014

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

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Middlesex County, Massachusetts (MA017)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Water		19.6	1.7%
6A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	A/D	17.3	1.5%
30B	Raynham silt loam, 0 to 5 percent slopes	C/D	1.5	0.1%
32B	Wareham loamy fine sand, 0 to 5 percent slopes	A/D	3.2	0.3%
51A	Swansea muck, 0 to 1 percent slopes	B/D	3.7	0.3%
52A	Freetown muck, 0 to 1 percent slopes	A/D	26.4	2.2%
53A	Freetown muck, ponded, 0 to 1 percent slopes MLRA 144A	A/D	38.1	3.2%
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	D	22.0	1.9%
73B	Whitman fine sandy loam, 0 to 5 percent slopes, extremely stony	D	51.1	4.3%
104C	Hollis-Rock outcrop-Charlton complex, 3 to 15 percent slopes	A	9.5	0.8%
106C	Narragansett-Hollis-Rock outcrop complex, 3 to 15 percent slopes	A	25.7	2.2%
106D	Narragansett-Hollis-Rock outcrop complex, 15 to 25 percent slopes	A	3.6	0.3%
253B	Hinckley loamy sand, 3 to 8 percent slopes	A	10.0	0.8%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	A	15.5	1.3%
260B	Sudbury fine sandy loam, 3 to 8 percent slopes	B	32.6	2.7%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	C	21.3	1.8%

Hydrologic Soil Group— Summary by Map Unit — Middlesex County, Massachusetts (MA017)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
305C	Paxton fine sandy loam, 8 to 15 percent slopes	D	12.2	1.0%
307B	Paxton fine sandy loam, 3 to 8 percent slopes, extremely stony	D	25.0	2.1%
307C	Paxton fine sandy loam, 8 to 15 percent slopes, extremely stony	D	30.6	2.6%
307D	Paxton fine sandy loam, 15 to 25 percent slopes, extremely stony	D	52.5	4.4%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	C/D	81.3	6.8%
312B	Woodbridge fine sandy loam, 0 to 8 percent slopes, extremely stony	C/D	76.6	6.4%
317B	Scituate fine sandy loam, 3 to 8 percent slopes, extremely stony	D	7.4	0.6%
335B	Rainbow silt loam, 3 to 8 percent slopes	C/D	11.0	0.9%
336B	Rainbow silt loam, 3 to 8 percent slopes, very stony	C/D	40.5	3.4%
415B	Narragansett silt loam, 3 to 8 percent slopes	A	32.1	2.7%
416B	Narragansett silt loam, 3 to 8 percent slopes, very stony	A	155.7	13.1%
416C	Narragansett silt loam, 8 to 15 percent slopes, very stony	A	48.3	4.1%
416D	Narragansett silt loam, 15 to 25 percent slopes, very stony	A	14.9	1.3%
422C	Canton fine sandy loam, 8 to 15 percent slopes, extremely stony	A	0.6	0.1%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	A	58.8	4.9%
653	Udorthents, sandy		25.0	2.1%
654	Udorthents, loamy		68.4	5.8%
655	Udorthents, wet substratum		6.6	0.6%

Hydrologic Soil Group— Summary by Map Unit — Middlesex County, Massachusetts (MA017)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
656	Udorthents-Urban land complex		141.1	11.9%
Totals for Area of Interest			1,189.8	100.0%

Description

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

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

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

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

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

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

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

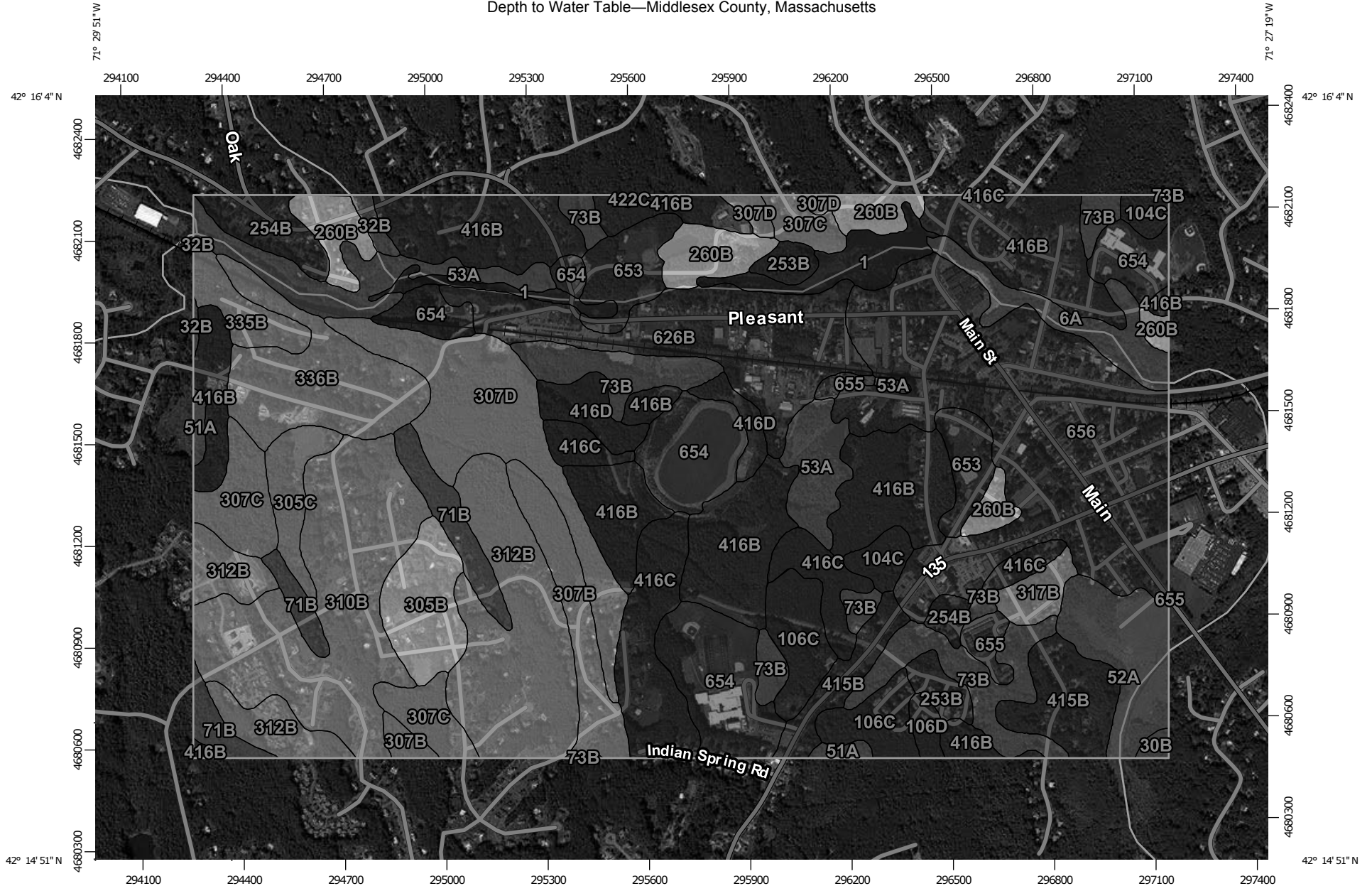
Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Depth to Water Table—Middlesex County, Massachusetts
































Map Scale: 1:15,900 if printed on A landscape (11" x 8.5") sheet.

0 200 400 800 1200 Meters

0 500 1000 2000 3000 Feet

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

MAP LEGEND

Area of Interest (AOI)	 Area of Interest (AOI)	 Not rated or not available
Soils		Water Features
Soil Rating Polygons		 Streams and Canals
 0 - 25		Transportation
 25 - 50		 Rails
 50 - 100		 Interstate Highways
 100 - 150		 US Routes
 150 - 200		 Major Roads
 > 200		 Local Roads
 Not rated or not available		Background
		 Aerial Photography
Soil Rating Lines		
 0 - 25		
 25 - 50		
 50 - 100		
 100 - 150		
 150 - 200		
 > 200		
 Not rated or not available		
Soil Rating Points		
 0 - 25		
 25 - 50		
 50 - 100		
 100 - 150		
 150 - 200		
 > 200		

MAP INFORMATION

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

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

Source of Map: Natural Resources Conservation Service
 Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>
 Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Middlesex County, Massachusetts
 Survey Area Data: Version 14, Sep 19, 2014

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

Date(s) aerial images were photographed: Sep 12, 2014—Sep 28, 2014

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.

Depth to Water Table

Depth to Water Table— Summary by Map Unit — Middlesex County, Massachusetts (MA017)				
Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
1	Water	>200	19.6	1.7%
6A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	0	17.3	1.5%
30B	Raynham silt loam, 0 to 5 percent slopes	23	1.5	0.1%
32B	Wareham loamy fine sand, 0 to 5 percent slopes	23	3.2	0.3%
51A	Swansea muck, 0 to 1 percent slopes	0	3.7	0.3%
52A	Freetown muck, 0 to 1 percent slopes	0	26.4	2.2%
53A	Freetown muck, ponded, 0 to 1 percent slopes MLRA 144A	0	38.1	3.2%
71B	Ridgebury fine sandy loam, 3 to 8 percent slopes, extremely stony	23	22.0	1.9%
73B	Whitman fine sandy loam, 0 to 5 percent slopes, extremely stony	0	51.1	4.3%
104C	Hollis-Rock outcrop-Charlton complex, 3 to 15 percent slopes	>200	9.5	0.8%
106C	Narragansett-Hollis-Rock outcrop complex, 3 to 15 percent slopes	>200	25.7	2.2%
106D	Narragansett-Hollis-Rock outcrop complex, 15 to 25 percent slopes	>200	3.6	0.3%
253B	Hinckley loamy sand, 3 to 8 percent slopes	>200	10.0	0.8%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	>200	15.5	1.3%
260B	Sudbury fine sandy loam, 3 to 8 percent slopes	69	32.6	2.7%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	61	21.3	1.8%

Depth to Water Table— Summary by Map Unit — Middlesex County, Massachusetts (MA017)				
Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
305C	Paxton fine sandy loam, 8 to 15 percent slopes	50	12.2	1.0%
307B	Paxton fine sandy loam, 3 to 8 percent slopes, extremely stony	50	25.0	2.1%
307C	Paxton fine sandy loam, 8 to 15 percent slopes, extremely stony	50	30.6	2.6%
307D	Paxton fine sandy loam, 15 to 25 percent slopes, extremely stony	50	52.5	4.4%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	46	81.3	6.8%
312B	Woodbridge fine sandy loam, 0 to 8 percent slopes, extremely stony	46	76.6	6.4%
317B	Scituate fine sandy loam, 3 to 8 percent slopes, extremely stony	50	7.4	0.6%
335B	Rainbow silt loam, 3 to 8 percent slopes	50	11.0	0.9%
336B	Rainbow silt loam, 3 to 8 percent slopes, very stony	50	40.5	3.4%
415B	Narragansett silt loam, 3 to 8 percent slopes	>200	32.1	2.7%
416B	Narragansett silt loam, 3 to 8 percent slopes, very stony	>200	155.7	13.1%
416C	Narragansett silt loam, 8 to 15 percent slopes, very stony	>200	48.3	4.1%
416D	Narragansett silt loam, 15 to 25 percent slopes, very stony	>200	14.9	1.3%
422C	Canton fine sandy loam, 8 to 15 percent slopes, extremely stony	>200	0.6	0.1%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	>200	58.8	4.9%
653	Udorthents, sandy	>200	25.0	2.1%
654	Udorthents, loamy	>200	68.4	5.8%
655	Udorthents, wet substratum	>200	6.6	0.6%

Depth to Water Table— Summary by Map Unit — Middlesex County, Massachusetts (MA017)				
Map unit symbol	Map unit name	Rating (centimeters)	Acres in AOI	Percent of AOI
656	Udorthents-Urban land complex	>200	141.1	11.9%
Totals for Area of Interest			1,189.8	100.0%

Description

"Water table" refers to a saturated zone in the soil. It occurs during specified months. Estimates of the upper limit are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone that lasts for less than a month is not considered a water table.

This attribute is actually recorded as three separate values in the database. A low value and a high value indicate the range of this attribute for the soil component. A "representative" value indicates the expected value of this attribute for the component. For this soil property, only the representative value is used.

Rating Options

Units of Measure: centimeters

Aggregation Method: Dominant Component

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

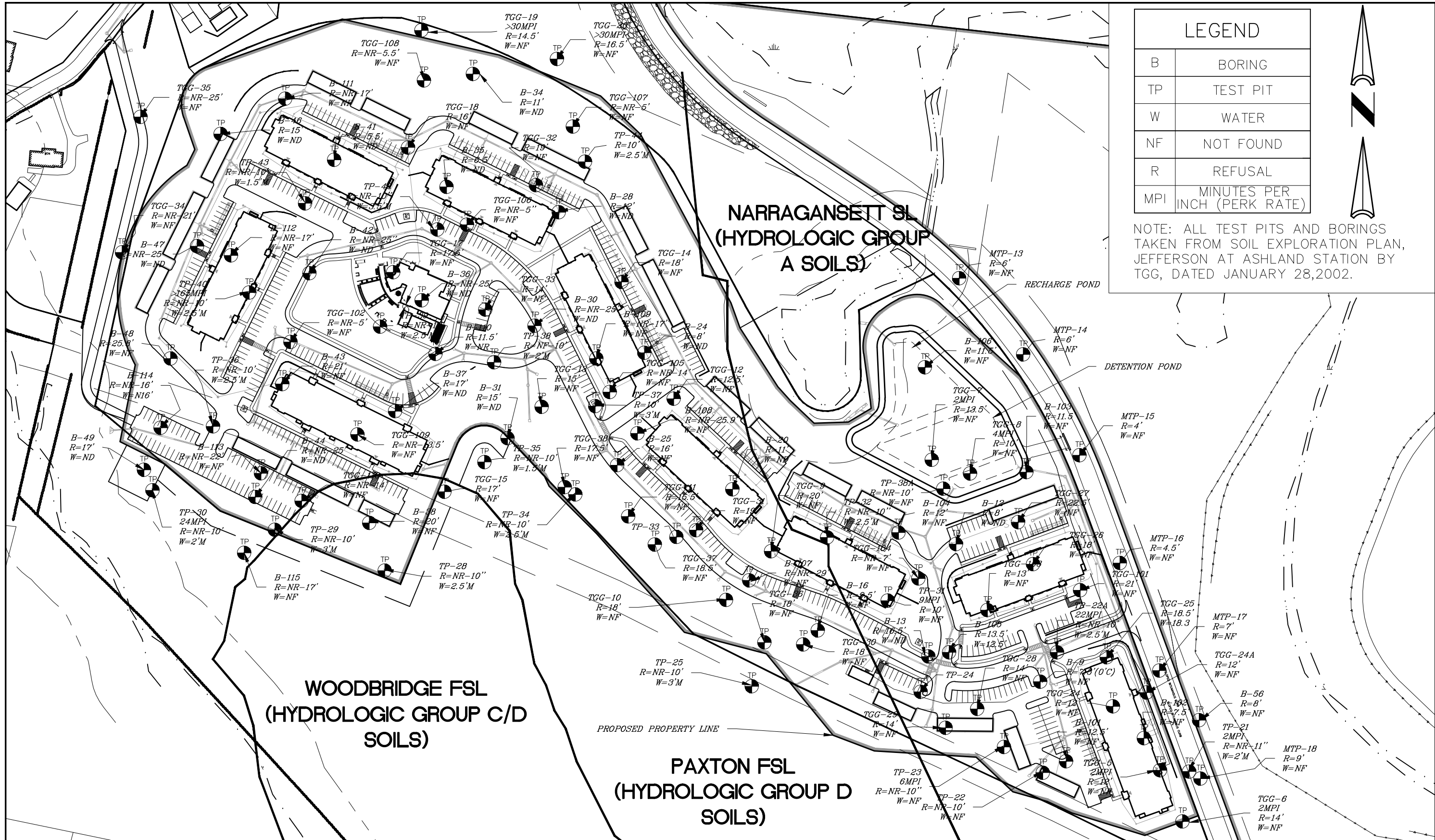
Interpret Nulls as Zero: No

Beginning Month: January

Ending Month: December

Summary of Previous Soil Explorations:

As noted in the Stormwater Management Summary the project proposed to modify a previous approval. The 2007 SWM Report included hundreds of test holes and borings. Kelly Engineering Group, Inc. have chosen to provide a portions of the previous soil testing that demonstrate that the NRCS soils mapping is accurate and the proposed recharge components will have more than 2' separation to seasonal high groundwater. The attached Soil Exploration Exhibit shows the extend of the previous soil testing with a summary of results including depth to refusal, water, and percolation rate.



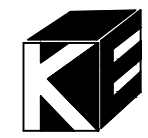
LEGEND	
B	BORING
TP	TEST PIT
W	WATER
NF	NOT FOUND
R	REFUSAL
MPI	MINUTES PER INCH (PERK RATE)

NOTE: ALL TEST PITS AND BORINGS TAKEN FROM SOIL EXPLORATION PLAN, JEFFERSON AT ASHLAND STATION BY TGG, DATED JANUARY 28, 2002.

**ASHLAND RAIL
TRANSIT APARTMENTS
ASHLAND, MA**

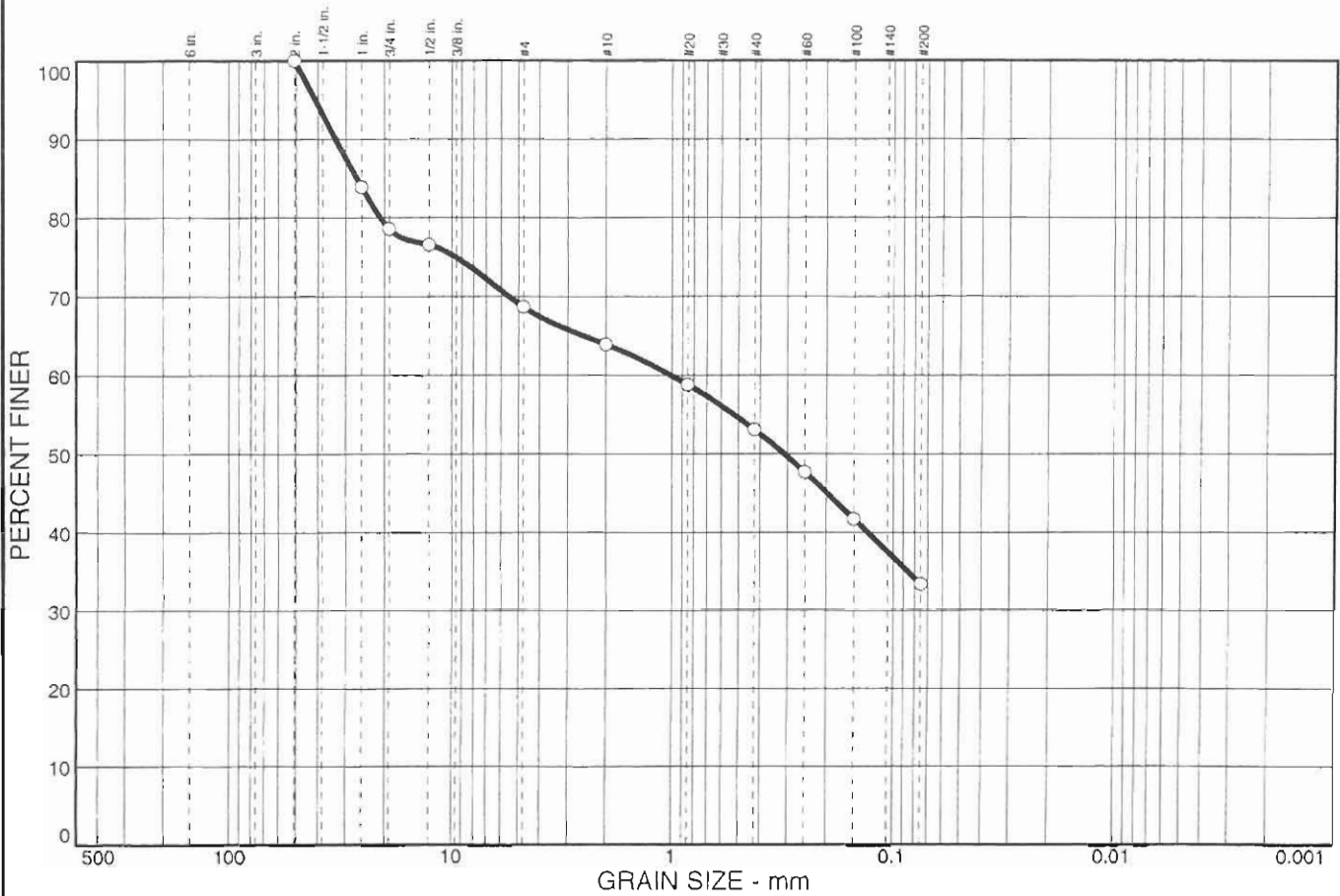
SCALE: 1" = 160'
DATE: 09/28/15
2015-042-SPOO-BORINGS

**SOIL
EXPLORATION
EXHIBIT**



KELLY ENGINEERING GROUP, INC.
CIVIL ENGINEERING CONSULTANTS
0 CAMPANELLI DRIVE · BRAINTREE MA · 02184
PHONE: 781 843 4333 FAX: 781 843 0028

PARTICLE SIZE DISTRIBUTION TEST REPORT



THE GEOTECHNICAL GROUP, INC.

Test Pit Log & Percolation Test	- PROJECT -		Test Pit No.	TGG-20 Page 1 of 2
	Jefferson at Ashland Station Ashland, MA		Date	1/9/02
			File No.	Y1503.01
Contractor	Titan Contractors	Make / Model	Cat. 330 Tracked Excavator	
Operator	Dave	Capacity / Reach	2± Cubic Yards/21± Feet	
Engineer	Bob Bosselman/Jeremy Haugh	Ground Elevation	270± Feet	
Weather	32 Degrees, Cloudy	Time Started & Completed	1315 hours/ 1415 hours	

Depth	Strata Change/	-Soil Description- (Burmister Class. System)	Excav. Effort	Boulder Count	Note No.	PERCOLATION TEST																																										
1	Forest Mat 0.5	*	E				<div style="text-align: center;"> <p>Hole Size</p> <p>Existing Ground Surface</p> </div> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th>Time Hrs-Min-Sec</th> <th>Elapsed Time (Min)</th> <th>Water Level Depth (Inches)</th> </tr> </thead> <tbody> <tr> <td>14:34-00 (1/10/02)</td> <td>0</td> <td>9.0</td> </tr> <tr> <td>15:34-00 (1/10/02)</td> <td>60</td> <td>8.75</td> </tr> <tr> <td>07:54-00 (1/11/02)</td> <td>1040</td> <td>6.0</td> </tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> <tr><td> </td><td> </td><td> </td></tr> </tbody> </table>	Time Hrs-Min-Sec	Elapsed Time (Min)	Water Level Depth (Inches)	14:34-00 (1/10/02)	0	9.0	15:34-00 (1/10/02)	60	8.75	07:54-00 (1/11/02)	1040	6.0																													
Time Hrs-Min-Sec	Elapsed Time (Min)	Water Level Depth (Inches)																																														
14:34-00 (1/10/02)	0	9.0																																														
15:34-00 (1/10/02)	60	8.75																																														
07:54-00 (1/11/02)	1040	6.0																																														
2	Subsoil	Orange, fine to coarse SAND and SILT, little fine to coarse Gravel, little Roots.	E	2±A 1±C																																												
3	3.0																																															
4		Brown, fine to medium SAND and SILT, some (-) Gravel.	D		3, 4																																											
5																																																
6																																																
7																																																
8	Glacial Till	Tan, fine to coarse SAND, little fine to coarse Gravel, little Silt.	D	12±A 1±B																																												
9																																																
10																																																
11																																																
12																																																
13																																																
14																																																

Test Pit Plan	Boulder Class	Class	Proportions Used	Abbreviations	Excavation Effort	Percolation Rate
N/S= 13±	6"-18"	A	Trace (TR)=0-10%	F=Fine	E=Easy	Time(9'-6" x 3" = >30 min / inch
E/W= 8±	18"-36"	B	Little (L)=10-20%	M=Medium	M=Moderate	
Volume= cu. yd	> 36"	C	Some (SO)=20-35%	C=Coarse	D=Difficult	
			And=35-50%	F/M= Fine to Medium		
				F/C=Fine to Coarse		

Remarks: * Black, fine to coarse SAND, some Roots, some Leaves, little Silt, trace (-) fine to coarse Gravel.

1. Test pit terminated at 16.5± feet.
2. Groundwater was not encountered at the time of the test pit.
3. Percolation test performed from about 3.5± to 4.5± feet.
4. Sample no. 5-1 obtained from about 3.5± to 4.5± feet.
5. A 4-inch diameter PVC well was installed upon completion of the test pit. The well contained perforations from about 2± to 16.5± feet.

THE GEOTECHNICAL GROUP, INC.

Test Pit Log & Percolation Test	- PROJECT -		Test Pit No.	TGG-7
	Jefferson at Ashland Station Ashland, MA		Date	1/7/02
			File No.	Y1503.01
Contractor	Titan Contractors	Make / Model	Cat. 330 Tracked Excavator	
Operator	Dave	Capacity / Reach	2± Cubic Yards/21± Feet	
Engineer	Bob Bosselman/John Fedirko	Ground Elevation	276± Feet	
Weather	32 Degrees, Rain/Snow	Time Started & Completed	1430 hours/ 1530 hours	

Depth	Strata Change/	-Soil Description- (Burmister Class. System)	Excav. Effort	Boulder Count	Note. No.	PERCOLATION TEST																																										
1	Forest Mat 0.5	*	E			<div style="text-align: left;"> <p>Hole Size</p> <p>Existing Ground Surface</p> </div> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th style="width: 30%;">Time Hrs-Min-Sec</th> <th style="width: 30%;">Elapsed Time (Min)</th> <th style="width: 40%;">Water Level Depth (Inches)</th> </tr> </thead> <tbody> <tr> <td>15:10:00</td> <td>0</td> <td>12</td> </tr> <tr> <td>15:15:00</td> <td>5.0</td> <td>9</td> </tr> <tr> <td>15:21:36</td> <td>11.6</td> <td>6</td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table>	Time Hrs-Min-Sec	Elapsed Time (Min)	Water Level Depth (Inches)	15:10:00	0	12	15:15:00	5.0	9	15:21:36	11.6	6																														
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15:15:00	5.0	9																																														
15:21:36	11.6	6																																														
2	Subsoil 2.0	Orange, fine to coarse SAND and fine to coarse Gravel, trace Silt.	E																																													
3																																																
4	Sand and Gravel 5.0	Tan, fine to coarse GRAVEL and medium to coarse SAND, trace Silt.	M	4±A	1, 2																																											
5																																																
6	Sand 7.0	Tan, fine to coarse SAND, little fine to coarse Gravel, trace Silt.	E																																													
7																																																
8																																																
9																																																
10	Boundary Glacial Till 13.5	Gray, fine to coarse SAND, and fine to coarse GRAVEL, trace (+) Silt.	D	10±A 4±B 3±C																																												
11																																																
12																																																
13																																																
14	///	Refusal at 13.5± feet.			5, 4																																											

Test Pit Plan	Boulder Class	Class	Proportions Used	Abbreviations	Excavation Effort	Percolation Rate
N/S= 6± E/W= 14± Volume= cu.yd	6"-18" 18"-36" > 36"	A B C	Trace (TR)=0-10% Little (L)=10-20% Some (SO)=20-35% And=35-50%	F=Fine M=Medium C=Coarse F/M= Fine to Medium F/C=Fine to Coarse	E=Easy M=Moderate D=Difficult	Time(9"-6")/3"= 2.2 min / inch

Remarks: *Black, fine to coarse SAND, some Organics, little Silt.

1. Percolation test performed from about 4± to 5± feet.
2. Sample no. S-1 obtained from percolation test hole.
3. Groundwater was not encountered at the time of the test pit.
4. Refusal to the excavator bucket on apparent bedrock at 13.5± feet.
5. A 4-inch diameter PVC well was installed upon completion of the test pit. The well contained perforations from about 2± to 13.5± feet. F - 17

THE GEOTECHNICAL GROUP, INC.

Test Pit Log & Percolation Test	- PROJECT -		Test Pit No.	TGG-8
	Jefferson at Ashland Station Ashland, MA		Date	1/7/02
			File No.	Y1503.01
Contractor	Titan Contractors	Make / Model	Cat. 330 Tracked Excavator	
Operator	Dave	Capacity / Reach	2± Cubic Yards/21± Feet	
Engineer	Bob Bosselman/John Fedirko	Ground Elevation	276± Feet	
Weather	32 Degrees, Rain/Snow	Time Started & Completed	1315 hours/ 1415 hours	

Depth	Strata Change/	-Soil Description- (Burmister Class. System)	Excav. Effort	Boulder Count	Note. No.	PERCOLATION TEST																																							
1	Forest Mat 0.5	*	E				<div style="text-align: center;"> <p>Hole Size</p> <p>Existing Ground Surface</p> </div> <table border="1" style="width: 100%; border-collapse: collapse; margin-top: 10px;"> <thead> <tr> <th>Time Hrs-Min-Sec</th> <th>Elapsed Time (Min)</th> <th>Water Level Depth (Inches)</th> </tr> </thead> <tbody> <tr> <td>13:40:00</td> <td>0</td> <td>12</td> </tr> <tr> <td>13:50:00</td> <td>10.0</td> <td>9</td> </tr> <tr> <td>14:02:18</td> <td>22.3</td> <td>6</td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> <tr> <td> </td> <td> </td> <td> </td> </tr> </tbody> </table>	Time Hrs-Min-Sec	Elapsed Time (Min)	Water Level Depth (Inches)	13:40:00	0	12	13:50:00	10.0	9	14:02:18	22.3	6																										
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2	Subsoil 2.0	Orange, fine to coarse SAND and SILT, trace Roots.	E																																										
3	Sand 3.0	Tan, fine to coarse SAND, little fine to coarse Gravel, little Silt.	E																																										
4	Bouldery Glacial Till 10.0	Tan, fine SAND and (-) fine to coarse GRAVEL, little (-) Silt.	D	10±A 3±C	1, 2																																								
5																																													
6																																													
7																																													
8																																													
9																																													
10																																													
11	///	Refusal at 10± feet. style="text-align: center;">///																																											
12																																													
13																																													
14																																													

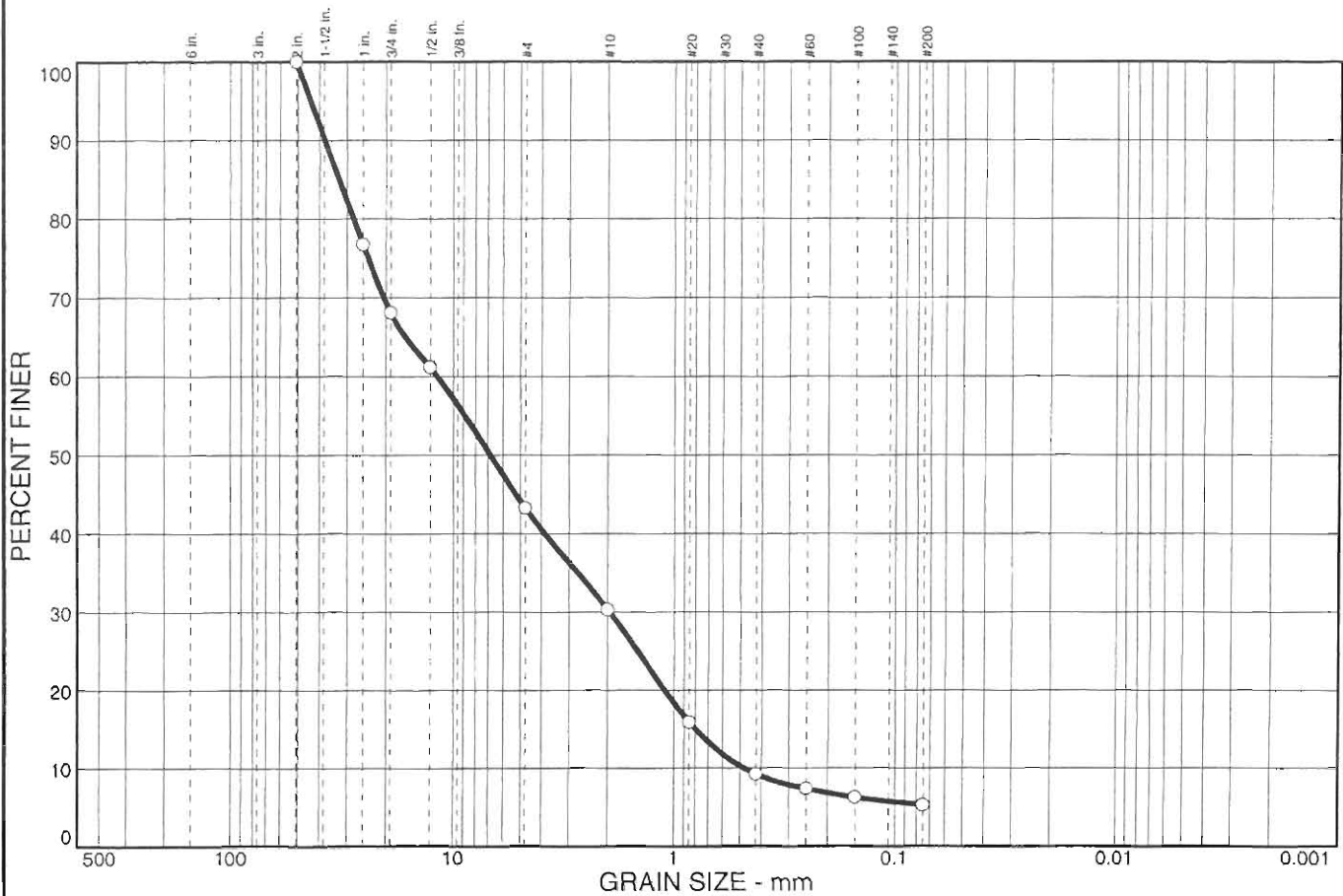
Test Pit Plan	Boulder Class	Class	Proportions Used	Abbreviations	Excavation Effort	Percolation Rate
N/S= 14±'	6"-18"	A	Trace (TA)=0-10%	F=Fine M=Medium C=Coarse	E=Easy M=Moderate D=Difficult	Time(9"-6")/3"= 4.1 min / inch
E/W= 6±'	18"-36"	B	Little (L)=10-20%	F/M= Fine to Medium F/C=Fine to Coarse		
Volume= cu.yd	>36"	C	Some (SO)=20-35%			
			And=35-50%			

Remarks: *Black, fine to coarse SAND, some Organics, little Silt.

1. Percolation test performed from about 4± to 5± feet.
2. Sample no. S-1 obtained from percolation test hole.
3. Groundwater was not encountered at the time of the test pit.
4. Refusal to the excavator bucket on apparent bedrock at 10± feet.
5. A 4-inch diameter PVC well was installed upon completion of this test pit. The well contained perforations from about 1.5± to 10± feet.

F - 18

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	31.9	24.8	13.0	21.0	4.0	5.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
2 in.	100.0		
1 in.	76.8		
.75 in.	68.1		
.5 in.	61.2		
#4	43.3		
#10	30.3		
#20	15.9		
#40	9.3		
#60	7.4		
#100	6.3		
#200	5.3		

Soil Description

Poorly graded gravel with silt and sand

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D₈₅= 32.5 D₆₀= 11.8 D₅₀= 6.83
 D₃₀= 1.96 D₁₅= 0.796 D₁₀= 0.477
 C_u= 24.66 C_c= 0.69

Classification

USCS= GP-GM AASHTO= A-1-a

Remarks

as rec'd w% = 6.5
natural soil

* (no specification provided)

Sample No.: S-1
Location:

Source of Sample: Test Pit No. TGG-7

Date: 1/21/02
Elev./Depth: 4-5'

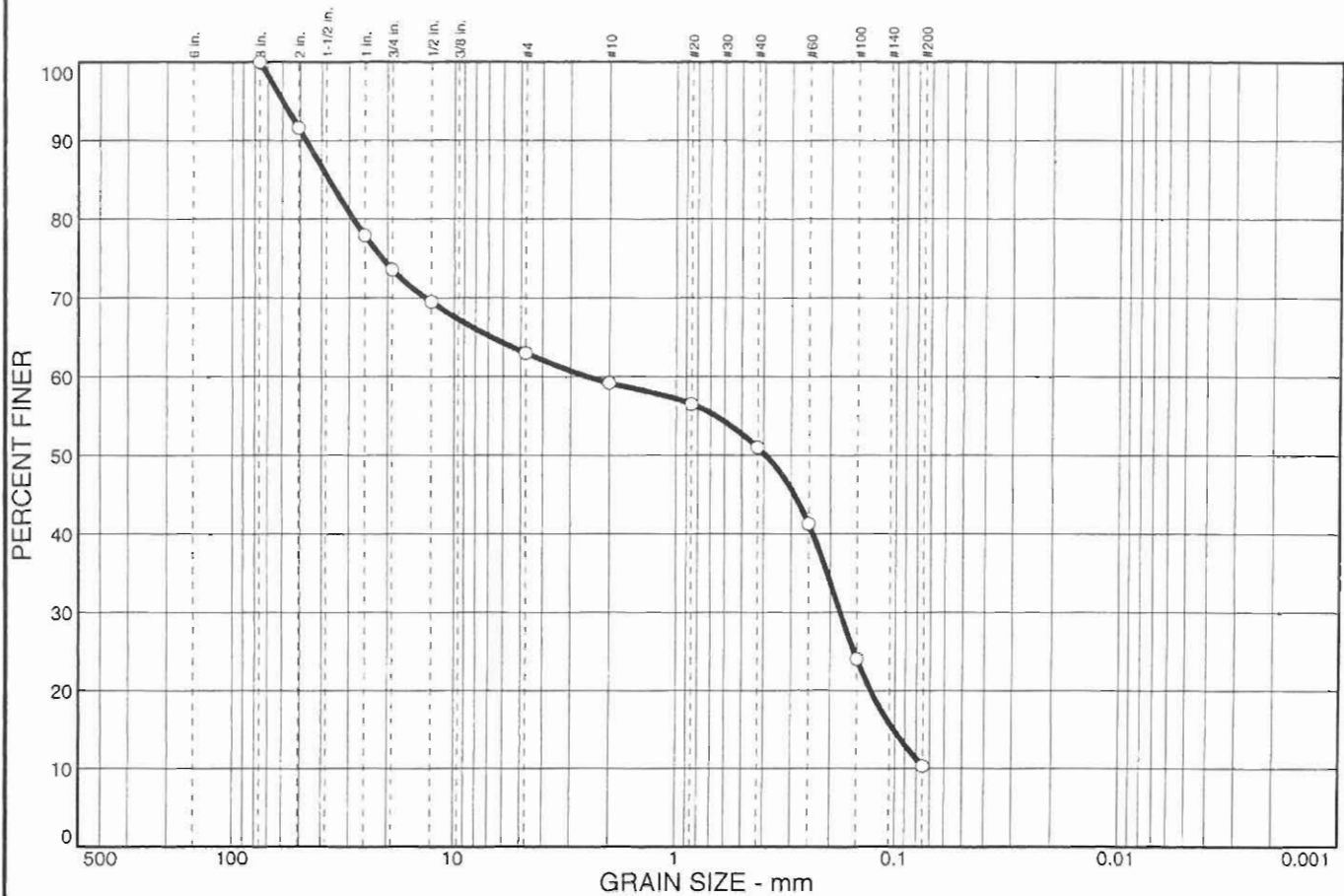
THE GEOTECHNICAL GROUP, INC.

Client: JPI
Project: Jefferson at Ashland Station
Ashland, MA

Project No: Y1503.01

Lab No. ~~SI~~-802

PARTICLE SIZE DISTRIBUTION TEST REPORT



% + 3"	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	26.4	10.6	3.8	8.2	40.7	10.3	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
3 in.	100.0		
2 in.	91.6		
1 in.	77.9		
.75 in.	73.6		
.5 in.	69.5		
#4	63.0		
#10	59.2		
#20	56.5		
#40	51.0		
#60	41.3		
#100	24.0		
#200	10.3		

Soil Description

Poorly graded sand with silt and gravel

Atterberg Limits

PL= -- LL= -- PI= --

Coefficients

D₈₅= 37.0 D₆₀= 2.51 D₅₀= 0.391
 D₃₀= 0.179 D₁₅= 0.102 D₁₀=
 C_u= C_c=

Classification

USCS= SP-SM AASHTO= A-3

Remarks

as rec'd w% = 3.1
 natural soil

(no specification provided)

Sample No.: S-1 Source of Sample: Test Pit No. TGG-8 Date: 1/21/02
 Location: Elev./Depth: 4-5'

THE GEOTECHNICAL GROUP, INC.

Test Boring Log	- PROJECT -	Boring No.	B-106
	Jefferson at Ashland Station Ashland, MA		Sheet 1 of 1
		File No.	Y1503.02
		Review by:	Mark Zambarnardi

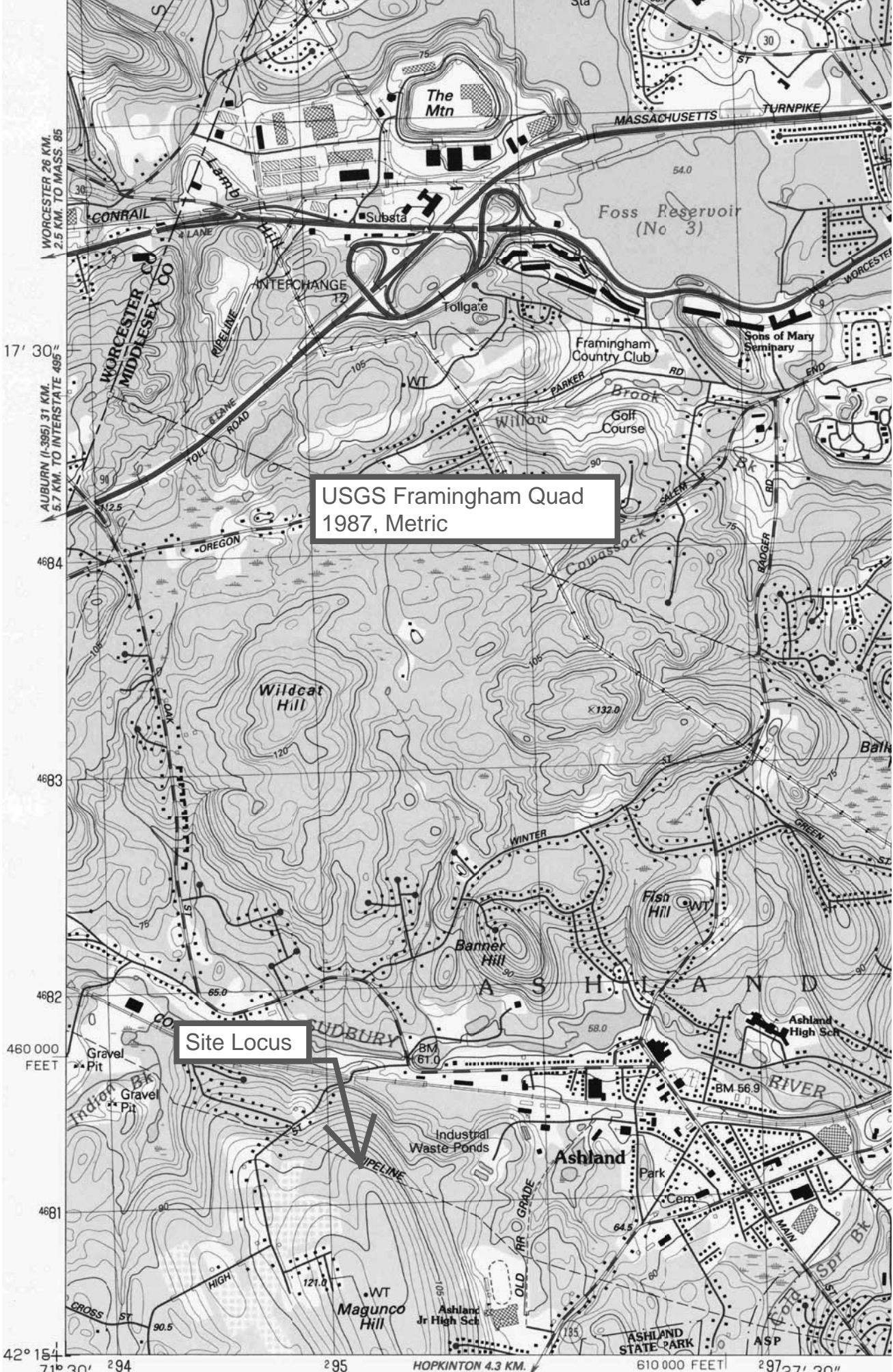
Boring Co.	Soil Exploration Corporation	Boring Location:	See Exploration Location Plan
Foreman	Mike Camacho	Ground Elev.	266± feet
TGG Observer	Jeremy Haugh	Date Start > End	7/16/02

Sampling Protocol	Ground Water Readings (See Notes)				
Unless otherwise noted, borings were accomplished using 4 inch inside diameter hollow stem augers. Samples were recovered using a 2-inch O.D. split spoon sampler, driven by blows of a 140 Lb. hammer falling 30 inches.	Date	Time	Depth to Bottom	Depth to Water	Rem.
	7/16	Comp.	11.5'±	--	3

Sample Data						Strata Change	Sample Description
No.	Depth	Blows per 6 in.	Pen.	Rec.	Rem.		
S-1	0.0-2.0	3-7-6-3	24	14		0.3'	**
					1	Subsoil	Medium dense, tan, fine to medium SAND, some Silt, trace Organics.
						3.0	
5							
S-2	5.0-5.5	80/6"	6	3		Glacial Till	Very dense, gray-tan, fine to medium SAND and fine to coarse GRAVEL, trace (+) Silt.
						10.0	
10						Weathered Bedrock	
S-3	10.0-10.9	30-90/5"	11	11		11.5	Very dense, dark gray-tan, fine to coarse SAND and fine GRAVEL, some Silt.
						Refusal	Refusal to augers and split spoon sampler at 11.5± feet.
15							
20							
25							

Remarks: *Forest Mat **Black, fine to coarse SAND, some Roots and Leaves, little Silt.

1. Augers grinding on apparent cobbles from 2± to 11.5± feet.
2. Refusal to augers at 11.5± feet on apparent ledge.
3. Groundwater was not encountered at the time of boring.



USGS Framingham Quad
1987, Metric

Site Locus

Worcester 26 KM.
2.5 KM. TO MASS. 85

Auburn (I-395) 31 KM.
5.7 KM. TO INTERSTATE 495

17' 30"

4684

4683

4682

460 000 FEET

4681

42° 15'

71° 30' 294

295

HOPKINTON 4.3 KM.
WESTBORO 14 KM.

610 000 FEET

297 27' 30"

