STORMWATER MANAGEMENT REPORT

Standley Street Gardens

Beverly, Massachusetts

Prepared for:

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Prepared by:

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July 9, 2015

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CIVIL
No. 30015
REGISTERED PROFESSIONAL ENGINEER

7-9-15

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Introduction and Background

The following report details the storm water management design of the proposed Standley Street Gardens development located at what is now #44 & #52 Standley Street in Beverly, MA. This report has been prepared to document compliance with the Massachusetts Department of Environmental Protection (MA DEP) Stormwater Management Standards.

The proposed site design is shown on a plan set titled: Definitive Subdivision Plan Standley Street Gardens, dated: July 9, 2015, prepared by: Marchionda & Associates, L.P.

Project Description

The land to be developed is an approximately 6.27 Acre tract of land made up of two parcels identified by the City of Beverly Assessor's office as Parcels 58-1B and 58-2.

Parcel 58-1B is an approximately 3.97 Acre parcel that is currently undeveloped with the exception of a path that extends along it's northerly edge from Standley Street to the City of Beverly land located to the west of the locus parcels. Parcel 58-1B is hilly, wooded terrain with a Bordering Vegetated Wetland located at its southwesterly corner. This wetland covers approximately 50 square feet of the parcel.

Parcel 58-2 is an approximately 2.3 Acre parcel that is the former site of a Garden Center. There is an existing single family dwelling, driveway, parking area, multiple concrete foundations that are presumably remnants of greenhouses and paths interconnecting the foundations. The site is currently abandoned and becoming overgrown. Along the northerly edge of the parcel, there is a drain line that conveys stormwater runoff from Standley Street to a wetland located at northwesterly corner of the parcel. This wetland covers approximately 6040 square feet of the parcel.

The proposed development is to consist of 8 Single Family Homes in an Open Space Residential Design (OSRD) Subdivision pursuant to the City of Beverly Zoning Ordinance Chapter XXXVIII Section 38-24.B. Approximately 3.76 acres of the tract is to remain open space. The plan proposes an approximately 400' long road with a cul-de-sac to provide access to the lots along with water, sewer and electrical utilities to provide service to the proposed dwellings. Associated with this project is the extension of a sewer main in Standley Street. A stormwater drainage system is designed to comply with the Massachusetts Stormwater Management Standards.

Compliance with Stormwater Management Standards

Standard 1: Untreated Stormwater

Stormwater Management Standard #1 requires that no new stormwater conveyances may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the commonwealth.

The proposed stormwater management system has been designed to provide treatment of runoff prior to discharge.

Standard 2: Post-Development Peak Flow Runoff Rates

Stormwater Management Standard #2 requires that Stormwater Management Systems be designed so that post development peak discharge rates do not exceed pre-development peak discharge rates. Peak flow runoff rates were studied for the proposed conditions for the 2, 10, and 100 year, 24-hour Type III storm events. The rainfall data used in the calculations was taken from the MA DEP Hydrology Handbook for Conservation Commissioners Appendix F-1 for Essex County. The 24 hour rainfall depths according the handbook for the 2, 10 and 100 year storm events are 3.1", 4.5" and 6.5" respectively.

Existing pre-development stormwater runoff from the site flows towards two main areas. The southerly portion of the site currently drains towards the "B" series wetlands and towards the City of Beverly land that lies westerly of the site. This portion of the site is not being altered and therefore is not part of this study. The runoff from the northerly portion of the site that is to be developed flows towards the "A" series wetland. A portion of this stormwater reaches the wetland by overland flow through the site. The rest of the runoff reaches the wetland by flowing towards Standley Street before being collected by the existing drainage system in Standley Street. This street drainage is then directed towards the wetland via an existing 15" pipe that runs along the northerly lot line of the parcel.

The proposed post development stormwater runoff will be directed towards the "A" series wetland. The drainage area will be broken into three subcatchments. Subcatchment 1 (PR SC-1) is comprised of the drainage area that will be collected by a pair of catchbasins proposed in the proposed roadway approximately 70' from Standley Street. This runoff will be piped through drainage system #1 to an underground stormwater recharge system. The outflow from this Chamber system will be piped into the existing 15" pipe along the northerly edge of the site. Subcatchment #2 (PR SC-2) is the drainage area that flows onto the proposed roadway and is to be collected by the proposed road drainage system (System #2). This stormwater will be directed through an underground recharge/infiltration system, and then piped to a flared end section that will eventually flow towards the "A" series wetland. Subcatchment #3 (PR SC-3) is the remaining area of the site that will flow overland towards the wetland. The outflow from

these three subcatchments are added together to represent the total post development peak flow to the wetlands.

See exhibits included in Appendix 1 for the limits of each watershed or subcatchment area.

The underlying soils on site are identified as Merrimac sandy loam by the National Resources Conservation Service (NRCS) Soil Survey for the area. This soil is classified as belonging to the Hydrologic Soil Group A. On site soil testing supports this classification. Curve Numbers (CN's) were generated using this soil group along with the land cover conditions.

CN's and TC's obtained using TR-55 methodology were input into the *Hydraflow*® Hydrographs software package, which utilizes the National Resources Conservation Service (NRCS) (formerly "SCS") methods to generate and route hydrographs. The resulting hydrographs and supporting calculations have been included in Appendix 1.

The resulting analysis determined that the peak runoff rates to the Design Points in the post-development condition do not exceed the pre-development peak runoff rates for the design storms. Table 2 (below) summarizes the attached *Hydraflow*® Hydrographs analysis.

TABLE 2: PEAK RUNOFF RATE COMPARISON

	Peak Flows (CFS)		
	Storm Events		
	2 YR	10 YR	100 YR
Existing Pre-Development	0.04	0.84	4.32
Rech. System 1 (PR SC-1)	0.00	0.63	1.20
Inf. System 2 (PR SC-2)	0.00	0.00	1.40
PR SC-3	0.01	0.31	2.20
Total Post Development	0.01	0.64	3.58

Standard 3: Recharge to Groundwater

Stormwater Management Standard #3 requires that the loss of annual recharge to groundwater be eliminated or minimized through the use of infiltration measures. The loss of groundwater recharge will be mitigated through the use of two underground infiltration chamber systems.

MADEP Stormwater Management Guidelines require a recharge volume based on the Hydrologic Soil Groups of the soil that will be covered by impervious surfaces. The Guidelines require a depth of 0.6 inches of runoff over the impervious are to be recharged

into the ground for the Hydrologic Group A soils. Runoff directed towards the proposed recharge areas will be pre treated. Per the guidelines a volume of 1571 sq. ft is required to be recharged into the ground. The two Recharge systems proposed together will supply a recharge volume of 3131 sq. ft.

See supporting calculations located in Appendix 2.

Standard 4: T.S.S. Removal

Stormwater Management Standard #4 requires that the stormwater management systems be designed to remove 80% of the average annual post construction load of Total Suspended Solids (TSS). The stormwater management system will include Best Management Practices (BMP's) treatment trains that will provide the removal of at least 80% of the Total Suspended Soils generated from the proposed development. These BMP's include Street Sweeping, Deep Sump Hooded Catch Basins, Underground Chamber Infiltration Systems and Propriety Water Quality Structures. See Appendix 4 for the removal rate worksheets for each of the proposed treatment trains.

Standard 5: Higher Pollutant Loads

The project does not propose any uses that could potentially generate higher pollutant loads.

Standard 6: Discharges within a Zone II or Interim Wellhead Protection Area

According to the MA GIS Mapping Application, The project does not lie within either a Zone II or an Interim Wellhead Protection Area.

Standard 7: Redevelopment Project

The project is not considered a redevelopment project under the criteria set forth in the Stormwater Handbook.

Standard 8: Erosion and sediment control

The project will include appropriate erosion and sediment controls to insure that exposed soils will remain stable and sediment will not be released from the proposed limit of work.

Standard 9: Operation & Maintenance Plan

An Operation and Maintenance (O&M) Plan will be provided for the development. The O & M Plan will state the parties responsible for the operation and maintenance of the proposed BMP's as well the maintenance requirements and schedule. The plan will be provided with the Notice of Intent filing.

Standard 10: Illicit Discharges

Prior to the discharge of stormwater runoff to post construction BMP's, the project owner shall prepare an illicit discharge compliance statement in accordance with standard 10.

Hydraulic Analysis

The revised roadway drainage system components have been design to accommodate a 10 year rainfall event. The 100 year storm event was also analyzed to ensure that there will be no surcharge from the structure rims during larger storm events.

The analysis was completed using the *HydraFlow Storm Sewers* Computer program. This program utilizes the Rational Method to determine flows that will be generated from the watersheds to each of the storm sewer systems. See Appendix 3 which includes the computations of the characteristics of the contributing subcatchment areas along with the results of the analysis.

Appendix 1

Stormwater Standard #2 – Hydrology Report

Figure 1 – Soils Map and Report

Exhibit 1- Existing Conditions Subcatchment Exhibit

Exhibit 2- Proposed Conditions Subcatchment Exhibit

Hydrograph Reports

2 yr, 10 yr & 100 yr Storm events including Time of Concentration calculations and Infiltration System information

70° 51' 7" W
70° 50' 26" W
42° 34' 24" N
42° 34' 8" N
348020
348100
348180
348260
348340
348420
348500
348580
348660
348740
348820
348900
4715090
4715010
4714930
4714850
4714770
4714690
4714610
State Hwy 128
128
242C
102C
52A
43A
31A
254A
260A
254B
616A
Map Scale: 1:2,500 if printed on B landscape (17" x 11") sheet.
Meters
0 35 70 140 210
Feet
0 100 200 400 600
N
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

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

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

May 29, 2015

Preface

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

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

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

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

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

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

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How Soil Surveys Are Made

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

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

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

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

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

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

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

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

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

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

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

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

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

Map Scale: 1:2,500 if printed on B landscape (17" x 11") sheet.

N

Meters
0 35 70 140 210

Feet
0 100 200 400 600

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: 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: Essex County, Massachusetts, Southern Part
Survey Area Data: Version 11, 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: Aug 29, 2014—Sep 19, 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.

Map Unit Legend

Essex County, Massachusetts, Southern Part (MA606)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
31A	Walpole sandy loam, 0 to 3 percent slopes	7.3	12.6%
43A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	1.5	2.5%
52A	Freetown muck, 0 to 1 percent slopes	8.3	14.5%
102C	Chatfield-Hollis-Rock outcrop complex, 3 to 15 percent slopes	15.0	26.1%
242C	Hinckley gravelly fine sandy loam, 8 to 15 percent slopes	0.0	0.0%
254A	Merrimac fine sandy loam, 0 to 3 percent slopes	13.2	23.0%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	3.5	6.1%
260A	Sudbury fine sandy loam, 0 to 3 percent slopes	7.6	13.2%
616A	Fluvaquents, frequently flooded, 0 to 3 percent slopes	1.1	2.0%
Totals for Area of Interest		**57.4**	**100.0%**

Map Unit Descriptions

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

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

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different

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

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

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

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

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

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

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

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

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

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

Essex County, Massachusetts, Southern Part

31A—Walpole sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2svkl
Elevation: 0 to 1,020 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Walpole and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Walpole

Setting

Landform: Deltas, depressions, outwash plains, depressions, outwash terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, talf, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy glaciofluvial deposits derived from igneous, metamorphic and sedimentary rock

Typical profile

Oe - 0 to 1 inches: mucky peat
A - 1 to 7 inches: sandy loam
Bg - 7 to 21 inches: sandy loam
BC - 21 to 25 inches: gravelly sandy loam
C - 25 to 65 inches: very gravelly sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to very high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 4 inches
Frequency of flooding: None
Frequency of ponding: None
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 6.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: A/D

Minor Components

Scarboro

Percent of map unit: 10 percent
Landform: Deltas, outwash plains, outwash terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave

Sudbury

Percent of map unit: 10 percent
Landform: Terraces, deltas, outwash plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Linear

43A—Scarboro mucky fine sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2svky
Elevation: 0 to 1,320 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Scarboro and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Scarboro

Setting

Landform: Depressions, outwash deltas, outwash terraces, drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy glaciofluvial deposits derived from schist and/or sandy glaciofluvial deposits derived from gneiss and/or sandy glaciofluvial deposits derived from granite

Typical profile

Oe - 0 to 3 inches: mucky peat
A - 3 to 11 inches: mucky fine sandy loam
Cg1 - 11 to 21 inches: sand
Cg2 - 21 to 65 inches: gravelly coarse sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: About 0 to 2 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D

Minor Components

Swansea

Percent of map unit: 10 percent
Landform: Bogs, swamps
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave

Wareham

Percent of map unit: 5 percent
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave

Walpole

Percent of map unit: 5 percent
Landform: Outwash plains, depressions, depressions, outwash terraces, deltas
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip, talf
Down-slope shape: Concave
Across-slope shape: Concave

52A—Freetown muck, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2t2q9
Elevation: 0 to 1,110 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Farmland of unique importance

Map Unit Composition

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

Description of Freetown

Setting

Landform: Kettles, depressions, depressions, bogs, marshes, swamps
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Highly decomposed organic material

Typical profile

Oe - 0 to 2 inches: mucky peat
Oa - 2 to 79 inches: muck

Properties and qualities

Slope: 0 to 1 percent
Percent of area covered with surface fragments: 0.0 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water storage in profile: Very high (about 19.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D

Minor Components

Scarboro

Percent of map unit: 5 percent
Landform: Depressions, drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave

Swansea

Percent of map unit: 5 percent
Landform: Kettles, depressions, depressions, marshes, bogs, swamps
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave

Whitman

Percent of map unit: 5 percent

Landform: Depressions, drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave

102C—Chatfield-Hollis-Rock outcrop complex, 3 to 15 percent slopes

Map Unit Setting

National map unit symbol: vk4f
Elevation: 100 to 1,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Chatfield and similar soils: 40 percent
Hollis and similar soils: 25 percent
Rock outcrop: 20 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Chatfield

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable, moderately deep coarse-loamy basal till derived from granite and gneiss over granite and gneiss

Typical profile

H1 - 0 to 5 inches: fine sandy loam
H2 - 5 to 34 inches: gravelly very fine sandy loam
H3 - 34 to 60 inches: unweathered bedrock

Properties and qualities

Slope: 8 to 15 percent
Percent of area covered with surface fragments: 9.0 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: B

Description of Hollis

Setting

Landform: Ridges on hills
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable, shallow loamy basal till derived from granite and gneiss over granite and gneiss

Typical profile

O - 0 to 2 inches: muck
H2 - 2 to 5 inches: fine sandy loam
H3 - 5 to 20 inches: gravelly fine sandy loam
H4 - 20 to 60 inches: unweathered bedrock

Properties and qualities

Slope: 8 to 15 percent
Percent of area covered with surface fragments: 9.0 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Natural drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately low (0.00 to 0.06 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 2.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D

Description of Rock Outcrop

Properties and qualities

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

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s

Minor Components

Canton

Percent of map unit: 4 percent

Montauk

Percent of map unit: 2 percent

Paxton
Percent of map unit: 2 percent

Whitman
Percent of map unit: 2 percent
Landform: Depressions

Woodbridge
Percent of map unit: 2 percent

Freetown
Percent of map unit: 1 percent
Landform: Bogs

Ridgebury
Percent of map unit: 1 percent
Landform: Depressions

Swansea
Percent of map unit: 1 percent
Landform: Bogs

242C—Hinckley gravelly fine sandy loam, 8 to 15 percent slopes

Map Unit Setting
National map unit symbol: vk5p
Elevation: 0 to 1,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

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

Description of Hinckley

Setting
Landform: Hills, drainageways, ridges
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope, riser
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Friable sandy and gravelly glaciofluvial deposits derived from granite and gneiss

Typical profile

H1 - 0 to 8 inches: gravelly fine sandy loam
H2 - 8 to 17 inches: gravelly loamy sand
H3 - 17 to 60 inches: stratified cobbly coarse sand to very gravelly loamy fine sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (6.00 to 20.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A

Minor Components

Windsor

Percent of map unit: 12 percent

Swansea

Percent of map unit: 1 percent
Landform: Bogs

Wareham

Percent of map unit: 1 percent
Landform: Terraces

Sudbury

Percent of map unit: 1 percent

254A—Merrimac fine sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2tyqr
Elevation: 0 to 1,100 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Merrimac

Setting

Landform: Moraines, outwash plains, eskers, outwash terraces, kames
Landform position (two-dimensional): Backslope, footslope, summit, shoulder
Landform position (three-dimensional): Side slope, crest, riser, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy glaciofluvial deposits derived from granite, schist, and gneiss over sandy and gravelly glaciofluvial deposits derived from granite, schist, and gneiss

Typical profile

Ap - 0 to 10 inches: fine sandy loam
Bw1 - 10 to 22 inches: fine sandy loam
Bw2 - 22 to 26 inches: stratified gravel to gravelly loamy sand
2C - 26 to 65 inches: stratified gravel to very gravelly sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline (0.0 to 1.4 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 1.0
Available water storage in profile: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: A

Minor Components

Hinckley

Percent of map unit: 5 percent
Landform: Outwash plains, eskers, kames, deltas
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope, crest, head slope, rise
Down-slope shape: Convex
Across-slope shape: Linear, convex

Sudbury

Percent of map unit: 5 percent
Landform: Outwash plains, terraces, deltas
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Linear

Agawam

Percent of map unit: 3 percent
Landform: Moraines, outwash plains, eskers, outwash terraces, kames, stream terraces
Landform position (three-dimensional): Rise
Down-slope shape: Convex
Across-slope shape: Convex

Windsor

Percent of map unit: 2 percent
Landform: Outwash terraces, dunes, outwash plains, deltas
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex

254B—Merrimac fine sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 2tyqs
Elevation: 0 to 1,290 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Merrimac

Setting

Landform: Eskers, kames, outwash terraces, moraines, outwash plains
Landform position (two-dimensional): Backslope, footslope, shoulder, summit
Landform position (three-dimensional): Side slope, crest, riser, tread
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Loamy glaciofluvial deposits derived from granite, schist, and gneiss over sandy and gravelly glaciofluvial deposits derived from granite, schist, and gneiss

Typical profile

Ap - 0 to 10 inches: fine sandy loam
Bw1 - 10 to 22 inches: fine sandy loam
Bw2 - 22 to 26 inches: stratified gravel to gravelly loamy sand
2C - 26 to 65 inches: stratified gravel to very gravelly sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat excessively drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 2 percent
Salinity, maximum in profile: Nonsaline (0.0 to 1.4 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 1.0
Available water storage in profile: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: A

Minor Components

Hinckley

Percent of map unit: 5 percent
Landform: Kames, eskers, outwash plains, deltas
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Nose slope, side slope, crest, head slope, rise
Down-slope shape: Convex
Across-slope shape: Convex, linear

Sudbury

Percent of map unit: 5 percent
Landform: Outwash plains, terraces, deltas
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Linear

Windsor

Percent of map unit: 3 percent
Landform: Outwash terraces, dunes, outwash plains, deltas
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread, riser
Down-slope shape: Linear, convex
Across-slope shape: Linear, convex

Agawam

Percent of map unit: 2 percent
Landform: Kames, stream terraces, eskers, outwash terraces, moraines, outwash plains
Landform position (three-dimensional): Rise
Down-slope shape: Convex
Across-slope shape: Convex

260A—Sudbury fine sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: vkj2
Elevation: 0 to 2,100 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Sudbury

Setting

Landform: Flats
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Friable loamy eolian deposits over loose sandy glaciofluvial deposits derived from granite and gneiss

Typical profile

H1 - 0 to 13 inches: fine sandy loam
H2 - 13 to 19 inches: sandy loam
H3 - 19 to 26 inches: gravelly coarse sand
H4 - 26 to 60 inches: stratified very gravelly coarse sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Moderately well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B

Minor Components

Merrimac
Percent of map unit: 10 percent

Walpole
Percent of map unit: 5 percent
Landform: Terraces

616A—Fluvaquents, frequently flooded, 0 to 3 percent slopes

Map Unit Setting
National map unit symbol: vk56
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

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

Description of Fluvaquents

Setting
Landform: Alluvial flats
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Talf
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Friable loamy alluvium over friable sandy eolian deposits

Properties and qualities
Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Depth to water table: About 0 to 12 inches
Frequency of flooding: Frequent
Frequency of ponding: None

Minor Components

Swansea
Percent of map unit: 10 percent
Landform: Bogs

Unnamed soils
Percent of map unit: 5 percent

Soil Information for All Uses

Soil Properties and Qualities

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

Soil Qualities and Features

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

Hydrologic Soil Group (Standley St Beverly, MA)

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.

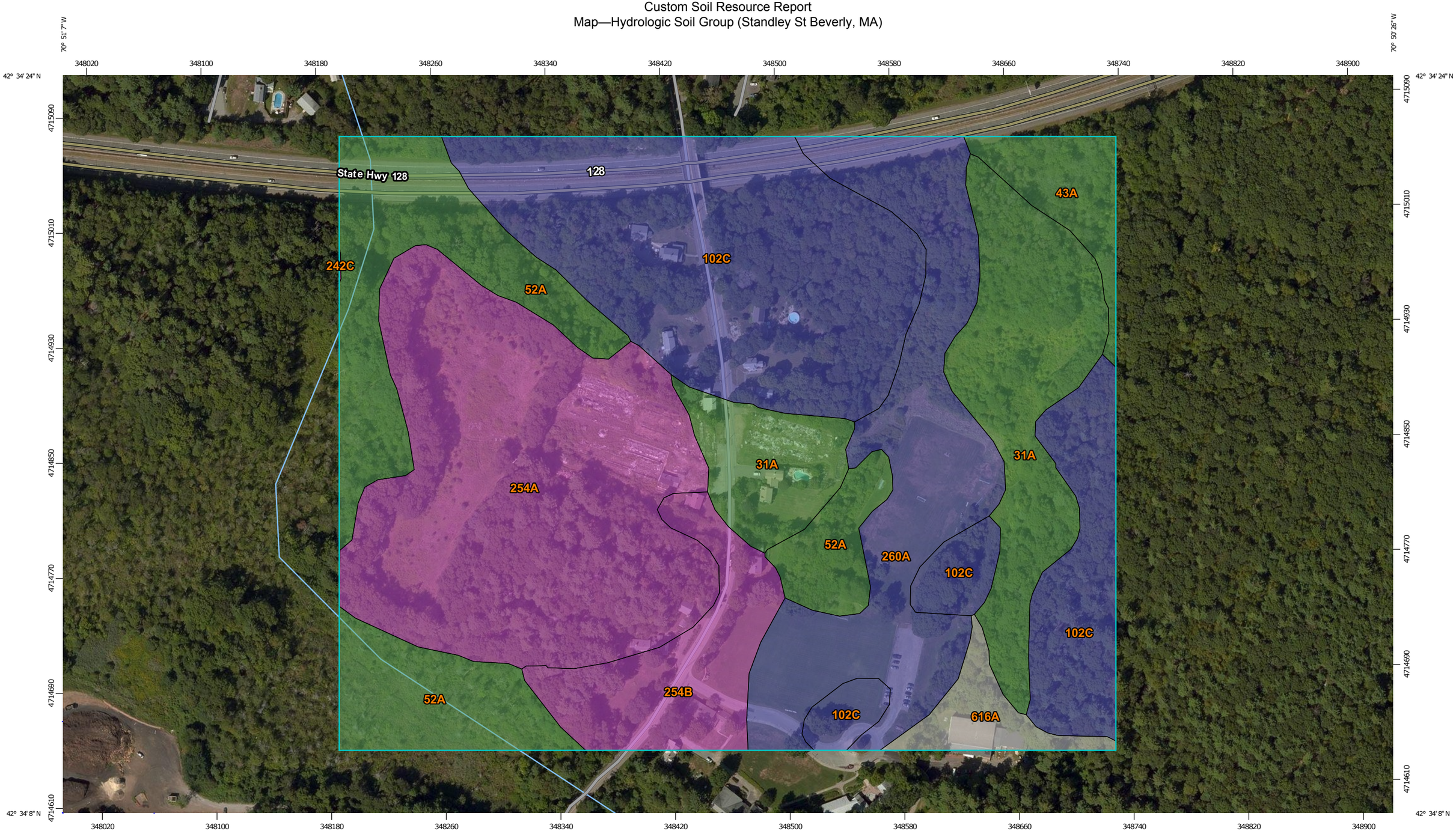
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

Map—Hydrologic Soil Group (Standley St Beverly, MA)



Map Scale: 1:2,500 if printed on B landscape (17" x 11") sheet.

N

Meters: 0 35 70 140 210

Feet: 0 100 200 400 600

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

Streams and Canals

Transportation

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

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: 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: Essex County, Massachusetts, Southern Part
Survey Area Data: Version 11, 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: Aug 29, 2014—Sep 19, 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.

Table—Hydrologic Soil Group (Standley St Beverly, MA)

Hydrologic Soil Group— Summary by Map Unit — Essex County, Massachusetts, Southern Part (MA606)				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
31A	Walpole sandy loam, 0 to 3 percent slopes	A/D	7.3	12.6%
43A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	A/D	1.5	2.5%
52A	Freetown muck, 0 to 1 percent slopes	A/D	8.3	14.5%
102C	Chatfield-Hollis-Rock outcrop complex, 3 to 15 percent slopes	B	15.0	26.1%
242C	Hinckley gravelly fine sandy loam, 8 to 15 percent slopes	A	0.0	0.0%
254A	Merrimac fine sandy loam, 0 to 3 percent slopes	A	13.2	23.0%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	A	3.5	6.1%
260A	Sudbury fine sandy loam, 0 to 3 percent slopes	B	7.6	13.2%
616A	Fluvaquents, frequently flooded, 0 to 3 percent slopes		1.1	2.0%
Totals for Area of Interest			**57.4**	**100.0%**

Rating Options—Hydrologic Soil Group (Standley St Beverly, MA)

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

References

American Association of State Highway and Transportation Officials (AASHTO). 2004. Standard specifications for transportation materials and methods of sampling and testing. 24th edition.

American Society for Testing and Materials (ASTM). 2005. Standard classification of soils for engineering purposes. ASTM Standard D2487-00.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deep-water habitats of the United States. U.S. Fish and Wildlife Service FWS/OBS-79/31.

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

National Research Council. 1995. Wetlands: Characteristics and boundaries.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_054262

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service, U.S. Department of Agriculture Handbook 436. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053577

Soil Survey Staff. 2010. Keys to soil taxonomy. 11th edition. U.S. Department of Agriculture, Natural Resources Conservation Service. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053580

Tiner, R.W., Jr. 1985. Wetlands of Delaware. U.S. Fish and Wildlife Service and Delaware Department of Natural Resources and Environmental Control, Wetlands Section.

United States Army Corps of Engineers, Environmental Laboratory. 1987. Corps of Engineers wetlands delineation manual. Waterways Experiment Station Technical Report Y-87-1.

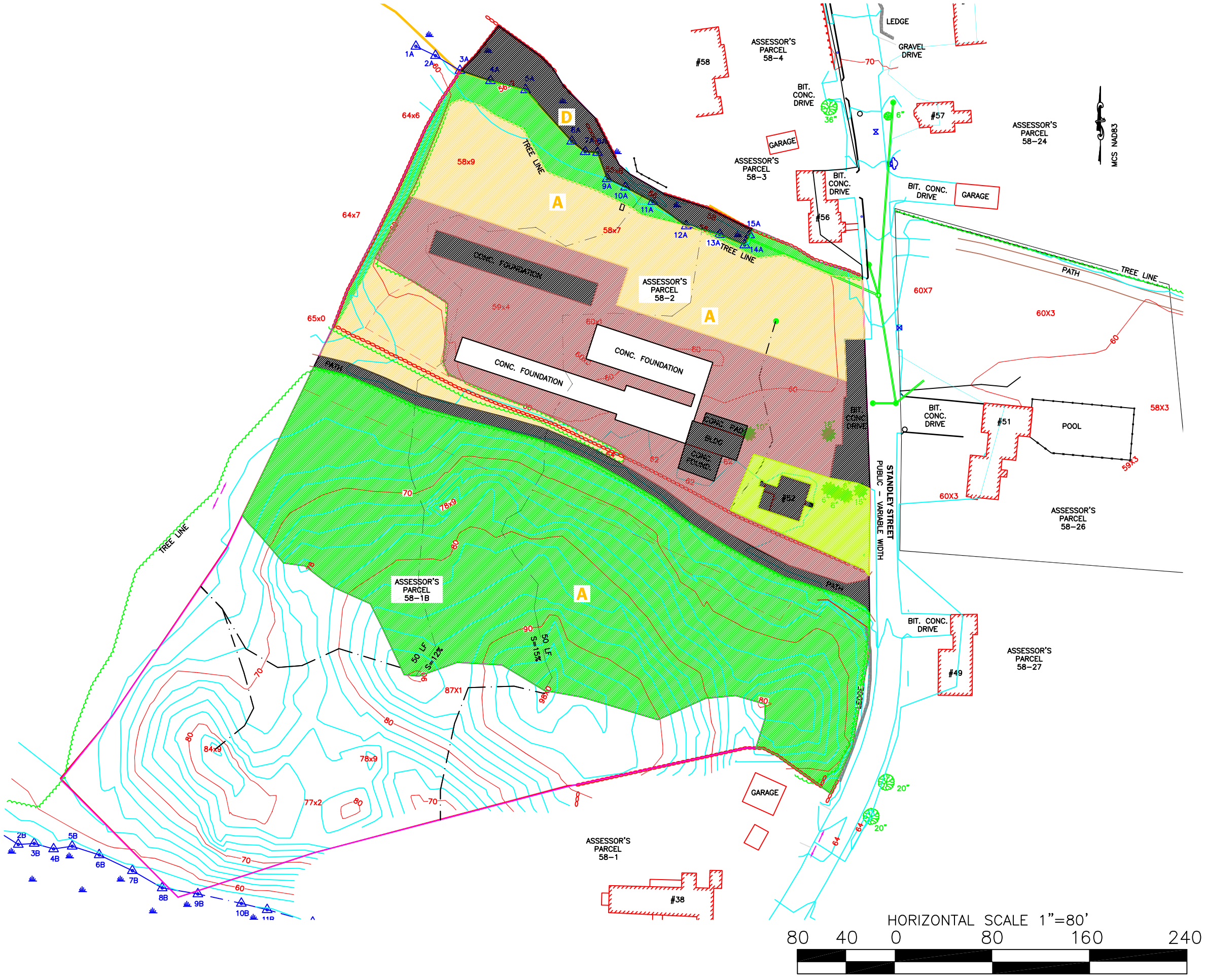
United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242

United States Department of Agriculture, Natural Resources Conservation Service. 2006. Land resource regions and major land resource areas of the United States, the Caribbean, and the Pacific Basin. U.S. Department of Agriculture Handbook 296. http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/soils/?cid=nrcs142p2_053624

United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf



EXISTING CONDITIONS SUBCATCHMENT EXHIBIT

STANDLEY STREET GARDENS

IN

BEVERLY, MA

PREPARED FOR:

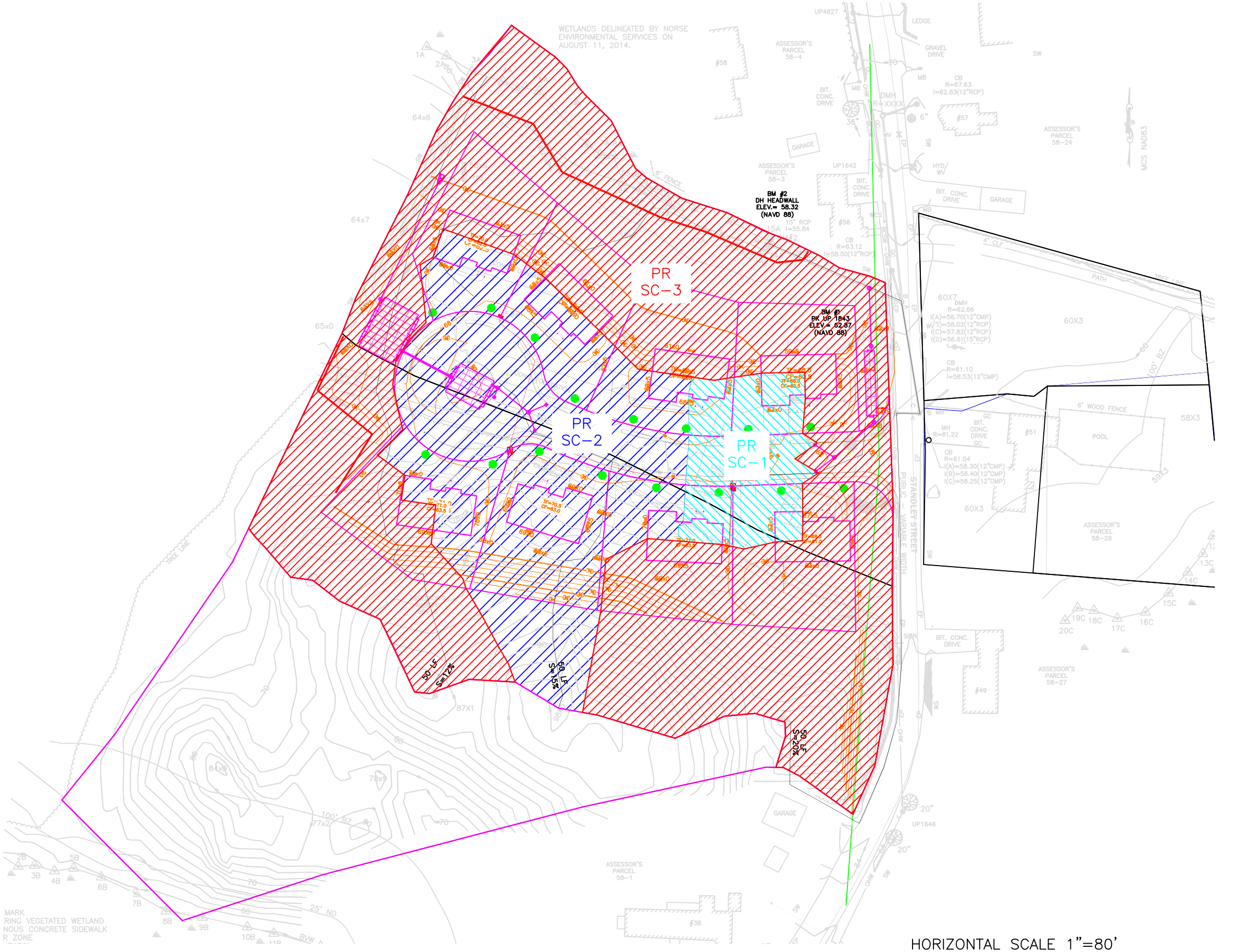
R.C. REALTY CONSTRUCTION AND DEVELOPMENT, LLC

7 NICOLE AVENUE
BEVERLY, MASSACHUSETTS 01915

Marchionda & Associates, L.P.
Engineering and Planning Consultants
62 MONTVALE AVE., SUITE I
STONEHAM, MA 02180
(781) 438-6121 FAX: (781) 438-9654

REV.	DATE:

DATE: 6/9/2015
SCALE: 1"=80'



PROPOSED CONDITIONS SUBCATCHMENT EXHIBIT

STANDLEY STREET GARDENS

IN

BEVERLY, MA

PREPARED FOR:

R.C. REALTY CONSTRUCTION AND DEVELOPMENT, LLC

7 NICOLE AVENUE
BEVERLY, MASSACHUSETTS 01915

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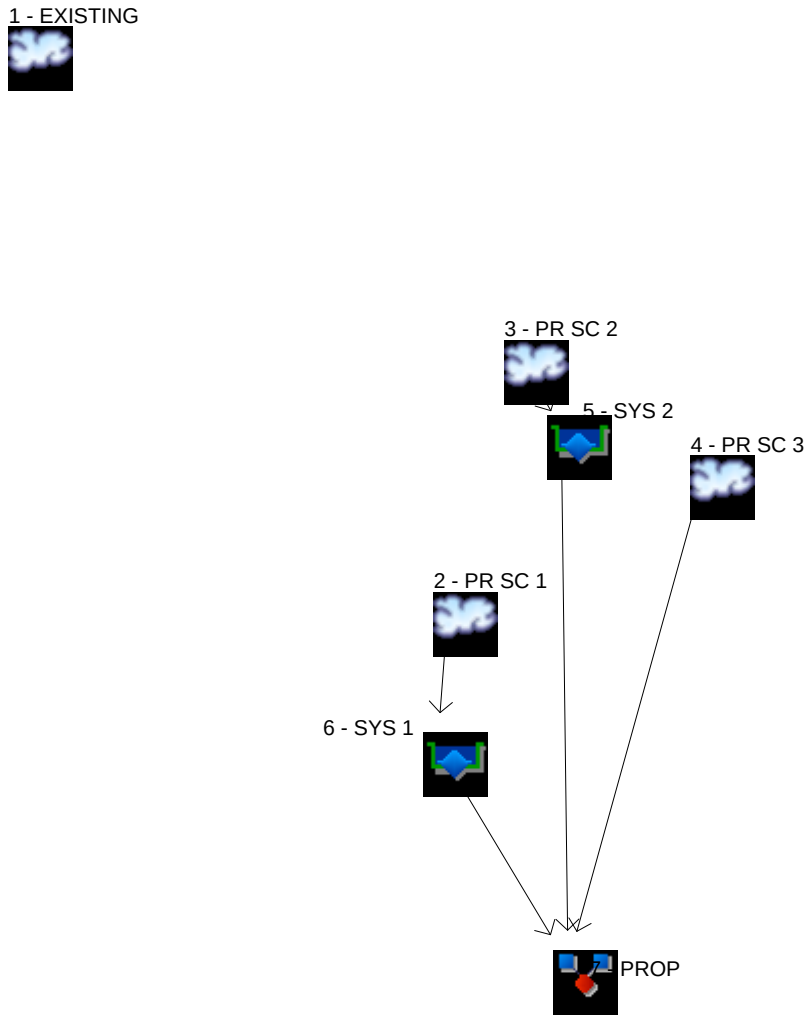
62 MONTVALE AVE., SUITE I
STONEHAM, MA 02180
(781) 438-6121 FAX: (781) 438-9654

REV.	DATE:

DATE: 6/18/2015
SCALE: 1"=80'

Watershed Model Schematic

Hydraflow Hydrographs by Intelisolve v9.2



Project: STANDLEY ST 2 YR.gpw

Tuesday, Jul 7, 2015

Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.2

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	0.044	1	887	1,187	----	------	------	EXISTING
2	SCS Runoff	0.281	1	725	943	----	------	------	PR SC 1
3	SCS Runoff	0.579	1	726	2,440	----	------	------	PR SC 2
4	SCS Runoff	0.013	1	1326	357	----	------	------	PR SC 3
5	Reservoir	0.000	1	959	0	3	62.06	526	SYS 2
6	Reservoir	0.005	1	776	8	2	60.86	319	SYS 1
7	Combine	0.013	1	1326	366	4, 5, 6	------	------	PROP

Hydrograph Report

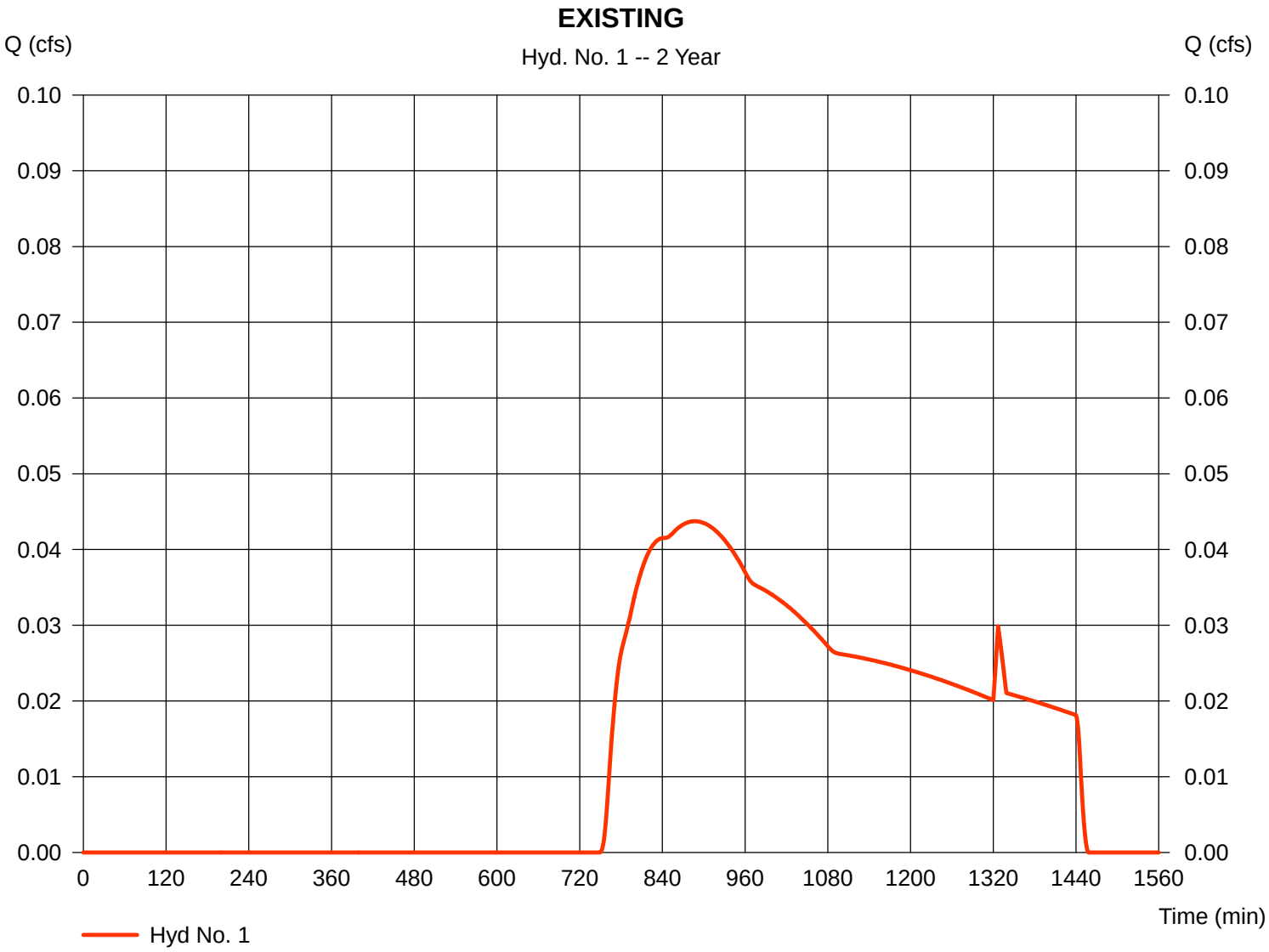
Hydraflow Hydrographs by Intelisolve v9.2 — Tuesday, Jul 7, 2015

Hyd. No. 1

EXISTING

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.044 cfs
Storm frequency	=	2 yrs	Time to peak	=	887 min
Time interval	=	1 min	Hyd. volume	=	1,187 cuft
Drainage area	=	4.340 ac	Curve number	=	48*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.70 min
Total precip.	=	3.10 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.450 x 98) + (2.130 x 30) + (0.790 x 72) + (0.850 x 48) + (0.120 x 39)] / 4.340



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.2

Hyd. No. 1

EXISTING

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.400		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 (%)	=	12.00		0.00		0.00		
Travel Time (min)	**=**	**6.12**	**+**	**0.00**	**+**	**0.00**	**=**	**6.12**
Shallow Concentrated Flow								
Flow length (ft)	=	145.00		410.00		0.00		
Watercourse slope (%)	=	16.00		1.00		0.00		
Surface description	=	Unpaved		Unpaved		Paved		
Average velocity (ft/s)	=	6.45		1.61		0.00		
Travel Time (min)	**=**	**0.37**	**+**	**4.24**	**+**	**0.00**	**=**	**4.61**
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 ..... 10.70 min

Hydrograph Report

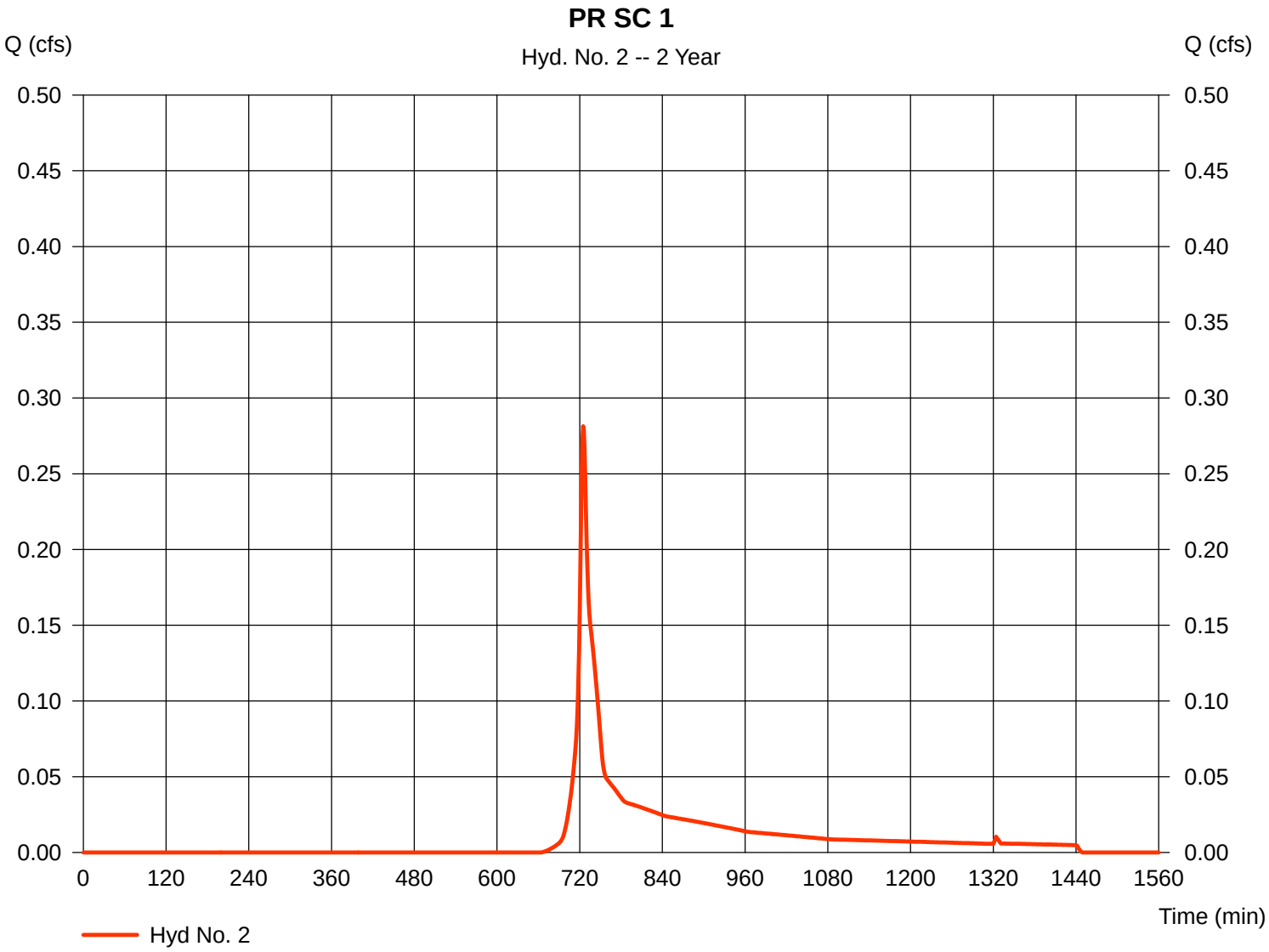
Hydraflow Hydrographs by Intelisolve v9.2 — Tuesday, Jul 7, 2015

Hyd. No. 2

PR SC 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.281 cfs
Storm frequency	=	2 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	943 cuft
Drainage area	=	0.290 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.50 min
Total precip.	=	3.10 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.160 x 98) + (0.130 x 39)] / 0.290



TR55 Tc Worksheet

Hyd. No. 2

PR SC 1

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.240		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 (%)	=	4.50		0.00		0.00		
Travel Time (min)	**=**	**6.02**	**+**	**0.00**	**+**	**0.00**	**=**	**6.02**
Shallow Concentrated Flow								
Flow length (ft)	=	72.00		0.00		0.00		
Watercourse slope (%)	=	3.50		0.00		0.00		
Surface description	=	Paved		Paved		Paved		
Average velocity (ft/s)	=	3.80		0.00		0.00		
Travel Time (min)	**=**	**0.32**	**+**	**0.00**	**+**	**0.00**	**=**	**0.32**
Channel Flow								
X sectional flow area (sqft)	=	3.14		0.00		0.00		
Wetted perimeter (ft)	=	6.28		0.00		0.00		
Channel slope (%)	=	1.00		0.00		0.00		
Manning's n-value	=	0.015		0.015		0.015		
Velocity (ft/s)	=	6.24		0.00		0.00		
Flow length (ft)	=	66.0		0.0		0.0		
Travel Time (min)	**=**	**0.18**	**+**	**0.00**	**+**	**0.00**	**=**	**0.18**

Total Travel Time, Tc ..... 6.50 min

Hydrograph Report

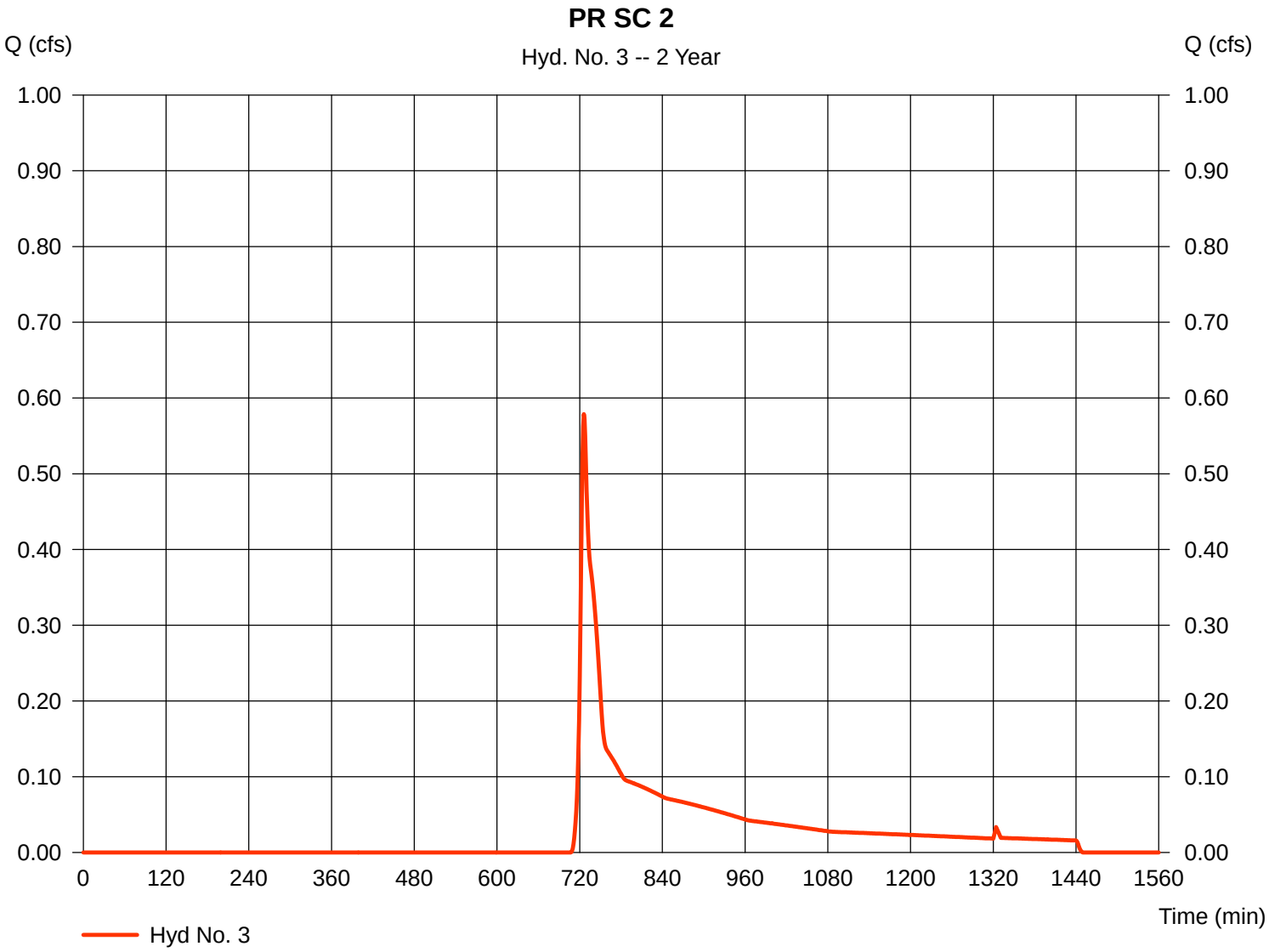
Hydraflow Hydrographs by Intelisolve v9.2 — Tuesday, Jul 7, 2015

Hyd. No. 3

PR SC 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.579 cfs
Storm frequency	=	2 yrs	Time to peak	=	726 min
Time interval	=	1 min	Hyd. volume	=	2,440 cuft
Drainage area	=	1.270 ac	Curve number	=	64*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.60 min
Total precip.	=	3.10 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.570 x 98) + (0.560 x 39) + (0.140 x 30)] / 1.270



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.2

Hyd. No. 3

PR SC 2

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.400		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 (%)	=	15.00		0.00		0.00		
Travel Time (min)	**=**	**5.60**	**+**	**0.00**	**+**	**0.00**	**=**	**5.60**
Shallow Concentrated Flow								
Flow length (ft)	=	169.00		118.00		0.00		
Watercourse slope (%)	=	15.00		2.00		0.00		
Surface description	=	Paved		Paved		Paved		
Average velocity (ft/s)	=	7.87		2.87		0.00		
Travel Time (min)	**=**	**0.36**	**+**	**0.68**	**+**	**0.00**	**=**	**1.04**
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 ..... 6.60 min

Hydrograph Report

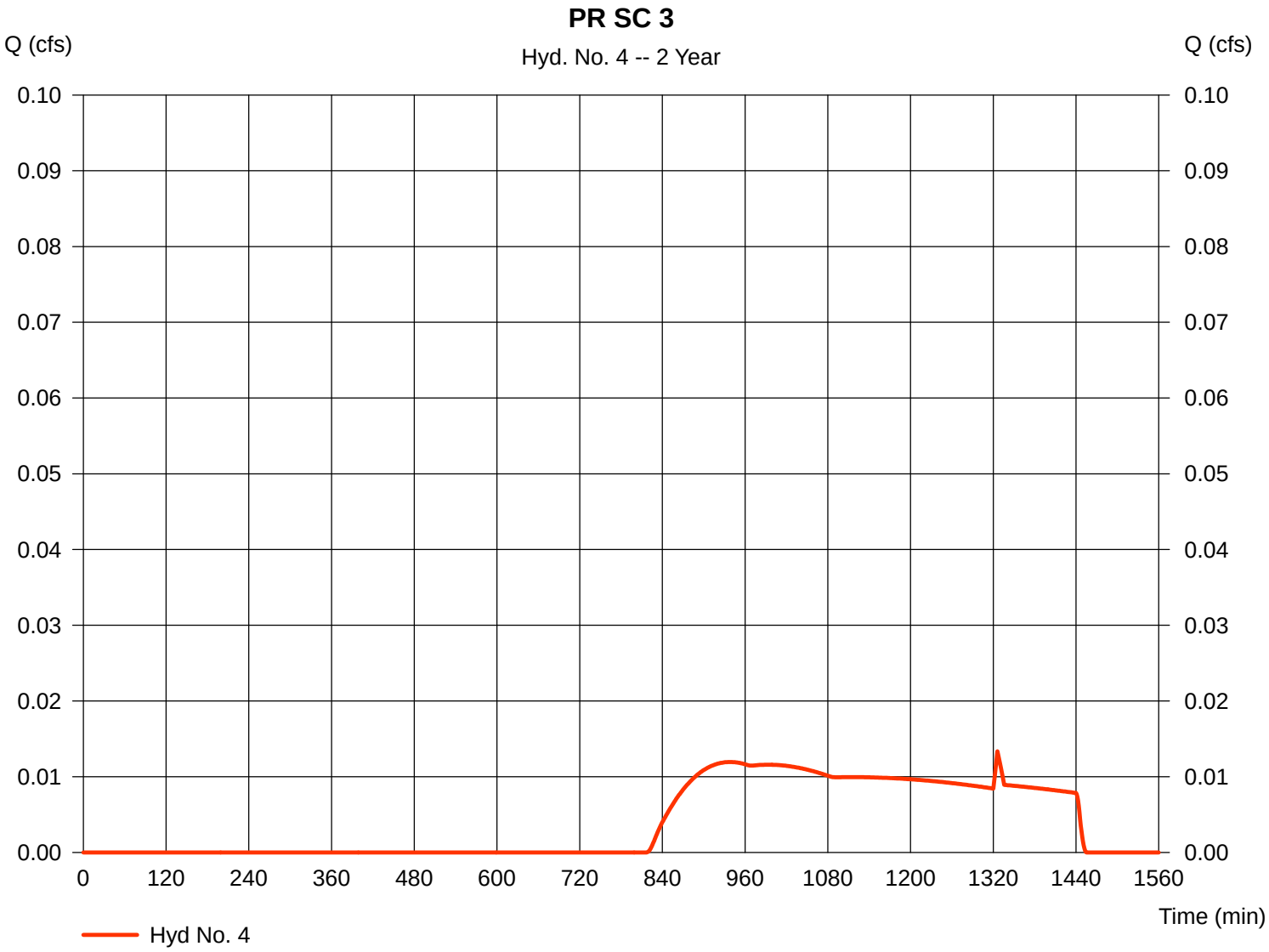
Hydraflow Hydrographs by Intelisolve v9.2 | Tuesday, Jul 7, 2015

Hyd. No. 4

PR SC 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.013 cfs
Storm frequency	=	2 yrs	Time to peak	=	1326 min
Time interval	=	1 min	Hyd. volume	=	357 cuft
Drainage area	=	2.950 ac	Curve number	=	45*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.90 min
Total precip.	=	3.10 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.430 x 98) + (1.030 x 39) + (1.110 x 30) + (0.380 x 48)] / 2.950



TR55 Tc Worksheet

Hydraflow Hydrographs by Intelisolve v9.2

Hyd. No. 4

PR SC 3

Description		A		B		C		Totals
Sheet Flow								
Manning's n-value	=	0.400		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 (%)	=	20.00		0.00		0.00		
Travel Time (min)	**=**	**4.99**	**+**	**0.00**	**+**	**0.00**	**=**	**4.99**
Shallow Concentrated Flow								
Flow length (ft)	=	64.00		560.00		0.00		
Watercourse slope (%)	=	10.00		1.50		0.00		
Surface description	=	Unpaved		Paved		Paved		
Average velocity (ft/s)	=	5.10		2.49		0.00		
Travel Time (min)	**=**	**0.21**	**+**	**3.75**	**+**	**0.00**	**=**	**3.96**
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 ..... 8.90 min

Hydrograph Report

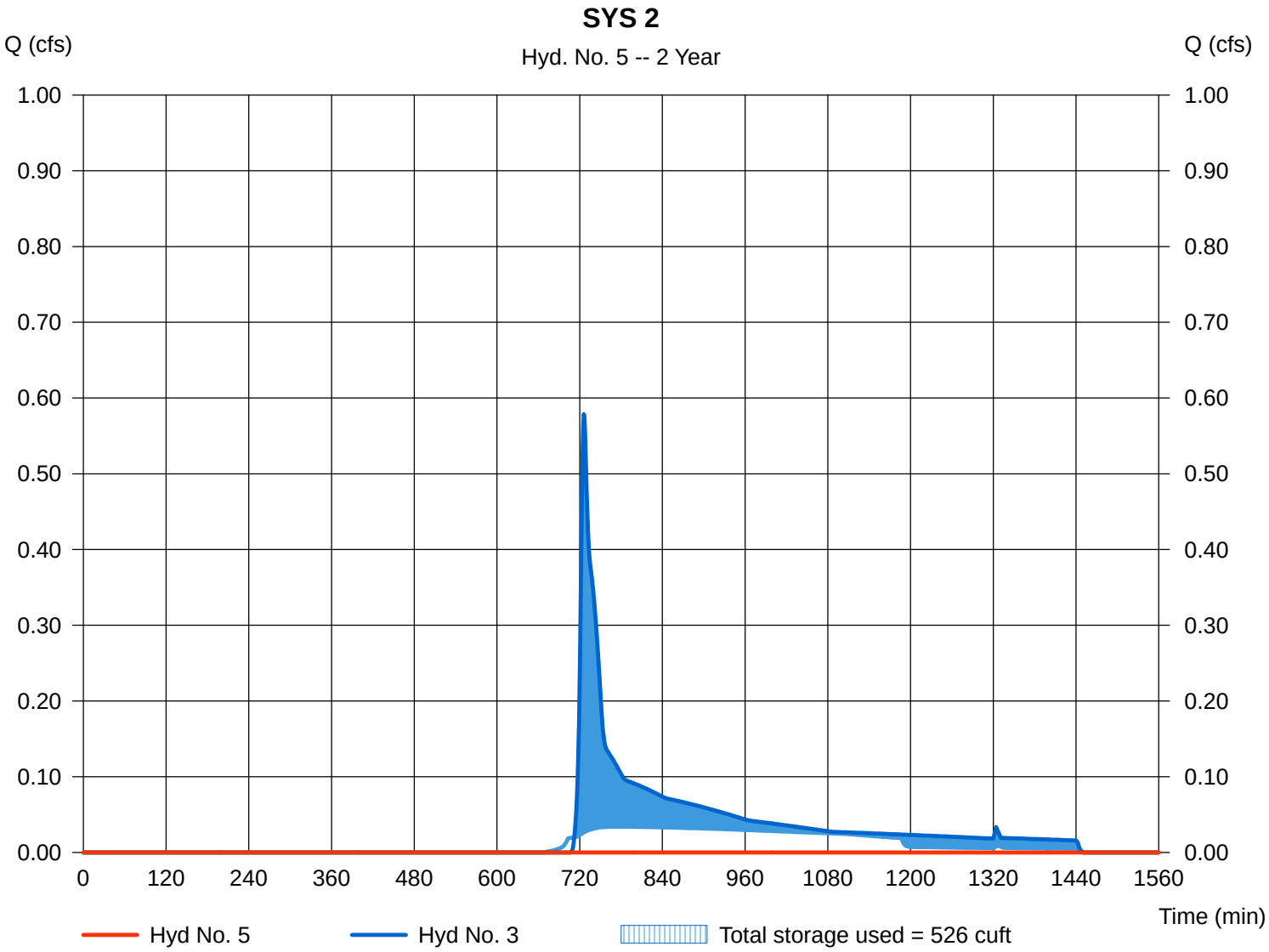
Hydraflow Hydrographs by Intelisolve v9.2 Tuesday, Jul 7, 2015

Hyd. No. 5

SYS 2

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	2 yrs	Time to peak	=	959 min
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	3 - PR SC 2	Max. Elevation	=	62.06 ft
Reservoir name	=	SYSTEM 2	Max. Storage	=	526 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs by Intelisolve v9.2 — Tuesday, Jul 7, 2015

Pond No. 1 - SYSTEM 2

Pond Data

UG Chambers - Invert elev. = 62.00 ft, Rise x Span = 2.50 x 4.25 ft, Barrel Len = 27.75 ft, No. Barrels = 14, Slope = 0.00%, Headers = No
Encasement - Invert elev. = 61.50 ft, Width = 4.75 ft, Height = 3.50 ft, Voids = 40.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	61.50	n/a	0	0
0.35	61.85	n/a	258	258
0.70	62.20	n/a	456	715
1.05	62.55	n/a	601	1,316
1.40	62.90	n/a	590	1,906
1.75	63.25	n/a	571	2,477
2.10	63.60	n/a	543	3,020
2.45	63.95	n/a	502	3,522
2.80	64.30	n/a	439	3,961
3.15	64.65	n/a	311	4,271
3.50	65.00	n/a	258	4,530

Culvert / Orifice Structures

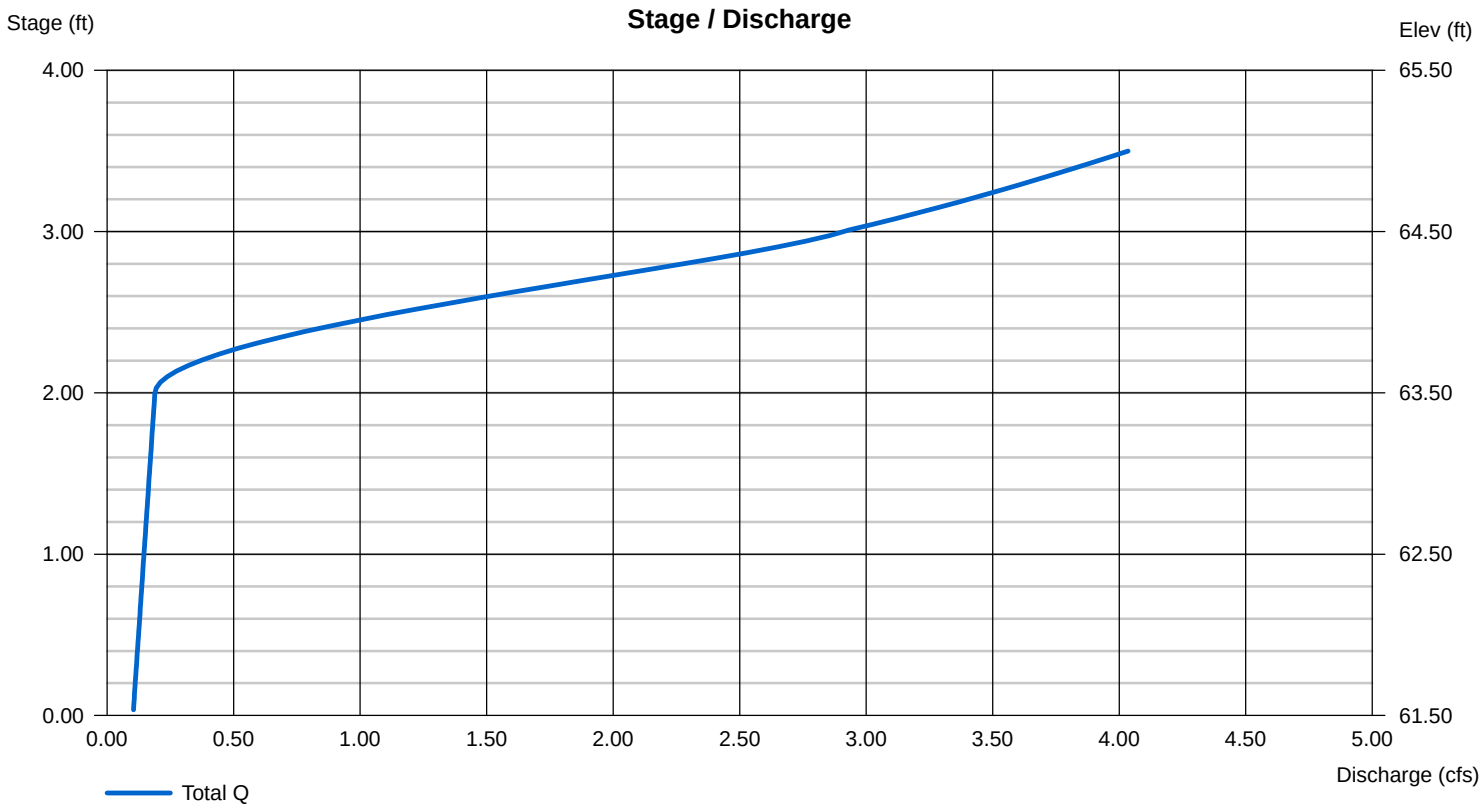
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 12.00	0.00	0.00	0.00
Span (in)	= 12.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 63.50	0.00	0.00	0.00
Length (ft)	= 115.00	0.00	0.00	0.00
Slope (%)	= 3.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 2.400 (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).



Hydrograph Report

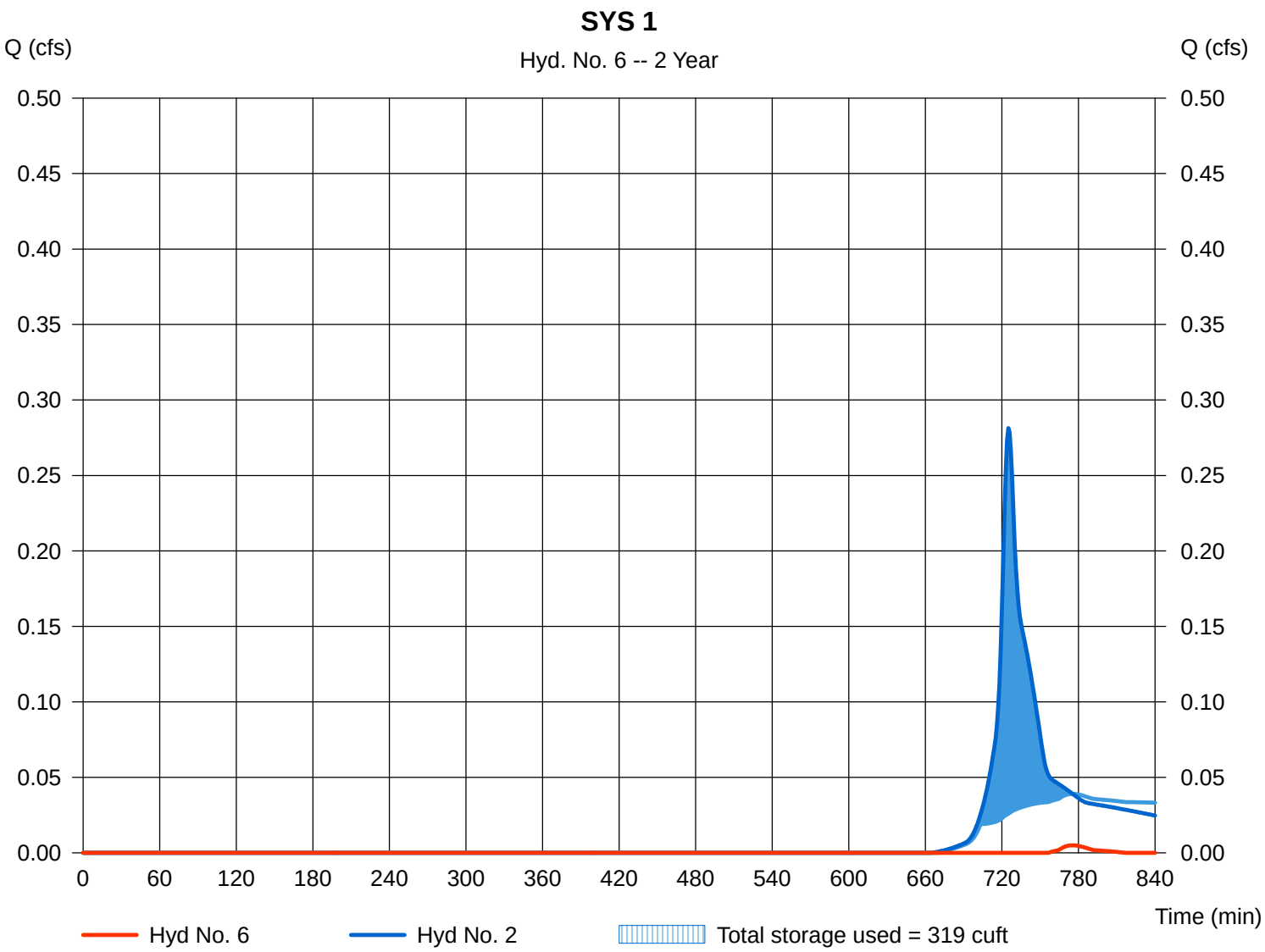
Hydraflow Hydrographs by Intelisolve v9.2 Tuesday, Jul 7, 2015

Hyd. No. 6

SYS 1

Hydrograph type	=	Reservoir	Peak discharge	=	0.005 cfs
Storm frequency	=	2 yrs	Time to peak	=	776 min
Time interval	=	1 min	Hyd. volume	=	8 cuft
Inflow hyd. No.	=	2 - PR SC 1	Max. Elevation	=	60.86 ft
Reservoir name	=	SYSTEM 1	Max. Storage	=	319 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Pond Report

Hydraflow Hydrographs by Intelisolve v9.2 — Tuesday, Jul 7, 2015

Pond No. 2 - SYSTEM 1

Pond Data

UG Chambers - Invert elev. = 60.00 ft, Rise x Span = 1.33 x 2.83 ft, Barrel Len = 50.60 ft, No. Barrels = 2, Slope = 0.00%, Headers = No
Encasement - Invert elev. = 59.50 ft, Width = 3.33 ft, Height = 2.50 ft, Voids = 40.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	59.50	n/a	0	0
0.25	59.75	n/a	34	34
0.50	60.00	n/a	34	67
0.75	60.25	n/a	76	144
1.00	60.50	n/a	75	219
1.25	60.75	n/a	72	290
1.50	61.00	n/a	66	356
1.75	61.25	n/a	56	412
2.00	61.50	n/a	37	449
2.25	61.75	n/a	34	483
2.50	62.00	n/a	34	517

Culvert / Orifice Structures

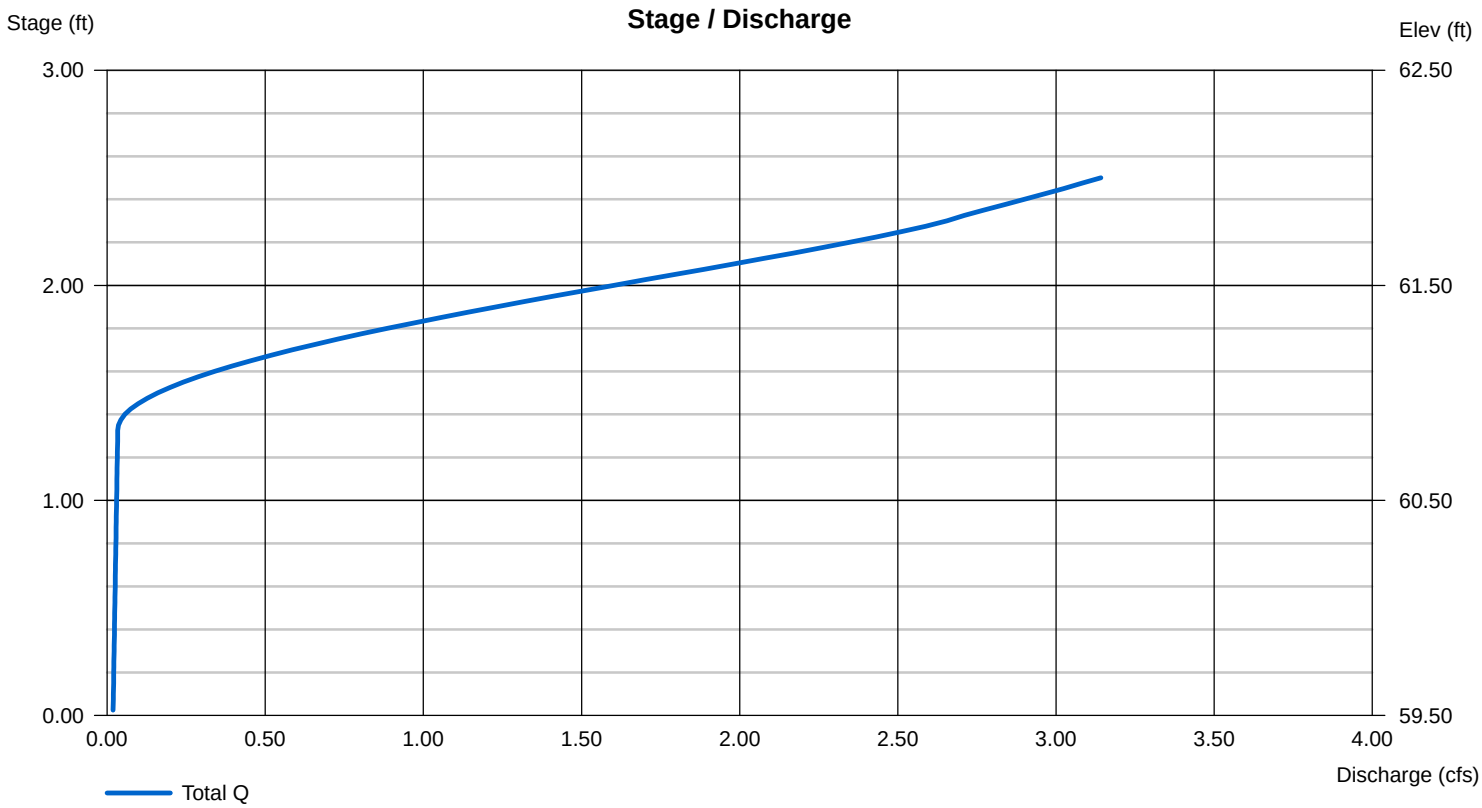
	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 12.00	0.00	0.00	0.00
Span (in)	= 12.00	0.00	0.00	0.00
No. Barrels	= 1	0	0	0
Invert El. (ft)	= 60.83	0.00	0.00	0.00
Length (ft)	= 100.00	0.00	0.00	0.00
Slope (%)	= 1.00	0.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 2.400 (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).



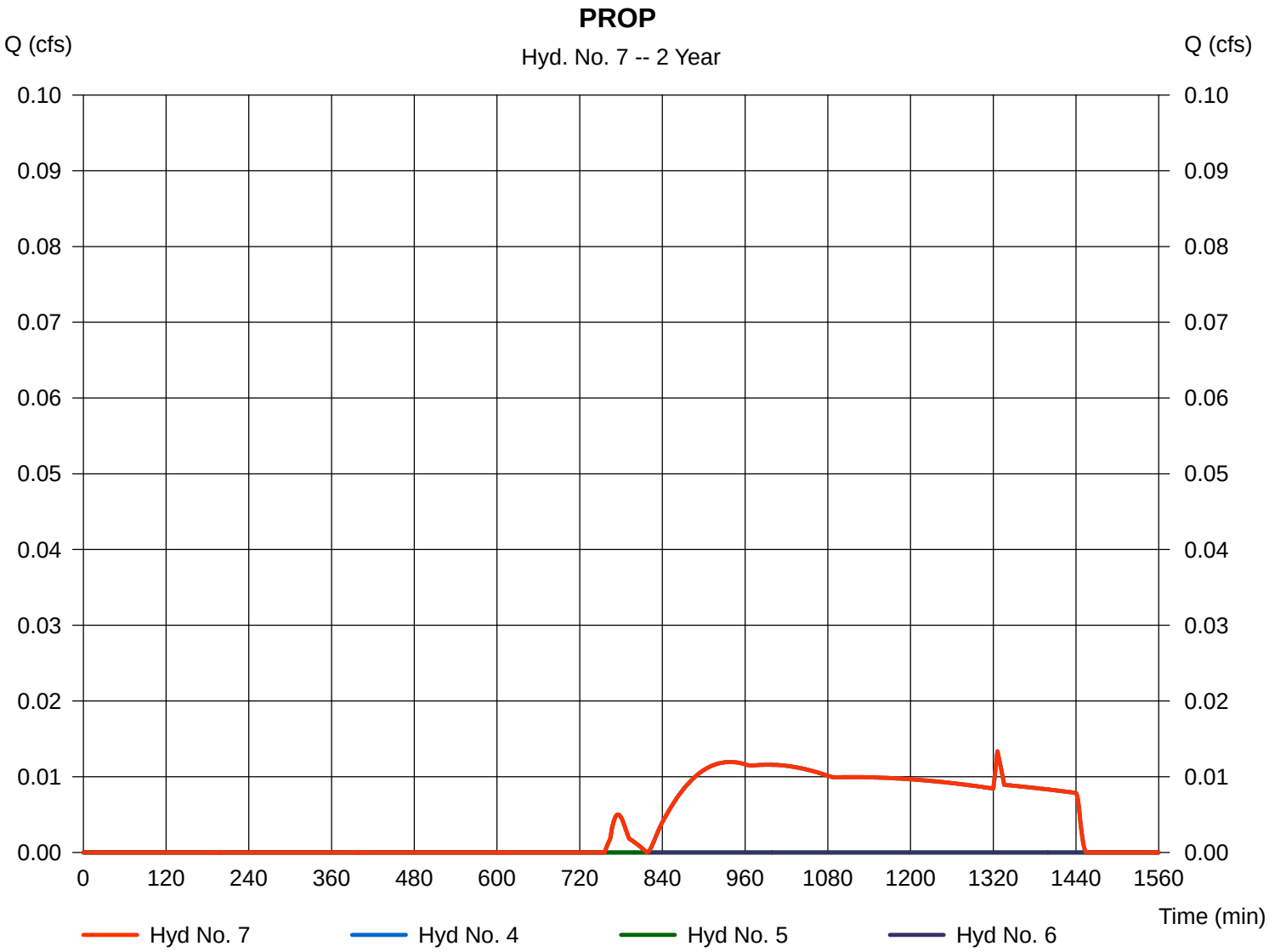
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 Tuesday, Jul 7, 2015

Hyd. No. 7

PROP

Hydrograph type	=	Combine	Peak discharge	=	0.013 cfs
Storm frequency	=	2 yrs	Time to peak	=	1326 min
Time interval	=	1 min	Hyd. volume	=	366 cuft
Inflow hyds.	=	4, 5, 6	Contrib. drain. area	=	2.950 ac



Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.2

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	0.835	1	739	6,631	----	------	------	EXISTING
2	SCS Runoff	0.632	1	725	1,976	----	------	------	PR SC 1
3	SCS Runoff	1.798	1	725	6,017	----	------	------	PR SC 2
4	SCS Runoff	0.311	1	743	3,168	----	------	------	PR SC 3
5	Reservoir	0.000	1	1444	0	3	63.15	2,311	Sys 2
6	Combine	0.640	1	725	5,144	2, 4, 5	------	------	PROP
7	Reservoir	0.468	1	729	671	2	61.17	394	Sys 1

Hydrograph Report

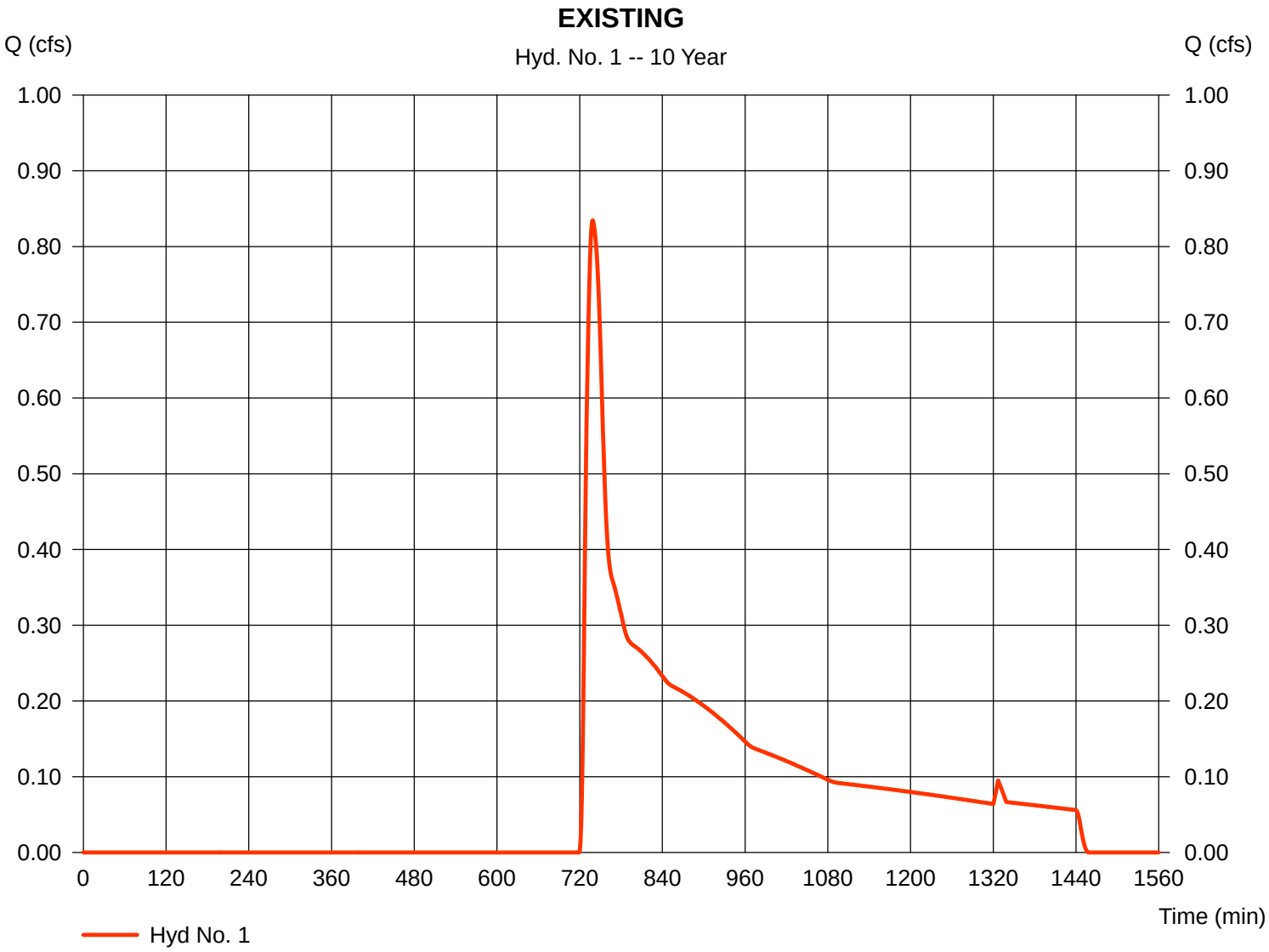
Hydraflow Hydrographs by Intelisolve v9.2 — Tuesday, Jul 7, 2015

Hyd. No. 1

EXISTING

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.835 cfs
Storm frequency	=	10 yrs	Time to peak	=	739 min
Time interval	=	1 min	Hyd. volume	=	6,631 cuft
Drainage area	=	4.340 ac	Curve number	=	48*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.70 min
Total precip.	=	4.50 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.450 x 98) + (2.130 x 30) + (0.790 x 72) + (0.850 x 48) + (0.120 x 39)] / 4.340



Hydrograph Report

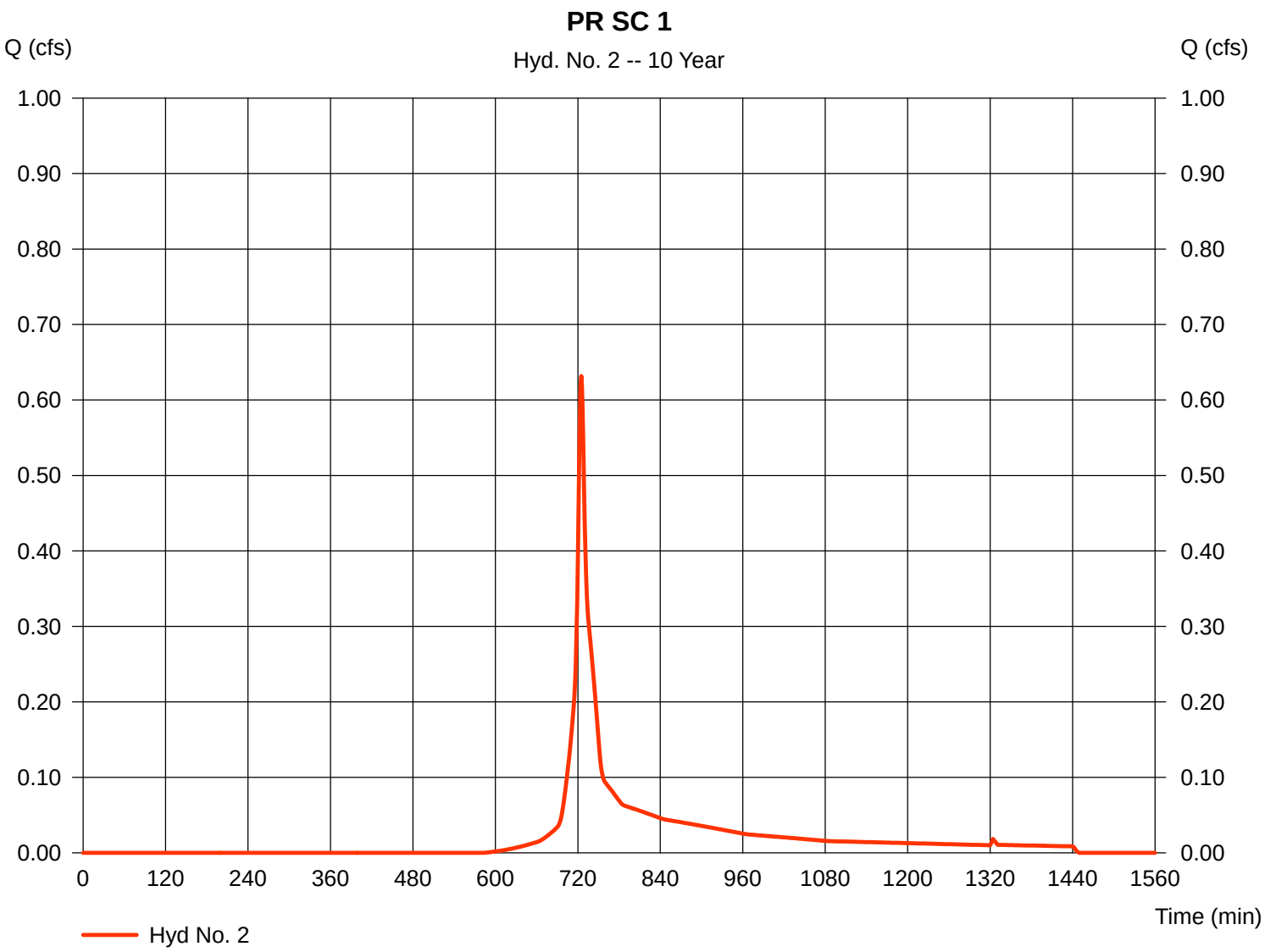
Hydraflow Hydrographs by Intelisolve v9.2 Tuesday, Jul 7, 2015

Hyd. No. 2

PR SC 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.632 cfs
Storm frequency	=	10 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	1,976 cuft
Drainage area	=	0.290 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.50 min
Total precip.	=	4.50 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.160 x 98) + (0.130 x 39)] / 0.290



Hydrograph Report

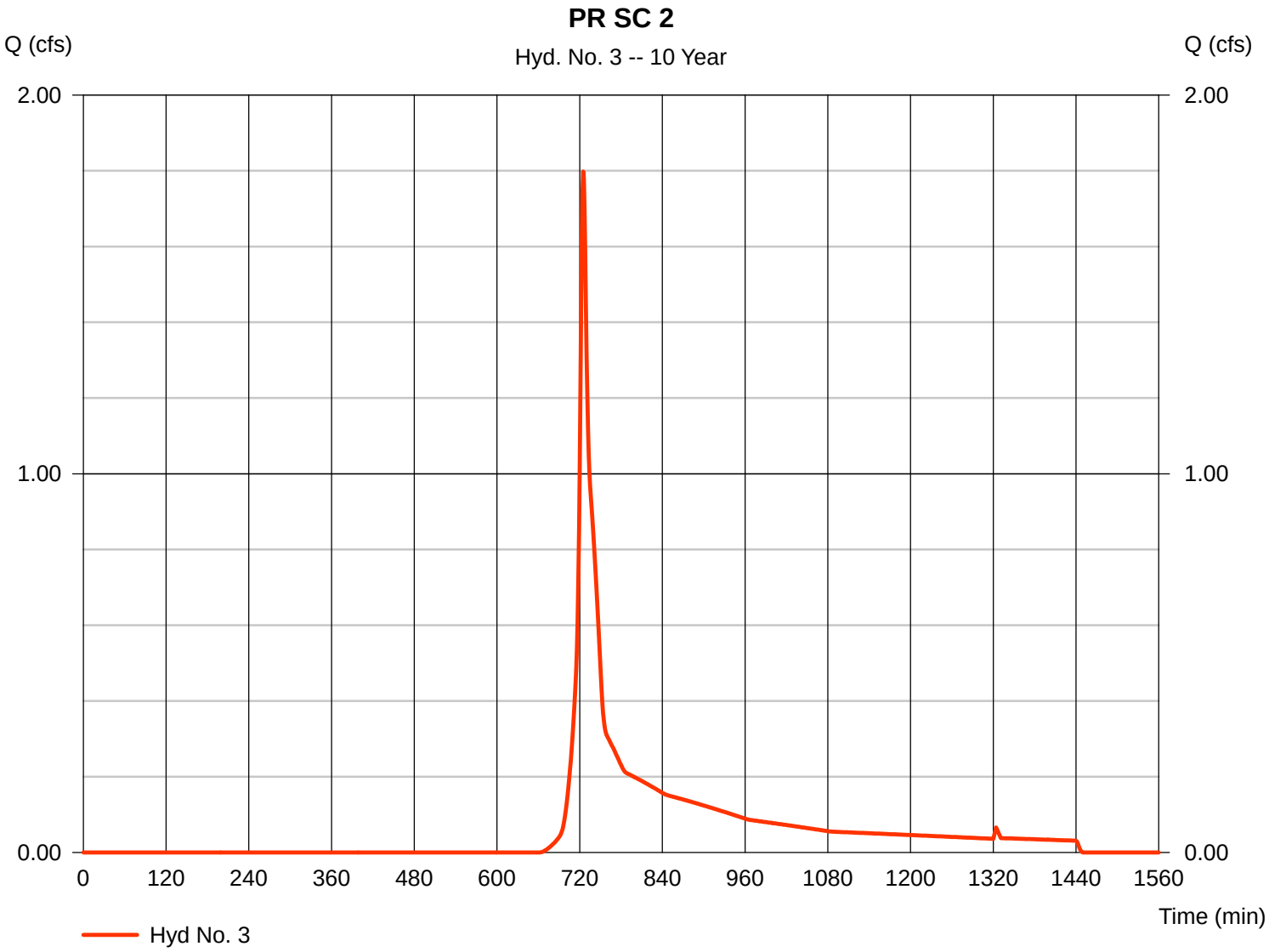
Hydraflow Hydrographs by Intelisolve v9.2 | Tuesday, Jul 7, 2015

Hyd. No. 3

PR SC 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.798 cfs
Storm frequency	=	10 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	6,017 cuft
Drainage area	=	1.270 ac	Curve number	=	64*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.60 min
Total precip.	=	4.50 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.570 x 98) + (0.560 x 39) + (0.140 x 30)] / 1.270



Hydrograph Report

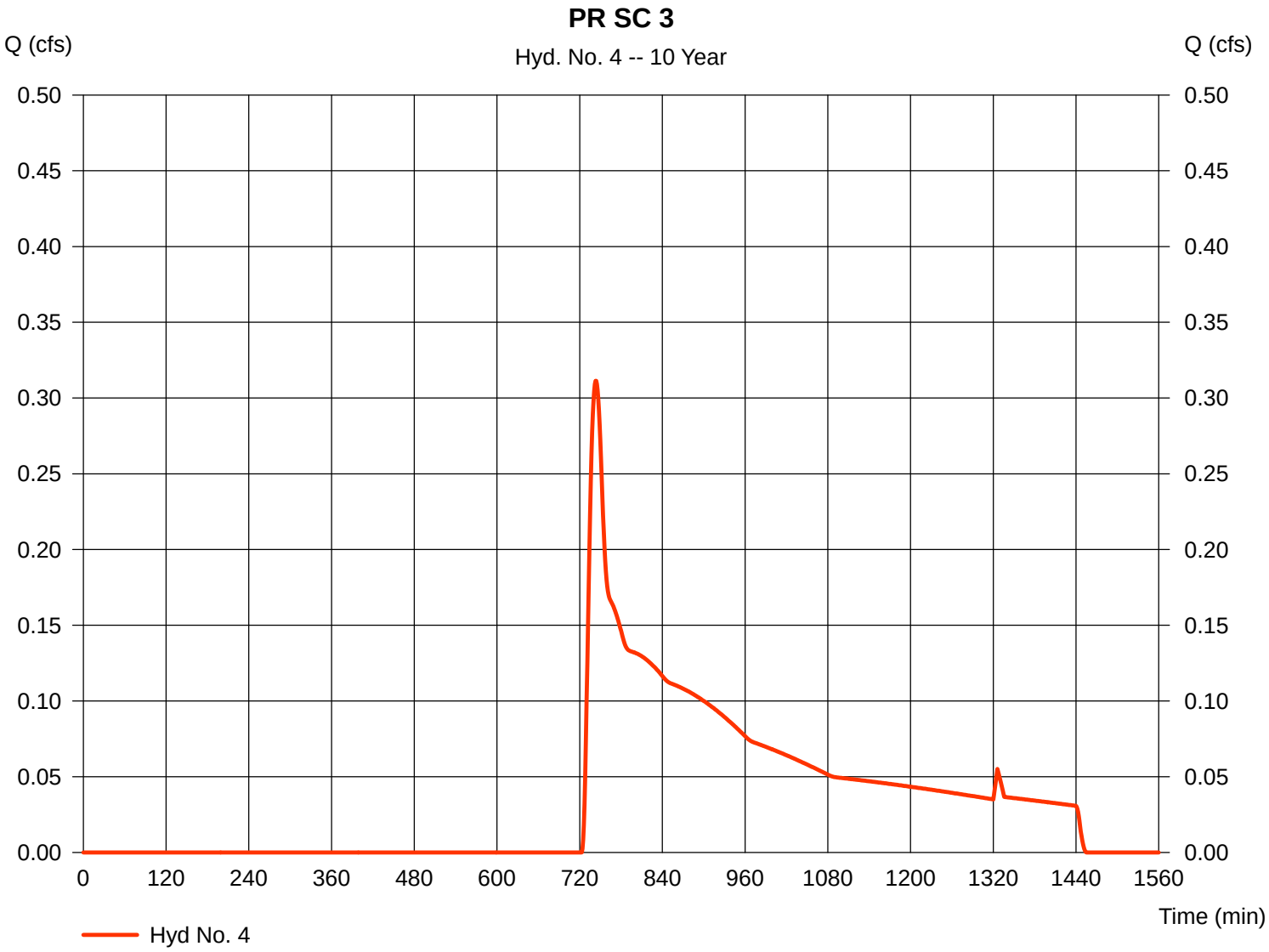
Hydraflow Hydrographs by Intelisolve v9.2 — Tuesday, Jul 7, 2015

Hyd. No. 4

PR SC 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.311 cfs
Storm frequency	=	10 yrs	Time to peak	=	743 min
Time interval	=	1 min	Hyd. volume	=	3,168 cuft
Drainage area	=	2.950 ac	Curve number	=	45*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.90 min
Total precip.	=	4.50 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.430 x 98) + (1.030 x 39) + (1.110 x 30) + (0.380 x 48)] / 2.950



Hydrograph Report

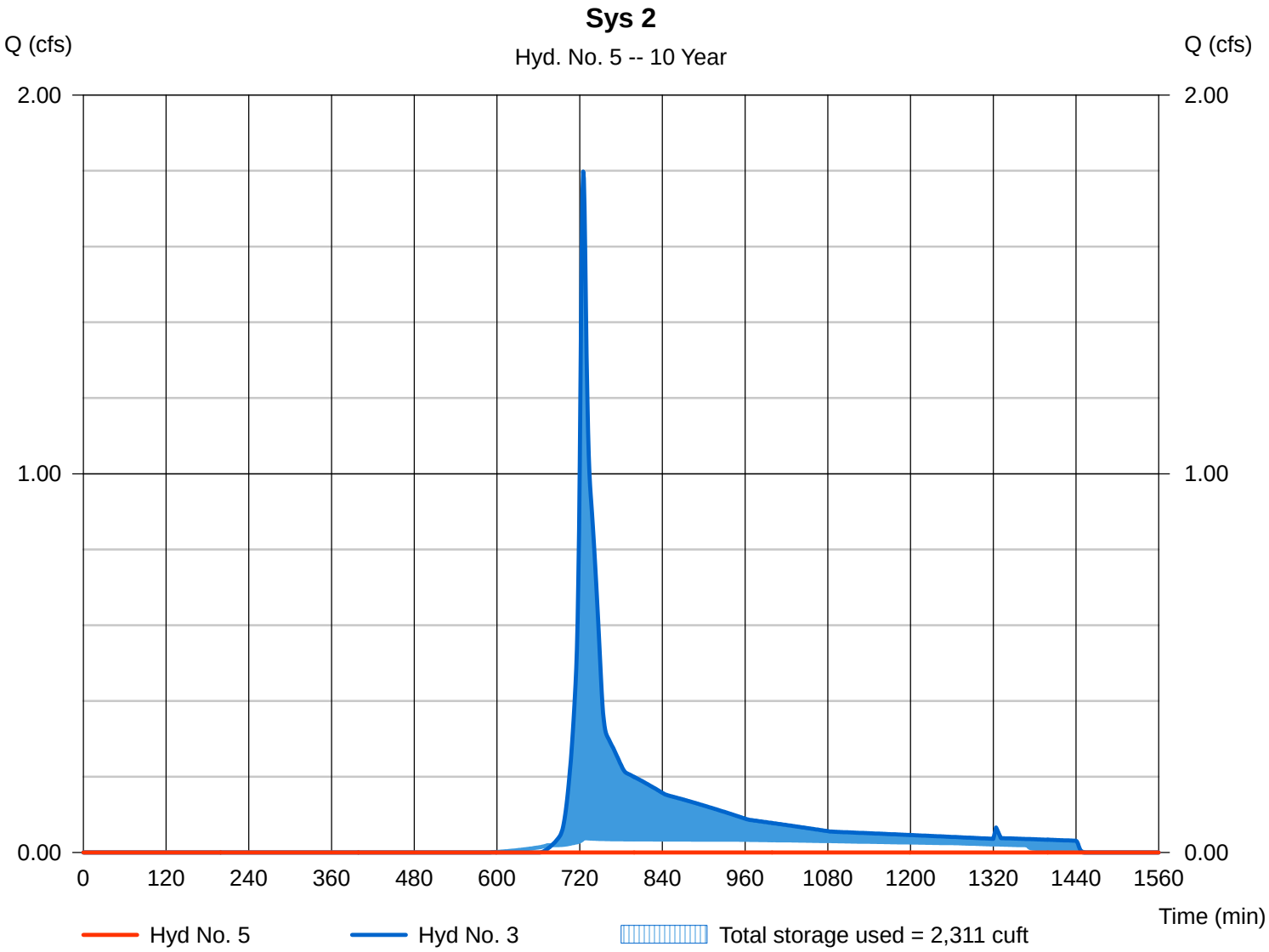
Hydraflow Hydrographs by Intelisolve v9.2 Tuesday, Jul 7, 2015

Hyd. No. 5

Sys 2

Hydrograph type	=	Reservoir	Peak discharge	=	0.000 cfs
Storm frequency	=	10 yrs	Time to peak	=	1444 min
Time interval	=	1 min	Hyd. volume	=	0 cuft
Inflow hyd. No.	=	3 - PR SC 2	Max. Elevation	=	63.15 ft
Reservoir name	=	system 2	Max. Storage	=	2,311 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



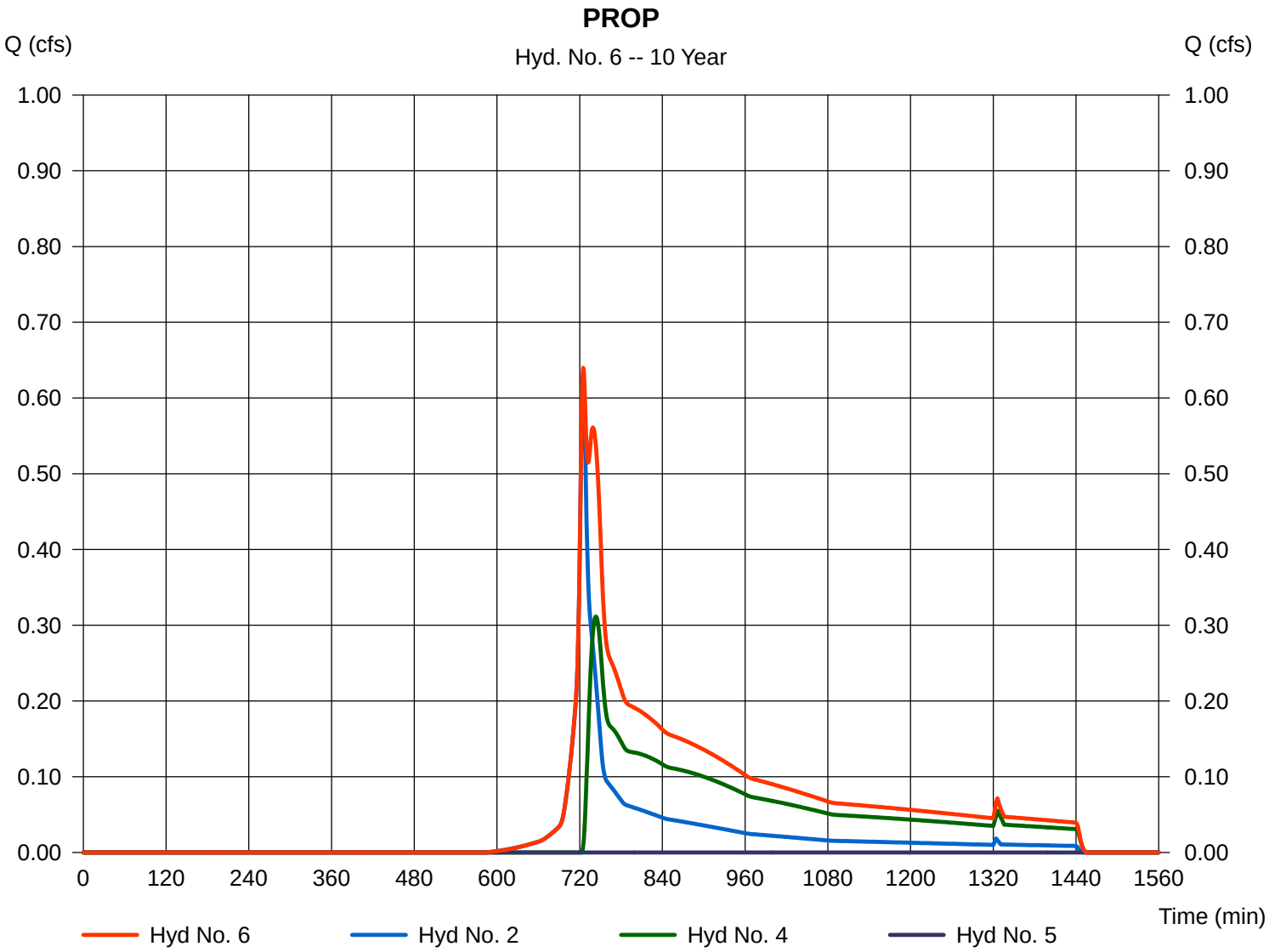
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 Tuesday, Jul 7, 2015

Hyd. No. 6

PROP

Hydrograph type	=	Combine	Peak discharge	=	0.640 cfs
Storm frequency	=	10 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	5,144 cuft
Inflow hyds.	=	2, 4, 5	Contrib. drain. area	=	3.240 ac



Hydrograph Report

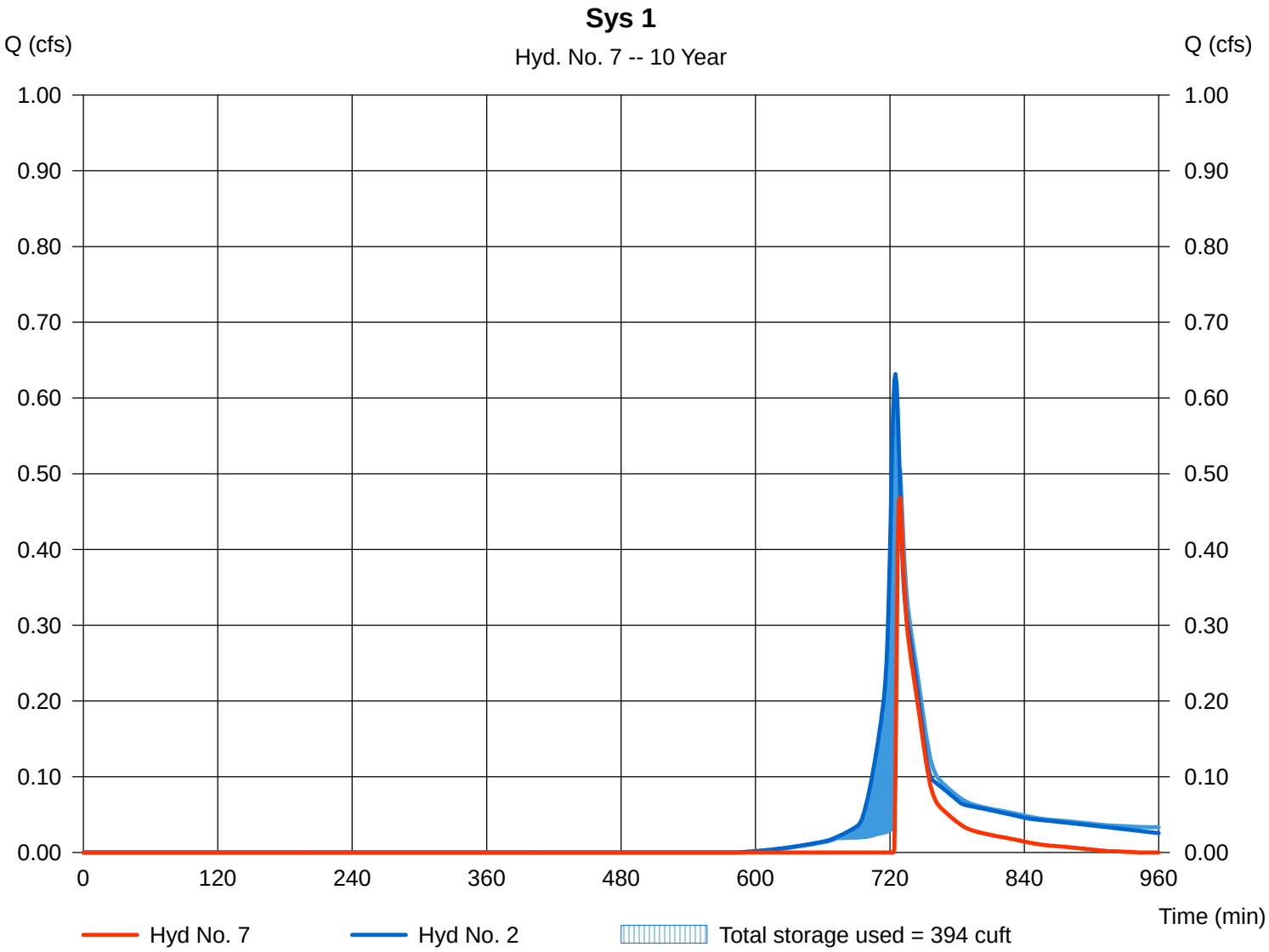
Hydraflow Hydrographs by Intelisolve v9.2 Tuesday, Jul 7, 2015

Hyd. No. 7

Sys 1

Hydrograph type	=	Reservoir	Peak discharge	=	0.468 cfs
Storm frequency	=	10 yrs	Time to peak	=	729 min
Time interval	=	1 min	Hyd. volume	=	671 cuft
Inflow hyd. No.	=	2 - PR SC 1	Max. Elevation	=	61.17 ft
Reservoir name	=	system 1	Max. Storage	=	394 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.2

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	2.091	1	732	11,918	----	------	------	EXISTING
2	SCS Runoff	0.881	1	725	2,725	----	------	------	PR SC 1
3	SCS Runoff	2.739	1	725	8,776	----	------	------	PR SC 2
4	SCS Runoff	0.891	1	733	6,163	----	------	------	PR SC 3
5	Reservoir	0.281	1	755	982	3	63.76	3,248	Sys 2
6	Combine	1.462	1	728	9,870	2, 4, 5	------	------	PROP
7	Reservoir	0.826	1	726	1,231	2	61.30	419	Sys 1

Hydrograph Report

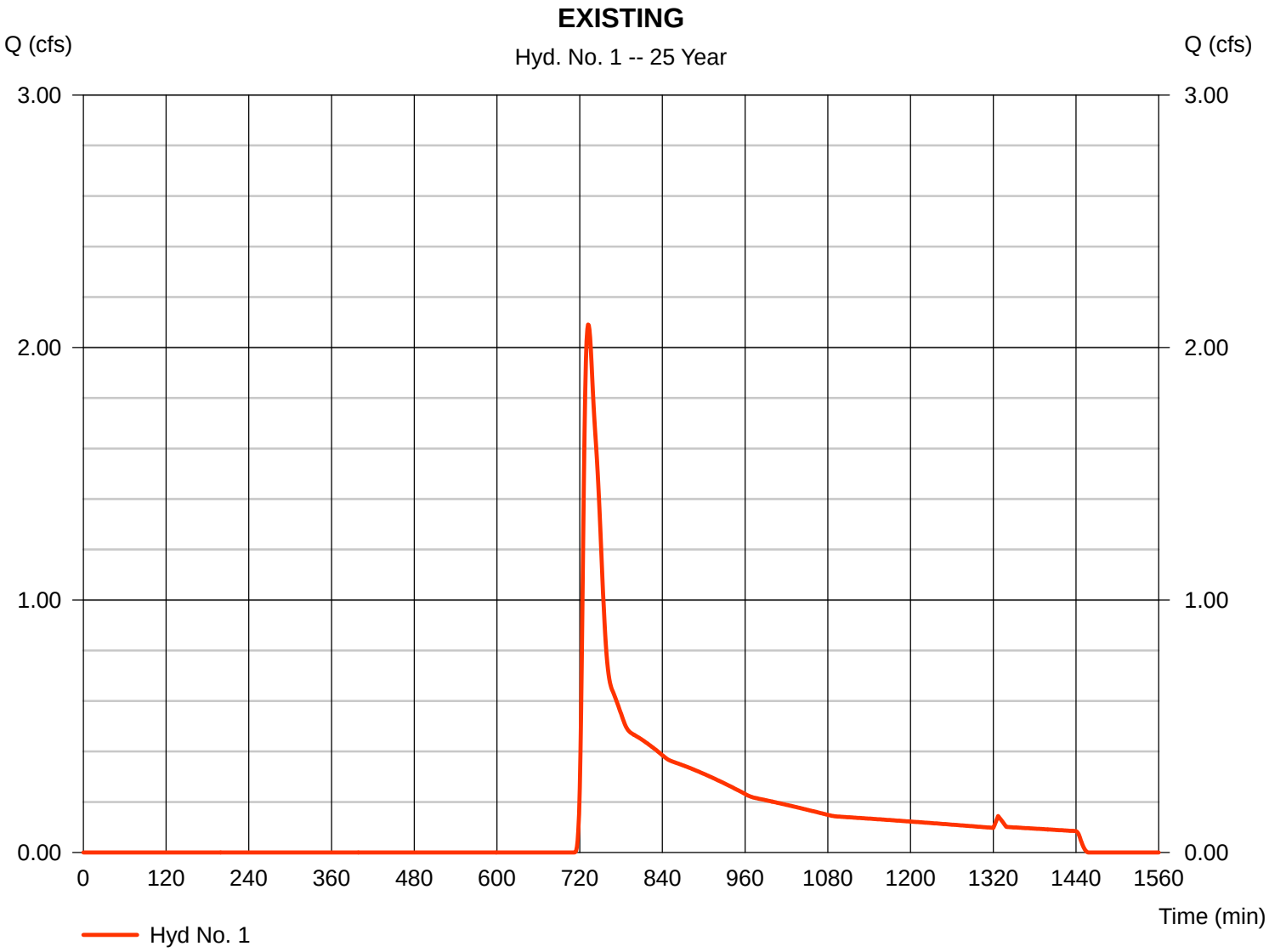
Hydraflow Hydrographs by Intelisolve v9.2 — Tuesday, Jul 7, 2015

Hyd. No. 1

EXISTING

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.091 cfs
Storm frequency	=	25 yrs	Time to peak	=	732 min
Time interval	=	1 min	Hyd. volume	=	11,918 cuft
Drainage area	=	4.340 ac	Curve number	=	48*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.70 min
Total precip.	=	5.40 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.450 x 98) + (2.130 x 30) + (0.790 x 72) + (0.850 x 48) + (0.120 x 39)] / 4.340



Hydrograph Report

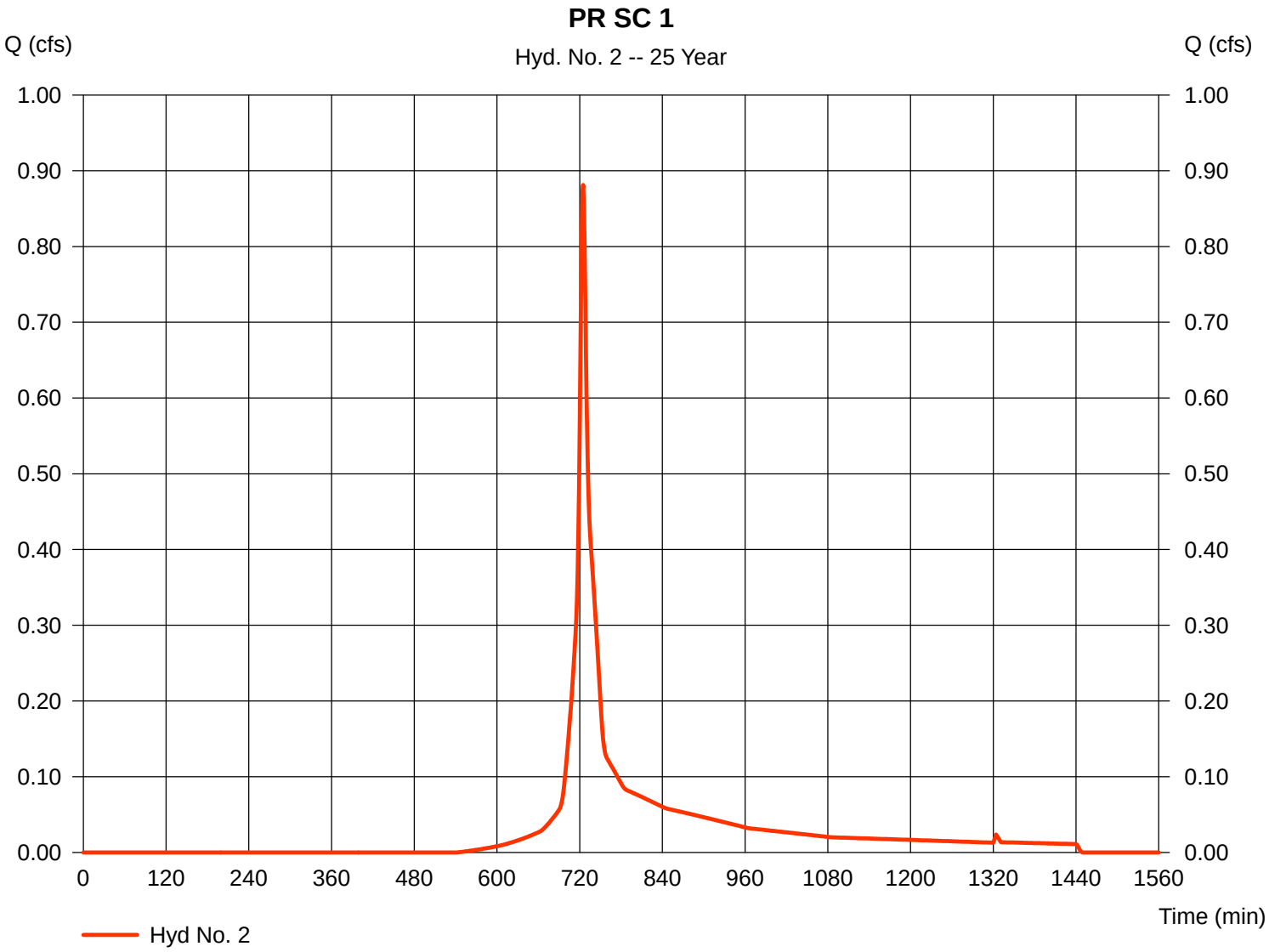
Hydraflow Hydrographs by Intelisolve v9.2 — Tuesday, Jul 7, 2015

Hyd. No. 2

PR SC 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.881 cfs
Storm frequency	=	25 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	2,725 cuft
Drainage area	=	0.290 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.50 min
Total precip.	=	5.40 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.160 x 98) + (0.130 x 39)] / 0.290



Hydrograph Report

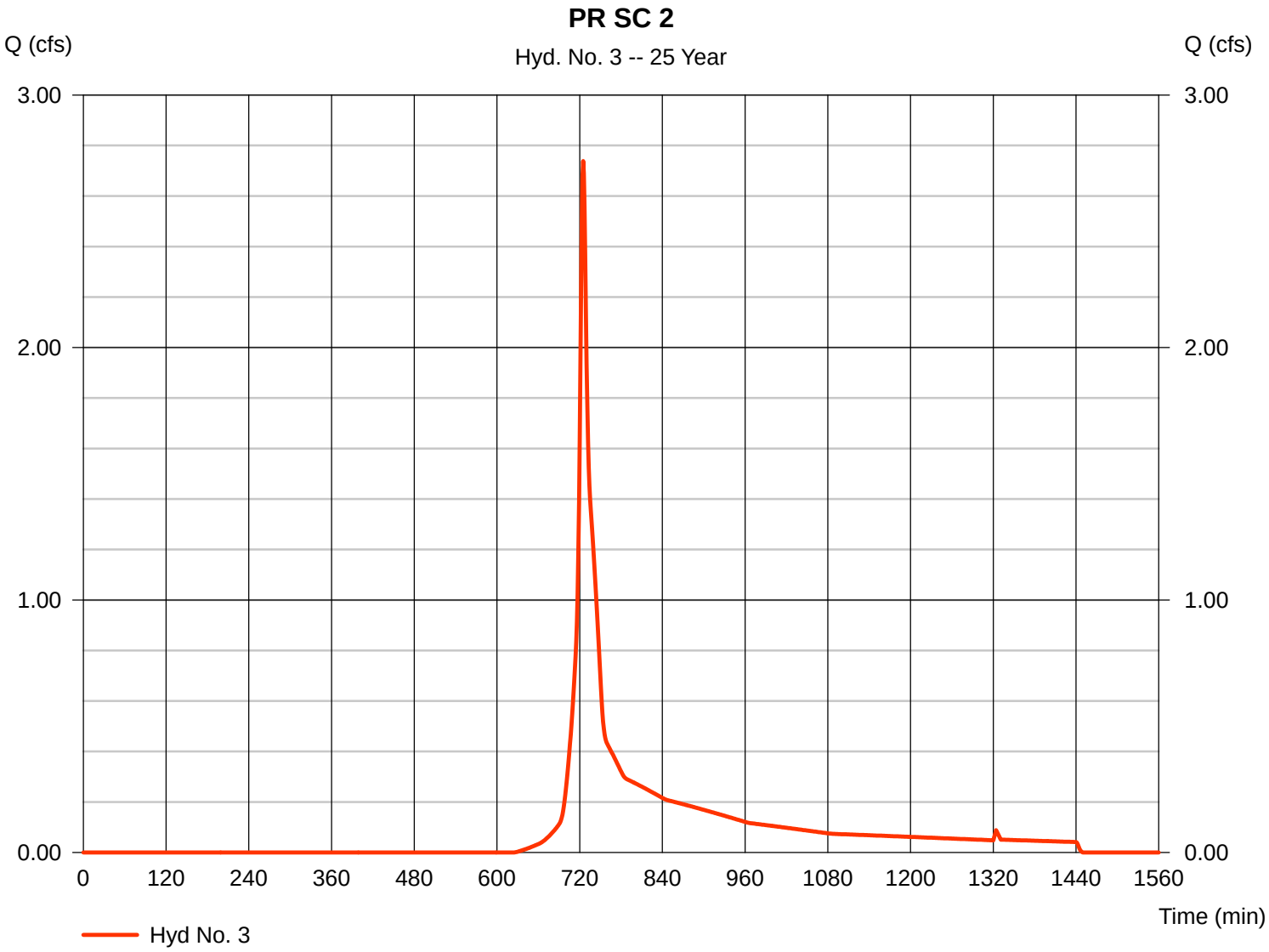
Hydraflow Hydrographs by Intelisolve v9.2 — Tuesday, Jul 7, 2015

Hyd. No. 3

PR SC 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.739 cfs
Storm frequency	=	25 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	8,776 cuft
Drainage area	=	1.270 ac	Curve number	=	64*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.60 min
Total precip.	=	5.40 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.570 x 98) + (0.560 x 39) + (0.140 x 30)] / 1.270



Hydrograph Report

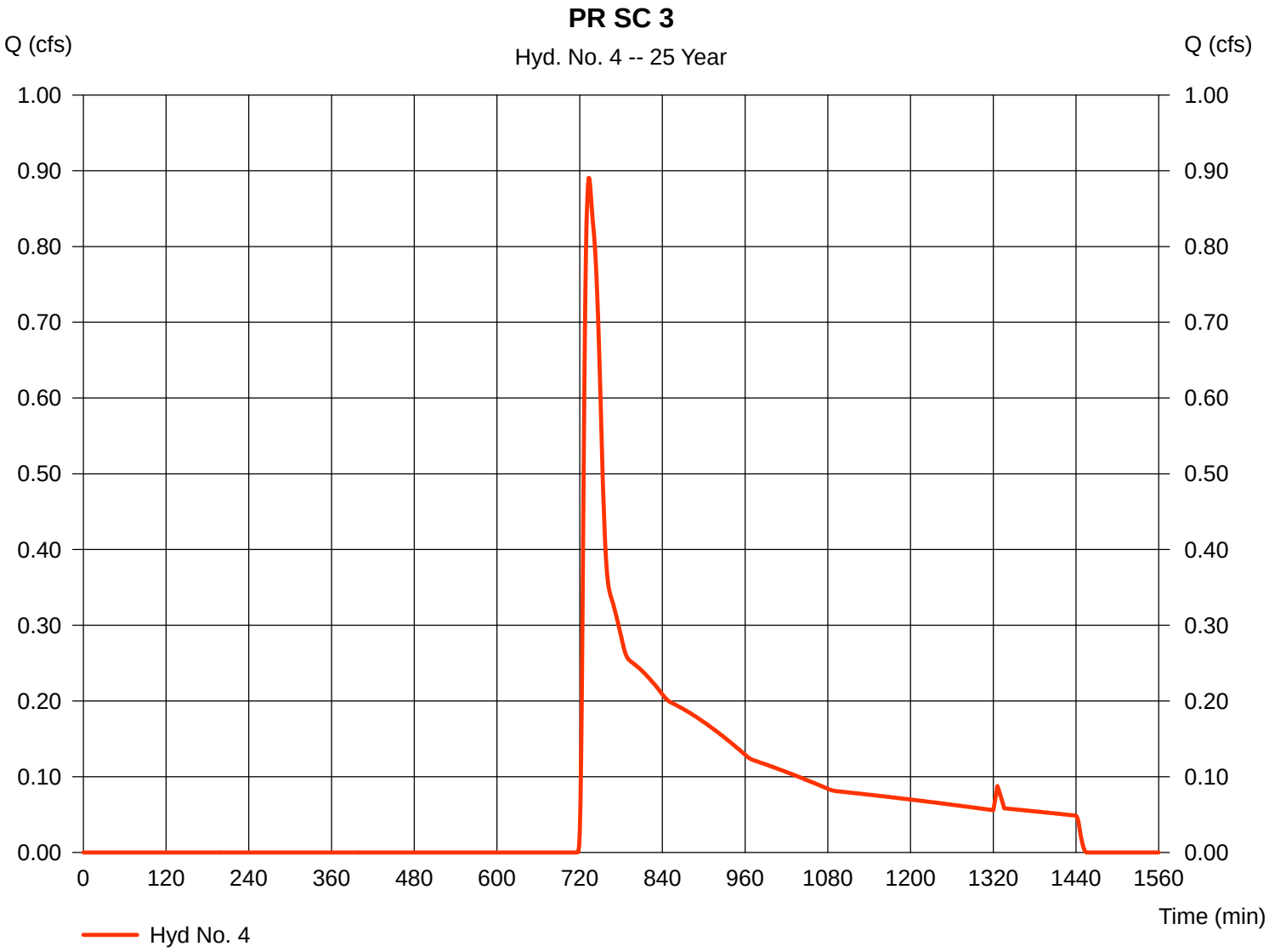
Hydraflow Hydrographs by Intelisolve v9.2 — Tuesday, Jul 7, 2015

Hyd. No. 4

PR SC 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	0.891 cfs
Storm frequency	=	25 yrs	Time to peak	=	733 min
Time interval	=	1 min	Hyd. volume	=	6,163 cuft
Drainage area	=	2.950 ac	Curve number	=	45*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.90 min
Total precip.	=	5.40 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.430 x 98) + (1.030 x 39) + (1.110 x 30) + (0.380 x 48)] / 2.950



Hydrograph Report

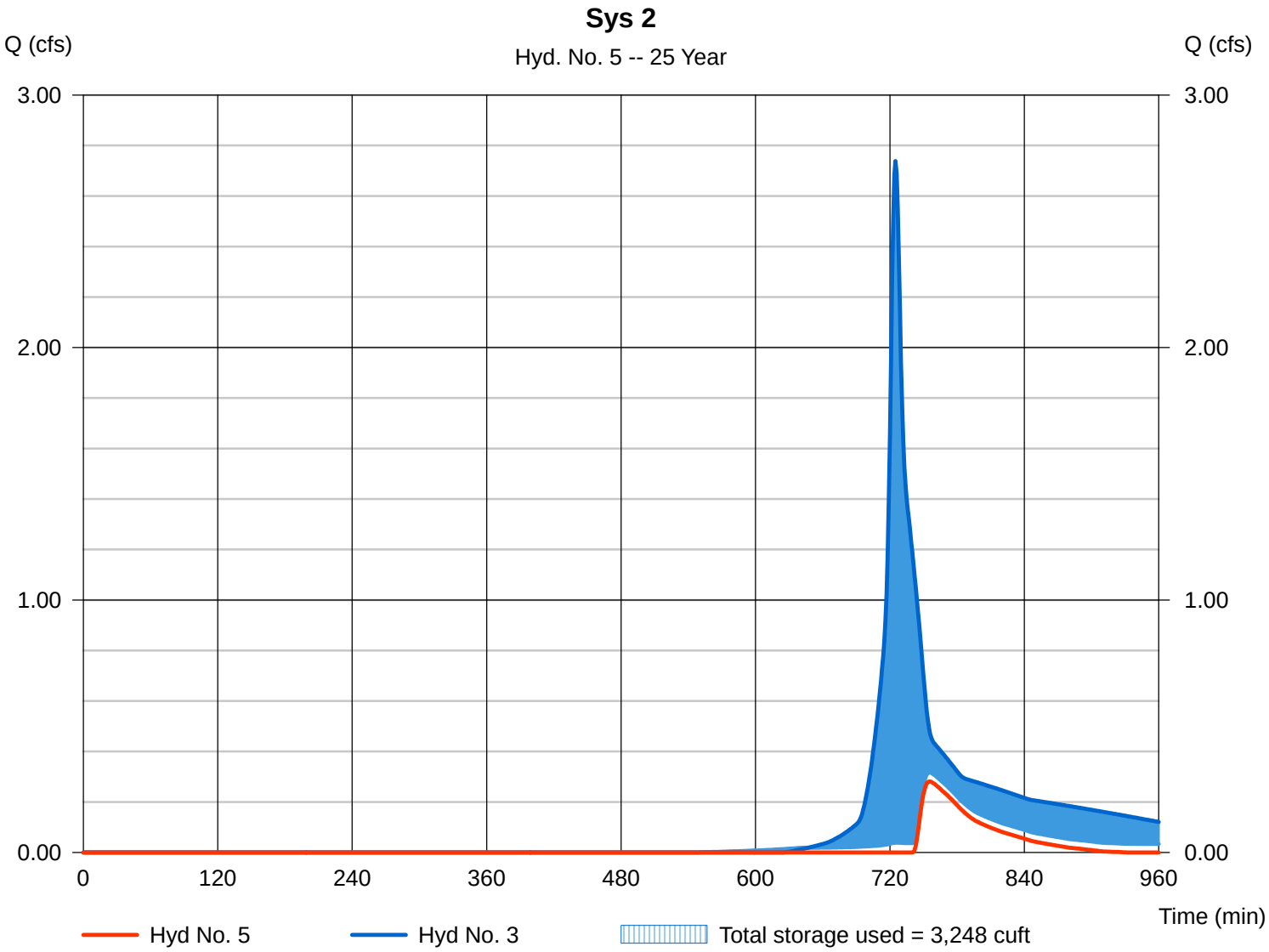
Hydraflow Hydrographs by Intelisolve v9.2 Tuesday, Jul 7, 2015

Hyd. No. 5

Sys 2

Hydrograph type	=	Reservoir	Peak discharge	=	0.281 cfs
Storm frequency	=	25 yrs	Time to peak	=	755 min
Time interval	=	1 min	Hyd. volume	=	982 cuft
Inflow hyd. No.	=	3 - PR SC 2	Max. Elevation	=	63.76 ft
Reservoir name	=	system 2	Max. Storage	=	3,248 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



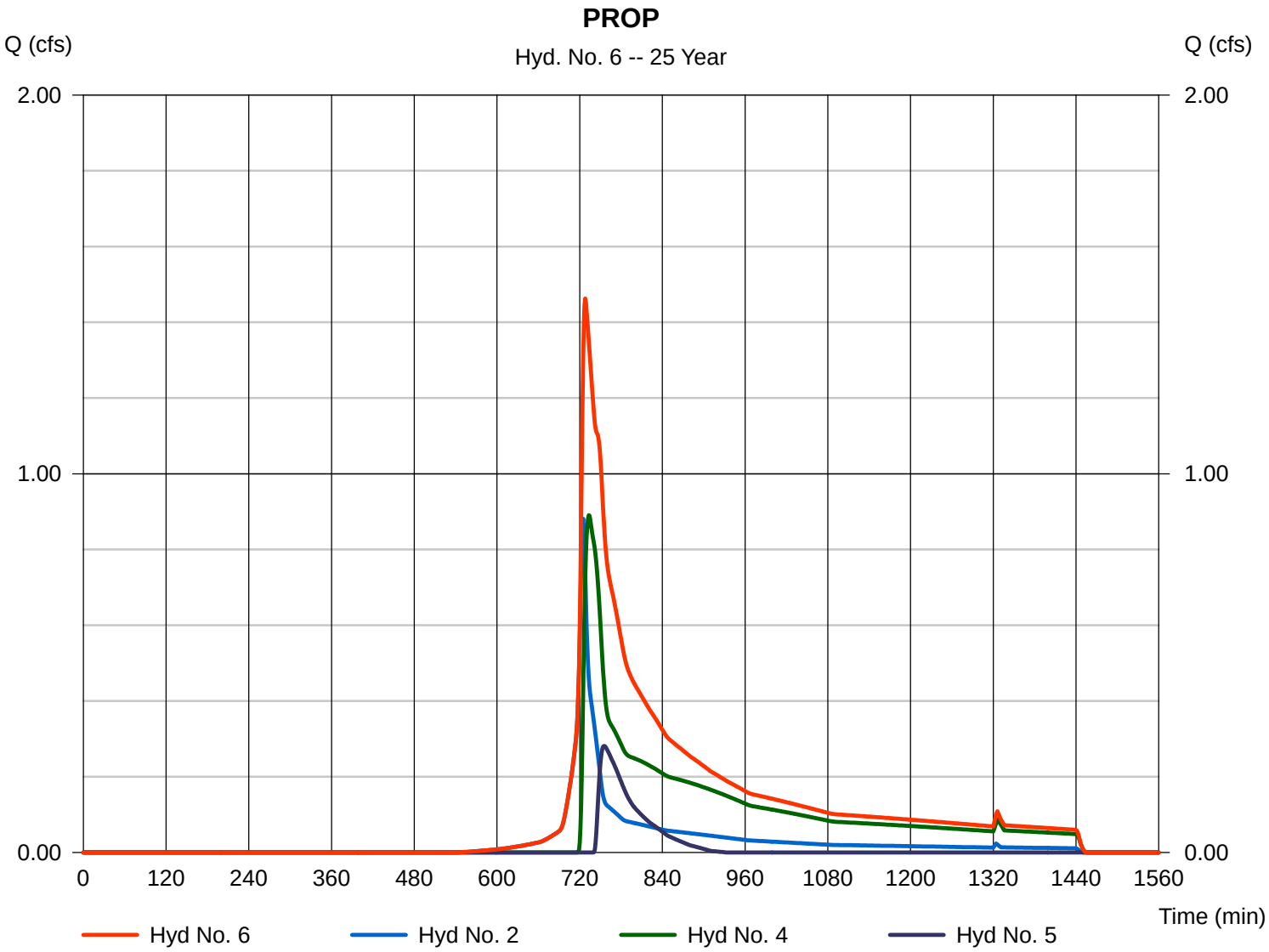
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 | Tuesday, Jul 7, 2015

Hyd. No. 6

PROP

Hydrograph type	=	Combine	Peak discharge	=	1.462 cfs
Storm frequency	=	25 yrs	Time to peak	=	728 min
Time interval	=	1 min	Hyd. volume	=	9,870 cuft
Inflow hyds.	=	2, 4, 5	Contrib. drain. area	=	3.240 ac



Hydrograph Report

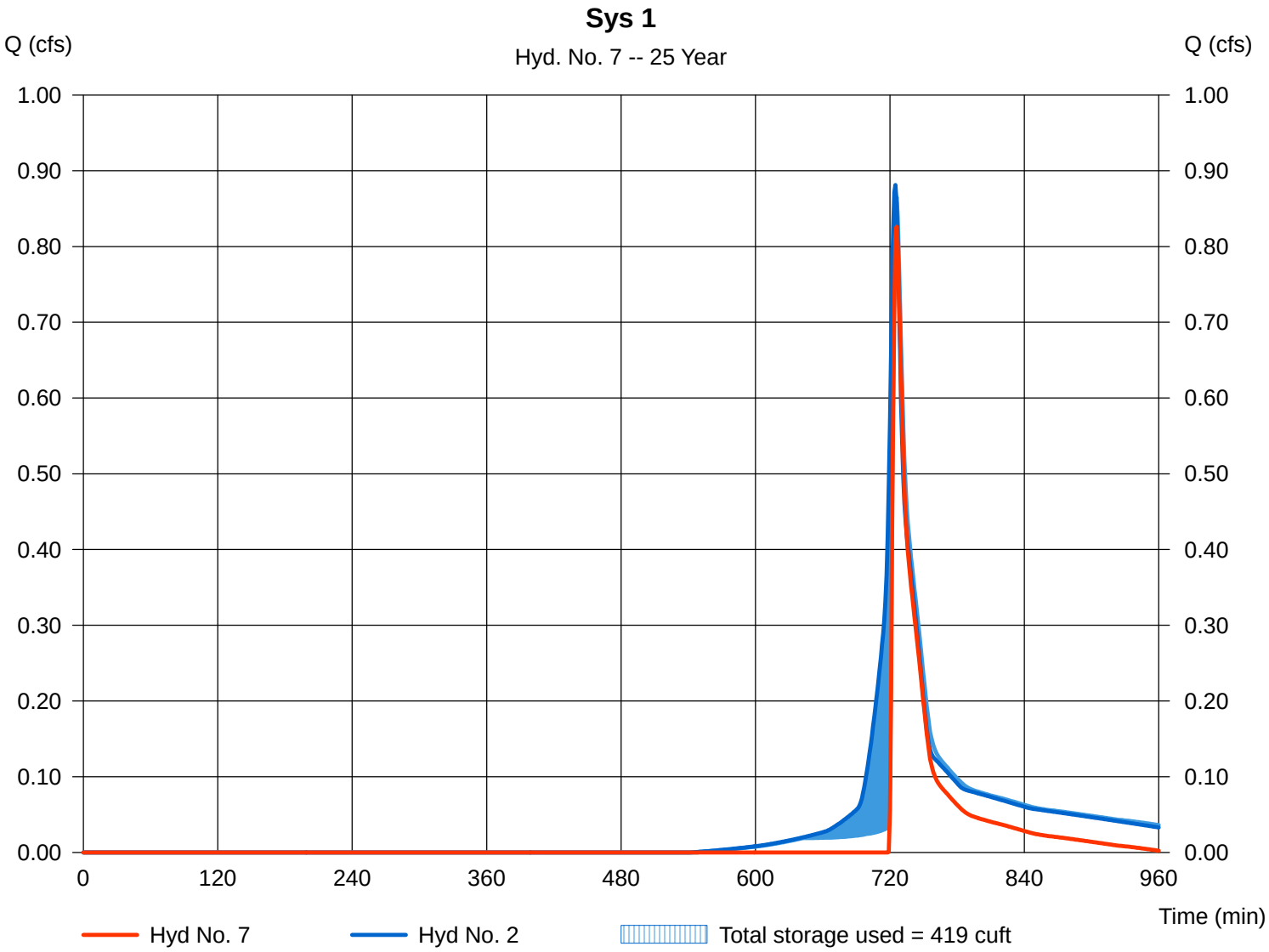
Hydraflow Hydrographs by Intelisolve v9.2 — Tuesday, Jul 7, 2015

Hyd. No. 7

Sys 1

Hydrograph type	=	Reservoir	Peak discharge	=	0.826 cfs
Storm frequency	=	25 yrs	Time to peak	=	726 min
Time interval	=	1 min	Hyd. volume	=	1,231 cuft
Inflow hyd. No.	=	2 - PR SC 1	Max. Elevation	=	61.30 ft
Reservoir name	=	system 1	Max. Storage	=	419 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Hydrograph Summary Report

Hydraflow Hydrographs by Intelisolve v9.2

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	4.322	1	730	19,853	----	------	------	EXISTING
2	SCS Runoff	1.201	1	725	3,698	----	------	------	PR SC 1
3	SCS Runoff	3.990	1	725	12,486	----	------	------	PR SC 2
4	SCS Runoff	2.201	1	729	10,820	----	------	------	PR SC 3
5	Reservoir	1.403	1	741	3,596	3	64.13	3,745	Sys 2
6	Combine	3.584	1	735	18,115	2, 4, 5	------	------	PROP
7	Reservoir	1.148	1	725	2,005	2	61.39	433	Sys 1

Hydrograph Report

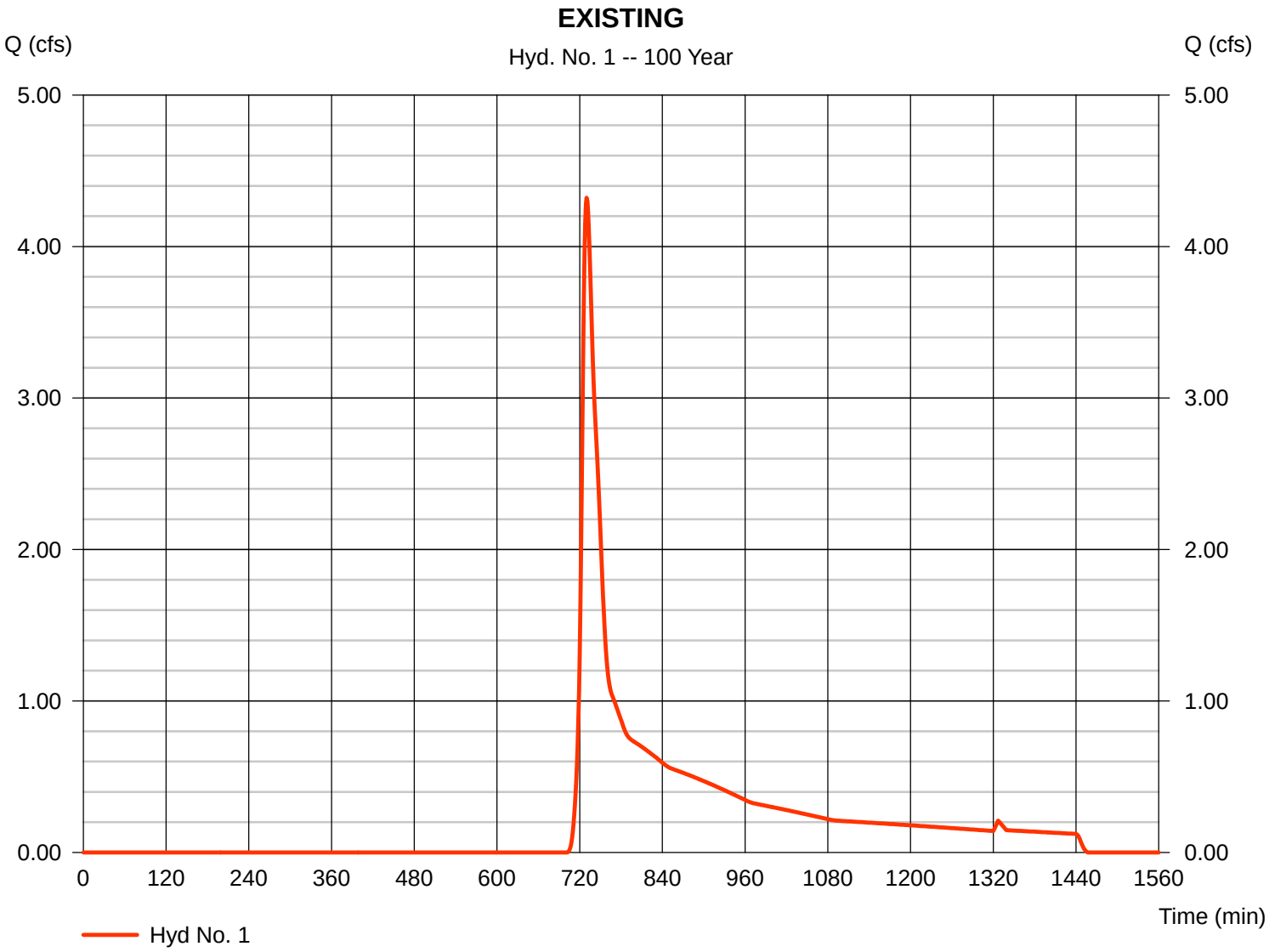
Hydraflow Hydrographs by Intelisolve v9.2 — Tuesday, Jul 7, 2015

Hyd. No. 1

EXISTING

Hydrograph type	=	SCS Runoff	Peak discharge	=	4.322 cfs
Storm frequency	=	100 yrs	Time to peak	=	730 min
Time interval	=	1 min	Hyd. volume	=	19,853 cuft
Drainage area	=	4.340 ac	Curve number	=	48*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	10.70 min
Total precip.	=	6.50 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.450 x 98) + (2.130 x 30) + (0.790 x 72) + (0.850 x 48) + (0.120 x 39)] / 4.340



Hydrograph Report

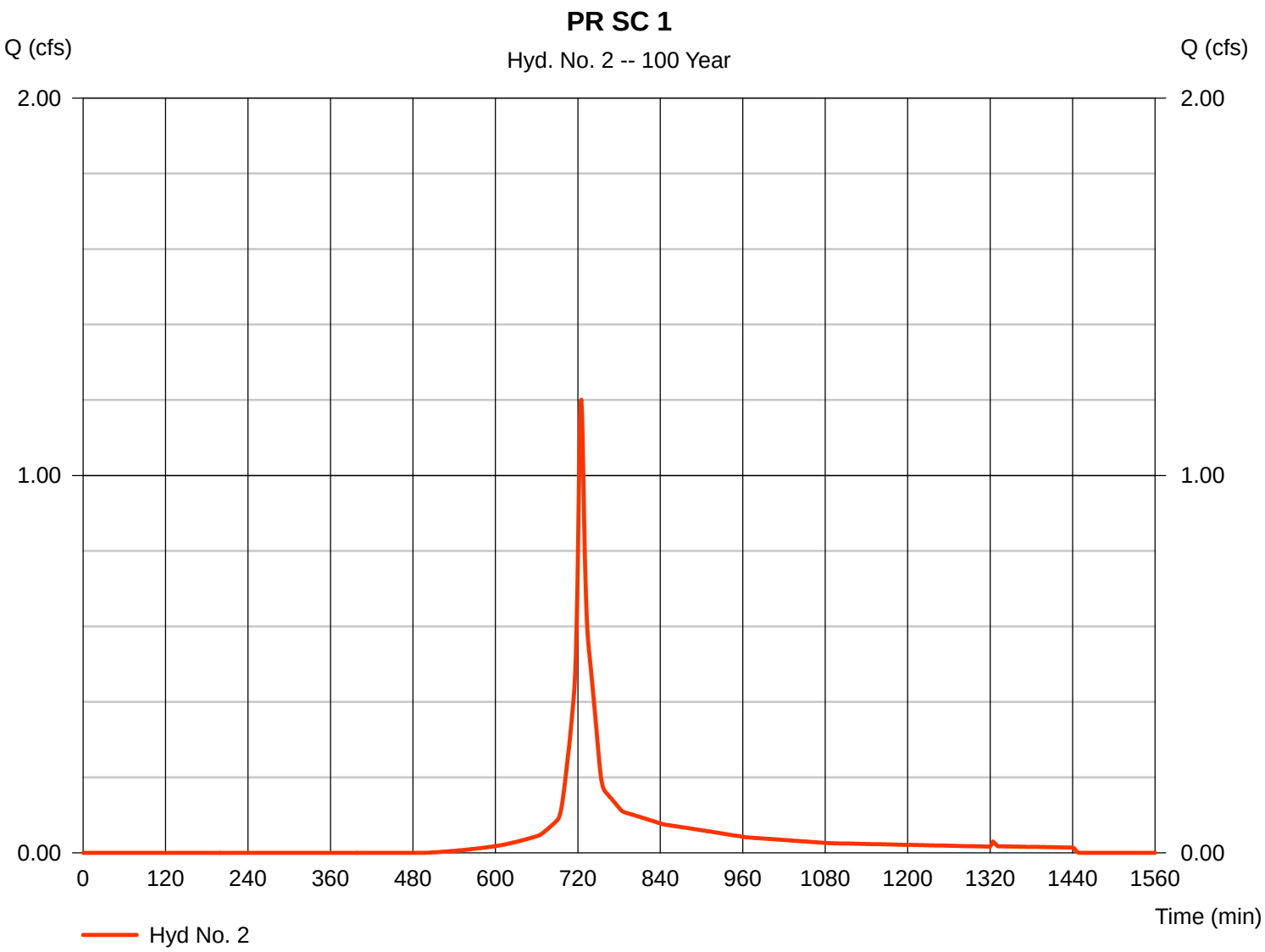
Hydraflow Hydrographs by Intelisolve v9.2 Tuesday, Jul 7, 2015

Hyd. No. 2

PR SC 1

Hydrograph type	=	SCS Runoff	Peak discharge	=	1.201 cfs
Storm frequency	=	100 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	3,698 cuft
Drainage area	=	0.290 ac	Curve number	=	72*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.50 min
Total precip.	=	6.50 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.160 x 98) + (0.130 x 39)] / 0.290



Hydrograph Report

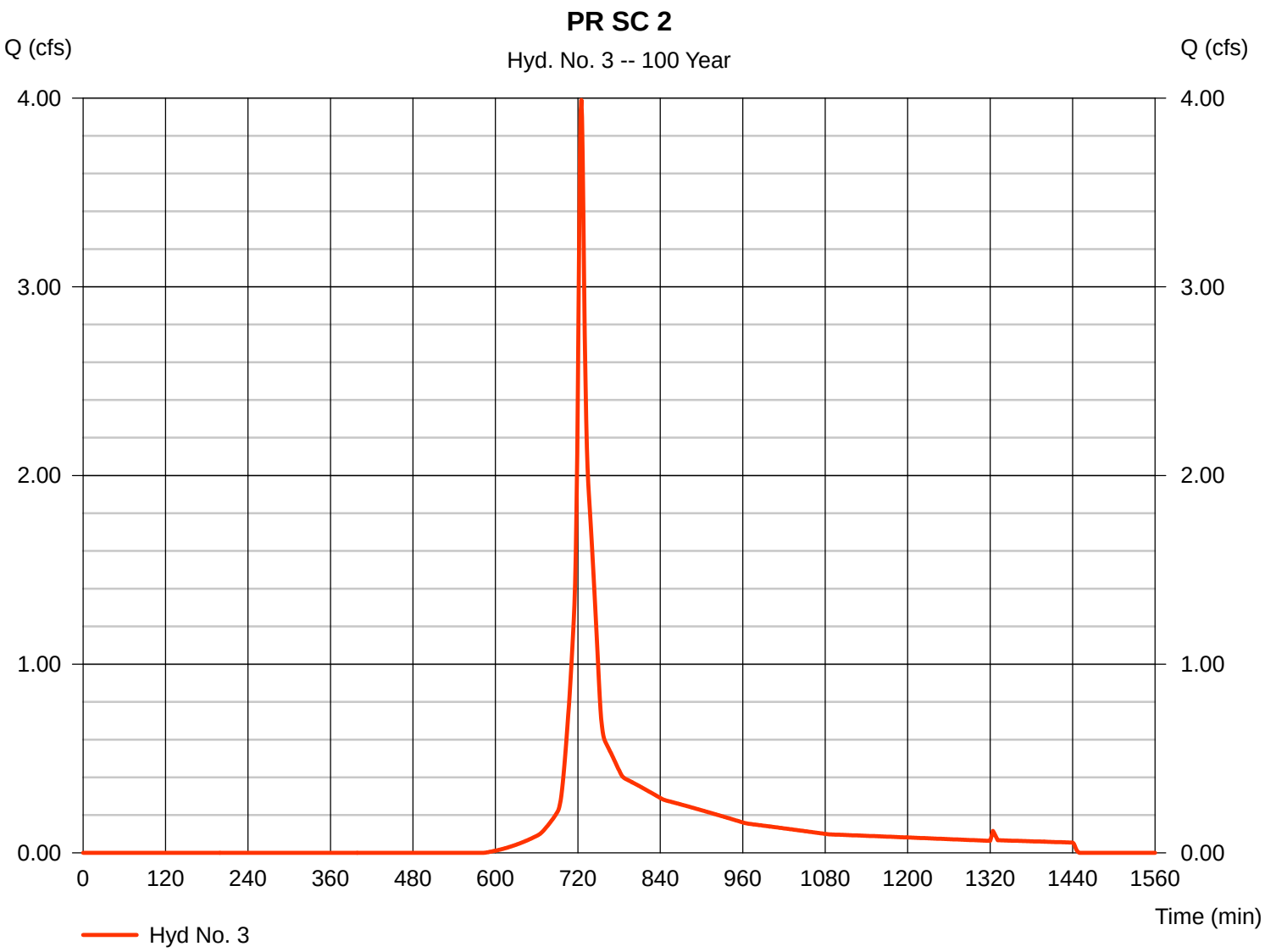
Hydraflow Hydrographs by Intelisolve v9.2 — Tuesday, Jul 7, 2015

Hyd. No. 3

PR SC 2

Hydrograph type	=	SCS Runoff	Peak discharge	=	3.990 cfs
Storm frequency	=	100 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	12,486 cuft
Drainage area	=	1.270 ac	Curve number	=	64*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	6.60 min
Total precip.	=	6.50 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.570 x 98) + (0.560 x 39) + (0.140 x 30)] / 1.270



Hydrograph Report

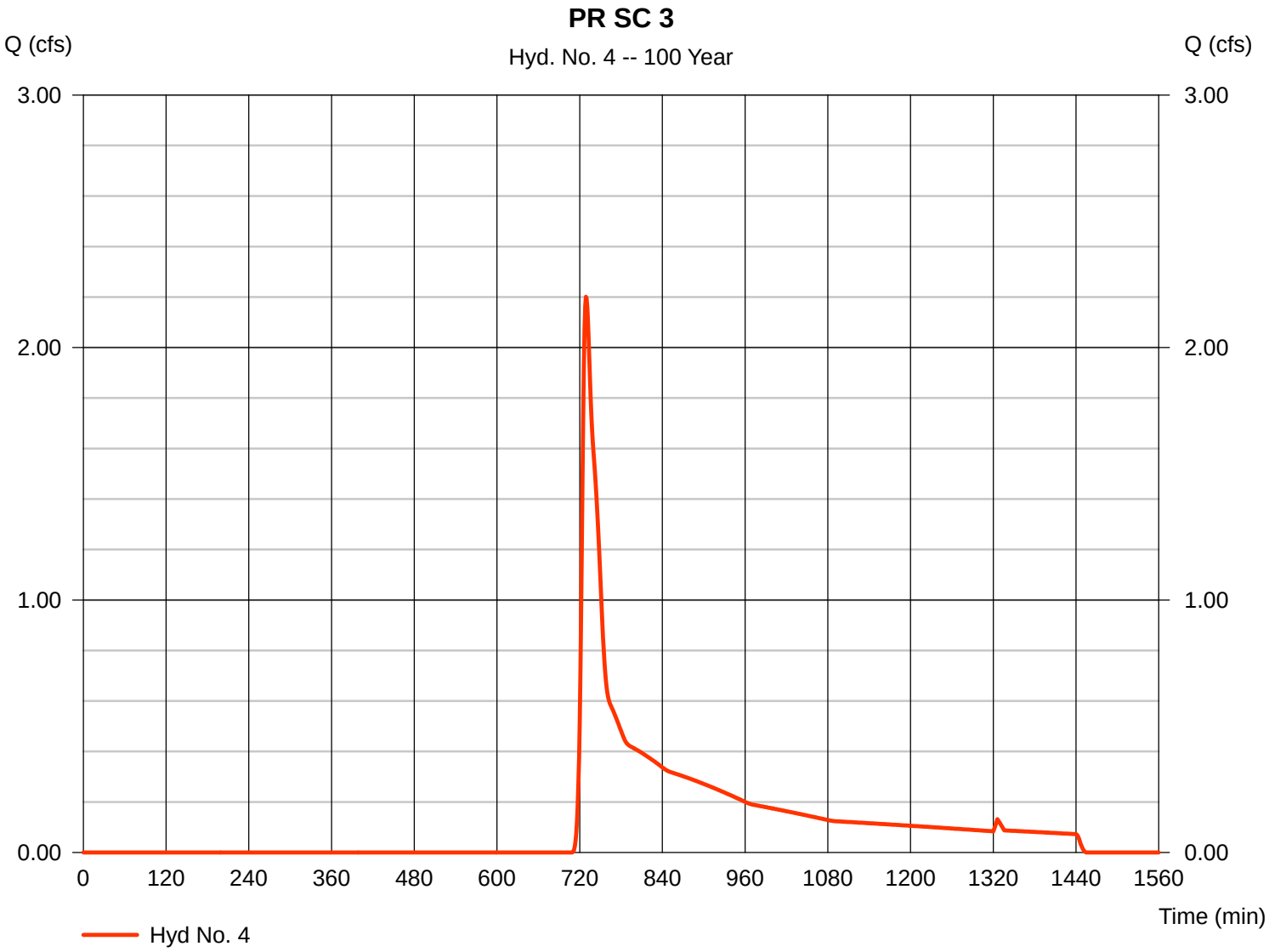
Hydraflow Hydrographs by Intelisolve v9.2 Tuesday, Jul 7, 2015

Hyd. No. 4

PR SC 3

Hydrograph type	=	SCS Runoff	Peak discharge	=	2.201 cfs
Storm frequency	=	100 yrs	Time to peak	=	729 min
Time interval	=	1 min	Hyd. volume	=	10,820 cuft
Drainage area	=	2.950 ac	Curve number	=	45*
Basin Slope	=	0.0 %	Hydraulic length	=	0 ft
Tc method	=	TR55	Time of conc. (Tc)	=	8.90 min
Total precip.	=	6.50 in	Distribution	=	Type III
Storm duration	=	24 hrs	Shape factor	=	484

* Composite (Area/CN) = [(0.430 x 98) + (1.030 x 39) + (1.110 x 30) + (0.380 x 48)] / 2.950



Hydrograph Report

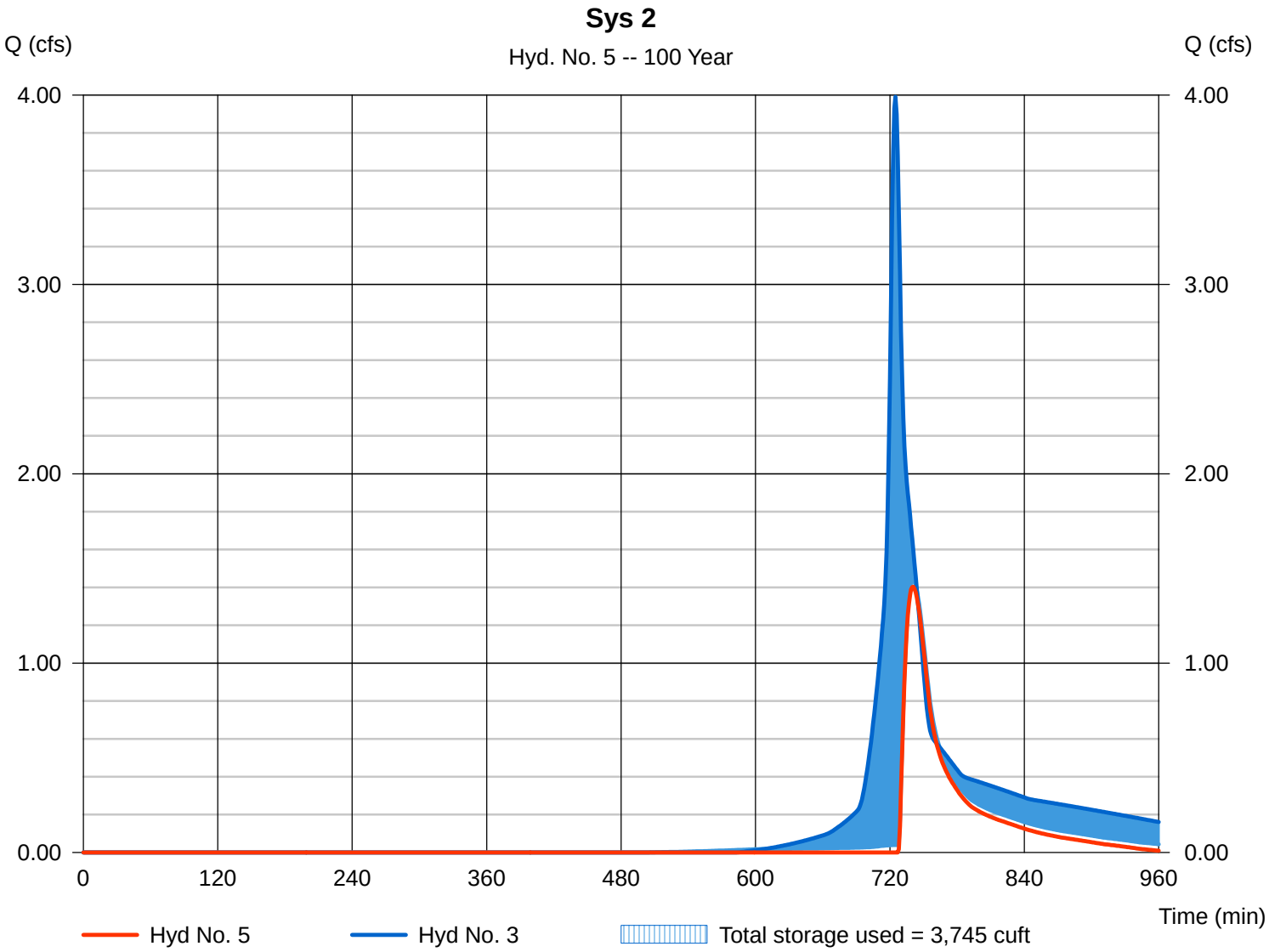
Hydraflow Hydrographs by Intelisolve v9.2 Tuesday, Jul 7, 2015

Hyd. No. 5

Sys 2

Hydrograph type	=	Reservoir	Peak discharge	=	1.403 cfs
Storm frequency	=	100 yrs	Time to peak	=	741 min
Time interval	=	1 min	Hyd. volume	=	3,596 cuft
Inflow hyd. No.	=	3 - PR SC 2	Max. Elevation	=	64.13 ft
Reservoir name	=	system 2	Max. Storage	=	3,745 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



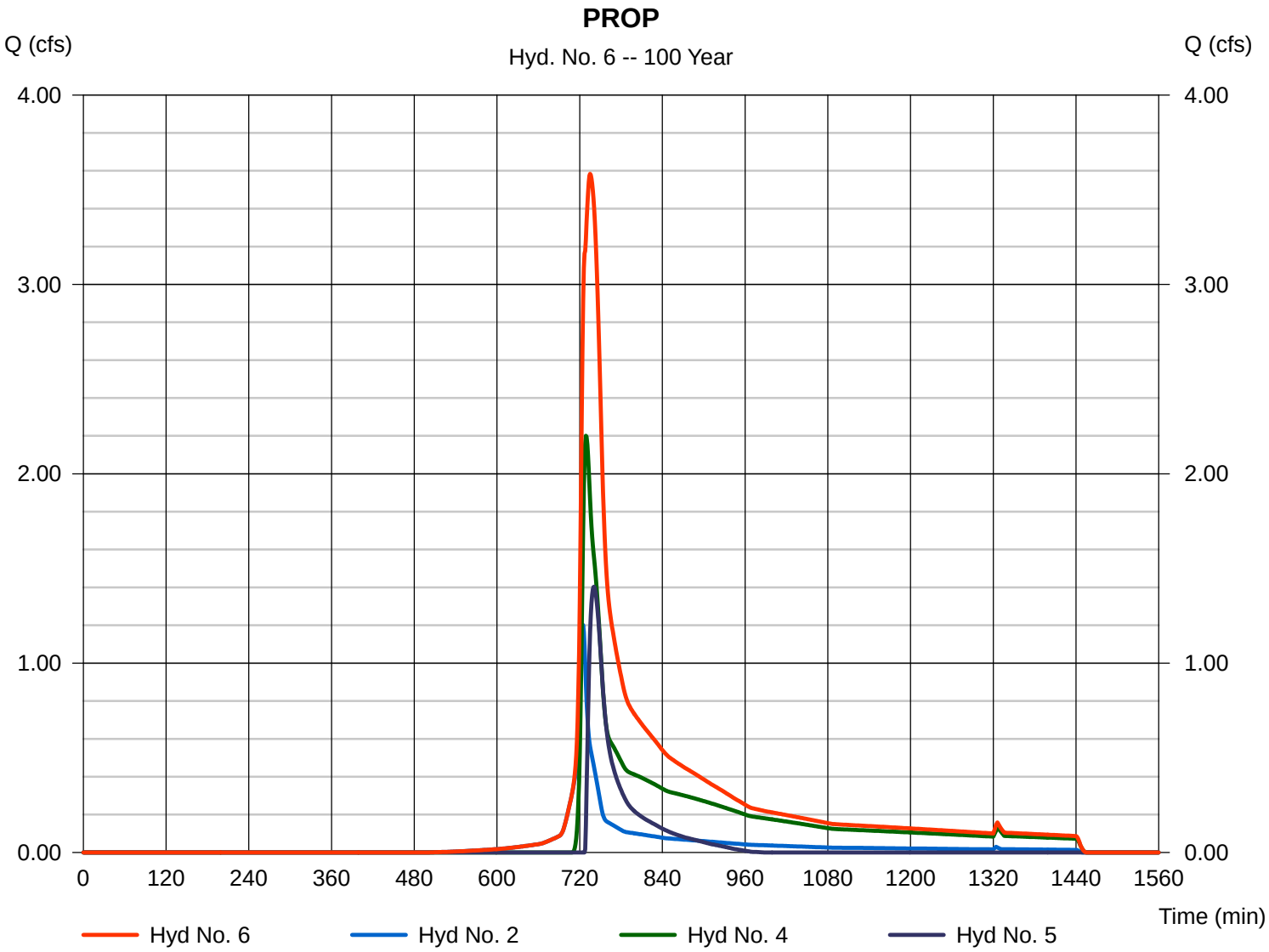
Hydrograph Report

Hydraflow Hydrographs by Intelisolve v9.2 Tuesday, Jul 7, 2015

Hyd. No. 6

PROP

Hydrograph type	=	Combine	Peak discharge	=	3.584 cfs
Storm frequency	=	100 yrs	Time to peak	=	735 min
Time interval	=	1 min	Hyd. volume	=	18,115 cuft
Inflow hyds.	=	2, 4, 5	Contrib. drain. area	=	3.240 ac



Hydrograph Report

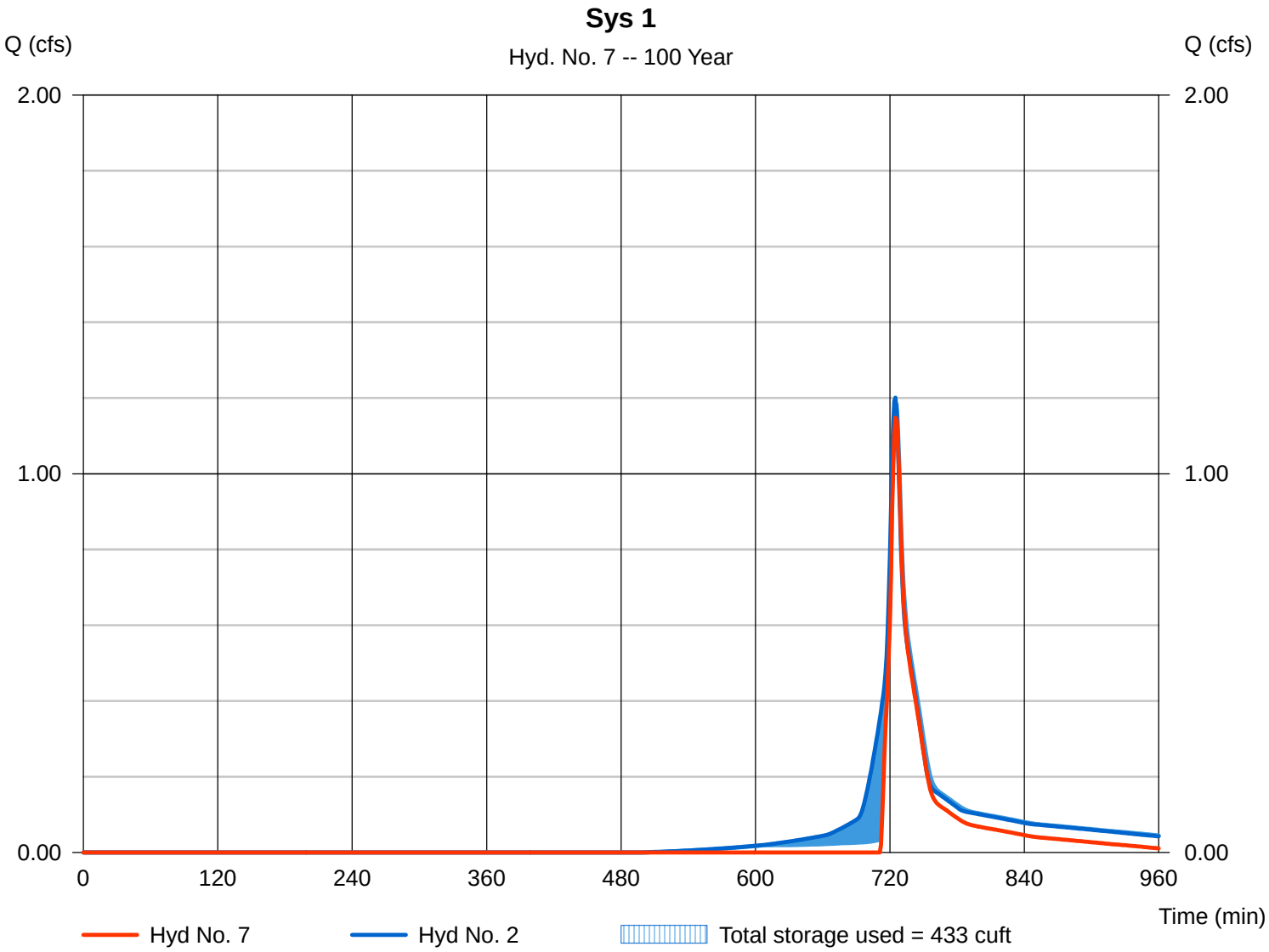
Hydraflow Hydrographs by Intelisolve v9.2 Tuesday, Jul 7, 2015

Hyd. No. 7

Sys 1

Hydrograph type	=	Reservoir	Peak discharge	=	1.148 cfs
Storm frequency	=	100 yrs	Time to peak	=	725 min
Time interval	=	1 min	Hyd. volume	=	2,005 cuft
Inflow hyd. No.	=	2 - PR SC 1	Max. Elevation	=	61.39 ft
Reservoir name	=	system 1	Max. Storage	=	433 cuft

Storage Indication method used. Exfiltration extracted from Outflow.



Appendix 2

Stormwater Standard #3 – Groundwater Recharge Calculations

Chamber Storage Calculations

Recharge Volume Calculations

Drawdown Calculations

Project: Standley St. System 1

StormTech
Detention • Retention • Water Quality
A division of ADS

Chamber Model -	SC-310	
Units -	Imperial	Click Here for Metric
Number of chambers -	14	
Voids in the stone (porosity) -	40	%
Base of Stone Elevation -	59.50	ft
Amount of Stone Above Chambers -	6	in
Amount of Stone Below Chambers -	6	in
Area of system -	420	sf Min. Area - 332 sf min. area

☑ Include Perimeter Stone in Calculations

Height of System (inches)	Incremental Single Chamber (cubic feet)	Incremental Total Chamber (cubic feet)	Incremental Stone (cubic feet)	Incremental Ch & St (cubic feet)	Cumulative Chamber (cubic feet)	Elevation (feet)
28	0.00	0.00	14.00	14.00	515.98	61.83
27	0.00	0.00	14.00	14.00	501.98	61.75
26	0.00	0.00	14.00	14.00	487.98	61.67
25	0.00	0.00	14.00	14.00	473.98	61.58
24	0.00	0.00	14.00	14.00	459.98	61.50
23	0.00	0.00	14.00	14.00	445.98	61.42
22	0.06	0.82	13.67	14.49	431.98	61.33
21	0.15	2.17	13.13	15.30	417.49	61.25
20	0.27	3.72	12.51	16.23	402.19	61.17
19	0.54	7.63	10.95	18.58	385.96	61.08
18	0.70	9.86	10.06	19.91	367.38	61.00
17	0.82	11.54	9.38	20.93	347.47	60.92
16	0.92	12.94	8.82	21.77	326.54	60.83
15	1.01	14.21	8.32	22.53	304.78	60.75
14	1.09	15.32	7.87	23.19	282.25	60.67
13	1.15	16.16	7.54	23.70	259.06	60.58
12	1.21	17.01	7.20	24.21	235.36	60.50
11	1.27	17.85	6.86	24.71	211.15	60.42
10	1.32	18.54	6.58	25.13	186.44	60.33
9	1.36	19.11	6.36	25.47	161.32	60.25
8	1.40	19.67	6.13	25.80	135.85	60.17
7	1.43	20.08	5.97	26.05	110.05	60.08
6	0.00	0.00	14.00	14.00	84.00	60.00
5	0.00	0.00	14.00	14.00	70.00	59.92
4	0.00	0.00	14.00	14.00	56.00	59.83
3	0.00	0.00	14.00	14.00	42.00	59.75
2	0.00	0.00	14.00	14.00	28.00	59.67
1	0.00	0.00	14.00	14.00	14.00	59.58

Project: **Standley Street System 2**

StormTech
Detention • Retention • Water Quality
A division of ADS

Chamber Model -	SC-740	
Units -	Imperial	Click Here for Metric
Number of chambers -	56	
Voids in the stone (porosity) -	40	%
Base of Stone Elevation -	61.50	ft
Amount of Stone Above Chambers -	6	in
Amount of Stone Below Chambers -	6	in
Area of system -	2133	sf Min. Area - 1893 sf min. area

☑ Include Perimeter Stone in Calculations

Height of System (inches)	Incremental Single Chamber (cubic feet)	Incremental Total Chamber (cubic feet)	Incremental Stone (cubic feet)	Incremental Ch & St (cubic feet)	Cumulative Chamber (cubic feet)	Elevation (feet)
42	0.00	0.00	71.10	71.10	4530.15	65.00
41	0.00	0.00	71.10	71.10	4459.05	64.92
40	0.00	0.00	71.10	71.10	4387.95	64.83
39	0.00	0.00	71.10	71.10	4316.85	64.75
38	0.00	0.00	71.10	71.10	4245.75	64.67
37	0.00	0.00	71.10	71.10	4174.65	64.58
36	0.05	3.08	69.87	72.95	4103.55	64.50
35	0.16	9.12	67.45	76.57	4030.60	64.42
34	0.28	15.79	64.78	80.57	3954.03	64.33
33	0.60	33.82	57.57	91.39	3873.45	64.25
32	0.80	44.90	53.14	98.04	3782.06	64.17
31	0.95	53.24	49.80	103.04	3684.02	64.08
30	1.07	60.17	47.03	107.20	3580.98	64.00
29	1.18	66.11	44.66	110.76	3473.78	63.92
28	1.27	70.88	42.75	113.63	3363.01	63.83
27	1.36	75.88	40.75	116.63	3249.39	63.75
26	1.45	81.43	38.53	119.96	3132.76	63.67
25	1.52	85.38	36.95	122.33	3012.80	63.58
24	1.58	88.61	35.66	124.27	2890.47	63.50
23	1.64	91.97	34.31	126.28	2766.20	63.42
22	1.70	95.17	33.03	128.20	2639.92	63.33
21	1.75	98.16	31.83	130.00	2511.72	63.25
20	1.80	100.96	30.72	131.67	2381.72	63.17
19	1.85	103.88	29.55	133.43	2250.05	63.08
18	1.89	106.01	28.69	134.71	2116.62	63.00
17	1.93	108.30	27.78	136.08	1981.91	62.92
16	1.97	110.60	26.86	137.46	1845.83	62.83
15	2.01	112.56	26.08	138.63	1708.37	62.75
14	2.04	114.52	25.29	139.81	1569.73	62.67
13	2.07	116.20	24.62	140.82	1429.92	62.58
12	2.10	117.88	23.95	141.83	1289.10	62.50
11	2.13	119.38	23.35	142.73	1147.28	62.42
10	2.15	120.62	22.85	143.47	1004.55	62.33
9	2.18	121.92	22.33	144.25	861.08	62.25
8	2.20	123.11	21.86	144.96	716.83	62.17
7	2.21	123.61	21.66	145.27	571.87	62.08
6	0.00	0.00	71.10	71.10	426.60	62.00
5	0.00	0.00	71.10	71.10	355.50	61.92
4	0.00	0.00	71.10	71.10	284.40	61.83
3	0.00	0.00	71.10	71.10	213.30	61.75
2	0.00	0.00	71.10	71.10	142.20	61.67
1	0.00	0.00	71.10	71.10	71.10	61.58

Standley St. Garden

7/7/15
Calc: DF

Recharge Area Calculations

Target Depth Factor per MA DEP: 0.6"

Existing Impervious = 13315 FT^2
Proposed Impervious = 44736 FT^2
Increase = 31421 FT^2

Required Volume

$$31421\ FT^2 \left(0.6''\right)\left(\frac{1FT}{12''}\right) = 1571\ FT^3$$

Captured Area Ratio

Imp Area to Recharge = 31884 FT^2
Total Proposed Impervious = 44736 FT^2

$$\frac{31884}{44736} = 0.71 = 71\%$$

Recharge Volume Provided (Simple Dynamic)

System 1 = 326 FT^3
System 2 = 2890 FT^3
total = 3216 FT^3

Standley St. Gardens
Recharge Area Drawdown

7/7/15
Calc: DF

System 1

$R_v = 326\ FT^3$ $K = 2.4''/hr$ Bottom Area: $423\ FT^2$

$$T = \frac{326\ FT^3}{2.4''/hr \left(\frac{1FT}{12''}\right) 423\ FT^2} = 3.9\ hr.$$

System 2

$R_v = 2890\ FT^3$ $K = 2.4''/hr$ Bot. Area: $2133\ FT^2$

$$T = \frac{2890\ FT^3}{2.4''/hr \left(\frac{1FT}{12''}\right)\left(2133\ FT^2\right)} = 6.8\ hr.$$

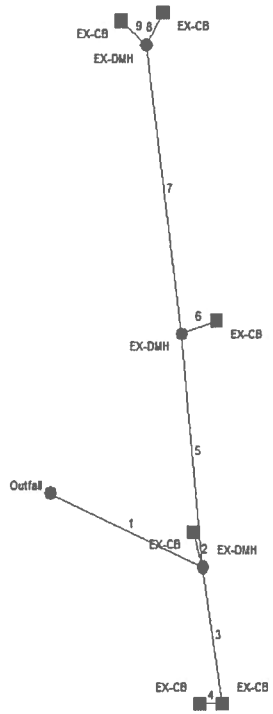
Appendix 3

Stormsewer Hydraulic Calculations

10 yr & 100 yr Storms

- Existing Drainage
- Exist. Drainage System with Recharge System 1 Outflow
- Drainage System 1
- Drainage System 2

Hydraflow Plan View



Standley Gardens Exist. Drain	No. Lines: 9	07-09-2015

Hydraflow Storm Sewers 2005

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Up	Dn	Up	Dn	Up	Dn	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	114.0	0.00	2.23	0.00	0.00	1.22	0.0	19.1	3.2	3.93	5.31	4.74	15	0.68	56.61	55.84	57.41	56.64	62.00	67.00	EX-DMH-HW
2	1	23.0	0.17	0.17	0.90	0.15	0.15	10.0	10.0	4.3	0.66	6.12	3.92	12	2.96	58.50	57.82	58.84	58.04	63.12	62.00	EX-CB-EX DMH
3	1	86.0	0.49	1.71	0.64	0.31	0.83	10.0	10.1	4.3	3.55	4.78	4.89	12	1.80	58.25	56.70	59.05	57.92	61.04	62.00	EX-CB-EX-CB
4	3	15.0	1.22	1.22	0.42	0.51	0.51	10.0	10.0	4.3	2.21	4.41	2.81	12	1.53	58.53	58.30	59.83	59.77	61.10	61.04	EX-CB-EX-CB
5	1	146.0	0.00	0.35	0.00	0.00	0.24	0.0	17.1	3.4	0.81	6.24	4.21	12	3.07	62.50	58.02	62.88	58.26	67.90	62.00	EX-DMH-EX-DM
6	5	25.0	0.24	0.24	0.58	0.14	0.14	10.0	10.0	4.3	0.60	3.42	2.23	12	0.92	62.83	62.60	63.16	63.04	67.60	67.90	EX-CB-EXDMH
7	5	181.0	0.00	0.11	0.00	0.00	0.10	0.0	11.6	4.1	0.40	9.13	1.79	12	6.57	74.50	62.60	74.77	63.04	78.00	67.90	EX-DMH-EXDMH
8	7	23.0	0.05	0.05	0.90	0.05	0.05	10.0	10.0	4.3	0.19	2.35	1.48	12	0.43	74.70	74.60	74.90	74.86	77.90	78.00	EXCB-EXDMH
9	7	23.0	0.06	0.06	0.90	0.05	0.05	10.0	10.0	4.3	0.23	2.35	1.69	12	0.43	74.70	74.60	74.91	74.86	77.90	78.00	EXCB-EXDMH

Standley Gardens Exist. Drain | Number of lines: 9 | Run Date: 07-09-2015

NOTES: Intensity = 49.26 / (Inlet time + 10.90) ^ 0.80; Return period = 10 Yrs.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	EX-DMH	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
2	EX-CB	0.66	0.00	0.55	0.10	Comb	0.3	3.00	0.00	2.00	2.00	0.025	2.00	0.020	0.020	0.013	0.10	4.85	0.15	3.18	1.00	Off
3	EX-CB	1.35	0.06	1.41	0.00	Grate	0.0	0.00	0.56	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.14	6.77	0.22	6.77	1.00	Off
4	EX-CB	2.21	0.00	2.21	0.00	Grate	0.0	0.00	0.87	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.16	8.17	0.25	8.17	1.00	Off
5	EX-DMH	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
6	EX-CB	0.60	0.00	0.54	0.06	Grate	0.0	0.00	0.00	2.00	2.00	0.090	2.00	0.020	0.020	0.013	0.07	3.70	0.11	1.82	1.00	3
7	EX-DMH	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
8	EX-CB	0.19	0.00	0.19	0.00	Comb	0.3	3.00	0.00	2.00	2.00	0.050	2.00	0.020	0.020	0.013	0.05	2.70	0.08	1.33	1.00	6
9	EX-CB	0.23	0.00	0.23	0.00	Comb	0.3	3.00	0.00	2.00	2.00	0.050	2.00	0.020	0.020	0.013	0.06	2.90	0.09	1.43	1.00	2

Standley Gardens Exist. Drain | Number of lines: 9 | Run Date: 07-09-2015

NOTES: Inlet N-Values = 0.016 ; Intensity = 49.26 / (Inlet time + 10.90) ^ 0.80; Return period = 10 Yrs. ; * Indicates Known Q added

Hydraflow Plan View

Standley Gardens Sys 1 Outlet	No. Lines: 11	07-09-2015

Hydraflow Storm Sewers 2005

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	85.0	0.00	2.23	0.00	0.00	1.22	0.0	19.2	3.2	4.72	5.24	4.83	15	0.66	56.40	55.84	57.33	56.77	62.00	67.00	WQU-HW
2	1	47.0	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.80	3.37	2.89	8	7.77	60.83	57.18	61.25	57.81	63.00	62.00	RECH-WQU
3	1	25.0	0.00	2.23	0.00	0.00	1.22	0.0	19.1	3.2	3.93	5.32	3.20	15	0.68	56.61	56.44	57.86	57.81	62.70	62.00	EX DMH-WQU
4	3	23.0	0.17	0.17	0.90	0.15	0.15	10.0	10.0	4.3	0.66	6.12	2.74	12	2.96	58.50	57.82	58.84	58.17	63.12	62.70	EX-CB-EX DMH
5	3	86.0	0.49	1.71	0.64	0.31	0.83	10.0	10.1	4.3	3.55	4.78	4.89	12	1.80	58.25	56.70	59.05	58.02	61.04	62.70	EX-CB-EXDMH
6	5	15.0	1.22	1.22	0.42	0.51	0.51	10.0	10.0	4.3	2.21	4.41	2.81	12	1.53	58.53	58.30	59.83	59.77	61.10	61.04	EXCB-EXCB
7	3	146.0	0.00	0.35	0.00	0.00	0.24	0.0	17.1	3.4	0.81	6.24	4.21	12	3.07	62.50	58.02	62.88	58.26	67.90	62.70	EXDMH-EXDMH
8	7	25.0	0.24	0.24	0.58	0.14	0.14	10.0	10.0	4.3	0.60	3.42	2.23	12	0.92	62.83	62.60	63.16	63.04	67.60	67.90	EX-CB-EXDMH
9	7	181.0	0.00	0.11	0.00	0.00	0.10	0.0	11.6	4.1	0.40	9.13	1.79	12	6.57	74.50	62.60	74.77	63.04	78.00	67.90	EX-DMH-EXDMH
10	9	23.0	0.05	0.05	0.90	0.05	0.05	10.0	10.0	4.3	0.19	2.35	1.48	12	0.43	74.70	74.60	74.90	74.86	77.90	78.00	EXCB-EXDMH
11	9	23.0	0.06	0.06	0.90	0.05	0.05	10.0	10.0	4.3	0.23	2.35	1.69	12	0.43	74.70	74.60	74.91	74.86	77.90	78.00	EXCB-EXDMH

Standley Gardens Sys 1 Outlet | Number of lines: 11 | Run Date: 07-09-2015

NOTES: Intensity = 49.26 / (Inlet time + 10.90) ^ 0.80; Return period = 10 Yrs.

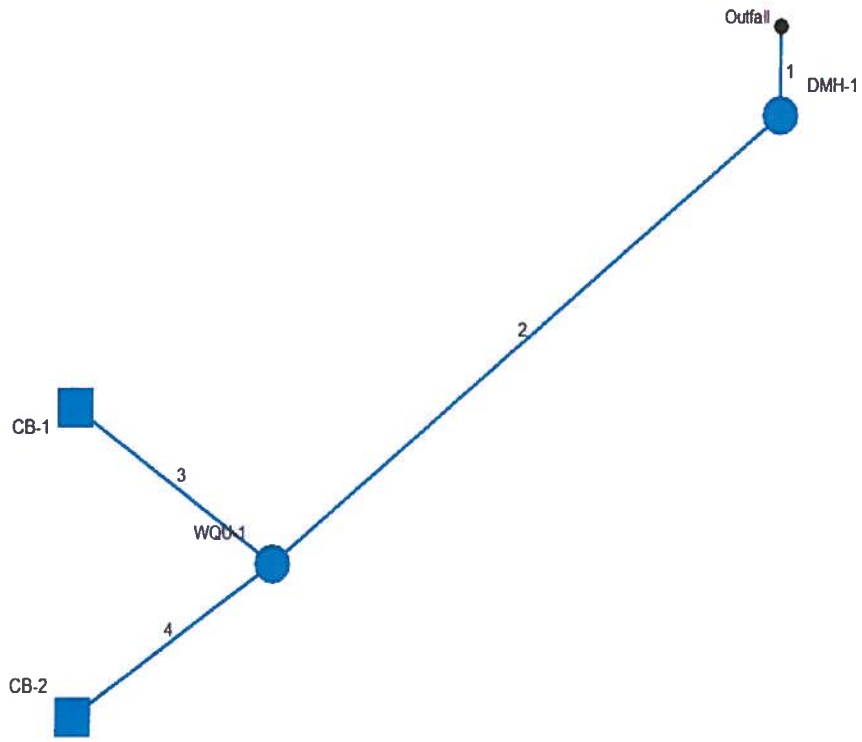
Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	WQU	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
2	RECH 2	0.80*	0.10	0.00	0.90	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
3	EX-DMH	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
4	EX-CB	0.66	0.00	0.55	0.10	Comb	0.3	3.00	0.00	2.00	2.00	0.025	2.00	0.020	0.020	0.013	0.10	4.85	0.15	3.18	1.00	2
5	EX-CB	1.35	0.06	1.41	0.00	Grate	0.0	0.00	0.56	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.14	6.78	0.22	6.78	1.00	Off
6	EX-CB	2.21	0.00	2.21	0.00	Grate	0.0	0.00	0.87	2.00	2.00	Sag	2.00	0.020	0.020	0.000	0.16	8.17	0.25	8.17	1.00	Off
7	EX-DMH	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
8	EX-CB	0.60	0.00	0.54	0.06	Grate	0.0	0.00	0.00	2.00	2.00	0.090	2.00	0.020	0.020	0.013	0.07	3.70	0.11	1.82	1.00	5
9	EX-DMH	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
10	EX-CB	0.19	0.00	0.19	0.00	Comb	0.3	3.00	0.00	2.00	2.00	0.050	2.00	0.020	0.020	0.013	0.05	2.70	0.08	1.33	1.00	8
11	EX-CB	0.23	0.00	0.23	0.00	Comb	0.3	3.00	0.00	2.00	2.00	0.050	2.00	0.020	0.020	0.013	0.06	2.90	0.09	1.43	1.00	4

Standley Gardens Sys 1 Outlet | Number of lines: 11 | Run Date: 07-09-2015

NOTES: Inlet N-Values = 0.016 ; Intensity = 49.26 / (Inlet time + 10.90) ^ 0.80; Return period = 10 Yrs. ; * Indicates Known Q added

Hydraflow Plan View



Standley Gardens System 1	No. Lines: 4	06-12-2015

Hydraflow Storm Sewers 2005

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	5.0	0.00	0.29	0.00	0.00	0.18	0.0	11.2	4.1	0.75	3.90	2.86	12	1.20	60.06	60.00	60.43	60.37	63.40	63.00	DMH1-BASIN
2	1	40.0	0.00	0.29	0.00	0.00	0.18	0.0	10.5	4.2	0.77	2.70	2.62	12	0.57	60.37	60.14	60.74	60.57	63.65	63.40	WQU1-DMH1
3	2	15.0	0.14	0.14	0.64	0.09	0.09	10.0	10.0	4.3	0.39	5.44	1.75	12	2.33	60.80	60.45	61.06	60.89	64.00	63.65	CB1-WQU1
4	2	15.0	0.15	0.15	0.62	0.09	0.09	10.0	10.0	4.3	0.40	5.44	1.78	12	2.33	60.80	60.45	61.07	60.89	64.00	63.65	CB2-WQU1

Standley Gardens System 1 | Number of lines: 4 | Run Date: 06-12-2015

NOTES: Intensity = 49.26 / (Inlet time + 10.90) ^ 0.80; Return period = 10 Yrs.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	DMH-1	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
2	WQU-1	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
3	CB-1	0.39	0.00	0.39	0.00	Comb	3.0	2.00	0.00	2.00	2.00	0.048	2.00	0.031	0.031	0.013	0.08	2.68	0.08	2.68	0.00	Off
4	CB-2	0.40	0.00	0.39	0.01	Comb	3.0	2.00	0.00	2.00	2.00	0.048	2.00	0.031	0.031	0.013	0.08	2.69	0.08	2.69	0.00	Off

Standley Gardens System 1 | Number of lines: 4 | Run Date: 06-12-2015

NOTES: Inlet N-Values = 0.016 ; Intensity = 49.26 / (Inlet time + 10.90) ^ 0.80; Return period = 10 Yrs. ; * Indicates Known Q added

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	5.0	0.00	0.29	0.00	0.00	0.18	0.0	10.8	5.9	1.07	3.90	3.22	12	1.20	60.06	60.00	60.50	60.44	63.40	63.00	DMH1-BASIN
2	1	40.0	0.00	0.29	0.00	0.00	0.18	0.0	10.4	6.0	1.09	2.70	2.82	12	0.57	60.37	60.14	60.82	60.70	63.65	63.40	WQU1-DMH1
3	2	15.0	0.14	0.14	0.64	0.09	0.09	10.0	10.0	6.0	0.54	5.44	1.89	12	2.33	60.80	60.45	61.11	61.01	64.00	63.65	CB1-WQU1
4	2	15.0	0.15	0.15	0.62	0.09	0.09	10.0	10.0	6.0	0.56	5.44	1.93	12	2.33	60.80	60.45	61.12	61.01	64.00	63.65	CB2-WQU1

Standley Gardens System 1 | Number of lines: 4 | Run Date: 06-12-2015

NOTES: Intensity = 83.47 / (Inlet time + 14.20) ^ 0.82; Return period = 100 Yrs.

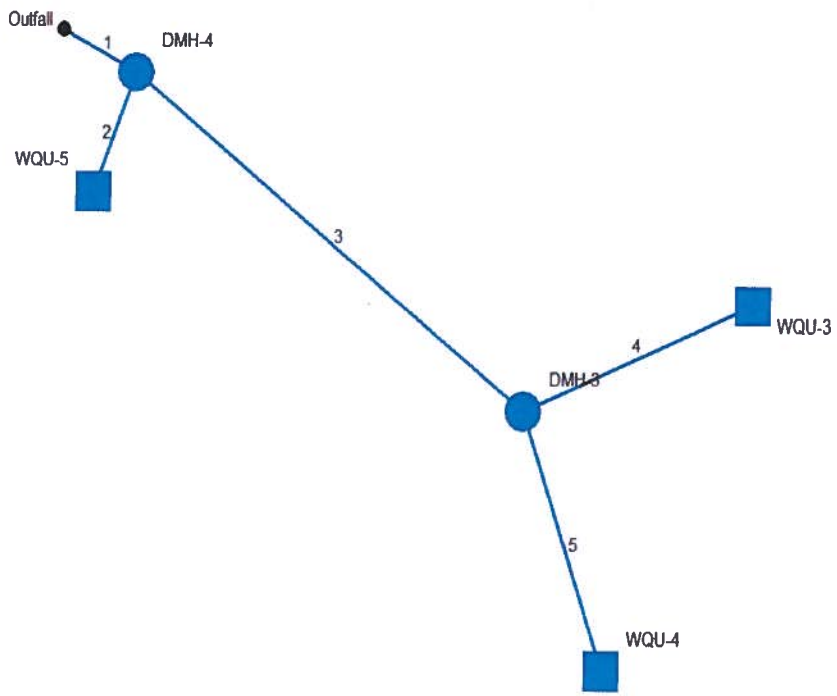
Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	DMH-1	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
2	WQU-1	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
3	CB-1	0.54	0.00	0.52	0.02	Comb	3.0	2.00	0.00	2.00	2.00	0.048	2.00	0.031	0.031	0.013	0.09	3.03	0.09	3.03	0.00	Off
4	CB-2	0.56	0.00	0.54	0.02	Comb	3.0	2.00	0.00	2.00	2.00	0.048	2.00	0.031	0.031	0.013	0.10	3.07	0.10	3.07	0.00	Off

Standley Gardens System 1 | Number of lines: 4 | Run Date: 06-12-2015

NOTES: Inlet N-Values = 0.016 ; Intensity = 83.47 / (Inlet time + 14.20) ^ 0.82; Return period = 100 Yrs. ; * Indicates Known Q added

Hydraflow Plan View



Standley Gardens System 2	No. Lines: 5	07-02-2015

Hydraflow Storm Sewers 2005

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line	(ft)	Incr (ac)	Total (ac)	(C)	Incr	Total	Inlet (min)	Syst (min)	(in/hr)	(cfs)	(cfs)	(ft/s)	Size (in)	Slope (%)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	Up (ft)	Dn (ft)	
1	End	5.0	0.00	1.28	0.00	0.00	0.72	0.0	10.3	4.3	3.08	24.78	1.75	24	1.20	62.06	62.00	63.13	63.13	66.80	67.00	DMH4-BASIN
2	1	7.0	0.10	0.10	0.72	0.07	0.07	10.0	10.0	4.3	0.31	7.49	0.43	12	4.43	62.45	62.14	63.23	63.23	66.43	66.80	WQU5-DMH4
3	1	30.0	0.00	1.18	0.00	0.00	0.65	0.0	10.2	4.3	2.79	2.52	3.55	12	0.50	62.29	62.14	63.36	63.18	66.80	66.80	DMH3-DMH4
4	3	15.0	0.44	0.44	0.64	0.28	0.28	10.0	10.0	4.3	1.21	2.60	1.54	12	0.53	62.45	62.37	63.71	63.70	66.43	66.80	WQU3-DMH3
5	3	15.0	0.74	0.74	0.50	0.37	0.37	10.0	10.0	4.3	1.59	2.60	2.03	12	0.53	62.45	62.37	63.70	63.67	66.43	66.80	WQU4-DMH3

Standley Gardens System 2 | Number of lines: 5 | Run Date: 07-02-2015

NOTES: Intensity = 49.26 / (Inlet time + 10.90) ^ 0.80; Return period = 10 Yrs.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	DMH-4	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
2	WQU-5	0.31	0.00	0.31	0.00	Comb	3.0	2.00	0.15	2.00	2.00	Sag	2.00	0.031	0.031	0.000	0.07	2.26	0.07	2.26	0.00	Off
3	DMH-3	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
4	WQU-3	1.21	0.00	1.21	0.00	Comb	3.0	2.00	0.58	2.00	2.00	Sag	2.00	0.031	0.031	0.000	0.17	5.48	0.17	5.48	0.00	Off
5	WQU-4	1.59	0.00	1.59	0.00	Comb	3.0	2.00	0.76	2.00	2.00	Sag	2.00	0.031	0.031	0.000	0.20	6.45	0.20	6.45	0.00	Off

Standley Gardens System 2 | Number of lines: 5 | Run Date: 07-02-2015

NOTES: Inlet N-Values = 0.016 ; Intensity = 49.26 / (Inlet time + 10.90) ^ 0.80; Return period = 10 Yrs. ; * Indicates Known Q added

Storm Sewer Tabulation

Station		Len	Drng Area		Rnoff coeff	Area x C		Tc		Rain (I)	Total flow	Cap full	Vel	Pipe		Invert Elev		HGL Elev		Grnd / Rim Elev		Line ID
Line	To Line		Incr	Total		Incr	Total	Inlet	Syst					Size	Slope	Up	Dn	Up	Dn	Up	Dn	
		(ft)	(ac)	(ac)	(C)			(min)	(min)	(in/hr)	(cfs)	(cfs)	(ft/s)	(in)	(%)	(ft)	(ft)	(ft)	(ft)	(ft)	(ft)	
1	End	5.0	0.00	1.28	0.00	0.00	0.72	0.0	10.2	6.0	4.34	24.78	1.38	24	1.20	62.06	62.00	64.12	64.12	66.80	67.00	DMH4-BASIN
2	1	7.0	0.10	0.10	0.72	0.07	0.07	10.0	10.0	6.0	0.44	7.49	0.55	12	4.43	62.45	62.14	64.18	64.18	66.43	66.80	WQU5-DMH4
3	1	30.0	0.00	1.18	0.00	0.00	0.65	0.0	10.1	6.0	3.92	2.52	4.99	12	0.50	62.29	62.14	64.52	64.15	66.80	66.80	DMH3-DMH4
4	3	15.0	0.44	0.44	0.64	0.28	0.28	10.0	10.0	6.0	1.70	2.60	2.17	12	0.53	62.45	62.37	65.21	65.18	66.43	66.80	WQU3-DMH3
5	3	15.0	0.74	0.74	0.50	0.37	0.37	10.0	10.0	6.0	2.24	2.60	2.85	12	0.53	62.45	62.37	65.18	65.13	66.43	66.80	WQU4-DMH3

Standley Gardens System 2 | Number of lines: 5 | Run Date: 07-02-2015

NOTES: Intensity = 83.47 / (Inlet time + 14.20) ^ 0.82; Return period = 100 Yrs.

Inlet Report

Line No	Inlet ID	Q = CIA (cfs)	Q carry (cfs)	Q capt (cfs)	Q byp (cfs)	Junc type	Curb Inlet		Grate Inlet			Gutter							Inlet			Byp line No
							Ht (in)	L (ft)	area (sqft)	L (ft)	W (ft)	So (ft/ft)	W (ft)	Sw (ft/ft)	Sx (ft/ft)	n	Depth (ft)	Spread (ft)	Depth (ft)	Spread (ft)	Depr (in)	
1	DMH-4	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
2	WQU-5	0.44	0.00	0.44	0.00	Comb	3.0	2.00	0.15	2.00	2.00	Sag	2.00	0.031	0.031	0.000	0.10	3.23	0.10	3.23	0.00	Off
3	DMH-3	0.00	0.00	0.00	0.00	MH	0.0	0.00	0.00	0.00	0.00	Sag	0.00	0.000	0.000	0.000	0.00	0.00	0.00	0.00	0.00	Off
4	WQU-3	1.70	0.00	1.70	0.00	Comb	3.0	2.00	0.58	2.00	2.00	Sag	2.00	0.031	0.031	0.000	0.18	5.81	0.18	5.81	0.00	Off
5	WQU-4	2.24	0.00	2.24	0.00	Comb	3.0	2.00	0.76	2.00	2.00	Sag	2.00	0.031	0.031	0.000	0.23	7.42	0.23	7.42	0.00	Off

Standley Gardens System 2 | Number of lines: 5 | Run Date: 07-02-2015

NOTES: Inlet N-Values = 0.016 ; Intensity = 83.47 / (Inlet time + 14.20) ^ 0.82; Return period = 100 Yrs. ; * Indicates Known Q added

Appendix 4

Total Suspended Solids (TSS) Removal

TSS Removal Worksheets

Contech Engineered Solutions Documentation

- Estimated TSS Removal Reports for Water Quality Units
- Water Quality Flow Rate Report for Water Quality Units
- Water Quality Unit Standard Details

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: System 2

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Street Sweeping	5%	1.00	0.05	0.95
Water Quality Units Model VSH536	91%	0.95	0.86	0.09
Sub Surface Chamber System	80% *	0.09	0.07	0.02

44% Pretreatment Achieved

Total TSS Removal = 98%

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

Project: Standley St.
Prepared By: DF
Date: 7/8/15

*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

Mass. Dept. of Environmental Protection

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: Existing Standley St. Drainage

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
COS WQU Model 2015-4	83%	1.00	0.83	0.17

Total TSS Removal = 83%

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

Project: Standley St.
Prepared By: DF
Date: 7/8/15

*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

Mass. Dept. of Environmental Protection

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: System #1

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Street Sweeping	5%	1.00	0.05	0.95
Deep Sump CB's	25%	0.95	0.24	0.71
CDS WQU model 2015-4	83%	0.71	0.59	0.12

Total TSS Removal = 88%

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

Project: Standley St

Prepared By: D.F.

Date: 7/8/15

*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

Mass. Dept. of Environmental Protection

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

CONTECH ENGINEERED SOLUTIONS

STANDLEY ST DRAINAGE
BEVERLY, MA
for SYSTEM: WQU 2

Area	0.85	acres	CDS Model	
Weighted C	0.90		2015-4	
Tc	6	minutes	CDS Treatment Capacity	
			1.4	cfs

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Removal Efficiency (%)	Incremental Removal (%)
0.02	10.2%	10.2%	0.02	0.02	96.5	9.8
0.04	9.6%	19.8%	0.03	0.03	95.7	9.2
0.06	9.4%	29.3%	0.05	0.05	95.0	9.0
0.08	7.7%	37.0%	0.06	0.06	94.2	7.3
0.10	8.6%	45.6%	0.08	0.08	93.5	8.0
0.12	6.3%	51.9%	0.09	0.09	92.8	5.8
0.14	4.7%	56.5%	0.11	0.11	92.0	4.3
0.16	4.6%	61.2%	0.12	0.12	91.3	4.2
0.18	3.5%	64.7%	0.14	0.14	90.5	3.2
0.20	4.3%	69.1%	0.15	0.15	89.8	3.9
0.25	8.0%	77.1%	0.19	0.19	87.9	7.0
0.30	5.6%	82.7%	0.23	0.23	86.1	4.8
0.35	4.4%	87.0%	0.27	0.27	84.2	3.7
0.40	2.5%	89.5%	0.31	0.31	82.3	2.1
0.45	2.5%	92.1%	0.34	0.34	80.5	2.0
0.50	1.4%	93.5%	0.38	0.38	78.6	1.1
0.75	5.0%	98.5%	0.57	0.57	69.3	3.5
1.00	1.0%	99.5%	0.77	0.77	60.0	0.6
1.50	0.0%	99.5%	1.15	1.15	41.4	0.0
2.00	0.0%	99.5%	1.53	1.40	26.6	0.0
3.00	0.5%	100.0%	2.30	1.40	17.8	0.1
						89.7

Removal Efficiency Adjustment[2] =	6.5%
Predicted % Annual Rainfall Treated =	93.4%
Predicted Net Annual Load Removal Efficiency =	**83.3%**

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.

VortSentry® HS Estimated Net Annual TSS Reduction

CONTECH® ENGINEERED SOLUTIONS

STANDLEY ST DRAINAGE
BEVERLY, MA
Model VSHS36
System WQU 3

Design Ratio[1] = $\frac{0.25 \text{ acres} \times 0.9}{27 \text{ ft}3}$ **= 0.008**

Rainfall Intensity "/hr	Flow Rate cfs	Operating Rate[2] cfs/ft^3	% Total Rainfall Depth[3]	Rmvl. Effcy[4] (%)	Rel. Effcy (%)
0.02	0.00	0.00017	10.2%	98.0%	10.0%
0.04	0.01	0.00034	9.6%	98.0%	9.5%
0.06	0.01	0.00051	9.4%	98.0%	9.3%
0.08	0.02	0.00068	7.7%	98.0%	7.6%
0.10	0.02	0.00085	8.6%	98.0%	8.4%
0.12	0.03	0.00102	6.3%	98.0%	6.2%
0.14	0.03	0.00119	4.7%	98.0%	4.6%
0.16	0.04	0.00136	4.6%	98.0%	4.5%
0.18	0.04	0.00153	3.5%	98.0%	3.5%
0.20	0.05	0.00170	4.3%	98.0%	4.3%
0.25	0.06	0.00212	8.0%	98.0%	7.8%
0.30	0.07	0.00255	5.6%	98.0%	5.5%
0.35	0.08	0.00297	4.4%	98.0%	4.3%
0.40	0.09	0.00340	2.5%	98.0%	2.5%
0.45	0.10	0.00382	2.5%	98.0%	2.5%
0.50	0.11	0.00424	1.4%	98.0%	1.4%
0.75	0.17	0.00637	5.0%	98.0%	4.9%
1.00	0.23	0.00849	1.0%	97.8%	1.0%
1.50	0.34	0.01273	0.0%	90.3%	0.0%
2.00	0.45	0.01698	0.0%	88.6%	0.0%
3.00	0.68	0.02546	0.5%	69.2%	0.3%
					97.9%
				% rain falling at >0"/hr =	0.0%
				Removal Efficiency Adjustment[4] =	6.5%
				Predicted Net Annual Load Removal Efficiency =	**91.4%**

1 - Design Ratio = (Total Drainage Area x Runoff Coefficient) / VortSentry HS Treatment Volume
= The Total Drainage Area and Runoff Coefficient are specified by the site engineer.
2 - Operating Rate (cfs/ft^3) = Rainfall Intensity ("/hr) x Design Ratio
3 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
4 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

Calculated by: CJA	Date: 06/26/14	Checked by:	Date:

VortSentry® HS Estimated Net Annual TSS Reduction

CONTECH® ENGINEERED SOLUTIONS

STANDLEY ST DRAINAGE
BEVERLY, MA
Model VSHS36
System WQU 4

Design Ratio[1] = $\frac{\text{0.25 acres x 0.9}}{\text{27 ft3}}$ **= 0.008**

Rainfall Intensity "/hr	Flow Rate cfs	Operating Rate[2] cfs/ft^3	% Total Rainfall Depth[3]	Rmvl. Effcy[4] (%)	Rel. Effcy (%)
0.02	0.00	0.00017	10.2%	98.0%	10.0%
0.04	0.01	0.00034	9.6%	98.0%	9.5%
0.06	0.01	0.00051	9.4%	98.0%	9.3%
0.08	0.02	0.00068	7.7%	98.0%	7.6%
0.10	0.02	0.00085	8.6%	98.0%	8.4%
0.12	0.03	0.00102	6.3%	98.0%	6.2%
0.14	0.03	0.00119	4.7%	98.0%	4.6%
0.16	0.04	0.00136	4.6%	98.0%	4.5%
0.18	0.04	0.00153	3.5%	98.0%	3.5%
0.20	0.05	0.00170	4.3%	98.0%	4.3%
0.25	0.06	0.00212	8.0%	98.0%	7.8%
0.30	0.07	0.00255	5.6%	98.0%	5.5%
0.35	0.08	0.00297	4.4%	98.0%	4.3%
0.40	0.09	0.00340	2.5%	98.0%	2.5%
0.45	0.10	0.00382	2.5%	98.0%	2.5%
0.50	0.11	0.00424	1.4%	98.0%	1.4%
0.75	0.17	0.00637	5.0%	98.0%	4.9%
1.00	0.23	0.00849	1.0%	97.8%	1.0%
1.50	0.34	0.01273	0.0%	90.3%	0.0%
2.00	0.45	0.01698	0.0%	88.6%	0.0%
3.00	0.68	0.02546	0.5%	69.2%	0.3%
					97.9%
				% rain falling at >0"/hr =	0.0%
				Removal Efficiency Adjustment[4] =	6.5%
				Predicted Net Annual Load Removal Efficiency =	**91.4%**

1 - Design Ratio = (Total Drainage Area x Runoff Coefficient) / VortSentry HS Treatment Volume
= The Total Drainage Area and Runoff Coefficient are specified by the site engineer.
2 - Operating Rate (cfs/ft^3) = Rainfall Intensity ("/hr) x Design Ratio
3 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
4 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

Calculated by: CJA	Date: 06/26/14	Checked by:	Date:

VortSentry® HS Estimated Net Annual TSS Reduction

CONTECH® ENGINEERED SOLUTIONS

STANDLEY ST DRAINAGE
BEVERLY, MA
Model VSHS36
System WQU 5

Design Ratio[1] = $\frac{\text{0.07 acres x 0.9}}{\text{27 ft3}}$ **= 0.002**

Rainfall Intensity "/hr	Flow Rate cfs	Operating Rate[2] cfs/ft^3	% Total Rainfall Depth[3]	Rmvl. Effcy[4] (%)	Rel. Effcy (%)
0.02	0.00	0.00005	10.2%	98.0%	10.0%
0.04	0.00	0.00010	9.6%	98.0%	9.5%
0.06	0.00	0.00014	9.4%	98.0%	9.3%
0.08	0.01	0.00019	7.7%	98.0%	7.6%
0.10	0.01	0.00024	8.6%	98.0%	8.4%
0.12	0.01	0.00029	6.3%	98.0%	6.2%
0.14	0.01	0.00033	4.7%	98.0%	4.6%
0.16	0.01	0.00038	4.6%	98.0%	4.5%
0.18	0.01	0.00043	3.5%	98.0%	3.5%
0.20	0.01	0.00048	4.3%	98.0%	4.3%
0.25	0.02	0.00059	8.0%	98.0%	7.8%
0.30	0.02	0.00071	5.6%	98.0%	5.5%
0.35	0.02	0.00083	4.4%	98.0%	4.3%
0.40	0.03	0.00095	2.5%	98.0%	2.5%
0.45	0.03	0.00107	2.5%	98.0%	2.5%
0.50	0.03	0.00119	1.4%	98.0%	1.4%
0.75	0.05	0.00178	5.0%	98.0%	4.9%
1.00	0.06	0.00238	1.0%	98.0%	1.0%
1.50	0.09	0.00357	0.0%	98.0%	0.0%
2.00	0.13	0.00475	0.0%	98.0%	0.0%
3.00	0.19	0.00713	0.5%	98.0%	0.5%
					98.0%
				% rain falling at >0"/hr =	0.0%
				Removal Efficiency Adjustment[4] =	6.5%
				Predicted Net Annual Load Removal Efficiency =	**91.5%**

1 - Design Ratio = (Total Drainage Area x Runoff Coefficient) / VortSentry HS Treatment Volume
= The Total Drainage Area and Runoff Coefficient are specified by the site engineer.
2 - Operating Rate (cfs/ft^3) = Rainfall Intensity ("/hr) x Design Ratio
3 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
4 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

Calculated by: CJA Date: 06/26/14 | Checked by: Date:

Project: Standley St Drainage
Location: Beverly, MA
Prepared For: Dave Farrar - Marchionda & Associates, LP

CONTECH ENGINEERED SOLUTIONS

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)
WQU 2	0.85	0.0013241	6.0	0.100	1.00
WQU 3	0.25	0.0003919	6.0	0.100	1.00
WQU 4	0.25	0.0003931	6.0	0.100	1.00
WQU 5	0.07	0.0001094	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 tc, read the unit peak discharge (qu) from Figure 1 or Table in Figure 2. qu is expressed in the following units: cfs/mi^2/watershed inches (csm/in).

Structure Name	qu (csm/in.)
WQU 2	774.00
WQU 3	774.00
WQU 4	774.00
WQU 5	774.00

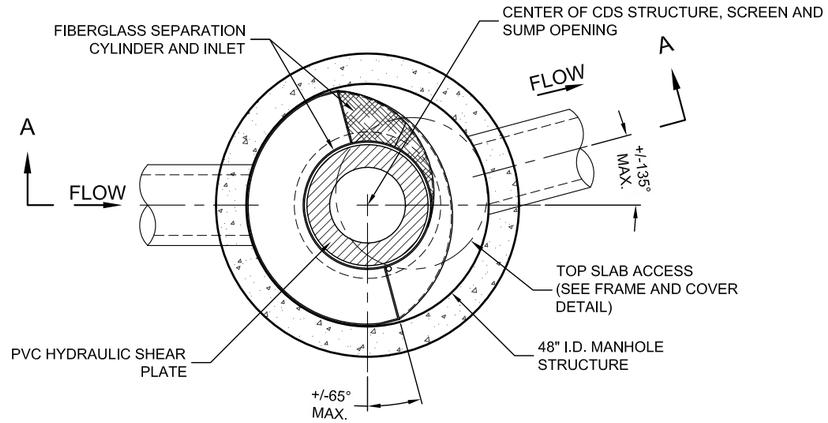
1. Compute Q Rate using the following equation:

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

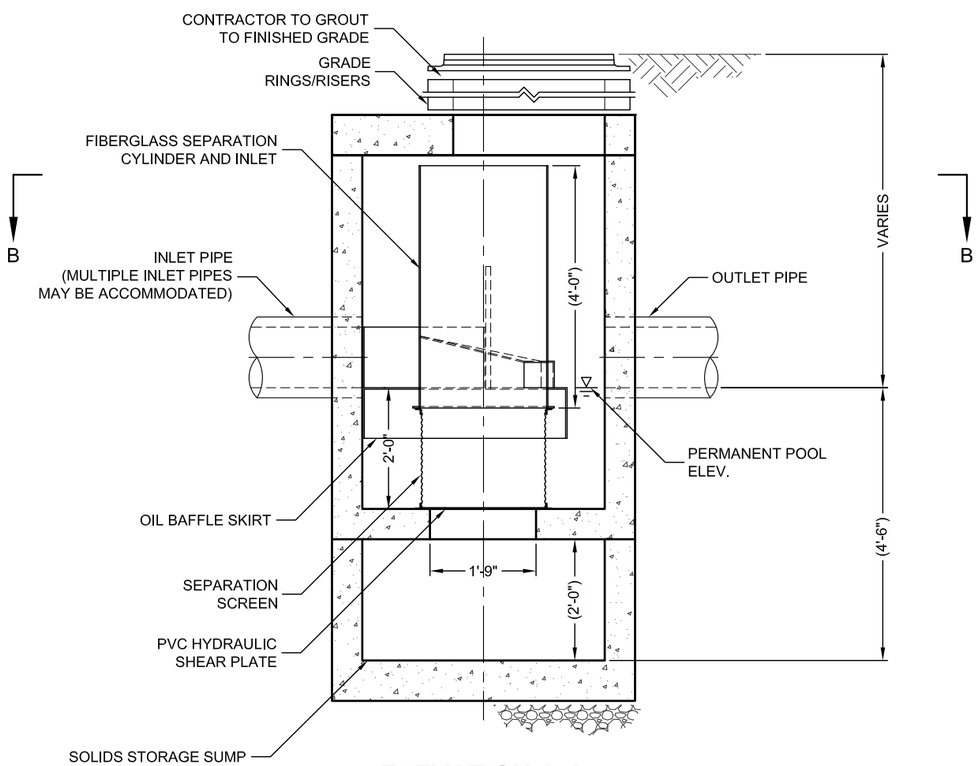
where:

Q_1 = flow fate 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)
WQU 2	1.02
WQU 3	0.30
WQU 4	0.30
WQU 5	0.08



PLAN VIEW B-B
N.T.S.



ELEVATION A-A
N.T.S.

THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 5,788,848; 6,641,720; 6,511,590; 6,581,783; RELATED FOREIGN PATENTS, OR OTHER PATENTS PENDING.

CDS2015-4-C DESIGN NOTES

CDS2015-4-C RATED TREATMENT CAPACITY IS 1.4 CFS, OR PER LOCAL REGULATIONS.

THE STANDARD CDS2015-4-C CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW. SOME CONFIGURATIONS MAY BE COMBINED TO SUIT SITE REQUIREMENTS.

CONFIGURATION DESCRIPTION
GRATED INLET ONLY (NO INLET PIPE)
GRATED INLET WITH INLET PIPE OR PIPES
CURB INLET ONLY (NO INLET PIPE)
CURB INLET WITH INLET PIPE OR PIPES

FRAME AND COVER
(DIAMETER VARIES)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID			
WATER QUALITY FLOW RATE (CFS)			*
PEAK FLOW RATE (CFS)			*
RETURN PERIOD OF PEAK FLOW (YRS)			*
SCREEN APERTURE (2400 OR 4700)			*
PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
INLET PIPE 2	*	*	*
OUTLET PIPE	*	*	*
RIM ELEVATION			*
ANTI-FLOTATION BALLAST	WIDTH	HEIGHT	
	*	*	

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES
1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHTS, PLEASE CONTACT YOUR CONTECH CONSTRUCTION PRODUCTS REPRESENTATIVE. www.contech-cpi.com
4. CDS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET AASHTO M306 LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.
6. PVC HYDRAULIC SHEAR PLATE IS PLACED ON SHELF AT BOTTOM OF SCREEN CYLINDER. REMOVE AND REPLACE AS NECESSARY DURING MAINTENANCE CLEANING.

INSTALLATION NOTES
1. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
2. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE CDS MANHOLE STRUCTURE (LIFTING CLUTCHES PROVIDED).
3. CONTRACTOR TO ADD JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS, AND ASSEMBLE STRUCTURE.
4. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
5. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH®
CONSTRUCTION PRODUCTS INC.
www.contech-cpi.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

CDS2015-4-C
CDS INLINE
STANDARD DETAIL

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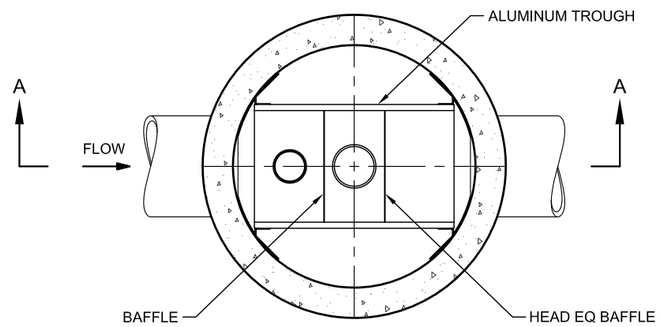
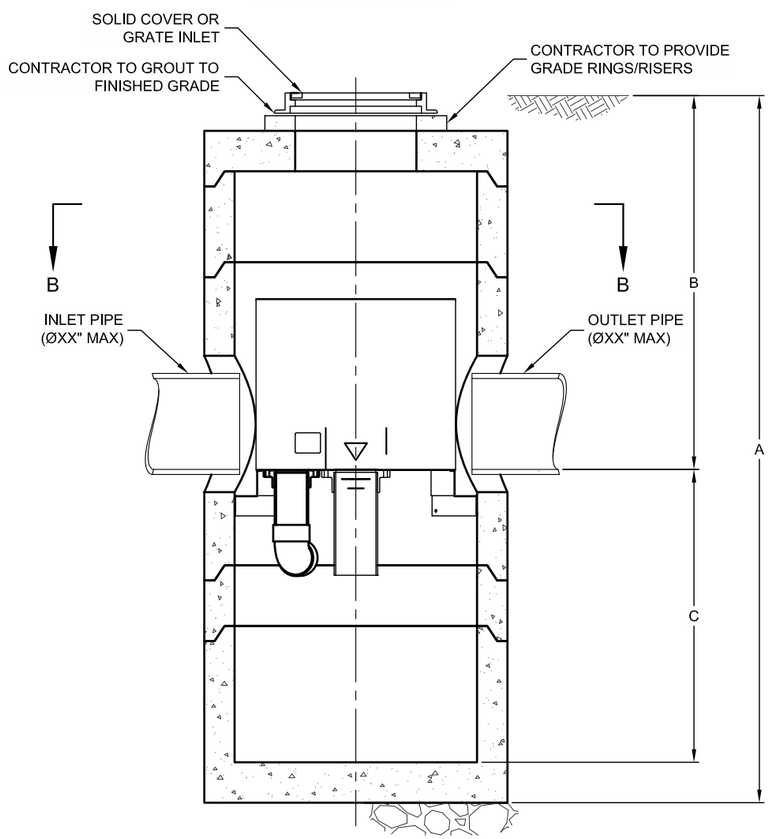


PLAN VIEW B-B



SECTION A-A

VortSentry®

THIS PRODUCT MAY BE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 6,991,114; 7,296,692; RELATED FOREIGN PATENTS, OR OTHER PATENTS PENDING.

VORTSENTRY HS DESIGN NOTES

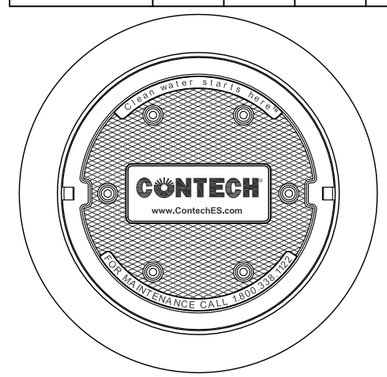
VSHS RATED TREATMENT CAPACITY IS SHOWN IN THE TABLE BELOW, OR PER LOCAL REGULATIONS. MAXIMUM HYDRAULIC INTERNAL BYPASS CAPACITY VARIES. CONTACT YOUR CONTECH REPRESENTATIVE FOR ADITIONAL INFORMATION.

THE STANDARD SOLID COVER CONFIGURATION IS SHOWN. ALTERNATE CONFIGURATIONS ARE AVAILABLE AND ARE LISTED BELOW.

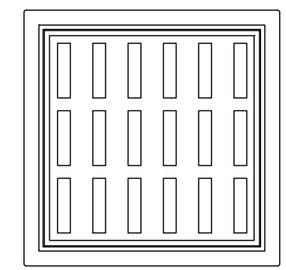
	CONFIGURATION OPTION DESCRIPTION
	GRATE INLET (NO INLET PIPE)
	GRATE INLET WITH INLET PIPE

VORTSENTRY HS GENERAL INFORMATION

Model	Manhole Diameter (ID)		Total Treatment Flow Rate		Typical Total Distance Rim to Outside Bottom A		Typical Distance Rim to Invert B		Typical Depth Below Invert (inside) C		Approximate Minimum Distance Rim to Invert		Maximum Pipe Diameter (ID)	
	FT	mm	CFS	L/S	FT	m	FT	m	FT	mm	FT	m	IN	mm
HS36	3	900	0.55	15.6	10.16	3.10	4.08	1.24	5.58	1702	3.00	0.91	18	450
HS48	4	1200	1.20	34.0	13.25	4.04	6.00	1.83	6.75	2057	4.00	1.22	24	600
HS60	5	1500	2.20	62.3	15.13	4.61	6.50	1.98	7.96	2426	4.82	1.47	30	750
HS72	6	1800	3.70	104.8	16.56	5.05	6.75	2.06	9.15	2788	5.59	1.70	36	900
HS84	7	2100	5.60	158.6	18.85	5.75	7.75	2.36	10.35	3156	5.00	1.52	42	1050
HS96	8	2400	8.10	229.4	20.87	6.36	8.50	2.59	11.54	3518	6.91	2.11	48	1200



FRAME AND COVER
(DIAMETER VARIES)
N.T.S.



FRAME AND GRATE
(24" SQUARE)
N.T.S.

SITE SPECIFIC DATA REQUIREMENTS

STRUCTURE ID	
WATER QUALITY FLOW RATE (CFS)	*
PEAK FLOW RATE (CFS)	*
RETURN PERIOD OF PEAK FLOW (YRS)	*

PIPE DATA:	I.E.	MATERIAL	DIAMETER
INLET PIPE 1	*	*	*
OUTLET PIPE	*	*	*

RIM ELEVATION	*

ANTI-FLOTATION BALLAST	WIDTH	HEIGHT
	*	*

NOTES/SPECIAL REQUIREMENTS:

* PER ENGINEER OF RECORD

GENERAL NOTES

1. CONTECH TO PROVIDE ALL MATERIALS UNLESS NOTED OTHERWISE.
2. DIMENSIONS MARKED WITH ( ) ARE REFERENCE DIMENSIONS. ACTUAL DIMENSIONS MAY VARY.
3. FOR FABRICATION DRAWINGS WITH DETAILED STRUCTURE DIMENSIONS AND WEIGHT, PLEASE CONTACT YOUR CONTECH ENGINEERED SOLUTIONS LLC REPRESENTATIVE. www.ContechES.com
4. VORTSENTRY HS WATER QUALITY STRUCTURE SHALL BE IN ACCORDANCE WITH ALL DESIGN DATA AND INFORMATION CONTAINED IN THIS DRAWING.
5. STRUCTURE SHALL MEET AASHTO HS20 AND CASTINGS SHALL MEET AASHTO M306 LOAD RATING, ASSUMING GROUNDWATER ELEVATION AT, OR BELOW, THE OUTLET PIPE INVERT ELEVATION. ENGINEER OF RECORD TO CONFIRM ACTUAL GROUNDWATER ELEVATION.

INSTALLATION NOTES

1. ANY SUB-BASE, BACKFILL DEPTH, AND/OR ANTI-FLOTATION PROVISIONS ARE SITE-SPECIFIC DESIGN CONSIDERATIONS AND SHALL BE SPECIFIED BY ENGINEER OF RECORD.
2. CONTRACTOR TO PROVIDE EQUIPMENT WITH SUFFICIENT LIFTING AND REACH CAPACITY TO LIFT AND SET THE VORTSENTRY HS MANHOLE STRUCTURE (LIFTING CLUTCHES PROVIDED).
3. CONTRACTOR TO INSTALL JOINT SEALANT BETWEEN ALL STRUCTURE SECTIONS AND ASSEMBLE STRUCTURE.
4. CONTRACTOR TO PROVIDE, INSTALL, AND GROUT PIPES. MATCH PIPE INVERTS WITH ELEVATIONS SHOWN.
5. CONTRACTOR TO TAKE APPROPRIATE MEASURES TO ASSURE UNIT IS WATER TIGHT, HOLDING WATER TO FLOWLINE INVERT MINIMUM. IT IS SUGGESTED THAT ALL JOINTS BELOW PIPE INVERTS ARE GROUTED.

CONTECH® ENGINEERED SOLUTIONS LLC
www.ContechES.com
9025 Centre Pointe Dr., Suite 400, West Chester, OH 45069
800-338-1122 513-645-7000 513-645-7993 FAX

VORTSENTRY HS
STANDARD DETAIL

I:\STORMWATER\COMMOPS\26 VORTSENTRY HS\40 STANDARD DRAWINGS\DWG\VSHS-DTL.DWG 5/16/2014 4:31 PM

Appendix 5

Soil Assessment Logs

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

STANDLEY STREET - BEVERLY

C. On-Site Review (continued)

Deep Observation Hole Number: TP #1 EL= 60.0 11/26/14

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0"-8"	A+B										
8"-120"	C	10YR 5/4				L.S.	50%	20%	GRAN	LOOSE	

Additional Notes:

OBS WATER @ 54" (EL= 55.5)

MOTTLES @ 36" (EL= 57.0)

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

STANDLEY STREET - BEVERLY

C. On-Site Review (continued)

Deep Observation Hole Number: TP 2 EL = 59.0

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0"-2"	A										
2"-16"	B										
16"-72"	C	5YR 4/3				L.S	50%		GRAN	LOOSE	

Additional Notes:

OBS WATER @ 54" (EL = 54.6)

MOTTLES @ 18" (EL = 57.5)

Commonwealth of Massachusetts
City/Town of
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

STANDLEY STREET - BEVERLY

C. On-Site Review (continued)

Deep Observation Hole Number: TP 3 EL= 58.9

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
NONE	A										
0"-72"	C	10YR 5/4				L.S.	50%		GRAN	LOOSE	

Additional Notes:

OBS WATER @ 48" (EL= 54.9)

MOTTLES @ 24" (EL= 56.9)

Commonwealth of Massachusetts
City/Town of
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

STANDLEY STREET - BEVERLY

C. On-Site Review (continued)

Deep Observation Hole Number: TP 4 EL: 59.0

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
NONE	A										
0"-72"	C	10YR 5/4				L.S.	50%		GRAN	LOOSE	

Additional Notes:

OBS WATER @ 36" (EL = 56.0)

MOTTLES @ 18" (EL = 57.5)

Commonwealth of Massachusetts
City/Town of
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

STANDLEY STREET - BEVERLY

C. On-Site Review (continued)

Deep Observation Hole Number: TP 5 EL: 63.5

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0"-20"	A+B										
20"-78"	C	10YR 5/4				L.S	5%	5%	GRAN	LOOSE	

Additional Notes:

NO OBS WATER (EL = 57.0)

NO APP MOTTLES

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

STANDLEY STREET - BEVERLY

C. On-Site Review (continued)

Deep Observation Hole Number: TP 6 EL= 59.6

Depth (in.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0"-24"	FILL										
24"-42"	A+B										
42"-96"	C	10YR 5/4				L.S.	50%		GRAN	LOOSE	

Additional Notes:

OBS WATER @ 60" (EL= 54.6)

MOTTLES @ 42" (EL= 56.1)