STORMWATER MANAGEMENT REPORT

PROPOSED RETAIL MOTOR FUEL OUTLET
ASSESSORS MAP 47 LOT 1-2
158 EPPING ROAD
EXETER, NEW HAMPSHIRE 03833

GPI

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Prepared For:

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April 20, 2021

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(GPI Project No.: NEX-2020283)

Nouria Energy Corporation
Stormwater Management Report

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SECTION 1 EXECUTIVE SUMMARY

This report contains a stormwater management analysis for the proposed retail motor fuel outlet facility located at 158 Epping Road (Route 27) in Exeter, New Hampshire. The analysis includes both pre- and post-development calculations of stormwater runoff rates at specific locations on the project site.

The analysis has been prepared in accordance with both the Town of Exeter requirements and the guidelines contained in the New Hampshire Department of Environmental Services (NHDES) New Hampshire Stormwater Manual.

The project site is a portion of the property identified as Map 47 Lot 1-2 which has an area of approximately 3.80 acres. The site is located on the southern corner of the intersection of Continental Drive and Epping Road and is bordered by Continental Drive to the north, Epping Road to the East, a commercial/industrial use to the south, and a contractor's yard located in the western portion of the property.

The Applicant is proposing to redevelop the eastern portion of the property with a new retail motor fuel outlet facility consisting of a 5,500 sf convenience store, a fuel dispensing area with 6 dispensers (12 fueling positions), a 4,182 sf tunnel car wash, 7 outdoor vacuum spaces, and a paved parking lot with 22 parking spaces. Site work includes site grading, erosion control measures, new utility connections, and the construction of a new stormwater management system. The proposed development will be accessed via two site driveways, including a reconfigured access driveway along Epping Road which is shared with Lot 1-1 to the south, and a new 30-foot wide full access driveway along Continental Drive. Water and sewer services for the site will be provided by municipal water and sewer mains within Continental Drive.

In order to mitigate any increases in peak discharge rates of stormwater runoff as a result of the redevelopment, a comprehensive stormwater management system has been designed that includes deep-sump, hooded catch basins, First Defense hydrodynamic separator units, underground detention systems, a bioretention area, and a Jellyfish Treatment Unit.

The study watershed area is approximately 3.0 acres. Based on site topography and discharge points, two analysis points are identified for the purposes of this report. Design Point #1 is the existing drainage system which discharges at the southern corner of the project site through a 12" diameter corrugated metal pipe (CMP) and continues south. Design Point #2 is the existing drainage system in Epping Road which conveys drainage across the road to the northeast and discharges into the surrounding wooded area through an existing headwall.

The tables below summarize the comparative pre- and post-development peak rates of stormwater runoff and volume at each design point.

TABLE 1: PEAK RATE ANALYSIS SUMMARY

Design Storm	Pre-Development (cfs)	Post-Development (cfs)	Change (cfs)
DESIGN POINT #1 – Existing Drainage System			
2-year	7.4	3.1	-4.3
10-year	11.8	4.7	-7.1
25-year	15.1	6.0	-9.1
50-year	18.3	9.1	-9.2
DESIGN POINT #2 – Epping Road Drainage System			
2-year	1.4	1.3	-0.1
10-year	2.6	2.3	-0.3
25-year	3.5	3.2	-0.3
50-year	4.4	4.0	-0.4

(All values shown are peak rates in cubic feet per second)

Table 2: Volume Analysis Summary

Design Storm	Pre-Development (acre-feet)	Post-Development (acre-feet)	Change (acre-feet)
DESIGN POINT #1 – Existing Drainage System			
2-year	0.59	0.58	-0.01
10-year	0.96	0.96	0.00
25-year	1.25	1.27	+0.02
50-year	1.53	1.56	+0.03
DESIGN POINT #2 – Epping Road Drainage System			
2-year	0.12	0.09	-0.03
10-year	0.21	0.17	-0.04
25-year	0.29	0.23	-0.06
50-year	0.37	0.29	-0.08

(All values shown are total volumes in acre-feet)

As shown in Tables 1 & 2, the proposed stormwater management system will result in a decrease in post-development peak flow rates for all storms analyzed. Volumes will be reduced for most storms with only an insignificant increase in volume to Design Point #1 for the 25 and 50-year design storm.

Compliance with the channel protection criteria identified in Section 9.3.4.4 of the *Stormwater Management Standards for Post Construction and Construction* is summarized in the following table.

TABLE 3: CHANNEL PROTECTION CRITERIA SUMMARY

1-Year Pre Peak Rate (cfs)	2-Year Pre Peak Rate (cfs)	2-Year Post Peak Rate (cfs)	2-Year Pre Volume (ac-ft)	2-Year Post Volume (ac-ft)	Channel Protection Criteria Met?
DESIGN POINT #1 – Existing Drainage System					
6.0	7.4	3.1	0.59	0.58	Yes 1(a)
DESIGN POINT #2 – Epping Road Drainage System					
1.1	1.4	1.3	0.12	0.10	Yes 1(a) & 1(b)

As shown above, the channel protection criteria are met for all design points.

In conclusion, by incorporating a new on-site drainage system that includes provisions for stormwater treatment, there will be no increase in peak rates of runoff as a result of this project. Volumes will also be decreased except for the 25 and 50-year design storms to Design Point #1 due to limited ability to infiltrate. Both design points still meet the Channel Protection Criteria and will not contribute to water quality impairments. The proposed stormwater management system meets the requirements for a redevelopment project as outlined in the Town of Exeter *Stormwater Management Standards for Post Construction and Construction.*

Implementing the maintenance procedures outlined in the Inspection and Maintenance Manual (I&M) will ensure the long-term performance of the system.

SECTION 2 EXISTING CONDITIONS

The project site is a portion of the property identified as Map 47 Lot 1-2 which has an area of approximately 3.80 acres. The site is located on the southern corner of the intersection of Continental Drive and Epping Road and is bordered by Continental Drive to the north, Epping Road to the East, a commercial/industrial use to the south, and a contractor's yard located in the western portion of the property.

The eastern portion of the property is currently developed with an approximately 10,531 sf building and associated paved parking lot which most recently served as a car dealership. The western portion of the property contains a contractor's yard consisting of paved parking and laydown area and several sheds and structures used for material storage. The two uses are separated by a fence line and the project area will be separated from the contractor's yard by a proposed lease line. The project area is almost entirely paved with the exception of grass and wooded areas along Continental Drive and a grassed drainage swale along Epping Road. Stormwater runoff from the majority of the site flows over pavement and is captured by one of several catch basins and directed through pipes to the southern corner of the project area discharging through an existing 12" CMP pipe at Design Point #1. Stormwater runoff from areas along Continental Drive and Epping Road enter the closed drainage system located in Epping Road at Design Point #2.

Site topography is variable and slopes generally from north to south with elevations ranging from 104 along Continental Drive to 93 along the southern edge of the project area.

The NRCS Web Soil Survey identifies on-site soils as Charlton, Squamscott, and Eldridge fine sandy loams as well as a large area of Urban Land classification. The Hydrologic Soil Group (HSG) classification consists of both B and C. Refer to Appendix B for additional information.

Test pits were performed by Greenman-Pedersen, Inc. (GPI) on April 6, 2021. Test pits encountered a fill layer of varying depth underlain by silt loam. Estimated seasonal high water table (ESHWT) depths range from 21"-52" below existing grade. Test pit logs are included in Appendix C.

The project site is located within Zone X, which is an area of minimal flood hazard outside the 100-year flood zone, according to the Federal Emergency Management Agency (FEMA) FIRM panel 33015C0401E effective on 5/17/2005.

SECTION 3 PROPOSED CONDITIONS

The Applicant is proposing to redevelop the eastern portion of the property with a new retail motor fuel outlet facility consisting of a 5,500 sf convenience store, a fuel dispensing area with 6 dispensers (12 fueling positions), a 4,182 sf tunnel car wash, 7 outdoor vacuum spaces, and a paved parking lot with 22 parking spaces. Site work includes site grading, erosion control measures, new utility connections, and the construction of a new stormwater management system. The proposed development will be accessed via two site driveways, including a reconfigured access driveway along Epping Road which is shared with Lot 1-1 to the south, and a new 30-foot wide full access driveway along Continental Drive.

In order to mitigate any increases in peak discharge rates & volumes of stormwater runoff as a result of the redevelopment, a comprehensive stormwater management system has been designed that includes deep-sump, hooded catch basins, First Defense hydrodynamic separator units, underground detention systems, a bioretention area, and a Jellyfish Treatment Unit.

The bioretention area is designed to reduce peak flow rates at all design points and provide groundwater recharge prior to discharging through outlet pipes or infiltrating into the underlying soil.

Stormwater runoff from the redeveloped site will be captured by proposed deep-sump catch basins with hooded outlets to remove debris and heavy particles, directed through pipes to a First Defense hydrodynamic separator unit to remove floatables and suspended solids, then into a detention system where the discharge will be controlled with the use of an outlet control structure , then through a Jellyfish filter unit designed to provide treatment of the water quality flow, remove fine particles, and remove a high percentage of pollutants such as phosphorous and nitrogen prior to discharge through the existing drainage system.

The proposed project results in a reduction of impervious area of 7,700 square feet and qualifies as a redevelopment per the *Stormwater Management Standards for Post Construction and Construction.* Groundwater recharge measures have been implemented where possible on-site and together with the reduction in impervious coverage result in an increase in annual groundwater recharge compared with pre-redevelopment conditions. New impervious pavement and roof areas are routed through the proposed stormwater management system to achieve at least 80% Total Suspended Solids (TSS), 60% Total Nitrogen (TN) and 60% Total Phosphorous (TP) Removal , see table below and refer to Appendix G.

TABLE 4: POLLUTANT REMOVAL EFFICIENCIES

BMP	Total Suspended Solids (TSS)	Total Nitrogen (TN)	Total Phosphorus (TP)
Off-line Deep Sump Catch Basin	15%	5%	5%
First Defense (Hydrodynamic Separator)	35%	10%	5%
Jellyfish Filter	89%	51%	59%

In accordance with *Section 9.3 Stormwater Management Standards for Post Construction and Construction*, the Water Quality Flow for the Jellyfish filter is being met. See Appendix G for more detailed information from the manufacturer.

Another safeguard against future intrusion of contaminants into the groundwater is the implementation of an Operation & Maintenance Plan, which would assure proper function of drainage components and reduce TSS entering the system. To prevent erosion and discharge of sediment during construction, Best Management Practices including silt fence, a stabilized construction exit, mulch and seeding have been incorporated into the construction sequence.

Since the total area of disturbance related to construction of the proposed redevelopment is approximately 94,000 square feet, the project will not require an NHDES Alteration of Terrain Permit. The project will however require an EPA Construction General Permit under the NPDES program since the area of disturbance is greater than one acre.

SECTION 4 STORMWATER MODELING METHODOLOGY

The drainage system for this project was modeled using HydroCAD, a stormwater modeling computer program that analyzes the hydrology, and hydraulics of stormwater runoff. HydroCAD is based largely on the hydrology techniques developed by the Soil Conservation Service (SCS/NRCS), combined with other hydrology and hydraulics calculations. For a given rainfall event, these techniques are used to generate hydrographs throughout a watershed. This provides verification that a given drainage system is adequate for the area under consideration, or to predict where flooding or erosion is likely to occur.

In HydroCAD, each watershed is modeled as a Subcatchment, streams and culverts as a Reach (or Pond, depending on available storage capacity), and large wetlands and other natural or artificial storage areas as a Pond. SCS hydrograph generation and routing procedures were used to model both Pre-development and Post-development runoff conditions.

The Pre-development and Post-development watershed limits and the subcatchment characteristics were determined using both USGS and on-the-ground topographic survey information and through visual, on-site inspection. Conservative estimates were used at all times in estimating the hydrologic characteristics of each watershed or subcatchment.

APPENDIX A

USGS Map

USGS SITE LOCATION MAP

EXETER QUADRANGLE

PROJECT:
Proposed Retail Motor Fuel Outlet
Exeter, NH
Map 47 Lot 1–2

PREPARED FOR:
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DATE: April 20, 2021

PROJECT NUMBER: NEX–2020283

SCALE: 1"=2,000'

APPENDIX B

NRCS Soils Information

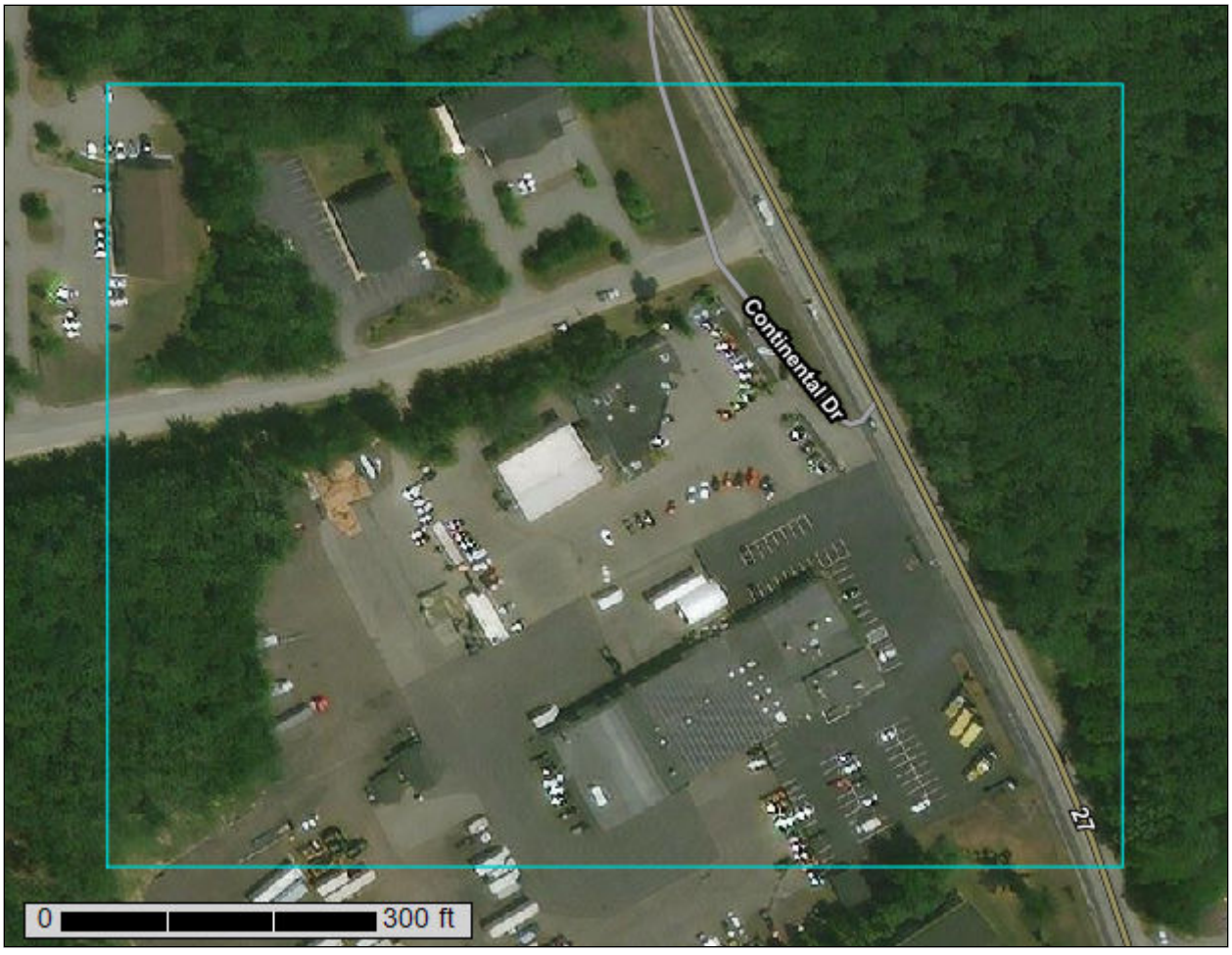
United States Department of Agriculture

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 Rockingham County, New Hampshire



March 22, 2021

Preface

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

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

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

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

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

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

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Contents

How Soil Surveys Are Made

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

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

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

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

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

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

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

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

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

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

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

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

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

Soil Map

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

Custom Soil Resource Report
Soil Map

Map Scale: 1:1,910 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 25 50 100 150

Feet
0 50 100 200 300

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

MAP LEGEND

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

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

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

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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: Rockingham County, New Hampshire
Survey Area Data: Version 22, 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 12, 2016

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
33A	Scitico silt loam, 0 to 5 percent slopes	1.2	7.3%
38B	Eldridge fine sandy loam, 3 to 8 percent slopes	2.9	17.6%
63B	Charlton fine sandy loam, 3 to 8 percent slopes, very stony	6.4	38.8%
538A	Squamscott fine sandy loam, 0 to 5 percent slopes	3.1	18.9%
699	Urban land	2.9	17.5%
Totals for Area of Interest		**16.4**	**100.0%**

Map Unit Descriptions

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

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

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

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

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

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

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

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

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

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

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

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

Rockingham County, New Hampshire

33A—Scitico silt loam, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 9cn6
Elevation: 0 to 180 feet
Mean annual precipitation: 47 to 49 inches
Mean annual air temperature: 48 degrees F
Frost-free period: 155 to 165 days
Farmland classification: Farmland of local importance

Map Unit Composition

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

Description of Scitico

Setting

Landform: Marine terraces

Typical profile

H1 - 0 to 6 inches: silt loam
H2 - 6 to 12 inches: silty clay loam
H3 - 12 to 60 inches: silty clay

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly 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: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: Moderate (about 7.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: C/D
Ecological site: F144AY019NH - Wet Lake Plain
Hydric soil rating: Yes

Minor Components

Squamscott

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

Maybid

Percent of map unit: 5 percent
Landform: Marine terraces

Hydric soil rating: Yes

Boxford

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

38B—Eldridge fine sandy loam, 3 to 8 percent slopes

Map Unit Setting

National map unit symbol: 9cnb
Elevation: 90 to 1,000 feet
Mean annual precipitation: 30 to 55 inches
Mean annual air temperature: 45 to 54 degrees F
Frost-free period: 120 to 180 days
Farmland classification: All areas are prime farmland

Map Unit Composition

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

Description of Eldridge

Setting

Parent material: Outwash over glaciolacustrine

Typical profile

H1 - 0 to 8 inches: fine sandy loam
H2 - 8 to 23 inches: loamy fine sand
H3 - 23 to 62 inches: loamy very fine sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: About 12 to 24 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: C/D
Ecological site: F144AY027MA - Moist Sandy Outwash
Hydric soil rating: No

Minor Components

Squamscott
Percent of map unit: 5 percent
Landform: Marine terraces
Hydric soil rating: Yes

Well drained inclusion
Percent of map unit: 5 percent
Hydric soil rating: No

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

Scitico
Percent of map unit: 5 percent
Landform: Marine terraces
Hydric soil rating: Yes

63B—Charlton fine sandy loam, 3 to 8 percent slopes, very stony

Map Unit Setting
National map unit symbol: 2wh0r
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: Farmland of local importance

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: Ridges, hills, ground moraines
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Side slope, crest, nose 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: 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): 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: F142XB009VT - Acidic Till Upland
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: Hills, ground moraines, drumlins
Landform position (two-dimensional): Backslope, shoulder, summit
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: Ridges, hills
Landform position (two-dimensional): Backslope, shoulder, summit
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: Depressions, drainageways
Down-slope shape: Linear
Across-slope shape: Concave
Hydric soil rating: Yes

538A—Squamscott fine sandy loam, 0 to 5 percent slopes

Map Unit Setting

National map unit symbol: 9cp9
Elevation: 0 to 1,000 feet
Mean annual precipitation: 30 to 55 inches
Mean annual air temperature: 45 to 54 degrees F
Frost-free period: 120 to 180 days
Farmland classification: Farmland of local importance

Map Unit Composition

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

Description of Squamscott

Setting

Landform: Marine terraces

Typical profile

H1 - 0 to 4 inches: fine sandy loam
H2 - 4 to 12 inches: loamy sand
H3 - 12 to 19 inches: fine sand
H4 - 19 to 65 inches: silt loam

Properties and qualities

Slope: 0 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.60 in/hr)
Depth to water table: About 0 to 12 inches
Frequency of flooding: None
Frequency of ponding: None
Available water capacity: High (about 9.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: C/D
Ecological site: F144AY019NH - Wet Lake Plain
Hydric soil rating: Yes

Minor Components

Scitico

Percent of map unit: 5 percent
Landform: Marine terraces

Hydric soil rating: Yes

Maybid

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

Eldridge

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

699—Urban land

Map Unit Composition

Urban land: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

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.

Custom Soil Resource Report
Map—Hydrologic Soil Group

Map Scale: 1:1,910 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 25 50 100 150

Feet: 0 50 100 200 300

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

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: Rockingham County, New Hampshire
Survey Area Data: Version 22, 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 12, 2016

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

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
33A	Scitico silt loam, 0 to 5 percent slopes	C/D	1.2	7.3%
38B	Eldridge fine sandy loam, 3 to 8 percent slopes	C/D	2.9	17.6%
63B	Charlton fine sandy loam, 3 to 8 percent slopes, very stony	B	6.4	38.8%
538A	Squamscott fine sandy loam, 0 to 5 percent slopes	C/D	3.1	18.9%
699	Urban land		2.9	17.5%
Totals for Area of Interest			**16.4**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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APPENDIX C

Test Pit Logs

TEST PIT DATA

NEW HAMPSHIRE Designer of Subsurface Disposal Systems ★★★ Diane M. Pantermoller No. 1665 Department of Environmental Services

Client: Nouria Energy Corporation
Project Address: 158 Epping Road
Town, State: Exeter, NH
Job Number: NEX-2020283
Date: April 6, 2021
Performed by: Diane Pantermoller

Test Pit No. **1** SCS Soil: Urban Land
ESHWT: 52” Standing Water: None
Refusal: >104” Roots: None

Depth	Horizon	Soil Texture	Color	Consistence	Mottles; Quantity/Contrast
0-52”	Fill/pavement	Mixed Soils	Variable		
52-104”	Cd	Silt Loam	2.5y 5/3	Platy	@52” Distinct

Test Pit No. **2** SCS Soil: Urban Land
ESHWT: 44” Standing Water: None
Refusal: >117” Roots: None

Depth	Horizon	Soil Texture	Color	Consistence	Mottles; Quantity/Contrast
0-22”	Fill/pavement	Mixed Soils	Variable		
22-117”	Cd	Silt Loam	2.5y 5/3	Platy	@44” Distinct

Test Pit No. **3** SCS Soil: Scitico Silt Loam
ESHWT: 42” Standing Water: 104”
Refusal: >108” Roots: None

Depth	Horizon	Soil Texture	Color	Consistence	Mottles; Quantity/Contrast
0-36”	Fill	Mixed Soils	Variable		
36-108”	Cd	Silt Loam	2.5y 5/3	Platy	@42” Distinct

Test Pit No. **4** SCS Soil: Scitico Silt Loam
ESHWT: 24” Standing Water: None
Refusal: 56” Roots: None

Depth	Horizon	Soil Texture	Color	Consistence	Mottles; Quantity/Contrast
0-24”	Fill	Mixed Soils	Variable		
24-56”	Cd	Silt Loam	2.5y 5/3	Platy	@ 24” Distinct

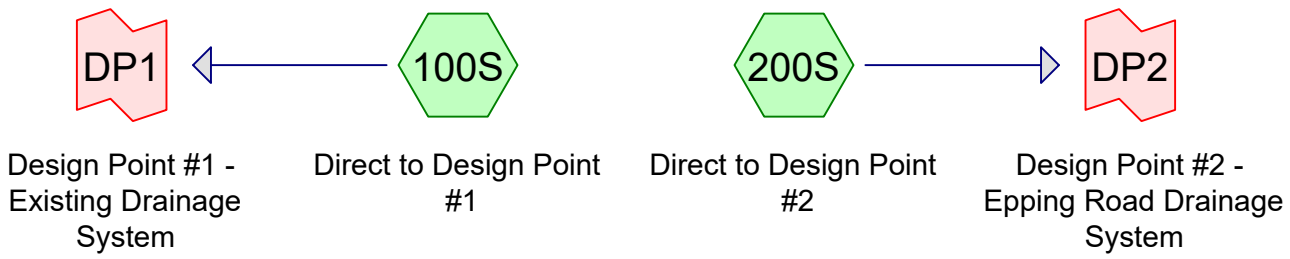
Test Pit No. **5** SCS Soil: Squamscott
ESHWT: 48” Standing Water: 60”
Refusal: >102” Roots: None

Depth	Horizon	Soil Texture	Color	Consistence	Mottles; Quantity/Contrast
0-21”	Fill	Mixed Soils	Variable		
21-72”	C1	Sand	10yr 6/6	FR	
72-102”	C2	Silt Loam	2.5y 5/3	Platy	@48” Distinct

NOTES

APPENDIX D

Pre-Development HydroCAD Computations



Design Point #1 - Existing Drainage System

Direct to Design Point #1

Direct to Design Point #2

Design Point #2 - Epping Road Drainage System

Subcat Reach Pond Link

Routing Diagram for 20283 Pre REV-1
Prepared by Greenman-Pedersen, Inc., Printed 7/14/2021
HydroCAD® 10.10-5a s/n 01710 © 2020 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-yr	Type III 24-hr		Default	24.00	1	3.67	2
2	10-yr	Type III 24-hr		Default	24.00	1	5.60	2
3	25-yr	Type III 24-hr		Default	24.00	1	7.13	2
4	50-yr	Type III 24-hr		Default	24.00	1	8.55	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
6,386	61	>75% Grass cover, Good, HSG B (100S, 200S)
12,304	74	>75% Grass cover, Good, HSG C (100S, 200S)
21,714	98	Paved parking, HSG B (100S, 200S)
71,612	98	Paved parking, HSG C (100S, 200S)
4,370	98	Roofs, HSG B (100S)
7,372	98	Roofs, HSG C (100S)
7,155	66	Woods, Poor, HSG B (100S, 200S)
0	77	Woods, Poor, HSG C (200S)
130,912	**92**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
39,625	HSG B	100S, 200S
91,287	HSG C	100S, 200S
0	HSG D	
0	Other	
130,912		**TOTAL AREA**

Ground Covers (all 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	6,386	12,304	0	0	18,690	>75% Grass cover, Good	
0	21,714	71,612	0	0	93,326	Paved parking	
0	4,370	7,372	0	0	11,742	Roofs	
0	7,155	0	0	0	7,155	Woods, Poor	
0	**39,625**	**91,287**	**0**	**0**	**130,912**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	100S	0.00	0.00	120.0	0.0050	0.025	0.0	12.0	0.0
2	100S	0.00	0.00	128.0	0.0050	0.025	0.0	12.0	0.0
3	100S	0.00	0.00	166.0	0.0070	0.025	0.0	12.0	0.0

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 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

Subcatchment100S: Direct to Design Point Runoff Area=2.338 ac 88.24% Impervious Runoff Depth=3.00"
Flow Length=584' Tc=7.6 min CN=94 Runoff=7.40 cfs 25,471 cf

Subcatchment200S: Direct to Design Runoff Area=29,079 sf 52.32% Impervious Runoff Depth=2.08"
Flow Length=393' Tc=10.1 min CN=84 Runoff=1.42 cfs 5,047 cf

Link DP1: Design Point #1 - Existing Drainage System Inflow=7.40 cfs 25,471 cf
Primary=7.40 cfs 25,471 cf

Link DP2: Design Point #2 - Epping Road Drainage System Inflow=1.42 cfs 5,047 cf
Primary=1.42 cfs 5,047 cf

Total Runoff Area = 130,912 sf Runoff Volume = 30,518 cf Average Runoff Depth = 2.80"
19.74% Pervious = 25,844 sf 80.26% Impervious = 105,068 sf

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 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

Subcatchment100S: Direct to Design Point Runoff Area=2.338 ac 88.24% Impervious Runoff Depth=4.90"
Flow Length=584' Tc=7.6 min CN=94 Runoff=11.75 cfs 41,588 cf

Subcatchment200S: Direct to Design Runoff Area=29,079 sf 52.32% Impervious Runoff Depth=3.82"
Flow Length=393' Tc=10.1 min CN=84 Runoff=2.58 cfs 9,266 cf

Link DP1: Design Point #1 - Existing Drainage System Inflow=11.75 cfs 41,588 cf
Primary=11.75 cfs 41,588 cf

Link DP2: Design Point #2 - Epping Road Drainage System Inflow=2.58 cfs 9,266 cf
Primary=2.58 cfs 9,266 cf

Total Runoff Area = 130,912 sf Runoff Volume = 50,853 cf Average Runoff Depth = 4.66"
19.74% Pervious = 25,844 sf 80.26% Impervious = 105,068 sf

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 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

Subcatchment100S: Direct to Design Point Runoff Area=2.338 ac 88.24% Impervious Runoff Depth=6.42"
Flow Length=584' Tc=7.6 min CN=94 Runoff=15.16 cfs 54,458 cf

Subcatchment200S: Direct to Design Runoff Area=29,079 sf 52.32% Impervious Runoff Depth=5.26"
Flow Length=393' Tc=10.1 min CN=84 Runoff=3.51 cfs 12,755 cf

Link DP1: Design Point #1 - Existing Drainage System Inflow=15.16 cfs 54,458 cf
Primary=15.16 cfs 54,458 cf

Link DP2: Design Point #2 - Epping Road Drainage System Inflow=3.51 cfs 12,755 cf
Primary=3.51 cfs 12,755 cf

Total Runoff Area = 130,912 sf Runoff Volume = 67,213 cf Average Runoff Depth = 6.16"
19.74% Pervious = 25,844 sf 80.26% Impervious = 105,068 sf

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 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

Subcatchment100S: Direct to Design Point Runoff Area=2.338 ac 88.24% Impervious Runoff Depth=7.83"
Flow Length=584' Tc=7.6 min CN=94 Runoff=18.31 cfs 66,437 cf

Subcatchment200S: Direct to Design Runoff Area=29,079 sf 52.32% Impervious Runoff Depth=6.62"
Flow Length=393' Tc=10.1 min CN=84 Runoff=4.37 cfs 16,053 cf

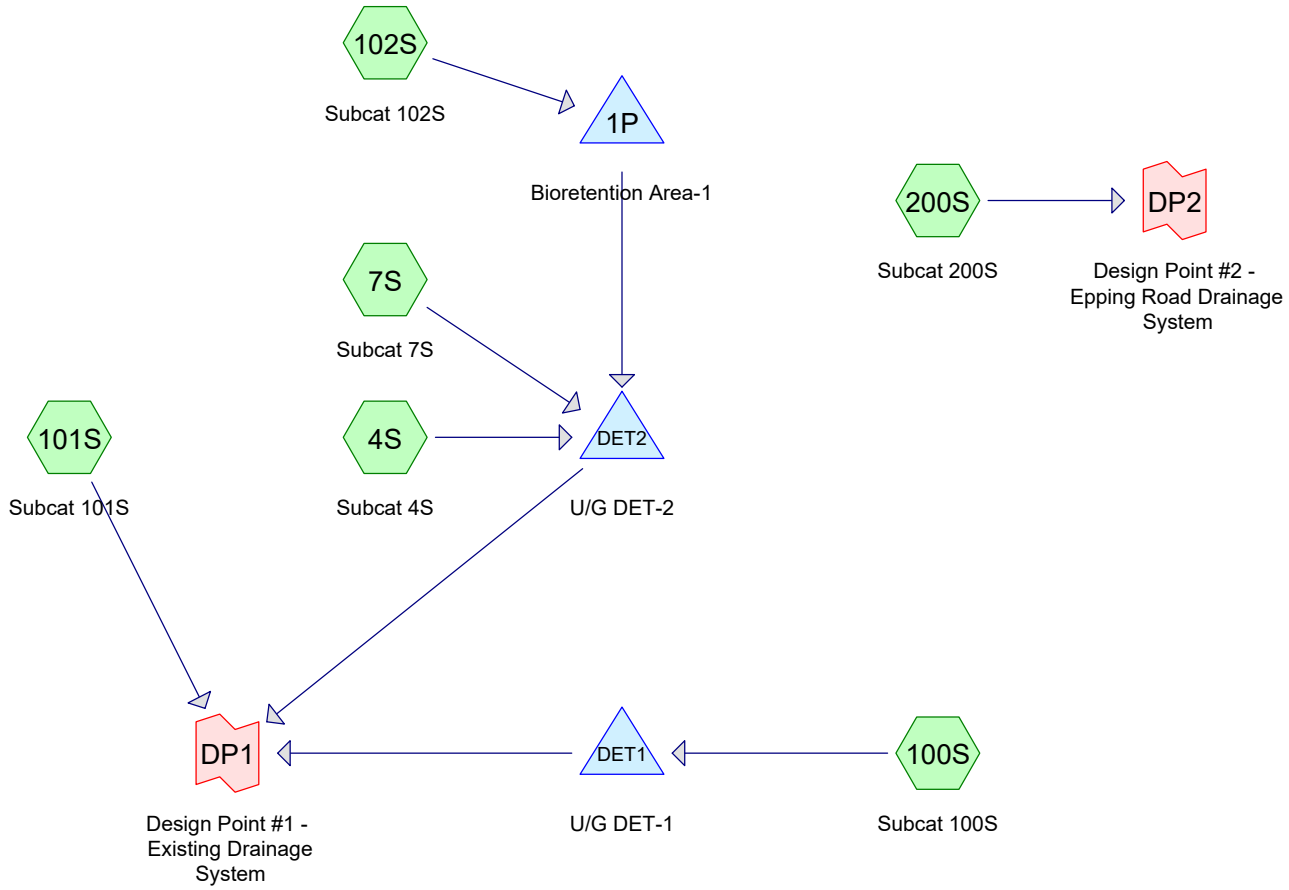
Link DP1: Design Point #1 - Existing Drainage System Inflow=18.31 cfs 66,437 cf
Primary=18.31 cfs 66,437 cf

Link DP2: Design Point #2 - Epping Road Drainage System Inflow=4.37 cfs 16,053 cf
Primary=4.37 cfs 16,053 cf

Total Runoff Area = 130,912 sf Runoff Volume = 82,490 cf Average Runoff Depth = 7.56"
19.74% Pervious = 25,844 sf 80.26% Impervious = 105,068 sf

APPENDIX E

Post-Development HydroCAD Computations



Subcat Reach Pond Link

Routing Diagram for 20283 Post REV-1
Prepared by Greenman-Pedersen, Inc., Printed 7/14/2021
HydroCAD® 10.10-5a s/n 01710 © 2020 HydroCAD Software Solutions LLC

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-yr	Type III 24-hr		Default	24.00	1	3.67	2
2	10-yr	Type III 24-hr		Default	24.00	1	5.60	2
3	25-yr	Type III 24-hr		Default	24.00	1	7.13	2
4	50-yr	Type III 24-hr		Default	24.00	1	8.55	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
12,066	61	>75% Grass cover, Good, HSG B (4S, 7S, 101S, 102S, 200S)
21,423	74	>75% Grass cover, Good, HSG C (4S, 100S, 101S, 200S)
23,346	98	Paved parking, HSG B (4S, 7S, 100S, 101S, 102S, 200S)
65,631	98	Paved parking, HSG C (4S, 100S, 101S, 200S)
4,115	98	Roofs, HSG B (4S)
4,253	98	Roofs, HSG C (4S, 100S, 101S)
96	55	Woods, Good, HSG B (101S)
130,930	**91**	**TOTAL AREA**

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
39,623	HSG B	4S, 7S, 100S, 101S, 102S, 200S
91,307	HSG C	4S, 100S, 101S, 200S
0	HSG D	
0	Other	
130,930		**TOTAL AREA**

Ground Covers (all 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	12,066	21,423	0	0	33,489	>75% Grass cover, Good	
0	23,346	65,631	0	0	88,977	Paved parking	
0	4,115	4,253	0	0	8,368	Roofs	
0	96	0	0	0	96	Woods, Good	
0	**39,623**	**91,307**	**0**	**0**	**130,930**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	100S	0.00	0.00	35.0	0.0100	0.012	0.0	12.0	0.0
2	1P	96.00	95.35	11.0	0.0591	0.012	0.0	8.0	0.0
3	DET1	90.50	90.30	35.0	0.0057	0.012	0.0	12.0	0.0
4	DET2	90.45	90.30	23.0	0.0065	0.012	0.0	12.0	0.0

Notes Listing (all nodes)

Line#	Node Number	Notes
1	1P	Surrounding soils include Eldridge (Ksat low B = 6 in/hr), Charlton (Ksat low B = 0.6 in/hr), and Squamscott (Ksat low B = 6 in/hr). For design purposes, the average of 0.6 in/hr and 6 in/hr was used, which with a factor of safety yields a design infiltration rate of 1.65 in/hr.

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 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

Subcatchment4S: Subcat 4S Runoff Area=29,818 sf 78.55% Impervious Runoff Depth=2.70"
Flow Length=53' Tc=3.0 min CN=91 Runoff=2.36 cfs 6,715 cf

Subcatchment7S: Subcat 7S Runoff Area=0.050 ac 58.24% Impervious Runoff Depth=2.00"
Flow Length=31' Tc=1.2 min CN=83 Runoff=0.14 cfs 360 cf

Subcatchment100S: Subcat 100S Runoff Area=1.202 ac 91.80% Impervious Runoff Depth=3.21"
Flow Length=226' Tc=6.1 min CN=96 Runoff=4.16 cfs 14,018 cf

Subcatchment101S: Subcat 101S Runoff Area=19,995 sf 58.34% Impervious Runoff Depth=2.08"
Flow Length=105' Tc=2.7 min CN=84 Runoff=1.26 cfs 3,471 cf

Subcatchment102S: Subcat 102S Runoff Area=3,558 sf 78.84% Impervious Runoff Depth=2.61"
Flow Length=45' Slope=0.0200 '/' Tc=1.1 min CN=90 Runoff=0.29 cfs 773 cf

Subcatchment200S: Subcat 200S Runoff Area=23,053 sf 43.99% Impervious Runoff Depth=2.08"
Flow Length=140' Tc=6.1 min CN=84 Runoff=1.29 cfs 4,001 cf

Pond 1P: Bioretention Area-1 Peak Elev=97.22' Storage=56 cf Inflow=0.29 cfs 773 cf
Discarded=0.01 cfs 262 cf Primary=0.28 cfs 511 cf Outflow=0.28 cfs 773 cf

Pond DET1: U/G DET-1 Peak Elev=91.96' Storage=3,694 cf Inflow=4.16 cfs 14,018 cf
Outflow=1.04 cfs 14,018 cf

Pond DET2: U/G DET-2 Peak Elev=91.63' Storage=1,100 cf Inflow=2.76 cfs 7,586 cf
Outflow=1.22 cfs 7,586 cf

Link DP1: Design Point #1 - Existing Drainage System Inflow=3.12 cfs 25,075 cf
Primary=3.12 cfs 25,075 cf

Link DP2: Design Point #2 - Epping Road Drainage System Inflow=1.29 cfs 4,001 cf
Primary=1.29 cfs 4,001 cf

Total Runoff Area = 130,930 sf Runoff Volume = 29,338 cf Average Runoff Depth = 2.69"
25.65% Pervious = 33,585 sf 74.35% Impervious = 97,345 sf

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 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

Subcatchment4S: Subcat 4S Runoff Area=29,818 sf 78.55% Impervious Runoff Depth=4.57"
Flow Length=53' Tc=3.0 min CN=91 Runoff=3.88 cfs 11,346 cf

Subcatchment7S: Subcat 7S Runoff Area=0.050 ac 58.24% Impervious Runoff Depth=3.72"
Flow Length=31' Tc=1.2 min CN=83 Runoff=0.25 cfs 669 cf

Subcatchment100S: Subcat 100S Runoff Area=1.202 ac 91.80% Impervious Runoff Depth=5.13"
Flow Length=226' Tc=6.1 min CN=96 Runoff=6.48 cfs 22,376 cf

Subcatchment101S: Subcat 101S Runoff Area=19,995 sf 58.34% Impervious Runoff Depth=3.82"
Flow Length=105' Tc=2.7 min CN=84 Runoff=2.29 cfs 6,371 cf

Subcatchment102S: Subcat 102S Runoff Area=3,558 sf 78.84% Impervious Runoff Depth=4.46"
Flow Length=45' Slope=0.0200 '/' Tc=1.1 min CN=90 Runoff=0.49 cfs 1,322 cf

Subcatchment200S: Subcat 200S Runoff Area=23,053 sf 43.99% Impervious Runoff Depth=3.82"
Flow Length=140' Tc=6.1 min CN=84 Runoff=2.34 cfs 7,345 cf

Pond 1P: Bioretention Area-1 Peak Elev=97.27' Storage=63 cf Inflow=0.49 cfs 1,322 cf
Discarded=0.01 cfs 311 cf Primary=0.47 cfs 1,011 cf Outflow=0.48 cfs 1,322 cf

Pond DET1: U/G DET-1 Peak Elev=92.67' Storage=6,534 cf Inflow=6.48 cfs 22,376 cf
Outflow=1.46 cfs 22,376 cf

Pond DET2: U/G DET-2 Peak Elev=92.35' Storage=2,304 cf Inflow=4.56 cfs 13,026 cf
Outflow=1.75 cfs 13,026 cf

Link DP1: Design Point #1 - Existing Drainage System Inflow=4.67 cfs 41,773 cf
Primary=4.67 cfs 41,773 cf

Link DP2: Design Point #2 - Epping Road Drainage System Inflow=2.34 cfs 7,345 cf
Primary=2.34 cfs 7,345 cf

Total Runoff Area = 130,930 sf Runoff Volume = 49,429 cf Average Runoff Depth = 4.53"
25.65% Pervious = 33,585 sf 74.35% Impervious = 97,345 sf

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 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

Subcatchment4S: Subcat 4S Runoff Area=29,818 sf 78.55% Impervious Runoff Depth=6.07"
Flow Length=53' Tc=3.0 min CN=91 Runoff=5.07 cfs 15,074 cf

Subcatchment7S: Subcat 7S Runoff Area=0.050 ac 58.24% Impervious Runoff Depth=5.15"
Flow Length=31' Tc=1.2 min CN=83 Runoff=0.35 cfs 926 cf

Subcatchment100S: Subcat 100S Runoff Area=1.202 ac 91.80% Impervious Runoff Depth=6.65"
Flow Length=226' Tc=6.1 min CN=96 Runoff=8.31 cfs 29,024 cf

Subcatchment101S: Subcat 101S Runoff Area=19,995 sf 58.34% Impervious Runoff Depth=5.26"
Flow Length=105' Tc=2.7 min CN=84 Runoff=3.11 cfs 8,770 cf

Subcatchment102S: Subcat 102S Runoff Area=3,558 sf 78.84% Impervious Runoff Depth=5.95"
Flow Length=45' Slope=0.0200 '/' Tc=1.1 min CN=90 Runoff=0.64 cfs 1,764 cf

Subcatchment200S: Subcat 200S Runoff Area=23,053 sf 43.99% Impervious Runoff Depth=5.26"
Flow Length=140' Tc=6.1 min CN=84 Runoff=3.18 cfs 10,112 cf

Pond 1P: Bioretention Area-1 Peak Elev=97.30' Storage=68 cf Inflow=0.64 cfs 1,764 cf
Discarded=0.01 cfs 330 cf Primary=0.62 cfs 1,435 cf Outflow=0.63 cfs 1,764 cf

Pond DET1: U/G DET-1 Peak Elev=93.19' Storage=8,395 cf Inflow=8.31 cfs 29,024 cf
Outflow=2.58 cfs 29,024 cf

Pond DET2: U/G DET-2 Peak Elev=93.00' Storage=3,331 cf Inflow=5.98 cfs 17,435 cf
Outflow=2.16 cfs 17,435 cf

Link DP1: Design Point #1 - Existing Drainage System Inflow=5.98 cfs 55,230 cf
Primary=5.98 cfs 55,230 cf

Link DP2: Design Point #2 - Epping Road Drainage System Inflow=3.18 cfs 10,112 cf
Primary=3.18 cfs 10,112 cf

Total Runoff Area = 130,930 sf Runoff Volume = 65,671 cf Average Runoff Depth = 6.02"
25.65% Pervious = 33,585 sf 74.35% Impervious = 97,345 sf

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 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

Subcatchment4S: Subcat 4S Runoff Area=29,818 sf 78.55% Impervious Runoff Depth=7.47"
Flow Length=53' Tc=3.0 min CN=91 Runoff=6.17 cfs 18,556 cf

Subcatchment7S: Subcat 7S Runoff Area=0.050 ac 58.24% Impervious Runoff Depth=6.50"
Flow Length=31' Tc=1.2 min CN=83 Runoff=0.43 cfs 1,169 cf

Subcatchment100S: Subcat 100S Runoff Area=1.202 ac 91.80% Impervious Runoff Depth=8.07"
Flow Length=226' Tc=6.1 min CN=96 Runoff=10.00 cfs 35,203 cf

Subcatchment101S: Subcat 101S Runoff Area=19,995 sf 58.34% Impervious Runoff Depth=6.62"
Flow Length=105' Tc=2.7 min CN=84 Runoff=3.87 cfs 11,038 cf

Subcatchment102S: Subcat 102S Runoff Area=3,558 sf 78.84% Impervious Runoff Depth=7.35"
Flow Length=45' Slope=0.0200 '/' Tc=1.1 min CN=90 Runoff=0.78 cfs 2,179 cf

Subcatchment200S: Subcat 200S Runoff Area=23,053 sf 43.99% Impervious Runoff Depth=6.62"
Flow Length=140' Tc=6.1 min CN=84 Runoff=3.95 cfs 12,726 cf

Pond 1P: Bioretention Area-1 Peak Elev=97.33' Storage=72 cf Inflow=0.78 cfs 2,179 cf
Discarded=0.01 cfs 343 cf Primary=0.76 cfs 1,835 cf Outflow=0.76 cfs 2,179 cf

Pond DET1: U/G DET-1 Peak Elev=93.47' Storage=9,146 cf Inflow=10.00 cfs 35,203 cf
Outflow=4.41 cfs 35,203 cf

Pond DET2: U/G DET-2 Peak Elev=93.42' Storage=3,849 cf Inflow=7.28 cfs 21,560 cf
Outflow=4.21 cfs 21,560 cf

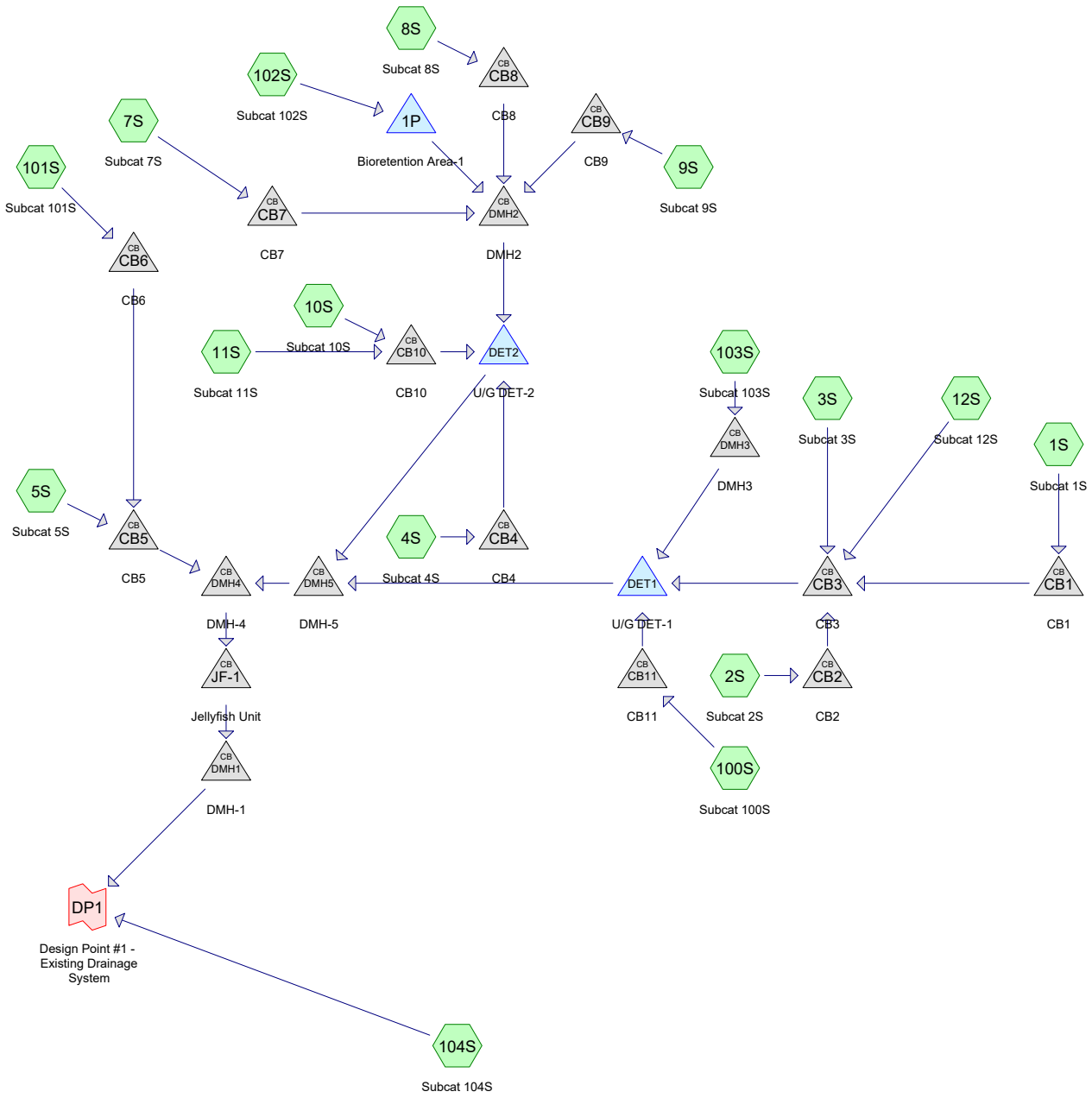
Link DP1: Design Point #1 - Existing Drainage System Inflow=9.14 cfs 67,801 cf
Primary=9.14 cfs 67,801 cf

Link DP2: Design Point #2 - Epping Road Drainage System Inflow=3.95 cfs 12,726 cf
Primary=3.95 cfs 12,726 cf

Total Runoff Area = 130,930 sf Runoff Volume = 80,871 cf Average Runoff Depth = 7.41"
25.65% Pervious = 33,585 sf 74.35% Impervious = 97,345 sf

APPENDIX F

Post-Development Pipe Sizing Computations



Routing Diagram for 20283 Post REV-1 PIPE SIZING
Prepared by Greenman-Pedersen, Inc., Printed 7/14/2021
HydroCAD® 10.10-5a s/n 01710 © 2020 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	10-yr	Type III 24-hr		Default	24.00	1	5.60	2

Area Listing (selected nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.262	61	>75% Grass cover, Good, HSG B (4S, 5S, 7S, 8S, 9S, 10S, 101S, 102S, 104S)
0.210	74	>75% Grass cover, Good, HSG C (1S, 2S, 3S, 4S, 5S, 9S, 10S, 100S, 104S)
0.497	98	Paved parking, HSG B (4S, 5S, 7S, 8S, 9S, 10S, 101S, 102S, 103S, 104S)
1.313	98	Paved parking, HSG C (1S, 2S, 3S, 4S, 5S, 9S, 10S, 100S, 103S, 104S)
0.094	98	Roofs, HSG B (11S)
0.098	98	Roofs, HSG C (11S, 12S, 104S)
0.002	55	Woods, Good, HSG B (101S)
2.476	**92**	**TOTAL AREA**

Soil Listing (selected nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.856	HSG B	4S, 5S, 7S, 8S, 9S, 10S, 11S, 101S, 102S, 103S, 104S
1.621	HSG C	1S, 2S, 3S, 4S, 5S, 9S, 10S, 11S, 12S, 100S, 103S, 104S
0.000	HSG D	
0.000	Other	
2.476		**TOTAL AREA**

Ground Covers (selected nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.262	0.210	0.000	0.000	0.472	>75% Grass cover, Good	1S, 2S, 3S, 4S, 5S, 7S, 8S, 9S, 10S, 100S, 101S, 102S, 104S
0.000	0.497	1.313	0.000	0.000	1.810	Paved parking	1S, 2S, 3S, 4S, 5S, 7S, 8S, 9S, 10S, 100S, 101S, 102S, 103S, 104S
0.000	0.094	0.098	0.000	0.000	0.192	Roofs	11S, 12S, 104S
0.000	0.002	0.000	0.000	0.000	0.002	Woods, Good	101S
0.000	**0.856**	**1.621**	**0.000**	**0.000**	**2.476**	**TOTAL AREA**	

Pipe Listing (selected nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	1P	96.00	95.35	11.0	0.0591	0.012	0.0	8.0	0.0
2	CB1	91.95	91.34	46.0	0.0133	0.012	0.0	12.0	0.0
3	CB10	92.40	92.35	5.0	0.0100	0.012	0.0	12.0	0.0
4	CB11	91.55	91.00	22.0	0.0250	0.012	0.0	12.0	0.0
5	CB2	91.55	91.34	23.0	0.0091	0.012	0.0	12.0	0.0
6	CB3	91.24	91.15	9.0	0.0100	0.012	0.0	12.0	0.0
7	CB4	92.25	92.15	8.0	0.0125	0.012	0.0	12.0	0.0
8	CB5	91.90	91.50	25.0	0.0160	0.012	0.0	12.0	0.0
9	CB6	93.10	92.00	104.0	0.0106	0.012	0.0	12.0	0.0
10	CB7	94.65	93.80	84.0	0.0101	0.012	0.0	12.0	0.0
11	CB8	94.75	94.35	23.0	0.0174	0.012	0.0	12.0	0.0
12	CB9	94.30	93.80	24.0	0.0208	0.012	0.0	12.0	0.0
13	DET1	90.50	90.30	35.0	0.0057	0.012	0.0	12.0	0.0
14	DET2	90.45	90.30	23.0	0.0065	0.012	0.0	12.0	0.0
15	DMH1	89.60	88.92	102.0	0.0067	0.025	0.0	12.0	0.0
16	DMH2	93.70	92.45	37.0	0.0338	0.012	0.0	12.0	0.0
17	DMH3	93.40	93.00	4.0	0.1000	0.012	0.0	6.0	0.0
18	DMH4	89.95	89.90	5.0	0.0100	0.012	0.0	15.0	0.0
19	DMH5	90.20	90.05	31.0	0.0048	0.012	0.0	12.0	0.0
20	JF-1	89.80	89.70	10.0	0.0100	0.012	0.0	15.0	0.0

Notes Listing (selected nodes)

Line#	Node Number	Notes
1	1P	Surrounding soils include Eldridge (Ksat low B = 6 in/hr), Charlton (Ksat low B = 0.6 in/hr), and Squamscott (Ksat low B = 6 in/hr). For design purposes, the average of 0.6 in/hr and 6 in/hr was used, which with a factor of safety yields a design infiltration rate of 1.65 in/hr.

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 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

Subcatchment1S: Subcat 1S Runoff Area=0.156 ac 92.20% Impervious Runoff Depth=5.13"
Flow Length=188' Tc=2.3 min CN=96 Runoff=0.96 cfs 0.067 af

Subcatchment2S: Subcat 2S Runoff Area=0.074 ac 96.77% Impervious Runoff Depth=5.25"
Flow Length=83' Tc=2.0 min CN=97 Runoff=0.47 cfs 0.033 af

Subcatchment3S: Subcat 3S Runoff Area=0.222 ac 95.15% Impervious Runoff Depth=5.25"
Flow Length=192' Tc=2.6 min CN=97 Runoff=1.37 cfs 0.097 af

Subcatchment4S: Subcat 4S Runoff Area=7,251 sf 80.70% Impervious Runoff Depth=4.79"
Flow Length=53' Tc=3.0 min CN=93 Runoff=0.97 cfs 0.066 af

Subcatchment5S: Subcat 5S Runoff Area=0.082 ac 74.66% Impervious Runoff Depth=4.35"
Flow Length=35' Slope=0.0250 '/' Tc=2.9 min CN=89 Runoff=0.45 cfs 0.030 af

Subcatchment7S: Subcat 7S Runoff Area=0.050 ac 58.24% Impervious Runoff Depth=3.72"
Flow Length=31' Tc=1.2 min CN=83 Runoff=0.25 cfs 0.015 af

Subcatchment8S: Subcat 8S Runoff Area=0.162 ac 53.25% Impervious Runoff Depth=3.52"
Flow Length=110' Tc=0.9 min CN=81 Runoff=0.80 cfs 0.047 af

Subcatchment9S: Subcat 9S Runoff Area=0.170 ac 79.17% Impervious Runoff Depth=4.57"
Flow Length=91' Tc=2.9 min CN=91 Runoff=0.97 cfs 0.065 af

Subcatchment10S: Subcat 10S Runoff Area=0.090 ac 95.83% Impervious Runoff Depth=5.25"
Flow Length=35' Tc=1.4 min CN=97 Runoff=0.58 cfs 0.039 af

Subcatchment11S: Subcat 11S Runoff Area=0.096 ac 100.00% Impervious Runoff Depth=5.36"
Tc=1.0 min CN=98 Runoff=0.63 cfs 0.043 af

Subcatchment12S: Subcat 12S Runoff Area=0.086 ac 100.00% Impervious Runoff Depth=5.36"
Tc=1.0 min CN=98 Runoff=0.56 cfs 0.038 af

Subcatchment100S: Subcat 100S Runoff Area=0.537 ac 86.38% Impervious Runoff Depth=5.01"
Flow Length=191' Tc=6.0 min CN=95 Runoff=2.88 cfs 0.224 af

Subcatchment101S: Subcat 101S Runoff Area=8,498 sf 59.84% Impervious Runoff Depth=3.72"
Flow Length=105' Tc=2.7 min CN=83 Runoff=0.95 cfs 0.061 af

Subcatchment102S: Subcat 102S Runoff Area=3,558 sf 78.84% Impervious Runoff Depth=4.46"
Flow Length=45' Slope=0.0200 '/' Tc=1.1 min CN=90 Runoff=0.49 cfs 0.030 af

Subcatchment103S: Subcat 103S Runoff Area=5,500 sf 100.00% Impervious Runoff Depth=5.36"
Tc=1.0 min CN=98 Runoff=0.83 cfs 0.056 af

Subcatchment104S: Subcat 104S Runoff Area=7,922 sf 49.66% Impervious Runoff Depth=3.82"
Flow Length=110' Tc=3.4 min CN=84 Runoff=0.89 cfs 0.058 af

Pond 1P: Bioretention Area-1 Peak Elev=97.27' Storage=63 cf Inflow=0.49 cfs 0.030 af
Discarded=0.01 cfs 0.007 af Primary=0.47 cfs 0.023 af Outflow=0.48 cfs 0.030 af

Pond CB1: CB1 Peak Elev=93.10' Inflow=0.96 cfs 0.067 af
12.0" Round Culvert n=0.012 L=46.0' S=0.0133 '/' Outflow=0.96 cfs 0.067 af

Pond CB10: CB10 Peak Elev=93.10' Inflow=1.20 cfs 0.082 af
12.0" Round Culvert n=0.012 L=5.0' S=0.0100 '/' Outflow=1.20 cfs 0.082 af

Pond CB11: CB11 Peak Elev=93.11' Inflow=2.88 cfs 0.224 af
12.0" Round Culvert n=0.012 L=22.0' S=0.0250 '/' Outflow=2.88 cfs 0.224 af

Pond CB2: CB2 Peak Elev=93.10' Inflow=0.47 cfs 0.033 af
12.0" Round Culvert n=0.012 L=23.0' S=0.0091 '/' Outflow=0.47 cfs 0.033 af

Pond CB3: CB3 Peak Elev=93.10' Inflow=3.32 cfs 0.235 af
12.0" Round Culvert n=0.012 L=9.0' S=0.0100 '/' Outflow=3.32 cfs 0.235 af

Pond CB4: CB4 Peak Elev=93.10' Inflow=0.97 cfs 0.066 af
12.0" Round Culvert n=0.012 L=8.0' S=0.0125 '/' Outflow=0.97 cfs 0.066 af

Pond CB5: CB5 Peak Elev=96.41' Inflow=1.40 cfs 0.090 af
12.0" Round Culvert n=0.012 L=25.0' S=0.0160 '/' Outflow=1.40 cfs 0.090 af

Pond CB6: CB6 Peak Elev=96.41' Inflow=0.95 cfs 0.061 af
12.0" Round Culvert n=0.012 L=104.0' S=0.0106 '/' Outflow=0.95 cfs 0.061 af

Pond CB7: CB7 Peak Elev=94.95' Inflow=0.25 cfs 0.015 af
12.0" Round Culvert n=0.012 L=84.0' S=0.0101 '/' Outflow=0.25 cfs 0.015 af

Pond CB8: CB8 Peak Elev=95.20' Inflow=0.80 cfs 0.047 af
12.0" Round Culvert n=0.012 L=23.0' S=0.0174 '/' Outflow=0.80 cfs 0.047 af

Pond CB9: CB9 Peak Elev=94.89' Inflow=0.97 cfs 0.065 af
12.0" Round Culvert n=0.012 L=24.0' S=0.0208 '/' Outflow=0.97 cfs 0.065 af

Pond DET1: U/G DET-1 Peak Elev=93.09' Storage=8,067 cf Inflow=6.49 cfs 0.516 af
Outflow=1.94 cfs 0.516 af

Pond DET2: U/G DET-2 Peak Elev=93.09' Storage=3,462 cf Inflow=4.53 cfs 0.300 af
Outflow=2.20 cfs 0.300 af

Pond DMH1: DMH-1 Peak Elev=95.99' Inflow=4.25 cfs 0.905 af
12.0" Round Culvert n=0.025 L=102.0' S=0.0067 '/' Outflow=4.25 cfs 0.905 af

Pond DMH2: DMH2 Peak Elev=94.60' Inflow=2.42 cfs 0.151 af
12.0" Round Culvert n=0.012 L=37.0' S=0.0338 '/' Outflow=2.42 cfs 0.151 af

Pond DMH3: DMH3 Peak Elev=94.41' Inflow=0.83 cfs 0.056 af
6.0" Round Culvert n=0.012 L=4.0' S=0.1000 '/' Outflow=0.83 cfs 0.056 af

Pond DMH4: DMH-4 Peak Elev=96.41' Inflow=4.25 cfs 0.905 af
15.0" Round Culvert n=0.012 L=5.0' S=0.0100 '/' Outflow=4.25 cfs 0.905 af

Pond DMH5: DMH-5 Peak Elev=97.27' Inflow=4.09 cfs 0.815 af
12.0" Round Culvert n=0.012 L=31.0' S=0.0048 '/' Outflow=4.09 cfs 0.815 af

Pond JF-1: Jellyfish Unit Peak Elev=96.13' Inflow=4.25 cfs 0.905 af
15.0" Round Culvert n=0.012 L=10.0' S=0.0100 '/' Outflow=4.25 cfs 0.905 af

Link DP1: Design Point #1 - Existing Drainage System Inflow=5.06 cfs 0.963 af
Primary=5.06 cfs 0.963 af

Total Runoff Area = 2.476 ac Runoff Volume = 0.970 af Average Runoff Depth = 4.70"
19.14% Pervious = 0.474 ac 80.86% Impervious = 2.002 ac

Summary for Subcatchment 1S: Subcat 1S

Runoff = 0.96 cfs @ 12.03 hrs, Volume= 0.067 af, Depth= 5.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (ac)	CN	Description
0.012	74	>75% Grass cover, Good, HSG C
0.144	98	Paved parking, HSG C
0.156	96	Weighted Average
0.012		7.80% Pervious Area
0.144		92.20% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.4	18	0.0650	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.67"
0.9	170	0.0220	3.01		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.3	188	Total			

Summary for Subcatchment 2S: Subcat 2S

Runoff = 0.47 cfs @ 12.03 hrs, Volume= 0.033 af, Depth= 5.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (ac)	CN	Description
0.002	74	>75% Grass cover, Good, HSG C
0.072	98	Paved parking, HSG C
0.074	97	Weighted Average
0.002		3.23% Pervious Area
0.072		96.77% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.7	15	0.0300	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.67"
0.3	68	0.0440	4.26		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.0	83	Total			

Summary for Subcatchment 3S: Subcat 3S

Runoff = 1.37 cfs @ 12.04 hrs, Volume= 0.097 af, Depth= 5.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (ac)	CN	Description
0.011	74	>75% Grass cover, Good, HSG C
0.212	98	Paved parking, HSG C
0.222	97	Weighted Average
0.011		4.85% Pervious Area
0.212		95.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	20	0.0650	0.21		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.67"
1.0	172	0.0220	3.01		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.6	192	Total			

Summary for Subcatchment 4S: Subcat 4S

Runoff = 0.97 cfs @ 12.04 hrs, Volume= 0.066 af, Depth= 4.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (sf)	CN	Description
18	61	>75% Grass cover, Good, HSG B
1,381	74	>75% Grass cover, Good, HSG C
155	98	Paved parking, HSG B
5,696	98	Paved parking, HSG C
7,251	93	Weighted Average
1,399		19.30% Pervious Area
5,851		80.70% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	25	0.0250	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.67"
0.2	28	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
3.0	53	Total			

Summary for Subcatchment 5S: Subcat 5S

Runoff = 0.45 cfs @ 12.04 hrs, Volume= 0.030 af, Depth= 4.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (ac)	CN	Description
0.019	61	>75% Grass cover, Good, HSG B
0.002	74	>75% Grass cover, Good, HSG C
0.042	98	Paved parking, HSG B
0.020	98	Paved parking, HSG C
0.082	89	Weighted Average
0.021		25.34% Pervious Area
0.061		74.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.8	25	0.0250	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.67"
0.1	10	0.0250	3.21		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.9	35	Total			

Summary for Subcatchment 7S: Subcat 7S

Runoff = 0.25 cfs @ 12.02 hrs, Volume= 0.015 af, Depth= 3.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (ac)	CN	Description
0.021	61	>75% Grass cover, Good, HSG B
0.029	98	Paved parking, HSG B
0.050	83	Weighted Average
0.021		41.76% Pervious Area
0.029		58.24% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	16	0.1000	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.67"
0.1	15	0.0230	3.08		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.2	31	Total			

Summary for Subcatchment 8S: Subcat 8S

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.80 cfs @ 12.01 hrs, Volume= 0.047 af, Depth= 3.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (ac)	CN	Description
0.076	61	>75% Grass cover, Good, HSG B
0.086	98	Paved parking, HSG B
0.162	81	Weighted Average
0.076		46.75% Pervious Area
0.086		53.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	25	0.0250	1.22		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.67"
0.2	35	0.0250	3.21		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	35	0.0790	1.97		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.9	110	Total			

Summary for Subcatchment 9S: Subcat 9S

Runoff = 0.97 cfs @ 12.04 hrs, Volume= 0.065 af, Depth= 4.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (ac)	CN	Description
0.024	61	>75% Grass cover, Good, HSG B
0.011	74	>75% Grass cover, Good, HSG C
0.076	98	Paved parking, HSG B
0.059	98	Paved parking, HSG C
0.170	91	Weighted Average
0.035		20.83% Pervious Area
0.135		79.17% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.6	25	0.0290	0.16		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.67"
0.3	66	0.0250	3.21		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.9	91	Total			

Summary for Subcatchment 10S: Subcat 10S

Runoff = 0.58 cfs @ 12.02 hrs, Volume= 0.039 af, Depth= 5.25"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (ac)	CN	Description
0.001	61	>75% Grass cover, Good, HSG B
0.003	74	>75% Grass cover, Good, HSG C
0.071	98	Paved parking, HSG B
0.016	98	Paved parking, HSG C
0.090	97	Weighted Average
0.004		4.17% Pervious Area
0.087		95.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	5	0.0100	0.08		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.67"
0.2	15	0.0250	1.10		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.67"
0.1	15	0.0250	3.21		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.4	35	Total			

Summary for Subcatchment 11S: Subcat 11S

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.63 cfs @ 12.01 hrs, Volume= 0.043 af, Depth= 5.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (ac)	CN	Description
0.094	98	Roofs, HSG B
0.002	98	Roofs, HSG C
0.096	98	Weighted Average
0.096		100.00% Impervious Area

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

Summary for Subcatchment 12S: Subcat 12S

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.56 cfs @ 12.01 hrs, Volume= 0.038 af, Depth= 5.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (ac)	CN	Description
0.086	98	Roofs, HSG C
0.086		100.00% Impervious Area

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

Summary for Subcatchment 100S: Subcat 100S

Runoff = 2.88 cfs @ 12.08 hrs, Volume= 0.224 af, Depth= 5.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (ac)	CN	Description
0.073	74	>75% Grass cover, Good, HSG C
0.464	98	Paved parking, HSG C
0.537	95	Weighted Average
0.073		13.62% Pervious Area
0.464		86.38% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	25	0.0100	0.10		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.67"
1.2	50	0.0100	0.70		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.8	116	0.0150	2.49		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
6.0	191	Total			

Summary for Subcatchment 101S: Subcat 101S

Runoff = 0.95 cfs @ 12.04 hrs, Volume= 0.061 af, Depth= 3.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (sf)	CN	Description
3,317	61	>75% Grass cover, Good, HSG B
5,085	98	Paved parking, HSG B
96	55	Woods, Good, HSG B
8,498	83	Weighted Average
3,413		40.16% Pervious Area
5,085		59.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.0	5	0.1000	0.09		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.67"
1.3	20	0.1000	0.25		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.67"
0.2	50	0.0500	4.54		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.1	12	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	18	0.0500	4.54		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
2.7	105	Total			

Summary for Subcatchment 102S: Subcat 102S

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.49 cfs @ 12.02 hrs, Volume= 0.030 af, Depth= 4.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (sf)	CN	Description
753	61	>75% Grass cover, Good, HSG B
2,805	98	Paved parking, HSG B
3,558	90	Weighted Average
753		21.16% Pervious Area
2,805		78.84% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.7	4	0.0200	0.10		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.67"
0.3	16	0.0200	1.02		**Sheet Flow,** Smooth surfaces n= 0.011 P2= 3.67"
0.1	25	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.1	45	Total			

Summary for Subcatchment 103S: Subcat 103S

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.83 cfs @ 12.01 hrs, Volume= 0.056 af, Depth= 5.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (sf)	CN	Description
1	98	Paved parking, HSG B
5,499	98	Paved parking, HSG C
5,500	98	Weighted Average
5,500		100.00% Impervious Area

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

Summary for Subcatchment 104S: Subcat 104S

Runoff = 0.89 cfs @ 12.05 hrs, Volume= 0.058 af, Depth= 3.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=5.60"

Area (sf)	CN	Description
1,232	61	>75% Grass cover, Good, HSG B
2,756	74	>75% Grass cover, Good, HSG C
398	98	Paved parking, HSG B
3,093	98	Paved parking, HSG C
443	98	Roofs, HSG C
7,922	84	Weighted Average
3,988		50.34% Pervious Area
3,934		49.66% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	15	0.2000	0.31		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.67"
0.9	5	0.0150	0.09		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.67"
1.7	90	0.0150	0.86		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
3.4	110	Total			

Summary for Pond 1P: Bioretention Area-1

Surrounding soils include Eldridge (Ksat low B = 6 in/hr), Charlton (Ksat low B = 0.6 in/hr), and Squamscott (Ksat low B = 6 in/hr). For design purposes, the average of 0.6 in/hr and 6 in/hr was used, which with a factor of safety yields a design infiltration rate of 1.65 in/hr.

Inflow Area = 0.082 ac, 78.84% Impervious, Inflow Depth = 4.46" for 10-yr event
Inflow = 0.49 cfs @ 12.02 hrs, Volume= 0.030 af
Outflow = 0.48 cfs @ 12.03 hrs, Volume= 0.030 af, Atten= 2%, Lag= 0.5 min
Discarded = 0.01 cfs @ 12.03 hrs, Volume= 0.007 af
Primary = 0.47 cfs @ 12.03 hrs, Volume= 0.023 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 97.27' @ 12.03 hrs Surf.Area= 144 sf Storage= 63 cf
Flood Elev= 97.50' Surf.Area= 192 sf Storage= 102 cf

Plug-Flow detention time= 33.5 min calculated for 0.030 af (100% of inflow)
Center-of-Mass det. time= 33.6 min (816.0 - 782.4)

Volume	Invert	Avail.Storage	Storage Description
#1	96.50'	102 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
96.50	30	31.0	0	0	30
97.00	98	47.0	30	30	131
97.50	192	63.0	71	102	274

Device	Routing	Invert	Outlet Devices
#1	Discarded	96.50'	**1.650 in/hr Exfiltration over Surface area**
#2	Primary	96.00'	**8.0" Round Culvert** L= 11.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 96.00' / 95.35' S= 0.0591 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.35 sf
#3	Device 2	97.10'	**8.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.01 cfs @ 12.03 hrs HW=97.27' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.47 cfs @ 12.03 hrs HW=97.27' TW=94.60' (Dynamic Tailwater)
└**2=Culvert** (Passes 0.47 cfs of 1.62 cfs potential flow)
└**3=Orifice/Grate** (Weir Controls 0.47 cfs @ 1.34 fps)

Summary for Pond CB1: CB1

Inflow Area = 0.156 ac, 92.20% Impervious, Inflow Depth = 5.13" for 10-yr event
Inflow = 0.96 cfs @ 12.03 hrs, Volume= 0.067 af
Outflow = 0.96 cfs @ 12.03 hrs, Volume= 0.067 af, Atten= 0%, Lag= 0.0 min
Primary = 0.96 cfs @ 12.03 hrs, Volume= 0.067 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 93.10' @ 12.57 hrs
Flood Elev= 95.95'

Device	Routing	Invert	Outlet Devices
#1	Primary	91.95'	**12.0" Round Culvert** L= 46.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 91.95' / 91.34' S= 0.0133 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.66 cfs @ 12.03 hrs HW=92.81' TW=92.75' (Dynamic Tailwater)
└**1=Culvert** (Outlet Controls 0.66 cfs @ 1.24 fps)

Summary for Pond CB10: CB10

Inflow Area = 0.186 ac, 97.98% Impervious, Inflow Depth = 5.31" for 10-yr event
Inflow = 1.20 cfs @ 12.02 hrs, Volume= 0.082 af
Outflow = 1.20 cfs @ 12.02 hrs, Volume= 0.082 af, Atten= 0%, Lag= 0.0 min
Primary = 1.20 cfs @ 12.02 hrs, Volume= 0.082 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 93.10' @ 12.40 hrs
Flood Elev= 97.25'

Device	Routing	Invert	Outlet Devices
#1	Primary	92.40'	**12.0" Round Culvert** L= 5.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 92.40' / 92.35' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.20 cfs @ 12.02 hrs HW=93.08' TW=92.06' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 1.20 cfs @ 2.95 fps)

Summary for Pond CB11: CB11

Inflow Area = 0.537 ac, 86.38% Impervious, Inflow Depth = 5.01" for 10-yr event
Inflow = 2.88 cfs @ 12.08 hrs, Volume= 0.224 af
Outflow = 2.88 cfs @ 12.08 hrs, Volume= 0.224 af, Atten= 0%, Lag= 0.0 min
Primary = 2.88 cfs @ 12.08 hrs, Volume= 0.224 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 93.11' @ 12.56 hrs
Flood Elev= 94.55'

Device	Routing	Invert	Outlet Devices
#1	Primary	91.55'	**12.0" Round Culvert** L= 22.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 91.55' / 91.00' S= 0.0250 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=2.75 cfs @ 12.08 hrs HW=92.83' TW=92.30' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.75 cfs @ 3.50 fps)

Summary for Pond CB2: CB2

Inflow Area = 0.074 ac, 96.77% Impervious, Inflow Depth = 5.25" for 10-yr event
Inflow = 0.47 cfs @ 12.03 hrs, Volume= 0.033 af
Outflow = 0.47 cfs @ 12.03 hrs, Volume= 0.033 af, Atten= 0%, Lag= 0.0 min
Primary = 0.47 cfs @ 12.03 hrs, Volume= 0.033 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 93.10' @ 12.57 hrs
Flood Elev= 94.22'

Device	Routing	Invert	Outlet Devices
#1	Primary	91.55'	**12.0" Round Culvert** L= 23.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 91.55' / 91.34' S= 0.0091 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.00 cfs @ 12.03 hrs HW=92.66' TW=92.73' (Dynamic Tailwater)
1=Culvert (Controls 0.00 cfs)

Summary for Pond CB3: CB3

[80] Warning: Exceeded Pond CB1 by 0.01' @ 12.40 hrs (0.39 cfs 0.007 af)
[80] Warning: Exceeded Pond CB2 by 0.09' @ 12.01 hrs (1.08 cfs 0.020 af)

Inflow Area = 0.539 ac, 95.29% Impervious, Inflow Depth = 5.23" for 10-yr event
Inflow = 3.32 cfs @ 12.03 hrs, Volume= 0.235 af
Outflow = 3.32 cfs @ 12.03 hrs, Volume= 0.235 af, Atten= 0%, Lag= 0.0 min
Primary = 3.32 cfs @ 12.03 hrs, Volume= 0.235 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Peak Elev= 93.10' @ 12.56 hrs
Flood Elev= 95.70'

Device	Routing	Invert	Outlet Devices
#1	Primary	91.24'	**12.0" Round Culvert** L= 9.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 91.24' / 91.15' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=3.20 cfs @ 12.03 hrs HW=92.74' TW=92.03' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 3.20 cfs @ 4.07 fps)

Summary for Pond CB4: CB4

Inflow Area = 0.166 ac, 80.70% Impervious, Inflow Depth = 4.79" for 10-yr event
Inflow = 0.97 cfs @ 12.04 hrs, Volume= 0.066 af
Outflow = 0.97 cfs @ 12.04 hrs, Volume= 0.066 af, Atten= 0%, Lag= 0.0 min
Primary = 0.97 cfs @ 12.04 hrs, Volume= 0.066 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 93.10' @ 12.40 hrs
Flood Elev= 96.25'

Device	Routing	Invert	Outlet Devices
#1	Primary	92.25'	**12.0" Round Culvert** L= 8.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 92.25' / 92.15' S= 0.0125 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.97 cfs @ 12.04 hrs HW=92.82' TW=92.27' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 0.97 cfs @ 3.00 fps)

Summary for Pond CB5: CB5

[80] Warning: Exceeded Pond CB6 by 3.15' @ 12.59 hrs (5.40 cfs 0.132 af)

Inflow Area = 0.277 ac, 64.23% Impervious, Inflow Depth = 3.91" for 10-yr event
Inflow = 1.40 cfs @ 12.04 hrs, Volume= 0.090 af
Outflow = 1.40 cfs @ 12.04 hrs, Volume= 0.090 af, Atten= 0%, Lag= 0.0 min
Primary = 1.40 cfs @ 12.04 hrs, Volume= 0.090 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 96.41' @ 12.59 hrs
Flood Elev= 96.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	91.90'	**12.0" Round Culvert** L= 25.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 91.90' / 91.50' S= 0.0160 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.40 cfs @ 12.04 hrs HW=92.53' TW=91.21' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 1.40 cfs @ 2.70 fps)

Summary for Pond CB6: CB6

Inflow Area = 0.195 ac, 59.84% Impervious, Inflow Depth = 3.72" for 10-yr event
Inflow = 0.95 cfs @ 12.04 hrs, Volume= 0.061 af
Outflow = 0.95 cfs @ 12.04 hrs, Volume= 0.061 af, Atten= 0%, Lag= 0.0 min
Primary = 0.95 cfs @ 12.04 hrs, Volume= 0.061 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 96.41' @ 12.60 hrs
Flood Elev= 97.10'

Device	Routing	Invert	Outlet Devices
#1	Primary	93.10'	**12.0" Round Culvert** L= 104.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 93.10' / 92.00' S= 0.0106 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.95 cfs @ 12.04 hrs HW=93.60' TW=92.53' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 0.95 cfs @ 2.41 fps)

Summary for Pond CB7: CB7

Inflow Area = 0.050 ac, 58.24% Impervious, Inflow Depth = 3.72" for 10-yr event
Inflow = 0.25 cfs @ 12.02 hrs, Volume= 0.015 af
Outflow = 0.25 cfs @ 12.02 hrs, Volume= 0.015 af, Atten= 0%, Lag= 0.0 min
Primary = 0.25 cfs @ 12.02 hrs, Volume= 0.015 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 94.95' @ 12.03 hrs
Flood Elev= 97.65'

Device	Routing	Invert	Outlet Devices
#1	Primary	94.65'	**12.0" Round Culvert** L= 84.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 94.65' / 93.80' S= 0.0101 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.24 cfs @ 12.02 hrs HW=94.95' TW=94.60' (Dynamic Tailwater)
└**1=Culvert** (Outlet Controls 0.24 cfs @ 1.84 fps)

Summary for Pond CB8: CB8

Inflow Area = 0.162 ac, 53.25% Impervious, Inflow Depth = 3.52" for 10-yr event
Inflow = 0.80 cfs @ 12.01 hrs, Volume= 0.047 af
Outflow = 0.80 cfs @ 12.01 hrs, Volume= 0.047 af, Atten= 0%, Lag= 0.0 min
Primary = 0.80 cfs @ 12.01 hrs, Volume= 0.047 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 95.20' @ 12.01 hrs
Flood Elev= 98.55'

Device	Routing	Invert	Outlet Devices
#1	Primary	94.75'	**12.0" Round Culvert** L= 23.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 94.75' / 94.35' S= 0.0174 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=0.79 cfs @ 12.01 hrs HW=95.20' TW=94.59' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.79 cfs @ 2.29 fps)

Summary for Pond CB9: CB9

Inflow Area = 0.170 ac, 79.17% Impervious, Inflow Depth = 4.57" for 10-yr event
Inflow = 0.97 cfs @ 12.04 hrs, Volume= 0.065 af
Outflow = 0.97 cfs @ 12.04 hrs, Volume= 0.065 af, Atten= 0%, Lag= 0.0 min
Primary = 0.97 cfs @ 12.04 hrs, Volume= 0.065 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 94.89' @ 12.04 hrs
Flood Elev= 97.80'

Device	Routing	Invert	Outlet Devices
#1	Primary	94.30'	**12.0" Round Culvert** L= 24.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 94.30' / 93.80' S= 0.0208 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=1.00 cfs @ 12.04 hrs HW=94.89' TW=94.58' (Dynamic Tailwater)
1=Culvert (Outlet Controls 1.00 cfs @ 2.98 fps)

Summary for Pond DET1: U/G DET-1

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=106)

Inflow Area = 1.202 ac, 91.81% Impervious, Inflow Depth = 5.15" for 10-yr event
Inflow = 6.49 cfs @ 12.04 hrs, Volume= 0.516 af
Outflow = 1.94 cfs @ 12.56 hrs, Volume= 0.516 af, Atten= 70%, Lag= 31.0 min
Primary = 1.94 cfs @ 12.56 hrs, Volume= 0.516 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 93.09' @ 12.55 hrs Surf.Area= 7,060 sf Storage= 8,067 cf
Flood Elev= 93.50' Surf.Area= 6,875 sf Storage= 9,213 cf

Plug-Flow detention time= 64.5 min calculated for 0.515 af (100% of inflow)
Center-of-Mass det. time= 64.5 min (820.5 - 756.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	90.00'	0 cf	**27.50'W x 98.00'L x 4.50'H Field A** 12,127 cf Overall - 4,333 cf Embedded = 7,794 cf x 0.0% Voids
#2A	90.50'	3,472 cf	**ADS N-12 36"** x 20 Inside #1 Inside= 36.1"W x 36.1"H => 7.10 sf x 20.00'L = 142.0 cf Outside= 42.0"W x 42.0"H => 8.86 sf x 20.00'L = 177.2 cf Row Length Adjustment= +8.00' x 7.10 sf x 5 rows 24.50' Header x 7.10 sf x 2 = 347.9 cf Inside
#3	90.50'	318 cf	**36.0" Round Pipe Storage** L= 45.0'
#4B	90.00'	0 cf	**38.00'W x 110.00'L x 4.50'H Field B** 18,810 cf Overall - 6,823 cf Embedded = 11,987 cf x 0.0% Voids
#5B	90.50'	5,467 cf	**ADS N-12 36"** x 35 Inside #4 Inside= 36.1"W x 36.1"H => 7.10 sf x 20.00'L = 142.0 cf Outside= 42.0"W x 42.0"H => 8.86 sf x 20.00'L = 177.2 cf 35 Chambers in 7 Rows 35.00' Header x 7.10 sf x 2 = 497.0 cf Inside
#6	90.50'	318 cf	**36.0" Round Pipe Storage** L= 45.0'
		9,575 cf	Total Available Storage

Storage Group A created with Chamber Wizard
Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	90.50'	**12.0" Round Culvert** L= 35.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 90.50' / 90.30' S= 0.0057 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	90.50'	**6.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	92.17'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	93.00'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 12.56 hrs HW=93.09' TW=95.91' (Dynamic Tailwater)
↑└─**1=Culvert** (Controls 0.00 cfs)
  ↑├─**2=Orifice/Grate** (Controls 0.00 cfs)
  ├─**3=Orifice/Grate** (Controls 0.00 cfs)
  └─**4=Orifice/Grate** (Controls 0.00 cfs)

Summary for Pond DET2: U/G DET-2

[87] Warning: Oscillations may require smaller dt or Finer Routing (severity=110)
[80] Warning: Exceeded Pond CB10 by 0.02' @ 12.39 hrs (0.35 cfs 0.001 af)
[80] Warning: Exceeded Pond CB4 by 0.02' @ 12.31 hrs (0.47 cfs 0.002 af)

Inflow Area = 0.816 ac, 77.34% Impervious, Inflow Depth = 4.41" for 10-yr event
Inflow = 4.53 cfs @ 12.03 hrs, Volume= 0.300 af
Outflow = 2.20 cfs @ 12.42 hrs, Volume= 0.300 af, Atten= 51%, Lag= 23.6 min
Primary = 2.20 cfs @ 12.42 hrs, Volume= 0.300 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 93.09' @ 12.39 hrs Surf.Area= 3,160 sf Storage= 3,462 cf
Flood Elev= 93.45' Surf.Area= 3,160 sf Storage= 3,880 cf

Plug-Flow detention time= 27.3 min calculated for 0.299 af (100% of inflow)
Center-of-Mass det. time= 27.3 min (800.3 - 773.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	89.95'	0 cf	**17.00'W x 110.00'L x 4.50'H Field A** 8,415 cf Overall - 2,906 cf Embedded = 5,509 cf x 0.0% Voids
#2A	90.45'	2,329 cf	**ADS N-12 36"** x 15 Inside #1 Inside= 36.1"W x 36.1"H => 7.10 sf x 20.00'L = 142.0 cf Outside= 42.0"W x 42.0"H => 8.86 sf x 20.00'L = 177.2 cf 15 Chambers in 3 Rows 14.00' Header x 7.10 sf x 2 = 198.8 cf Inside
#3B	89.95'	0 cf	**22.25'W x 58.00'L x 4.50'H Field B** 5,807 cf Overall - 2,042 cf Embedded = 3,765 cf x 0.0% Voids
#4B	90.45'	1,637 cf	**ADS N-12 36"** x 8 Inside #3 Inside= 36.1"W x 36.1"H => 7.10 sf x 20.00'L = 142.0 cf Outside= 42.0"W x 42.0"H => 8.86 sf x 20.00'L = 177.2 cf Row Length Adjustment= +8.00' x 7.10 sf x 4 rows 19.25' Header x 7.10 sf x 2 = 273.3 cf Inside
#5	90.45'	75 cf	**24.0" Round Pipe Storage** L= 24.0'
		4,041 cf	Total Available Storage

Storage Group A created with Chamber Wizard
Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	90.45'	**12.0" Round Culvert** L= 23.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 90.45' / 90.30' S= 0.0065 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf
#2	Device 1	90.45'	**7.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Device 1	91.98'	**3.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Device 1	93.10'	**12.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.49 cfs @ 12.42 hrs HW=93.08' TW=92.12' (Dynamic Tailwater)
└─**1=Culvert** (Passes 1.49 cfs of 3.70 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 1.26 cfs @ 4.72 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 0.23 cfs @ 4.72 fps)
  └─**4=Orifice/Grate** (Controls 0.00 cfs)

Summary for Pond DMH1: DMH-1

[80] Warning: Exceeded Pond JF-1 by 4.88' @ 12.56 hrs (13.05 cfs 0.748 af)

Inflow Area = 2.295 ac, 83.33% Impervious, Inflow Depth = 4.73" for 10-yr event
Inflow = 4.25 cfs @ 12.56 hrs, Volume= 0.905 af
Outflow = 4.25 cfs @ 12.56 hrs, Volume= 0.905 af, Atten= 0%, Lag= 0.0 min
Primary = 4.25 cfs @ 12.56 hrs, Volume= 0.905 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 95.99' @ 12.56 hrs
Flood Elev= 97.55'

Device	Routing	Invert	Outlet Devices
#1	Primary	89.60'	**12.0" Round Culvert** L= 102.0' CMP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 89.60' / 88.92' S= 0.0067 '/' Cc= 0.900 n= 0.025 Corrugated metal, Flow Area= 0.79 sf

Primary OutFlow Max=4.25 cfs @ 12.56 hrs HW=95.99' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Barrel Controls 4.25 cfs @ 5.41 fps)

Summary for Pond DMH2: DMH2

Inflow Area = 0.463 ac, 67.83% Impervious, Inflow Depth = 3.91" for 10-yr event
Inflow = 2.42 cfs @ 12.03 hrs, Volume= 0.151 af
Outflow = 2.42 cfs @ 12.03 hrs, Volume= 0.151 af, Atten= 0%, Lag= 0.0 min
Primary = 2.42 cfs @ 12.03 hrs, Volume= 0.151 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 94.60' @ 12.03 hrs
Flood Elev= 98.35'

Device	Routing	Invert	Outlet Devices
#1	Primary	93.70'	**12.0" Round Culvert** L= 37.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 93.70' / 92.45' S= 0.0338 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=2.41 cfs @ 12.03 hrs HW=94.60' TW=92.13' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 2.41 cfs @ 3.24 fps)

Summary for Pond DMH3: DMH3

Inflow Area = 0.126 ac,100.00% Impervious, Inflow Depth = 5.36" for 10-yr event
Inflow = 0.83 cfs @ 12.01 hrs, Volume= 0.056 af
Outflow = 0.83 cfs @ 12.01 hrs, Volume= 0.056 af, Atten= 0%, Lag= 0.0 min
Primary = 0.83 cfs @ 12.01 hrs, Volume= 0.056 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 94.41' @ 12.01 hrs
Flood Elev= 97.60'

Device	Routing	Invert	Outlet Devices
#1	Primary	93.40'	**6.0" Round Culvert** L= 4.0' CPP, square edge headwall, Ke= 0.500

Inlet / Outlet Invert= 93.40' / 93.00' S= 0.1000 '/' Cc= 0.900
n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.20 sf

Primary OutFlow Max=0.82 cfs @ 12.01 hrs HW=94.40' TW=91.94' (Dynamic Tailwater)
1=Culvert (Inlet Controls 0.82 cfs @ 4.17 fps)

Summary for Pond DMH4: DMH-4

[80] Warning: Exceeded Pond CB5 by 4.31' @ 12.58 hrs (7.57 cfs 0.271 af)
[80] Warning: Exceeded Pond DMH5 by 5.89' @ 12.44 hrs (8.78 cfs 0.461 af)

Inflow Area = 2.295 ac, 83.33% Impervious, Inflow Depth = 4.73" for 10-yr event
Inflow = 4.25 cfs @ 12.56 hrs, Volume= 0.905 af
Outflow = 4.25 cfs @ 12.56 hrs, Volume= 0.905 af, Atten= 0%, Lag= 0.0 min
Primary = 4.25 cfs @ 12.56 hrs, Volume= 0.905 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 96.41' @ 12.58 hrs
Flood Elev= 98.20'

Device	Routing	Invert	Outlet Devices
#1	Primary	89.95'	**15.0" Round Culvert**
			L= 5.0' CPP, square edge headwall, Ke= 0.500
			Inlet / Outlet Invert= 89.95' / 89.90' S= 0.0100 '/' Cc= 0.900
			n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=2.57 cfs @ 12.56 hrs HW=91.31' TW=91.12' (Dynamic Tailwater)
1=Culvert (Inlet Controls 2.57 cfs @ 2.09 fps)

Summary for Pond DMH5: DMH-5

[80] Warning: Exceeded Pond DET1 by 4.23' @ 12.11 hrs (7.78 cfs 0.283 af)
[80] Warning: Exceeded Pond DET2 by 4.11' @ 12.45 hrs (7.67 cfs 0.337 af)

Inflow Area = 2.017 ac, 85.96% Impervious, Inflow Depth = 4.85" for 10-yr event
Inflow = 4.09 cfs @ 12.56 hrs, Volume= 0.815 af
Outflow = 4.09 cfs @ 12.56 hrs, Volume= 0.815 af, Atten= 0%, Lag= 0.0 min
Primary = 4.09 cfs @ 12.56 hrs, Volume= 0.815 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 97.27' @ 12.45 hrs
Flood Elev= 98.65'

Device	Routing	Invert	Outlet Devices
#1	Primary	90.20'	**12.0" Round Culvert**
			L= 31.0' CPP, square edge headwall, Ke= 0.500
			Inlet / Outlet Invert= 90.20' / 90.05' S= 0.0048 '/' Cc= 0.900
			n= 0.012 Corrugated PP, smooth interior, Flow Area= 0.79 sf

Primary OutFlow Max=8.11 cfs @ 12.56 hrs HW=95.91' TW=91.30' (Dynamic Tailwater)
1=Culvert (Inlet Controls 8.11 cfs @ 10.33 fps)

Summary for Pond JF-1: Jellyfish Unit

[80] Warning: Exceeded Pond DMH4 by 4.88' @ 12.57 hrs (13.05 cfs 0.730 af)

Inflow Area = 2.295 ac, 83.33% Impervious, Inflow Depth = 4.73" for 10-yr event
Inflow = 4.25 cfs @ 12.56 hrs, Volume= 0.905 af
Outflow = 4.25 cfs @ 12.56 hrs, Volume= 0.905 af, Atten= 0%, Lag= 0.0 min
Primary = 4.25 cfs @ 12.56 hrs, Volume= 0.905 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 96.13' @ 12.43 hrs
Flood Elev= 98.20'

Device	Routing	Invert	Outlet Devices
#1	Primary	89.80'	**15.0" Round Culvert** L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 89.80' / 89.70' S= 0.0100 '/' Cc= 0.900 n= 0.012 Corrugated PP, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=0.00 cfs @ 12.56 hrs HW=91.12' TW=95.99' (Dynamic Tailwater)
↑—**1=Culvert** (Controls 0.00 cfs)

Summary for Link DP1: Design Point #1 - Existing Drainage System

Inflow Area = 2.476 ac, 80.86% Impervious, Inflow Depth = 4.67" for 10-yr event
Inflow = 5.06 cfs @ 12.08 hrs, Volume= 0.963 af
Primary = 5.06 cfs @ 12.08 hrs, Volume= 0.963 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

APPENDIX G

Supplemental Calculations and Backup Data

Extreme Precipitation Tables

Northeast Regional Climate Center

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

Smoothing	Yes
State	New Hampshire
Location	
Longitude	70.970 degrees West
Latitude	42.994 degrees North
Elevation	0 feet
Date/Time	Mon, 01 Oct 2018 15:03:29 -0400

+15% Rainfall

2-yr	3.67
10-yr	5.60
25-yr	7.13
50-yr	8.55

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	0.50	0.66	0.82	1.04	**1yr**	0.71	0.99	1.22	1.57	2.04	2.66	2.87	**1yr**	2.36	2.76	3.17	3.88	4.50	**1yr**
2yr	0.32	0.50	0.62	0.81	1.02	1.30	**2yr**	0.88	1.18	1.51	1.93	2.48	3.19	3.54	**2yr**	2.83	3.40	3.91	4.64	5.29	**2yr**
5yr	0.37	0.58	0.73	0.98	1.25	1.61	**5yr**	1.08	1.47	1.89	2.43	3.14	4.06	4.55	**5yr**	3.59	4.38	5.00	5.93	6.70	**5yr**
10yr	0.41	0.65	0.82	1.12	1.46	1.90	**10yr**	1.26	1.73	2.24	2.90	3.76	4.87	5.51	**10yr**	4.31	5.30	6.03	7.14	8.01	**10yr**
25yr	0.48	0.77	0.98	1.35	1.79	2.36	**25yr**	1.54	2.15	2.80	3.65	4.76	6.20	7.09	**25yr**	5.48	6.82	7.71	9.13	10.16	**25yr**
50yr	0.54	0.87	1.11	1.55	2.09	2.78	**50yr**	1.81	2.53	3.32	4.36	5.71	7.44	8.59	**50yr**	6.58	8.26	9.29	11.00	12.17	**50yr**
100yr	0.60	0.98	1.26	1.79	2.45	3.29	**100yr**	2.11	2.99	3.95	5.21	6.84	8.93	10.41	**100yr**	7.91	10.01	11.21	13.27	14.59	**100yr**
200yr	0.69	1.12	1.45	2.08	2.87	3.89	**200yr**	2.47	3.54	4.68	6.21	8.18	10.73	12.62	**200yr**	9.50	12.14	13.51	16.01	17.49	**200yr**
500yr	0.82	1.34	1.75	2.53	3.54	4.85	**500yr**	3.06	4.41	5.86	7.83	10.38	13.68	16.28	**500yr**	12.11	15.65	17.32	20.54	22.25	**500yr**

GPI Project No.	2020283	**Sheet**	1 of 1
Project Description	158 Epping Road - Exeter, NH		
Task	Drawdown Calculations		
Calculated By	SJB	**Date**	07/12/21
Checked By		**Date**	

Greenman-Pedersen, Inc.

Drawdown within 72 hours Analysis for Static Method

Proposed Bioretention Area

Infiltration Rate:	3.30	inches/hour (Based on Ksat values for Eldridge/Charlton/Squamscott)
Design Infiltration Rate:	1.65	inches/hour
Volume Provided for Recharge:	41	cf
Basin bottom area:	30	sf

Time $_{drawdown}$ = (Recharge Volume in cubic feet as determined by the Static Method)(1/Design Infiltration Rate in inches per hour)(conversion for inches to feet)(1/bottom area in feet)

Time $_{drawdown}$ = (41 cf) (1 / 1.65 in/hr) (1ft/12 in.) (1 / 30 sf)

= 9.94 hours

Pollutant Removal Efficiencies for Best Management Practices for Use in Pollutant Loading Analysis				Values Accepted for Loading Analyses		
BMP Type	**BMP**	**Notes**	**Lit. Ref.**	**TSS**	**TN**	**TP**
Stormwater Ponds	Wet Pond		B, F	70%	35%	45%
	Wet Extended Detention Pond		A, B	80%	55%	68%
	Micropool Extended Detention Pond	TBA				
	Multiple Pond System	TBA				
	Pocket Pond	TBA				
Stormwater Wetlands	Shallow Wetland		A, B, F, I	80%	55%	45%
	Extended Detention Wetland		A, B, F, I	80%	55%	45%
	Pond/Wetland System	TBA				
	Gravel Wetland		H	95%	85%	64%
Infiltration Practices	Infiltration Trench (≥75 ft from surface water)		B, D, I	90%	55%	60%
	Infiltration Trench (<75 ft from surface water)		B, D, I	90%	10%	60%
	Infiltration Basin (≥75 ft from surface water)		A, F, B, D, I	90%	60%	65%
	Infiltration Basin (<75 ft from surface water)		A, F, B, D, I	90%	10%	65%
	Dry Wells			90%	55%	60%
	Drip Edges			90%	55%	60%
Filtering Practices	Aboveground or Underground Sand Filter that infiltrates WQV (≥75 ft from surface water)		A, F, B, D, I	90%	60%	65%
	Aboveground or Underground Sand Filter that infiltrates WQV (<75 ft from surface water)		A, F, B, D, I	90%	10%	65%
	Aboveground or Underground Sand Filter with underdrain		A, I, F, G, H	85%	10%	45%
	Tree Box Filter	TBA				
	Bioretention System		I, G, H	90%	65%	65%
	Permeable Pavement that infiltrates WQV (≥75 ft from surface water)		A, F, B, D, I	90%	60%	65%
	Permeable Pavement that infiltrates WQV (<75 ft from surface water)		A, F, B, D, I	90%	10%	65%
	Permeable Pavement with underdrain		Use TN and TP values for sand filter w/ underdrain and outlet pipe	90%	10%	45%

Pollutant Removal Efficiencies for Best Management Practices for Use in Pollutant Loading Analysis				Values Accepted for Loading Analyses		
BMP Type	**BMP**	**Notes**	**Lit. Ref.**	**TSS**	**TN**	**TP**
Treatment Swales	Flow Through Treatment Swale	TBA				
Vegetated Buffers	Vegetated Buffers		A, B, I	73%	40%	45%
Pre-Treatment Practices	Sediment Forebay	TBA				
	Vegetated Filter Strip		A, B, I	73%	40%	45%
	Vegetated Swale		A, B, C, F, H, I	65%	20%	25%
	Flow-Through Device - Hydrodynamic Separator		A, B, G, H	35%	10%	5%
	Flow-Through Device - ADS Underground Multichamber Water Quality Unit (WQU)		G, H	72%	10%	9%
	Other Flow-Through Devices	TBA				
	Off-line Deep Sump Catch Basin		J, K, L, M	15%	5%	5%

Project: **158 Epping Rd**
Location: **Exeter, NH**
Prepared For: **GPI**

Purpose: To calculate the Water Quality Flow (WQF) associated with Water Quality Volume (WQV). The WQV results in the capture and treatment of 90% of annual average storm events, and is equivalent to runoff associated with the first inch of rainfall.

Reference: New Hampshire Stormwater Manual December 2008. United States Department of Agriculture Natural Resources Conservation Service TR-55 Manual.

Given:

Structure Name	A (acres)	Percent Imp. (%)*	A ($miles^2$)	Runoff Coefficient	t_c (min)*	t_c (hr)
DMH-3	0.13	100.0	0.00020	0.950	6.0	0.100
DMH-4	2.24	86.0	0.00350	0.824	6.0	0.100

* A minimum t_c of 6 minutes (0.1 hours) should be used.

Procedure: The Water Quality Flow (WQF) is calculated using the Water Quality Volume (WQV).

1. Compute WQV in watershed inches using the following equation:

$$WQV = P * R * A$$

where: WQV = water quality volume
P = 1"
R = volumetric runoff coefficient = 0.05 + 0.009*percent impervious
A = Area (acres)

Structure Name	R	P (in)	WQV (ac-in)	WQV (ac-ft)	WQV (cu ft)
DMH-3	0.950	1.00	0.124	0.010	448
DMH-4	0.824	1.00	1.846	0.154	6,700

2. Compute the NRCS Runoff Curve Number (CN) using the following equation, or graphically using Figure 2-1 from TR-55 (USDA, 1986):

$$CN = 1000 / [10+5P+10Q-10(Q^2+1.25QP)^{1/2}]$$

where: CN = Runoff Curve Number
P = 1"
Q = runoff depth (watershed inches)

Structure Name	Q (in)	CN
DMH-3	0.950	98
DMH-4	0.824	98

3. Using computed CN, read initial abstraction (I_a) from Table 4-1 in Chapter 4 of TR-55; compute I_a/P, interpolating when appropriate.

Structure Name	I_a (in)	I_a/P
DMH-3	0.041	0.041
DMH-4	0.041	0.041

4. Compute the time of concentration (t_c) in hours and the drainage area in square miles.

Structure Name	t_c (hr)	A (miles^2)
DMH-3	0.100	0.00020
DMH-4	0.100	0.00350

5. Read the unit peak discharge (q_u) from Exhibit 4-II or 4-III in Chapter 4 of TR-55 for appropriate t_c and rainfall distribution type.

Rainfall Distribution Type:	III

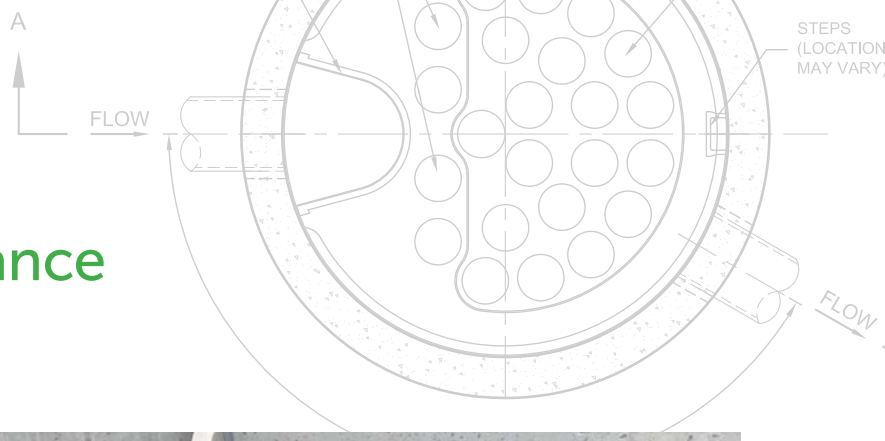
Structure Name	t_c (hr)	I_a/P	q_u (csm/in)
DMH-3	0.100	0.041	700
DMH-4	0.100	0.041	700

6. Compute the water quality flow (WQF) from the following equation:

WQF = (q_u)*(A)*(Q)

where: WQF = water quality flow (cfs)
q_u = unit peak discharge (cfs/mi^2/inch)
A = drainage area (mi^2)
Q = runoff depth (watershed inches)

Structure Name	q_u (csm/in)	A (miles^2)	Q (in)	WQF (cfs)	Proposed Device
DMH-3	700	0.00020	0.950	**0.14**	**FD-4HC**
DMH-4	700	0.00350	0.824	**2.02**	**FD-5HC**



Jellyfish® Filter Performance Testing Results

APPLICATION TIPS

- The Peak Diversion Jellyfish provides treatment and high-flow bypass in one structure, eliminating the need for a separate bypass structure.
- LID and GI are complemented by filtration solutions, as they help keep sites free from fine sediments that can impede performance, remove unsightly trash, and provide a single point of maintenance.
- Selecting a filter with a long maintenance cycle and low maintenance cost will result in healthy waterways and happy property owners.

The pleated tentacles of the Jellyfish® Filter provide a large surface area for pollutant removal.

POLLUTANT OF CONCERN	% REMOVAL
Total Trash	99%
Total Suspended Solids (TSS)	89%
Total Phosphorus (TP)	59%
Total Nitrogen (TN)	51%
Total Copper (TCu)	> 50%
Total Zinc (TZn)	> 50%

Sources:
TARP II Field Study – 2012 JF 4-2-1 Configuration
MRDC Floatables Testing – 2008 JF6-6-1 Configuration

CONTECH Stormwater Solutions Inc. Engineer: DRA
Date Prepared: **5/3/2021**

Site Information

Project Name	**Nouria**
Project State	**NH**
Project City	**Exeter**

Total Drainage Area, Ad	**2.25**	ac
Post Development Impervious Area, Ai	**1.87**	ac
Pervious Area, Ap	**0.37**	ac
% Impervious	**83%**	
Runoff Coefficient, Rc	**0.80**	
Upstream pretreatment credit	**0%**	

Mass Loading Calculations

Mean Annual Rainfall, P	**49.7**	in
Agency Required % Removal	**80%**	
Percent Runoff Capture	**90%**	
Mean Annual Runoff, Vt	**292,226**	ft^3
Event Mean Concentration of Pollutant, EMC	**75**	mg/l
Annual Mass Load, M total	**1,367**	lbs

Filter System

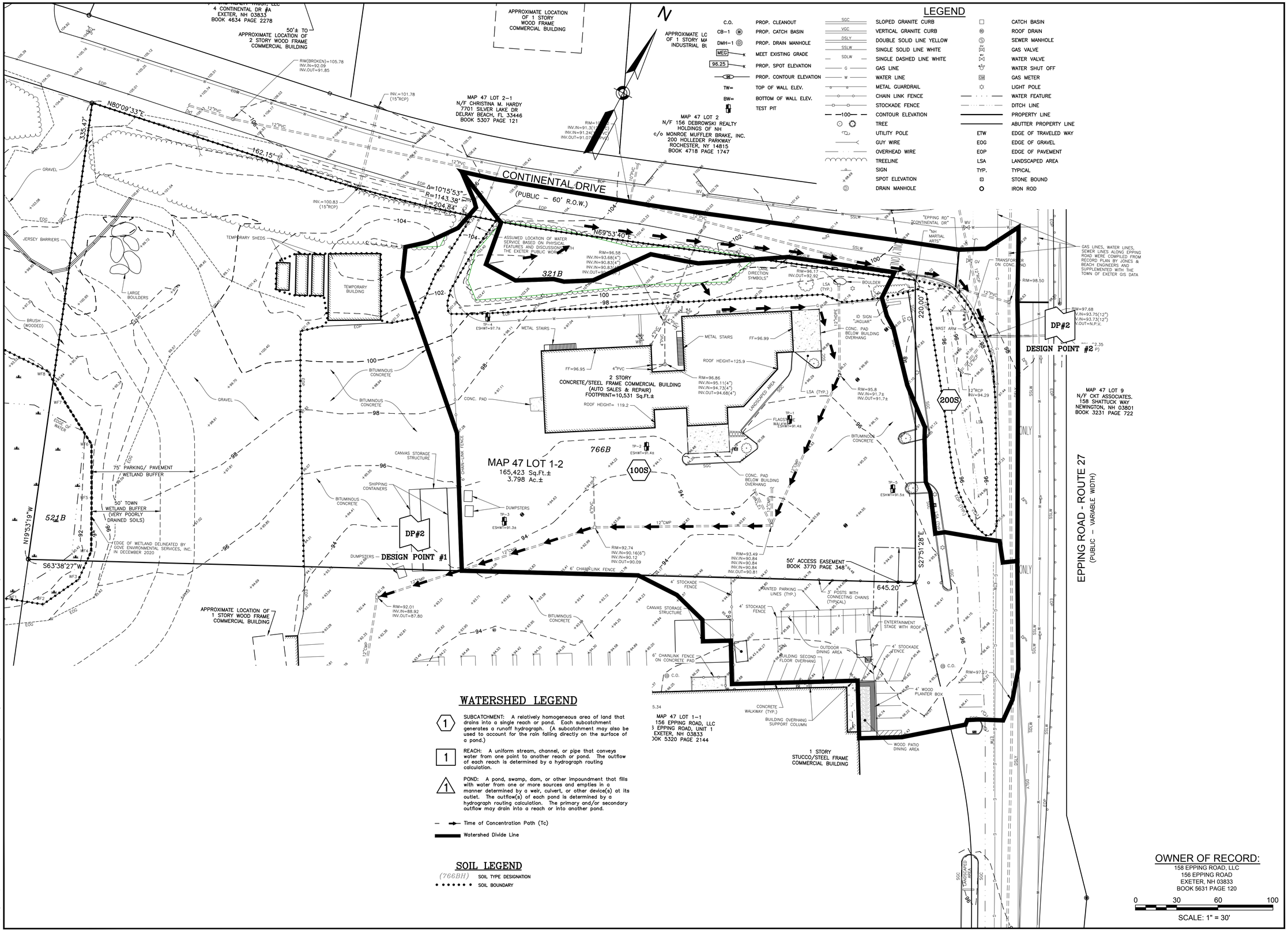
Filtration Brand	**Jelly Fish**	
Cartridge Length	**54**	in

Jelly Fish Sizing

Mass to be Captured by System	**1,094**	lbs
Mass removed by pretreatment system	**0**	lbs
Mass load to filters after pretreatment	**1,367**	lbs
Mass to be Captured by System	**1,094**	lbs
Water Quality Flow	**1.77**	cfs

Method to Use **FLOW BASED**

Summary			
Flow	Treatment Flow Rate	1.78	cfs
	Required Size	**JFPD0806-9-2**	



LEGEND

C.O.	PROP. CLEANOUT	SGC	SLOPED GRANITE CURB
CB-1	PROP. CATCH BASIN	VGC	VERTICAL GRANITE CURB
DMH-1	PROP. DRAIN MANHOLE	DSLY	DOUBLE SOLID LINE YELLOW
MEG	MEET EXISTING GRADE	SSLW	SINGLE SOLID LINE WHITE
96.25	PROP. SPOT ELEVATION	SDLW	SINGLE DASHED LINE WHITE
98	PROP. CONTOUR ELEVATION	G	GAS LINE
TW=	TOP OF WALL ELEV.	W	WATER LINE
BW=	BOTTOM OF WALL ELEV.		METAL GUARDRAIL
	TEST PIT		CHAIN LINK FENCE
			STOCKADE FENCE
		100	CONTOUR ELEVATION
			TREE
			UTILITY POLE
			GUY WIRE
			OVERHEAD WIRE
			TREELINE
			SIGN
		+98.89	SPOT ELEVATION
			DRAIN MANHOLE

	CATCH BASIN	ETW	EDGE OF TRAVELED WAY
	ROOF DRAIN	EOG	EDGE OF GRAVEL
S	SEWER MANHOLE	EOP	EDGE OF PAVEMENT
GV	GAS VALVE	LSA	LANDSCAPED AREA
WV	WATER VALVE	TYP.	TYPICAL
WF	WATER SHUT OFF		STONE BOUND
GM	GAS METER		IRON ROD
	LIGHT POLE		
	WATER FEATURE		
	DITCH LINE		
	PROPERTY LINE		
	ABUTTER PROPERTY LINE		

WATERSHED LEGEND

1 — SUBCATCHMENT: A relatively homogeneous area of land that drains into a single reach or pond. Each subcatchment generates a runoff hydrograph. (A subcatchment may also be used to account for the rain falling directly on the surface of a pond.)

1 — REACH: A uniform stream, channel, or pipe that conveys water from one point to another reach or pond. The outflow of each reach is determined by a hydrograph routing calculation.

1 — POND: A pond, swamp, dam, or other impoundment that fills with water from one or more sources and empties in a manner determined by a weir, culvert, or other device(s) at its outlet. The outflow(s) of each pond is determined by a hydrograph routing calculation. The primary and/or secondary outflow may drain into a reach or into another pond.

Time of Concentration Path (Tc)

Watershed Divide Line

SOIL LEGEND

(766BH) SOIL TYPE DESIGNATION

SOIL BOUNDARY

OWNER OF RECORD:

158 EPPING ROAD, LLC
156 EPPING ROAD
EXETER, NH 03833
BOOK 5631 PAGE 120

0 30 60 100

SCALE: 1" = 30'

GPI Engineering Design Planning Construction Management
603.893.0720 GPINET.COM
Greenman-Pedersen, Inc.
44 Stiles Road, Suite One
Salem, NH 03079

PREPARED FOR
NOURIA ENERGY CORPORATION
326 CLARK STREET
WORCESTER, MA 01606

PROPOSED RETAIL MOTOR FUEL OUTLET
158 EPPING ROAD (ROUTE 27)
EXETER, NH 03833

REVISIONS		
1	MISC. REVISIONS	7/12/21
NO.	REVISION	DATE

APRIL 20, 2021

DRAWN/DESIGN BY	CHECKED BY
CCC/CMT	FCM

PRE DEVELOPMENT DRAINAGE PLAN

SCALE: 1"=30'

PROJECT NO. NEX-2020283

1 OF 1

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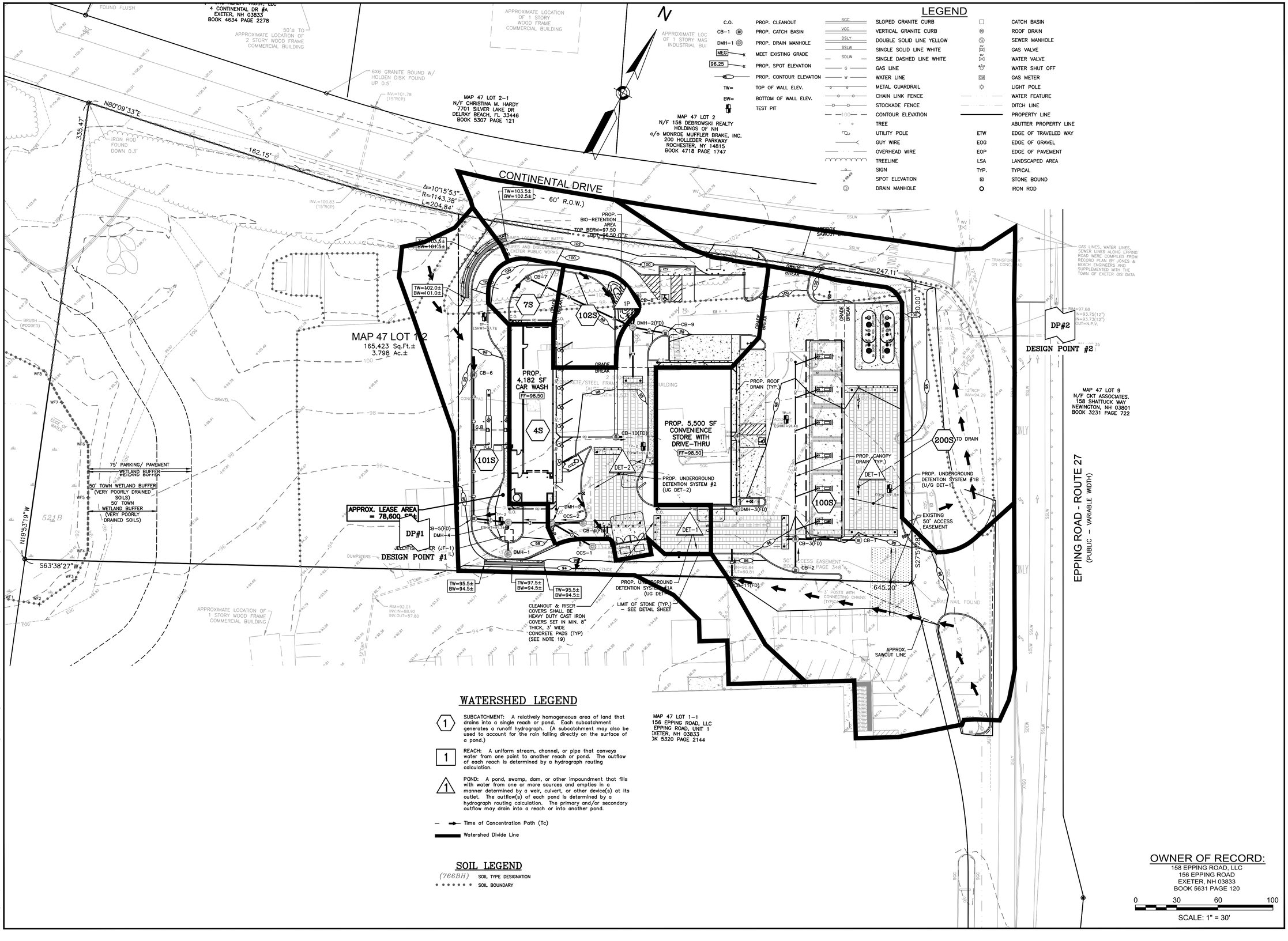

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PREPARED FOR
NOURIA ENERGY CORPORATION
326 CLARK STREET
WORCESTER, MA 01606

PROPOSED RETAIL MOTOR FUEL OUTLET
158 EPPING ROAD (ROUTE 27)
EXETER, NH 03833

REVISIONS		
1	MISC. REVISIONS	7/12/21
NO.	REVISION	DATE

APRIL 20, 2021

DRAWN/DESIGN BY	CHECKED BY
CCC/CMT	FCM

POST DEVELOPMENT DRAINAGE PLAN

SCALE: 1"=30'

PROJECT NO. NEX-2020283

1 OF 1

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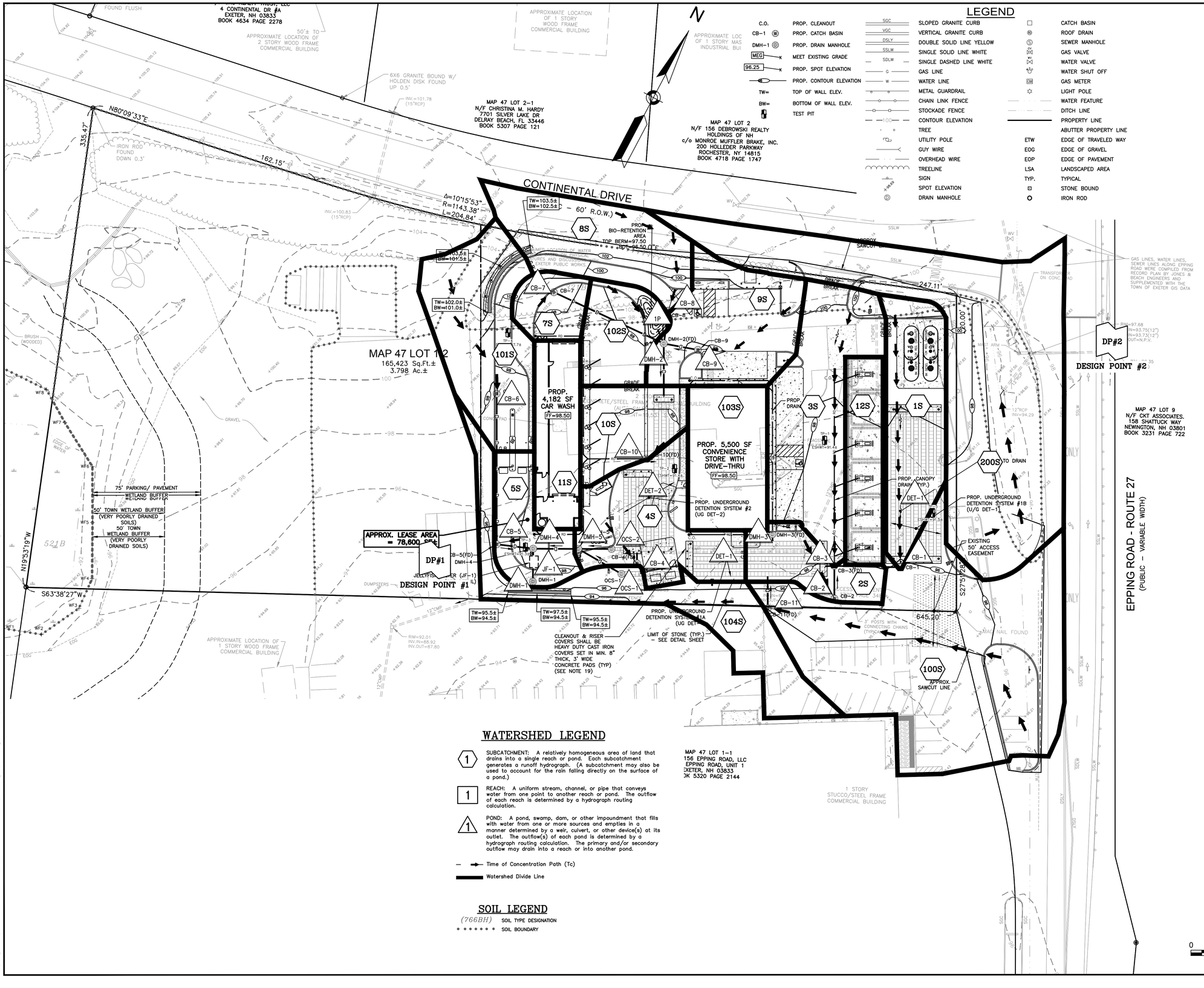

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PROPOSED RETAIL MOTOR FUEL OUTLET
158 EPPING ROAD (ROUTE 27)
EXETER, NH 03833

REVISIONS		
NO.	REVISION	DATE
	JULY 12, 2021	

DRAWN/DESIGN BY: CCC/CMT
CHECKED BY: FCM

POST DEVELOPMENT DRAINAGE PLAN (PIPE SIZING)

SCALE: 1"=30'
PROJECT NO. NEX-2020283

1 OF 1

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INSPECTION & MAINTENANCE MANUAL FOR STORMWATER MANAGEMENT SYSTEMS

PROPOSED RETAIL MOTOR FUEL OUTLET
ASSESSOR'S MAP 47 LOT 1-2
158 EPPING ROAD
EXETER, NEW HAMPSHIRE

GPI

44 Stiles Road, Suite One
Salem, NH 03079
(603) 893-0720

Prepared For:

Nouria Energy Corporation
326 Clark Street
Worcester, MA 01606

April 20, 2021

Revised: July 12, 2021

(GPI Project No.: NEX-2020283)

Nouria Energy Corporation
Inspection & Maintenance Manual

TABLE OF CONTENTS

SECTION 1 I & M DOCUMENTATION REQUIREMENTS

The Owner of Record shall be responsible for the continued operation, and maintenance of all stormwater management systems in accordance with this manual. Logs of inspections and maintenance shall be maintained and filed annually with the Town of Exeter Public Works Department on or before January 31st. Copies will need to be kept for the most recent three years and made available to the Planning Board upon request.

Logs shall include the date on which each inspection or maintenance task was performed, a description of the inspection findings or maintenance completed, and the name of the inspector or maintenance personnel performing the task. If a maintenance task requires the cleanout of any sediments or debris, the location where the sediment and debris was disposed after removal will be indicated. Disposal of the accumulated sediment and hydrocarbons must be in accordance with applicable local, state, and federal guidelines and regulations.

All stormwater facilities associated with this development are identified on Figure 1 contained within Section 3 of this manual and listed individually on the log form included herein, and shall be inspected and maintained in accordance with the procedures outlined in Section 4.

SECTION 2 BMP SPECIFIC I & M PROCEDURES

Driveway/Parking Lot Sweeping

Sweeping shall be done at least once annually, preferably as soon as possible after the snow melts to reduce the amount of sand, grit, and debris and associated pollutants from winter sanding from entering surface waters. Pavement surfaces shall be swept at other times such as in the fall after leaves have dropped to remove accumulated debris. Since contaminants typically accumulate within 12 inches of the curbline, street cleaning operations should concentrate in cleaning curb and gutter lines for maximum pollutant removal efficiency. Other areas shall also be swept periodically when visual buildup of debris is apparent. Once removed from paved surfaces, the sweeping must be handled and disposed of properly. Disposal of the accumulated sediment and hydrocarbons must be in accordance with applicable local, state, and federal guidelines and regulations.

Deep Sump Hooded Catch Basins

Inspect and clean as required all catch basins at least twice annually, once following snow melt and once following leaf-dump, and cleaned as indicated by inspection. Sediment must be removed whenever the depth of deposits is greater than or equal to one half the depth from the bottom of sump to the invert of the lowest pipe in the basin. If the basin outlet is designed with a hood to trap floatable materials check to ensure watertight seal is working. Damaged hoods should be replaced when noted by inspection. At a minimum, remove floating debris and hydrocarbons at the time of the inspection. Sediment and debris can be removed by a clamshell bucket; however, a vacuum truck is preferred. Disposal of the accumulated sediment and hydrocarbons must be in accordance with applicable local, state, and federal guidelines and regulations.

Subsurface Stormwater Detention Systems

All subsurface systems should initially be inspected within the first three months after completion of the site's construction

Preventive maintenance should be performed at least every six months and sediment shall be removed from pretreatment BMP's after every major storm event. The Detention System shall be inspected on regular bi-annual scheduled dates. Sediment and debris removal should be through the use of truck mounted vacuum equipment. Outlet pipes should be flushed to point of discharge on the same frequency as mentioned above. Disposal of the accumulated sediment and hydrocarbons must be in accordance with applicable local, state, and federal guidelines and regulations.

The following is the recommended procedure to inspect the underground system in service:

1. Locate the riser or cleanout section of the system. The riser/cleanout will typically be 6 or 12" in diameter or larger.
2. Remove the lid from the riser/cleanout.
3. Measure the sediment buildup at each riser and cleanout location. Only certified confined space entry personnel having appropriate equipment should be permitted to enter the system.
4. Inspect each manifold, all laterals, and outlet pipes for sediment build up, obstructions, or other problems. Obstructions should be removed at this time.

5. If measured sediment build up is between 2" to 8", cleaning should be considered; if sediment build up exceeds 8", cleaning should be performed at the earliest opportunity. A thorough cleaning of the system (manifolds and laterals) shall be performed by water jets and/or truck mounted vacuum equipment.

Pretreatment BMP's shall be inspected and cleaned during the regular bi-annual inspections.

The inlet and outlet of the subsurface systems should be checked periodically to ensure that flow structures are not blocked by debris. All pipes connecting the structures to the system should be checked for debris that may obstruct flow. Inspections should be conducted monthly during wet weather conditions from March to November.

Bioretention Areas

The bioretention areas should initially be inspected within the first three months after completion of the site's construction and after any rainfall event exceeding 2.5 inches in a 24 hour period. The system should be inspected at least twice annually thereafter.

Preventative maintenance will aid in proper function of the bioretention area. Inspect for trash and debris on a month to month basis year round. Additional mulch should be laid down on an annual basis, preferably in the springtime. Prune any plantings and remove dead vegetation on an annual basis in the spring or fall and any dead vegetation should be replanted in the springtime. At least annually, the system should be inspected for drawdown time. In the event the bioretention area needs to be replaced due to failure or other reasons, any vegetation & filter media should be replaced in either the late spring or early summer.

Hydrodynamic Separator (First Defense Unit)

Initial maintenance to be performed quarterly, or more frequently as recommended by manufacturer. A vacuum truck must be used at a minimum of once per year for sediment removal. Refer to the attached First Defense Owner's manual for operation and maintenance procedures and schedules thereafter.

"Jellyfish Filter" treatment unit

See attached product maintenance materials by Contech ES.

Vegetated Areas

Inspect slopes and embankments early in the growing season to identify active or potential erosion problems. Replant bare areas or areas with sparse growth. Where rill erosion is evident, armor the area with an appropriate lining or divert the erosive flows to on-site areas able to withstand the concentrated flows. During the summer months, all landscape features are to be maintained with the minimum possible amount of fertilizers, pesticides or herbicides.

Winter Maintenance

Proposed snow storage is located along the edge of the roadways. Any excess snow is to be trucked offsite. During the winter months all snow is to be stored such that snowmelt is controlled. Avoid disposing of snow on top of storm drain catch basins or in stormwater drainage swales or ditches. The minimum amount of deicing chemicals needed is to be used. It is recommended that winter maintenance contractors be current UNHT2 Green SnowPro Certified applicators or equivalent. In addition, a NHDES Salt Applicator Certification is recommended, but not required. Information on these certifications can be found in the links provided below:

- http://t2.unh.edu/green-snopro-training-and-nhdes-certification
- http://des.nh.gov/organization/divisions/water/wmb/was/salt-reduction-initiative/salt-applicator-certification.htm

Control of Invasive Species

During maintenance activities, check for the presence of invasive species. Invasive species must be managed/removed in accordance with RSA 430:530 and AGR 3800. See Section 4 of this manual for information from the University of New Hampshire Cooperative Extension and the New Hampshire Guide to Upland Invasive Species from the New Hampshire Department of Agriculture Markets and Food, Plant Industry Division or the information provided on their website (http://www.agriculture.nh.gov/divisions/plant-industry/invasive-plants.htm).

SECTION 3 LONG TERM MAINTENANCE PLAN EXHIBITS

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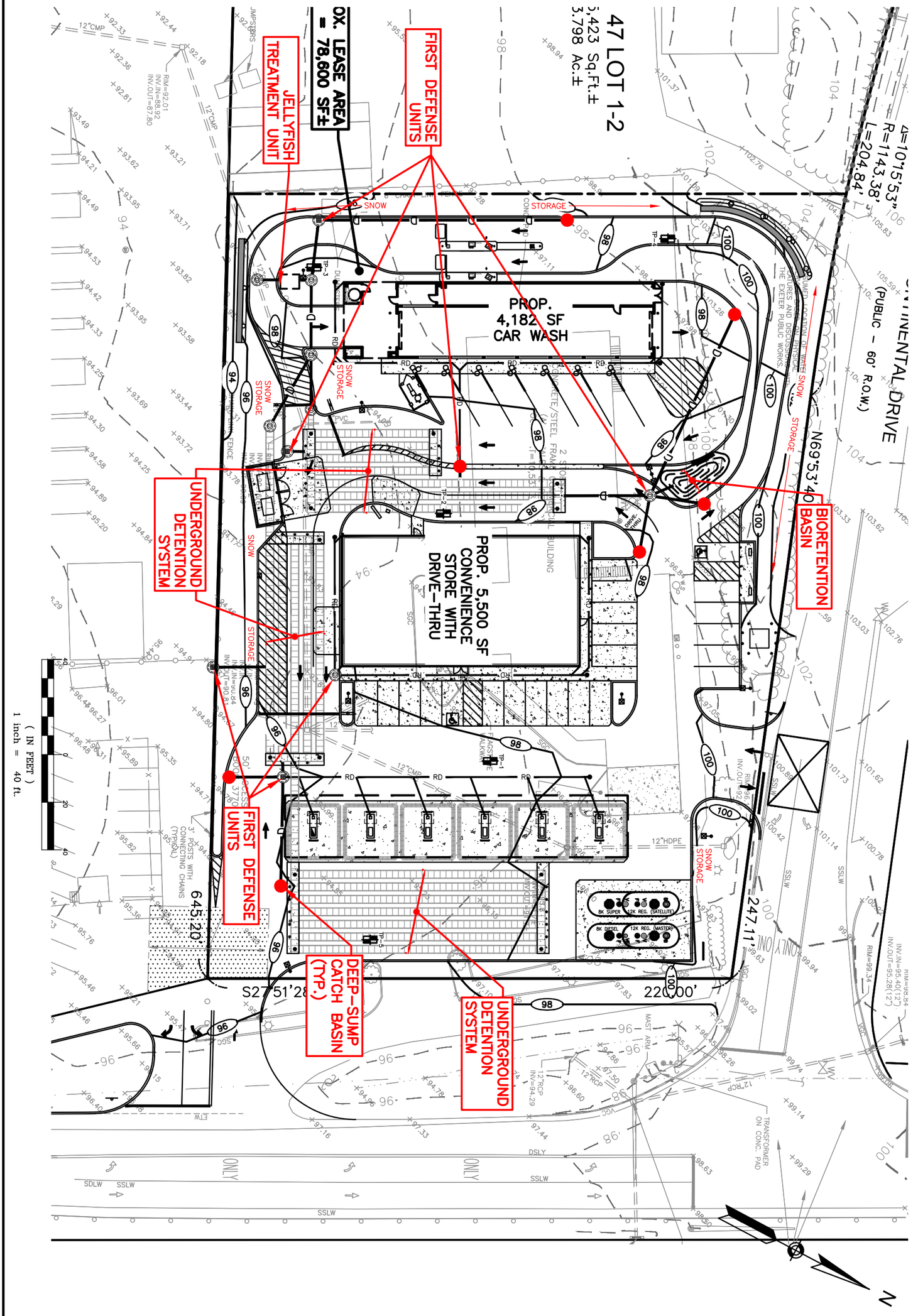


LONG TERM MAINTENANCE EXHIBIT

158 EPPING ROAD
EXETER, NEW HAMPSHIRE

GPI Engineering Design Planning Construction Management
603.893.0720 GPINET.COM
Greenman-Pedersen, Inc.
44 Stiles Road, Suite One
Salem, NH 03079

DRAWN BY:	SJB
PROJECT #:	NEX-2020283
DATE:	4/20/21
REV.:	7/12/21 –
FIGURE	1

SECTION 4 CONTROL OF INVASIVE SPECIES

UNIVERSITY of NEW HAMPSHIRE COOPERATIVE EXTENSION

Methods for Disposing Non-Native Invasive Plants

Prepared by the Invasives Species Outreach Group, volunteers interested in helping people control invasive plants. Assistance provided by the Piscataquog Land Conservancy and the NH Invasives Species Committee. Edited by Karen Bennett, Extension Forestry Professor and Specialist.

Tatarian honeysuckle
Lonicera tatarica
USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *An illustrated flora of the northern United States, Canada and the British Possessions.* Vol. 3: 282.

Non-native invasive plants crowd out natives in natural and managed landscapes. They cost taxpayers billions of dollars each year from lost agricultural and forest crops, decreased biodiversity, impacts to natural resources and the environment, and the cost to control and eradicate them.

Invasive plants grow well even in less than desirable conditions such as sandy soils along roadsides, shaded wooded areas, and in wetlands. In ideal conditions, they grow and spread even faster. There are many ways to remove these non-native invasives, but once removed, care is needed to dispose the removed plant material so the plants don't grow where disposed.

Knowing how a particular plant reproduces indicates its method of spread and helps determine the appropriate disposal method. Most are spread by seed and are dispersed by wind, water, animals, or people. Some reproduce by vegetative means from pieces of stems or roots forming new plants. Others spread through both seed and vegetative means.

Because movement and disposal of viable plant parts is restricted (see NH Regulations), viable invasive parts can't be brought to most transfer stations in the state. Check with your transfer station to see if there is an approved, designated area for invasives disposal. This fact sheet gives recommendations for rendering plant parts non-viable.

Control of invasives is beyond the scope of this fact sheet. For information about control visit www.nhinvasives.org or contact your UNH Cooperative Extension office.

New Hampshire Regulations

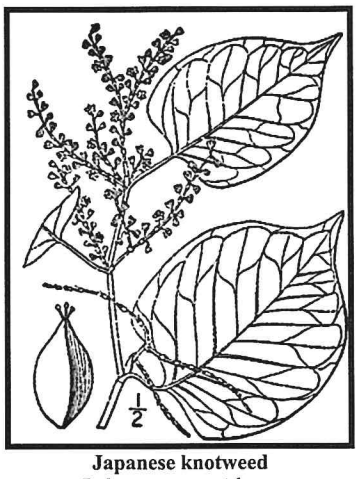
Prohibited invasive species shall only be disposed of in a manner that renders them nonliving and nonviable. (Agr. 3802.04)

No person shall collect, transport, import, export, move, buy, sell, distribute, propagate or transplant any living and viable portion of any plant species, which includes all of their cultivars and varieties, listed in Table 3800.1 of the New Hampshire prohibited invasive species list. (Agr 3802.01)

How and When to Dispose of Invasives?

To prevent seed from spreading remove invasive plants before seeds are set (produced). Some plants continue to grow, flower and set seed even after pulling or cutting. Seeds can remain viable in the ground for many years. If the plant has flowers or seeds, place the flowers and seeds in a heavy plastic bag "head first" at the weeding site and transport to the disposal site. The following are general descriptions of disposal methods. See the chart for recommendations by species.

Burning: Large woody branches and trunks can be used as firewood or burned in piles. For outside burning, a written fire permit from the local forest fire warden is required unless the ground is covered in snow. Brush larger than 5 inches in diameter can't be burned. Invasive plants with easily airborne seeds like black swallow-wort with mature seed pods (indicated by their brown color) shouldn't be burned as the seeds may disperse by the hot air created by the fire.



Japanese knotweed
Polygonum cuspidatum
USDA-NRCS PLANTS Database / Britton, N.L., and A. Brown. 1913. *An illustrated flora of the northern United States, Canada and the British Possessions*. Vol. 1: 676.

Bagging (solarization): Use this technique with softer-tissue plants. Use heavy black or clear plastic bags (contractor grade), making sure that no parts of the plants poke through. Allow the bags to sit in the sun for several weeks and on dark pavement for the best effect.

Tarping and Drying: Pile material on a sheet of plastic and cover with a tarp, fastening the tarp to the ground and monitoring it for escapes. Let the material dry for several weeks, or until it is clearly nonviable.

Chipping: Use this method for woody plants that don't reproduce vegetatively.

Burying: This is risky, but can be done with watchful diligence. Lay thick plastic in a deep pit before placing the cut up plant material in the hole. Place the material away from the edge of the plastic before covering it with more heavy plastic. Eliminate as much air as possible and toss in soil to weight down the material in the pit. Note that the top of the buried material should be at least three feet underground. Japanese knotweed should be at least 5 feet underground!

Drowning: Fill a large barrel with water and place soft-tissue plants in the water. Check after a few weeks and look for rotted plant material (roots, stems, leaves, flowers). Well-rotted plant material may be composted. A word of caution- seeds may still be viable after using this method. Do this before seeds are set. This method isn't used often. Be prepared for an awful stink!

Composting: Invasive plants can take root in compost. Don't compost any invasives unless you know there is no viable (living) plant material left. Use one of the above techniques (bagging, tarping, drying, chipping, or drowning) to render the plants nonviable before composting. Closely examine the plant before composting and avoid composting seeds.

Be diligent looking for seedlings for *years* in areas where removal and disposal took place.

Suggested Disposal Methods for Non-Native Invasive Plants

This table provides information concerning the disposal of removed invasive plant material. If the infestation is treated with herbicide and left in place, these guidelines don't apply. Don't bring invasives to a local transfer station, unless there is a designated area for their disposal, or they have been rendered non-viable. This listing includes wetland and upland plants from the New Hampshire Prohibited Invasive Species List. The disposal of aquatic plants isn't addressed.

Woody Plants	Method of Reproducing	Methods of Disposal
Norway maple *(Acer platanoides)* European barberry *(Berberis vulgaris)* Japanese barberry *(Berberis thunbergii)* autumn olive *(Elaeagnus umbellata)* burning bush *(Euonymus alatus)* Morrow's honeysuckle *(Lonicera morrowii)* Tatarian honeysuckle *(Lonicera tatarica)* showy bush honeysuckle *(Lonicera x bella)* common buckthorn *(Rhamnus cathartica)* glossy buckthorn *(Frangula alnus)*	**Fruit and Seeds**	**Prior to fruit/seed ripening** Seedlings and small plants ▪ Pull or cut and leave on site with roots exposed. No special care needed. Larger plants ▪ Use as firewood. ▪ Make a brush pile. ▪ Chip. ▪ Burn.
		After fruit/seed is ripe Don't remove from site. ▪ Burn. ▪ Make a covered brush pile. ▪ Chip once all fruit has dropped from branches. ▪ Leave resulting chips on site and monitor.
oriental bittersweet *(Celastrus orbiculatus)* multiflora rose *(Rosa multiflora)*	**Fruits, Seeds, Plant Fragments**	**Prior to fruit/seed ripening** Seedlings and small plants ▪ Pull or cut and leave on site with roots exposed. No special care needed. Larger plants ▪ Make a brush pile. ▪ Burn.
		After fruit/seed is ripe Don't remove from site. ▪ Burn. ▪ Make a covered brush pile. ▪ Chip – only after material has fully dried (1 year) and all fruit has dropped from branches. Leave resulting chips on site and monitor.

<table>
<tr><th>Non-Woody Plants</th><th>Method of Reproducing</th><th>Methods of Disposal</th></tr>
<tr><td rowspan="2">garlic mustard
(Alliaria petiolata)
spotted knapweed
(Centaurea maculosa)
▪ Sap of related knapweed can cause skin irritation and tumors. Wear gloves when handling.
black swallow-wort
(Cynanchum nigrum)
▪ May cause skin rash. Wear gloves and long sleeves when handling.
pale swallow-wort
(Cynanchum rossicum)
giant hogweed
(Heracleum mantegazzianum)
▪ Can cause major skin rash. Wear gloves and long sleeves when handling.
dame's rocket
(Hesperis matronalis)
perennial pepperweed
(Lepidium latifolium)
purple loosestrife
(Lythrum salicaria)
Japanese stilt grass
(Microstegium vimineum)
mile-a-minute weed
(Polygonum perfoliatum)</td><td rowspan="2">Fruits and Seeds
  </td><td>Prior to flowering
Depends on scale of infestation
Small infestation
▪ Pull or cut plant and leave on site with roots exposed.

Large infestation
▪ Pull or cut plant and pile. (You can pile onto or cover with plastic sheeting).
▪ Monitor. Remove any re-sprouting material.</td></tr>
<tr><td>During and following flowering
Do nothing until the following year or remove flowering heads and bag and let rot.

Small infestation
▪ Pull or cut plant and leave on site with roots exposed.

Large infestation
▪ Pull or cut plant and pile remaining material. (You can pile onto plastic or cover with plastic sheeting).
▪ Monitor. Remove any re-sprouting material.</td></tr>
<tr><td>common reed
(Phragmites australis)
Japanese knotweed
(Polygonum cuspidatum)
Bohemian knotweed
(Polygonum x bohemicum)</td><td>Fruits, Seeds, Plant Fragments
Primary means of spread in these species is by plant parts. Although all care should be given to preventing the dispersal of seed during control activities, the presence of seed doesn't materially influence disposal activities.</td><td>Small infestation
▪ Bag all plant material and let rot.
▪ Never pile and use resulting material as compost.
▪ Burn.

Large infestation
▪ Remove material to unsuitable habitat (dry, hot and sunny or dry and shaded location) and scatter or pile.
▪ Monitor and remove any sprouting material.
▪ Pile, let dry, and burn.</td></tr>
</table>

January 2010

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RESOURCES

NH Coastal Watershed Invasive Plant Partnership (CWIPP)
www.des.nh.gov/organization/divisions/water/wmb/coastal/cwipp/index.htm
Invasive Plant Atlas of New England (IPANE)
http://invasives.eeb.uconn.edu/ipane
Natural Resource Conservation Service (NRCS)
http://plants.usda.gov
New England Wildflower Society (NEWS)
www.newfs.org
New Hampshire Department of Agriculture, Markets & Food (DAMF)
www.agriculture.nh.gov
New Hampshire Department of Resources & Economic Development, Natural Heritage Bureau (DRED)
http://www.naturalheritage.org
New Hampshire Department of Resources & Economic Development, Division of Forests and Lands (DRED)
http://www.nhdfl.org/organization/div_nhnhi.htm
New Hampshire Department of Environmental Services (DES)
www.des.state.nh.us/wmb/exoticspecies
New Hampshire Fish & Game Department
www.wildlife.state.nh.us
The Nature Conservancy (TNC)
www.nature.org
U.S. Department of Agriculture's Animal Plant Health Inspection Service (USDA APHIS)
www.aphis.usda.gov
University of New Hampshire Cooperative Extension (UNHCE)
www.ceinfo.unh.edu

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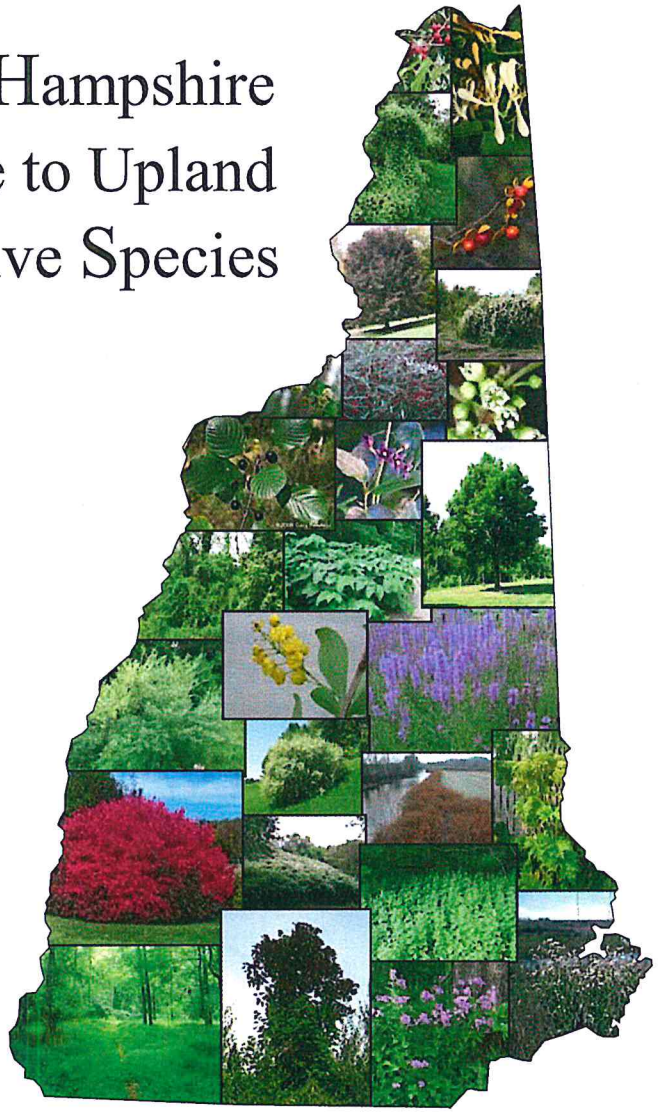
New Hampshire Guide to Upland Invasive Species



New Hampshire
Department of Agriculture
Markets and Food, Plant Industry Division

3rd Edition
2011

Douglas Cygan

Introduction

Throughout the world, non-native invasive species have become an overwhelming problem resulting in impacts to the natural environment and managed landscapes. Invasive species typically possess certain traits that give them an advantage over most native species. The most common traits include the production of many offspring, early and rapid development, and adaptability and high tolerance to many environmental conditions. These traits allow invasive species to be highly competitive and, in many cases, suppress native species. Studies show that invasives can reduce natural diversity, impact endangered or threatened species, reduce wildlife habitat, create water quality impacts, stress and reduce forest and agricultural crop production, damage personal property, and cause health problems.

Invasive species began arriving in North America in the mid-to-late 1700s by various means. Many were brought here for ornamental uses, erosion control, or to provide for wildlife habitat. Others arrived inadvertently through international travel and commerce.

Impacts and Actions

Biologists have found that invasive species cover more than 100 million acres of land in the U.S. and their population numbers continue to spread. The repeated process of spread has become so extreme that invasive species cost the United States billions of dollars per year. This is a result of lost agricultural and forest crops, impacts to natural resources and the environment, and the control efforts required to eradicate them.

On February 3, 1999, President Clinton signed Executive Order 13112, which established the National Invasive Species Council. The Council is responsible for assessing the impacts of invasive species, providing the nation with guidance and leadership on invasive species issues, and seeing that federal programs are coordinated and compatible with state and local initiatives.

Each state is also required to participate by evaluating and responding to their invasive species concerns. In the summer of 2000, the State of New Hampshire passed House Bill 1258-FN, which created the Invasive Species Act (ISA) and the New Hampshire Invasive Species Committee.

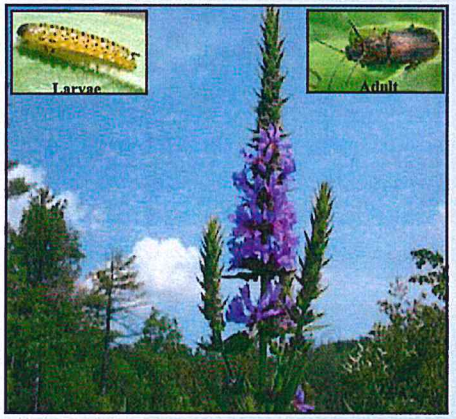
GLOSSARY OF PLANT TERMS

Alternate: Arranged singly at each node, as leaves or buds on different sides of a stem.
Annual: Living or growing for only one year or season.
Aril: A fleshy, usually brightly colored cover of a seed that develops from the ovule stalk and partially or entirely envelops the seed.
Axis: The point at which the leaf is attached to the main stem or branch.
Berry: A small, juicy, fleshy fruit.
Biennial: Having a life cycle that normally takes two growing seasons to complete.
Capsule: A dry dehiscent fruit that develops from two or more united capsules.
Compound: Composed of more than one part.
Deciduous: Shedding or losing foliage at the end of the growing season.
Dehiscent: The spontaneous opening of a fruit at maturity.
Drupe: A fleshy fruit usually having a single hard stone enclosing a seed.
Entire: Referring to a leaf not having an indented margin.
Filiform: Having the form resembling a thread or filament.
Furrowed: A rut groove or narrow depression.
Glabrous: Having no hairs or projections; smooth.
Imbricate: To be arranged with regular overlapping edges.
Inflorescence: A cluster of small flowers arranged on a flower stalk.
Lanceolate: A leaf tapering from a rounded base toward an apex, lance-shaped
Lenticels: The small, corky pores or narrow lines on the surface of the stems of woody plants that allow the interchange of gases between the interior tissue and the surrounding air.
Lustrous: Having a sheen or glow.
Native: A species that originated in a certain place or region; indigenous.
Naturalized: Adapted or acclimated to a new environment without cultivation.
Opposite: Growing in pairs on either side of a stem.
Ovate: Broad or rounded at the base and tapering toward the end.
Panicle: A branched cluster of flowers in which the branches are racemes
Peduncle: The stalk of a solitary flower of an inflorescence.
Peltate: Leaf being round with the stem attached near its center.
Perennial: Living three or more years.
Perfect: Having both stamens and pistals in the same flower.
Pod: A dry, several-sealed, dehiscent fruit.
Pubescent: Covered in fine short hairs.
Raceme: Elongated cluster of flowers along the main stem in which the flowers at the base open first.
Rhizome: A horizontal, usually underground stem that often sends out roots and shoots from its nodes.
Samara: A winged, often one-seed indehiscent fruit as of the ash, elm or maple.
Simple: Having no divisions or branches; not compound.
Umbel: A flat-topped or rounded inflorescence.

Lythrum salicaria - Purple Loosestrife

Family: Lythraceae
Native to: Eurasia

Description: Perennial growing 30-80" tall by $^{2}/_{3}$'s as wide. **Stems:** 4-6 sided, turning woody in summer. **Leaves:** Opposite to whorled, lanceolate, 2-4" long. **Flowers:** Spiked raceme, purple to magenta, June to October. **Fruit:** Capsule. **Habitat:** Mostly found in wetlands and aquatic systems, full to partial sun. **Spread:** Each plant can produce approximately 2.5-4.5 million seeds. Seeds dispersed by water, wildlife and humans. **Comments:** Invades wetlands suppressing native species and destroying wildlife habitat. **Controls:** Hand pull, use a spade to dig larger plants or use biocontrols (*Galerucella Spp.*, top left is a larvae & top right is an adult).

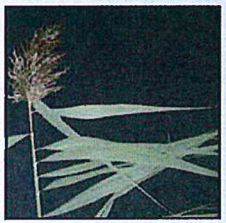


Photos by Douglas Cygan

Phragmites australis - Common Reed

Family: Poaceae
Native to: Eurasia

Description: Perennial rhizomatous grass growing 14' tall. **Stems:** Called 'culms' are large, hollow and grow up to 1" dia. **Leaves:** Lanceolate, up to 24" long, bluish-green in color. **Flowers:** Panicles with many spikelets having seven small reddish flowers. **Habitat:** Mostly found in marshlands, but also grows in freshwater wetlands and aquatic systems, full to partial sun. **Spread:** Spreads primarily by rhizomes. **Comments:** Forms dense colonies that suppress native species and alter wildlife habitat. **Controls:** Hand pull small plants. Use a spade to dig larger plants or apply herbicides.



Photos by Douglas Cygan

New Hampshire Invasive Species Committee

The New Hampshire Invasive Species Committee (ISC) is an advisory group for the Commissioner of the NH Department of Agriculture, Markets & Food (DAMF) on matters concerning invasive species in the state. The ISC consists of 11 appointed members representing the following: the NH Department of Agriculture, the NH Department of Environmental Services, the NH Department of Resources & Economic Development, the NH Department of Transportation, the NH Department of Fish & Game, The College of Life Science & Agriculture of the University of NH, the UNH Cooperative Extension, environmental interests, horticultural interests, general public interests, and livestock owners & feed growers interests. The ISC meets regularly to conduct the following efforts:

- Review information;
- Evaluate and discuss potentially invasive plant, insect and fungi species of concern;
- Host guest presentations on related topics;
- Develop outreach and educational materials;
- Formulate management practices as guidance for the control of invasive species; and
- Prepare lists of proposed prohibited and restricted species.

(*Note: This committee is not charged with the evaluation or listing of aquatic plant species, which is conducted by the Department of Environmental Services under RSA-487:16-a. However, a brief description of the program and four of the aquatic species are described on pages 29 & 30 of this book*).

New Hampshire Rules

In accordance with the Invasive Species Act (ISA), HB 1258-FN, the DAMF is the lead state agency for terrestrial invasive plants, insects and fungi species. The DAMF has the responsibility for the evaluation, publication and development of rules on invasive plant species. This is for the purpose of protecting the health of native species, the environment, commercial agriculture, forest crop production, and human health. Therefore, the rule, Agr 3800, states "**No person shall collect, transport, import, export, move, buy, sell, distribute, propagate or transplant any living or viable portion of any listed prohibited invasive plant species, which includes all of their cultivars and varieties, listed"** (see the New Hampshire Department of Agriculture's website at www.agriculture.nh.gov to review the complete set of rules).

Invasive Upland Plant Species (Agr 3800)

Invasive Insect Species

(To see the complete list of all 16 invasive insects refer to rules Agr 3800)

Invasive Aquatic Plant Species

To see the complete list of invasive aquatic plants refer to DES's Env-Wq 1300 rules

New Hampshire Department of Environmental Services Aquatic Invasive Plant Species

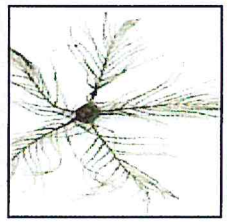
"Exotic aquatic species" are plants or animals that are not part of New Hampshire's native aquatic flora and fauna. Since the first exotic aquatic plant infestation in New Hampshire was discovered in 1965 in Lake Winnipesaukee, exotic aquatic plant infestations have increased to a total of 83 infestations in 72 waterbodies in 2008. Species present include variable milfoil (63 waterbodies), Eurasian milfoil (3 waterbodies), fanwort (9 waterbodies), water chestnut (1 waterbody) and Brazilian elodea (1 waterbody), Curly Leaf Pondweed (3 waterbodies), and European Naiad (3 waterbodies), and Didymo (1 waterbody). Most of these exotic plants can propagate by fragmentation as well as by seed.

Exotic aquatic plant fragments can easily become attached to aquatic recreational equipment, such as boats, motors, and trailers, and can spread from waterbody to waterbody through transient boating activities. Infestations can have detrimental effects on the ecological, recreational, aesthetic, and economic values of the state's precious surface waters, limiting use of the waterbodies and decreasing shorefront property values by as much as 1020 percent according to a UNH study (Halstead, et al., 2001).

Myriophyllum heterophyllum - Variable Milfoil

Family: Haloragaceae
Native to: Eurasia

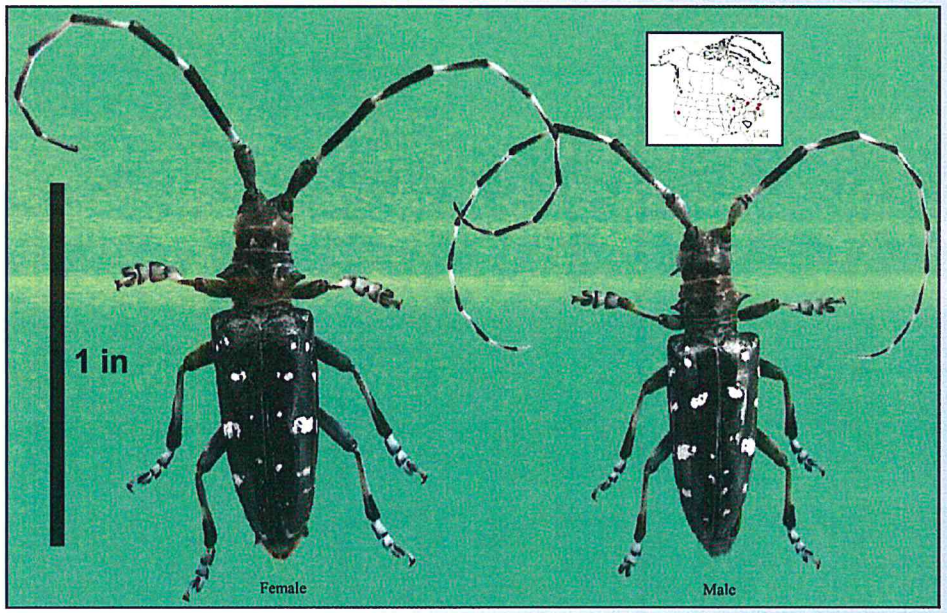
Description: Submerged aquatic perennial growing 20' tall. **Stems:** Round, thick and reddish. **Leaves:** Feathery leaflets surrounding the stem. **Flowers:** Stalks that emerge above the water with green leaves, June to August. **Habitat:** Lakes, ponds, calm streams, and other similar aquatic systems with full to partial sun. **Spread:** It reproduces primarily by vegetative propagules when individual plant segments break off, and dispersed by water movement, humans, and boats. **Comments:** Invades water bodies, suppresses native species and destroys fish habitat. **Controls:** Prevention, hand pulling, bottom screening, and aquatic herbicide use.



Photos by Amy Smagula

Anoplophora glabripennis - Asian Longhorned Beetle

Family: Cerambycidae
Native to: Europe



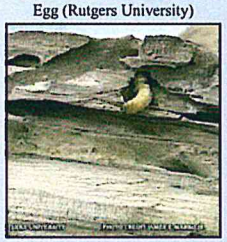
Asian Longhorned Beetle—*Anoplophora glabripennis* (Photo by Chris Rallis)

The Asian longhorned beetle (ALB) is a serious threat to a large variety of deciduous hardwoods in North America. ALB is a large glossy black insect with white spots dotting its elytra. Adults grow to 1-1.5" long and have whitish bandings on their antennae. Females are typically bigger than males. Tree injury occurs when larvae tunnel through the xylem (heartwood) of the host, thus weakening the tree. Hosts trees include, but aren't limited to: Maple, Chestnut, Poplar, Willow, Birch, Elm, and Mountain ash. Adult females chew a crater in the bark and lay 1-egg per site. Upon hatching the larvae feed on the wood and emerge as adults in 1-2 years through perfect $^{3}/_{8}$" diameter exit holes. Other signs include coarse wood shavings called frass, oozing sap, oviposition sites, leaf-feeding damage, and mature beetles. **If found, please call the NH Dept. of Agriculture at (603) 271-2561.**


Oviposition Site


Egg (Rutgers University)


Sap flow from injury


Larval damage (Rutgers Univ.)


Adult feeding damage on leaf


3/8" diameter exit hole

Photos by Douglas Cygan, Chris Rallis & Rutgers University

DO NOT MOVE FIREWOOD

WHAT YOU CAN DO

There are many things that you, as an individual, can do to help control the spread of invasive species and preserve native flora and fauna:

- Minimize impacts to natural vegetation, soils, and drainage.
- Learn how to identify invasive plants and know how to tell them apart from native species.
- Control invasives on your property by following recommended practices.
- When landscaping, ask your local garden center or contact your County Extension Service about alternative plantings.
- Become active in local or regional initiatives to control invasives.
- After working in an area with invasive species remove any soil, or propagules that may have adhered to clothing, shoes, vehicle tires, etc.

CONTROL METHODS

Mechanical: Mechanical control involves hand pulling, digging, cultivation, mowing, cutting or utilizing some type of physical barrier such as a tarpaulin, mulch, wood chips, etc. This method is most effective when populations of unwanted species are low.

Cultural: Cultural control is the manipulation of a plant community to prevent the introduction or spread of an unwanted species. This can be accomplished by modifying the growing environment such as the soil, available light or moisture, or planting trees or shrubs that can outcompete the invasive species.

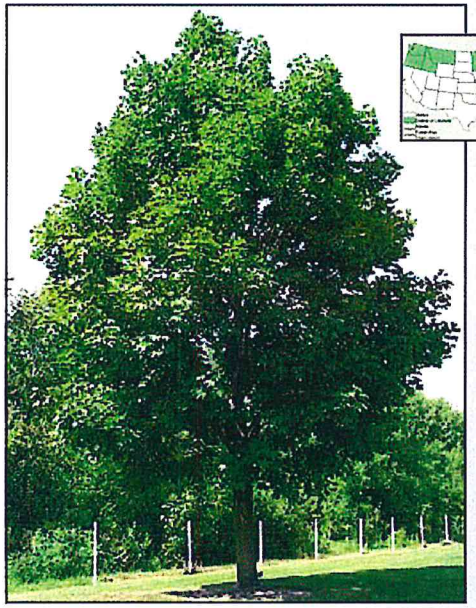
Chemical: Chemical control involves the use of an approved herbicide to manage a targeted species. The application method must be chosen to avoid damage to beneficial or native species. The applicator must adhere to all State and Federal pesticide regulations and in many cases be licensed by the state. For more information, contact the NH Department of Agriculture's Pesticide Control Division at 603-271-3550 or www.agriculture.nh.gov.

Biological: Biological control is the use of native or introduced beneficial organisms to naturally reduce populations of unwanted species. Most biological controls are found to be self-sustaining and host specific.

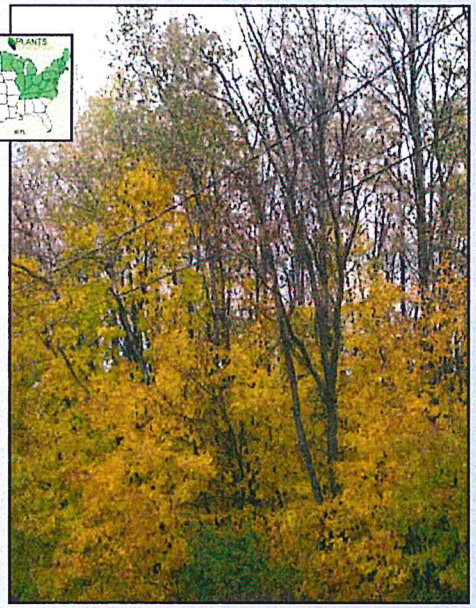

Pulling Digging Cutting-Hand tools Herbiciding Mowing Cutting-Saws Biocontrols

Acer platanoides - Norway Maple

Family: Aceraceae
Native to: Europe

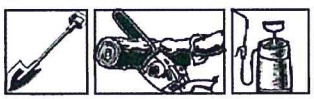


Norway Maple—*Acer platanoides*



Norway Maple (in yellow) Invasion in Franklin, NH

Description: Large deciduous tree 60' high by 40' wide. **Bark:** Grayish and somewhat furrowed. **Twigs:** Smooth, olive-brown. **Buds:** Terminal, imbricate, rounded, smooth, greenish-red. **Leaves:** Opposite, 4-7" wide, 5-lobed, dark green to dark red above, lustrous below. **Flowers:** Greenish-yellow, April. **Fruit:** Horizontal samara. **Zone:** 3-7. **Habitat:** Moist, well drained soils, full sun to partial shade. **Spread:** Seeds spread by wind and water. **Comments:** Leaf stalks exude milky white sap. Fast growing, buds break earlier than most native species. Naturalizes in woodlands where it can outcompete native species. **Controls:** Pull or dig seedlings/saplings. Cut large trees and prune suckers when they sprout. Herbicide: foliar spray, cut-stem, bark banding, or slash bark with ax and apply to wounds.



Milky white sap-leaf petiole

Leaf with winged seed

Terminal buds rounded

Flowers greenish-yellow

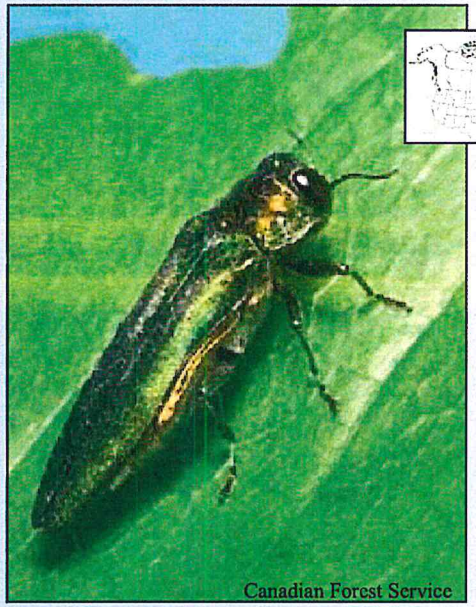
Bark is grayish & furrowed

Leaves turn yellow in Fall

Photos by Douglas Cygan

Agrilus planipennis - Emerald Ash Borer

Family: Buprestidae
Native to: Asia



Emerald Ash Borer—*Agrilus planipennis*

Dead standing Ash trees (Canadian Forest Service)

Emerald Ash Borers (EAB) are small invasive wood boring beetles that attack all species of ash trees (*Fraxinus spp.*). Native to East Asia, it is suspected that they were accidentally introduced to North America in infested wood packing material. The adults are 3/8" to ½" in length by 1/16" in width. Their bodies have a dark metallic green appearance. Adults emerge from a D-shaped exit hole from late May to mid-July and live for 3-6 weeks, during which time they feed on ash foliage, and fly 1-mile or so in search of a mate and to lay eggs. Females will lay 60-90 eggs in the crevices of ash tree bark. Larvae emerging from the eggs create distinctive S-shaped feeding galleries within the cambium which is directly beneath the bark. These feeding galleries can girdle the tree and result in tree death. Movement of EAB into new uninfested areas is principally through transportation of firewood.

If found, please contact the NH Dept. of Agriculture at (603) 271-2561.

Egg

Larvae in feeding galleries

Adult with wings spread

Feeding galleries in cambium

D-shaped exit hole

EAB Purple prism trap

Photos by Douglas Cygan & Chris Rallis

DO NOT MOVE FIREWOOD

Adelges tsugae - Hemlock Wooly Adelgid

Family: Adelgidae
Native to: Asia

Hemlock Wooly Adelgid—*Adelges tsugae* Nests

Hemlock trees dead from Adelgid (www.earthportal.org)

Hemlock Wooly Adelgid (*Adelges tsugae*) (HWA) is a serious pest to all North American hemlock trees (*Tsuga spp.*). It is native to Japan & China and was first found in the Pacific Northwest in the 1920's. By the 1950's it had reached the east coast and now infects hemlock trees from Georgia to Maine. It spreads by movement of nursery stock, wind and animals. These insects are extremely small averaging about $^{1}/_{8}$" in length with piercing-sucking mouth parts similar in appearance to aphids. All adults are females with each producing 50-300 eggs. To protect themselves & their eggs they produce a white-waxy covering. Adults insert their piercing mouth parts into the stem at the base of the needles. Trees die from needle loss & lack of nutrition. **If found, please call the NH Dept. of Agriculture at (603) 271-2561.**

Adult female laying eggs

Egg mass in protective nest

Eggs & crawlers (Chris Rallis)

Heavily infested branch

Crawlers (Chris Rallis)

Crawler leaving nest (Chris Rallis)

Photos by Douglas Cygan & Chris Rallis

DO NOT MOVE FIREWOOD

Ailanthus altissima - Tree of Heaven

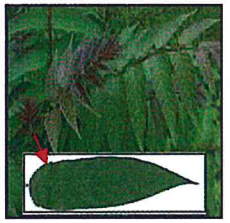
Family: Simaroubaceae
Native to: China

Tree of Heaven—*Ailanthus altissima*

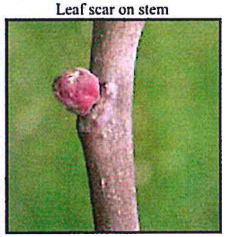
Tree of Heaven invasion

Description: Deciduous tree up to 60' tall by 40' wide. **Bark:** Grayish, slightly furrowed. **Twigs:**Reddish-brown. **Leaves:** Compound, 18-24" long with 13-25 leaflets arranged alternately on stem, lanceolate, 3-5" long with 2-4 teeth near base. **Flowers:** Panicles, 8-16" long, yellowish-green, mid-June. **Fruit:** Samara. **Zone:** 4-8. **Habitat:** Highly adaptable and pollution tolerant, full sun to partial shade. **Spread:** Seeds are wind dispersed. **Comments:** Very fast growing, dense canopy shades out native species. **Controls:** Remove seedlings and saplings by hand. Larger trees can be mechanically removed or cut. To prevent suckering, if trees are cut, apply herbicide to cut portion of stump.

Leaf scar on stem

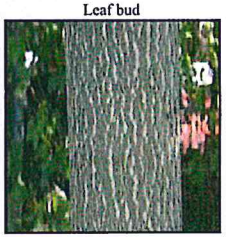


Compound leaves & leaf



Leaf bud

Flowers yellowish-green



Bark grayish & furrowed

Winged seed cluster

Photos by Douglas Cygan

Alliaria petiolata - Garlic Mustard

Family: Cruciferae
Native to: Europe

Garlic Mustard—*Alliaria petiolata*

Woodland invasion (photo by Cornell University)

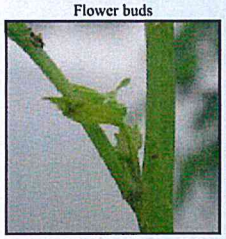
Description: Cool season biennial, 2nd year plants flower and reach 2-3$^1/_2$' tall. **Leaves:** Triangular, coarsely toothed, heart-shaped. **Flowers:** Umbel, small, 4-petals, white, April-May. **Fruit:** Pods, seeds turn black when mature. **Zone:** 4-8. **Habitat:** Prefers moist shaded floodplains, forests and roadsides, adaptable to most soil and light conditions. **Spread:** Seeds spread by water and wildlife. **Comments:** Plants spread quickly into natural areas leading to competition and displacement of native species. **Controls:** Small populations can be hand pulled while large populations can be continuously cut back to prevent flowering and seed production. Herbicide treatments are also effective.

Basal rosette

Leaf

Flower buds

Flowers 4-petaled, white



Stems

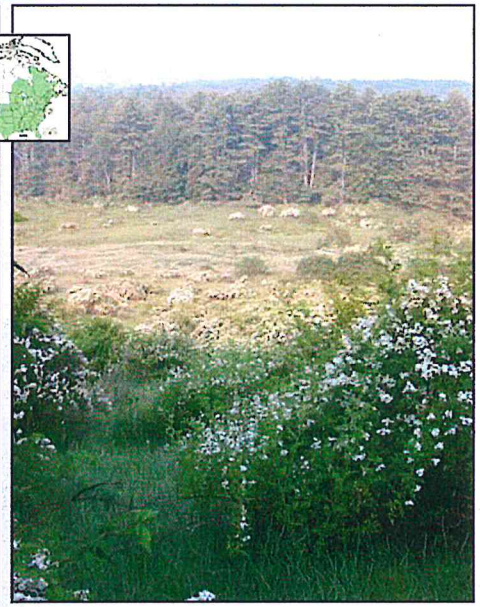
Seed pods

Photos by Douglas Cygan

Rosa multiflora - Multiflora Rose

Family: Rosaceae
Native to: Japan & Korea

Multiflora Rose-*Rosa multiflora*

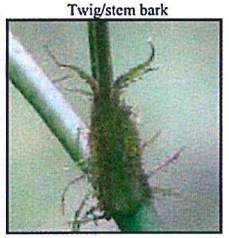


Multiflora Rose invasion, Canterbury, NH

Description: Hardy shrub / climber reaching up to 15' or more in height and 10' in width. **Stems:** Long and arching, forming dense clumps, thorns may or may not be present. **Leaves:** Alternately arranged, compound with 7-9 leaflets and having feather margins at base. **Flowers:** Clusters of white or pink, June to July. **Fruit:** Rose hips turn red in fall. **Zone:** 3-8. **Habitat:** Prefers moist, well drained soils, full sun. **Spread**: Fruits with seeds are dispersed by birds. **Comments:** Very aggressive, leading to competition and displacement of native species. **Controls:** Hand or mechanical removal, cutting, or herbicide application.

Twig/stem bark

Leaves



Feathery margin at base of leaf

Flowers white

Fall color

Fruit is called a hip

Photos by Douglas Cygan

Rhamnus cathartica - Common Buckthorn

Family: Rhamnaceae
Native to: Eurasia

Description: Deciduous shrub or small tree measuring 20' by 15'. **Bark:** Grayish to brown with raised lenticels. **Stems:** Cinnamon colored with terminal spine. **Leaves:** Opposite, simple and broadly ovate with toothed margins. **Flowers:** Inconspicuous, 4-petaled, greenish-yellow, mid-June. **Fruit:** Fleshy, 1/4" diameter turning black in the fall. **Zone:** 3-7. **Habitat:** Adapts to most conditions including pH, heavy shade to full sun. **Spread:** Seeds are bird dispersed. **Comments: Highly:** Aggressive, fast growing, outcompetes native species. **Controls:** Remove seedlings and saplings by hand. Larger trees can be cut or plants can be treated with an herbicide.

Photos courtesy of John M. Randall/The Nature Conservancy

Rhamnus frangula - Glossy Buckthorn

Family: Rhamnaceae
Native to: Japan

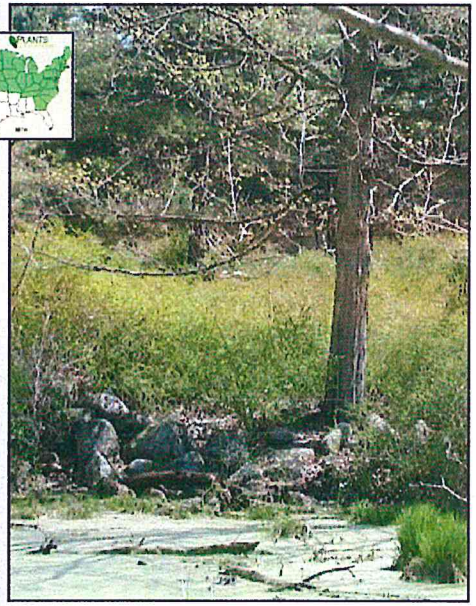
Description: Tall deciduous shrub up to 20' in height by 15' wide, **Bark:** Grayish with whitish lenticels. **Twigs:** Reddish-brown. **Leaves:** Ovate, 4-5" long by 3-4" wide, arranged oppositely or whorled on stem. **Flowers:** Small, greenish-white, mid-June. **Fruit:** Fleshy, turning black in the fall. **Zone:** 2-7. **Habitat:** Highly adaptable and pollution tolerant, full sun to partial shade. **Spread:** Seeds are bird dispersed. **Comments:** Very fast growing, dense canopy shades out native species. **Controls:** Remove seedlings and saplings by hand. Larger trees can be cut or herbicide may be used.

Photos by Douglas Cygan

Berberis thunbergii - Japanese Barberry

Family: Berberidaceae
Native to: Japan

Japanese Barberry-*Berberis thunbergii*

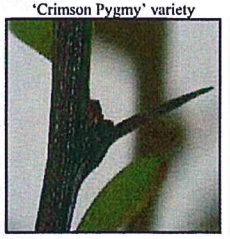


Japanese Barberry invasion, Antrim, NH

Description: Deciduous shrub, 2-4$^{1}/_{2}$' tall. **Leaves:** Ovate, simple, entire. Color varies depending on variety. **Flowers:** Small yellowish, bloom in May in clusters of 2-4. **Fruit:** Drupe, turning red in summer. **Zone:** 4-8. **Habitat:** Prefers well drained soils in semi shade and often occurring in forests, roadsides, and open fields. **Spread:** Seeds are dispersed by wildlife. **Comments:** Forms dense thickets in natural environments where it becomes established, resulting in impacts to native flora and fauna. **Controls:** Remove small immature plants by hand. Dig larger plants with a garden spade or remove mechanically. Cut stems at base or control with herbicide treatment.

'Crimson Pygmy' variety

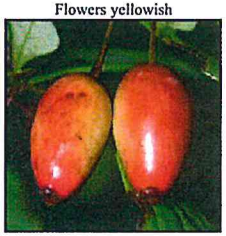
Leaves



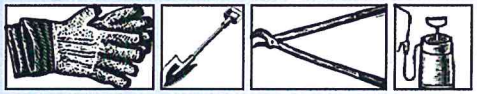
Thorn

Flowers yellowish

Frost covered Barberry



Fruit is a fleshy drupe



Photos by Douglas Cygan

Berberis vulgaris - European Barberry

Family: Berberidaceae
Native to: China

European Barberry-*Berberis vulgaris*

Woodland invasion, Claremont, NH

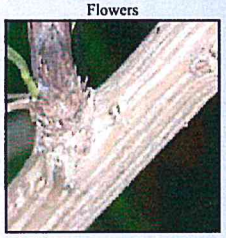
Description: Shrub 3-8' in height by 3-6' in width. **Stems:** Tan bark with 3 long spines at each leaf axis. **Leaves:** Alternate, simple, $^1/_2$"-1$^1/_2$" long, bright green above, dull below. **Flowers:** Perfect, yellow, $^1/_2$" long, mid-April to May. **Fruit:** Oblong drupe turning pale red in fall. **Zone:** 4-8. **Habitat:** Prefers full sun to partial shade and open spaces to wooded areas. **Spread:** Seeds are dispersed by birds and wildlife. **Comments:** Highly adaptable to most environments and is pollution tolerant. **Controls:** Hand pull young plants. Cut or mechanically remove older larger plants or apply approved herbicides for large populations.

Thorns

Leaves

Flowers

Flowers whitish-yellow



Stems

Seed pods

Photos by Douglas Cygan

Polygonum cuspidatum - Japanese Knotweed

Family: Polygonaceae
Native to: Japan

Description: Perennial reaching 10' in height and width. Bohemian Knotweed (*Reynoutria x bohemica*) is similar. **Stems:** Greenish, hollow and jointed, similar to bamboo. **Leaves:** Alternate, broadly ovate, 3-7" long. **Flowers:** Small, whitish, forming panicles, August-September. **Seeds:** Calyx, brown, triangular. **Habitat:** Found in woodland sites, open spaces, ditches, roadsides, riverbanks. Prefers moist, well-drained soils. **Spread:** Stem & root fragments, and by seed. **Comments:** Aggressive, spreads quickly along surface waters and in right-of-ways. **Controls: Do <u>not</u> mow**, cut stems at base then smother by covering area with heavy-duty fabric/plastic, herbicides also recommended.

Photos by Douglas Cygan

Polygonum perfoliatum - Mile-a-Minute Vine

Family: Polygonaceae
Native to: Asia

Description: Very fast growing herbaceous perennial vine growing to 25' in height. **Stems:** Greenish with stiff barbs used for support. **Leaves:** Alternate, triangular in shape with clasping bract at the base, 1-3" long. **Flowers:** Racemes, inconspicuous and white forming at the bract, August - October. **Seeds:** An achene within a greenish, berry-like fruit. **Habitat:** Grows in partial shade to full sun, fields, roadsides & forests. Prefers moist, well-drained soils. **Spread:** Seed spread by birds & wildlife. **Comments:** Fast growing, aggressive. **Controls:** Mowing, hand cutting or herbicide use is recommended.

Photos by Leslie J. Mehrhoff

Microstegium vimineum - Japanese Stilt Grass

Family: Poaceae
Native to: Asia

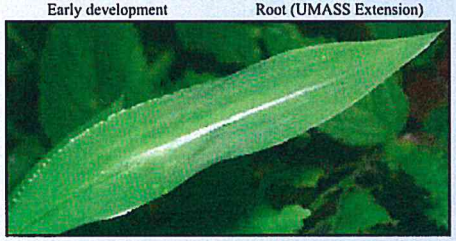
Japanese Stilt Grass—*Microstegium vimineum*

Japanese Stilt Grass woodland invasion

Description: Weak-stemmed annual grass, reaching 2-4' tall. **Leaves:** Lanceolate, tapered at both ends, 2-3" long with silvery stripe of reflective hairs down the midrib. **Flowers:** Racemes occur at the ends of the stalk itself, late August. **Fruit:** Achenes develop in late fall. **Zone:** 5-11. **Habitat:** Occurs along riverbanks, floodplains, forests and roadsides, adaptable to most soil and light conditions. **Spread:** Seeds spread by water, wildlife & humans. **Comments:** Plants spread quickly into natural areas leading to competition and displacement of native species. **Controls:** Small populations can be hand pulled while large populations can be continuously cut back to prevent flowering and seed production. Herbicide treatments are also effective.

Early development

Root (UMASS Extension)



Leaf with silvery reflective hairs along midrib

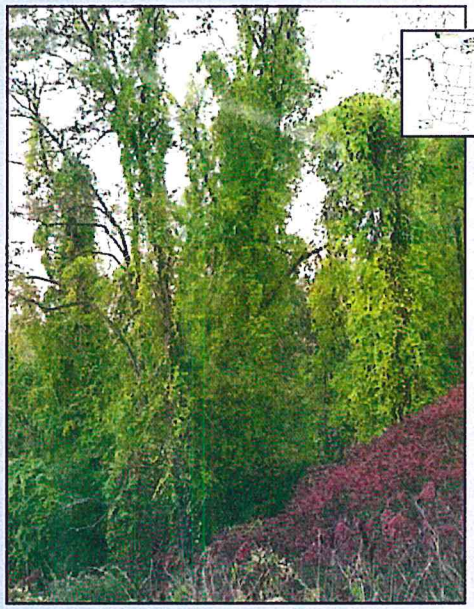
Fall-leaves turn purplish

Seed-Achene

Photos courtesy of Leslie J. Mehrhoff/UCONN-IPANE and UMASS Extension

Celastrus orbiculatus - Oriental Bittersweet

Family: Celastraceae
Native to: Japan, China



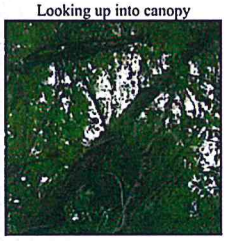
Oriental Bittersweet-*Celastrus orbiculatus*

Oriental Bittersweet invasion, Concord, NH

Description: Deciduous vine reaching heights of 40-60'. **Bark:** Tannish, furrowed. **Leaves:** Alternate, ovate, bluntly toothed, 3-4" long by 2/3's as wide, tapered at the base. **Flowers:** Small, greenish, blooming in spring. **Fruit:** Yellow dehiscent capsule surrounding an orange-red aril. *Fruits occur in the axils of the stems whereas native bittersweet (Celastrus scandens) fruits at the ends.* **Zone:** 4-8. **Habitat:** Disturbed edges, roadsides, fields, forests and along rivers and streams. **Spread:** Birds and humans. **Comments:** Very aggressive, climbs up and over trees and smothers them. Do not buy wreaths made of these vines. **Controls:** Difficult to manage. Cutting, pulling, or recommended herbicide use applied to foliage, bark, or cut-stump.

Looking up into canopy

Leaves



Native trees being strangled

Flowers yellowish-white

Mature Orange-yellow fruit

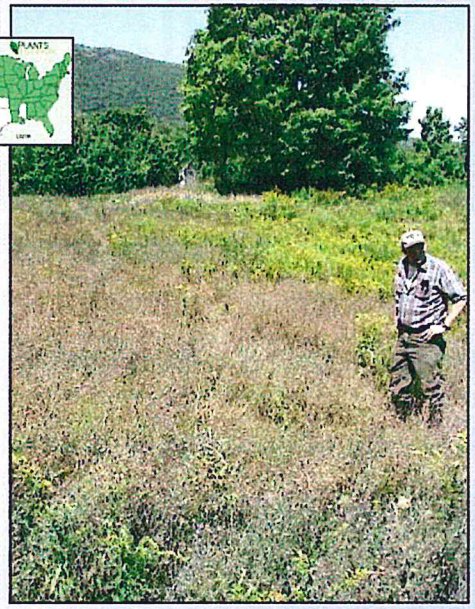
Fruit is a fleshy capsule

Photos by Douglas Cygan

Centaurea maculosa - Spotted Knapweed

Family: Compositae
Native to: Eurasia

Spotted Knapweed—*Centaurea maculosa*



Invasion (photo by Leslie Mehrhoff)

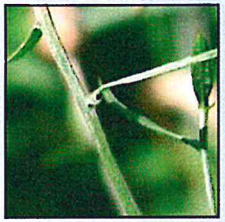
Description: Tall erect herbaceous perennial living 3-5 years. **Leaves:** Alternate, divided, Pale green, 1-3" long. **Flowers:** Aster-like, terminal, purple, July-August. **Fruit:** Each plant produces thousands of brownish seeds per year. **Zone:** 3-10. **Habitat:** Invades dry sunny roadsides, fields and waste places. Its large taproot allows it to survive harsh winters and draught **Spread:** Seeds spread by wind and wildlife. **Comments:** Plants spread quickly into natural meadows and fields leading to competition and displacement of native species. Roots excrete a toxin killing off other plants. **Controls:** Small populations can be hand pulled while large populations can be continuously cut back to prevent flowering and seed production. Herbicide treatments are also effective.

Basal rosette

Leaf

Seed head

Flowers—Aster like



Stems

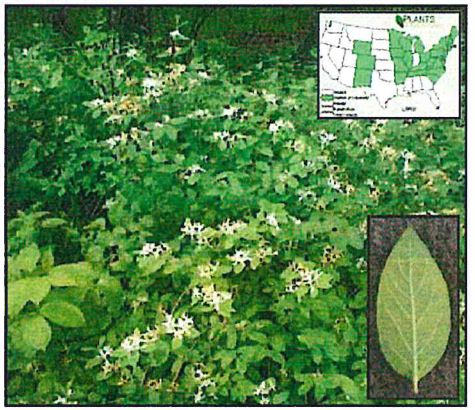
Seeds

Photos by Leslie Mehrhoff & Douglas Cygan

Lonicera morrowii - Morrow's Honeysuckle

Family: Caprifoliaceae
Native to: Japan

Description: Shrub reaching 6-8' tall. **Stems:** Smooth, glabrous, Tannish, hollow. **Leaves:** Ovate, simple, entire, opposite, pubescent beneath, 1-2$^1/_2$" long. **Flowers:** Tubular, white, turning yellow with age, May to June. **Fruits:** Berry turning red. **Zone:** 3 . **Habitat:** Moist to wet shaded floodplains, forests, roadsides, fields, waste places. **Spread:** Seeds are dispersed by wildlife and humans. **Comments:** Rapidly invades sites, forming a dense vegetative layer that outcompetes native flora and fauna species. **Controls:** Hand control is effective for small plants, while mechanical removal and repetitive cutting also work well. Herbicide treatment is better for areas with greater infestations.

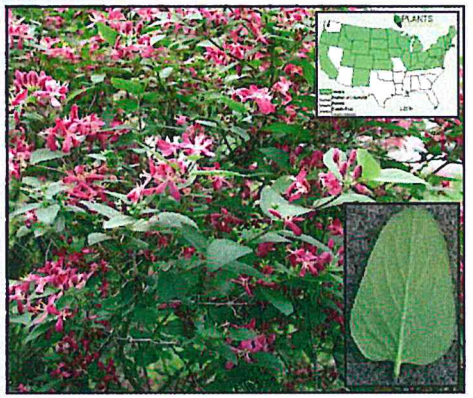


Photos by Douglas Cygan & Leaf Photo by Leslie J. Mehrhoff

Lonicera tatarica - Tatarian Honeysuckle

Family: Caprifoliaceae
Native to: Eurasia

Description: Upright deciduous shrub reaching 6-15' tall. **Stems:** Smooth, glabrous, tan, hollow. **Leaves:** Ovate, smooth, bluish-green, opposite, 1-2$^1/_2$" long. **Flowers:** Tubular, pink or white, April to May. **Fruit:** Berry with two seeds, turning red in fall. **Zone:** 3. **Habitat:** Under story species in woodland sites, also invades open spaces. Thrives in moist soils. **Spread:** Seeds dispersed by wildlife and humans. **Comments:** Rapidly invades forests, fields, roadsides and floodplains. Outcompetes native species. **Controls:** Hand control is effective for small plants while mechanical removal, cutting and chemical applications are better for larger stands.

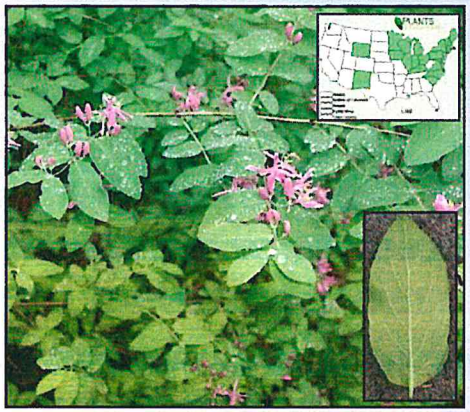


Photos by Leslie J. Mehrhoff & Berry Photo by Douglas Cygan

Lonicera x bella - Showy Bush Honeysuckle

Family: Caprifoliaceae
Native to: Eurasia

Description: Shrub reaching 20' in height and width. **Stems:** Greenish to tan with corky wings. **Leaves:** Oppositely arranged, simple and elliptic, 1-3" long by half as wide, light green. **Flowers:** Yellow, white or pink, May to early June. **Fruit:** Fleshy red, forming in pairs in leaf axis. **Zone:** 4. **Habitat:** Prefers dry upland soils, full sun to heavy shade, pH adaptable. **Spread:** Seeds are dispersed by birds. **Comments:** *L. x bella* is a cross between *L. tatarica* & *L. morrowii*. Spreads into natural areas forming dense stands, which displace native species. **Controls**: Hand or mechanical removal, continuous cutting, girdling, and herbicide treatment.

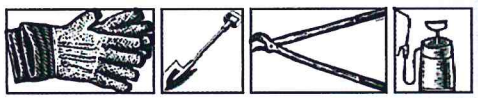


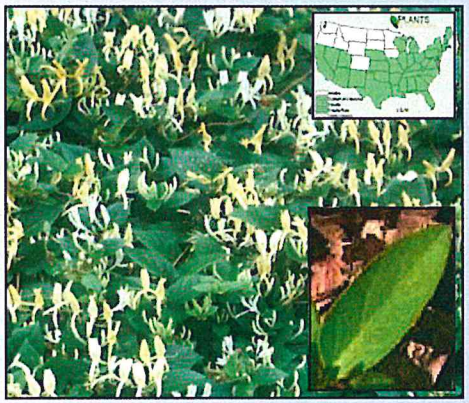
Photos courtesy of Leslie J. Mehrhoff/UCONN-IPANE

Lonicera japonica - Japanese Honeysuckle

Family: Caprifoliaceae
Native to: Eurasia

Description: Climbing vine. **Stems:** Reddish-brown, pubescent. **Leaves:** Opposite and not clasping the stem as opposed to the three native honeysuckle vines that do clasp the stem, oblong, $1^1/_2$-2" long, rounded at base. **Flowers:** Tubular, white or yellow, fragrant, May to mid-July. **Fruit:** Berry, smooth, blackish to slightly purplish. **Zone:** 4-8. **Habitat:** Prefers moist soils and full sun to partial shade. **Spread:** Seeds spread by wildlife. **Comments:** Vines grow quickly, covering native vegetation, resulting in loss of habitat. **Controls:** hand or mechanical removal, cutting, girdling, chemical.



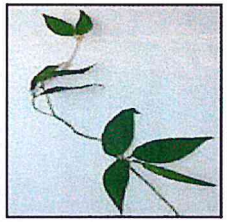


Photos courtesy of John M. Randall/The Nature Conservancy
& Leaf Photo by Leslie J. Mehrhoff

Cynanchum nigrum - Black Swallow-Wort

Family: Asclepiadaceae
Native to: Eurasia

Description: Perennial herbaceous vine that grows to 6'. **Leaves:** Opposite, lanceolate, dark glossy green, simple with a smooth edge, 2-4" long. **Flowers:** Small $^1/_4$", 5-petaled, purplish, from June to September. **Seed:** Seeds are similar to those of milkweed. **Zone:** 4 to 8. **Habitat:** It prefers full to partial sun. **Spread:** Seeds dispersed by wind. **Comments:** Invades roadsides, fields, disturbed sites, meadows, and woodlands, outcompeting native species. **Controls:** Hand pull young plants. Remove and destroy seed pods before they open. Apply herbicides as a foliar spray during the growing season. If plants are to be dug, use a spade and make sure that all root fragments are removed.

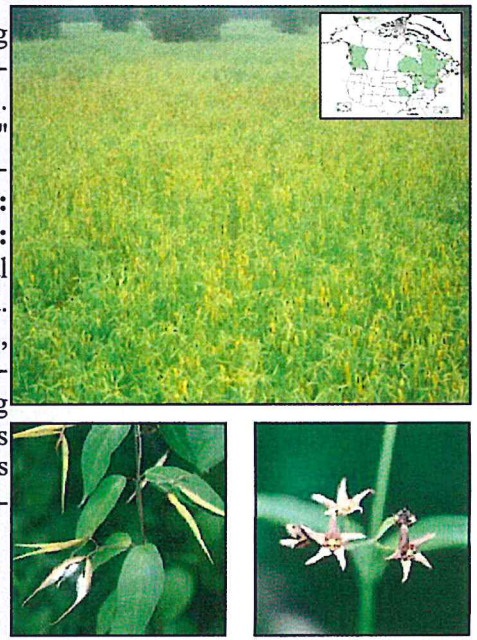


Photos by Douglas Cygan

Cynanchum rossicum - Pale Swallow-Wort

Family: Asclepiadaceae
Native to: China

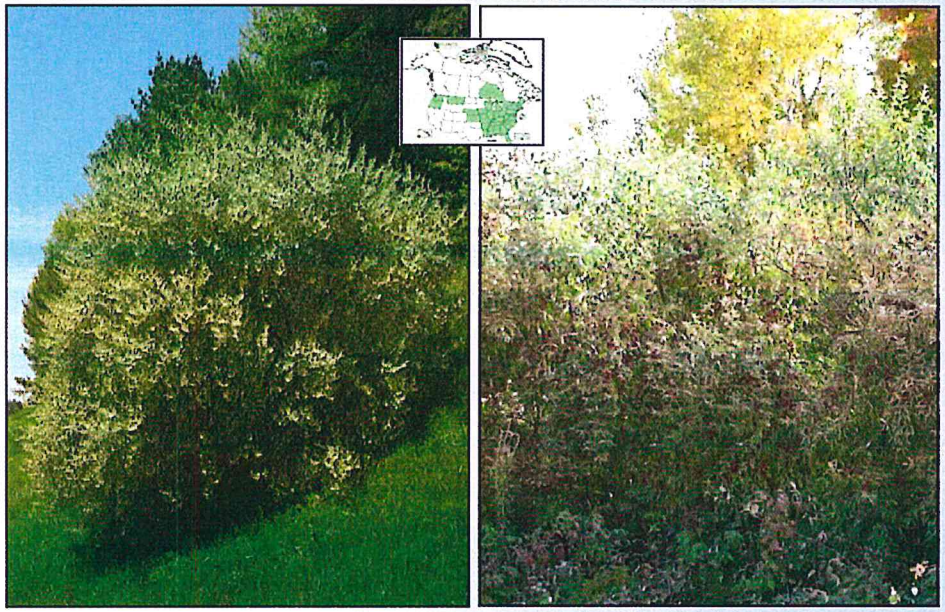
Description: Perennial vine growing to 3-6'. Very similar to black swallow-wort with the exception of the flowers. **Leaves:** Opposite, lanceolate, 2-4" long. **Flowers:** Magenta, $^3/_8$", flowering from June to September. **Seed:** Seeds are similar to milkweed. **Zone:** 4 to 8. **Habitat:** It prefers full to partial sun. **Spread:** Seeds dispersed by wind. **Comments:** Invades roadsides, fields, disturbed sites, meadows and woodlands. **Controls:** Hand pull young plants. Remove and destroy seed pods before they open. Apply herbicides as a foliar spray. Dig using a spade to ensure all root fragments are removed.



Photos courtesy of John M. Randall/The Nature Conservancy

Elaeagnus umbellata - Autumn Olive

Family: Elaeagnaceae
Native to: Asia



Autumn Olive—Elaeagnus umbellata

Autumn Olive invasion in Concord, NH

Description: Weedy deciduous shrub measuring 20' by 20'. **Bark:** Silvery-gray and smooth with whitish lenticels. **Stems:** Cinnamon-brown. **Leaves:** Elliptical, 2-3" long, glossy, green above and silverish below. **Flowers:** Solitary, whitish, 4-petaled, mid-June. **Fruit:** Drupe. **Zone:** 3-8. **Habitat:** Naturalizes in open spaces exposed to full sun. **Spread:** Seeds dispersed by birds and wildlife. **Comments:** Very aggressive. Outcompetes and displaces native species. **Controls:** Remove seedlings and saplings by hand. Larger shrubs can be mechanically removed, or cut and apply herbicide to stump.

Silvery-gray Bark

Leaves

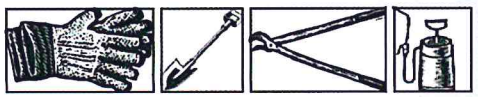
Terminal bud

Flowers whitish

Fall Color

Fruit is a fleshy drupe

Photos by Douglas Cygan



Ligustrum obtusifolium - Blunt-leaved Privet

Family: Oleaceae
Native to: Europe

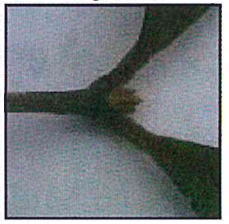
Blunt-leaved Privet-*Ligustrum obtusifolium*

Blunt-leaved Privet (Photo: Leslie J. Mehrhoff)

Description: Shrub reaching 12' tall by 10-12' wide. **Stems:** Greenish, smooth. **Leaves:** Opposite, simple and elliptic, 1-3" long by half as wide, blunt tipped, light green. **Flowers:** Small white panicles, May to early June. **Fruit:** Small blackish drupe. **Zone:** 4-7. **Habitat:** Prefers dry upland soils, full sun to heavy shade, pH adaptable. **Spread:** Seeds dispersed by birds. **Comments**: Becomes established in natural areas leading to competition and displacement of native species. **Controls:** Hand or mechanical removal, cutting, herbicide applications such as foliar or cut-stem.

Twig/stem bark

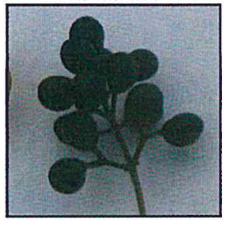
Leaves



Terminal bud

Flowers white

Fall color

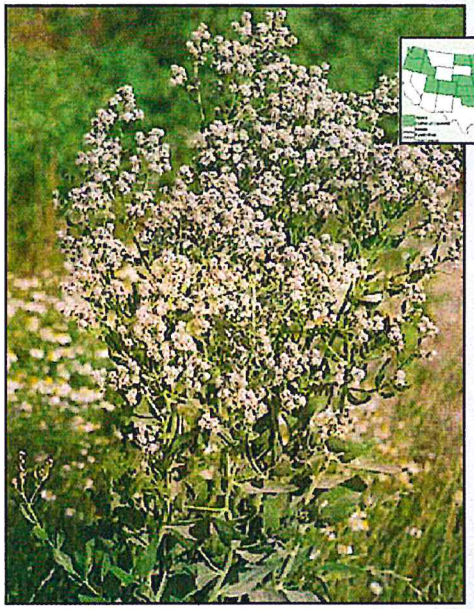


Fruit is a dark drupe

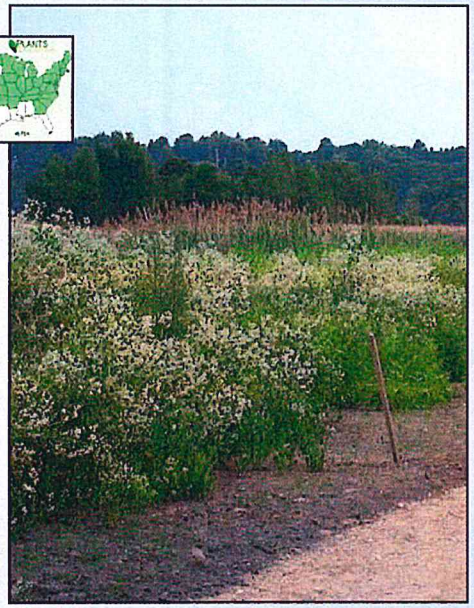
Photos by Douglas Cygan & Leslie Mehrhoff

Lepidium latifolium - Perennial Pepperweed

Family: Cruciferae
Native to: Eurasia

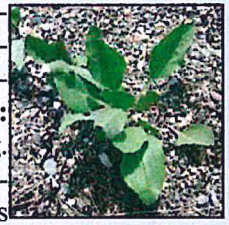


Perennial Pepperweed—*Lepidium latifolium*



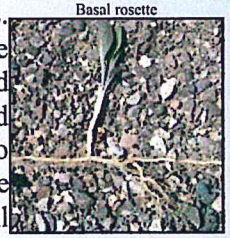
Perennial Pepperweed invasion Seacoast area, NH

Description: Long lived perennial growing 2-4' tall. **Leaves:** Alternate, lanceolate with serrated edge. **Flowers:** Terminal, tightly clustered, white, July. **Fruit:** Silicle, rounded, flattish, hairy $^{1}/_{16}$" long. **Zone:** 4-8. **Habitat:** Prefers wet, brackish soils such as coastal tidal marshes and ditches, wetlands, and floodplains. **Spread:** Seeds and creeping rhizome fragments spread by water, wildlife and humans. **Comments:** Plants spread quickly into natural areas leading to competition and displacement of native coastal wetland species. **Controls:** Small populations can be hand pulled while large populations can be continuously cut back to prevent flowering and seed production. Herbicide treatments are also effective.



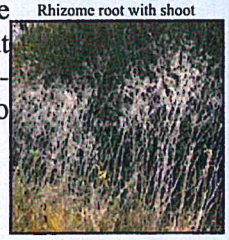
Basal rosette

Leaf



Rhizome root with shoot

Flower head



Persistent stems

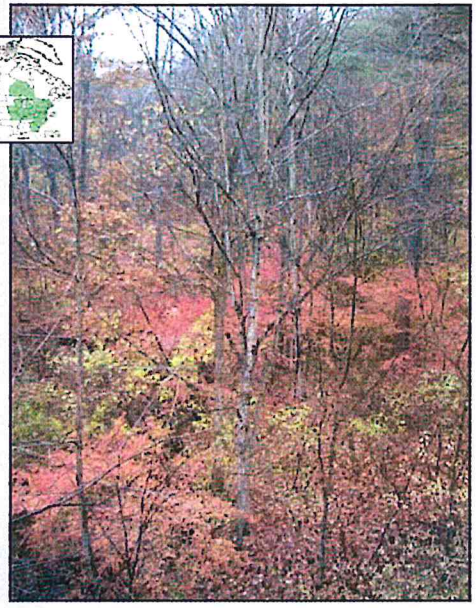
Seeds (photo—USDA)

Photos by Kevin Lucey & Jennifer Forman

Euonymus alatus - Burning Bush

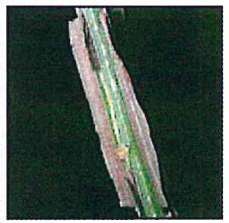
Family: Celastraceae
Native to: Asia

Burning Bush-*Euonymus alatus*



Burning Bush invasion, Boscawen, NH

Description: Deciduous shrub reaching 20' in height and width. **Stems:** Greenish with corky wings. **Leaves:** Oppositely arranged, simple and elliptic, 1-3" long by half as wide, light green. **Flowers:** Inconspicuous greenish-yellow, May to June. **Fruit:** Fleshy green capsule turning red in fall. **Zone:** 3 to 8. **Habitat:** Prefers dry upland soils, full sun to heavy shade, pH adaptable. **Spread**: Seeds are dispersed by birds and wildlife. **Comments:** Outcompetes and displaces native species. **Controls:** Hand remove seedlings and saplings. Use a spade or shovel to dig out larger plants. Large populations may be controlled with herbicide use.



Corky-winged bark

Leaves

Terminal buds

Flowers yellowish-white

Fall color

Fruit is a fleshy capsule

Photos by Douglas Cygan

Heracleum mantegazzianum - Giant Hogweed

Family: Apiaceae
Native to: China

Giant Hogweed-*Heracleum mantegazzianum*

Open field invasion (Photo-Bugwood.org)

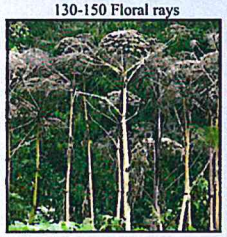
Description: Biennial growing to 15' tall. **Stems:** Greenish with purple splotches, 2-4" diameter with coarse hairs, hollow. **Leaves:** Large, compound, deeply incised, 3-5' wide, hairy on underside. **Flowers:** White inflorescence, 1-2' in diameter, May-June. **Seeds:** Flattened, $^{3}/_{8}$" long, ovate with 4 brown resin canals. **Zone:** 3-8. **Habitat:** Found in wet areas, roadsides, gardens, open spaces, full sun to partial shade. **Spread:** Seeds dispersed by water, wildlife and humans. **Comments:** The clear, watery sap is phototoxic to human skin, causing severe blistering and burns. Spreads readily and displaces native species. **Controls:** Remove plants by digging up tap root. Herbicide can also be used as a foliar treatment.

Purple spotted, hairy stem

Leaf

130-150 Floral rays

Flowers whitish umbel



Persistent dead stalks

Seeds with resinous veins

Photos by Douglas Cygan

Hesperis matronalis - Dame's Rocket

Family: Brassicaceae
Native to: Eurasia

Dame's Rocket—*Hesperis matronalis*

Dame's Rocket invasion

Description: Cool season biennial, 2nd year plants flower and reach 30" tall. **Leaves:** Alternately arranged and lanceolate in shape with toothed margins. **Flowers:** Terminal racemes, 4-petals, purplish, early to mid spring. **Fruit:** Pods, seeds turn brown when mature. **Zone:** 4-8. **Habitat:** Prefers partial sun, moist to mesic conditions such as floodplains, forests and roadsides, adaptable to full sun with adequate moisture. **Spread:** Seeds spread by water and wildlife. **Comments:** Plants spread quickly into natural areas leading to competition and displacement of native species. **Controls:** Small populations can be hand pulled while large populations can be continuously cut back to prevent flowering and seed production. Herbicide treatments are also effective.

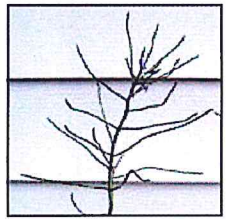
Basal rosette

Leaf

Flower buds

Flowers 4-petaled, white

Stems



Seed pods

Photos by Leslie Mehroff

SECTION 5 STORMWATER INSPECTION & MAINTENANCE LOG

STORMWATER INSPECTION MAINTENANCE LOG

158 Epping Road - Exeter, NH

General Information			
Project Name	Retail Motor Fuel Outlet	**Location**	Exeter, NH
Date of Inspection		**Start/ End Time**	
Inspector's Name(s)			
Inspector's Title(s)			
Inspector's Contact Information			

	Site Specific BMP's	Maintenance Interval
1	Street Sweeping	1 year
2	Deep Sump Catch Basins	6 months
3	Underground Detention Systems	6 months
4	Bioretention Areas	6 months
5	Hydrodynamic Separators (First Defense Unit)	3 months (See separate maintenance log for First Defense Unit)
6	Contech "Jellyfish" Filter units	See separate maintenance log for Jellyfish Unit

STORMWATER INSPECTION MAINTENANCE LOG

158 Epping Road - Exeter, NH

BMP Description	Corrective Action Required?		Notes
Street Sweeping			
Evidence of debris accumulation	YES	NO	
Evidence of oil grease	YES	NO	
Other (specify)	YES	NO	
Deep Sump Catch Basins			
Grates clear of debris	YES	NO	
Inlet and outlet clear of debris	YES	NO	
Evidence of oil grease	YES	NO	
Observance of accumulated sediment	YES	NO	Sediment Depth =
Evidence of structural deterioration	YES	NO	
Evidence of flow bypassing facility	YES	NO	
Other (specify)	YES	NO	
Underground Detention System #1			
Inlet and outlet clear of debris	YES	NO	
Bottom surface clear of debris	YES	NO	
Evidence of rilling or gullying	YES	NO	
Observance of accumulated sediment	YES	NO	Sediment Depth =
Bottom dewaters within 72 hrs. of a storm event	YES	NO	
Standing water or wet spots	YES	NO	
Other (specify)	YES	NO	
Underground Detention System #2			
Inlet and outlet clear of debris	YES	NO	
Bottom surface clear of debris	YES	NO	
Evidence of rilling or gullying	YES	NO	
Observance of accumulated sediment	YES	NO	Sediment Depth =
Bottom dewaters within 72 hrs. of a storm event	YES	NO	
Standing water or wet spots	YES	NO	
Other (specify)	YES	NO	
Bioretention Area			
Inlet and outlet clear of debris	YES	NO	
Bottom surface clear of debris	YES	NO	
Evidence of rilling or gullying	YES	NO	
Observance of accumulated sediment	YES	NO	Sediment Depth =
Bottom dewaters between storms	YES	NO	
Vegetation healthy and growing	YES	NO	
Standing water or wet spots	YES	NO	
Tree growth	YES	NO	
Other (specify)	YES	NO	

STORMWATER INSPECTION MAINTENANCE LOG

158 Epping Road - Exeter, NH

Hydrodynamic Separators (First Defense Units)
See separate maintenance log for First Defense Unit
Jellyfish Treatment Unit (First Defense Unit)
See separate maintenance log for Jellyfish Unit

NOTE: Photos shall be provided with each inspection log and shall be sufficiently labeled to identify photo location.

INSPECTION AND MAINTENANCE CHECKLIST

158 Epping Road - Exeter, NH

BMP System	Minimum Inspection Frequency	Minimum Inspection Requirements	Maintenance/ Cleanout Threshold
Paved Surface:			
Pavement Sweeping	Annually	Check for debris accumulation, check for oil grease	N/A
Litter & Trash Removal	Routinely	N/A	Parcel will be free of litter/ trash
Deicing Agents	NA	Keep De-Icing Log	Low Salt
Closed Drainage System:			
Drainage Pipe	1 time per 2 years	Check for sdiment acculation & clogging.	Less than 2" sediment depth
Cach Basins	6 months	Check for sediment accumulation (Less than 24" sediment), check for blocked hood, and floating debris, check for oil grease, check for structural deterioration, check for flow bypassing facility	Clean sumps. Remove all floating debris
Drain Manhole	Annually	Check for sdeiment, debris, and obstructions	Remove all obstructions
BMPs:			
Underground Detention Systems	6 months	Clear of debris, check for accumulated sediment, check that bottom dewaters within 72 hrs. of a storm event, check for standing water	Remove trash & debris. Remove accumulated sediment.

INSPECTION AND MAINTENANCE CHECKLIST

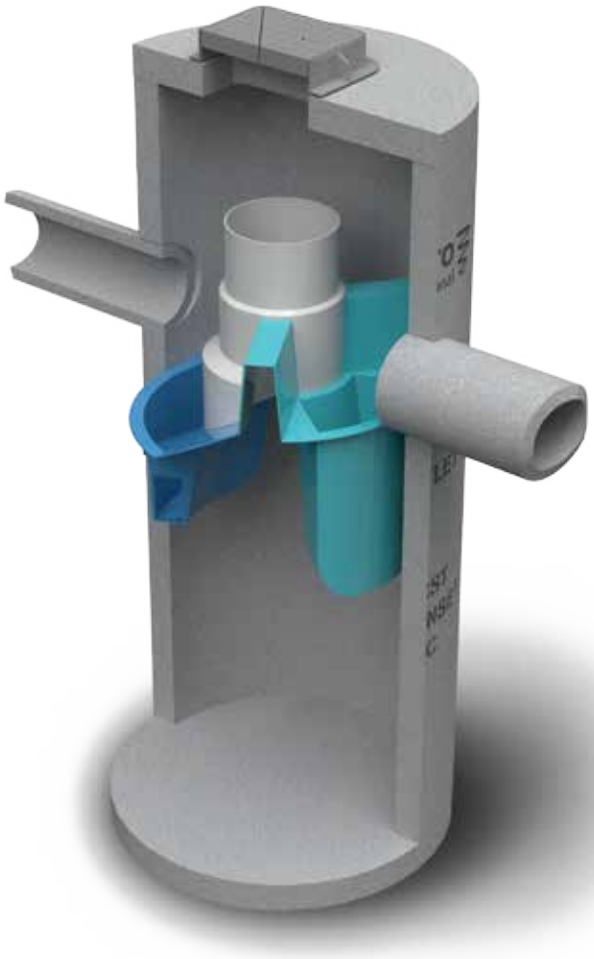
158 Epping Road - Exeter, NH

Bioretention Area	6 months	Check for debris, check for rilling or gullying, check for accumulated sediment, check bottom dewaters between storms, check for standing water, check vegetation and tree growth	Remove trash & debris, sediment, woody vegetation and invasive species. Replant vegetation if required.
Hydrodynamic Separator (First Defense Unit)	3 months	Check for debris, check for standing water, check for accumulated sediment, check for floatable	Remove trash & debris. Remove accumulated sediment. Remove floatables.
Contech "Jellyfish" Filter Unit	Annually	Check for debris, check for standing water, check for physical damage	Remove trash & debris. Remove acccumulated sediment. Replace filter cartridges if requrired.

SECTION 6 DE-ICING LOG

Deicing Log

Date Applied	Type of Deicing Material	Amount Applied



Operation and Maintenance Manual

First Defense® and First Defense®-HC

Vortex Separator for Stormwater Treatment

Stormwater Solutions

Turning Water Around ...®

Table of Contents

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Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
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I. First Defense® by Hydro International

Introduction

The First Defense® is an enhanced vortex separator that combines an effective and economical stormwater treatment chamber with an integral peak flow bypass. It efficiently removes total suspended solids (TSS), trash and hydrocarbons from stormwater runoff without washing out previously captured pollutants. The First Defense® is available in several model configurations (refer to *Section II. Model Sizes & Configurations*, page 4) to accommodate a wide range of pipe sizes, peak flows and depth constraints.

Operation

The First Defense® operates on simple fluid hydraulics. It is self-activating, has no moving parts, no external power requirement and is fabricated with durable non-corrosive components. No manual procedures are required to operate the unit and maintenance is limited to monitoring accumulations of stored pollutants and periodic clean-outs. The First Defense® has been designed to allow for easy and safe access for inspection, monitoring and clean-out procedures. Neither entry into the unit nor removal of the internal components is necessary for maintenance, thus safety concerns related to confined-space-entry are avoided.

Pollutant Capture and Retention

The internal components of the First Defense® have been designed to optimize pollutant capture. Sediment is captured and retained in the base of the unit, while oil and floatables are stored on the water surface in the inner volume (Fig.1).

The pollutant storage volumes are isolated from the built-in bypass chamber to prevent washout during high-flow storm events. The sump of the First Defense® retains a standing water level between storm events. This ensures a quiescent flow regime at the onset of a storm, preventing resuspension and washout of pollutants captured during previous events.

Accessories such as oil absorbent pads are available for enhanced oil removal and storage. Due to the separation of the oil and floatable storage volume from the outlet, the potential for washout of stored pollutants between clean-outs is minimized.

Applications

- Stormwater treatment at the point of entry into the drainage line
- Sites constrained by space, topography or drainage profiles with limited slope and depth of cover
- Retrofit installations where stormwater treatment is placed on or tied into an existing storm drain line
- Pretreatment for filters, infiltration and storage

Advantages

- Inlet options include surface grate or multiple inlet pipes
- Integral high capacity bypass conveys large peak flows without the need for “offline” arrangements using separate junction manholes
- Proven to prevent pollutant washout at up to 500% of its treatment flow
- Long flow path through the device ensures a long residence time within the treatment chamber, enhancing pollutant settling
- Delivered to site pre-assembled and ready for installation

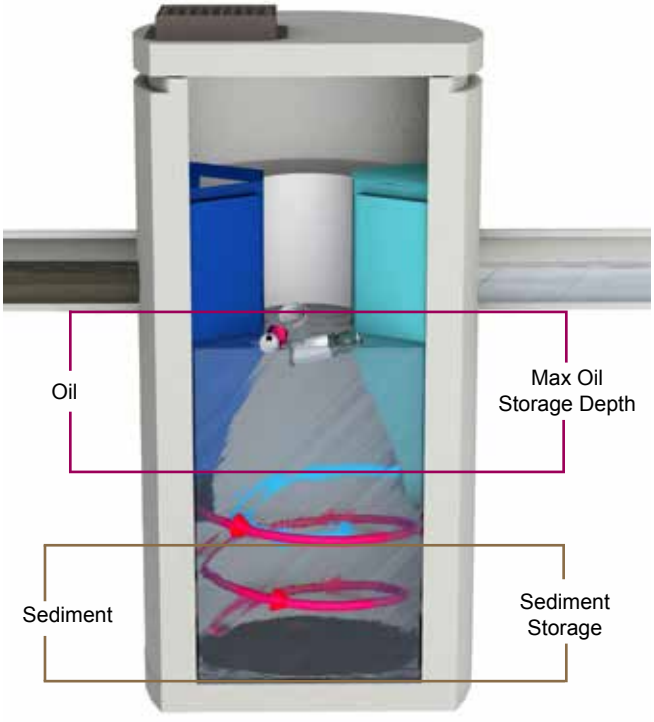

Fig.1 Pollutant storage volumes in the First Defense®.

II. Model Sizes & Configurations

The First Defense® inlet and internal bypass arrangements are available in several model sizes and configurations. The components of the First Defense®-4HC and First Defense®-6HC have modified geometries as to allow greater design flexibility needed to accommodate various site constraints.

All First Defense® models include the internal components that are designed to remove and retain total suspended solids (TSS), gross solids, floatable trash and hydrocarbons (Fig.2a - 2b). First Defense® model parameters and design criteria are shown in Table 1.

First Defense® Components

1. **Built-In Bypass**
2. **Inlet Pipe**
3. **Inlet Chute**
4. **Floatables Draw-off Port**
5. **Outlet Pipe**
6. **Floatables Storage**
7. **Sediment Storage**
8. **Inlet Grate or Cover**

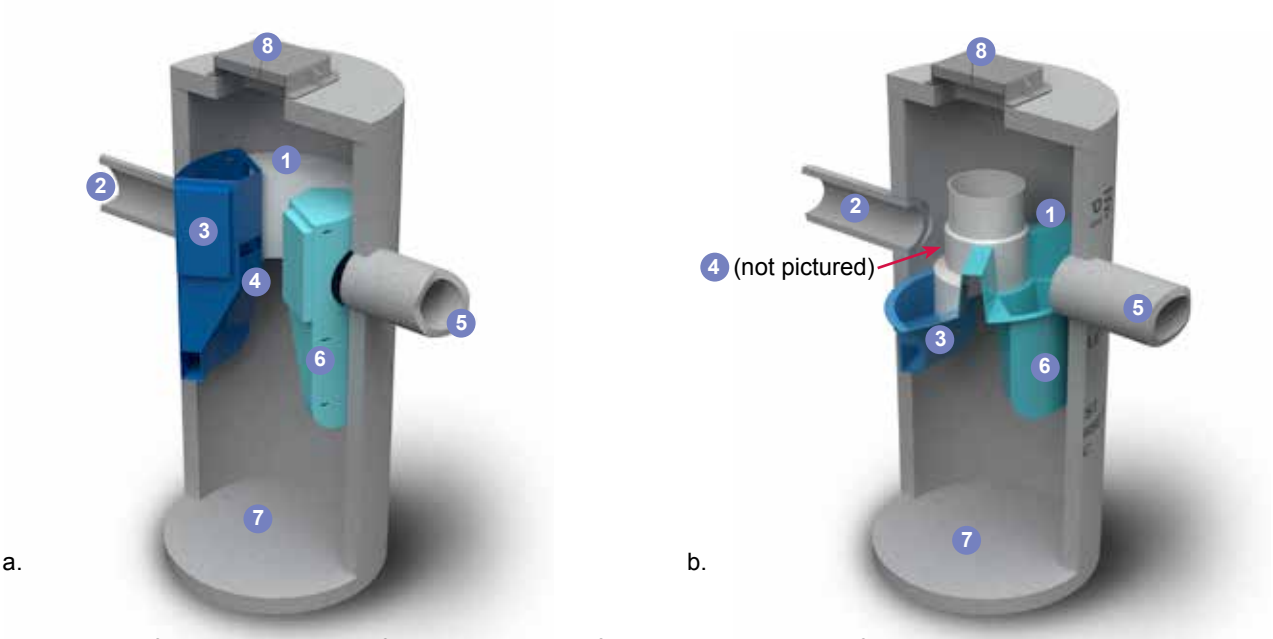

Fig.2a) First Defense®-4 and First Defense®-6; b) First Defense®-4HC and First Defense®-6HC, with higher capacity dual internal bypass and larger maximum pipe diameter.

Table 1. First Defense® Pollutant Storage Capacities and Maximum Clean out Depths

First Defense® Model Number	Diameter	Oil Storage Capacity	Oil Clean Out Depth	Maximum Sediment Storage Capacity[1]		Recommended Sediment Clean-out Capacity	
				Volume	Depth	Volume	Depth
	(ft / m)	(gal / L)	(in / cm)	(yd^3 / m^3)	(in / cm)	(yd^3 / m^3)	(in / cm)
FD-4	4 / 1.2	180 / 681	<23.5 / 60	1.3 / 1.0	33 / 84	0.7 / 0.5	18 / 46
FD-4HC		191 / 723	<24.4 / 62				
FD-6	6 / 1.8	420 / 1,590	<23.5 / 60	3.3 / 2.5	37.5 / 95	1.3 / 1.0	15 / 38
FD-6HC		496 / 1,878	<28.2 / 72				

NOTE

[1] Sediment storage capacity and clean out depth may vary, as larger sediment storage sump volumes are provided when required.

III. Maintenance

Overview

The First Defense® protects the environment by removing a wide range of pollutants from stormwater runoff. Periodic removal of these captured pollutants is essential to the continuous, long-term functioning of the First Defense®. The First Defense® will capture and retain sediment and oil until the sediment and oil storage volumes are full to capacity. When sediment and oil storage capacities are reached, the First Defense® will no longer be able to store removed sediment and oil. Maximum pollutant storage capacities are provided in Table 1.

The First Defense® allows for easy and safe inspection, monitoring and clean-out procedures. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables. Access ports are located in the top of the manhole.

Maintenance events may include Inspection, Oil & Floatables Removal, and Sediment Removal. Maintenance events do not require entry into the First Defense®, nor do they require the internal components of the First Defense® to be removed. In the case of inspection and floatables removal, a vactor truck is not required. However, a vactor truck is required if the maintenance event is to include oil removal and/or sediment removal.

Maintenance Equipment Considerations

The internal components of the First Defense®-HC have a centrally located circular shaft through which the sediment storage sump can be accessed with a sump vac hose. The open diameter of this access shaft is 15 inches in diameter (Fig.3). Therefore, the nozzle fitting of any vactor hose used for maintenance should be less than 15 inches in diameter.

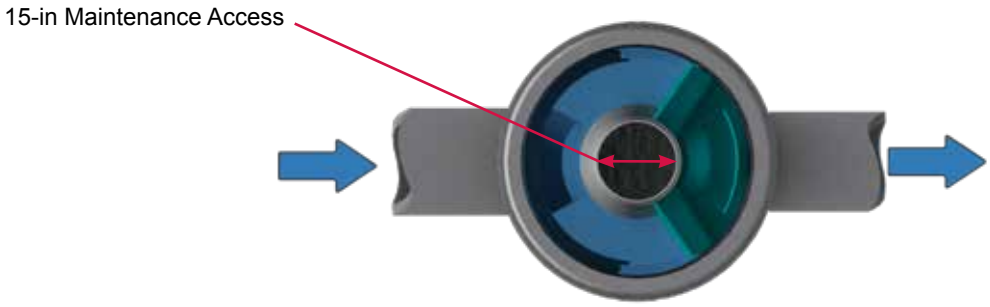

Fig.3 The central opening to the sump of the First Defense®-HC is 15 inches in diameter.

Determining Your Maintenance Schedule

The frequency of clean out is determined in the field after installation. During the first year of operation, the unit should be inspected every six months to determine the rate of sediment and floatables accumulation. A simple probe such as a Sludge-Judge® can be used to determine the level of accumulated solids stored in the sump. This information can be recorded in the maintenance log (see page 9) to establish a routine maintenance schedule.

The vactor procedure, including both sediment and oil / flotables removal, for a 6-ft First Defense® typically takes less than 30 minutes and removes a combined water/oil volume of about 765 gallons.

Inspection Procedures

1. Set up any necessary safety equipment around the access port or grate of the First Defense® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.

2. Remove the grate or lid to the manhole.

3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities. Fig.4 shows the standing water level that should be observed.

4. Without entering the vessel, use the pole with the skimmer net to remove floatables and loose debris from the components and water surface.

5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel.

6. On the Maintenance Log (see page 9), record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components or blockages.

7. Securely replace the grate or lid.

8. Take down safety equipment.

9. Notify Hydro International of any irregularities noted during inspection.

Floatables and Sediment Clean Out

Floatables clean out is typically done in conjunction with sediment removal. A commercially or municipally owned sump-vac is used to remove captured sediment and floatables (Fig.5).

Floatables and loose debris can also be netted with a skimmer and pole. The access port located at the top of the manhole provides unobstructed access for a vactor hose and skimmer pole to be lowered to the base of the sump.

Scheduling

- Floatables and sump clean out are typically conducted once a year during any season.

- Floatables and sump clean out should occur as soon as possible following a spill in the contributing drainage area.

Fig.4 Floatables are removed with a vactor hose (First Defense model FD-4, shown).

Recommended Equipment

- Safety Equipment (traffic cones, etc)
- Crow bar or other tool to remove grate or lid
- Pole with skimmer or net (if only floatables are being removed)
- Sediment probe (such as a Sludge Judge®)
- Vactor truck (flexible hose recommended)
- First Defense® Maintenance Log

Floatables and sediment Clean Out Procedures

1. Set up any necessary safety equipment around the access port or grate of the First Defense® as stipulated by local ordinances. Safety equipment should notify passing pedestrian and road traffic that work is being done.

2. Remove the grate or lid to the manhole.

3. Without entering the vessel, look down into the chamber to inspect the inside. Make note of any irregularities.

4. Remove oil and floatables stored on the surface of the water with the vactor hose (Fig.5) or with the skimmer or net (not pictured).

5. Using a sediment probe such as a Sludge Judge®, measure the depth of sediment that has collected in the sump of the vessel and record it in the Maintenance Log (page 9).

6. Once all floatables have been removed, drop the vactor hose to the base of the sump. Vactor out the sediment and gross debris off the sump floor (Fig.5).

7. Retract the vactor hose from the vessel.

8. On the Maintenance Log provided by Hydro International, record the date, unit location, estimated volume of floatables and gross debris removed, and the depth of sediment measured. Also note any apparent irregularities such as damaged components, blockages, or irregularly high or low water levels.

9. Securely replace the grate or lid.

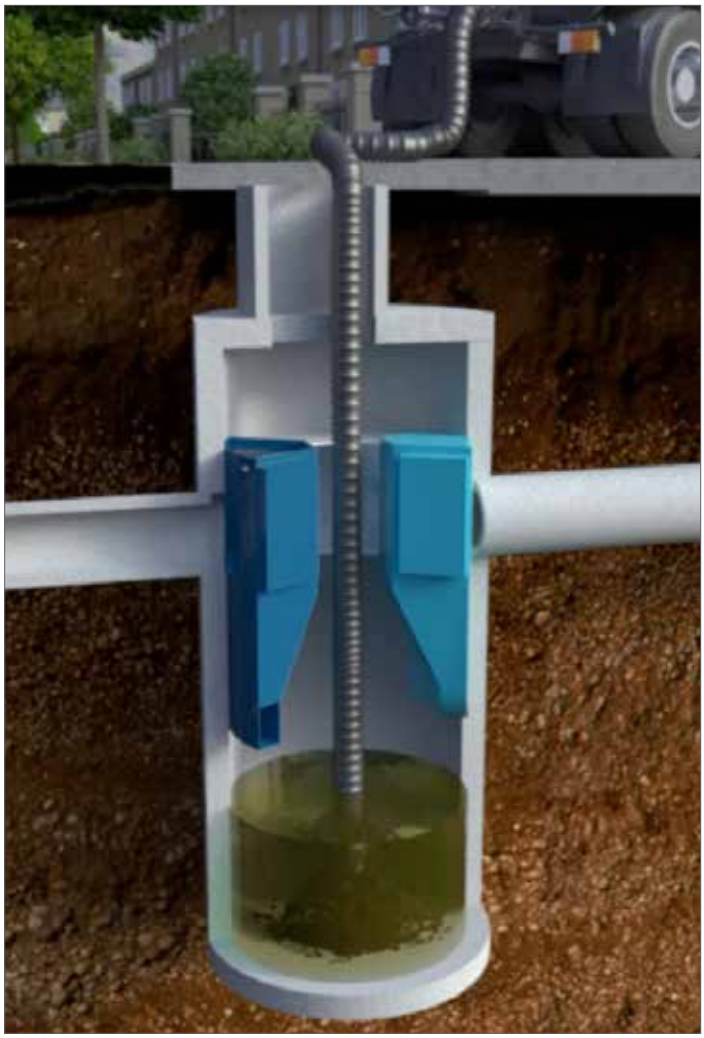

Fig.5 Sediment is removed with a vactor hose (First Defense model FD-4, shown).

Maintenance at a Glance

Activity	Frequency
Inspection	- Regularly during first year of installation - Every 6 months after the first year of installation
Oil and Floatables Removal	- Once per year, with sediment removal - Following a spill in the drainage area
Sediment Removal	- Once per year or as needed - Following a spill in the drainage area
NOTE: For most clean outs the entire volume of liquid does not need to be removed from the manhole. Only remove the first few inches of oils and floatables from the water surface to reduce the total volume of liquid removed during a clean out.	

First Defense® Installation Log

HYDRO INTERNATIONAL REFERENCE NUMBER:	
SITE NAME:	
SITE LOCATION:	
OWNER:	CONTRACTOR:
CONTACT NAME:	CONTACT NAME:
COMPANY NAME:	COMPANY NAME:
ADDRESS:	ADDRESS:
TELEPHONE:	TELEPHONE:
FAX:	FAX:

INSTALLATION DATE: / /

MODEL SIZE (CIRCLE ONE): **FD-4** **FD-4HC** **FD-6** **FD-6HC**

INLET (CIRCLE ALL THAT APPLY): **GRATED INLET (CATCH BASIN)** **INLET PIPE (FLOW THROUGH)**

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First Defense® Inspection and Maintenance Log

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

Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

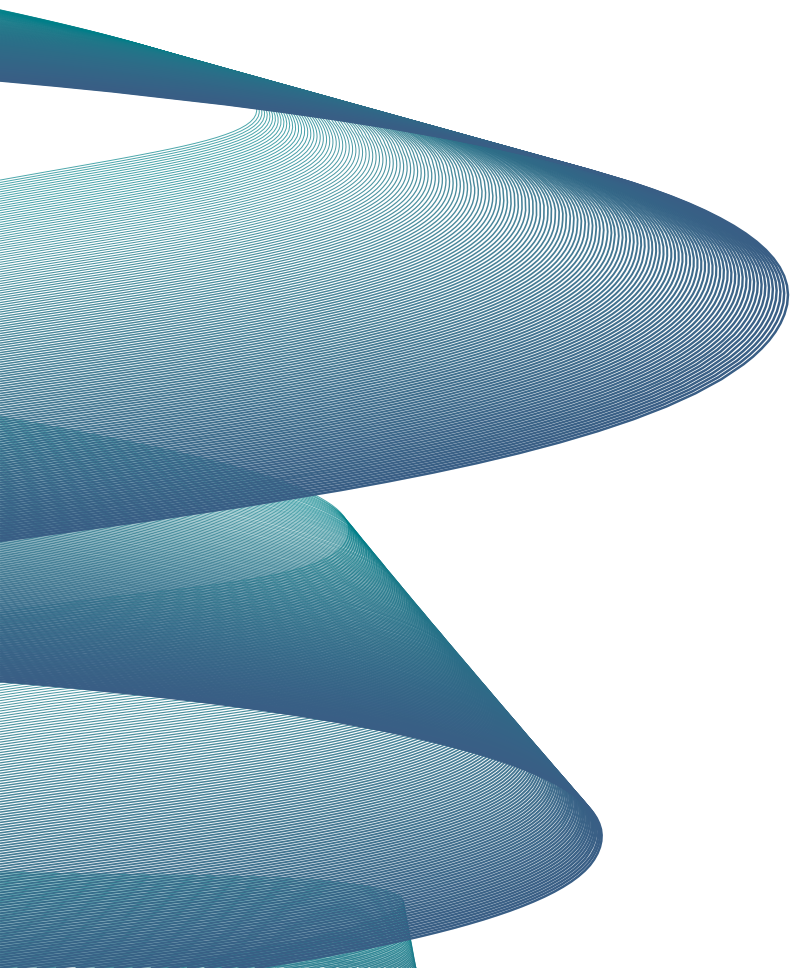
Hydro International (Stormwater), 94 Hutchins Drive, Portland ME 04102
Tel: (207) 756-6200 Fax: (207) 756-6212 Web: www.hydro-int.com

What is HX?

HX is Hydro Experience, it is the essence of Hydro. It's interwoven into every strand of Hydro's story, from our products to our people, our engineering pedigree to our approach to business and problem-solving.

HX is a stamp of quality and a mark of our commitment to optimum process performance. A Hydro solution is tried, tested and proven.

There is no equivalent to Hydro HX.



Stormwater Solutions

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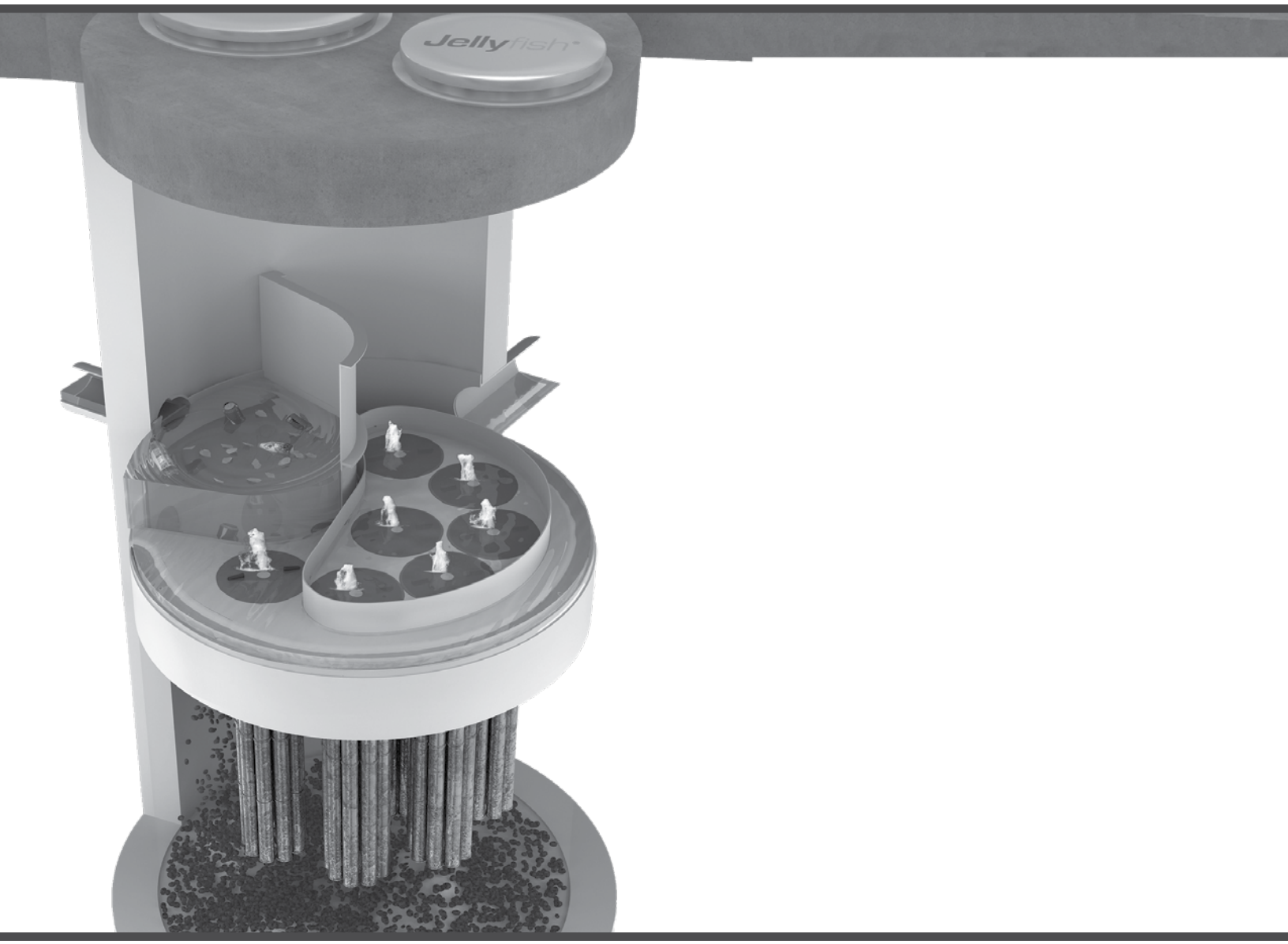
Jellyfish® Filter Maintenance Guide



Jellyfish®

JELLYFISH® FILTER
INSPECTION & MAINTENANCE GUIDE

Jellyfish units are often just one of many structures in a more comprehensive stormwater drainage and treatment system.

In order for maintenance of the Jellyfish filter to be successful, it is imperative that all other components be properly maintained. The maintenance and repair of upstream facilities should be carried out prior to Jellyfish maintenance activities.

In addition to considering upstream facilities, it is also important to correct any problems identified in the drainage area. Drainage area concerns may include: erosion problems, heavy oil loading, and discharges of inappropriate materials.

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1.0 Inspection and Maintenance Overview

The primary purpose of the Jellyfish® Filter is to capture and remove pollutants from stormwater runoff. As with any filtration system, these pollutants must be removed to maintain the filter's maximum treatment performance. Regular inspection and maintenance are required to insure proper functioning of the system.

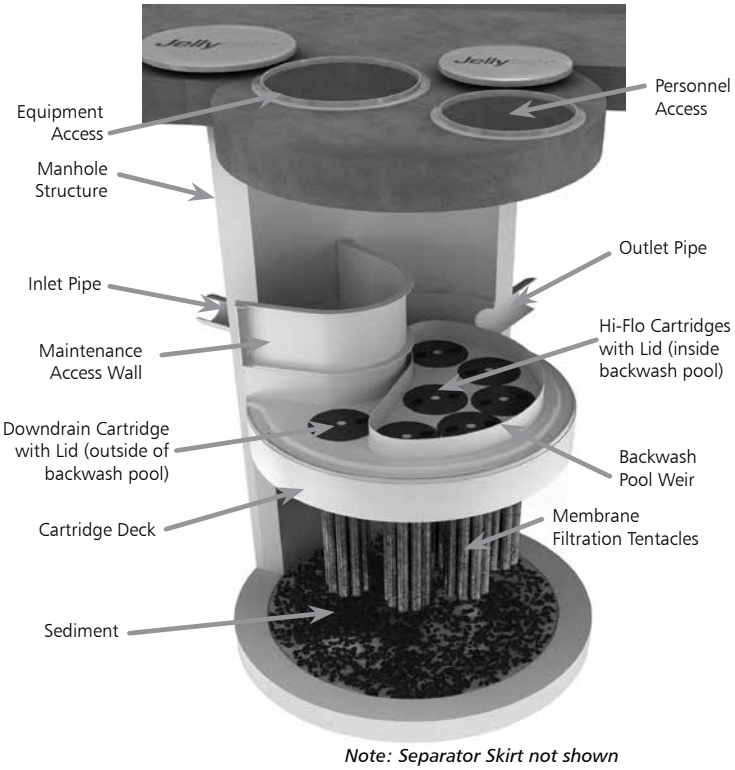
Maintenance frequencies and requirements are site specific and vary depending on pollutant loading. Additional maintenance activities may be required in the event of non-storm event runoff, such as base-flow or seasonal flow, an upstream chemical spill or due to excessive sediment loading from site erosion or extreme runoff events. It is a good practice to inspect the system after major storm events.

Inspection activities are typically conducted from surface observations and include:

- Observe if standing water is present
- Observe if there is any physical damage to the deck or cartridge lids
- Observe the amount of debris in the Maintenance Access Wall (MAW) or inlet bay for vault systems

Maintenance activities include:

- Removal of oil, floatable trash and debris
- Removal of collected sediments
- Rinsing and re-installing the filter cartridges
- Replace filter cartridge tentacles, as needed



Note: Separator Skirt not shown

2.0 Inspection Timing

Inspection of the Jellyfish Filter is key in determining the maintenance requirements for, and to develop a history of, the site's pollutant loading characteristics. In general, inspections should be performed at the times indicated below; *or per the approved project stormwater quality documents (if applicable), whichever is more frequent*.

1. A minimum of quarterly inspections during the first year of operation to assess the sediment and floatable pollutant accumulation, and to ensure proper functioning of the system.
2. Inspection frequency in subsequent years is based on the inspection and maintenance plan developed in the first year of operation. Minimum frequency should be once per year.
3. Inspection is recommended after each major storm event.
4. Inspection is required immediately after an upstream oil, fuel or other chemical spill.

3.0 Inspection Procedure

The following procedure is recommended when performing inspections:

1. Provide traffic control measures as necessary.
2. Inspect the MAW or inlet bay for floatable pollutants such as trash, debris, and oil sheen.
3. Measure oil and sediment depth in several locations, by lowering a sediment probe until contact is made with the floor of the structure. Record sediment depth, and presences of any oil layers.
4. Inspect cartridge lids. Missing or damaged cartridge lids to be replaced.
5. Inspect the MAW (where appropriate), cartridge deck and receptacles, and backwash pool weir, for damaged or broken components.

3.1 Dry weather inspections

- Inspect the cartridge deck for standing water, and/or sediment on the deck.
- No standing water under normal operating conditions.
- Standing water inside the backwash pool, but not outside the backwash pool indicates, that the filter cartridges need to be rinsed.

Inspection Utilizing Sediment Probe

- Standing water outside the backwash pool is not anticipated and may indicate a backwater condition caused by high water elevation in the receiving water body, or possibly a blockage in downstream infrastructure.
- Any appreciable sediment (≥1/16") accumulated on the deck surface should be removed.

3.2 Wet weather inspections

- Observe the rate and movement of water in the unit. Note the depth of water above deck elevation within the MAW or inlet bay.
- Less than 6 inches, flow should be exiting the cartridge lids of each of the draindown cartridges (i.e. cartridges located outside the backwash pool).
- Greater than 6 inches, flow should be exiting the cartridge lids of each of the draindown cartridges and each of the hi-flo cartridges (i.e. cartridges located inside the backwash pool), and water should be overflowing the backwash pool weir.
- 18 inches or greater and relatively little flow is exiting the cartridge lids and outlet pipe, this condition indicates that the filter cartridges need to be rinsed.

4.0 Maintenance Requirements

Required maintenance for the Jellyfish Filter is based upon results of the most recent inspection, historical maintenance records, or the site specific water quality management plan; whichever is more frequent. In general, maintenance requires some combination of the following:

1. Sediment removal for depths reaching 12 inches or greater, or within 3 years of the most recent sediment cleaning, whichever occurs sooner.
2. Floatable trash, debris, and oil removal.
3. Deck cleaned and free from sediment.
4. Filter cartridges rinsed and re-installed as required by the most recent inspection results, or within 12 months of the most recent filter rinsing, whichever occurs sooner.
5. Replace tentacles if rinsing does not restore adequate hydraulic capacity, remove accumulated sediment, or if damaged or missing. It is recommended that tentacles should remain in service no longer than 5 years before replacement.
6. Damaged or missing cartridge deck components must be repaired or replaced as indicated by results of the most recent inspection.
7. The unit must be cleaned out and filter cartridges inspected immediately after an upstream oil, fuel, or chemical spill. Filter cartridge tentacles should be replaced if damaged or compromised by the spill.

5.0 Maintenance Procedure

The following procedures are recommended when maintaining the Jellyfish Filter:

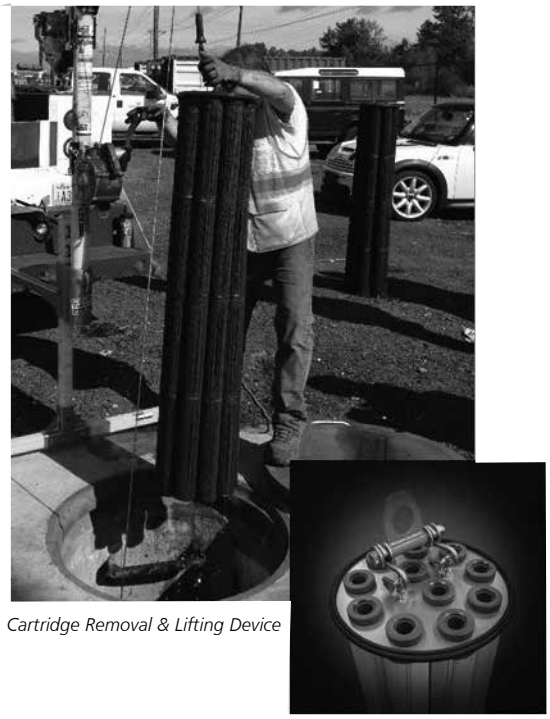
1. Provide traffic control measures as necessary.
2. Open all covers and hatches. Use ventilation equipment as required, according to confined space entry procedures. *Caution: Dropping objects onto the cartridge deck may cause damage*.
3. Perform Inspection Procedure prior to maintenance activity.
4. To access the cartridge deck for filter cartridge service, descend into the structure and step directly onto the deck. Caution: Do not step onto the maintenance access wall (MAW) or backwash pool weir, as damage may result. Note that the cartridge deck may be slippery.
5. Maximum weight of maintenance crew and equipment on the cartridge deck not to exceed 450 lbs.

5.1 Filter Cartridge Removal

1. Remove a cartridge lid.
2. Remove cartridges from the deck using the lifting loops in the cartridge head plate. Rope or a lifting device (available from Contech) should be used. *Caution: Should a snag occur, do not force the cartridge upward as damage to the tentacles may result. Wet cartridges typically weigh between 100 and 125 lbs*.
3. Replace and secure the cartridge lid on the exposed empty receptacle as a safety precaution. Contech does not recommend exposing more than one empty cartridge receptacle at a time.

5.2 Filter Cartridge Rinsing

1. Remove all 11 tentacles from the cartridge head plate. Take care not to lose or damage the O-ring seal as well as the plastic threaded nut and connector.



Cartridge Removal & Lifting Device

2. Position tentacles in a container (or over the MAW), with the threaded connector (open end) facing down, so rinse water is flushed through the membrane and captured in the container.
3. Using the Jellyfish rinse tool (available from Contech) or a low-pressure garden hose sprayer, direct water spray onto the tentacle membrane, sweeping from top to bottom along the length of the tentacle. Rinse until all sediment is removed from the membrane. *Caution: Do not use a high pressure sprayer or focused stream of water on the membrane. Excessive water pressure may damage the membrane*.

4. Collected rinse water is typically removed by vacuum hose.
5. Reassemble cartridges as detailed later in this document. Reuse O-rings and nuts, ensuring proper placement on each tentacle.

5.3 Sediment and Flotables Extraction

1. Perform vacuum cleaning of the Jellyfish Filter only after filter cartridges have been removed from the system. Access the lower chamber for vacuum cleaning only through the maintenance access wall (MAW) opening. Be careful not to damage the flexible plastic separator skirt that is attached to the underside of the deck on manhole systems. Do not lower the vacuum wand through a cartridge receptacle, as damage to the receptacle will result.
2. Vacuum floatable trash, debris, and oil, from the MAW opening or inlet bay. Alternatively, floatable solids may be removed by a net or skimmer.

Vacuuming Sump Through MAW

3. Pressure wash cartridge deck and receptacles to remove all sediment and debris. Sediment should be rinsed into the sump area. Take care not to flush rinse water into the outlet pipe.
4. Remove water from the sump area. Vacuum or pump equipment should only be introduced through the MAW or inlet bay.
5. Remove the sediment from the bottom of the unit through the MAW or inlet bay opening.

Vacuuming Sump Through MAW

6. For larger diameter Jellyfish Filter manholes (≥8-ft) and some vaults complete sediment removal may be facilitated by removing a cartridge lid from an empty receptacle and inserting a jetting wand (not a vacuum wand) through the receptacle. Use the sprayer to rinse loosened sediment toward the vacuum hose in the MAW opening, being careful not to damage the receptacle.

5.4 Filter Cartridge Reinstallation and Replacement

1. Cartridges should be installed after the deck has been cleaned. It is important that the receptacle surfaces be free from grit and debris.
2. Remove cartridge lid from deck and carefully lower the filter cartridge into the receptacle until head plate gasket is seated squarely in receptacle. ***Caution: Do not force the cartridge downward; damage may occur.***
3. Replace the cartridge lid and check to see that both male threads are properly seated before rotating approximately 1/3 of a full rotation until firmly seated. Use of an approved rim gasket lubricant may facilitate installation. See next page for additional details.
4. If rinsing is ineffective in removing sediment from the tentacles, or if tentacles are damaged, provisions must be made to replace the spent or damaged tentacles with new tentacles. Contact Contech to order replacement tentacles.

5.5 Chemical Spills

Caution: If a chemical spill has been captured, do not attempt maintenance. Immediately contact the local hazard response agency and contact Contech.

5.6 Material Disposal

The accumulated sediment found in stormwater treatment and conveyance systems must be handled and disposed of in accordance with regulatory protocols. It is possible for sediments to contain measurable concentrations of heavy metals and organic chemicals (such as pesticides and petroleum products). Areas with the greatest potential for high pollutant loading include industrial areas and heavily traveled roads. Sediments and water must be disposed of in accordance with all applicable waste disposal regulations. When scheduling maintenance, consideration must be made for the disposal of solid and liquid wastes. This typically requires coordination with a local landfill for solid waste disposal. For liquid waste disposal a number of options are available including a municipal vacuum truck decant facility, local waste water treatment plant or on-site treatment and discharge.

Jellyfish Filter Components & Filter Cartridge Assembly and Installation

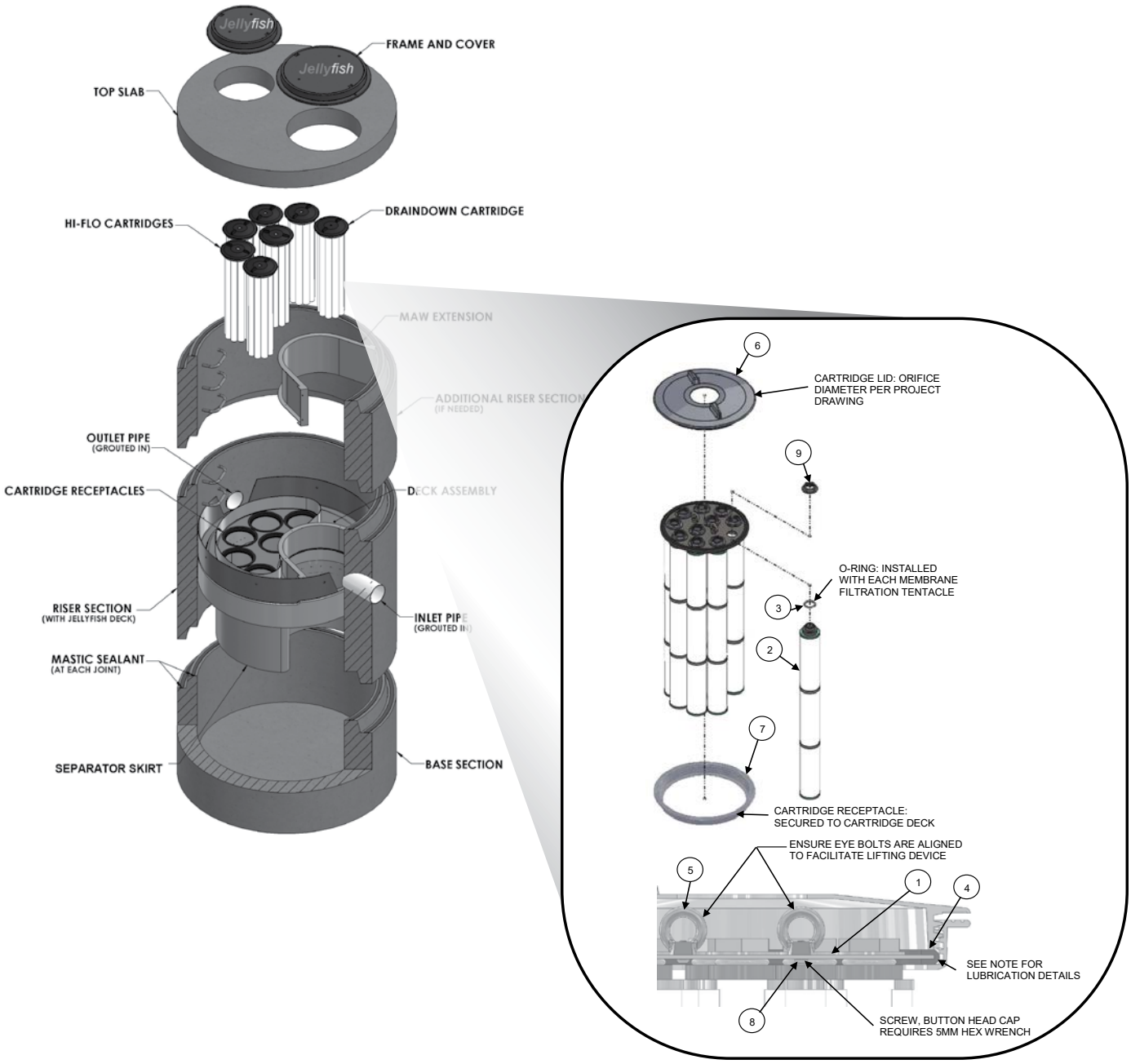


TABLE 1: BOM

ITEM NO.	DESCRIPTION
1	JF HEAD PLATE
2	JF TENTACLE
3	JF O-RING
4	JF HEAD PLATE GASKET
5	JF CARTRIDGE EYELET
6	JF 14IN COVER
7	JF RECEPTACLE
8	BUTTON HEAD CAP SCREW M6X14MM SS
9	JF CARTRIDGE NUT

TABLE 2: APPROVED GASKET LUBRICANTS

PART NO.	MFR	DESCRIPTION
78713	LA-CO	LUBRI-JOINT
40501	HERCULES	DUCK BUTTER
30600	OATEY	PIPE LUBRICANT
PSLUBXL1Q	PROSELECT	PIPE JOINT LUBRICANT

NOTES:

Head Plate Gasket Installation:
Install Head Plate Gasket (Item 4) onto the Head Plate (Item 1) and liberally apply a lubricant from Table 2: Approved Gasket Lubricants onto the gasket where it contacts the Receptacle (Item 7) and Cartridge Lide (ITem 6). Follow Lubricant manufacturer's instructions.

Lid Assembly:
Rotate Cartridge Lid counter-clockwise until both male threads drop down and properly seat. Then rotate Cartridge Lid clock-wise approximately one-third of a full rotation until Cartridge Lid is firmly secured, creating a watertight seal.

Jellyfish Filter Inspection and Maintenance Log

Owner:				Jellyfish Model No:		
Location:				GPS Coordinates:		
Land Use:	Commercial:		Industrial:		Service Station:	
	Roadway/Highway:		Airport:		Residential:	

Date/Time:						
Inspector:						
Maintenance Contractor:						
Visible Oil Present: (Y/N)						
Oil Quantity Removed:						
Floatable Debris Present: (Y/N)						
Floatable Debris Removed: (Y/N)						
Water Depth in Backwash Pool						
Draindown Cartridges externally rinsed and recommissioned: (Y/N)						
New tentacles put on Draindown Cartridges: (Y/N)						
Hi-Flo Cartridges externally rinsed and recommissioned: (Y/N)						
New tentacles put on Hi-Flo Cartridges: (Y/N)						
Sediment Depth Measured: (Y/N)						
Sediment Depth (inches or mm):						
Sediment Removed: (Y/N)						
Cartridge Lids intact: (Y/N)						
Observed Damage:						
Comments:						

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Support

- Drawings and specifications are available at www.conteches.com/jellyfish.
- Site-specific design support is available from Contech Engineered Solutions.
- Find a Certified Maintenance Provider at www.conteches.com/ccmp

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