TOWN OF DURHAM
STORMWATER MANAGEMENT PLAN

TOOMERFS, LLC
19 MAIN STREET and 21 MAIN STREET
TAX MAP 5, LOTS 1-9, 1-10, 1-15, and 1-16
Durham, New Hampshire

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TOWN OF DURHAM
STORMWATER MANAGEMENT PLAN
FOR
TOOMERFS, LLC

19 MAIN STREET and 21 MAIN STREET
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DURHAM, NEW HAMPSHIRE

FEBRUARY 2022

Project Number 20601

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SECTION 1.0 PROJECT INFORMATION NARRATIVE

1.1 Project Narrative

1.1.1 Project summary

Toomerfs, LLC intents to develop a parking facility at 19 and 21 Main Street, in Durham, New Hampshire, on Tax Map 5, Lots 1-9, 1-10, 1-15, and 1-16. The parking facility will serve the apartments at the front of the site, as well as providing needed extra parking capacity for the Main Street area. Additionally, the driveway to the site will be reconstructed to improve clearances to the existing buildings.

The parking area will be constructed on a filled pad, on the south end of the site. Fill and grading for subgrade preparation will be required to complete the pad improvements. Stormwater from the parking area will be directed via sheet flow to grass swales leading to catch basins feeding two underground ADS Stormtech chamber system within the fill area. The chambers will allow infiltration into the fill area and to native ground. An overflow structure is provided to control flow rates for larger storm events.

Table 1 shows the 1-inch storm; 2, 10, 25, 50, and 100 year peak flow rate comparison at the discharge points.

Peak flow [cubic feet per second]									
	1 inch			2 year			10 year		
	pre	post	diff	pre	post	diff	pre	post	diff
Dp-1	0.01	0.00	-0.01	2.35	2.00	-0.35	5.54	4.48	-1.06
Dp-2	0.15	0.11	-0.04	0.70	0.60	-0.10	1.11	0.99	-0.12
	25 year			50 year			100 year		
	pre	post	diff	pre	post	diff	pre	post	diff
Dp-1	8.33	7.32	-1.01	11.06	9.76	-1.30	14.39	12.89	-1.50
Dp-2	1.43	1.28	-0.15	1.72	1.56	-0.16	2.08	1.89	-0.19

Table 1: Peak flow rate during selected design storms

Impacts to watershed water quality from grading within the watersheds would be likely to occur from uncontrolled discharge of site runoff during construction activities and stabilized post-project surfaces. To minimize the impacts to the watersheds, the site has been designed to cause no increase in runoff and erosion control methods have been sized in accordance with the Env-Wq 1500 and the *New Hampshire Stormwater Management Manual* (December, 2008).

1.1.2 Existing site conditions

The proposed work is located on the south side of Main Street approximately 0.10 miles east of the intersection of Newmarket Road. The primary project site is located behind existing residential apartments.

The project site currently consists of forest sloping to the south down to College Brook. The upper portion of the site includes four residences, a garage, and 43 paved parking spaces.

There are existing no delineated wetlands located with the project disturbance area, and no wetland impacts are proposed as part of this project. Wetland exists in the extreme south of the property; buffer areas are to be maintained to the wetlands.

1.1.3 Proposed site conditions and disturbances

The project proposes the removal of an existing structure, reconstruction of the site's driveway, and construction of a 121-space parking lot. To create the relatively level area required for the parking lot, an engineered concrete block retaining wall will be constructed, and significant quantities of engineered fill will be imported to the site. An underground chamber system is proposed to detain and infiltrate stormwater from the site. In the immediate vicinity of the chamber system, the imported fill will be design to produce a hydraulic conductivity matching the underlying soils.

The impacts to water quality during site development will be minimized using erosion control measures. Frequent site inspections during construction are required during or directly following rainfall events to ensure erosion control devices are working properly. A copy of the Stormwater Inspection and Maintenance Manual can be found in section 2.6 of this report.

1.1.4 Rainfall data

Using SCS TR-20, run under HydroCAD Version 10.0 with Type III-24 hour rainfall events, pre- and post-development cover types and drainage paths were modeled to generate peak discharge rates. Rainfall events modeled have intensities described by data provided by the Northeast Regional Climate Center for the geographic location of the project. These data are provided in full in section 1.3 of this report, and are summarized below in Table 2.

Storm event	Depth (inches)
1-Inch	1.00
2-Year	3.14
10-Year	4.76
25-Year	6.03
50-Year	7.22
100-Year	8.64

Table 2: 24-h storm events for project site (data from NRCC)

1.1.5 Peak runoff control requirement

Town of Durham Site Design Standards require that measures be taken to control the post-development peak rate runoff so that it does not exceed pre-development runoff for the 2-year, 10-year, and 17-year[a], 24-hour storm events. Due to the post-project grading of the site and changes in land cover, stormwater devices were used to attenuate flow in order to meet these Peak Runoff Control requirements. Table 3 summarizes the stormwater runoff peak flow rate for the 1 inch, 2-, 10-, and 25-year storm events. Additionally, for reference we are providing a comparison of the 50- and 100-year storm events in the table.

a Understood to be a typo, and the 25-year event is intended

Peak flow [cubic feet per second]									
	1 inch			2 year			10 year		
	pre	post	diff	pre	post	diff	pre	post	diff
Dp-1	0.01	0.00	-0.01	2.35	2.00	-0.35	5.54	4.48	-1.06
Dp-2	0.15	0.11	-0.04	0.70	0.60	-0.10	1.11	0.99	-0.12
	25 year			50 year			100 year		
	pre	post	diff	pre	post	diff	pre	post	diff
Dp-1	8.33	7.32	-1.01	11.06	9.76	-1.30	14.39	12.89	-1.50
Dp-2	1.43	1.28	-0.15	1.72	1.56	-0.16	2.08	1.89	-0.19

Table 3: Reprint of peak flow rate during selected design storms

1.1.6 Runoff volume requirement

Town of Durham Site Design Standards require that measures be taken to control the post-development peak rate runoff so that it does not exceed pre-development runoff for the 2-year, 10-year, and 17-year[a], 24-hour storm events. Additionally, shown in the table for reference, are the 50 and 100 year storm events. Receiving waters and downstream wetland channels must be protected from erosion and sedimentation resulting from the project development. Table 4 summarizes the flow volume data. The overall runoff from the site does not increase in most storm events, and the model shows a small increase in larger storms (about 1-2% increase of the pre-development runoff).

Total runoff [cubic feet]									
	1 inch			2 year			10 year		
	pre	post	diff	pre	post	diff	pre	post	diff
Dp-1	169	36	-133	9325	8264	-1061	20671	20897	226
Dp-2	465	334	-131	2297	1906	-391	3762	3204	-558
Total	634	370	-264	11622	10170	-1452	24433	24101	-332
	25 year			50 year			100 year		
	pre	post	diff	pre	post	diff	pre	post	diff
Dp-1	30736	31741	1005	40727	42350	1623	53131	55364	2233
Dp-2	4921	4238	-683	6012	5213	-799	7316	6381	-935
Total	35657	35979	322	46739	47563	824	60447	61745	1298

Table 4: Runoff volumes during selected design storms

a Understood to be a typo, and the 25-year event is intended

1.1.7 Infiltration volume requirement

Town of Durham Site Design Standards require that a portion of the stormwater runoff be infiltrated to protect groundwater resources. The amount of groundwater recharge required per soil group, as a ratio of the Water Quality Volume is summarized in Section 2.1. To provide stormwater management an infiltrating underground chamber systems are proposed, providing a combined 4 447 cubic feet of storage below the lowest outlet, equivalent to the full water quality volume for the area draining to the structure, for groundwater recharge through infiltration. The required recharge volume by Durham is 1 905 cubic feet. For more information see section 2.1.

1.2 NRCS Soils Information (SSURGO data)

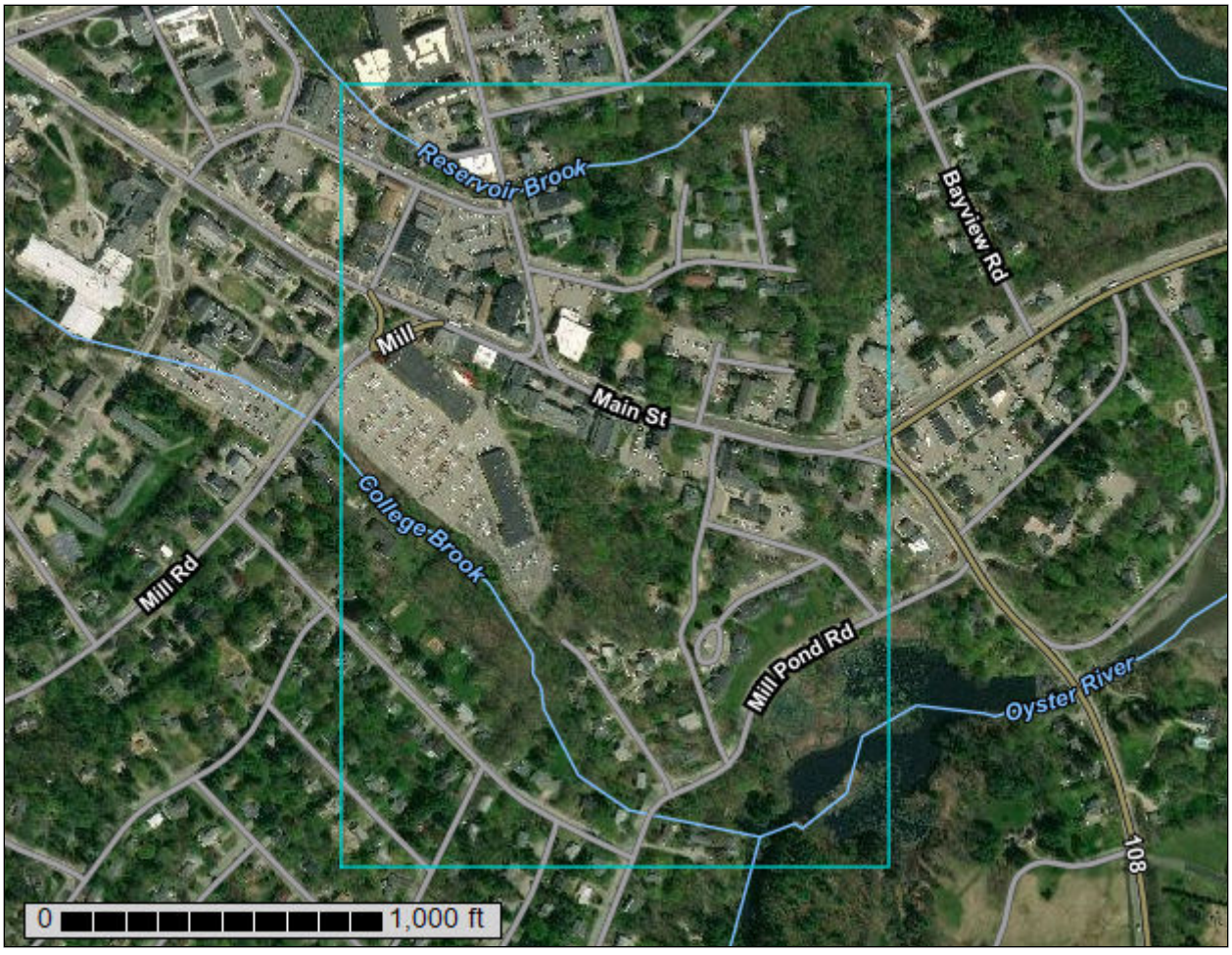
United States Department of Agriculture

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 Strafford County, New Hampshire



October 20, 2020

Preface

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

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

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

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

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

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

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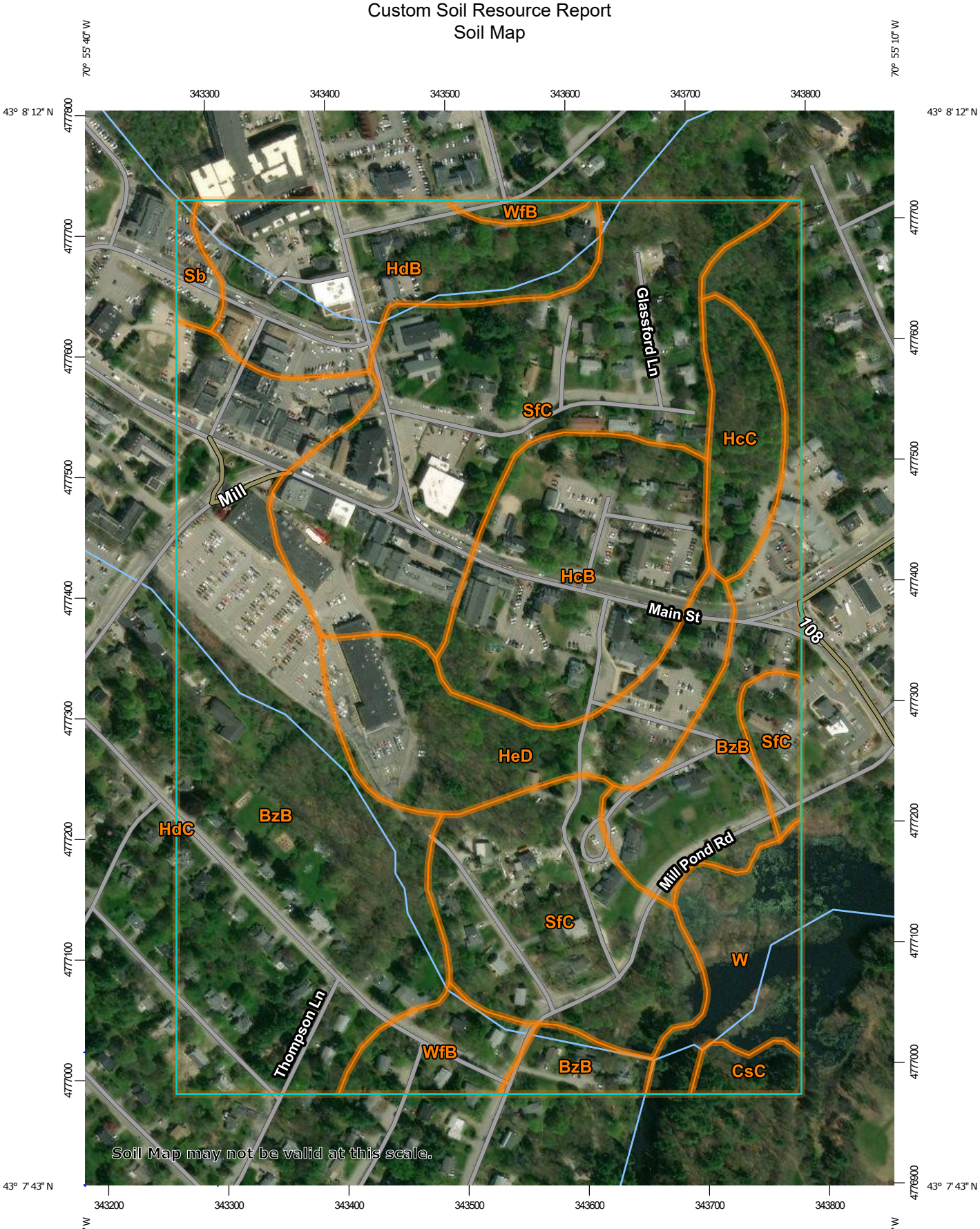
Contents

Soil Map

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

Custom Soil Resource Report
Soil Map



Map Scale: 1:4,340 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

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 1:20,000.

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

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

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

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

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

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

Soil Survey Area: Strafford County, New Hampshire
Survey Area Data: Version 20, May 29, 2020

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

Date(s) aerial images were photographed: Dec 31, 2009—Sep 9, 2017

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
BzB	Buxton silt loam, 3 to 8 percent slopes	31.7	33.2%
CsC	Charlton fine sandy loam, 8 to 15 percent slopes, very stony	0.8	0.9%
HcB	Hollis-Charlton fine sandy loams, 3 to 8 percent slopes	10.0	10.5%
HcC	Hollis-Charlton fine sandy loams, 8 to 15 percent slopes	3.0	3.1%
HdB	Hollis-Charlton very rocky fine sandy loams, 3 to 8 percent slopes	8.2	8.5%
HdC	Hollis-Charlton very rocky fine sandy loams, 8 to 15 percent slopes	0.0	0.0%
HeD	Hollis-Charlton extremely rocky fine sandy loams, 8 to 25 percent slopes	7.5	7.8%
Sb	Saugatuck loamy sand	0.7	0.7%
SfC	Suffield silt loam, 8 to 15 percent slopes	26.9	28.1%
W	Water	4.1	4.3%
WfB	Windsor loamy fine sand, clay subsoil variant, 0 to 8 percent slopes	2.7	2.8%
Totals for Area of Interest		**95.6**	**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.

Strafford County, New Hampshire

BzB—Buxton silt loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 9d6p
Elevation: 0 to 260 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

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

Description of Buxton

Setting

Parent material: Glaciomarine

Typical profile

H1 - 0 to 10 inches: silt loam
H2 - 10 to 28 inches: silty clay loam
H3 - 28 to 43 inches: silty clay

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 12 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C/D
Ecological site: F145XY006CT - Semi-Rich Moist Lake Plain
Hydric soil rating: No

Minor Components

Elmwood

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

Not named

Percent of map unit: 5 percent
Hydric soil rating: No

CsC—Charlton fine sandy loam, 8 to 15 percent slopes, very stony

Map Unit Setting

National map unit symbol: 2wh0p
Elevation: 0 to 1,570 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: Not prime farmland

Map Unit Composition

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

Description of Charlton, Very Stony

Setting

Landform: Hills, ground moraines, ridges
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Crest, side slope
Down-slope shape: Linear, convex
Across-slope shape: Convex
Parent material: Coarse-loamy melt-out till derived from granite, gneiss, and/or schist

Typical profile

Oe - 0 to 2 inches: moderately decomposed plant material
A - 2 to 4 inches: fine sandy loam
Bw - 4 to 27 inches: gravelly fine sandy loam
C - 27 to 65 inches: gravelly fine sandy loam

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water capacity: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: B

Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Sutton, very stony
Percent of map unit: 5 percent
Landform: Hills, ground moraines
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Linear
Hydric soil rating: No

Paxton, very stony
Percent of map unit: 5 percent
Landform: Drumlins, hills, ground moraines
Landform position (two-dimensional): Shoulder, summit, backslope
Landform position (three-dimensional): Side slope, crest
Down-slope shape: Linear, convex
Across-slope shape: Convex
Hydric soil rating: No

Chatfield, very stony
Percent of map unit: 3 percent
Landform: Hills, ridges
Landform position (two-dimensional): Summit, backslope, shoulder
Landform position (three-dimensional): Crest, side slope, nose slope
Down-slope shape: Convex
Across-slope shape: Linear, convex
Hydric soil rating: No

Leicester, very stony
Percent of map unit: 2 percent
Landform: Drainageways, ground moraines, hills, depressions
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear, concave
Across-slope shape: Concave
Hydric soil rating: Yes

HcB—Hollis-Charlton fine sandy loams, 3 to 8 percent slopes

Map Unit Setting
National map unit symbol: 9d7j
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: 120 to 240 days
Farmland classification: Farmland of local importance

Map Unit Composition

Hollis and similar soils: 55 percent
Charlton and similar soils: 35 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hollis

Setting

Parent material: Till

Typical profile

H1 - 0 to 14 inches: fine sandy loam
H2 - 14 to 18 inches: bedrock

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Charlton

Setting

Parent material: Till

Typical profile

H1 - 0 to 13 inches: fine sandy loam
H2 - 13 to 36 inches: fine sandy loam
H3 - 36 to 40 inches: gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Not named

Percent of map unit: 5 percent
Hydric soil rating: No

Buxton

Percent of map unit: 5 percent
Hydric soil rating: No

HcC—Hollis-Charlton fine sandy loams, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 9d7k
Elevation: 0 to 1,080 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 120 to 240 days
Farmland classification: Farmland of local importance

Map Unit Composition

Hollis and similar soils: 55 percent
Charlton and similar soils: 35 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hollis

Setting

Parent material: Till

Typical profile

H1 - 0 to 14 inches: fine sandy loam
H2 - 14 to 18 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Charlton

Setting

Parent material: Till

Typical profile

H1 - 0 to 13 inches: fine sandy loam
H2 - 13 to 36 inches: fine sandy loam
H3 - 36 to 40 inches: gravelly loamy sand

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Not named

Percent of map unit: 5 percent
Hydric soil rating: No

Buxton

Percent of map unit: 5 percent
Hydric soil rating: No

HdB—Hollis-Charlton very rocky fine sandy loams, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 9d7m
Elevation: 0 to 1,000 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 120 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Hollis and similar soils: 40 percent
Charlton and similar soils: 30 percent
Minor components: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hollis

Setting

Parent material: Till

Typical profile

H1 - 0 to 14 inches: very stony fine sandy loam
H2 - 14 to 18 inches: bedrock

Properties and qualities

Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Charlton

Setting

Parent material: Till

Typical profile

H1 - 0 to 13 inches: very stony fine sandy loam
H2 - 13 to 36 inches: fine sandy loam
H3 - 36 to 40 inches: gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Rock outcrop

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

Not named

Percent of map unit: 5 percent
Hydric soil rating: No

Sutton

Percent of map unit: 5 percent
Hydric soil rating: No

Buxton

Percent of map unit: 5 percent
Hydric soil rating: No

Leicester

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

HdC—Hollis-Charlton very rocky fine sandy loams, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 9d7n
Elevation: 0 to 1,200 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 120 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Hollis and similar soils: 40 percent
Charlton and similar soils: 30 percent
Minor components: 30 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hollis

Setting

Parent material: Till

Typical profile

H1 - 0 to 14 inches: very stony fine sandy loam
H2 - 14 to 18 inches: bedrock

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Charlton

Setting

Parent material: Till

Typical profile

H1 - 0 to 13 inches: very stony fine sandy loam
H2 - 13 to 36 inches: fine sandy loam
H3 - 36 to 40 inches: gravelly loamy sand

Properties and qualities

Slope: 8 to 15 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Rock outcrop

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

Not named

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

Woodbridge

Percent of map unit: 5 percent
Hydric soil rating: No

Sutton

Percent of map unit: 5 percent
Hydric soil rating: No

HeD—Hollis-Charlton extremely rocky fine sandy loams, 8 to 25 percent slopes

Map Unit Setting

National map unit symbol: 9d7q
Elevation: 0 to 1,180 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 120 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Hollis and similar soils: 30 percent
Charlton and similar soils: 25 percent
Minor components: 45 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hollis

Setting

Parent material: Till

Typical profile

H1 - 0 to 14 inches: extremely stony fine sandy loam
H2 - 14 to 18 inches: bedrock

Properties and qualities

Slope: 8 to 25 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Drainage class: Well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 2.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: D
Ecological site: F144AY033MA - Shallow Dry Till Uplands
Hydric soil rating: No

Description of Charlton

Setting

Parent material: Till

Typical profile

H1 - 0 to 13 inches: extremely stony fine sandy loam
H2 - 13 to 36 inches: fine sandy loam
H3 - 36 to 40 inches: gravelly loamy sand

Properties and qualities

Slope: 8 to 25 percent
Surface area covered with cobbles, stones or boulders: 1.6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F144AY034CT - Well Drained Till Uplands
Hydric soil rating: No

Minor Components

Rock outcrop

Percent of map unit: 25 percent
Hydric soil rating: No

Not named

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

Leicester

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

Sutton

Percent of map unit: 5 percent
Hydric soil rating: No

Sb—Saugatuck loamy sand

Map Unit Setting

National map unit symbol: 9d8r
Elevation: 300 to 1,000 feet
Mean annual precipitation: 27 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 125 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Saugatuck

Setting

Landform: Outwash terraces
Parent material: Outwash

Typical profile

H1 - 0 to 4 inches: loamy sand
H2 - 4 to 7 inches: sand
H3 - 7 to 26 inches: loamy sand
H4 - 26 to 42 inches: sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 10 to 16 inches to undefined
Drainage class: Poorly drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Very low (about 1.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: B/D
Hydric soil rating: Yes

Minor Components

Not named wet

Percent of map unit: 15 percent

Landform: Outwash terraces
Hydric soil rating: Yes

SfC—Suffield silt loam, 8 to 15 percent slopes

Map Unit Setting

National map unit symbol: 9d8v
Elevation: 0 to 250 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 statewide importance

Map Unit Composition

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

Description of Suffield

Typical profile

H1 - 0 to 19 inches: silt loam
H2 - 19 to 28 inches: silt loam
H3 - 28 to 41 inches: silty clay

Properties and qualities

Slope: 8 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: C
Ecological site: F144AY017NH - Well Drained Lake Plain
Hydric soil rating: No

Minor Components

Not named

Percent of map unit: 9 percent
Hydric soil rating: No

Buxton
Percent of map unit: 5 percent
Hydric soil rating: No

Rock outcrop
Percent of map unit: 1 percent
Hydric soil rating: No

W—Water

Map Unit Composition
Water (less than 40 acres): 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

WfB—Windsor loamy fine sand, clay subsoil variant, 0 to 8 percent slopes

Map Unit Setting
National map unit symbol: 9d9b
Elevation: 0 to 280 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
Windsor variant and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Windsor Variant

Typical profile
H1 - 0 to 26 inches: loamy fine sand
H2 - 26 to 30 inches: loamy sand
H3 - 30 to 42 inches: silt loam

Properties and qualities
Slope: 0 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: About 24 to 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Low (about 5.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Ecological site: F144AY022MA - Dry Outwash
Hydric soil rating: No

Minor Components

Not named

Percent of map unit: 15 percent
Hydric soil rating: No

Soil Information for All Uses

Soil Properties and Qualities

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

Soil Qualities and Features

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

Hydrologic Soil Group

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

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

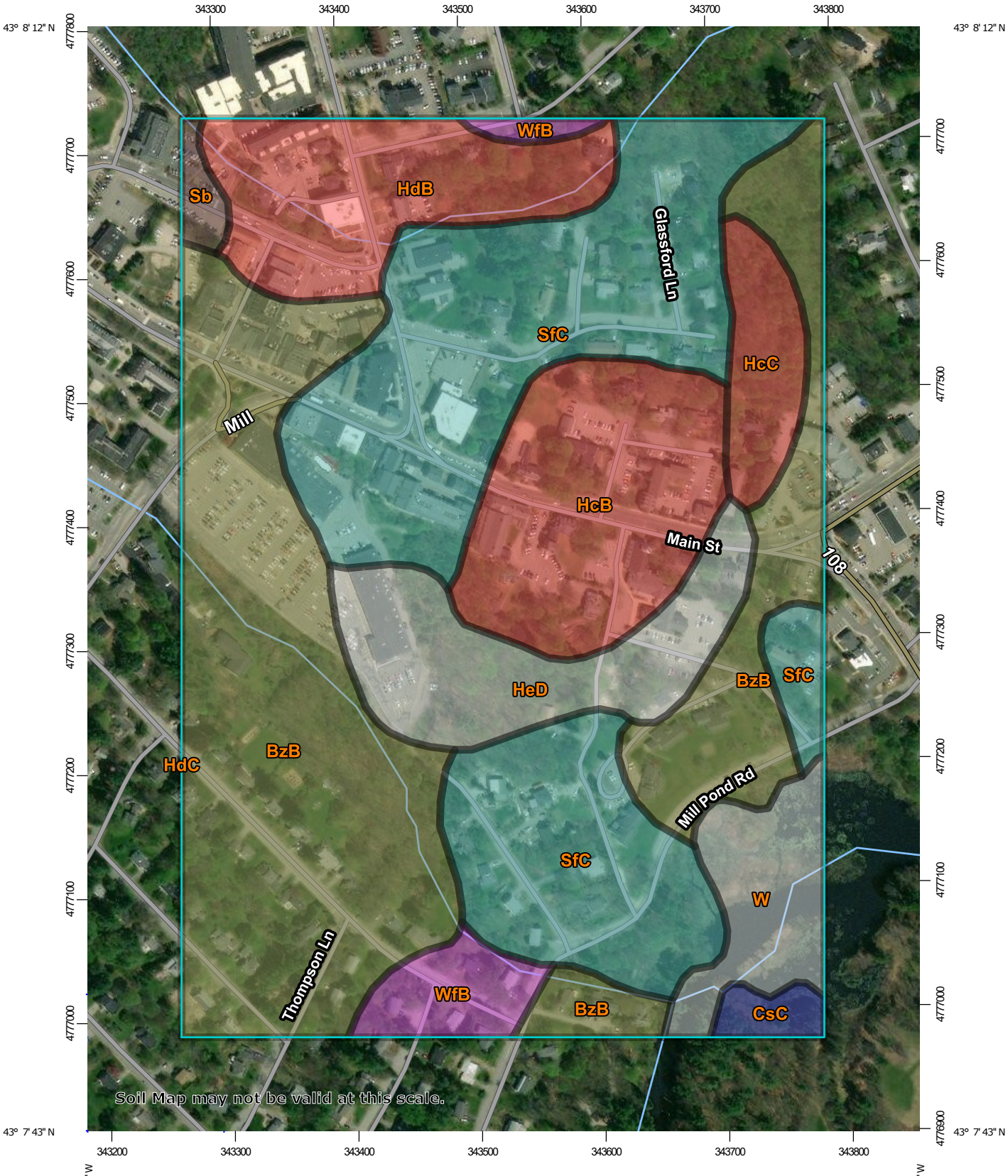
Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

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

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

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

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



Map Scale: 1:4,340 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 200 400 800 1200

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 1:20,000.

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

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

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

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

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

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

Soil Survey Area: Strafford County, New Hampshire
Survey Area Data: Version 20, May 29, 2020

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

Date(s) aerial images were photographed: Dec 31, 2009—Sep 9, 2017

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

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BzB	Buxton silt loam, 3 to 8 percent slopes	C/D	31.7	33.2%
CsC	Charlton fine sandy loam, 8 to 15 percent slopes, very stony	B	0.8	0.9%
HcB	Hollis-Charlton fine sandy loams, 3 to 8 percent slopes	D	10.0	10.5%
HcC	Hollis-Charlton fine sandy loams, 8 to 15 percent slopes	D	3.0	3.1%
HdB	Hollis-Charlton very rocky fine sandy loams, 3 to 8 percent slopes	D	8.2	8.5%
HdC	Hollis-Charlton very rocky fine sandy loams, 8 to 15 percent slopes	D	0.0	0.0%
HeD	Hollis-Charlton extremely rocky fine sandy loams, 8 to 25 percent slopes		7.5	7.8%
Sb	Saugatuck loamy sand	B/D	0.7	0.7%
SfC	Suffield silt loam, 8 to 15 percent slopes	C	26.9	28.1%
W	Water		4.1	4.3%
WfB	Windsor loamy fine sand, clay subsoil variant, 0 to 8 percent slopes	A	2.7	2.8%
Totals for Area of Interest			**95.6**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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1.3 Extreme precipitation tables (Northeast Regional Climate Center)

Extreme Precipitation Tables

Northeast Regional Climate Center

Data represents point estimates calculated from partial duration series. All precipitation amounts are displayed in inches.

Smoothing	No
State	New Hampshire
Location	
Longitude	70.923 degrees West
Latitude	43.133 degrees North
Elevation	0 feet
Date/Time	Tue, 20 Oct 2020 14:53:49 -0400

Extreme Precipitation Estimates

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.26	0.40	0.49	0.66	0.81	1.00	**1yr**	0.70	0.98	1.13	1.59	2.03	2.61	2.84	**1yr**	2.31	2.74	3.14	3.86	4.44	**1yr**
2yr	0.32	0.49	0.61	0.82	1.01	1.19	**2yr**	0.88	1.17	1.39	1.86	2.41	3.14	3.48	**2yr**	2.78	3.34	3.84	4.57	5.21	**2yr**
5yr	0.37	0.57	0.70	0.96	1.23	1.48	**5yr**	1.06	1.44	1.72	2.32	2.96	3.98	4.46	**5yr**	3.52	4.29	4.90	5.79	6.55	**5yr**
10yr	0.41	0.63	0.78	1.10	1.42	1.73	**10yr**	1.22	1.69	2.02	2.73	3.46	4.76	5.39	**10yr**	4.21	5.18	5.90	6.92	7.80	**10yr**
25yr	0.48	0.74	0.91	1.31	1.72	2.14	**25yr**	1.48	2.09	2.51	3.40	4.26	6.03	6.91	**25yr**	5.34	6.65	7.53	8.78	9.83	**25yr**
50yr	0.54	0.83	1.03	1.48	2.00	2.51	**50yr**	1.72	2.46	2.96	4.01	4.99	7.22	8.36	**50yr**	6.39	8.04	9.06	10.51	11.72	**50yr**
100yr	0.62	0.93	1.17	1.69	2.32	2.95	**100yr**	2.00	2.89	3.48	4.73	5.84	8.64	10.11	**100yr**	7.65	9.72	10.91	12.58	13.97	**100yr**
200yr	0.70	1.05	1.33	1.93	2.69	3.48	**200yr**	2.32	3.40	4.10	5.59	6.84	10.36	12.22	**200yr**	9.16	11.75	13.14	15.07	16.66	**200yr**
500yr	0.83	1.24	1.59	2.31	3.29	4.31	**500yr**	2.84	4.22	5.10	6.97	8.45	13.16	15.72	**500yr**	11.64	15.12	16.81	19.15	21.05	**500yr**

Lower Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.24	0.37	0.45	0.60	0.74	0.90	**1yr**	0.64	0.88	0.91	1.26	1.56	2.02	2.52	**1yr**	1.79	2.42	2.93	3.27	4.01	**1yr**
2yr	0.31	0.49	0.60	0.81	1.00	1.18	**2yr**	0.86	1.16	1.37	1.83	2.36	3.04	3.39	**2yr**	2.69	3.26	3.74	4.46	5.05	**2yr**
5yr	0.35	0.54	0.67	0.92	1.16	1.40	**5yr**	1.01	1.37	1.62	2.15	2.78	3.72	4.14	**5yr**	3.29	3.98	4.59	5.43	6.14	**5yr**
10yr	0.38	0.59	0.73	1.02	1.32	1.60	**10yr**	1.14	1.57	1.82	2.45	3.13	4.30	4.82	**10yr**	3.80	4.63	5.34	6.30	7.08	**10yr**
25yr	0.44	0.67	0.83	1.18	1.56	1.91	**25yr**	1.35	1.87	2.11	2.85	3.66	5.03	5.87	**25yr**	4.45	5.65	6.54	7.68	8.56	**25yr**
50yr	0.48	0.74	0.92	1.32	1.77	2.19	**50yr**	1.53	2.14	2.36	3.20	4.11	5.77	6.81	**50yr**	5.11	6.55	7.63	8.92	9.87	**50yr**
100yr	0.54	0.82	1.02	1.48	2.03	2.51	**100yr**	1.75	2.45	2.64	3.59	4.60	6.60	7.89	**100yr**	5.84	7.59	8.91	10.35	11.35	**100yr**
200yr	0.60	0.90	1.15	1.66	2.31	2.87	**200yr**	2.00	2.80	2.94	4.01	5.14	7.55	9.15	**200yr**	6.68	8.80	10.41	12.02	13.08	**200yr**
500yr	0.70	1.05	1.34	1.95	2.78	3.45	**500yr**	2.40	3.37	3.42	4.65	5.98	8.99	11.12	**500yr**	7.95	10.69	12.80	14.67	15.72	**500yr**

Upper Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.28	0.43	0.53	0.71	0.87	1.08	**1yr**	0.75	1.05	1.24	1.75	2.22	2.84	3.03	**1yr**	2.51	2.91	3.38	4.18	4.78	**1yr**
2yr	0.33	0.51	0.62	0.84	1.04	1.25	**2yr**	0.90	1.22	1.48	1.95	2.50	3.26	3.58	**2yr**	2.88	3.44	3.95	4.71	5.40	**2yr**
5yr	0.39	0.60	0.75	1.03	1.31	1.58	**5yr**	1.13	1.55	1.85	2.50	3.19	4.23	4.77	**5yr**	3.74	4.59	5.22	6.16	6.93	**5yr**
10yr	0.46	0.70	0.87	1.21	1.57	1.92	**10yr**	1.35	1.88	2.23	3.04	3.84	5.21	5.94	**10yr**	4.61	5.71	6.48	7.56	8.45	**10yr**
25yr	0.55	0.84	1.05	1.50	1.97	2.48	**25yr**	1.70	2.42	2.87	3.96	4.93	7.05	7.95	**25yr**	6.24	7.65	8.59	9.94	11.01	**25yr**
50yr	0.64	0.97	1.21	1.74	2.34	2.99	**50yr**	2.02	2.92	3.48	4.83	5.99	8.73	9.93	**50yr**	7.73	9.55	10.65	12.21	13.47	**50yr**
100yr	0.74	1.12	1.41	2.03	2.79	3.61	**100yr**	2.40	3.53	4.23	5.91	7.27	10.81	12.40	**100yr**	9.57	11.92	13.19	15.02	16.48	**100yr**
200yr	0.86	1.29	1.64	2.37	3.31	4.38	**200yr**	2.86	4.28	5.14	7.23	8.81	13.43	15.50	**200yr**	11.88	14.91	16.34	18.47	20.19	**200yr**
500yr	1.05	1.56	2.01	2.92	4.15	5.63	**500yr**	3.58	5.50	6.63	9.47	11.40	17.92	20.82	**500yr**	15.86	20.02	21.69	24.30	26.43	**500yr**

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SECTION 2.0 DRAINAGE CALCULATIONS, ANALYSIS, & DESIGN

2.1 Infiltration Volume Calculations

GENERAL CALCULATIONS - WQV and WQF
(optional worksheet)

This worksheet may be useful when designing a BMP **that does not fit into one of the specific worksheets already provided** (i.e. for a technology which is not a stormwater wetland, infiltration practice, etc.)

Water Quality Volume (WQV)

2.97	ac	A = Area draining to the practice
1.37	ac	A_I = Impervious area draining to the practice
0.46	decimal	I = Percent impervious area draining to the practice, in decimal form
0.47	unitless	Rv = Runoff coefficient = 0.05 + (0.9 x I)
1.38	ac-in	WQV= 1" x Rv x A
5 015	cf	WQV conversion (ac-in x 43,560 sf/ac x 1ft/12")

Water Quality Flow (WQF)

1	inches	P = Amount of rainfall. For WQF in NH, P = 1".
0.47	inches	Q = Water quality depth. Q = WQV/A
93	unitless	CN = Unit peak discharge curve number. $CN = 1000/(10+5P+10Q-10*[Q^2 + 1.25*Q*P]^{0.5})$
0.7	inches	S = Potential maximum retention. S = (1000/CN) - 10
0.144	inches	Ia = Initial abstraction. Ia = 0.2S
	minutes	T_c = Time of Concentration
	$cfs/mi^2/in$	q_u is the unit peak discharge. Obtain this value from TR-55 exhibits 4-II and 4-III.
-	cfs	WQF = q_u x WQV. Conversion: to convert "$cfs/mi^2/in$ * ac-in" to "cfs" multiply by $1mi^2/640ac$.

Designer's Notes: This sheet is being used to calculate the Water Quality Volume for the entire drainage area of the project. This value is used in support of Town of Durham infiltration requirements.

The Town requires volume be infiltrated based on a ratio per Hydrologic Soil Group disturbed. This requirement was interpreted to relate to net impervious surface, and an average volume ratio was calculated for the project site as follows:

HSG A	Ratio: 1.00	Net Impervious: 0.000 acre
HSG B	Ratio: 0.75	Net Impervious: 0.21 acre
HSG C	Ratio: 0.40	Net Impervious: 0.59 acre
HSG D	Ratio: 0.16	Net Impervious: -0.06 acre

Overall net impervious area: 0.74 acre

Weighted average for site: 0.38

Site overall WQV: 5015 cf

Required infiltration volume: 0.54 x 5,015 cf = 1,905 cf

Provided infiltration volume: 4,447 cf

INFILTRATION PRACTICE CRITERIA
(Env-Wq 1508.06)

Type/Node Name: **MC-3500 #2 (MC1) Underground Stormtech Chamber System**

Enter the type of infiltration practice (e.g., basin, trench) and the node name in the drainage analysis, if applicable.

YES		Have you reviewed Env-Wq 1508.06(a) to ensure that infiltration is allowed?	← **yes**
0.50	ac	A = Area draining to the practice	
0.34	ac	A_I = Impervious area draining to the practice	
0.67	decimal	I = Percent impervious area draining to the practice, in decimal form	
0.65	unitless	Rv = Runoff coefficient = 0.05 + (0.9 x I)	
0.33	ac-in	WQV= 1" x Rv x A	
1 199	cf	WQV conversion (ac-in x 43,560 sf/ac x 1ft/12")	
300	cf	25% x WQV (check calc for sediment forebay volume)	
ISOLATOR ROW		Method of pretreatment? (not required for clean or roof runoff)	
	cf	V_{SED} = Sediment forebay volume, if used for pretreatment	≥ **25%WQV**
2 207	cf	V = Volume[1] (attach a stage-storage table)	≥ **WQV**
1 807	sf	A_{SA} = Surface area of the bottom of the pond	
0.83	iph	$Ksat_{DESIGN}$ = Design infiltration rate[2]	
9.7	hours	I_{DRAIN} = Drain time = V / (A_{SA} * I_{DESIGN})	≤ **72-hrs**
51.75	feet	E_{BTM} = Elevation of the bottom of the basin	
43.00	feet	E_{SHWT} = Elevation of SHWT (if none found, enter the lowest elevation of the test pit)	
43.00	feet	E_{ROCK} = Elevation of bedrock (if none found, enter the lowest elevation of the test pit)	
8.75	feet	D_{SHWT} = Separation from SHWT	≥ *[3]
8.8	feet	D_{ROCK} = Separation from bedrock	≥ *[3]
	ft	D_{amend} = Depth of amended soil, if applicable due high infiltation rate	≥ **24"**
	ft	D_T = Depth of trench, if trench proposed	**4 - 10 ft**
YES	Yes/No	If a trench or underground system is proposed, has observation well been provided?	←**yes**
		If a trench is proposed, does materialmeet Env-Wq 1508.06(k)(2) requirements.[4]	← **yes**
	Yes/No	If a basin is proposed, Is the perimeter curvilinear, and basin floor flat?	← **yes**
	:1	If a basin is proposed, pond side slopes.	≥**3:1**
50.76	ft	Peak elevation of the 10-year storm event (infiltration can be used in analysis)	
52.08	ft	Peak elevation of the 50-year storm event (infiltration can be used in analysis)	
53.10	ft	Elevation of the top of the practice (if a basin, this is the elevation of the berm)	
YES		10 peak elevation ≤ Elevation of the top of the trench?[5]	← **yes**
YES		If a basin is proposed, 50-year peak elevation ≤ Elevation of berm?	← **yes**

1. Volume below the lowest invert of the outlet structure and excludes forebay volume
2. $Ksat_{DESIGN}$ includes a factor of safety. See Env-Wq 1504.14 for requirements for determining the infiltr. rate
3. 1' separation if treatment not required; 4' for treatment in GPAs & WSIPAs; & 3' in all other areas.
4. Clean, washed well graded diameter of 1.5 to 3 inches above the in-situ soil.
5. If 50-year peak elevation exceeds top of trench, the overflow must be routed in HydroCAD as secondary discharge.

Designer's Notes: Test pit #3 restrictive layer @ 42.9'

Stage-Area-Storage for Pond MC1: MC-3500 #1

Elevation (feet)	Horizontal (sq-ft)	Storage (cubic-feet)
51.75	**1,807**	0
51.85	1,807	72
51.95	1,807	145
52.05	1,807	217
52.15	1,807	289
52.25	1,807	361
52.35	1,807	434
52.45	1,807	506
52.55	1,807	578
52.65	1,807	650
52.75	1,807	723
52.85	1,807	874
52.95	1,807	1,025
53.05	1,807	1,175
53.15	1,807	1,324
53.25	1,807	1,473
53.35	1,807	1,621
53.45	1,807	1,769
53.55	1,807	1,916
53.65	1,807	2,062
53.75	1,807	2,207
53.85	1,807	2,352
53.95	1,807	2,495
54.05	1,807	2,638
54.15	1,807	2,779
54.25	1,807	2,920
54.35	1,807	3,059
54.45	1,807	3,197
54.55	1,807	3,333
54.65	1,807	3,469
54.75	1,807	3,602
54.85	1,807	3,735
54.95	1,807	3,865
55.05	1,807	3,994
55.15	1,807	4,120
55.25	1,807	4,245
55.35	1,807	4,367
55.45	1,807	4,487
55.55	1,807	4,604
55.65	1,807	4,718
55.75	1,807	4,829
55.85	1,807	4,937
55.95	1,807	5,040
56.05	1,807	5,137
56.15	1,807	5,228
56.25	1,807	5,310
56.35	1,807	5,389
56.45	1,807	5,465
56.55	1,807	5,537
56.65	1,807	5,610
56.75	1,807	5,682
56.85	1,807	5,754
56.95	1,807	5,826
57.05	1,807	5,899
57.15	1,807	5,971
57.25	1,807	6,043
57.35	1,807	6,116
57.45	1,807	**6,188**

INFILTRATION PRACTICE CRITERIA
(Env-Wq 1508.06)

Type/Node Name: **MC-3500 #2 (MC2) Underground Stormtech Chamber System**

Enter the type of infiltration practice (e.g., basin, trench) and the node name in the drainage analysis, if applicable.

YES		Have you reviewed Env-Wq 1508.06(a) to ensure that infiltration is allowed?	**← yes**
0.96	ac	A = Area draining to the practice	
0.83	ac	A_I = Impervious area draining to the practice	
0.86	decimal	I = Percent impervious area draining to the practice, in decimal form	
0.83	unitless	Rv = Runoff coefficient = 0.05 + (0.9 x I)	
0.79	ac-in	WQV= 1" x Rv x A	
2 884	cf	WQV conversion (ac-in x 43,560 sf/ac x 1ft/12")	
721	cf	25% x WQV (check calc for sediment forebay volume)	
ISOLATOR ROW		Method of pretreatment? (not required for clean or roof runoff)	
	cf	V_{SED} = Sediment forebay volume, if used for pretreatment	**≥ 25%WQV**
2 240	cf	V = Volume[1] (attach a stage-storage table)	**≥ WQV**
2 101	sf	A_{SA} = Surface area of the bottom of the pond	
0.83	iph	$Ksat_{DESIGN}$ = Design infiltration rate[2]	
20.0	hours	I_{DRAIN} = Drain time = V / (A_{SA} * I_{DESIGN})	**≤ 72-hrs**
51.75	feet	E_{BTM} = Elevation of the bottom of the basin	
48.08	feet	E_{SHWT} = Elevation of SHWT (if none found, enter the lowest elevation of the test pit)	
48.08	feet	E_{ROCK} = Elevation of bedrock (if none found, enter the lowest elevation of the test pit)	
3.67	feet	D_{SHWT} = Separation from SHWT	**≥ *** [3]
3.7	feet	D_{ROCK} = Separation from bedrock	**≥ *** [3]
	ft	D_{amend} = Depth of amended soil, if applicable due high infiltation rate	**≥ 24"**
	ft	D_T = Depth of trench, if trench proposed	**4 - 10 ft**
YES	Yes/No	If a trench or underground system is proposed, has observation well been provided?	**←yes**
		If a trench is proposed, does materialmeet Env-Wq 1508.06(k)(2) requirements.[4]	**← yes**
	Yes/No	If a basin is proposed, Is the perimeter curvilinear, and basin floor flat?	**← yes**
	:1	If a basin is proposed, pond side slopes.	**≥3:1**
54.06	ft	Peak elevation of the 10-year storm event (infiltration can be used in analysis)	
54.85	ft	Peak elevation of the 50-year storm event (infiltration can be used in analysis)	
57.50	ft	Elevation of the top of the practice (if a basin, this is the elevation of the berm)	
YES		10 peak elevation ≤ Elevation of the top of the trench?[5]	**← yes**
YES		If a basin is proposed, 50-year peak elevation ≤ Elevation of berm?	**← yes**

1. Volume below the lowest invert of the outlet structure and excludes forebay volume
2. $Ksat_{DESIGN}$ includes a factor of safety. See Env-Wq 1504.14 for requirements for determining the infiltr. rate
3. 1' separation if treatment not required; 4' for treatment in GPAs & WSIPAs; & 3' in all other areas.
4. Clean, washed well graded diameter of 1.5 to 3 inches above the in-situ soil.
5. If 50-year peak elevation exceeds top of trench, the overflow must be routed in HydroCAD as secondary discharge.

Designer's Notes: Test pit #4 restrictive layer @ 48.08'

Stage-Area-Storage for Pond MC2: MC-3500 #2

Elevation (feet)	Horizontal (sq-ft)	Storage (cubic-feet)
47.35	**2,101**	0
47.45	2,101	84
47.55	2,101	168
47.65	2,101	252
47.75	2,101	336
47.85	2,101	420
47.95	2,101	504
48.05	2,101	588
48.15	2,101	672
48.25	2,101	756
48.35	2,101	840
48.45	2,101	1,018
48.55	2,101	1,195
48.65	2,101	1,371
48.75	2,101	1,546
48.85	2,101	1,721
48.95	2,101	1,895
49.05	2,101	2,068
49.15	2,101	2,240
49.25	2,101	2,412
49.35	2,101	2,582
49.45	2,101	2,751
49.55	2,101	2,920
49.65	2,101	3,087
49.75	2,101	3,253
49.85	2,101	3,417
49.95	2,101	3,581
50.05	2,101	3,742
50.15	2,101	3,903
50.25	2,101	4,061
50.35	2,101	4,218
50.45	2,101	4,373
50.55	2,101	4,525
50.65	2,101	4,676
50.75	2,101	4,824
50.85	2,101	4,970
50.95	2,101	5,113
51.05	2,101	5,254
51.15	2,101	5,391
51.25	2,101	5,525
51.35	2,101	5,654
51.45	2,101	5,780
51.55	2,101	5,900
51.65	2,101	6,015
51.75	2,101	6,120
51.85	2,101	6,216
51.95	2,101	6,308
52.05	2,101	6,396
52.15	2,101	6,480
52.25	2,101	6,565
52.35	2,101	6,649
52.45	2,101	6,733
52.55	2,101	6,817
52.65	2,101	6,901
52.75	2,101	6,985
52.85	2,101	7,069
52.95	2,101	7,153
53.05	2,101	**7,237**

GENERAL CALCULATIONS - WQV and WQF
(optional worksheet)

This worksheet may be useful when designing a BMP **that does not fit into one of the specific worksheets already provided** (i.e. for a technology which is not a stormwater wetland, infiltration practice, etc.)

Water Quality Volume (WQV)

2.98	ac	A = Area draining to the practice
1.67	ac	A_I = Impervious area draining to the practice
0.56	decimal	I = Percent impervious area draining to the practice, in decimal form
0.55	unitless	Rv = Runoff coefficient = 0.05 + (0.9 x I)
1.65	ac-in	WQV= 1" x Rv x A
5,982	cf	WQV conversion (ac-in x 43,560 sf/ac x 1ft/12")

Water Quality Flow (WQF)

1	inches	P = Amount of rainfall. For WQF in NH, P = 1".
0.55	inches	Q = Water quality depth. Q = WQV/A
95	unitless	CN = Unit peak discharge curve number. $CN = 1000/(10+5P+10Q-10*[Q^2 + 1.25*Q*P]^{0.5})$
0.5	inches	S = Potential maximum retention. S = (1000/CN) - 10
0.109	inches	Ia = Initial abstraction. Ia = 0.2S
	minutes	T_c = Time of Concentration
	$cfs/mi^2/in$	q_u is the unit peak discharge. Obtain this value from TR-55 exhibits 4-II and 4-III.
-	cfs	WQF = q_u x WQV. Conversion: to convert "$cfs/mi^2/in$ * ac-in" to "cfs" multiply by $1mi^2/640ac$.

Designer's Notes: This sheet is being used to calculate the Water Quality Volume for the entire drainage area of the project. This value is used in support of Town of Durham infiltration requirements. The Town requires volume be infiltrated based on a ratio per Hydrologic Soil Group disturbed. This requirement was interpreted to relate to net impervious surface, and an average volume ratio was calculated for the project site as follows:

HSG A Ratio: 1.00 Net Impervious: 0.000 acre

HSG B Ratio: 0.75 Net Impervious: 0.396 acre

HSG C Ratio: 0.40 Net Impervious: 0.678 acre

HSG D Ratio: 0.16 Net Impervious: -0.022 acre

Overall net impervious area: 1.052 acre

Weighted average for site: 0.54

Site overall WQV: 5982 cf

Required infiltration volume: 0.54 x 5,982 cf = 3,230 cf

Provided infiltration volume: 5,310 cf

INFILTRATION PRACTICE CRITERIA
(Env-Wq 1508.06)

Type/Node Name: **MC45 -- Stormwtech MC-4500 Chamber System**

Enter the type of infiltration practice (e.g., basin, trench) and the node name in the drainage analysis, if applicable.

YES		Have you reviewed Env-Wq 1508.06(a) to ensure that infiltration is allowed?	← **yes**
1.88	ac	A = Area draining to the practice	
1.52	ac	A_I = Impervious area draining to the practice	
0.81	decimal	I = Percent impervious area draining to the practice, in decimal form	
0.78	unitless	Rv = Runoff coefficient = 0.05 + (0.9 x I)	
1.46	ac-in	WQV= 1" x Rv x A	
5,307	cf	WQV conversion (ac-in x 43,560 sf/ac x 1ft/12")	
1,327	cf	25% x WQV (check calc for sediment forebay volume)	
ISOLATOR ROW		Method of pretreatment? (not required for clean or roof runoff)	
	cf	V_{SED} = Sediment forebay volume, if used for pretreatment	≥ **25%WQV**
5,310	cf	V = Volume[1] (attach a stage-storage table)	≥ **WQV**
3,047	sf	A_{SA} = Surface area of the bottom of the pond	
0.83	iph	$Ksat_{DESIGN}$ = Design infiltration rate[2]	
25.3	hours	T_{DRAIN} = Drain time = V / (A_{SA} * I_{DESIGN})	≤ **72-hrs**
53.50	feet	E_{BTM} = Elevation of the bottom of the basin	
49.79	feet	E_{SHWT} = Elevation of SHWT (if none found, enter the lowest elevation of the test pit)	
47.30	feet	E_{ROCK} = Elevation of bedrock (if none found, enter the lowest elevation of the test pit)	
3.71	feet	D_{SHWT} = Separation from SHWT	≥ *[3]
6.2	feet	D_{ROCK} = Separation from bedrock	≥ *[3]
	ft	D_{amend} = Depth of amended soil, if applicable due high infiltation rate	≥ **24"**
	ft	D_T = Depth of trench, if trench proposed	**4 - 10 ft**
	Yes/No	If a trench or underground system is proposed, has observation well been provided?	←**yes**
		If a trench is proposed, does materialmeet Env-Wq 1508.06(k)(2) requirements.[4]	← **yes**
	Yes/No	If a basin is proposed, Is the perimeter curvilinear, and basin floor flat?	← **yes**
	:1	If a basin is proposed, pond side slopes.	≥**3:1**
57.13	ft	Peak elevation of the 10-year storm event (infiltration can be used in analysis)	
58.12	ft	Peak elevation of the 50-year storm event (infiltration can be used in analysis)	
58.47	ft	Elevation of the top of the practice (if a basin, this is the elevation of the berm)	
YES		10 peak elevation ≤ Elevation of the top of the trench?[5]	← **yes**
YES		If a basin is proposed, 50-year peak elevation ≤ Elevation of berm?	← **yes**

1. Volume below the lowest invert of the outlet structure and excludes forebay volume
2. $Ksat_{DESIGN}$ includes a factor of safety. See Env-Wq 1504.14 for requirements for determining the infiltr. rate
3. 1' separation if treatment not required; 4' for treatment in GPAs & WSIPAs; & 3' in all other areas.
4. Clean, washed well graded diameter of 1.5 to 3 inches above the in-situ soil.
5. If 50-year peak elevation exceeds top of trench, the overflow must be routed in HydroCAD as secondary discharge.

Designer's Notes:

2.2 Pre-development analysis

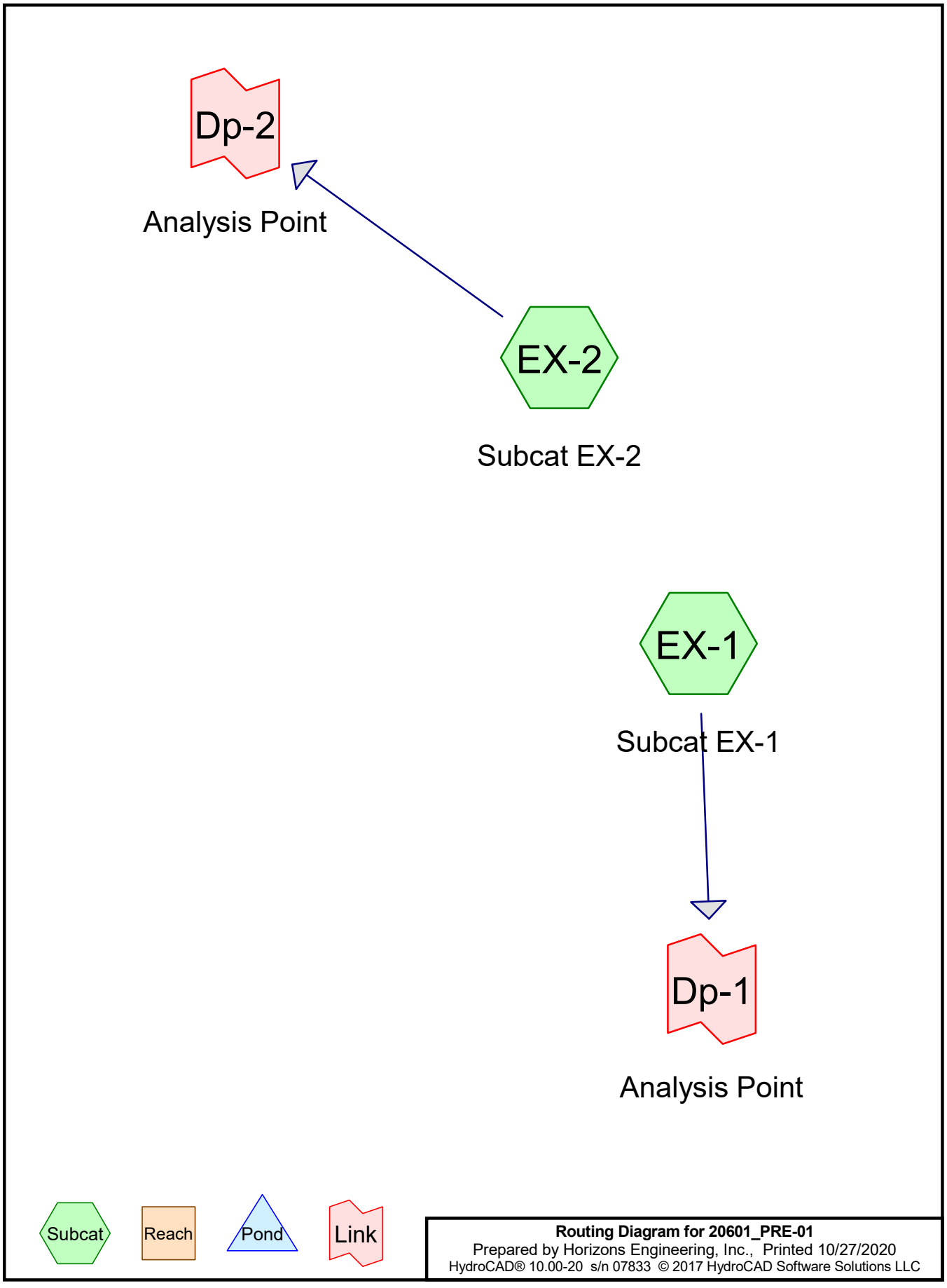
2.2.1 Pre-development analysis

A pre-development analysis covering 129 549 square feet which includes the area to be disturbed by the proposed project. The site has been divided into two pre-development subcatchment area. Subcatchments EX-1 and EX-2 representing the areas draining directly to Drainage Point 1 (Dp-1) and Drainage Point 2 (Dp-2) respectively. EX-1 models area at the front of the site which drains to a point on Main Street, and consists primarily of the existing developed areas at the front of the project site. Drainage Point 2 is in the south of the site, and represents flow toward college brook. EX-2 represents the area draining to Dp-2, and consists primarily of forested slope, but includes a portion of the existing developed area at the north end of the project site.

For more detailed information on the pre-developed area, including watershed areas and drainage paths, see attached drainage plans found in Section 3 and the HydroCAD area listing found in section 2.2.2. A pre- versus post-development comparison flow rate table for the 1-inch; 2-, 10-, 25-, 50-, and 100-year storm events can be found in Table 1 in section 1.1.1.

A High Intensity Soil Survey (HISS) within the work area was completed by Joseph W. Noel, Certified Soil Scientist #17, on 16 October, 2020. This information can be found included on the Existing Conditions Plan.

2.2.2 Pre-development diagram, area listing, soil listing



Routing Diagram for 20601_PRE-01
Prepared by Horizons Engineering, Inc., Printed 10/27/2020

Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
6,205	61	>75% Grass cover, Good, HSG B (EX-1)
1,321	74	>75% Grass cover, Good, HSG C (EX-1, EX-2)
9,052	80	>75% Grass cover, Good, HSG D (EX-1, EX-2)
508	98	Existing Concrete Pads, HSG C (EX-2)
223	98	Existing Concrete Pads, HSG D (EX-1, EX-2)
25	98	Existing Decks and Steps, HSG B (EX-1)
6	98	Existing Decks and Steps, HSG C (EX-2)
493	98	Existing Decks and Steps, HSG D (EX-1, EX-2)
227	98	Paved parking, HSG B (EX-1)
2,767	98	Paved parking, HSG C (EX-2)
17,991	98	Paved parking, HSG D (EX-1, EX-2)
767	98	Roofs, HSG B (EX-1)
3,732	98	Roofs, HSG D (EX-1, EX-2)
18,332	55	Woods, Good, HSG B (EX-1)
65,194	70	Woods, Good, HSG C (EX-1)
1,919	77	Woods, Good, HSG D (EX-1)

Soil Listing (selected nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
25,556	HSG B	EX-1
69,797	HSG C	EX-1, EX-2
33,411	HSG D	EX-1, EX-2
0	Other	

Ground Covers (selected nodes)

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Su Nu
0	6,205	1,321	9,052	0	16,578	>75% Grass cover, Good	
0	0	508	223	0	731	Existing Concrete Pads	
0	25	6	493	0	525	Existing Decks and Steps	
0	227	2,767	17,991	0	20,986	Paved parking	
0	767	0	3,732	0	4,499	Roofs	
0	18,332	65,194	1,919	0	85,445	Woods, Good	

2.2.3 Pre-development node listing for design storm events

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Subcat EX-1 Runoff Area=2.706 ac 15.74% Impervious Runoff Depth=0.01"
Flow Length=653' Tc=11.0 min CN=72 Runoff=0.00 cfs 118 cf

Subcatchment EX-2: Subcat EX-2 Runoff Area=0.250 ac 75.28% Impervious Runoff Depth=0.45"
Flow Length=154' Tc=6.0 min CN=93 Runoff=0.13 cfs 408 cf

Link Dp-1: Analysis Point Inflow=0.00 cfs 118 cf
Primary=0.00 cfs 118 cf

Link Dp-2: Analysis Point Inflow=0.13 cfs 408 cf
Primary=0.13 cfs 408 cf

Total Runoff Area = 128,764 sf Runoff Volume = 526 cf Average Runoff Depth = 0.05"
79.23% Pervious = 102,024 sf 20.77% Impervious = 26,741 sf

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Subcat EX-1 Runoff Area=2.706 ac 15.74% Impervious Runoff Depth=0.89"
Flow Length=653' Tc=11.0 min CN=72 Runoff=2.17 cfs 8,769 cf

Subcatchment EX-2: Subcat EX-2 Runoff Area=0.250 ac 75.28% Impervious Runoff Depth=2.39"
Flow Length=154' Tc=6.0 min CN=93 Runoff=0.66 cfs 2,166 cf

Link Dp-1: Analysis Point Inflow=2.17 cfs 8,769 cf
Primary=2.17 cfs 8,769 cf

Link Dp-2: Analysis Point Inflow=0.66 cfs 2,166 cf
Primary=0.66 cfs 2,166 cf

Total Runoff Area = 128,764 sf Runoff Volume = 10,935 cf Average Runoff Depth = 1.02"
79.23% Pervious = 102,024 sf 20.77% Impervious = 26,741 sf

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Subcat EX-1 Runoff Area=2.706 ac 15.74% Impervious Runoff Depth=2.01"
Flow Length=653' Tc=11.0 min CN=72 Runoff=5.29 cfs 19,792 cf

Subcatchment EX-2: Subcat EX-2 Runoff Area=0.250 ac 75.28% Impervious Runoff Depth=3.96"
Flow Length=154' Tc=6.0 min CN=93 Runoff=1.07 cfs 3,593 cf

Link Dp-1: Analysis Point Inflow=5.29 cfs 19,792 cf
Primary=5.29 cfs 19,792 cf

Link Dp-2: Analysis Point Inflow=1.07 cfs 3,593 cf
Primary=1.07 cfs 3,593 cf

Total Runoff Area = 128,764 sf Runoff Volume = 23,385 cf Average Runoff Depth = 2.18"
79.23% Pervious = 102,024 sf 20.77% Impervious = 26,741 sf

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Subcat EX-1 Runoff Area=2.706 ac 15.74% Impervious Runoff Depth=3.02"
Flow Length=653' Tc=11.0 min CN=72 Runoff=8.03 cfs 29,645 cf

Subcatchment EX-2: Subcat EX-2 Runoff Area=0.250 ac 75.28% Impervious Runoff Depth=5.21"
Flow Length=154' Tc=6.0 min CN=93 Runoff=1.38 cfs 4,727 cf

Link Dp-1: Analysis Point Inflow=8.03 cfs 29,645 cf
Primary=8.03 cfs 29,645 cf

Link Dp-2: Analysis Point Inflow=1.38 cfs 4,727 cf
Primary=1.38 cfs 4,727 cf

Total Runoff Area = 128,764 sf Runoff Volume = 34,372 cf Average Runoff Depth = 3.20"
79.23% Pervious = 102,024 sf 20.77% Impervious = 26,741 sf

2.2.4 Pre-development: full summary of 10-year storm event

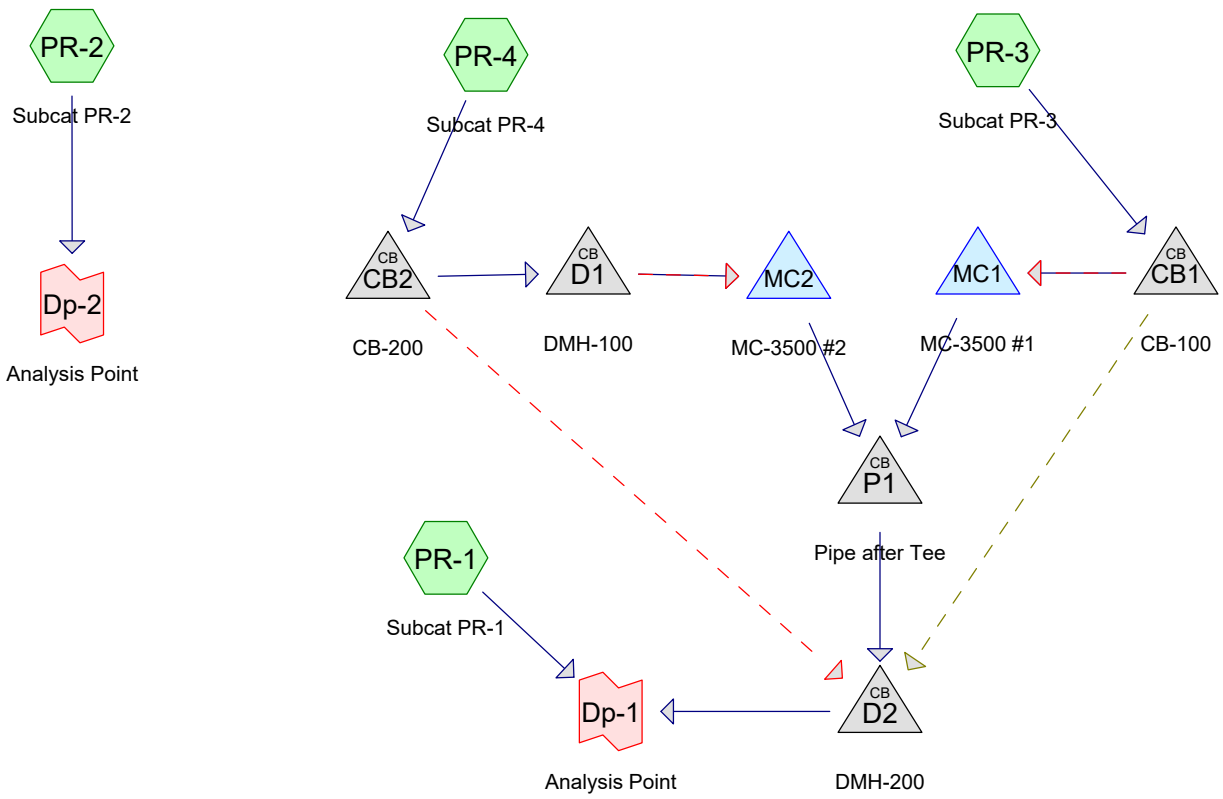
2.3 Post-development Analysis

2.3.1 Post-development analysis

A post-development analysis covering 129 549 square feet includes the 79,700 square feet of disturbed area within the proposed project site as well as previously developed areas and undisturbed areas. The site has been divided into four post-development subcatchment areas. Subcatchments PR-1 and PR-2 representing the areas draining directly to Drainage Point 1 (Dp-1) and Drainage Point 2 (Dp-2) respectively. PR-1 is modified from the pre-development condition by the reconstruction of the site driveway, resulting in a smaller area draining to Dp-1. PR-2 is smaller than the pre-development equivalent, EX-2, due to the exclusion of areas draining to an underground chamber system. A third and fourth subcatchment, PR-3 and PR-4, each represent the flow contributing to underground chamber systems, and consists primarily of parking lot areas. PR-3 is the catchment for the upper part of the parking lot, while PR-4 is the catchment for the lower part of the parking lot. Stormwater from the proposed parking area will be conveyed via sheet flow to grass swale islands which lead to catch basins. These catch basins then direct stormwater into the isolator row of an underground chamber systems under the parking lot. R-3 is routed to the underground chamber system (MC1) and PR-4 is routed to the underground chamber system (MC2). The chamber systems have been designed to detain a volume greater than the water quality volume. The system has been designed to include emergency overflows in the event that the outlets to the underground systems are blocked or if maintenance is required on the systems. The overflows from CB-100 and CB-200 are routed to Dp-1. The underground system have been designed to maintain water levels within the profile of the chamber system during events up to the 100-year storm event. Orifices within the overflow structure additionally manage peak flow rates out of the system during storm events.

For more detailed information on the post-developed area, see attached drainage plans found in Section 4 and the HydroCAD area listing found in section 2.3.2. A pre- versus postdevelopment comparison flow rate table for the 1-inch; 2-, 10-, 25-, 50-, and 100-year storm events can be found in Table 1 in Section 1.1.1.

2.3.2 Diagram, area listing, soil listing



Subcat Reach Pond Link

Routing Diagram for 18-041_POST_03
Prepared by Horizons Engineering

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
9,342	61	>75% Grass cover, Good, HSG B (PR-1, PR-3, PR-4)
17,237	74	>75% Grass cover, Good, HSG C (PR-1, PR-3, PR-4)
11,742	80	>75% Grass cover, Good, HSG D (PR-1, PR-2, PR-3, PR-4)
10,404	98	Paved parking, HSG B (PR-1, PR-3, PR-4)
25,515	98	Paved parking, HSG C (PR-1, PR-3, PR-4)
19,610	98	Paved parking, HSG D (PR-1, PR-2, PR-3, PR-4)
4,217	98	Roofs, HSG D (PR-2, PR-3, PR-4)
5,810	55	Woods, Good, HSG B (PR-1)
9,171	70	Woods, Good, HSG C (PR-1)
16,502	77	Woods, Good, HSG D (PR-1)
129,549	**84**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
25,556	HSG B	PR-1, PR-3, PR-4
51,923	HSG C	PR-1, PR-3, PR-4
52,071	HSG D	PR-1, PR-2, PR-3, PR-4
0	Other	
129,549		**TOTAL AREA**

2.3.3 Post-development node listing for design storm events

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment PR-1: Subcat PR-1 Runoff Area=55,656 sf 3.78% Impervious Runoff Depth=0.01"
Tc=6.0 min CN=71 Runoff=0.00 cfs 36 cf

Subcatchment PR-2: Subcat PR-2 Runoff Area=9,973 sf 67.62% Impervious Runoff Depth=0.40"
Tc=6.0 min CN=92 Runoff=0.11 cfs 334 cf

Subcatchment PR-3: Subcat PR-3 Runoff Area=21,985 sf 67.17% Impervious Runoff Depth=0.32"
Tc=6.0 min CN=90 Runoff=0.18 cfs 587 cf

Subcatchment PR-4: Subcat PR-4 Runoff Area=41,936 sf 86.15% Impervious Runoff Depth=0.56"
Tc=6.0 min CN=95 Runoff=0.64 cfs 1,969 cf

Pond CB1: CB-100 Peak Elev=55.87' Inflow=0.18 cfs 587 cf
Primary=0.18 cfs 587 cf Secondary=0.00 cfs 0 cf Tertiary=0.00 cfs 0 cf Outflow=0.18 cfs 587 cf

Pond CB2: CB-200 Peak Elev=50.95' Inflow=0.64 cfs 1,969 cf
Primary=0.64 cfs 1,969 cf Secondary=0.00 cfs 0 cf Outflow=0.64 cfs 1,969 cf

Pond D1: DMH-100 Peak Elev=49.92' Inflow=0.64 cfs 1,969 cf
Primary=0.64 cfs 1,969 cf Secondary=0.00 cfs 0 cf Outflow=0.64 cfs 1,969 cf

Pond D2: DMH-200 Peak Elev=46.30' Inflow=0.00 cfs 0 cf
24.0" Round Culvert n=0.013 L=135.0' S=0.0100 '/' Outflow=0.00 cfs 0 cf

Pond MC1: MC-3500 #1 Peak Elev=51.98' Storage=167 cf Inflow=0.18 cfs 587 cf
Discarded=0.03 cfs 587 cf Primary=0.00 cfs 0 cf Outflow=0.03 cfs 587 cf

Pond MC2: MC-3500 #2 Peak Elev=48.39' Storage=912 cf Inflow=0.64 cfs 1,969 cf
Discarded=0.04 cfs 1,969 cf Primary=0.00 cfs 0 cf Outflow=0.04 cfs 1,969 cf

Pond P1: Pipe after Tee Peak Elev=48.20' Inflow=0.00 cfs 0 cf
24.0" Round Culvert n=0.013 L=47.0' S=0.0370 '/' Outflow=0.00 cfs 0 cf

Link Dp-1: Analysis Point Inflow=0.00 cfs 36 cf
Primary=0.00 cfs 36 cf

Link Dp-2: Analysis Point Inflow=0.11 cfs 334 cf
Primary=0.11 cfs 334 cf

Total Runoff Area = 129,549 sf Runoff Volume = 2,926 cf Average Runoff Depth = 0.27"
53.88% Pervious = 69,804 sf 46.12% Impervious = 59,746 sf

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment PR-1: Subcat PR-1 Runoff Area=55,656 sf 3.78% Impervious Runoff Depth=0.84"
Tc=6.0 min CN=71 Runoff=1.14 cfs 3,906 cf

Subcatchment PR-2: Subcat PR-2 Runoff Area=9,973 sf 67.62% Impervious Runoff Depth=2.29"
Tc=6.0 min CN=92 Runoff=0.60 cfs 1,906 cf

Subcatchment PR-3: Subcat PR-3 Runoff Area=21,985 sf 67.17% Impervious Runoff Depth=2.11"
Tc=6.0 min CN=90 Runoff=1.24 cfs 3,871 cf

Subcatchment PR-4: Subcat PR-4 Runoff Area=41,936 sf 86.15% Impervious Runoff Depth=2.59"
Tc=6.0 min CN=95 Runoff=2.76 cfs 9,038 cf

Pond CB1: CB-100 Peak Elev=56.14' Inflow=1.24 cfs 3,871 cf
Primary=1.15 cfs 3,836 cf Secondary=0.08 cfs 36 cf Tertiary=0.00 cfs 0 cf Outflow=1.24 cfs 3,871 cf

Pond CB2: CB-200 Peak Elev=51.38' Inflow=2.76 cfs 9,038 cf
Primary=2.76 cfs 9,038 cf Secondary=0.00 cfs 0 cf Outflow=2.76 cfs 9,038 cf

Pond D1: DMH-100 Peak Elev=50.31' Inflow=2.76 cfs 9,038 cf
Primary=2.28 cfs 8,771 cf Secondary=0.49 cfs 267 cf Outflow=2.76 cfs 9,038 cf

Pond D2: DMH-200 Peak Elev=46.74' Inflow=1.13 cfs 4,358 cf
24.0" Round Culvert n=0.013 L=135.0' S=0.0100 '/' Outflow=1.13 cfs 4,358 cf

Pond MC1: MC-3500 #1 Peak Elev=53.78' Storage=2,247 cf Inflow=1.24 cfs 3,871 cf
Discarded=0.03 cfs 3,694 cf Primary=0.03 cfs 177 cf Outflow=0.06 cfs 3,871 cf

Pond MC2: MC-3500 #2 Peak Elev=49.83' Storage=3,389 cf Inflow=2.76 cfs 9,038 cf
Discarded=0.04 cfs 4,857 cf Primary=1.13 cfs 4,181 cf Outflow=1.17 cfs 9,038 cf

Pond P1: Pipe after Tee Peak Elev=48.64' Inflow=1.13 cfs 4,358 cf
24.0" Round Culvert n=0.013 L=47.0' S=0.0370 '/' Outflow=1.13 cfs 4,358 cf

Link Dp-1: Analysis Point Inflow=2.00 cfs 8,264 cf
Primary=2.00 cfs 8,264 cf

Link Dp-2: Analysis Point Inflow=0.60 cfs 1,906 cf
Primary=0.60 cfs 1,906 cf

Total Runoff Area = 129,549 sf Runoff Volume = 18,722 cf Average Runoff Depth = 1.73"
53.88% Pervious = 69,804 sf 46.12% Impervious = 59,746 sf

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment PR-1: Subcat PR-1 Runoff Area=55,656 sf 3.78% Impervious Runoff Depth=2.92"
Tc=6.0 min CN=71 Runoff=4.37 cfs 13,557 cf

Subcatchment PR-2: Subcat PR-2 Runoff Area=9,973 sf 67.62% Impervious Runoff Depth=5.10"
Tc=6.0 min CN=92 Runoff=1.28 cfs 4,238 cf

Subcatchment PR-3: Subcat PR-3 Runoff Area=21,985 sf 67.17% Impervious Runoff Depth=4.88"
Tc=6.0 min CN=90 Runoff=2.75 cfs 8,931 cf

Subcatchment PR-4: Subcat PR-4 Runoff Area=41,936 sf 86.15% Impervious Runoff Depth=5.44"
Tc=6.0 min CN=95 Runoff=5.58 cfs 19,016 cf

Pond CB1: CB-100 Peak Elev=56.33' Inflow=2.75 cfs 8,931 cf
Primary=2.30 cfs 8,604 cf Secondary=0.45 cfs 328 cf Tertiary=0.00 cfs 0 cf Outflow=2.75 cfs 8,931 cf

Pond CB2: CB-200 Peak Elev=51.79' Inflow=5.58 cfs 19,016 cf
Primary=5.58 cfs 19,016 cf Secondary=0.00 cfs 0 cf Outflow=5.58 cfs 19,016 cf

Pond D1: DMH-100 Peak Elev=51.45' Inflow=5.58 cfs 19,016 cf
Primary=3.97 cfs 16,801 cf Secondary=1.68 cfs 2,215 cf Outflow=5.58 cfs 19,016 cf

Pond D2: DMH-200 Peak Elev=47.13' Inflow=3.84 cfs 18,185 cf
24.0" Round Culvert n=0.013 L=135.0' S=0.0100 '/' Outflow=3.84 cfs 18,185 cf

Pond MC1: MC-3500 #1 Peak Elev=54.46' Storage=3,208 cf Inflow=2.75 cfs 8,931 cf
Discarded=0.03 cfs 4,368 cf Primary=1.27 cfs 4,563 cf Outflow=1.30 cfs 8,931 cf

Pond MC2: MC-3500 #2 Peak Elev=51.43' Storage=5,759 cf Inflow=5.58 cfs 19,016 cf
Discarded=0.04 cfs 5,394 cf Primary=2.57 cfs 13,622 cf Outflow=2.61 cfs 19,016 cf

Pond P1: Pipe after Tee Peak Elev=49.03' Inflow=3.84 cfs 18,185 cf
24.0" Round Culvert n=0.013 L=47.0' S=0.0370 '/' Outflow=3.84 cfs 18,185 cf

Link Dp-1: Analysis Point Inflow=7.32 cfs 31,741 cf
Primary=7.32 cfs 31,741 cf

Link Dp-2: Analysis Point Inflow=1.28 cfs 4,238 cf
Primary=1.28 cfs 4,238 cf

Total Runoff Area = 129,549 sf Runoff Volume = 45,741 cf Average Runoff Depth = 4.24"
53.88% Pervious = 69,804 sf 46.12% Impervious = 59,746 sf

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment PR-1: Subcat PR-1 Runoff Area=55,656 sf 3.78% Impervious Runoff Depth=3.91"
Tc=6.0 min CN=71 Runoff=5.86 cfs 18,131 cf

Subcatchment PR-2: Subcat PR-2 Runoff Area=9,973 sf 67.62% Impervious Runoff Depth=6.27"
Tc=6.0 min CN=92 Runoff=1.56 cfs 5,213 cf

Subcatchment PR-3: Subcat PR-3 Runoff Area=21,985 sf 67.17% Impervious Runoff Depth=6.04"
Tc=6.0 min CN=90 Runoff=3.36 cfs 11,064 cf

Subcatchment PR-4: Subcat PR-4 Runoff Area=41,936 sf 86.15% Impervious Runoff Depth=6.62"
Tc=6.0 min CN=95 Runoff=6.72 cfs 23,151 cf

Pond CB1: CB-100 Peak Elev=56.39' Inflow=3.36 cfs 11,064 cf
Primary=2.75 cfs 10,560 cf Secondary=0.62 cfs 504 cf Tertiary=0.00 cfs 0 cf Outflow=3.36 cfs 11,064 cf

Pond CB2: CB-200 Peak Elev=52.25' Inflow=6.72 cfs 23,151 cf
Primary=6.72 cfs 23,151 cf Secondary=0.00 cfs 0 cf Outflow=6.72 cfs 23,151 cf

Pond D1: DMH-100 Peak Elev=52.10' Inflow=6.72 cfs 23,151 cf
Primary=4.50 cfs 20,153 cf Secondary=2.31 cfs 2,998 cf Outflow=6.72 cfs 23,151 cf

Pond D2: DMH-200 Peak Elev=47.26' Inflow=4.98 cfs 24,218 cf
24.0" Round Culvert n=0.013 L=135.0' S=0.0100 '/' Outflow=4.98 cfs 24,218 cf

Pond MC1: MC-3500 #1 Peak Elev=54.85' Storage=3,739 cf Inflow=3.36 cfs 11,064 cf
Discarded=0.03 cfs 4,503 cf Primary=1.62 cfs 6,561 cf Outflow=1.66 cfs 11,064 cf

Pond MC2: MC-3500 #2 Peak Elev=52.08' Storage=6,424 cf Inflow=6.72 cfs 23,151 cf
Discarded=0.04 cfs 5,493 cf Primary=3.36 cfs 17,658 cf Outflow=3.40 cfs 23,151 cf

Pond P1: Pipe after Tee Peak Elev=49.16' Inflow=4.98 cfs 24,218 cf
24.0" Round Culvert n=0.013 L=47.0' S=0.0370 '/' Outflow=4.98 cfs 24,218 cf

Link Dp-1: Analysis Point Inflow=9.76 cfs 42,350 cf
Primary=9.76 cfs 42,350 cf

Link Dp-2: Analysis Point Inflow=1.56 cfs 5,213 cf
Primary=1.56 cfs 5,213 cf

Total Runoff Area = 129,549 sf Runoff Volume = 57,559 cf Average Runoff Depth = 5.33"
53.88% Pervious = 69,804 sf 46.12% Impervious = 59,746 sf

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment PR-1: Subcat PR-1 Runoff Area=55,656 sf 3.78% Impervious Runoff Depth=5.14"
Tc=6.0 min CN=71 Runoff=7.69 cfs 23,838 cf

Subcatchment PR-2: Subcat PR-2 Runoff Area=9,973 sf 67.62% Impervious Runoff Depth=7.68"
Tc=6.0 min CN=92 Runoff=1.89 cfs 6,381 cf

Subcatchment PR-3: Subcat PR-3 Runoff Area=21,985 sf 67.17% Impervious Runoff Depth=7.44"
Tc=6.0 min CN=90 Runoff=4.09 cfs 13,623 cf

Subcatchment PR-4: Subcat PR-4 Runoff Area=41,936 sf 86.15% Impervious Runoff Depth=8.04"
Tc=6.0 min CN=95 Runoff=8.08 cfs 28,094 cf

Pond CB1: CB-100 Peak Elev=56.46' Inflow=4.09 cfs 13,623 cf
Primary=3.27 cfs 12,886 cf Secondary=0.82 cfs 738 cf Tertiary=0.00 cfs 0 cf Outflow=4.09 cfs 13,623 cf

Pond CB2: CB-200 Peak Elev=53.06' Inflow=8.08 cfs 28,094 cf
Primary=8.08 cfs 27,721 cf Secondary=0.83 cfs 373 cf Outflow=8.08 cfs 28,094 cf

Pond D1: DMH-100 Peak Elev=52.86' Inflow=8.08 cfs 27,721 cf
Primary=5.17 cfs 23,920 cf Secondary=2.91 cfs 3,801 cf Outflow=8.08 cfs 27,721 cf

Pond D2: DMH-200 Peak Elev=47.45' Inflow=6.83 cfs 31,526 cf
24.0" Round Culvert n=0.013 L=135.0' S=0.0100 '/' Outflow=6.83 cfs 31,526 cf

Pond MC1: MC-3500 #1 Peak Elev=55.30' Storage=4,311 cf Inflow=4.09 cfs 13,623 cf
Discarded=0.03 cfs 4,613 cf Primary=1.95 cfs 9,010 cf Outflow=1.98 cfs 13,623 cf

Pond MC2: MC-3500 #2 Peak Elev=52.83' Storage=7,051 cf Inflow=8.08 cfs 27,721 cf
Discarded=0.04 cfs 5,578 cf Primary=4.08 cfs 22,143 cf Outflow=4.12 cfs 27,721 cf

Pond P1: Pipe after Tee Peak Elev=49.27' Inflow=6.00 cfs 31,153 cf
24.0" Round Culvert n=0.013 L=47.0' S=0.0370 '/' Outflow=6.00 cfs 31,153 cf

Link Dp-1: Analysis Point Inflow=12.89 cfs 55,364 cf
Primary=12.89 cfs 55,364 cf

Link Dp-2: Analysis Point Inflow=1.89 cfs 6,381 cf
Primary=1.89 cfs 6,381 cf

Total Runoff Area = 129,549 sf Runoff Volume = 71,935 cf Average Runoff Depth = 6.66"
53.88% Pervious = 69,804 sf 46.12% Impervious = 59,746 sf

2.3.4 Post developments: full summary of 10-year storm event

Summary for Subcatchment PR-1: Subcat PR-1

Runoff = 2.85 cfs @ 12.09 hrs, Volume= 8,983 cf, Depth= 1.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 010-YR Rainfall=4.76"

Area (sf)	CN	Description
7,713	61	>75% Grass cover, Good, HSG B
13,042	74	>75% Grass cover, Good, HSG C
1,312	80	>75% Grass cover, Good, HSG D
1	98	Paved parking, HSG B
33	98	Paved parking, HSG C
2,073	98	Paved parking, HSG D
5,810	55	Woods, Good, HSG B
9,171	70	Woods, Good, HSG C
16,502	77	Woods, Good, HSG D
55,656	71	Weighted Average
53,549		96.22% Pervious Area
2,106		3.78% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 Minimum**

Summary for Subcatchment PR-2: Subcat PR-2

Runoff = 0.99 cfs @ 12.08 hrs, Volume= 3,204 cf, Depth= 3.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 010-YR Rainfall=4.76"

Area (sf)	CN	Description
3,229	80	>75% Grass cover, Good, HSG D
5,533	98	Paved parking, HSG D
1,211	98	Roofs, HSG D
9,973	92	Weighted Average
3,229		32.38% Pervious Area
6,744		67.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 Minimum**

Summary for Subcatchment PR-3: Subcat PR-3

Runoff = 2.09 cfs @ 12.09 hrs, Volume= 6,678 cf, Depth= 3.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 010-YR Rainfall=4.76"

Area (sf)	CN	Description
1,593	61	>75% Grass cover, Good, HSG B
1,587	74	>75% Grass cover, Good, HSG C
4,037	80	>75% Grass cover, Good, HSG D
4,071	98	Paved parking, HSG B
1,367	98	Paved parking, HSG C
8,114	98	Paved parking, HSG D
1,214	98	Roofs, HSG D
21,985	90	Weighted Average
7,218		32.83% Pervious Area
14,767		67.17% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 Minimum**

Summary for Subcatchment PR-4: Subcat PR-4

Runoff = 4.35 cfs @ 12.08 hrs, Volume= 14,614 cf, Depth= 4.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 010-YR Rainfall=4.76"

Area (sf)	CN	Description
36	61	>75% Grass cover, Good, HSG B
2,607	74	>75% Grass cover, Good, HSG C
3,164	80	>75% Grass cover, Good, HSG D
6,333	98	Paved parking, HSG B
24,115	98	Paved parking, HSG C
3,890	98	Paved parking, HSG D
1,792	98	Roofs, HSG D
41,936	95	Weighted Average
5,807		13.85% Pervious Area
36,129		86.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, TR-55 Minimum**

Summary for Pond CB1: CB-100

[57] Hint: Peaked at 56.26' (Flood elevation advised)

Inflow Area = 21,985 sf, 67.17% Impervious, Inflow Depth = 3.65" for 010-YR event
Inflow = 2.09 cfs @ 12.09 hrs, Volume= 6,678 cf
Outflow = 2.09 cfs @ 12.09 hrs, Volume= 6,678 cf, Atten= 0%, Lag= 0.0 min
Primary = 1.81 cfs @ 12.09 hrs, Volume= 6,508 cf
Secondary = 0.27 cfs @ 12.09 hrs, Volume= 170 cf
Tertiary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 56.26' @ 12.09 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	55.70'	**24.0" Round Pipe to isolator** L= 17.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 55.70' / 52.86' S= 0.1671 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Secondary	56.00'	**12.0" Round Pipe to manifold** L= 35.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 56.00' / 54.95' S= 0.0300 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#3	Tertiary	56.70'	**12.0" Round 12" Overflow Bypass** L= 39.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 56.70' / 54.70' S= 0.0513 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf

Primary OutFlow Max=1.81 cfs @ 12.09 hrs HW=56.26' TW=53.60' (Dynamic Tailwater)
1=Pipe to isolator (Inlet Controls 1.81 cfs @ 2.54 fps)

Secondary OutFlow Max=0.27 cfs @ 12.09 hrs HW=56.26' TW=53.60' (Dynamic Tailwater)
2=Pipe to manifold (Inlet Controls 0.27 cfs @ 1.72 fps)

Tertiary OutFlow Max=0.00 cfs @ 0.00 hrs HW=55.70' TW=46.30' (Dynamic Tailwater)
3=12" Overflow Bypass (Controls 0.00 cfs)

Summary for Pond CB2: CB-200

[57] Hint: Peaked at 51.61' (Flood elevation advised)

Inflow Area = 41,936 sf, 86.15% Impervious, Inflow Depth = 4.18" for 010-YR event
Inflow = 4.35 cfs @ 12.08 hrs, Volume= 14,614 cf
Outflow = 4.35 cfs @ 12.08 hrs, Volume= 14,614 cf, Atten= 0%, Lag= 0.0 min
Primary = 4.35 cfs @ 12.08 hrs, Volume= 14,614 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 51.61' @ 12.08 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	50.60'	**18.0" Round Pipe to DMH-100** L= 17.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 50.60' / 50.00' S= 0.0353 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#2	Secondary	52.60'	**12.0" Round 12" Overflow** L= 39.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 52.60' / 50.60' S= 0.0513 '/' Cc= 0.900 n= 0.013, Flow Area= 0.79 sf
#3	Primary	55.00'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 in 24.0" x 24.0" Grate (100% open area) Limited to weir flow at low heads

Primary OutFlow Max=4.34 cfs @ 12.08 hrs HW=51.61' TW=50.49' (Dynamic Tailwater)
1=Pipe to DMH-100 (Inlet Controls 4.34 cfs @ 3.42 fps)
3=Orifice/Grate (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=50.60' TW=46.30' (Dynamic Tailwater)
2=12" Overflow (Controls 0.00 cfs)

Summary for Pond D1: DMH-100

[57] Hint: Peaked at 50.78' (Flood elevation advised)

Inflow Area =	41,936 sf,	86.15% Impervious,	Inflow Depth =	4.18"	for 010-YR event
Inflow =	4.35 cfs @	12.08 hrs, Volume=	14,614 cf		
Outflow =	4.35 cfs @	12.08 hrs, Volume=	14,614 cf,	Atten= 0%,	Lag= 0.0 min
Primary =	3.36 cfs @	12.09 hrs, Volume=	13,327 cf		
Secondary =	1.06 cfs @	12.07 hrs, Volume=	1,287 cf		

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 50.78' @ 12.26 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	49.50'	**24.0" Round Pipe to isolator row** L= 5.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 49.50' / 49.50' S= 0.0000 '/' Cc= 0.900 n= 0.013, Flow Area= 3.14 sf
#2	Secondary	50.00'	**18.0" Round Pipe to manifold** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 50.00' / 49.50' S= 0.0500 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf

Primary OutFlow Max=2.95 cfs @ 12.09 hrs HW=50.49' TW=50.30' (Dynamic Tailwater)
1=Pipe to isolator row (Outlet Controls 2.95 cfs @ 2.77 fps)

Secondary OutFlow Max=0.96 cfs @ 12.07 hrs HW=50.47' TW=50.19' (Dynamic Tailwater)
2=Pipe to manifold (Outlet Controls 0.96 cfs @ 3.05 fps)

Summary for Pond D2: DMH-200

[57] Hint: Peaked at 46.98' (Flood elevation advised)

Inflow Area = 63,921 sf, 79.62% Impervious, Inflow Depth = 2.24" for 010-YR event
Inflow = 2.66 cfs @ 12.30 hrs, Volume= 11,914 cf
Outflow = 2.66 cfs @ 12.30 hrs, Volume= 11,914 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.66 cfs @ 12.30 hrs, Volume= 11,914 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 46.98' @ 12.30 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	46.30'	**24.0" Round Culvert** L= 135.0' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 46.30' / 44.95' S= 0.0100 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=2.66 cfs @ 12.30 hrs HW=46.98' TW=0.00' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.66 cfs @ 2.81 fps)

Summary for Pond MC1: MC-3500 #1

ADS Stormtech MC3500 chamber system.
Exfiltration rate based on published Ksat value of 2.33E-5 m/s [3.3 in/hr) for Hollis-Charlton fine sandy loam, converted to in/hr with a 4X factor of safety applied via discharge multiplier.

Inflow Area = 21,985 sf, 67.17% Impervious, Inflow Depth = 3.65" for 010-YR event
Inflow = 2.09 cfs @ 12.09 hrs, Volume= 6,678 cf
Outflow = 0.79 cfs @ 12.33 hrs, Volume= 6,678 cf, Atten= 62%, Lag= 14.7 min
Discarded = 0.03 cfs @ 9.04 hrs, Volume= 4,142 cf
Primary = 0.75 cfs @ 12.33 hrs, Volume= 2,536 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 54.06' @ 12.33 hrs Surf.Area= 1,807 sf Storage= 2,647 cf

Plug-Flow detention time= 405.2 min calculated for 6,677 cf (100% of inflow)
Center-of-Mass det. time= 405.3 min (1,197.7 - 792.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	51.75'	2,776 cf	**37.08'W x 48.72'L x 5.75'H Field A** 10,389 cf Overall - 3,448 cf Embedded = 6,941 cf x 40.0% Voids
#2A	52.75'	3,448 cf	**ADS_StormTech MC-3500 d +Cap** x 30 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 30 Chambers in 5 Rows Cap Storage= +14.9 cf x 2 x 5 rows = 149.0 cf
		6,224 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	51.75'	**3.300 in/hr Exfiltration X 0.25 over Horizontal area** Phase-In= 0.05'
#2	Device 5	53.75'	**24.0" W x 2.0" H Vert. Low Orifice 24"W x 2"H** C= 0.600
#3	Device 5	55.65'	**12.0" W x 2.0" H Vert. Medium Flow 12"W x 2"H** C= 0.600
#4	Device 5	57.20'	**5.0' long 5' Weir** 2 End Contraction(s)
#5	Primary	49.32'	**24.0" Round 24" HDPE outlet** L= 32.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 49.32' / 48.20' S= 0.0350 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Discarded OutFlow Max=0.03 cfs @ 9.04 hrs HW=51.81' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.75 cfs @ 12.33 hrs HW=54.06' TW=48.88' (Dynamic Tailwater)
└**5=24" HDPE outlet** (Passes 0.75 cfs of 29.24 cfs potential flow)
  ├**2=Low Orifice 24"W x 2"H** (Orifice Controls 0.75 cfs @ 2.26 fps)
  ├**3=Medium Flow 12"W x 2"H** (Controls 0.00 cfs)
  └**4=5' Weir** (Controls 0.00 cfs)

Summary for Pond MC2: MC-3500 #2

ADS Stormtech MC3500 chamber system.
Exfiltration rate based on published Ksat value of 2.33E-5 m/s [3.3 in/hr) for Hollis-Charlton fine sandy loam, converted to in/hr with a 4X factor of safety applied via discharge multiplier.

Inflow Area =	41,936 sf,	86.15% Impervious,	Inflow Depth =	4.18"	for 010-YR event
Inflow =	4.35 cfs @	12.08 hrs, Volume=	14,614 cf		
Outflow =	1.96 cfs @	12.26 hrs, Volume=	14,614 cf,	Atten= 55%,	Lag= 10.3 min
Discarded =	0.04 cfs @	6.65 hrs, Volume=	5,237 cf		
Primary =	1.92 cfs @	12.26 hrs, Volume=	9,377 cf		

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 50.76' @ 12.26 hrs Surf.Area= 2,101 sf Storage= 4,841 cf

Plug-Flow detention time= 231.7 min calculated for 14,614 cf (100% of inflow)
Center-of-Mass det. time= 231.7 min (1,001.2 - 769.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	47.35'	3,201 cf	**29.92'W x 70.23'L x 5.75'H Field A** 12,081 cf Overall - 4,077 cf Embedded = 8,004 cf x 40.0% Voids
#2A	48.35'	4,077 cf	**ADS_StormTech MC-3500 d +Cap** x 36 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap 36 Chambers in 4 Rows Cap Storage= +14.9 cf x 2 x 4 rows = 119.2 cf
		7,279 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	47.35'	**3.300 in/hr Exfiltration X 0.25 over Horizontal area** Phase-In= 0.05'
#2	Device 5	49.25'	**24.0" W x 2.0" H Vert. Low Orifice 2"HX24"W** C= 0.600
#3	Device 5	51.25'	**12.0" W x 2.0" H Vert. Medium Flow 2"Hx12"W** C= 0.600
#4	Device 5	52.80'	**6.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#5	Primary	48.25'	**24.0" Vert. 24" outlet** C= 0.600

Discarded OutFlow Max=0.04 cfs @ 6.65 hrs HW=47.41' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=1.92 cfs @ 12.26 hrs HW=50.76' TW=48.88' (Dynamic Tailwater)
└**5=24" outlet** (Passes 1.92 cfs of 18.60 cfs potential flow)
  ├**2=Low Orifice 2"HX24"W** (Orifice Controls 1.92 cfs @ 5.75 fps)
  ├**3=Medium Flow 2"Hx12"W** (Controls 0.00 cfs)
  └**4=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond P1: Pipe after Tee

[57] Hint: Peaked at 48.88' (Flood elevation advised)

Inflow Area = 63,921 sf, 79.62% Impervious, Inflow Depth = 2.24" for 010-YR event
Inflow = 2.66 cfs @ 12.30 hrs, Volume= 11,914 cf
Outflow = 2.66 cfs @ 12.30 hrs, Volume= 11,914 cf, Atten= 0%, Lag= 0.0 min
Primary = 2.66 cfs @ 12.30 hrs, Volume= 11,914 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 48.88' @ 12.30 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	48.20'	**24.0" Round 24" HDPE outlet** L= 47.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 48.20' / 46.46' S= 0.0370 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 3.14 sf

Primary OutFlow Max=2.66 cfs @ 12.30 hrs HW=48.88' TW=46.98' (Dynamic Tailwater)
└**1=24" HDPE outlet** (Inlet Controls 2.66 cfs @ 2.81 fps)

Summary for Link Dp-1: Analysis Point

Inflow Area = 119,576 sf, 44.32% Impervious, Inflow Depth = 2.10" for 010-YR event
Inflow = 4.48 cfs @ 12.10 hrs, Volume= 20,897 cf
Primary = 4.48 cfs @ 12.10 hrs, Volume= 20,897 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link Dp-2: Analysis Point

Inflow Area = 9,973 sf, 67.62% Impervious, Inflow Depth = 3.86" for 010-YR event
Inflow = 0.99 cfs @ 12.08 hrs, Volume= 3,204 cf
Primary = 0.99 cfs @ 12.08 hrs, Volume= 3,204 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

2.4 Energy dissipation calculations (rip rap apron)

PIPE OUTLET PROTECTION APRON DESIGN
And
d_{50} RIPRAP SIZING

PROJECT NAME :	19-21 Main Street, Durham NH				
LOCATION:	Outfall #1 (24" CPP)				
BY :	MCS		CHECKED BY :	MJS	
DATE :	2022-02-15	STORM:	25 YR	DATE :	2022-02-15

DOWMSTREAM CHANNEL (OR SPREADER) HYDRAULICS

Peak Discharge Required =	7.32	cfs
Channel Bottom Width =	3.0	Feet
Hydraulic Gradient =	0.120	Feet/Feet
Left Side Slope =	3.0	:1(h:v)
Right Side Slope =	3.0	:1(h:v)
Depth of Flow* =	0.400	Feet
Manning's "n" =	0.0630	Please refer to Figure 7-52 of HANDBOOK
Area =	1.68	Square Feet
Wetted Perimeter =	5.53	Feet
Hydraulic Radius =	0.30	Feet
Top Width =	5.40	Feet
Velocity =	3.69	Feet/Second
Peak Discharge Determined =	6.20	cfs

La AND W CALCULATIONS:

Culvert Diameter (Do) =	24.0	Inches
Tail Water Depth (TW)* =	**0.40**	Feet
Length of Apron (La) =	**19**	Feet
Width of Apron @ D.S End (W) =	**25**	Feet
Width of D.S. Apron if Channel (W) =	**5.4**	Feet

Assumes Channel Bottom at the Culvert Equals the Invert Outlet Elevation of the Pipe. If this is not the case, the calculations involving the Tailwater will have to be calculated by hand.

***If outletting to Flat Area use TW depth = 0.2 x Do**

ROCK RIPRAP SIZE

d_{50} =	0.36	Feet	or	4.26	Inches

USE 6.0

$d_{50} = (0.02 \times Q^{4/3})/(Tw \times Do)$

ROCK RIPRAP GRADATION (TABLE 7-24 OF NHDES HANDBOOK)

% of Weight Smaller Than The Given Size	Size of Stone in Inches		
100	9.0	to	12.0
85	7.8	to	10.8
50	6.0	to	9.0
15	1.8	to	3.0

Minimum Rock Riprap Blanket Thickness = 18.0 Inches
Minimum Six inch Sand/Gravel Bedding or Geotextile Fabric Required Under All Rock Riprap

FORMULAS USED (Reference NHDES HANDBOOK, Pages 7-114, 7-115)

Manning's Uniform Channel Flow -	Q = (A x 1.486 x R^(2/3) x S^(1/2))/"n"
Length of Apron (La) TW< Do/2 -	La = (1.8 x Q/Do^1.5) + 7 x Do
Length of Apron (La) TW>= Do/2 -	La = 3.0 x Q/Do^1.5 + 7 x Do
Width of Apron @ D.S End TW < Do/2 -	W = 3 x Do + La
Width of Apron @ D.S End TW >= Do/2 -	W = 3 x Do + 0.4 x La
Width of D.S. Apron if in Channel -	Ch. BW +Sum of Side Slopes x Flow Depth
Width of Apron @ Culvert -	Wc = 3 x Do

2.5 Site specific soil survey

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(207) 384-5587

*CERTIFIED SOIL SCIENTIST * WETLAND SCIENTIST * LICENSED SITE EVALUATOR*

October 25, 2020

TEST PIT LOGS
TAX MAP 5 - LOTS 1-15 & 1-16
MAIN STREET
DURHAM, NEW HAMPSHIRE

Test Pits Conducted: October 16, 2020
By: Joseph W. Noel
New Hampshire Certified Soil Scientist #017

Test Pit 1

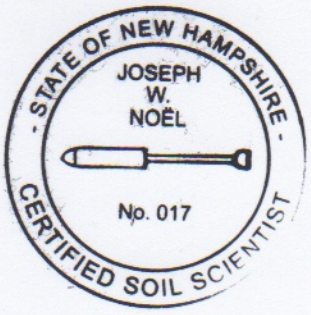
1-0 inches	partially decomposed organic matter
0-8 inches	brown (10YR 4/3) very fine sandy loam, friable, granular
8-11 inches	light olive brown (2.5Y 5/3) very fine sandy loam, friable, blocky
11-40 inches	light yellowish brown (2.5Y 6/3) silt to silt loam, firm, massive, common prominent redox features

Seasonal High Water Table @ 11" (perched)
Observed Water Table none to 40"
Restrictive Horizon @ 11"
Bedrock none to 40"

Test Pit 2

1-0 inches	partially decomposed organic matter
0-9 inches	brown (10YR 4/3) very fine sandy loam, friable, granular
9-12 inches	dark yellowish brown (10YR 4/4) very fine sandy loam, friable, blocky
12-22 inches	light olive brown (2.5Y 5/3) silt loam, firm, blocky, common distinct redox features
22-48 inches	olive gray (5Y 4/2) silt loam, very firm, blocky, common distinct redox features and manganese stains on ped faces

Seasonal High Water Table @ 12" (perched)
Observed Water Table none to 48"
Restrictive Horizon @ 12"
Bedrock none to 48"



Test Pit 3

1-0 inches	partially decomposed organic matter
0-8 inches	brown (10YR 4/3) very fine sandy loam, friable, granular
8-13 inches	dark yellowish brown (10YR 4/4) very fine sandy loam, friable, blocky
13-43 inches	light olive brown (2.5Y 5/3) silt loam, firm to very firm, massive, common prominent redox features

Seasonal High Water Table @ 13" (perched)
Observed Water Table none to 43"
Restrictive Horizon @ 13"
Bedrock none to 43"

Test Pit 4

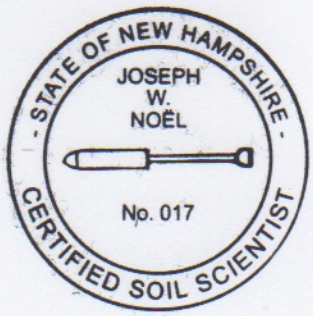
1-0 inches	partially decomposed organic matter
0-6 inches	dark brown (10YR 3/3) very fine sandy loam, friable, granular
6-11 inches	dark yellowish brown (10YR 4/4) very fine sandy loam, friable, blocky
11-40 inches	light olive brown (2.5Y 5/3) silt loam, firm to very firm, massive, common prominent redox features

Seasonal High Water Table @ 11" (perched)
Observed Water Table none to 40"
Restrictive Horizon @ 11"
Bedrock none to 40"

Test Pit 5

1-0 inches	partially decomposed organic matter
0-8 inches	very dark grayish brown (10YR 3/2) very fine sandy loam, friable, granular
8-13 inches	dark yellowish brown (10YR 4/4) very fine sandy loam, friable, blocky
13-40 inches	light olive brown (2.5Y 5/3) silt loam, firm to very firm, massive, common prominent redox features

Seasonal High Water Table @ 13" (perched)
Observed Water Table none to 40"
Restrictive Horizon @ 13"
Bedrock none to 40"



2.6 Inspection and maintenance manual

Inspection and Maintenance Plan

Toomerfs, LLC – 19 and 21 Main Street
Durham, NH

Introduction

This document is intended to provide a unified procedure for the party (ies) responsible for inspecting and maintaining the stormwater management device(s) that are located within the site development (see Design Plan for the device locations).

Responsible Parties

The ultimate responsibility for complying with this plan rests with the owners of the Property.

Owner's Name: Toomerfs, LLC

Prior to transfer of ownership to another entity the existing owner shall notify DES in writing of such transfer.

Parties assigned to complete inspection and maintenance tasks are presented in the following table:

DEVICE	TASK	PARTY RESPONSIBLE
Structural Stormwater Devices		
MC-4500 Chamber System	Inspection	OWNER
	Maintenance	OWNER
	Reporting	OWNER
Riprap/Stone Outlet Protections	Inspection	OWNER
	Maintenance	OWNER
	Reporting	OWNER
Grass Lined Swales	Inspection	OWNER
	Maintenance	OWNER
	Reporting	OWNER

Frequency of Activities

The best time to perform inspections is during the onset of rain. To the extent practicable inspections should be timed to coincide with moderate storms that do not have the potential for severe (thunderstorms, etc.) precipitation. The frequency of inspection and maintenance will vary by intensity of use; however the recommended inspection frequency for each feature has been described in the protocol sheets to follow.

Maintenance frequencies will be determined based upon the results of the inspections and if specific maintenance thresholds are observed to have been crossed during inspections.

Records

A record of inspection and maintenance activities shall be recorded on the Inspection and Maintenance Log presented following. Records of Inspection and Maintenance Logs shall be made available upon request.

Control of Invasive Plants

Invasive plants are introduced, alien, or non-native plants, which have been moved by people from their native habitat to a new area. Some exotic plants are imported for human use such as landscaping, erosion control, or food crops. They also can arrive as "hitchhikers" among shipments of other plants, seeds, packing materials, or fresh produce. Some exotic plants become invasive and cause harm by:

- becoming weedy and overgrown;
- killing established shade trees;
- obstructing pipes and drainage systems;
- forming dense beds in water;
- lowering water levels in lakes, streams, and wetlands;
- destroying natural communities;
- promoting erosion on stream banks and hillsides; and
- resisting control except by hazardous chemical.

During maintenance activities, check for the presence of invasive plants and remove in a safe manner as described on the following pages. They should be controlled as described on the following pages.

_______ Year

Stormwater BMP
Inspection and Maintenance Log

Toomerfs, LLC – 19 and 21 Main Street
Durham, NH

DEVICE/ LOCATION	INSPECTION		FOLLOW UP ACTIVITY	
	Date	Insp. Name	Date	Notes/Action Taken

CB- CATCH BASINS

(*To include trench drains, drain manholes, and double catchbasins, and drop inlets*)

Inspection Frequency:

Inspect 2 times per year (spring and fall-after leaf drop) unless otherwise described- maintain features as described below.

Maintenance Requirements:

- Remove debris from inlets grates.
- If an oily sheen or hydrocarbons are present on the water surface contact your supervisor
    - Skimming/absorbants should be used to remove to the material and disposed of in accordance with state and federal regulations.
- Remove accumulated sediment in sump if sediment has accumulated to ½ sump depth or is within 1 foot below invert out of basin.
    - If sediment has accumulated to pipe invert out, check discharge end of pipe for sediment accumulations and remove sediment from pipe.
    - Note such conditions and increase inspection frequency if it is determined that the loads of sediment to the basin are consistently high.
    - Address source of sediment if possible.
- For drop inlets with no sump sediments will typically only accumulate if there is an obstruction in the downstream culvert and/or culvert outlet. Therefore where sediments are present in structure:
    - Inspect culvert and culvert outlet and remove debris and sediments.
- Do not dispose of catch basin cleanings in wetland areas or within 40 feet of wetland areas- refer to Appendix b; pages B-2 and B-4 in NH DES guidance document http://des.nh.gov/organization/divisions/water/stormwater/documents/nh_idde_sop.pdf to determine where catchbasin cleanings and street sweepings may be disposed of.

GS-GRASS SWALES
(*Includes grass ditches, grass Pre-Treatment Swales, and grass Treatment Swales*)

Inspection Frequency:
Inspect once per year unless otherwise described.
Grassed channels should be inspected for sediment accumulation, vegetation loss, and presence of invasive species. Maintain features as described below.

Maintenance Requirements:

- Repairs, including vegetation replacement, should be made based on inspection.
    - Grass Treatment Swales require a relatively flat swale floor (both laterally (side to side), and longitudinally (along their length)) to spread water across the swale floor and slow flows down to enable sediments to settle in the swale. This may create areas of standing water and associated dead spots in the grass.
        - Reseed such areas by scratching in seed and applying mulch matting for areas that exceed 4 ft. in diameter.
        - If reseeding does not work or water is seen ponding for more than 48 hours turf aeration of the swale floor may rejuvenate it.
            - Re-seed and rake out plugs created by aeration activities.
- Remove sediment and debris annually, or more frequently as warranted by inspection.
    - Leaves should be raked from swales to avoid smothering grass.
- Mow vegetated channels at least once a year to control establishment of woody vegetation.
    - It is recommended to cut grass no shorter than 4 inches.
    - Rake/collect grass clippings from swales.

ST- STORMTECH INFILTRATION CHAMBERS
(*To include stormtech isolator rows*)

Photo Credit: Stormtech

Inspection Frequency:
Isolator Rows shall be inspected immediately after completion of the site construction and cleaned out if necessary. The typical inspection schedule after construction for the Isolator Rows is a minimum of twice a year (spring & fall) - maintain features as described below.

Inspection of the Isolator Row shall involve a visual check using either the inspection ports or the access manholes

Maintenance Requirements:

- If upon visual inspection of the Isolator Row, it is found that sediment has accumulated to an average depth exceeding 3 inches throughout the length of the Isolator Row, cleanout is required.
- Cleanout of the accumulated material in the Isolator Row should be accomplished by vacuum pumping.
- Cleanout should be performed during dry weather and care should be taken to avoid tearing the fabric in the Isolator Rows.
- A site maintenance log will be kept. This log will record the dates when maintenance tasks were completed, the person who completed the task, and any observations of malfunctions in components of the stormwater management system. Call 1-888-892-2694 to speak with a Technical representative or visit www.stormtech.com.

RR- RIP RAP OUTLET APRONS
(To include Rip Rap Channels/Swales)

Inspection Frequency:
Inspect once per year unless otherwise indicated or if apron is inlet to a stormwater Detention/treatment Pond or Bioretention Area (if so, see DP and BR, respectively). Maintain features as described below.

Maintenance Requirements:

- Remove debris accumulations if they redirect flow off of the apron or otherwise restrict flow or cause any backflow into the culvert outlet.
- Repair and replace gaps in stone coverage with stone of similar or larger size stone.
    - Refer to design plans for apron dimensions, stone size and any required geotextile underlayment.
    - Be careful not to extend apron into jurisdictional wetland areas or local wetland buffers.
- Ensure that any flared end sections are level to help spread water out onto apron. Re-level if needed.
- Ensure concrete or masonry headwalls are not undermined or have evidence of piping/voids; evidence that flow has bypassed culvert. If voids are found:
    - Check again during storms to determine what has caused voids and contact an engineer if water is flowing around/bypassing culvert.

2.7 References

Mays, Larry. *Stormwater Collection Systems Design Handbook*. McGraw-Hill. New York, NY. 2001

McCarthy, David. *Essentials of Soil Mechanics and Foundations: Sixth Edition*. Prentice Hall. Columbus, Ohio. 2002.

NHDES. *New Hampshire Stormwater Manual*. New Hampshire Department of Environmental Services. 2008.

NHDES. *New Hampshire Homeowner's Guide to Stormwater Management*. New Hampshire Department of Environmental Services. 2012

The UNH Stormwater Center, *The LID Stormwater Management Systems Demonstrate LID Stormwater Management Systems Demonstrate Superior Cold Climate Performance than Superior Cold Climate Performance than Conventional Stormwater Management Systems,UNH Stormwater Center, NEIWPCC 2007 NPS Conference, Newport, RI,May 2007*

SECTION 3.0 PLANS

3.1 Design plans (unbound)

3.2 Pre- and post-development drainage area plans