

# Limited Stormwater Hydrology Report

Using Applicable Portions of the DEP Stormwater  
Management Standards Handbook

Proposed Wireless Telecommunications Facility  
Wellfleet 6 (VW-MA-0057)  
724 US Route 6  
Wellfleet, MA 02667

October 22, 2014

**Applicant:**



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***Section 1***

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***Narrative & Figures***

## ***Stormwater Narrative for a Raw Land Cell Tower In Existing Commercial Parking Lot***

### **EXECUTIVE SUMMARY**

Varsity Wireless, LLC (“Applicant”) proposes to construct a permanent wireless telecommunications facility located at the rear of the developed commercial area designated as Assessor’s Tax ID No. 42-43-0-R “Lot 1” with street address of 724 US Route 6 in Wellfleet, Massachusetts. The parcel is owned by Wendon Realty Trust and is occupied by a single-story metal building with three overhead door bays and a two-story metal building with three overhead door bays, an office, and a small apartment. Currently, the commercial business, Cape Cod Disposal Co. operates on the property. The wireless facility will be located within a leased area on the aforementioned parcel with easements providing an access and utility corridor to and from US Route 6. The project is identified by the Applicant (and Lessee) as “Wellfleet 6 (VW-MA-0057).”

The subject property is a 4.205 acre± trapezoidal shaped parcel with the long axis oriented north to south. The parcel’s US Route 6 frontage is located to the west. Occupied residential parcels abut to the west across US Route 6. Developed commercial property abuts to the north. Undeveloped Cape Cod National Seashore lands abut to the east with a pedestrian rail trail. Undeveloped future residential property abuts to the south. The two metal buildings with large gravel parking lots dominate the central half of the property. The north one-quarter and south one-quarter of the parcel are largely undeveloped and partially wooded. A large earthened berm runs along the west side of the parcel directing stormwater flows to the east and south. A small earthened berm runs along the east side of the parcel directing stormwater to the southeast corner. Between the berms, the parcel slopes gently towards the southeast.

Zoning district boundaries run north to south along the east and west property lines of the parcel. The parcel is zoned as “Commercial 2 (C2).” Directly east of the parcel is zoned “National Seashore Park (NSP)”, and directly west is zoned “Residential 1 (R1).” According to the July 2, 1992 FEMA Flood Insurance Rate Map for the Town of Wellfleet, Community Panel Number 2500140007C, the entire parcel is located within Zone C unshaded, which is defined as “areas of minimal flooding.”

Erosion control will be provided between the improvements and the downstream undeveloped areas. A long term pollution prevention plan has been prepared and is contained in Section 2.

### **PROPOSED IMPROVEMENTS**

The Applicant proposes to construct the proposed wireless telecommunications facility within a 3,600 sf lease area off the southeast side of the gravel parking lot in the southeast corner of the parcel. Trees bordering the extents of the new facility will be minimally cleared. The existing parking area and driveways will be used for access to and from the facility. Utilities will be extended from an existing utility pole south of the single-story metal building. Conduit will be laid within an approximately 185’ long trench to the facility. The area chosen for the compound is primarily in a previously disturbed

gravel parking lot area. Storage containers, fill mounds, and misc. trash & debris are strewn about in the area indicating previous disturbance.

The facility itself will be constructed of a 57'x57' fenced-in compound on an elevated pad surfaced with 4" depth clean stone over filter fabric gently graded to 1.5%. A steel monopole supporting antenna equipment will be placed on a reinforced concrete footing. Ground and monopole space will be allotted for up to five carriers estimated to be about 1,249 sf of impervious area or approximately 38% coverage of the compound surface. A common utility area will be located at the southwest corner of the compound. The lease area containing the compound, tower, and radio equipment represents less than 3% of the total parcel area.

The proposed site improvements are shown on the plans provided under separate cover entitled "Wellfleet 6; VW-MA-0057; 724 Route 6; Wellfleet, MA 02667" revised through October 22, 2014 as prepared by ProTerra Design Group, LLC.

### **OBJECTIVE OF CALCULATIONS & METHODOLOGY**

The purpose of this stormwater narrative is to examine the stormwater runoff from the proposed wireless telecommunications facility based upon the applicable performance standards contained within the Massachusetts Department of Environmental Protection Stormwater Management Handbook within the context of the Town of Wellfleet Rules and Regulations Governing the Subdivision of Land.

The goal of the calculations is to mitigate for the addition of the 3,249 sf fenced compound. The hydrology calculations attached show that addition of stone surfaces, a sand filter basin, and a bioretention area is sufficient to ensure post-development peak runoff rates approximate pre-development peak flow. Type III 24-hour SCS design storms for the 2-year, 10-year, and 100-year design storm events were compared for both pre-development and post-development drainage conditions.

The HydroCAD Stormwater Modeling System computer program (version 10.00) by Applied Microcomputer Systems, Inc. is used to develop stormwater runoff rates and volumes for the existing and proposed conditions at the project site. The HydroCAD software is a hydrograph generation and routing program similar to TR-20. The software uses Soil Conservation Service (SCS) Unit Hydrograph Methodology. This drainage analysis was developed utilizing a Type III 24-hour storm as developed by the SCS. Information regarding the equations and calculation procedures utilized in HydroCAD will be made available upon request. Drainage area maps for both pre- and post-constructed conditions have been included in this submission.

The design storm frequencies and corresponding rainfall depths were compiled from Technical Paper No. 40, "Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and 1 to 100 Years" and have been estimated as follows for Barnstable County:

<u>Storm Frequency (Years)</u>	<u>Rainfall Depth (Inches)</u>
2	3.6
10	4.8
100	7.1

## **SITE SURFACE WATER HYDROLOGY & SOILS**

Two metal buildings with large gravel parking lots dominate the central half of the property. The north one-quarter and south one-quarter of the parcel are largely undeveloped and partially wooded. Runoff from the developed and undeveloped areas is released off-site untreated via surface sheet flow in the southeast corner of the parcel. Eventually, stormwater drains southerly towards Fresh Brook, a wetland area tributary to Wellfleet Harbor approximately 0.4 miles south of the project site.

The soils underlying the parcel, including the project area, are classified as "Carver Coarse Sand." These soils are classified by the USDA Natural Resources Conservation Service (NRCS) as hydrologic group A. Groundwater near the project area is estimated greater than 80 inches below existing grade according to NRCS.

Based on record test-hole log data associated with the on-site septic system, loamy sand and medium sand were observed. Groundwater was not encountered within twelve feet below grade. Seasonal groundwater elevation shall be confirmed by subsurface exploration prior to final design.

## **DESCRIPTION OF STORMWATER MANAGEMENT STANDARDS**

The following is an explanation of how the proposed raw land cell tower project contributes to proper stormwater management practices using the applicable provisions of the 2008 Massachusetts Stormwater Regulations near the lease area.

No New Untreated Discharges (Standard 1) - No new stormwater system conveyances will discharge untreated runoff into the watershed. The compound directs runoff towards a sand filter basin and bioretention area. An appropriately designed underdrain maintains a low runoff head height to reduce the likelihood of erosive flow. Ninety-eight percent calculated removal efficiency is achieved in the treatment train.

Peak Rate Attenuation (Standard 2) - The peak discharge rates were calculated with the aid of a hydrograph routing program using TR-20 methodology. The sand filter basin and bioretention area contain sufficient storage to attenuate the peak flows. Calculations show that pre and post levels are approximately the same or below at the 2-year, 10-year, and 100-year design storm events.

Recharge (Standard 3) – Increased recharge has been provided by a bioretention area to promote mitigation of small amounts of impervious runoff from the compound.

Water Quality (Standard 4) –The proposed electronic and radio equipment will be contained within cabinets, shelters, or weather-resistant housings. The equipment will be isolated from precipitation that would create untreated runoff. A sand filter basin is proposed to intercept runoff from the compound. The sand filter basin is estimated to provide for a water quality volume using the "1 inch rule" and providing pretreatment for the bioretention area.

Land Uses with Higher Pollutant Loads (Standard 5) –The proposed use within the lease area as a cellular telecommunications facility is not considered a land use with high pollutant loads.

Critical Areas (Standard 6) - The project area is located within the Cape Cod Watershed. Runoff from the proposed facility and the existing developments on the parcel eventually drain to the lightly wooded area at the southeast of the parcel. Stormwater drains southerly towards Fresh Brook, a wetland area tributary to Wellfleet Harbor approximately 0.4 miles south of the project site.

The site is located outside a known Area of Critical Environmental Concern (ACEC) "Wellfleet Harbor"; however, the site is located inside the Interim Wellhead Protection Areas (IWPA) for Wells #1 & #2 of Eventide Motel and Cottages as shown on Figure 2 based upon MassGIS data resources. The Wellfleet Harbor is classified as a Category 2 Water shown on the Mass EPA Integrated List of Water (2012) not requiring assessments for any TMDLs. The proposed facility does not contain any machinery containing PCBs and will not produce any sewerage or untreated runoff that would exacerbate the TMDL. As a result, in our opinion the project will not contribute to impairments.

Redevelopment (Standard 7) – The project strives to meet all of the applicable Stormwater Management Standards.

Construction Period Pollution Prevention Plan and Erosion and Sedimentation Control (Standard 8) – A combination of staked hay bales, filter-fabric fencing, and/or mulch socks will be used during construction as outlined in the Operation & Maintenance Plan of Standard 9 and shown on the accompanying plan set. Silt-laden runoff shall be directed towards vegetated areas, temporary sedimentation basins, and diversion swales. Any dewatering activities will utilize a temporary stilling basin as required to promote infiltration and include methods for source control. A 5,000 gallon or greater frac tank may be employed as necessary to help settle additional suspended solids before discharge (as applicable).

Operation and Maintenance Plan (Standard 9) – An Operation and Maintenance (O&M) plan has been customized to fit the design of the cellular telecommunications site. Provisions to maintain runoff control devices have been assured through structural, non-structural, and construction management approaches. Please see the O&M plan appended to this report.

Prohibition of Illicit Discharges (Standard 10) – The Operation and Maintenance plan required by Standard 9 includes measures to prevent illicit discharges. An Illicit Discharge Compliance Statement has not been completed at this time.

## **BEST MANAGEMENT PRACTICES (BMPs)**

The facility design was able to meet the existing drainage conditions by providing a sand filter basin, bioretention area, and the use of energy dissipaters to increase infiltration and reduce erosion near the southeast corner of the parcel. A general description of the devices incorporated is indicated below.

### *1. Bioretention Area*

A bioretention area is a common type of stormwater BMP consisting of a low-lying vegetated area underlain by a sand and peat bed with an underdrain pipe. The underdrain pipe is surrounded by washed stone wrapped in non-woven geo-fabric to prevent mitigation of soil into the void spaces. Once collected in the underdrain, stormwater will flow to the discharge point with an energy dissipater. During a storm, the bioretention area will intercept surface runoff from the graveled telecommunications facility and impervious concrete pad improvements. Accumulated runoff ponds in the vegetated zone and gradually infiltrates into the underlying sand and peat bed, filling the void spaces of the sand. The bioretention area provides for filtering, adsorption, and biological uptake of constituents in stormwater.

### *2. Sand Filter Basin*

Sand filter basins consist of a flat surfaced area of sand, a filtration chamber, and a flat sand filter bed with an underdrain system. A surcharge zone exists within the filtration chamber for temporary storage of the water quality volume. During a storm, runoff enters the flat surfaced area of sand, where a majority of sediments are deposited. The runoff then enters the filtration chamber where it ponds above the sand bed and gradually infiltrates into the underlying sand filter, filling the void spaces of the sand. The underdrain gradually dewateres the sand bed and discharges the runoff to the bioretention area located downstream. The sand filter basin provides for filtering and absorption of pollutants in the stormwater.

### *3. Energy Dissipaters*

Energy dissipaters with plunge pools are proposed to disperse concentrated stormwater runoff before discharging to the woodland. Stone rip-rap and large stone/boulders are placed at the end of a pipe or drainage swale where concentrated stormwater occurs. Stormwater flows are slowed and spread out to reduce potential for erosion at the discharge locations.

## SUMMARY OF HYDROLOGIC CALCULATIONS

The results of the pre- and post-construction hydrology calculations for the raw land cell tower project provided are summarized in the following table. The table corresponds to the design point or study area as indicated on the drainage area maps and hydrograph routing calculations. The project aim was to study pre and post runoff for the raw land cell tower compound improvements.

### TOTAL RUNOFF PEAK (CFS) FROM THE SITE TO OFFSITE SOUTHEAST DESIGN POINT 1/10

Type III SCS 24-HR STORM	EXISTING (DP#1)	PROPOSED (DP#10)	DIFFERENCE
2 - YEAR	1.20	1.20	0.00
10 - YEAR	1.94	1.80	-0.14
100 - YEAR	3.43	2.64	-0.79

The peak runoff flow at this design point (DP1/10) shows slight decreases indicating no change in the proposed constructed condition for the 2-year, 10-year, and 100-year design storm events. Statistically, these differences in peak flow are negligible and it shows that the scale of the improvements (~3% of overall site area) within the overall watershed should not impact the downstream receptors. This is consistent with the long standing methodology of constructing these small cell sites to limit disturbance and provide for environmentally sensitive site design as located all over New England.

## CONCLUSION

The project has provided sufficient mitigation to offset the impacts of light clearing and grading by providing sediment capture, increasing infiltrative cover, and reducing erosion through Best Management Practices (BMPs). Storm runoff volumes and flows will be maintained over existing conditions for the 2-year, 10-year, and 100-year design storm events.



REF: OFFICE OF GEOGRAPHIC INFORMATION (MASSGIS), COMMONWEALTH OF MASSACHUSETTS, INFORMATION TECHNOLOGY DIVISION;  
 "FEMA Q3 FLOOD ZONES FROM PAPER FIRMS" DATALAYER (JULY 1997)



ZONE A3 – AREAS OF 100-YR FLOOD. BASED FLOOD ELEVATIONS AND FLOOD HAZARD FACTORS DETERMINED



ZONE C – AREAS OF MINIMAL FLOODING



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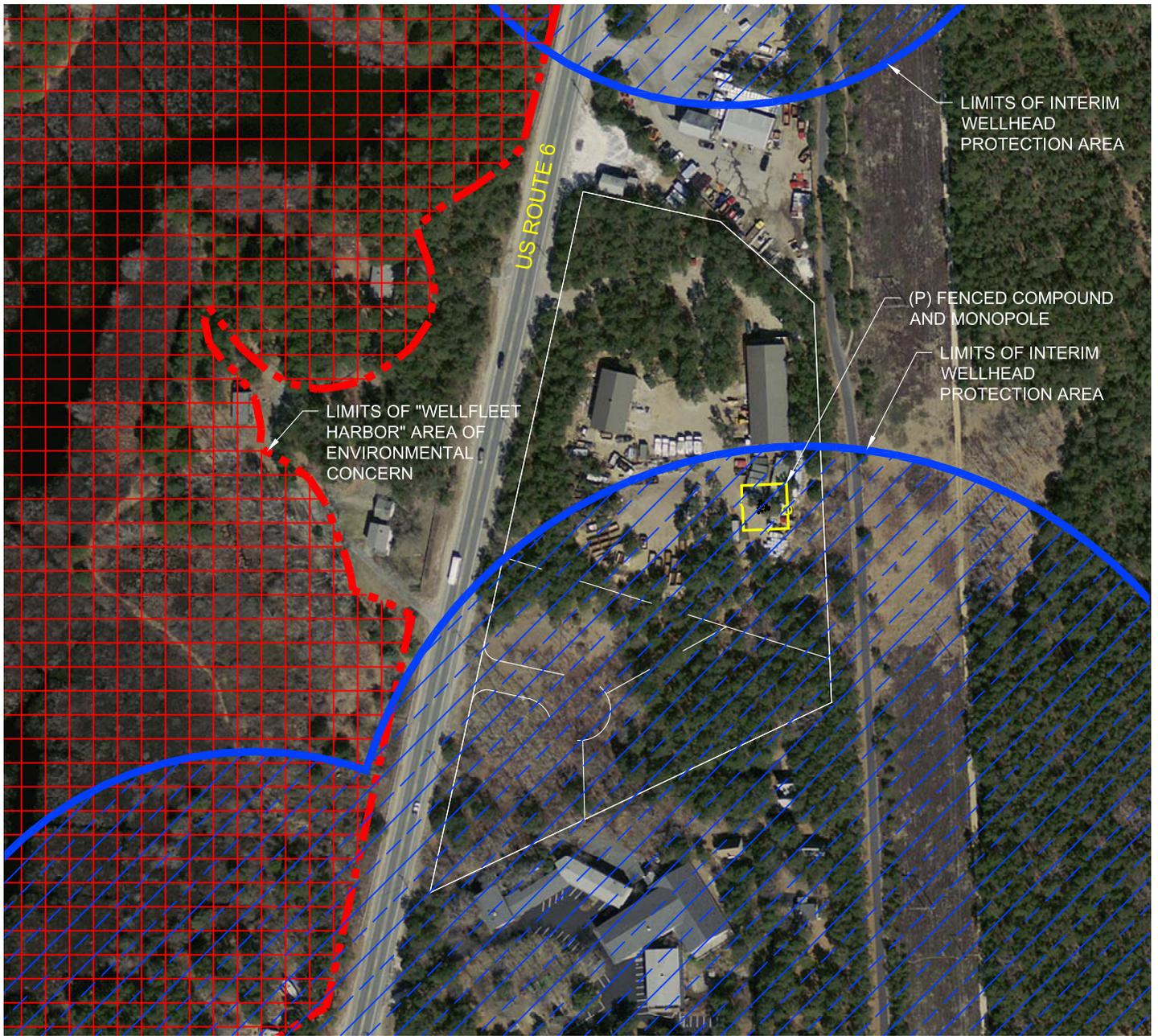
FEMA FLOOD  
 INSURANCE  
 RATE MAP

SITE NAME: WELLFLEET 6  
 SITE NUMBER: VW-MA-0057  
 ADDRESS: 724 US ROUTE 6  
 WELLFLEET, MA 02667

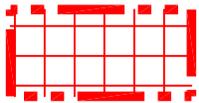
**FIG.1**

SCALE: 1" = 200'

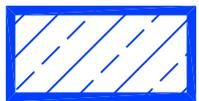
DATE: OCTOBER 22, 2014



REF: OFFICE OF GEOGRAPHIC INFORMATION (MASSGIS), COMMONWEALTH OF MASSACHUSETTS, INFORMATION TECHNOLOGY DIVISION;  
 "AREAS OF CRITICAL ENVIRONMENTAL CONCERN" DATALAYER (APRIL 2009)



"WELLFLEET HARBOR" AREA OF ENVIRONMENTAL CONCERN



INTERIM WELLHEAD PROTECTION AREA



**ProTerra**  
 DESIGN GROUP, LLC

AREAS OF  
 CRITICAL  
 ENVIRONMENTAL  
 CONCERN (ACEC)  
 MAP

SITE NAME: WELLFLEET 6  
 SITE NUMBER: VW-MA-0057  
 ADDRESS: 724 US ROUTE 6  
 WELLFLEET, MA 02667

**FIG.2**

SCALE: 1" = 200'

DATE: OCTOBER 22, 2014

### 1.3 REFERENCES

1. Commonwealth of Massachusetts, Department of Environmental Protection, Stormwater Management Standards Handbook. Volumes 1-3 February 2008 (DEP Stormwater Management Policy 2008).
2. Commonwealth of Massachusetts, Department of Environmental Protection. 310 CMR 10.00: Massachusetts Wetlands Protection Act Regulations. 2008.
3. Commonwealth of Massachusetts, Department of Environmental Protection. 314 CMR 6.00: Massachusetts Groundwater Quality Standards. 1990.
4. Commonwealth of Massachusetts, Department of Environmental Protection. 314 CMR 4.00: Massachusetts Surface Water Quality Standards. 2007.
5. Commonwealth of Massachusetts, Department of Environmental Protection. 314 CMR 9.00: Massachusetts Water Quality Regulations. 2008.
6. United States Department of Agriculture, Natural Resources Conservation Services Urban Hydrology for Small Watersheds, Technical Release 55 (TR-55). June 1986.
7. United States Department of Agriculture, Natural Resources Conservation Services Project Formulation Hydrology Program System, Technical Release 20 (TR-20). Oct. 2004.
8. Tetra Tech, Inc., United States EPA – Region 1, Stormwater Best Management Practices (BMP) Performance Analysis. Dec 2008.
9. PVPC, MA DEP, & USEPA – Region 1, Artificial Recharge: Evaluation and Guidance to Municipalities. Nov 1996.

## **Section 2**

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# ***Long-Term Pollution Prevention and Operation & Maintenance Plan***

**RECOMMENDED LONG-TERM STORMWATER POLLUTION  
PREVENTION PLAN and OPERATION & MAINTENANCE (O&M) PLAN  
TO COMPLY WITH STORMWATER STANDARDS 4, 8, 9 & 10  
FOR RAW LAND CELL TOWER**

**PROJECT OVERVIEW**

Varsity Wireless, LLC (“Applicant”) proposes to construct the proposed wireless telecommunications facility within a 3,600 sf lease area at the rear of the developed commercial area designated as Assessor’s Tax ID No. 42-43-0-R “Lot 1”. The facility itself will be constructed of a 57’x57’ fenced-in compound surfaced with clean crushed stone over filter fabric. A steel monopole supporting antenna equipment will be placed on a reinforced concrete footing. Ground and monopole space will be allotted for up to five carriers. A common utility area will be located at the southwest corner of the compound.

Runoff from off-site areas will be released from the property untreated. Runoff from the compound itself will be directed towards a sand filter basin and bioretention area. Off-site and compound runoff will flow to the southeast corner of the property through a lightly wooded area. The project will require disturbance of 18,000 square feet of land.

The proposed site improvements are shown on the plans provided under separate cover entitled “*Wellfleet 6; VW-MA-0057; 724 Route 6; Wellfleet, MA 02667*” revised through October 22, 2014 as prepared by ProTerra Design Group, LLC.

**OWNER AND RESPONSIBLE PARTY**

Owner:	Responsible Party:
Wendon Realty Trust Donald & Wendy Horton, Trustees 724 US Route 6 Wellfleet, MA 02667	Varsity Wireless, LLC 346 Congress Street Suite 703 Boston, MA 02210

The Responsible Party has obtained/will obtain ground and access leases from the Owner which allows for maintenance of the stormwater system and the associated telecommunications equipment.

## CONSTRUCTION MANAGEMENT

Contractor: \_\_\_\_\_

Address: \_\_\_\_\_

Phone Number: \_\_\_\_\_

A construction manager with adequate knowledge and experience on projects of similar size and scope shall be employed to oversee all site work related construction. The contractor shall incorporate appropriate techniques to control sediment and erosion pollution during construction in accordance with the Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas.

Care should be taken when constructing stormwater control structures and dewatering to install foundations. Light earthmoving equipment shall be used to excavate in the vicinity of the bioretention area. Use of heavy-equipment causes excessive compaction of the soils resulting in reduced infiltration capacity. At no time shall temporary settling basins be constructed in the vicinity of the proposed sand filter basin or bioretention area in order to prevent the soils from becoming clogged with sediment.

Dewatering activities shall be directed towards a berm and filter sack to promote infiltration into the ground. If silt-laden sediment is encountered, a frac tank approximately 5,000 gallons in size or greater can be employed to settle pumped groundwater before discharge.

## EROSION CONTROL BEST MANAGEMENT PRACTICES (BMPs)

During construction, silt-laden runoff or discharge from dewatering operations (if necessary) will be prevented from exiting the construction area untreated. Siltation barriers consisting of a filter fabric silt fence, hay bales or silt socks will be erected in advance of construction along the down-gradient edge of all disturbed areas and maintained throughout the construction period. The control of dust and erosion during the construction period will be managed using a number of Best Management Practices (BMPs) described below and as shown on the Erosion Control sheet (EC-1) of the Construction Drawings.

### *Temporary Sediment Traps (During Construction)*

Small depressions that have stormwater runoff directed into them for increase retention time that promotes settling out of suspended solids. Tributary drainage area should be under 1 acre. The storage volumes should be 1,800 cubic feet per acre of tributary area equaling 1,350 cubic feet required.

### *Silt Fence, Reinforced with Haybales as Required (Compost Berms & Socks can be used as alternatives)*

Silt fence or silt sock is installed at the down gradient limit of work. It should be trenched into the ground 6" and staked without drooping. The woven fabric will allow the passage of stormwater while filtering out suspended solids. Haybales give added filtering and erosion control. Every 100' two bales or silt socks shall be placed and staked perpendicular to the fence. Haybales shall be inert straw or salt hay type.

### *Dewatering*

If dewatering is required, discharges shall be directed through a settling pool or filter bag prior to discharge. Outflow of silt-laden runoff shall not be permitted to flow directly into resource areas. In some instances, a settling tank may need to be employed. Upon completion of site stabilization, the BMP's and conveyance systems shall be thoroughly cleaned of silt and sediment and made ready for the proposed operation. Discharge points shall be set back from the edge of the resource areas and monitored by qualified personnel to ensure no impacts to resource areas and compliance with applicable federal and state regulations. Discharges shall be free from visible floating, suspended, and settleable solids that would impair the functions of the nearby wetlands and downstream rivers.

#### **ON-GOING MAINTENANCE CONTRACT**

The Responsible Party shall hire appropriate staff, contract with a maintenance company, or designate a qualified party to complete ongoing maintenance.

#### **LIVING DOCUMENT PROVISIONS**

Due to the difficulty of identifying all sources of potential stormwater contamination and maintenance activities, this document shall be updated as necessary to reflect new procedures, technologies or requirements. Ultimately, the Responsible Party will have the authority to implement a plan and frequency of maintenance as required.

#### **MAINTENANCE LOG**

The Responsible Party shall develop and maintain a log of inspections, maintenance, repairs, and disposal (including location of disposal) during the life of the project. Records shall be maintained for at least three years and be made available to the Massachusetts Department of Environmental Protection in accordance with the provisions of the Massachusetts Stormwater Handbook. A sample of such a maintenance log is provided.

#### **GOOD HOUSEKEEPING PRACTICES DURING CONSTRUCTION**

The Responsible Party shall maintain good housekeeping practices by maintaining a clean and orderly facility to prevent potential pollution sources from coming into contact with stormwater and degrading water quality. This includes establishing protocols to reduce the possibility of mishandling materials or equipment and training employees in good housekeeping techniques.

Common areas where good housekeeping practices should be followed shall include: material storage areas, vehicle and equipment maintenance areas, and loading areas. Good housekeeping practices must include a designated and secure location for garbage. A schedule for regular pickup and disposal of garbage and waste materials and routine inspections of containers for leaks and structural integrity shall be developed. Portable toilets shall be installed on site and maintained throughout construction. Excess concrete and cleanout water from redi-mix vehicles shall be directed towards small excavations or constructed boxes for cleanup. Catch basins and drainage conveyance systems shall not be used for this purpose.

#### **MINIMIZING EXPOSURE**

The Responsible Party shall minimize exposure of potential pollutant sources from coming into contact with precipitation and being picked up by stormwater and carried into drains and surface waters. All materials shall be plainly labeled and stored in an appropriate container in an appropriate location. All activities which can generate sources of contaminants shall be contained.

#### **LONG-TERM BMPS: MAINTENANCE**

Prior to final completion and full occupancy of the development, a representative of the contractor and/or Engineer at the responsible parties request shall properly instruct the user of the required maintenance responsibilities to maintain the effectiveness of the drainage system. The Responsible Party will implement the procedures and frequencies as they see fit under their current plan and inspect the systems as needed to maintain minimum effectiveness. Twelve foot wide barn style gates at the entrance to the compound and twelve foot wide barn style gates near the sand filter basin are adequate to maintain the small scale improvements of the site.

##### *Bioretention Area*

During the construction phases of the project, the bioretention area shall be inspected monthly and cleaned as necessary and/or after storms events with 1" of rainfall or greater. Once the system goes online, inspections shall occur after each major storm event over ½" for the first six months to ensure proper stabilization, function, and to ensure that the inlets and outlets remain free of obstructions. Thereafter, these structures shall be inspected and cleaned at least twice per year. Cleanings shall include removal of accumulated sediment, inspection of the filter media, and monitoring of groundwater to ensure proper operation of the system. Important items to check for include differential settlement, cracking, breakout, clogging of outlets, and root infestation. Water levels should be checked and recorded against rainfall amounts to verify that the drainage system is working properly. Should the bioretention area become clogged with sediment beyond the ability to clean, the bioretention area shall be excavated of all clogged material and reconstructed as shown on the Construction Drawings. Excavated material shall be disposed of off-site.

##### *Sand Filter Basin*

During the construction phases of the project, the sand filter basin shall be inspected monthly and cleaned as necessary and/or after storms events with 1" of rainfall or greater. Thereafter, these structures shall be inspected and cleaned at least two times per year, as needed during the owner's regular maintenance of the grounds, and after 2-year or greater rain events (3" of rain.) Cleanings shall include removal of vegetation, removal of excess sediment accumulation, inspection of filter media, and inspection of underdrain system/outlet works. Should the sand filter basin become clogged with sediment beyond the ability to clean, the sand filter basin shall be excavated of all clogged material and reconstructed as shown on the Construction Drawings. Excavated material shall be disposed of off-site.

*Energy Dissipaters*

During the construction phases of the project, the rip rap energy dissipaters shall be inspected monthly and cleaned as necessary and/or after storms events with 1" of rainfall or greater. Thereafter, these structures shall be cleaned at least once per year or as needed during the owner's regular maintenance of the grounds. Cleanings shall include removal of vegetation, removal of excess sediment accumulation and inspection of condition of stone.

**ANNUAL MAINTENANCE COST ESTIMATE**

<b>BMP</b>	<b>Frequency</b>	<b>Unit Cost</b>	<b>Subtotal</b>
Bioretention Area	2 visit per year	\$500	\$1000
Sand Filter Basin	2 visit per year	\$500	\$1000
Energy Dissipaters	1 visit per year	\$250	\$250
		<b>Total:</b>	\$2250

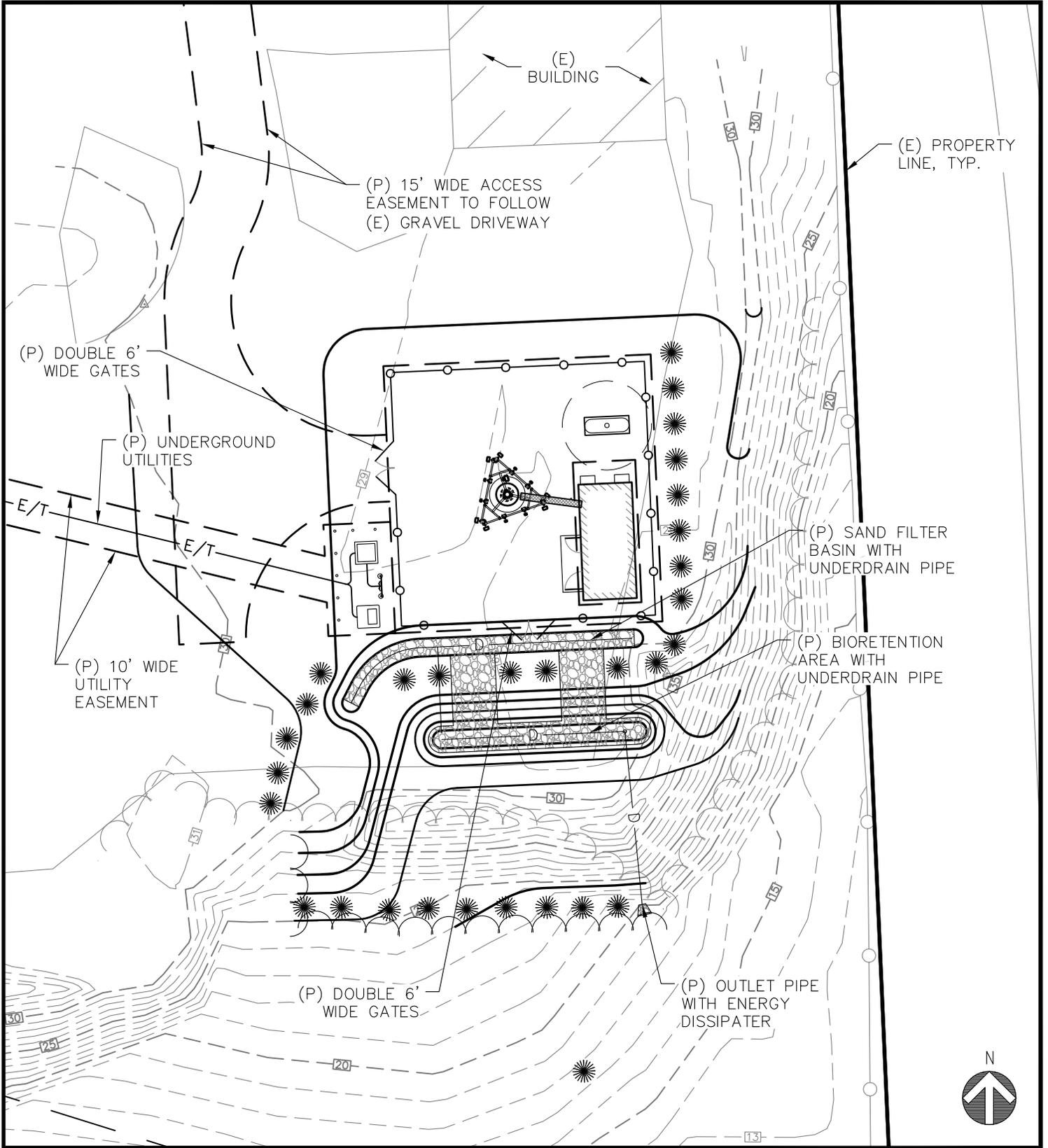
The annual maintenance cost does not include the owner's regular maintenance of the grounds that would consist of mowing & trash pickup.



**LONG TERM STRUCTURAL BEST MANAGEMENT PRACTICE INSPECTION & MAINTENANCE MATRIX AFTER CONSTRUCTION**

Note: BMP's shall be visually inspected and repaired by a qualified party in accordance with the following chart. Note these are minimum inspection criteria/frequencies and should be adjusted throughout the project lifespan as required to maintain effectiveness. Refer to maintenance standards for drainage facilities and structural best management practices in the "Recommended Long-Term Stormwater Pollution Prevention Plan."

Conventional & LID Best Management Practices	Recommended Minimum Inspection & Maintenance Frequency	Erosion/Scouring	Tree Growth Hazards	Differential Settlement/Seepage	Structural Damage/Obstructions	Trash & Debris	Removal of Accumulated Sediment	Slope Integrity	*Mow Vegetation/Poor Vegetation Coverage	Remove/Reset Filter Fabric & Stone As Required	Check - Remove & Replace mulch/media/stone	Remove/Reset Riprap as Required
Bioretention Area	Semi-Annual	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>						
Sand Filter Basin	Semi-Annual	<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>						
Energy Dissipaters	Annually	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>			<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>



**ProTerra**  
DESIGN GROUP, LLC

PERMANENT BMP  
LOCATION MAP

SITE NAME: WELLFLEET 6  
SITE NUMBER: VW-MA-0057  
ADDRESS: 724 US ROUTE 6  
WELLFLEET, MA 02667

**BMP**

SCALE: 1" = 30'

DATE: OCTOBER 22, 2014

**Lease Agreement (Land)**

This LEASE AGREEMENT ("Lease") dated this 30<sup>th</sup> day of September 2013 is entered into by and between Vertex Towers, LLC, a Massachusetts Limited Liability Company of 4 Maple Road Norfolk, MA 02056, with a mailing address of PO Box 211, Norfolk, MA 02056., as Tenant (hereinafter "Tenant") and Donald I. Horton and Wendy C. Horton trustees of the Wendon Realty Trust u/d/t May 20,1998 and recorded with the Barnstable County Registry of Deeds at Book 11440 Page 268, with a mailing address of 724 Route 6, Wellfleet, MA 02667(hereinafter "Landlord").

Whereas Landlord owns certain real property located at 724 Route 6 in the Town of Wellfleet, County of Barnstable, Commonwealth of Massachusetts, which is depicted as Lot 43, on Assessor's Map 42, and being further described as the same real property conveyed by that certain deed recorded in Deed Book 11440 at Page 272 of the Barnstable County Registry of Deeds, (hereinafter "Subject Property") and Tenant desires to lease a portion of the Subject Property to erect and operate a wireless communications tower (hereinafter "Tower");

NOW, THEREFORE, for the sum of One Dollar (\$1.00), the receipt of which is acknowledged and confirmed by Landlord, and in consideration of the mutual promises, conditions and other good and valuable consideration of the parties hereto, it is covenanted and agreed as follows:

**1. RIGHT TO LEASE.**

(a) Landlord grants to Tenant right to lease a portion of the Subject Property measuring approximately Three Thousand Six Hundred (3,600 SF) square feet together with an unrestricted access easement for Tenant's uses from the nearest public right-of-way along the Subject Property to the Premises as generally described/depicted on the attached Exhibit 2 (collectively, the "Premises").

(b) From and after the full execution date of this Lease and at any time during the term of this Lease, Tenant and its agents, engineers, surveyors and other representatives will have the right to enter upon the Subject Property to inspect, examine, conduct soil borings, drainage testing, material sampling, and other geological or engineering tests or studies of the Subject Property (collectively, the "Tests"), to apply for and obtain licenses, permits, approvals, or other relief required of or deemed necessary or appropriate at Tenant's sole discretion for its use of the Premises and include, without limitation, applications for zoning variances, zoning ordinances, amendments, special use permits, and construction permits (collectively, the "Government Approvals"), initiate the ordering and/or scheduling of necessary utilities, and otherwise to do those things on or off the Subject Property that, in the opinion of Tenant, are necessary in Tenant's sole discretion to determine the physical condition of the Subject Property, the environmental history of the Subject Property, Landlord's title to the Subject Property and the feasibility or suitability of the Subject Property for Tenant's Permitted Use, all at Tenant's expense. Tenant will not be liable to Landlord or any third party on account of any pre-existing defect or condition on or with respect to the Subject Property, whether or not such defect or condition is disclosed by Tenant's inspection. Tenant will restore the Property to its condition as it existed at the commencement of the Testing Period (as defined above), reasonable wear and tear and casualty not caused by Tenant excepted. In addition, Tenant shall indemnify, defend and hold Landlord harmless from and against any and all injury, loss, damage or claims arising directly out of Tenant's Tests.

(c) At any time after the full execution of this Lease, Tenant may commence this Lease by notifying Landlord in writing. If Tenant commences this Lease, then Landlord leases the Premises to the Tenant subject to the terms and conditions of this Lease. If Tenant does not commence the Lease within 30 months following the full execution date of this Lease, this Lease will terminate and the parties will have no further liability to each other. In the event that notwithstanding Tenant's diligent efforts the permits and approvals necessary for Tenant's use of the Premises have not been issued but have been applied for or have been issued but have been appealed, then Tenant may, with written notification to the Landlord prior to the expiration of the Testing Period, extend the Testing Period for the greater of (i) the amount of additional time necessary to acquire such permits and approvals, or (ii) one (1) additional year.



3. **TERM.** This Lease shall commence on date Tenant begins construction at the premises (the “Commencement Date”), which shall be confirmed in writing from Tenant to Landlord. Unless extended or sooner terminated as herein provided, the term shall be for a period of Fifty (50) Years following the Commencement Date (“Lease Term”).

4. **TITLE AND QUIET POSSESSION.** Landlord represents and agrees (i) that it is the Owner of the Premises and Subject Property; (ii) that it has the right to enter into this Lease; (iii) that the person signing this Lease has the authority to sign; (iv) that Tenant, its subtenants and assigns, are entitled to access to the Premises at all times and to the quiet possession of the Premises throughout the term of this Lease and any applicable renewal terms so long as Tenant is not in default beyond the expiration of any cure period.

5. **NOTICES.** All notices must be in writing and are effective only when deposited in the U.S. mail, certified and postage prepaid, or when sent via overnight delivery, to the address set forth above, or as otherwise required by law.

6. **USE.**

(a) The Premises are being leased for the purpose of erecting, installing, operating and maintaining radio and communications towers, transmitting and receiving equipment, antennas, dishes, mounting structures, buildings, and related equipment (“Communications Facility”). Tenant may make any improvement, alteration or modification to the Premises as are deemed appropriate by Tenant. Tenant shall have the right to clear the Premises of any trees, vegetation, or undergrowth which, in Tenant’s sole opinion, interferes with Tenant’s use of the Premises for the intended purposes. Tenant shall have the exclusive right to install upon the Premises communications towers, buildings, equipment, antennas, dishes, fencing, and other accessories related thereto, and to alter, supplement, and/or modify same as may be necessary. Landlord agrees to cooperate with respect to obtaining any required zoning approvals for the Premises and such improvements.

(b) Landlord grants Tenant a non-exclusive easement in, over, across and through other real property owned by Landlord as generally described/depicted in Exhibit 2 required for construction, installation, maintenance, and operation of the Communication Facilities. At all times during the term of this Lease, Tenant, and its guests, agents, customers, lessees, and assigns shall have the unrestricted, exclusive right to use, and shall have free access to, the Premises seven (7) days a week, twenty-four (24) hours a day. All improvements, equipment or other property attached to or otherwise brought onto the Premises shall at all times be the personal property of Tenant and/or its subtenants and licensees.

7. **DESTRUCTION OR CONDEMNATION.** If the Subject Property is damaged, destroyed, condemned or transferred in lieu of condemnation, Tenant may elect to terminate this Lease as of the date of the damage, destruction, condemnation or transfer in lieu of condemnation by giving notice to Landlord no more than thirty (30) days following the date of such damage, destruction, condemnation or transfer in lieu of condemnation. If

Tenant chooses not to terminate this Lease, rent shall be reduced or abated in proportion to the actual reduction or abatement of use of the Premises.

**8. ASSIGNMENT / SUBLETTING.** It is mutually understood, it being Tenant's intention to operate a commercial communications site, that Tenant may assign or transfer this Lease with the written notification to Landlord. Tenant may assign this Lease to any person or entity at any time with written notification to Landlord provided that Tenant delivers to Landlord an instrument of assumption by an assignee that assumes all of the obligations of Tenant under this Lease. Tenant will be relieved of all liability hereunder. Tenant shall be entitled to sublease or grant licenses to use the Premises and/or the Tower or any structure or equipment on the Premises without the prior written consent of Landlord, but no such sublease or license shall relieve or release Tenant from its obligations under the Lease. Landlord may assign this Lease to any person or entity who or which acquires fee title to the Subject Property and who or which agrees to be subject to and bound by all provisions of this Lease. Except for the foregoing, assignment of this Lease, in whole or in part, by Landlord must be approved by Tenant, in Tenant's sole discretion.

**9. COMPLIANCE WITH LAWS.** To the best of their knowledge, Landlord represents that the Subject Property, and the Premises, and all improvements located thereon, are in substantial compliance with building, life/safety, disability and other laws, codes and regulations of applicable governmental authorities. The Landlord will substantially comply with all applicable laws relating to its possession and use of the Subject Property, including all zoning and building permits.

**10. INTERFERENCE.** During the term of this Lease, Landlord, its successors and assigns, will not grant any ground lease, license, or easement with respect to any property adjacent to the Premises if such lease, license, or easement would detrimentally impact Tenant's communications facilities, or the use thereof. Landlord shall not cause or permit the construction of radio or communications towers on the Premises or on any other property of Landlord adjacent or contiguous to or in the immediate vicinity of the Premises, except for towers constructed by Tenant. Landlord will not permit the installation of any future equipment on the Subject Property which will result in technical interference problems with any equipment on the Facility or which Landlord has determined, upon Landlord's reasonable investigation of same, will cause such technical interference problems. Landlord shall promptly take all reasonable steps necessary to eliminate such technical interference in a timely manner and without cost and expense to Tenant, including but not limited to causing the source of such technical interference to cease operations.

**11. TERMINATION.** Tenant may terminate this Lease at any time with 90 days advance written notice to Landlord without further liability. Upon termination, all prepaid rent will be retained by Landlord unless such termination is due to Landlord's failure of proper ownership or authority, or such termination is a result of Landlord's default. Within 120 days from the termination or expiration of this Lease, for any reason, Tenant, its subtenants and/or sublessees at their expense shall remove all apparatus and materials associated with the telecommunications facility, including, but not limited to, the Wireless Communication Tower and all above ground improvements and restore the Premises to substantially the condition existing on the Commencement Date, excepting for ordinary wear and tear, underground improvements and casualty loss.

**12. UTILITIES.** Tenant will pay for all utilities used by it at the Premises. Landlord will cooperate with Tenant in Tenant's efforts to obtain utilities from any location provided by Landlord or the servicing utility, including signing any easement or other instrument reasonably required by the utility company.

**13. DEFAULT.** If either party is in default under this Lease for a period of (a) thirty (30) days following receipt of notice from the non-defaulting party with respect to a default which may be cured solely by the payment of money, or (b) sixty (60) days following receipt of notice from the non-defaulting party with respect to a default which may not be cured solely by the payment of money, then, in either event, the non-defaulting party may pursue any remedies available to it against the defaulting party under applicable law, including, but not limited to,

the right to terminate this Lease. If the non-monetary default may not reasonably be cured within a sixty (60) day period, this Lease may not be terminated if the defaulting party commences action to cure the default within such sixty (60) day period and proceeds with due diligence to fully cure the default.

14. **INDEMNITY.** Landlord and Tenant each indemnifies the other against and holds the other harmless from any and all costs (including reasonable attorneys' fees) and claims of liability or loss which arise out of the ownership, use and /or occupancy of the Premises by the indemnifying party. This indemnity does not apply to any claims arising from the sole negligence or intentional misconduct of the indemnified party. The indemnity obligations under this Paragraph will survive termination of this Lease.

15. **SUBORDINATION AND NON-DISTURBANCE.** This Lease is subordinate to any mortgage or deed of trust now of record against the Premises. However, Landlord, with the assistance of Tenant, will obtain a non-disturbance agreement reasonably acceptable to Tenant from the holder of any such mortgage or deed of trust.

16. **HAZARDOUS SUBSTANCES.** Landlord represents that to the best of its knowledge they are not aware of any substance, chemical or waste, oil or hazardous material (collectively, "Hazardous Substance") on the Premises, Subject Property or any adjacent real estate owned by the Landlord (collectively, "Premises") that is identified as hazardous, toxic or dangerous in any applicable federal, state or local law or regulation. Landlord shall assess and remediate (if necessary) in compliance with all applicable laws and hereby indemnifies Tenant and holds Tenant harmless from any and all costs (including reasonable attorneys' fees) and claims of liability or loss which arise out of the presence of any Hazardous Substance on or migrating from the Premises, provided that the Hazardous Substances were not introduced by Tenant, any of its sublessees or subtenants, or the result of Tenant's or its sublessees or subtenants operation, installation and/or maintenance of the Tower or Facility. Tenant will not introduce or use any Hazardous Substance on the Premises in violation of any applicable law.

17. **TAXES.** Tenant shall pay any personal property taxes assessed on, or any portion of such taxes attributable to, the Communication Facility. Landlord shall pay when due all real property taxes and all other fees and assessments attributable to the Subject Property and Premises. Tenant shall pay as additional Rent any increase in real property taxes levied against Premises, which are directly attributable to Tenant's use of the Premises (but not, however, taxes attributable to periods prior to the Commencement Date such as roll-back or greenbelt assessments) if Landlord furnishes proof of such increase to Tenant. In the event that Landlord fails to pay when due any taxes affecting the Premises or the Easement, as hereinafter defined, Tenant shall have the right but not the obligation to pay such taxes and deduct the full amount of the taxes paid by Tenant on Landlord's behalf from future installments of Rent.

**18. INSURANCE.**

(a) Tenant shall carry during the Lease term, at its own cost and expense, the following insurance: (i) "All Risk" property insurance for its property's replacement cost; and (ii) comprehensive general liability insurance with a commercial general liability endorsement having a minimum limit of liability of \$1,000,000 for injury or death arising out of one occurrence and \$1,000,000 for damage to property from any one occurrence.

(b) Tenant will name the Landlord as an additional insured under its liability policy. All insurance shall be issued through valid and enforceable policies issued by insurers licensed to do business in the State of that the Property is located who must be rated A+ or better by A.M. Best Company.

(c) Tenant shall indemnify and hold Landlord harmless against any liability or loss from personal injury or property damage resulting from or arising out of use of the Subject Property by Tenant or its employees or agents; excepting, however, such liabilities and losses as may be due to or caused by the acts or omissions of the Landlord or its employees or agents.

19. **MAINTENANCE.** Tenant will be responsible for repairing and maintaining the Premises and all improvements installed by Tenant (the Facility) in a proper operating and reasonably safe condition; provided, however if any such repair or maintenance is required due to the acts of the Landlord, its agents or employees

Landlord shall reimburse Tenant for the reasonable costs incurred by Tenant to restore the damaged areas to the condition which existed immediately prior thereto. Landlord will maintain and repair all other portions of the Subject Property in a proper operating and reasonably safe condition.

**20. HOLD OVER TENANCY.** Should Tenant or any assignee, sublessee or licensee of Tenant hold over the Premises or any part thereof after the expiration of the term set forth herein, such holdover shall constitute and be construed as a tenancy from month-to-month only, but otherwise upon the same terms and conditions.

**21. FORCE MAJEURE.** The time for performance by Landlord or Tenant of any term, provision, or covenant of this Agreement shall be deemed extended by time lost due to delays resulting from acts of God, strikes, civil riots, floods, material or labor restrictions by governmental authority, and any other cause not within the control of Landlord or Tenant, as the case may be.

**22. COLLATERAL ASSIGNMENT.** Tenant may collaterally assign, pledge, mortgage and/or grant a security interest to and/or otherwise encumber in favor of any third party (each a "Financing Entity" and, collectively, the "Financing Entities"), as security for any loan or other financing relationship, all of Tenant's right, title and interest in: (i) this Lease, (ii) the Premises, (iii) any other personal property owned by Tenant and located at the Property, and (iv) all subleases and licenses by Tenant of all and any portion of the Premises and the rents, issues and profits there from, all without the consent of Landlord. Tenant shall also have the right to obtain, at its sole expense, a title insurance policy insuring its leasehold interest in and to the Premises.

A Financing Entity may: (i) enforce its rights under its leasehold mortgage and/or other loan and security documents (each, a "Security Instrument"; collectively the "Security Instruments") that encumber or otherwise convey a security or other interests in and to the property and assets of Tenant, including, but not limited to, Tenant's leasehold interests in the Premises and its rights, title and interests in and to this Lease, all of Tenant's rights, title and interests in and to all subleases and licenses of portions of the Premises to Tenant's sublessees and licensees, and all other improvements, equipment and other personal property of Tenant located at the Premises, (ii) acquire title to Tenant's interest in the Premises under this Lease in any lawful way, (iii) pending foreclosure of such Security Instruments, take possession of the Premises, and (iv) obtain, at such Financing Entity's or Tenant's sole expense, a title insurance policy insuring those Security Instruments in favor of the Financing Entity that encumber Tenant's leasehold interest in the Premises. In connection with a Financing Entity's acquisition of such title insurance policy, Landlord shall promptly execute and deliver to the Title Company that is issuing such policy such landowner affidavits and/or certificates that the title company may reasonably request. If a Financing Entity shall acquire title to Tenant's interest in this Lease by whatever lawful means, including, without limitation, by foreclosure or otherwise, then the Financing Entity may freely assign this Lease with prior notification to Landlord after delivery by Financing Entity to Landlord of an instrument of assumption by an assignee that assumes all of the obligations of Tenant under this Lease and provided that Landlord has been properly notified of such assignment.

Landlord may encumber its interest in this Lease to any third party, as security for any loan(s) or other financing, without the consent of Tenant. This Lease shall run with the Property and shall be binding upon and inure to the benefit of the parties hereto and their respective successors, personal representatives, heirs, and assigns. Notwithstanding any provisions of this Lease to the contrary, so long as a Mortgage is in effect, the Tenant shall have no right to terminate the Lease with respect to any event unless the written approval of Lender holding a Mortgage on the leasehold estate is obtained, including, without limitation, the right to terminate in the event of any damage or condemnation.

**23. BANKRUPTCY.** The parties hereto agree that (1) the Tenant is in possession of the Premises notwithstanding the fact that the Tenant has subleased, or may in the future sublease, certain of the improvements thereon to third parties and (2) the requirements of Section 365(h) of Title 11 of the United States Code (the "Bankruptcy Code") with respect to the Tenant's possession of the leasehold under this Lease are satisfied. Accordingly, the right of the Tenant to remain in possession of the leasehold under this Lease shall continue notwithstanding any rejection of this Lease in any bankruptcy proceeding involving the Landlord, or any other

actions by any party in such a proceeding. This provision, while included in this Lease, has been separately negotiated and shall constitute a separate contract between the parties as well as a part of this Lease. The provisions of this Section 23 are for the benefit of the Tenant and its assigns, including, without limitation, Lender. The parties hereto also agree that Lender is a party in interest and shall have the right to appear as a party in any proceeding brought under any bankruptcy law or under any other law which may affect this Lease.

24. **MISCELLANEOUS.** (a) This Lease applies to and binds the heirs, successors, executors, administrators and assigns of the parties to this Lease; (b) This Lease is governed by the laws of the State in which the Premises is located; (c) If requested by Tenant, Landlord agrees promptly to execute and deliver to Tenant a Memorandum of this Lease, to be recorded, in the form of Exhibit 3; (d) This Lease (including the Exhibits) constitutes the entire agreement between the parties and supersedes all prior written and verbal agreements, leases, representations, promises or understandings between the parties. Any amendments to this Lease must be in writing and executed by both parties; (e) If any provision of this Lease is invalid or unenforceable with respect to any party, the remainder of this Lease or the application of such provision to persons other than those to whom it is held invalid or unenforceable, will not be affected and each provision of this Lease will be valid and enforceable to the fullest extent permitted by law; (f) The prevailing party in any action or proceeding in court or mutually agreed upon arbitration proceeding to enforce the terms of this Lease is entitled to receive its reasonable attorneys' fees and other reasonable enforcement costs and expenses from the non-prevailing party; (g) The Landlord shall, within ten days of the request of the Tenant or any Lender or prospective Lender, provide an estoppel certificate as to any matters reasonably requested by the Tenant or Lender. (h) It is intended that Exhibit 2 accurately reflects the intended placement of Premises as well as any easements and accordingly the parties agree that, if any part of the Premises is located beyond the description of the Premises as described/depicted in Exhibit 2 or any easements specified in the Lease, the Lease is hereby amended to provide that the Premises includes the existing location of any such improvements as part of the Premises demised in the Lease, to the extent that such improvements are located on real property owned by Landlord.

**[THE REMAINDER OF THIS PAGE IS INTENTIONALLY LEFT BLANK,  
SIGNATURES BEGIN ON NEXT PAGE]**

IN WITNESS WHEREOF, the parties hereto have executed this Lease as of the date last signed by a party hereto.

**WITNESS:**

Claudia Tuckey  
Sign  
CLAUDIA TUCKEY  
Print

David Tuckey  
Sign  
DAVID TUCKEY  
Print

**WITNESS:**

Erin E Vozzella  
Erin E Vozzella

Miriam Samarco  
Liane Samarco

**LANDLORD:**

WENDON REALTY TRUST

By: Donald I Horton  
Name: Donald I Horton  
Title: Trustee  
Date: 8-26-13

By: Wendy C Horton  
Name: Wendy C. Horton  
Title: Trustee  
Date: 8/25/13

**TENANT:**

VERTEX TOWERS LLC

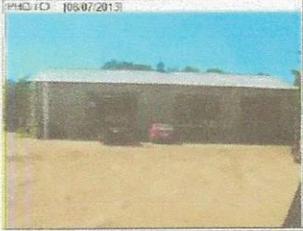
By: Stephen Kelleher  
Name: Stephen Kelleher  
Title: Manager  
Date: 9-30-13

# EXHIBIT 1

## TAX CARD

Note: Landlord and Tenant may, at Tenant's option, replace this Exhibit 1 with an exhibit setting forth the legal description of the property on which the Premises is located.

Key: 4524 Town of WELLFLEET - Fiscal Year 2014 Preliminary 9/16/2013 4:54 pm SEQ# 4.1/7

CURRENT OWNER		PARCEL ID		LOCATION		CLASS		CLASS%		DESCRIPTION		ENJL		CAHL				
HORTON DONALD & WENDY TRUSTEES		42-43-0-R		724 STATE HWY RTE 6		3160	100	WAREHOUSE				1	1 of 2					
724 ROUTE 6 WELLFLEET, MA 02667		TRANSFER HISTORY		DOCS	1	SALE PRICE	BR PG (Cert)											
		HORTON DONALD & WENDY TRU		05/20/1998	05	240,000	11440-272											
CD	I	ACQSPUN	Nbrhd	INI L1	INI L2	ADJ YASK	SAT	Score	LDI	VC	CREDIT AMT	ADJ VALUE						
103	S	30,000	C	1.00	100	1.00	100	1.00	300,000	1.21	100	1.00	C2	1.00	243,100			
203	A	2,755	C	1.00	100	1.00	100	1.00	50,000	1.00	100	1.00	C2	1.00	165,300			
303	A	3,385	C	1.00	100	1.00	100	1.00	17,200	1.00	100	1.00	C2	1.00	58,240			
TOTAL		6.130 Acres		ZONING C2		FHNI 0		ASSESSED		CURRENT		PREVIOUS						
Nbrhd		COMMERCIAL		N		ASSOC PAR 1-201-30 2/ PARADNO2-//		LAND		472,600		437,200						
INFL1		NO ADJUST		U				BUILDING		152,000		157,100						
INFL2		NO ADJUST		T				DETACHED		0		0						
				E				OTHER		273,100		279,000						
								TOTAL		897,700		873,300						
TY	QUAL	COND	URNOLE	YB	UNITS	ADJ PRICE	RCNLD	PHOTO [08/07/2013]										
																		
								BLDG COMMENTS CAPE COD DISPOSAL										
BUILDING	CD	ADJ	UR-SC		MEASUREMENT	8/7/2013	SF											
MODEL	5		CM		LIS1	1/14/2003	JC											
STYLE	52	1.87	SERVICE GARAGE (100%)		REVIEW	8/7/2013	SF											
QUALITY	1	0.83	LOW COST (100%)															
FRAME	4	1.00	METAL FRAME (100%)															
YEAR BLT	2002	SIZE ADJ	0.905		ELEMENT	CD	DESCRIPTION	ADJ	S	B	I	DESCRIPTION	UNITS	YB	ADJ PRICE	RCN	TOTAL RCN	1/3 /31
NET AREA	3,108	DETAIL ADJ	1.579		FOUNDATION	2	SLAB	1.00	A	B	L	BASE AREA	3,108	2002	54.93	170 /31	CORRELATION ELEM	CD
ENLARGEN	555	OVERALL	1.000		EXTERIOR WALL	10	PREFAB METAL	1.01										
CAPACITY				UNITS	ADJ	ROOF STRUCTURE	1	GABLE	1.00									
STORES	1	1.00			ROOF COVER	1	ASPH/COMP SHIN	1.00										
% HEATED	100	1.00			FLOORING	7	NONE	0.03										
% A/C	0	1.00			INT FINISH	6	MINIMUM	0.95										
% SPRINKLERS	0	1.00			HV A C	8	HEAT PUMP	1.03										
					FUEL SOURCE	1	OIL	1.00										
EFF. YRAGE   2002 / 10																		
COND 11 11%																		
FUND 0																		
ECON 0																		
DEPR 11 % GD 89																		
RCNLD 5152.000																		

Key: 4524

Town of WELLFLEET - Fiscal Year 2014 Preliminary

9/16/2013 4:54 pm SEQ# 4710

CURRENT OWNER		PARCEL ID		LOCATION		CLASS	CLASS%	DESCRIPTION	LNID	LN	CAID								
HORTON DONALD & WENDY TRUSTEES 724 ROUTE 6 WELLFLEET, MA 02867		42-43-0-R		724 STATE HWY RTE 6		3160	100	WAREHOUSE		2	2 of 2								
		TRANSFER HISTORY	DOS	1	SALE PRICE	BK-FG (Cmt)													
CD	1	ADJUST	Nbhd	INFL1	INFL2	ADJ BASE	SAP	Scenic	Lpn	VC	CR-DT AM	ADJ VALUE							
TOTAL		ZONING		FNN		ASSESSED	CURRENT	PREVIOUS											
Nbhd		INFL1		INFL2		LAND	BUILDING	DEACHED	OTHER	TOTAL									
							273,100												
Y	QUAL	COND	DRANAGE	YM	UNITS	ADJUST	HCNLU	PHOTO 08/17/2005											
																			
BUILDING		CD	ADJ	DESC		MEASURE	8/7/2013	SF	BLDG COMMENTS										
MODEL	5	CIM				US1	8/17/2006	RJM											
STYLE	53	1.41	STORAGE (GARAGE) (100%)																
QUALITY	-	0.90	AVE-LOW+ (100%)																
FRAME	4	1.00	METAL FRAME (100%)																
YEAR BLT	2004	SIZE ADJ	0.835	ELEMENT		CU	DESCRIPTION	ADJ	S	HAI	I	DESCRIPTION	UNITS	YS	ADJ PRICE	HCN	TOTAL HCN	296.806	
NET AREA	6,000	DETAIL ADJ	1.267	FOUNDATION	2	SLAB		1.00	A	BAS	L	BASE AREA	1,656	2004	44.07	205,204	COMBINATION ELEM	CD	
SNIA(RCN)	549	OVERALL	1.000	EXTENSION WALL	19	FRM-FAB METAL		1.01	B	BAS	L	BASE AREA	1,344	2004	44.07	59,234			
CAPACITY				UNITS	ADJ	ROOF STRUCTURE	10	GABLE	1.00	B	USU	N	UP-STORY LIN	1,344	21.99	29,553			
STORIES	1	1.00	FLOORING	9	CONCRETE	0.95	ROOF COVER	10	METAL	0.98	C	CAN	N	CANOPY	318	8.85	2,815		
% HEATED	100	1.00	INT FINISH	6	MINIMUM	0.95	STORIES	1	1.00										
% A/C	0	1.00	HVAC	1	FORCED AIR	1.00	% HEATED	100	1.00										
% SPRINKLERS	0	1.00	FUEL SOURCE	1	OIL	1.00	% A/C	0	1.00										
				UNITS	ADJ		% SPRINKLERS	0	1.00										
																	HCNLU	52,131.00	
																	EFF. YR/AGE	2004 / 8	
																	COND	08 DB%	
																	FUNC	0	
																	ECON	0	
																	DEPR	8 % CD 02	

### Exhibit 2

#### Drawing of the Lease Area

Note: Landlord and Tenant may, at Tenant's option, replace this Exhibit B with an exhibit setting forth the surveyed legal description of the Premises is located and/or an as-built drawing depicting the Premises.



**EXHIBIT 3  
FORM OF MEMORANDUM OF LEASE  
(NOT FOR EXECUTION)**

Record and Return to:

Vertex Towers, LLC  
PO Box 211  
Norfolk, MA 02056

This Memorandum of Lease evidences a Lease Agreement ("Lease") between Donald I. Horton and Wendy C. Horton Trustees of the Wendon Realty Trust ("Landlord"), whose mailing address is \_724 Route 6 Wellfleet, MA 02667 and Vertex Towers, LLC a Massachusetts Limited Liability Company ("Tenant") whose mailing address is PO Box 211 Norfolk, MA, commencing on the date Tenant begins construction at the Premises (the "Commencement Date"), which shall be confirmed in writing from Tenant to Landlord,

Landlord has leased to Tenant and Tenant has accepted and leased from Landlord a portion ("The Premises") of the following Property know as Map 42 Lot 43 on the Town of Wellfleet Assessors Maps and recorded with the Barnstable County Registry of Deeds at Book 11440, Page 272. A copy of said deed is attached as Exhibit A

The Premises is leased for a term of Fifty (50) years commencing on the date that Tenant begins construction at the Premises and the lease further provides;

1. The Lease restricts Landlord's ability to utilize, or allow the utilization of its adjacent property for the construction, operation and/or maintenance of communications towers and related facilities;
2. The Premises may be used exclusively by Tenant for all legal purposes, including without limitation, erecting, installing, operating and maintaining radio and communications towers, buildings, and equipment;
3. Tenant is entitled to sublease and/or sublicense the Premises, including any communications tower located thereon.

IN WITNESS WHEREOF, the parties have executed, or have caused this Memorandum of Lease to be properly executed, by their duly authorized agents or officers, all as of the this      day of      .

TENANT: VERTEX TOWERS LLC.

LANDLORD: WENDON REALTY TRUST

By: \_\_\_\_\_  
Name: Stephen Kelleher  
Title: Manager  
Date: \_\_\_\_\_

By: \_\_\_\_\_ Date: \_\_\_\_\_  
Name: Donald I. Horton  
Title: Trustee

By: \_\_\_\_\_ Date: \_\_\_\_\_  
Name: Wendy C. Horton  
Title: Trustee

**TENANT ACKNOWLEDGEMENT**

COMMONWEALTH OF MASSACHUSETTS

COUNTY OF NORFOLK

On the \_\_\_\_\_ day of \_\_\_\_\_, 2013 before me personally appeared Stephen Kelleher, Manager of Vertex Towers, LLC, to me known (or proved to me on the basis of satisfactory evidence) to be the individual who executed the foregoing instrument, and he acknowledged said instrument by him executed to be his free act and deed in said capacity of Manager of Vertex Towers, LLC.

\_\_\_\_\_  
Notary Public: \_\_\_\_\_

\_\_\_\_\_  
My Commission Expires

**LANDLORD ACKNOWLEDGEMENT**

COMMONWEALTH OF MASSACHUSETTS

COUNTY OF BARNSTABLE

On the \_\_\_\_\_ day of \_\_\_\_\_, 2013 before me personally appeared Donald I. Horton and Wendy C. Horton, trustees of the Wendon Realty Trust to me known (or proved to me on the basis of satisfactory evidence) to be the individual(s) who executed the foregoing instrument, and they acknowledged said instrument by them executed to be their free act and deed in said capacity as owner(s) of the subject property as described in Exhibit 1 attached hereto.

\_\_\_\_\_  
Notary Public: \_\_\_\_\_

\_\_\_\_\_  
My Commission Expires

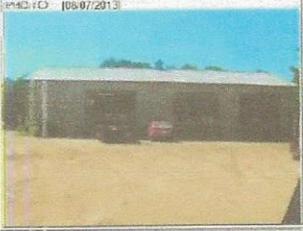
# EXHIBIT A

## Tax Card

Town of WELLFLEET - Fiscal Year 2014 Preliminary

Key: 4524

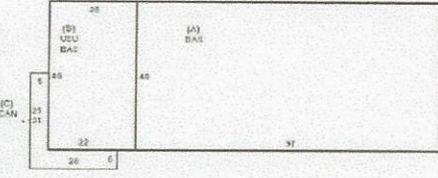
9/16/2013 4:54 pm SEQ#: 4/1/17

CURRENT OWNER		PARCEL ID	LOCATION				CLASS	CLASS%	DESCRIPTION		BN ID	BN	CAHL				
HORTON DONALD & WENDY TRUSTEES 724 ROUTE 6 WELLFLEET, MA 02867		42458-R	724 STATE HWY RTE 6				3160	100	WAREHOUSE			1	1 of 2				
TRANSFER HISTORY		DOS	1	SALE PRICE	BR+G (Cert)	PMI NO	PMI DT	LY	DESC	AMOUNT	INSP	BY	%				
HORTON DONALD & WENDY TRU		0528/1998	05	240,000	11440-272	0001	08/07/2013	1	CYCLICAL		08/07/2013	SP	100				
						04-19	03/29/2014	4	NEW CONSTRUC	225,000	08/17/2015	RJM	100				
						04-00	03/29/2014	4	NEW CONSTRUC	50	08/17/2015	RJM	100				
						02131	04/23/2012	4	NEW CONSTRUC	3,000	01/14/2013	JC	100				
						0223	01/18/2012	4	NEW CONSTRUC	100,000	01/14/2013	JC	100				
CU	I	ACSR/UN	Nbhd	INFL1	INFL2	ADJ BASE	SAF	Score	LPI	VC	CREDIT AMT	ADJ VALUE					
103	S	30,000	C	1.00	1.00	300,000	1.21	100	1.00	C2	1.00	249,100					
203	A	2,185	C	1.00	1.00	60,000	1.00	100	1.00	C2	1.00	160,300					
303	A	3,385	C	1.00	1.00	17,200	1.00	100	1.00	C2	1.00	50,240					
TOTAL		6.830 Acres	ZONING	C2	PHNT	g	ASSESSED	CURRENT	PREVIOUS								
Nbhd		COMMERCIAL	N	NO ADJUST	NO ADJUST	ASSOC PART 201-30 2/ PARADISE-2/	LAND	442,600	437,200								
			O				BUILDING	152,000	157,100								
			T				DETACHED	0	0								
			E				OTHER	243,100	279,000								
							TOTAL	897,700	873,300								
TY	QUAL	COND	UMWNT	YB	UNITS	ADJ PRICE	RCNLD	PHOTO [08/07/2013]									
																	
								BUILDING COMMENTS CAPE: COO DISPOSAL									
BUILDING	CU	ALU	DESC	MEASURE	8/7/2013	SF											
MODEL	5	CBM	SERVICE GARAGE (100%)	US1	1/14/2003	JC											
STYLE	52	1.87	LOW COST (100%)	REVIEW	8/7/2013	SF											
QUALITY	L	0.63	METAL FRAME (100%)														
FRAME	4	1.00															
YEAR BLT	2002	SIZE ADJ	0.905	ELEMENT	CU	DESCRIPTION	ADJ	S	BAL	I	DESCRIPTION	UNITS	YB	ADJ PRICE	RCN	TOTAL RCN	1/0/31
NET AREA	3,108	DETAIL ADJ	1.579	FOUNDATION	2	SLAB	1.00	A	BAS	L	BASE AREA	3,108	2002	54.93	170,731		
SNLARK (2)	555	OVERALL	1.000	EXTERIOR WALL	18	TRIPLE METAL	1.01										
CAPACITY				UNITS	ADJ	ROOF STRUCTURE	1										
STORIES	1	1.00	FLOORING	7	NONE	0.53											
% HEATED	100	1.00	INT FINISH	6	MINIMUM	0.95											
% A/C	0	1.00	HVAC	8	HEAT PUMP	1.03											
% SPRINKLERS	0	1.00	FUEL SOURCE	1	OIL	1.00											
EFF. YRAGE: 2002 / 10																	
COND: 11.11%																	
FUNC: 0																	
ECON: 0																	
DEPR: 11 % GD: 89																	
RCNLD: 5152,000																	

Key: 4524

Town of WELLFLEET - Fiscal Year 2014 Preliminary

9/16/2013 4:54 pm SEQ # 4/18

CURRENT OWNER		PINCH H		LOCATION		CLASS	CLASS%	DESCRIPTION	BN ID	BN	CARD								
HORTON DONALD & WENDY TRUSTEES 724 ROUTE 6 WELLFLEET, MA 02667		42 43 0 R		724 STATE HWY RTE 6		3160	100	WAREHOUSE		2	2 of 2								
TRANS-LR HISTORY		DOS	I	SALE PRICE	BRFG (Cat)	PMI NO	PMI DT	TY	DESC	AMOUNT	INSP	BY	TR	%					
CD	I	ACR/ST/UN	Nbhd	INFL1	INFL2	ADJ BASE	SAP	Scenic	LH	VC	CREDIT AMT	ADJ VALUE							
TOTAL		ZONING		PINCH		ASSESSED		CURRENT		PREVIOUS									
Nbhd		N O T E		LAND BUILDING DETACHED OTHER		273,100													
TY	QUAL	COND	DMND	YB	UNITS	ADJ PRICE	HCNLU	PHOTO 108/17/2005											
																			
BUILDING		CU	ADJ	DESC		MEASURE	8/7/2013	SF	BLDG COMMENTS										
MODEL	5	CIM				LS1	8/17/2005	RJM											
STYLE	53	1.41	STORAGE GARAGE (100%)				REVIEW	8/7/2013	SF										
QUALITY	-	0.90	AVE-LOW (100%)																
FRAME	4	1.00	METAL FRAME (100%)																
YEAR BLT	2004	SIZE ADJ	0.835	ELEMENT		CU	DESCRIPTION	ADJ	S	HAI	I	DESCRIPTION	UNITS	YB	ADJ PRICE	HCN	TOTAL HCN	296,806	
NET AREA	6,088	DETAIL ADJ	1.267	FOUNDATION	2	SLAB	1.00	A	BAS	L	BASE AREA	4,656	2004	44.07	205,704	CONSTRUCTION ELEM CD			
ENLARGEN	549	OVERALL	1.000	EXTENSION WALL	10	PRE-PAB METAL	1.01	B	EAS	L	BASE AREA	1,344	2004	44.07	59,234				
CAPACITY				UNITS	ADJ	ROOF STRUCTURE	1	GABLE	1.00	B	USU	N	EMPIRY UNH	1,344	21.99	29,553			
STORIES	1	1.00	ROOF COVER	10	METAL	0.98	C	CAN	N	CANOPY	318	8.85	2,815						
% HEATED	100	1.00	FLOORING	9	CONCRETE	0.05													
% AVG	0	1.00	INT FINISH	6	MINIMUM	0.05													
% SPRINKLERS	0	1.00	HVAC	1	FORCED AIR	1.00													
				FUEL SOURCE	1	OIL	1.00												
EFF. YRAGE 2004/18																			
COND 08 08%																			
FUNC 0																			
ECON 0																			
DEPR 8 % GD 52																			
HCNLU 52/3,100																			

**ASSIGNMENT AND ASSUMPTION AGREEMENT**  
**BETWEEN**  
**VERTEX TOWERS, LLC AND VARSITY WIRELESS INVESTORS, LLC**

**THIS ASSIGNMENT AND ASSUMPTION AGREEMENT** (hereinafter "Assignment and Assumption Agreement") is effective as of the 19th day of December, 2013 (hereinafter "Effective Date") by and between **VERTEX TOWERS, LLC**, a Massachusetts limited liability company with a principal address of 4 Maple Road, Norfolk, MA 02056 (hereinafter "Assignor") and **VARSITY WIRELESS INVESTORS, LLC**, a Delaware limited liability company with a principal address of 346 Congress Street, Unit 703, Boston, MA 02210 (hereinafter "Assignee").

**WHEREAS**, Assignor has entered into certain Lease Agreement (Land) with various landowners as of and as set forth on Exhibit A for a portion of those properties set forth on said on Exhibit A (hereinafter "Leased Premises").

**WHEREAS**, Assignor desires to transfer and assign to Assignee and Assignee desires to accept the transfer and assignment thereof from the Assignor, all of Assignor's rights, title and interest in, to and under said Leases Agreement (Land) as set forth on Exhibit A and to all easements and other rights associated with said Leases Agreement (Land) and the Leased Premises (collectively, the "Leases").

**NOW THEREFORE**, for and in consideration of the mutual covenants contained herein and other good and valuable consideration the receipt and sufficiency of which are hereby acknowledged, the parties hereto agree as follows:

1. **Assignment** Assignor hereby represents and warrants unto Assignee that Assignor is the lessee under the Leases and has the right to assign, and is hereby assigning, all of Assignor's right, title and interest under said Leases to Assignee; that Assignor has delivered all notices and obtained all consents to assign that are necessary under said Leases except as set forth on Exhibit A; that Assignor has not executed or granted any modifications to, or extensions of, the Leases; that the Leases are valid and subsisting and in full force and effect; and that, to the best of Assignor's knowledge, there are no defaults now existing and no event has occurred and no condition exists which with the passage of time or the giving of notice, or both, would constitute a default. As of the Effective Date of this Assignment and Assumption Agreement, the Assignor hereby transfers and assigns to Assignee all of its right, title and interest in, to and under the Leases and to hold the same unto Assignee and its successors and assigns from and after the date hereof subject to the covenants, conditions and provisions therein provided. Assignor will indemnify, defend and hold harmless Assignee, its successors and assigns and their respective agents, employees, directors and officers from and against any claim, damage, loss, liability, obligation, tax, demand, defense, judgment, suit, proceeding, disbursement or expenses of any nature whatsoever (collectively, "Losses and Liabilities") arising out of or in any way related to the Leases after the Effective Date with respect to any fact or circumstance occurring or existing prior to the Effective Date.

2. Acceptance of Assignment. As of the Effective Date of this Assignment and Assumption Agreement, Assignee hereby accepts the transfer and assignment of the Leases, and Assignee hereby assumes and agrees to pay, perform and discharge all obligations and liabilities of Assignor under the Leases which accrue and are to be performed after the Effective Date of this Assignment. Assignee will indemnify, defend and hold harmless Assignor, its successors and assigns and their representatives, agents, employees, directors and officers from and against any and all Losses and Liabilities arising out of or in any way related to the Leases on and after the Effective Date of this Assignment and Assumption Agreement or which arise out of or are in any way related to the Leases after the Effective Date other than on account of any fact or circumstance occurring or existing prior to the Effective Date. Except as expressly provided herein and in the Leases, Assignee shall not assume or be bound by any obligations or liabilities of the Assignor or any affiliate of the Assignor of any kind or nature, known, unknown, accrued, absolute, contingent or otherwise, whether now existing or hereafter arising, whatsoever.

3. Consent to Assignment. To the extent that any of the Leases require notice to any landlord or any other third party under the Leases and said notice(s) have not been sent as of the Effective Date of this Assignment and Assumption Agreement by Assignor and Assignee, Assignor will send out said notice(s) within five (5) business days of the Effective Date. To the extent that any of the Leases require the consent of any landlord or any other third party under the Leases and said consent(s) have not been received and delivered to Assignee as of the Effective Date of this Assignment and Assumption Agreement, Assignor will send out said a request for consent to said landlord or third party within five (5) business days of the Effective Date and will diligently work to obtain said consent(s) as soon as possible.

4. Binding Effect/Governing Law. This Assignment and Assumption Agreement will be binding on and inure to the benefit of the parties hereto, their heirs, executors, administrators, successors in interest and assigns. The assignment and assumption of the Leases shall not enlarge any rights of third parties under contracts or arrangements with Assignee, Assignor or any of their respective affiliates. This Assignment and Assumption Agreement shall be governed by and construed and enforced exclusively in accordance with the laws of the Commonwealth of Massachusetts without regard to conflicts of laws principles. This Assignment and Assumption Agreement may be executed in one or more original or facsimile counterparts, and all counterparts so executed shall constitute one agreement, binding upon the parties hereto, notwithstanding that the parties are not signatory to the same counterpart.

(signatures on next page)

IN WITNESS WHEREOF, the undersigned have each caused this Assignment and Assumption Agreement to be duly executed as of the date set forth above by their duly authorized representatives.

ASSIGNOR:

VERTEX TOWERS, LLC

By: [Signature]  
Name: Stephen Kelleher  
Title: President

ASSIGNEE :

VARSITY WIRELESS INVESTORS, LLC.

By: [Signature]  
Name: Christopher Davis  
Title: President

Commonwealth of Massachusetts

Norfolk, ss

May 23, 2014

Then personally appeared the above named Stephen Kelleher, President of Vertex Towers, LLC, proved to me through satisfactory evidence of identification, which was license, to be the person who signed the preceding or attached document in my presence on behalf of said limited liability company, and acknowledged the foregoing instrument to be the free act and deed of the limited liability company.

Before me [Signature]  
My Commission Expires: **Francis D. Parisi**  
Notary Public  
My Commission Expires 10/19/20

Commonwealth of Massachusetts

Suffolk, ss

May 22, 2014

Then personally appeared the above named Christopher Davis, President of Varsity Wireless Investors, LLC, proved to me through satisfactory evidence of identification, which was license, to be the person who signed the preceding or attached document in my presence on behalf of said limited liability company and acknowledged the foregoing instrument to be the free act and deed of the limited liability company.

Before me [Signature]  
My Commission Expires: **Francis D. Parisi**  
Notary Public  
My Commission Expires 10/19/20

## EXHIBIT A

VERTEX ID	VARSITY ID	DATE OF LEASE	LANDLORD	ADDRESS	DEED REFERENCE
Wellfleet	VW-MA-0057	9/30/13	Donald I. Horton and Wendy C. Horton, Trustees of the Wendon Realty Trust u/d/t May 20, 1998	724 Route 6 Wellfleet, MA 02667	Barnstable Book 11440 Page 272
Wrentham	VW-MA-0014	6/23/13	Thomas H. Morse, Jr., John A. Morse and Peter W. Morse, as Trustees of the Big Apple Two Realty	0 Arnold Street Wrentham, MA 02093	Norfolk Book 5964 Page 483
Franklin	WW-MA0026	6/28/13	William C. Roode and Jeanne M. Roode	Assessors Map 349 Lot 006 Wrentham, MA	Norfolk Book 5501 Page 521
Haverhill	VZ-MA-0051	7/24/13	Kimball Holdings, LLC	Assessors Map 460 Lots 2-11 and 2-12 Haverhill, MA	Essex Southern Book 28986 Page 89
Taunton	VW-MA-0054	3/15/13	George B. Hudson	Assessors Map 44 Lots 5 and 71 Taunton, MA	Bristol Northern Book 10269 Page 53
Bridgewater	VW-MA-0055	11/15/13	Donna J. DenBesten, Trustee of the DenBesten Farm Realty Trust	Assessors Map 60 Lots 6, 7 and 29 Bridgewater, MA	Plymouth Book 34064 Page 128
N. Attleborough	VW-MA-0052	8/28/13	Richard J. Aubin, Trustee of the RJA Realty Trust u/d/t dated March 6, 1997	491 Hickory Road North Attleborough, MA	Bristol Northern Book 7089 Page 349 and 350
Raynham	VW-MA-0056	11/13/13	Terry L. DenBesten and Donna J. DenBesten	399 Locust Street Raynham, MA	Bristol Northern Book 8482 Page 42
Plymouth	VW-MA-0053	8/14/13	Richard N. Noonan, Jr., Trustee of Woodside Realty Trust u/d/t dated 6/26/72	834 Bourne Rd Plymouth, MA	Plymouth Book 3839 Page 119

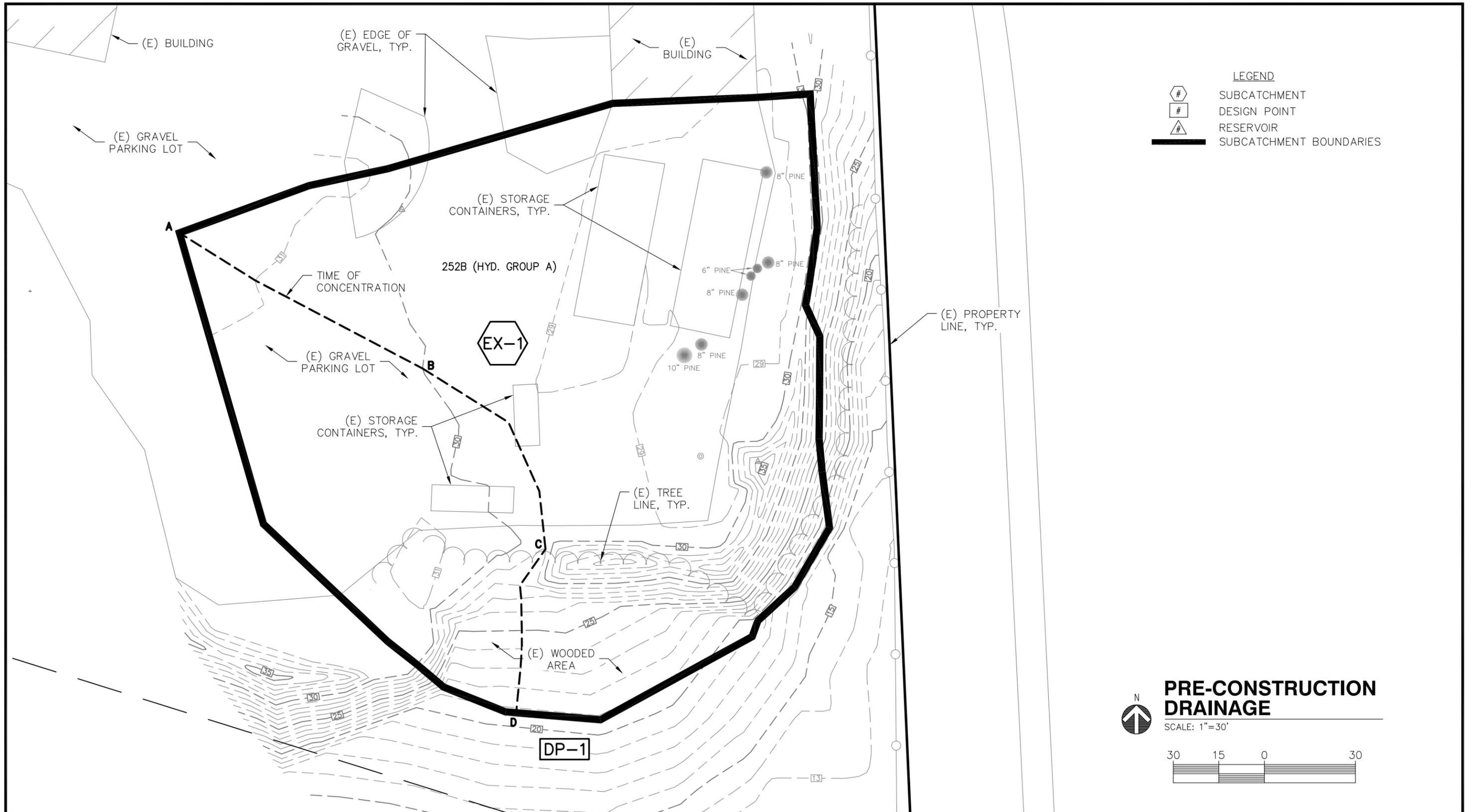
## ***Section 3***

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### ***Hydrology Model Using HydroCAD***

## TABLE OF SUBCATCHMENTS & COVER TYPE

Sub-catchment	Soil	Hyd. Group	Roof	Paved	Grass	Gravel	Wooded	Wet	Total
<b>Pre-Construction</b>									
EX-1	252B	A	2614	0	6198	18777	5126	0	32715
<b>Post-Construction</b>									
P-1	252B	A	1249	0	5144	17117	0	0	23510
P-2	252B	A	0	0	6357	1030	1818	0	9205



**ProTerra**  
DESIGN GROUP, LLC

4 Bay Road, Bldg A, Suite 200  
Hadley, MA 01035

Ph: (413)320-4918  
Fax: (413)320-4917



**VW-MA-0057**

WELLFLEET 6  
724 US ROUTE 6  
WELLFLEET, MA 02667

REVISIONS

0 DRAINAGE FOR REVIEW

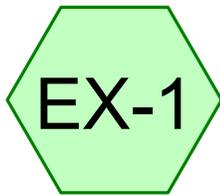
DESIGNED BY: JMM/TEJ JOB #: 14-009

DRAWN BY: BLM REV. #: 0

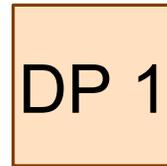
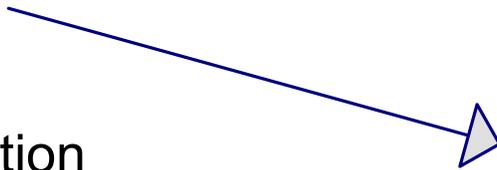
DATE: 10/22/14

SCALE: AS NOTED

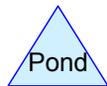
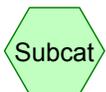
**PRE**



Pre-Construction  
Tributary Area



DP 1 - SE CORNER OF  
PROPERTY



## VW Wellfleet 6-Pre

Prepared by ProTerra Design Group, LLC

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Page 2

### Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.142	49	50-75% Grass cover, Fair, HSG A (EX-1)
0.431	96	Gravel surface, HSG A (EX-1)
0.060	98	Roofs, HSG A (EX-1)
0.118	43	Woods/grass comb., Fair, HSG A (EX-1)
<b>0.751</b>	<b>79</b>	<b>TOTAL AREA</b>

**VW Wellfleet 6-Pre**

Prepared by ProTerra Design Group, LLC

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Page 3

**Soil Listing (all nodes)**

Area (acres)	Soil Group	Subcatchment Numbers
0.751	HSG A	EX-1
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
<b>0.751</b>		<b>TOTAL AREA</b>

**VW Wellfleet 6-Pre**

Prepared by ProTerra Design Group, LLC

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Page 4

**Ground Covers (all nodes)**

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.142	0.000	0.000	0.000	0.000	0.142	50-75% Grass cover, Fair	EX-1
0.431	0.000	0.000	0.000	0.000	0.431	Gravel surface	EX-1
0.060	0.000	0.000	0.000	0.000	0.060	Roofs	EX-1
0.118	0.000	0.000	0.000	0.000	0.118	Woods/grass comb., Fair	EX-1
<b>0.751</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.751</b>	<b>TOTAL AREA</b>	

**VW Wellfleet 6-Pre**

*Type III 24-hr 2-Year Rainfall=3.60"*

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Page 5

Time span=5.00-30.00 hrs, dt=0.01 hrs, 2501 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment EX-1: Pre-Construction**

Runoff Area=32,715 sf 7.99% Impervious Runoff Depth=1.64"  
Flow Length=226' Tc=11.4 min CN=79 Runoff=1.20 cfs 0.103 af

**Reach DP 1: DP 1 - SE CORNER OF PROPERTY**

Inflow=1.20 cfs 0.103 af  
Outflow=1.20 cfs 0.103 af

**Total Runoff Area = 0.751 ac Runoff Volume = 0.103 af Average Runoff Depth = 1.64"**  
**92.01% Pervious = 0.691 ac 7.99% Impervious = 0.060 ac**

**VW Wellfleet 6-Pre**

Prepared by ProTerra Design Group, LLC

HydroCAD® 10.00-12 s/n 07277 © 2014 HydroCAD Software Solutions LLC

Type III 24-hr 2-Year Rainfall=3.60"

Printed 10/22/2014

Page 6

**Summary for Subcatchment EX-1: Pre-Construction Tributary Area**

Runoff = 1.20 cfs @ 12.16 hrs, Volume= 0.103 af, Depth= 1.64"

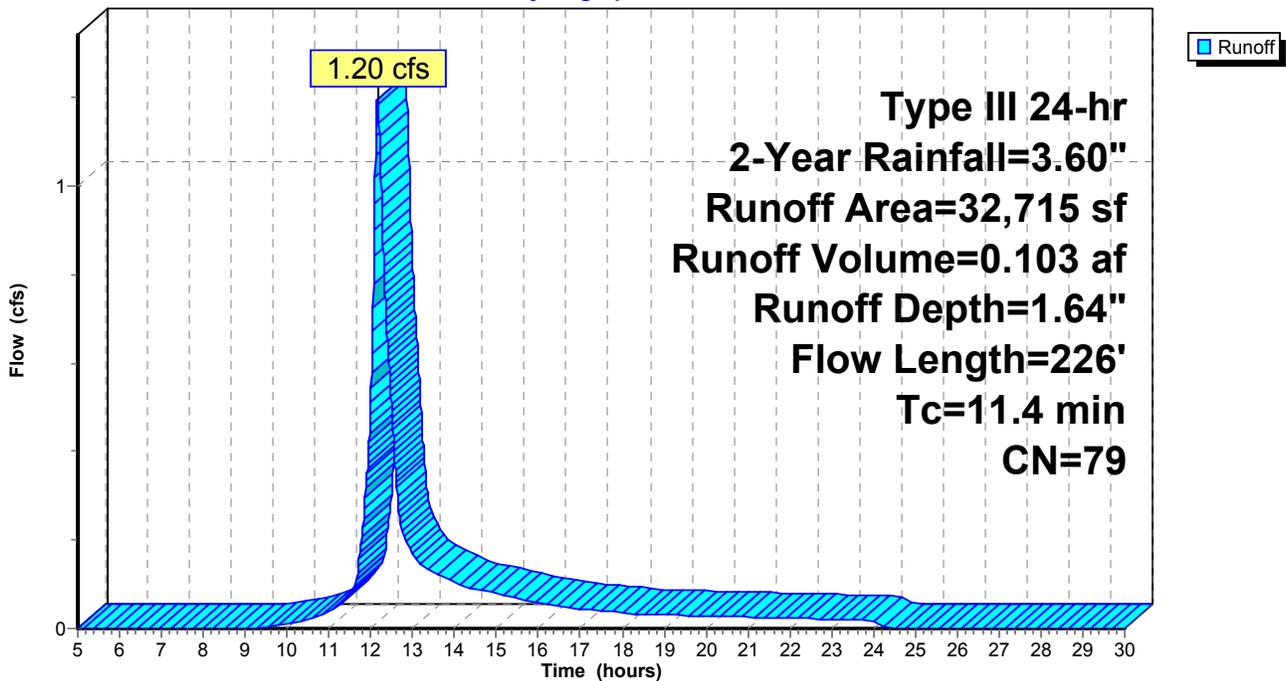
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-Year Rainfall=3.60"

Area (sf)	CN	Description
2,614	98	Roofs, HSG A
6,198	49	50-75% Grass cover, Fair, HSG A
18,777	96	Gravel surface, HSG A
5,126	43	Woods/grass comb., Fair, HSG A
32,715	79	Weighted Average
30,101		92.01% Pervious Area
2,614		7.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.2	92	0.0160	0.15		<b>Sheet Flow, Over Gravel A-B</b> Grass: Short n= 0.150 P2= 3.10"
0.7	77	0.0130	1.84		<b>Shallow Concentrated Flow, Over Gravel B-C</b> Unpaved Kv= 16.1 fps
0.5	57	0.1450	1.90		<b>Shallow Concentrated Flow, Wooded Area C-D</b> Woodland Kv= 5.0 fps
11.4	226	Total			

**Subcatchment EX-1: Pre-Construction Tributary Area**

Hydrograph

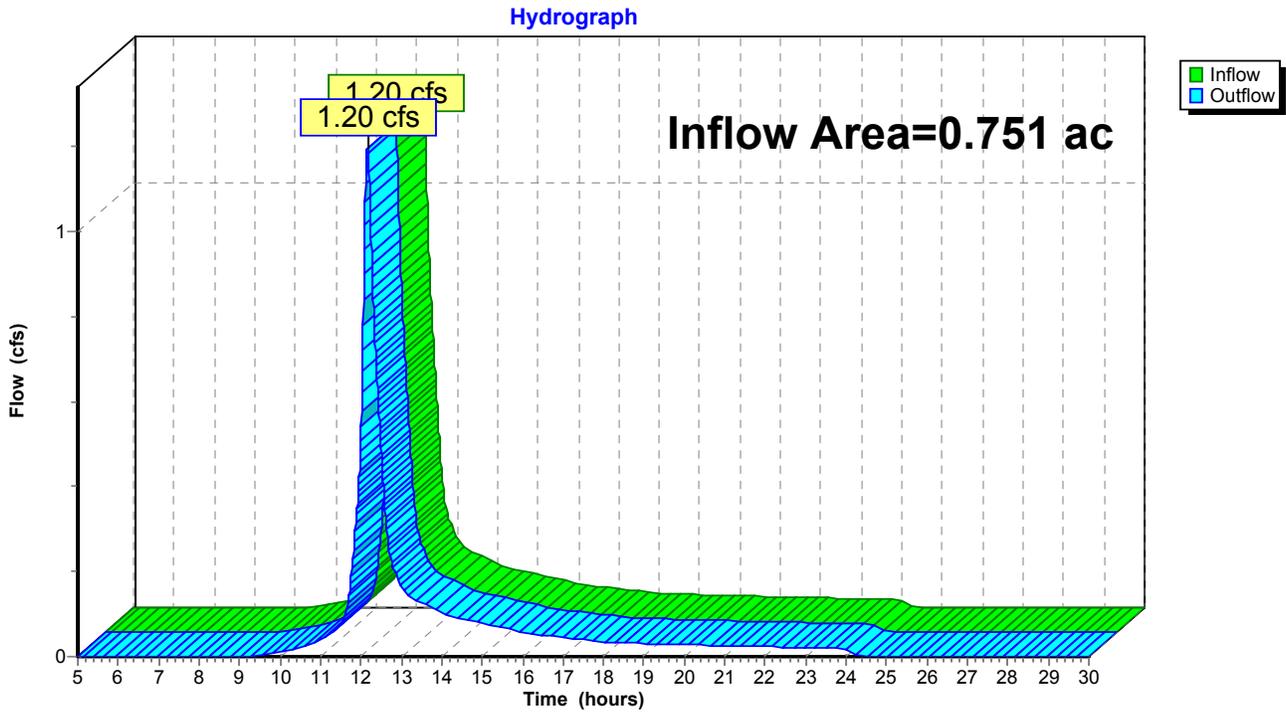


**Summary for Reach DP 1: DP 1 - SE CORNER OF PROPERTY**

Inflow Area = 0.751 ac, 7.99% Impervious, Inflow Depth = 1.64" for 2-Year event  
Inflow = 1.20 cfs @ 12.16 hrs, Volume= 0.103 af  
Outflow = 1.20 cfs @ 12.16 hrs, Volume= 0.103 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.01 hrs

**Reach DP 1: DP 1 - SE CORNER OF PROPERTY**



**VW Wellfleet 6-Pre**

Type III 24-hr 10-Year Rainfall=4.80"

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Time span=5.00-30.00 hrs, dt=0.01 hrs, 2501 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment EX-1: Pre-Construction**

Runoff Area=32,715 sf 7.99% Impervious Runoff Depth=2.63"  
Flow Length=226' Tc=11.4 min CN=79 Runoff=1.94 cfs 0.165 af

**Reach DP 1: DP 1 - SE CORNER OF PROPERTY**

Inflow=1.94 cfs 0.165 af  
Outflow=1.94 cfs 0.165 af

**Total Runoff Area = 0.751 ac Runoff Volume = 0.165 af Average Runoff Depth = 2.63"**  
**92.01% Pervious = 0.691 ac 7.99% Impervious = 0.060 ac**

**Summary for Subcatchment EX-1: Pre-Construction Tributary Area**

Runoff = 1.94 cfs @ 12.16 hrs, Volume= 0.165 af, Depth= 2.63"

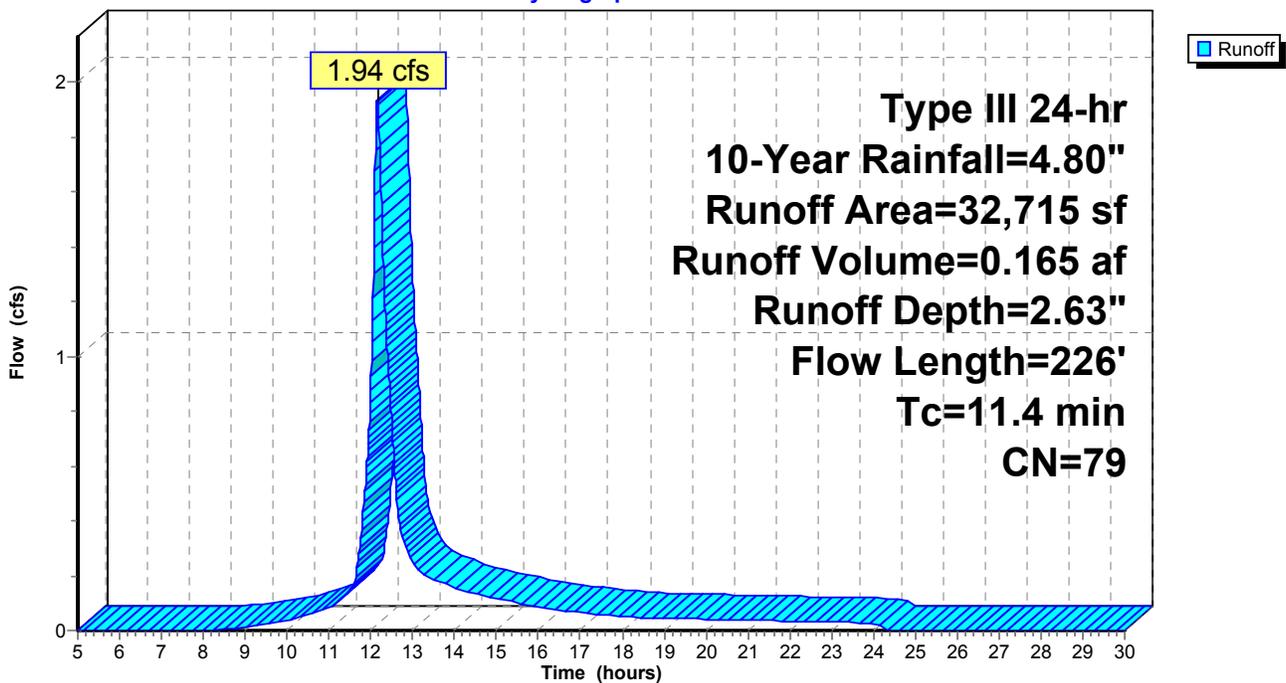
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.01 hrs  
Type III 24-hr 10-Year Rainfall=4.80"

Area (sf)	CN	Description
2,614	98	Roofs, HSG A
6,198	49	50-75% Grass cover, Fair, HSG A
18,777	96	Gravel surface, HSG A
5,126	43	Woods/grass comb., Fair, HSG A
32,715	79	Weighted Average
30,101		92.01% Pervious Area
2,614		7.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.2	92	0.0160	0.15		<b>Sheet Flow, Over Gravel A-B</b> Grass: Short n= 0.150 P2= 3.10"
0.7	77	0.0130	1.84		<b>Shallow Concentrated Flow, Over Gravel B-C</b> Unpaved Kv= 16.1 fps
0.5	57	0.1450	1.90		<b>Shallow Concentrated Flow, Wooded Area C-D</b> Woodland Kv= 5.0 fps
11.4	226	Total			

**Subcatchment EX-1: Pre-Construction Tributary Area**

Hydrograph

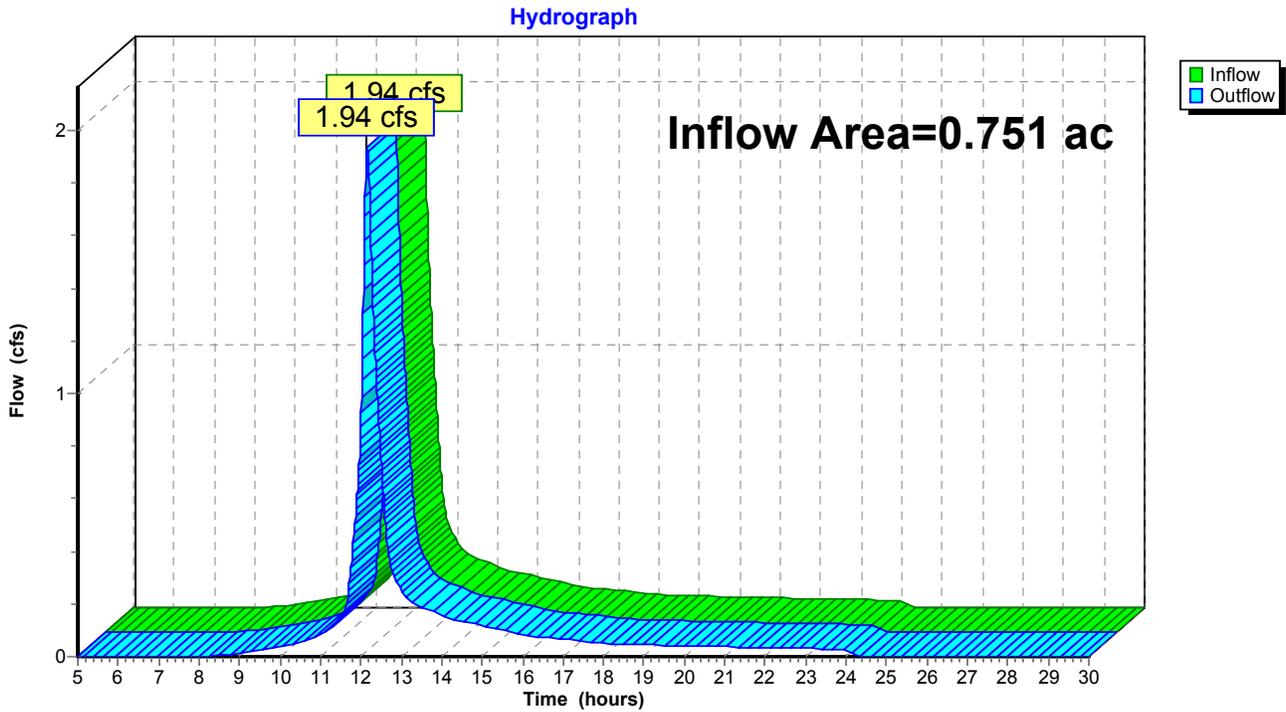


**Summary for Reach DP 1: DP 1 - SE CORNER OF PROPERTY**

Inflow Area = 0.751 ac, 7.99% Impervious, Inflow Depth = 2.63" for 10-Year event  
Inflow = 1.94 cfs @ 12.16 hrs, Volume= 0.165 af  
Outflow = 1.94 cfs @ 12.16 hrs, Volume= 0.165 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.01 hrs

**Reach DP 1: DP 1 - SE CORNER OF PROPERTY**



**VW Wellfleet 6-Pre**

Type III 24-hr 100-Year Rainfall=7.10"

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Time span=5.00-30.00 hrs, dt=0.01 hrs, 2501 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment EX-1: Pre-Construction**

Runoff Area=32,715 sf 7.99% Impervious Runoff Depth=4.68"  
Flow Length=226' Tc=11.4 min CN=79 Runoff=3.43 cfs 0.293 af

**Reach DP 1: DP 1 - SE CORNER OF PROPERTY**

Inflow=3.43 cfs 0.293 af  
Outflow=3.43 cfs 0.293 af

**Total Runoff Area = 0.751 ac Runoff Volume = 0.293 af Average Runoff Depth = 4.68"**  
**92.01% Pervious = 0.691 ac 7.99% Impervious = 0.060 ac**

**VW Wellfleet 6-Pre**

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Type III 24-hr 100-Year Rainfall=7.10"

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**Summary for Subcatchment EX-1: Pre-Construction Tributary Area**

Runoff = 3.43 cfs @ 12.15 hrs, Volume= 0.293 af, Depth= 4.68"

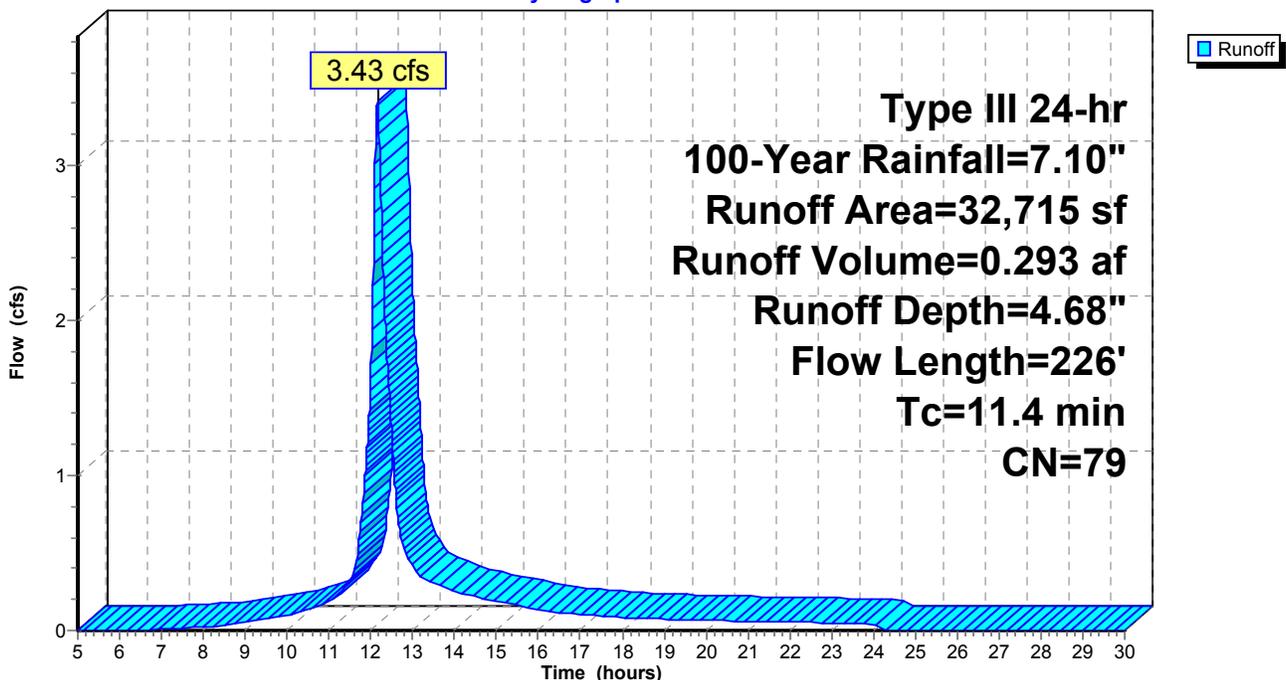
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-30.00 hrs, dt= 0.01 hrs  
Type III 24-hr 100-Year Rainfall=7.10"

Area (sf)	CN	Description
2,614	98	Roofs, HSG A
6,198	49	50-75% Grass cover, Fair, HSG A
18,777	96	Gravel surface, HSG A
5,126	43	Woods/grass comb., Fair, HSG A
32,715	79	Weighted Average
30,101		92.01% Pervious Area
2,614		7.99% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.2	92	0.0160	0.15		<b>Sheet Flow, Over Gravel A-B</b> Grass: Short n= 0.150 P2= 3.10"
0.7	77	0.0130	1.84		<b>Shallow Concentrated Flow, Over Gravel B-C</b> Unpaved Kv= 16.1 fps
0.5	57	0.1450	1.90		<b>Shallow Concentrated Flow, Wooded Area C-D</b> Woodland Kv= 5.0 fps
11.4	226	Total			

**Subcatchment EX-1: Pre-Construction Tributary Area**

Hydrograph

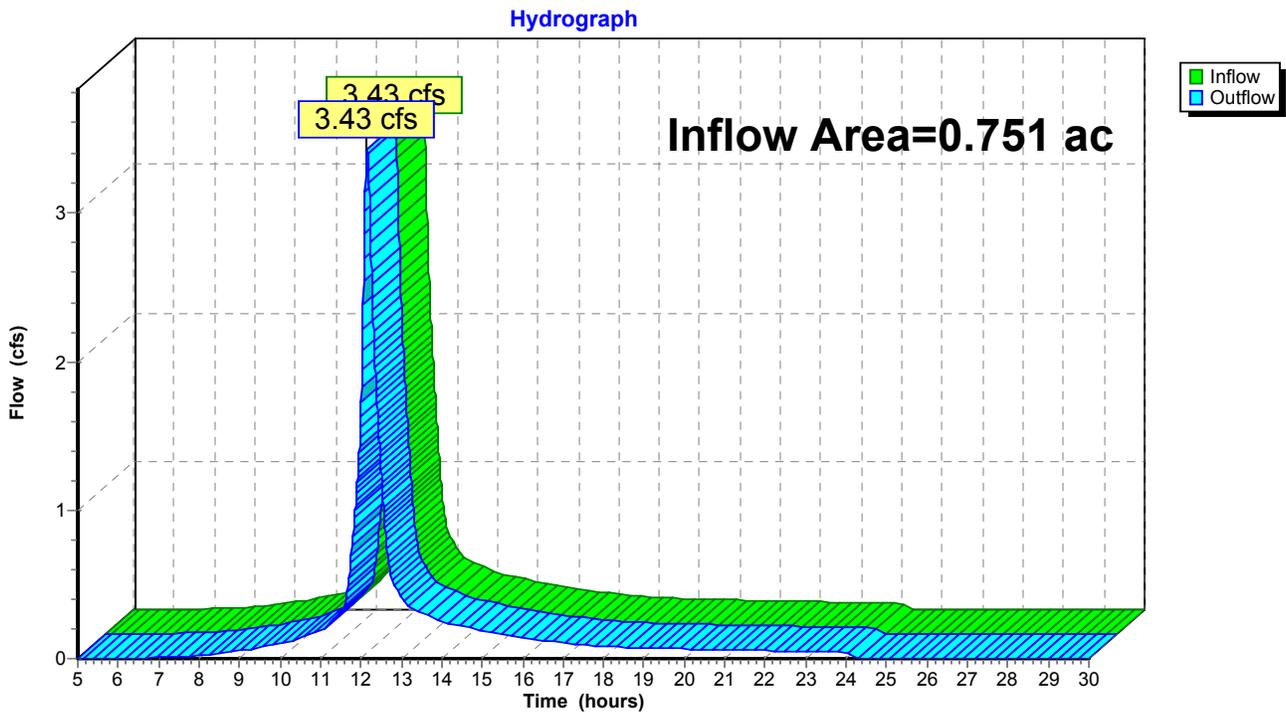


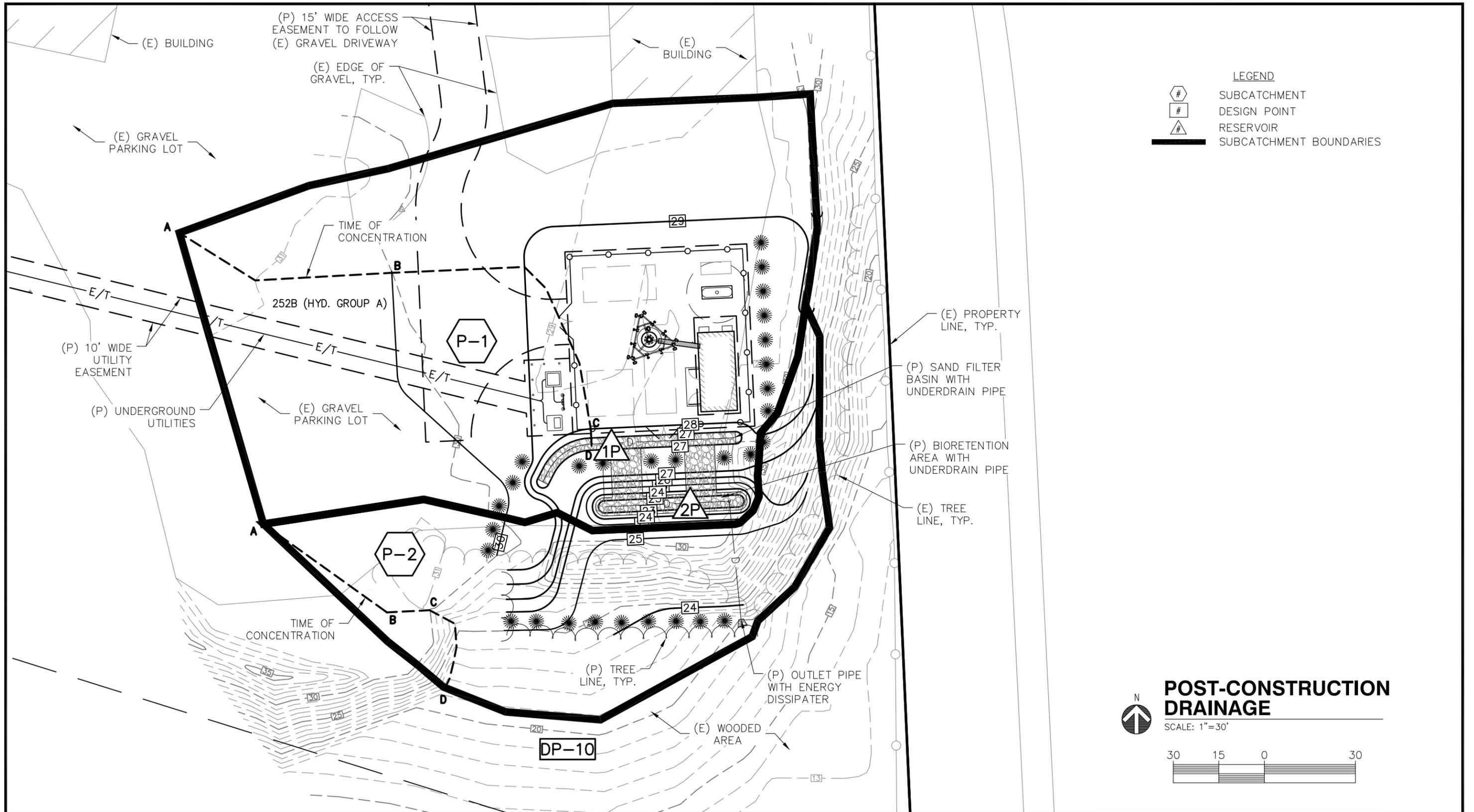
### Summary for Reach DP 1: DP 1 - SE CORNER OF PROPERTY

Inflow Area = 0.751 ac, 7.99% Impervious, Inflow Depth = 4.68" for 100-Year event  
Inflow = 3.43 cfs @ 12.15 hrs, Volume= 0.293 af  
Outflow = 3.43 cfs @ 12.15 hrs, Volume= 0.293 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-30.00 hrs, dt= 0.01 hrs

### Reach DP 1: DP 1 - SE CORNER OF PROPERTY





**LEGEND**

- SUBCATCHMENT
- DESIGN POINT
- RESERVOIR
- SUBCATCHMENT BOUNDARIES

**POST-CONSTRUCTION DRAINAGE**  
 SCALE: 1"=30'

N

**ProTerra**  
 DESIGN GROUP, LLC

4 Bay Road, Bldg A, Suite 200  
 Hadley, MA 01035

Ph: (413)320-4918  
 Fax: (413)320-4917

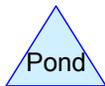
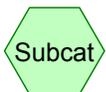
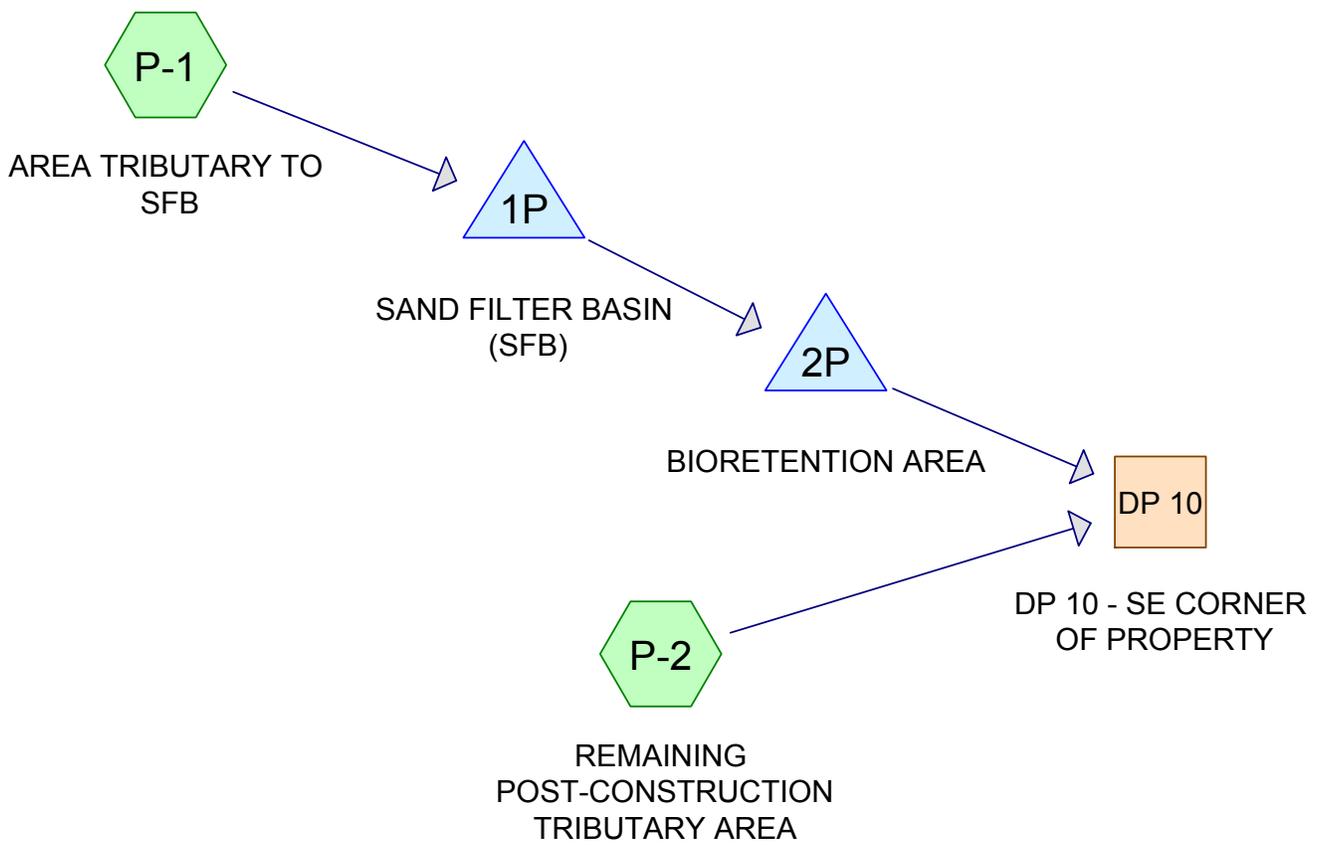
**varsity wireless**

**VW-MA-0057**

WELLFLEET 6  
 724 US ROUTE 6  
 WELLFLEET, MA 02667

REVISIONS	
0	DRAINAGE FOR REVIEW

DESIGNED BY:	JMM/TEJ	JOB #:	14-009
DRAWN BY:	BLM	REV. #:	0
DATE:	10/22/14	<b>POST</b>	
SCALE:	AS NOTED		



## VW Wellfleet 6-Post

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### Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.264	49	50-75% Grass cover, Fair, HSG A (P-1, P-2)
0.417	96	Gravel surface, HSG A (P-1, P-2)
0.029	98	Roofs, HSG A (P-1)
0.042	43	Woods/grass comb., Fair, HSG A (P-2)
<b>0.751</b>	<b>77</b>	<b>TOTAL AREA</b>

## VW Wellfleet 6-Post

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### Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.751	HSG A	P-1, P-2
0.000	HSG B	
0.000	HSG C	
0.000	HSG D	
0.000	Other	
<b>0.751</b>		<b>TOTAL AREA</b>

## VW Wellfleet 6-Post

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### Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.264	0.000	0.000	0.000	0.000	0.264	50-75% Grass cover, Fair	P-1, P-2
0.417	0.000	0.000	0.000	0.000	0.417	Gravel surface	P-1, P-2
0.029	0.000	0.000	0.000	0.000	0.029	Roofs	P-1
0.042	0.000	0.000	0.000	0.000	0.042	Woods/grass comb., Fair	P-2
<b>0.751</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.000</b>	<b>0.751</b>	<b>TOTAL AREA</b>	

**VW Wellfleet 6-Post**

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Type III 24-hr 2-Year Rainfall=3.60"

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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 Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment P-1: AREA TRIBUTARY TO** Runoff Area=23,510 sf 5.31% Impervious Runoff Depth=2.19"  
Flow Length=183' Tc=9.4 min CN=86 Runoff=1.23 cfs 0.098 af

**Subcatchment P-2: REMAINING** Runoff Area=9,205 sf 0.00% Impervious Runoff Depth=0.31"  
Flow Length=98' Tc=10.3 min CN=53 Runoff=0.03 cfs 0.005 af

**Reach DP 10: DP 10 - SE CORNER OF PROPERTY** Inflow=1.20 cfs 0.096 af  
Outflow=1.20 cfs 0.096 af

**Pond 1P: SAND FILTER BASIN (SFB)** Peak Elev=25.16' Storage=78 cf Inflow=1.23 cfs 0.098 af  
Outflow=1.21 cfs 0.097 af

**Pond 2P: BIORETENTION AREA** Peak Elev=21.63' Storage=74 cf Inflow=1.21 cfs 0.097 af  
Discarded=0.01 cfs 0.006 af Primary=1.18 cfs 0.091 af Outflow=1.19 cfs 0.097 af

**Total Runoff Area = 0.751 ac Runoff Volume = 0.104 af Average Runoff Depth = 1.66"**  
**96.18% Pervious = 0.722 ac 3.82% Impervious = 0.029 ac**

**VW Wellfleet 6-Post**

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Type III 24-hr 2-Year Rainfall=3.60"

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**Summary for Subcatchment P-1: AREA TRIBUTARY TO SFB**

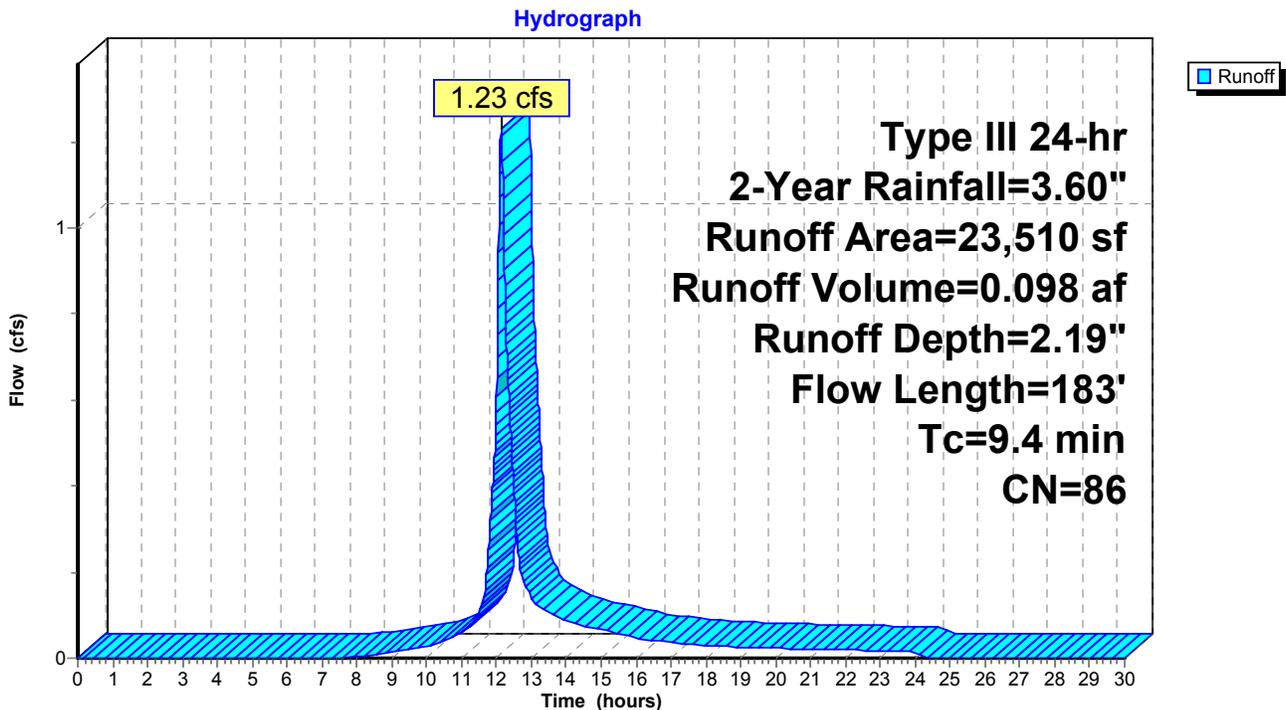
Runoff = 1.23 cfs @ 12.13 hrs, Volume= 0.098 af, Depth= 2.19"

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 2-Year Rainfall=3.60"

Area (sf)	CN	Description
1,249	98	Roofs, HSG A
5,144	49	50-75% Grass cover, Fair, HSG A
17,117	96	Gravel surface, HSG A
23,510	86	Weighted Average
22,261		94.69% Pervious Area
1,249		5.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	74	0.0160	0.14		<b>Sheet Flow, Over Gravel A-B</b> Grass: Short n= 0.150 P2= 3.10"
0.8	103	0.0200	2.28		<b>Shallow Concentrated Flow, Over Gravel B-C</b> Unpaved Kv= 16.1 fps
0.0	6	0.3333	4.04		<b>Shallow Concentrated Flow, Vegetated Slope C-D</b> Short Grass Pasture Kv= 7.0 fps
9.4	183	Total			

**Subcatchment P-1: AREA TRIBUTARY TO SFB**



**VW Wellfleet 6-Post**

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Type III 24-hr 2-Year Rainfall=3.60"

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**Summary for Subcatchment P-2: REMAINING POST-CONSTRUCTION TRIBUTARY AREA**

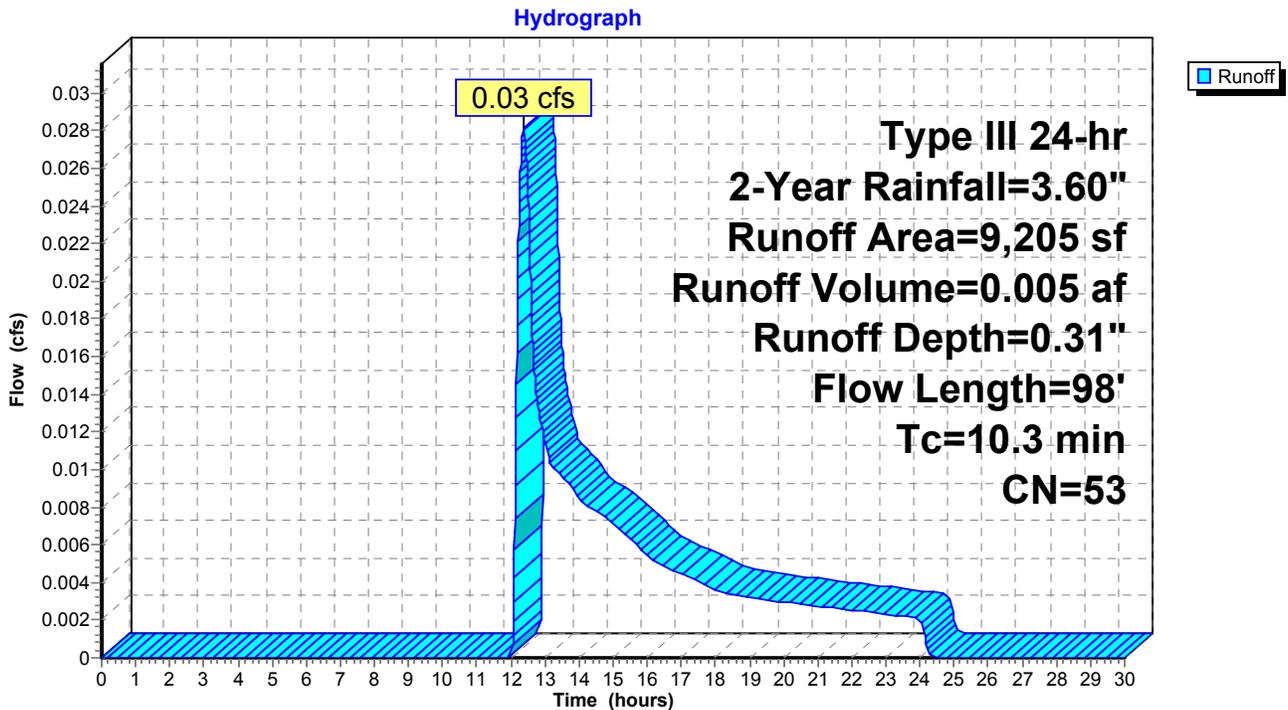
Runoff = 0.03 cfs @ 12.37 hrs, Volume= 0.005 af, Depth= 0.31"

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 2-Year Rainfall=3.60"

Area (sf)	CN	Description
6,357	49	50-75% Grass cover, Fair, HSG A
1,030	96	Gravel surface, HSG A
1,818	43	Woods/grass comb., Fair, HSG A
9,205	53	Weighted Average
9,205		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0	50	0.0050	0.08		<b>Sheet Flow, Over Gravel A-B</b> Grass: Short n= 0.150 P2= 3.10"
0.1	14	0.0600	3.94		<b>Shallow Concentrated Flow, Over Gravel B-C</b> Unpaved Kv= 16.1 fps
0.2	34	0.2500	2.50		<b>Shallow Concentrated Flow, Wooded Area C-D</b> Woodland Kv= 5.0 fps
10.3	98	Total			

**Subcatchment P-2: REMAINING POST-CONSTRUCTION TRIBUTARY AREA**

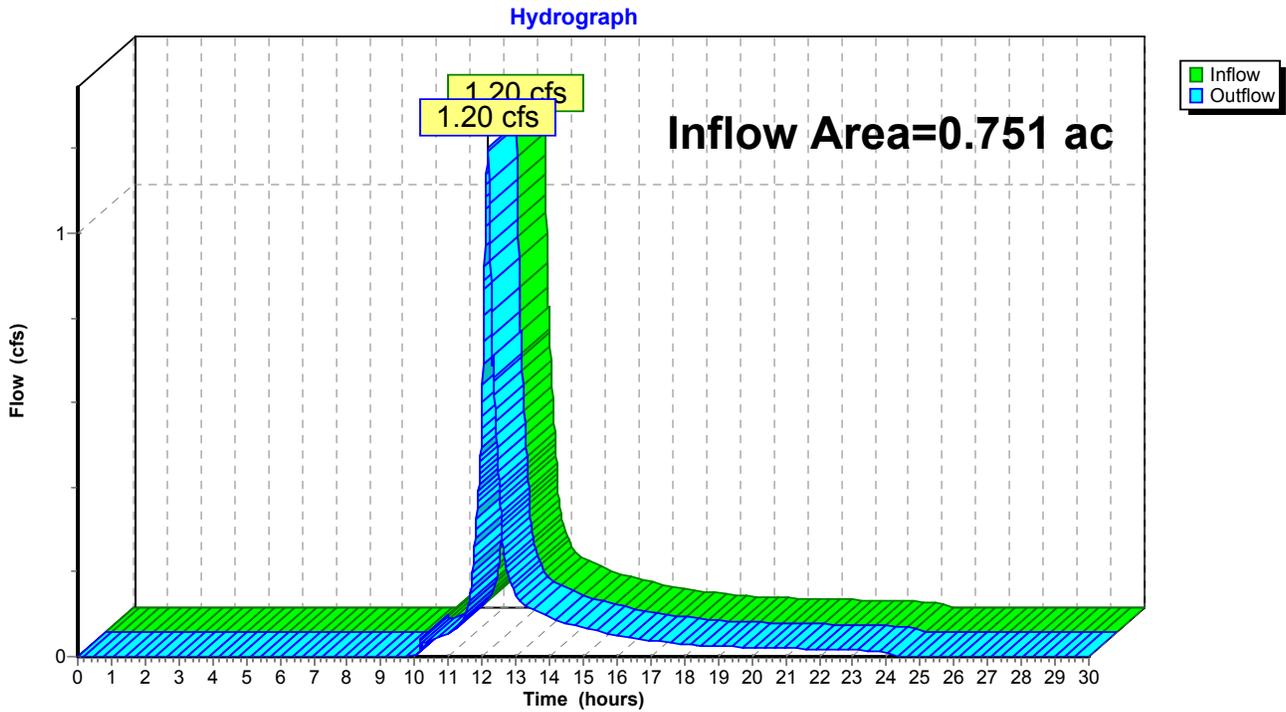


**Summary for Reach DP 10: DP 10 - SE CORNER OF PROPERTY**

Inflow Area = 0.751 ac, 3.82% Impervious, Inflow Depth = 1.54" for 2-Year event  
Inflow = 1.20 cfs @ 12.17 hrs, Volume= 0.096 af  
Outflow = 1.20 cfs @ 12.17 hrs, Volume= 0.096 af, Atten= 0%, Lag= 0.0 min

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

**Reach DP 10: DP 10 - SE CORNER OF PROPERTY**



**VW Wellfleet 6-Post**

Type III 24-hr 2-Year Rainfall=3.60"

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**Summary for Pond 1P: SAND FILTER BASIN (SFB)**

Inflow Area = 0.540 ac, 5.31% Impervious, Inflow Depth = 2.19" for 2-Year event  
 Inflow = 1.23 cfs @ 12.13 hrs, Volume= 0.098 af  
 Outflow = 1.21 cfs @ 12.15 hrs, Volume= 0.097 af, Atten= 2%, Lag= 1.2 min  
 Primary = 1.21 cfs @ 12.15 hrs, Volume= 0.097 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 25.16' @ 12.15 hrs Surf.Area= 268 sf Storage= 78 cf

Plug-Flow detention time= 14.0 min calculated for 0.097 af (98% of inflow)  
 Center-of-Mass det. time= 4.7 min ( 825.3 - 820.7 )

Volume	Invert	Avail.Storage	Storage Description
#1	24.00'	201 cf	<b>4.00'W x 67.00'L x 3.00'H Prismatoid</b> 804 cf Overall x 25.0% Voids
#2	27.00'	278 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
		479 cf	Total Available Storage

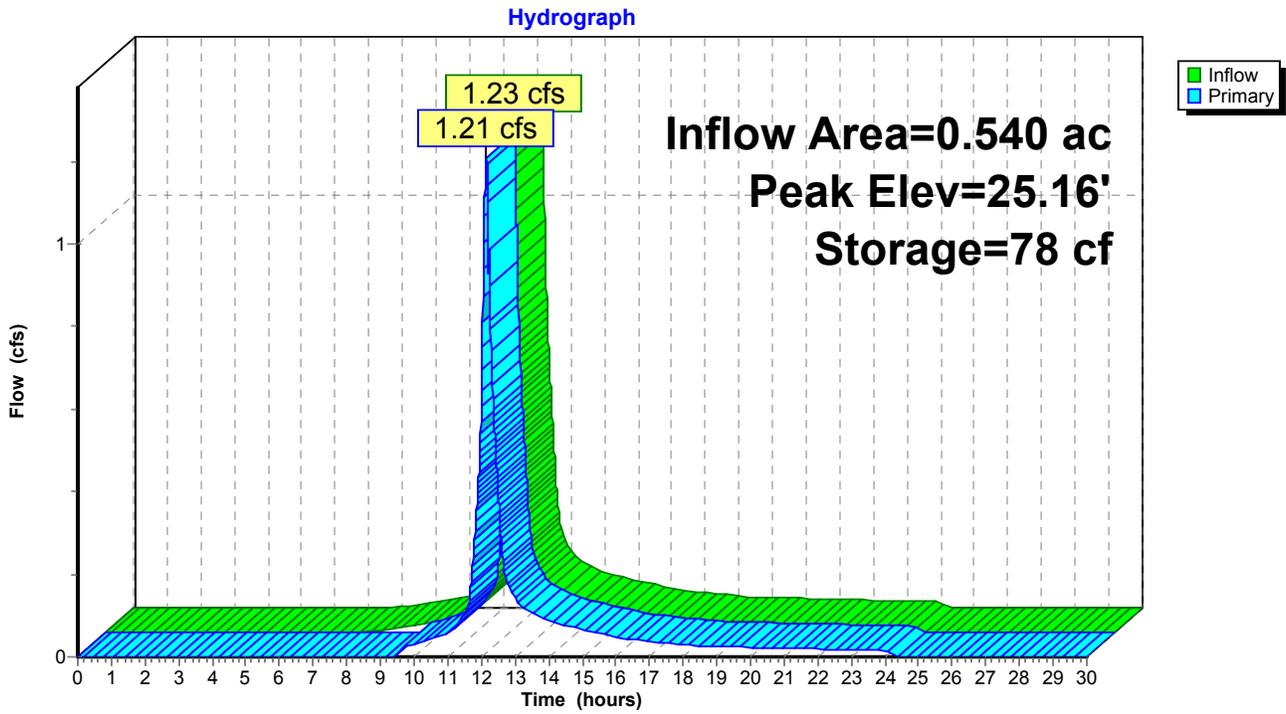
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
27.00	289	0	0
27.70	506	278	278

Device	Routing	Invert	Outlet Devices
#1	Primary	24.00'	<b>8.0" Round Culvert</b> L= 19.3' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 24.00' / 23.81' S= 0.0098 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf
#2	Device 1	25.00'	<b>0.27 cfs Exfiltration X 264.00 when above 25.00'</b>
#3	Primary	27.20'	<b>10.0' long x 6.0' breadth Broad-Crested Rectangular Weir X 2.00</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

**Primary OutFlow** Max=1.21 cfs @ 12.15 hrs HW=25.16' (Free Discharge)

- 1=Culvert (Inlet Controls 1.21 cfs @ 3.46 fps)
- 2=Exfiltration (Passes 1.21 cfs of 71.28 cfs potential flow)
- 3=Broad-Crested Rectangular Weir ( Controls 0.00 cfs)

**Pond 1P: SAND FILTER BASIN (SFB)**



**VW Wellfleet 6-Post**

Type III 24-hr 2-Year Rainfall=3.60"

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**Summary for Pond 2P: BIORETENTION AREA**

Inflow Area = 0.540 ac, 5.31% Impervious, Inflow Depth = 2.15" for 2-Year event  
 Inflow = 1.21 cfs @ 12.15 hrs, Volume= 0.097 af  
 Outflow = 1.19 cfs @ 12.17 hrs, Volume= 0.097 af, Atten= 2%, Lag= 1.2 min  
 Discarded = 0.01 cfs @ 12.17 hrs, Volume= 0.006 af  
 Primary = 1.18 cfs @ 12.17 hrs, Volume= 0.091 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 21.63' @ 12.17 hrs Surf.Area= 264 sf Storage= 74 cf

Plug-Flow detention time= 11.3 min calculated for 0.097 af (100% of inflow)  
 Center-of-Mass det. time= 10.2 min ( 835.5 - 825.3 )

Volume	Invert	Avail.Storage	Storage Description
#1	20.50'	165 cf	<b>6.00'W x 44.00'L x 2.50'H PrismaToid</b> 660 cf Overall x 25.0% Voids
#2	23.00'	806 cf	<b>Custom Stage Data (Conic)</b> Listed below (Recalc)
		971 cf	Total Available Storage

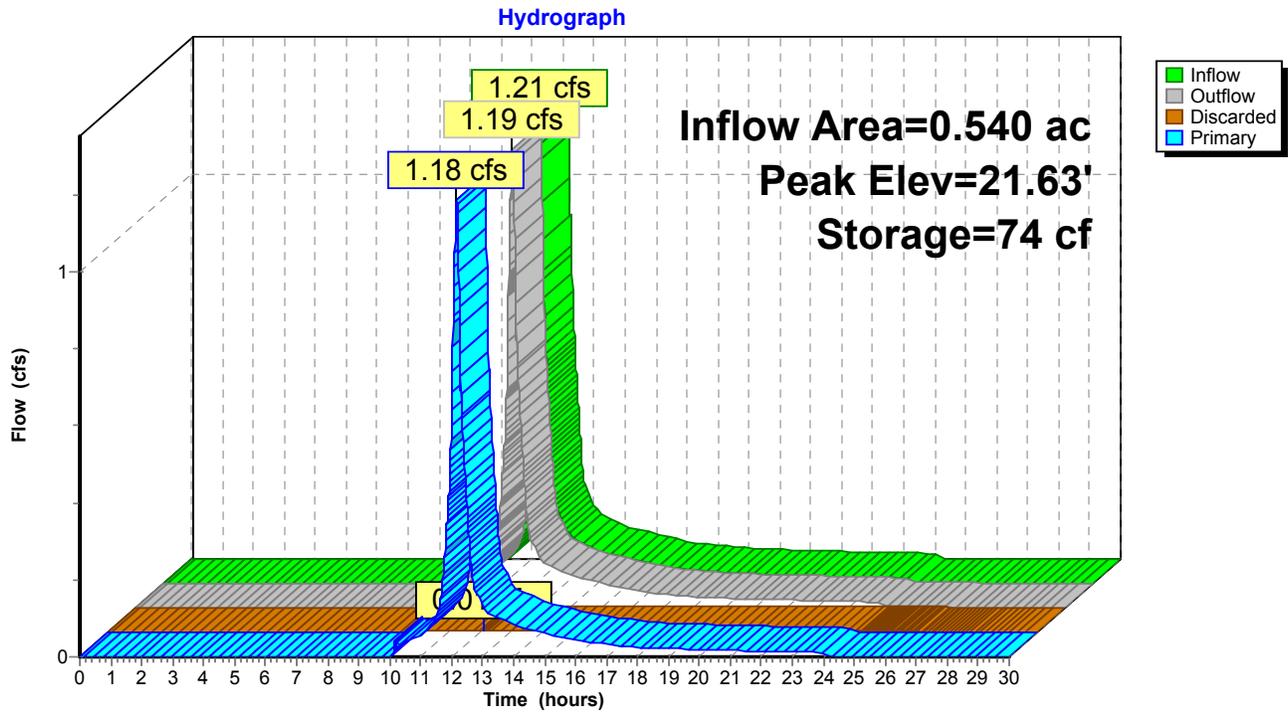
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
23.00	189	0	0	189
24.00	402	289	289	410
25.00	641	517	806	662

Device	Routing	Invert	Outlet Devices
#1	Discarded	20.50'	<b>2.410 in/hr Exfiltration over Wetted area from 20.50' - 23.00'</b> Excluded Wetted area = 264 sf
#2	Primary	20.50'	<b>8.0" Round Culvert</b> L= 39.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 20.50' / 20.11' S= 0.0100 '/ Cc= 0.900 n= 0.013, Flow Area= 0.35 sf
#3	Device 2	24.00'	<b>6.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 2	21.25'	<b>0.27 cfs Exfiltration X 264.00 when above 21.25'</b>

**Discarded OutFlow** Max=0.01 cfs @ 12.17 hrs HW=21.63' (Free Discharge)  
 ↳1=Exfiltration (Exfiltration Controls 0.01 cfs)

**Primary OutFlow** Max=1.18 cfs @ 12.17 hrs HW=21.63' (Free Discharge)  
 ↳2=Culvert (Inlet Controls 1.18 cfs @ 3.39 fps)  
 ↳3=Orifice/Grate ( Controls 0.00 cfs)  
 ↳4=Exfiltration (Passes 1.18 cfs of 71.28 cfs potential flow)

**Pond 2P: BIORETENTION AREA**



**VW Wellfleet 6-Post**

Type III 24-hr 10-Year Rainfall=4.80"

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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 Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment P-1: AREA TRIBUTARY TO** Runoff Area=23,510 sf 5.31% Impervious Runoff Depth=3.28"  
Flow Length=183' Tc=9.4 min CN=86 Runoff=1.83 cfs 0.148 af

**Subcatchment P-2: REMAINING** Runoff Area=9,205 sf 0.00% Impervious Runoff Depth=0.77"  
Flow Length=98' Tc=10.3 min CN=53 Runoff=0.11 cfs 0.014 af

**Reach DP 10: DP 10 - SE CORNER OF PROPERTY** Inflow=1.80 cfs 0.153 af  
Outflow=1.80 cfs 0.153 af

**Pond 1P: SAND FILTER BASIN (SFB)** Peak Elev=26.07' Storage=139 cf Inflow=1.83 cfs 0.148 af  
Outflow=1.75 cfs 0.146 af

**Pond 2P: BIORETENTION AREA** Peak Elev=22.45' Storage=129 cf Inflow=1.75 cfs 0.146 af  
Discarded=0.01 cfs 0.006 af Primary=1.69 cfs 0.139 af Outflow=1.70 cfs 0.146 af

**Total Runoff Area = 0.751 ac Runoff Volume = 0.161 af Average Runoff Depth = 2.57"**  
**96.18% Pervious = 0.722 ac 3.82% Impervious = 0.029 ac**

**VW Wellfleet 6-Post**

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Type III 24-hr 10-Year Rainfall=4.80"

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**Summary for Subcatchment P-1: AREA TRIBUTARY TO SFB**

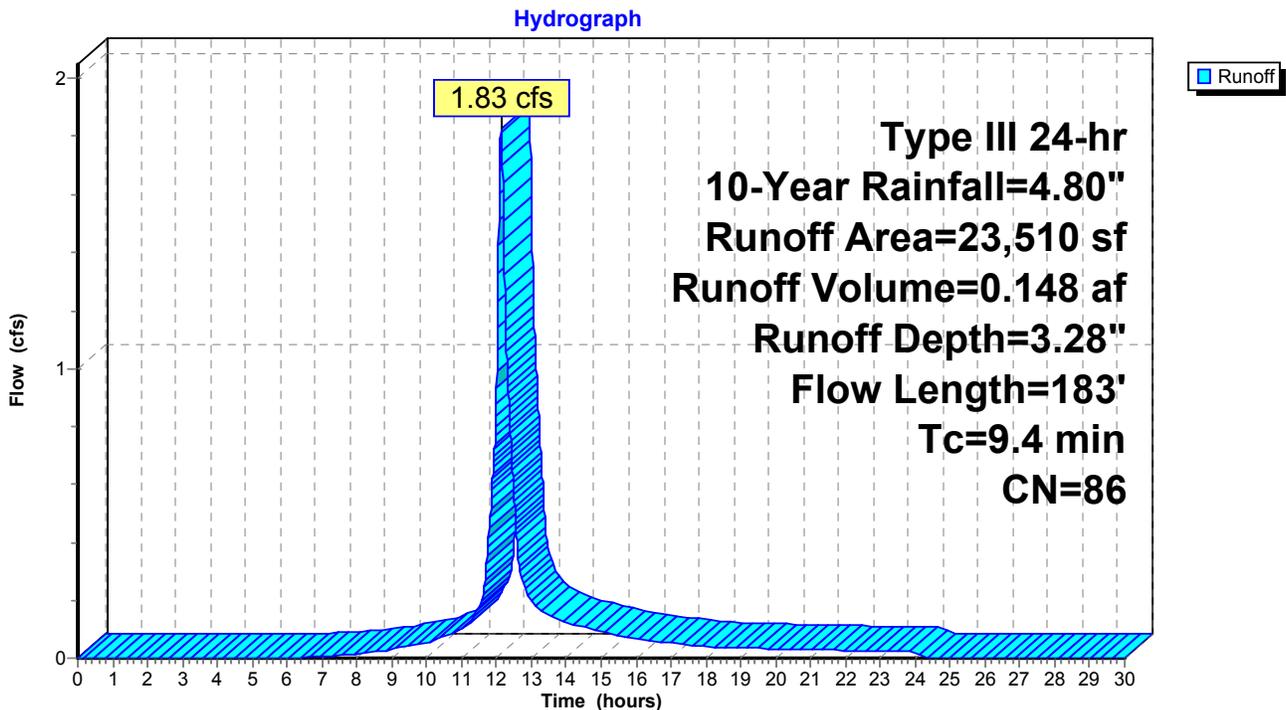
Runoff = 1.83 cfs @ 12.13 hrs, Volume= 0.148 af, Depth= 3.28"

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-Year Rainfall=4.80"

Area (sf)	CN	Description
1,249	98	Roofs, HSG A
5,144	49	50-75% Grass cover, Fair, HSG A
17,117	96	Gravel surface, HSG A
23,510	86	Weighted Average
22,261		94.69% Pervious Area
1,249		5.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	74	0.0160	0.14		<b>Sheet Flow, Over Gravel A-B</b> Grass: Short n= 0.150 P2= 3.10"
0.8	103	0.0200	2.28		<b>Shallow Concentrated Flow, Over Gravel B-C</b> Unpaved Kv= 16.1 fps
0.0	6	0.3333	4.04		<b>Shallow Concentrated Flow, Vegetated Slope C-D</b> Short Grass Pasture Kv= 7.0 fps
9.4	183	Total			

**Subcatchment P-1: AREA TRIBUTARY TO SFB**



**VW Wellfleet 6-Post**

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Type III 24-hr 10-Year Rainfall=4.80"

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**Summary for Subcatchment P-2: REMAINING POST-CONSTRUCTION TRIBUTARY AREA**

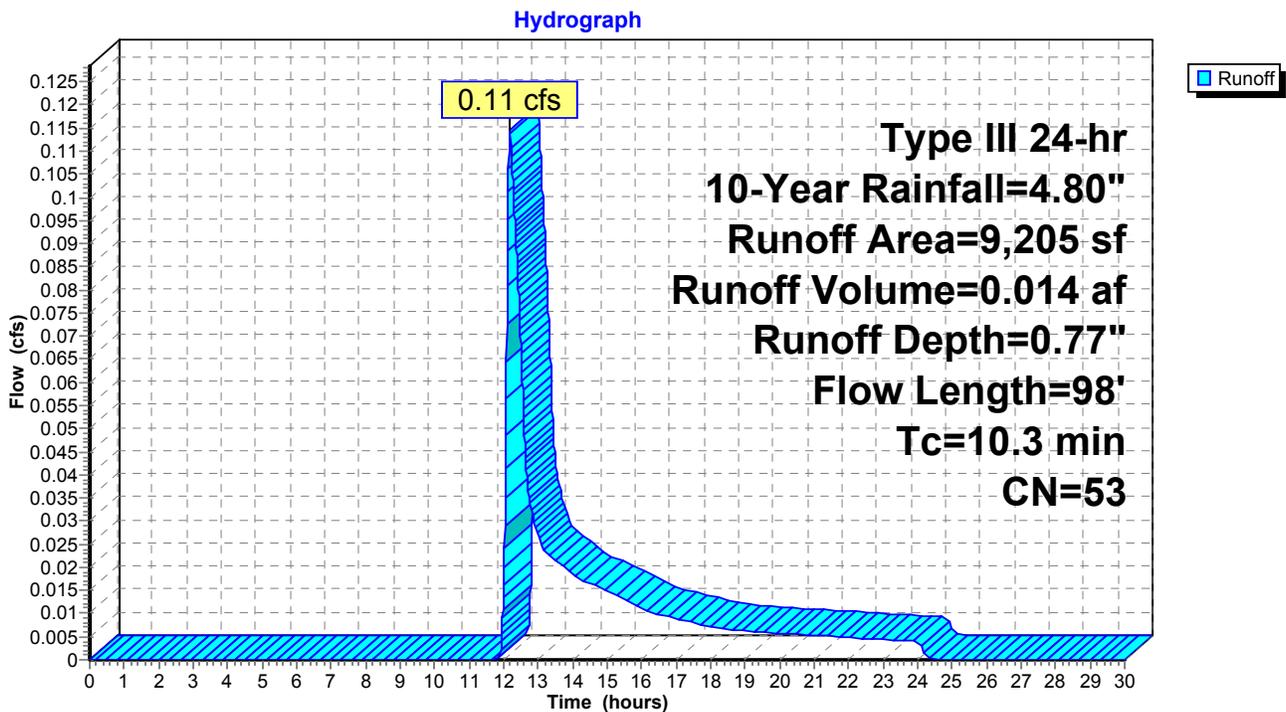
Runoff = 0.11 cfs @ 12.18 hrs, Volume= 0.014 af, Depth= 0.77"

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-Year Rainfall=4.80"

Area (sf)	CN	Description
6,357	49	50-75% Grass cover, Fair, HSG A
1,030	96	Gravel surface, HSG A
1,818	43	Woods/grass comb., Fair, HSG A
9,205	53	Weighted Average
9,205		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0	50	0.0050	0.08		<b>Sheet Flow, Over Gravel A-B</b> Grass: Short n= 0.150 P2= 3.10"
0.1	14	0.0600	3.94		<b>Shallow Concentrated Flow, Over Gravel B-C</b> Unpaved Kv= 16.1 fps
0.2	34	0.2500	2.50		<b>Shallow Concentrated Flow, Wooded Area C-D</b> Woodland Kv= 5.0 fps
10.3	98	Total			

**Subcatchment P-2: REMAINING POST-CONSTRUCTION TRIBUTARY AREA**

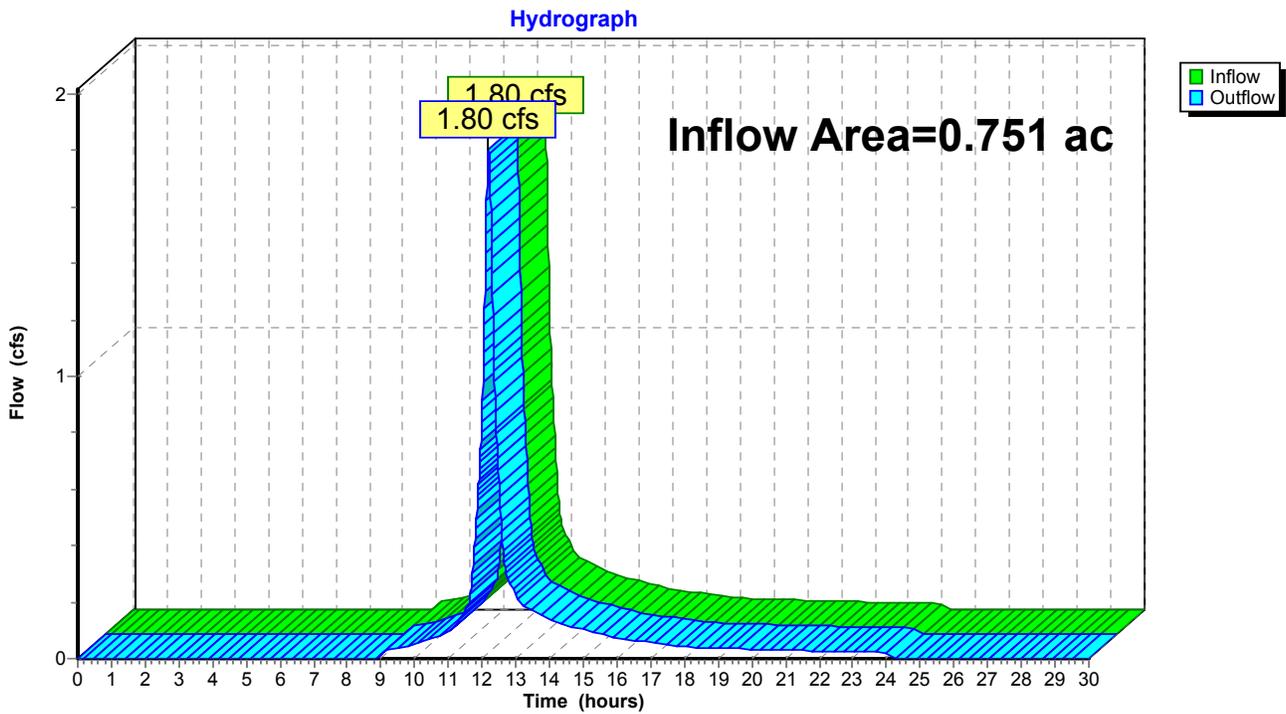


**Summary for Reach DP 10: DP 10 - SE CORNER OF PROPERTY**

Inflow Area = 0.751 ac, 3.82% Impervious, Inflow Depth = 2.44" for 10-Year event  
Inflow = 1.80 cfs @ 12.19 hrs, Volume= 0.153 af  
Outflow = 1.80 cfs @ 12.19 hrs, Volume= 0.153 af, Atten= 0%, Lag= 0.0 min

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

**Reach DP 10: DP 10 - SE CORNER OF PROPERTY**



**VW Wellfleet 6-Post**

Type III 24-hr 10-Year Rainfall=4.80"

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**Summary for Pond 1P: SAND FILTER BASIN (SFB)**

Inflow Area = 0.540 ac, 5.31% Impervious, Inflow Depth = 3.28" for 10-Year event  
 Inflow = 1.83 cfs @ 12.13 hrs, Volume= 0.148 af  
 Outflow = 1.75 cfs @ 12.16 hrs, Volume= 0.146 af, Atten= 4%, Lag= 1.8 min  
 Primary = 1.75 cfs @ 12.16 hrs, Volume= 0.146 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 26.07' @ 12.16 hrs Surf.Area= 268 sf Storage= 139 cf

Plug-Flow detention time= 10.3 min calculated for 0.146 af (99% of inflow)  
 Center-of-Mass det. time= 3.8 min ( 813.0 - 809.1 )

Volume	Invert	Avail.Storage	Storage Description
#1	24.00'	201 cf	<b>4.00'W x 67.00'L x 3.00'H Prismatoid</b> 804 cf Overall x 25.0% Voids
#2	27.00'	278 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
		479 cf	Total Available Storage

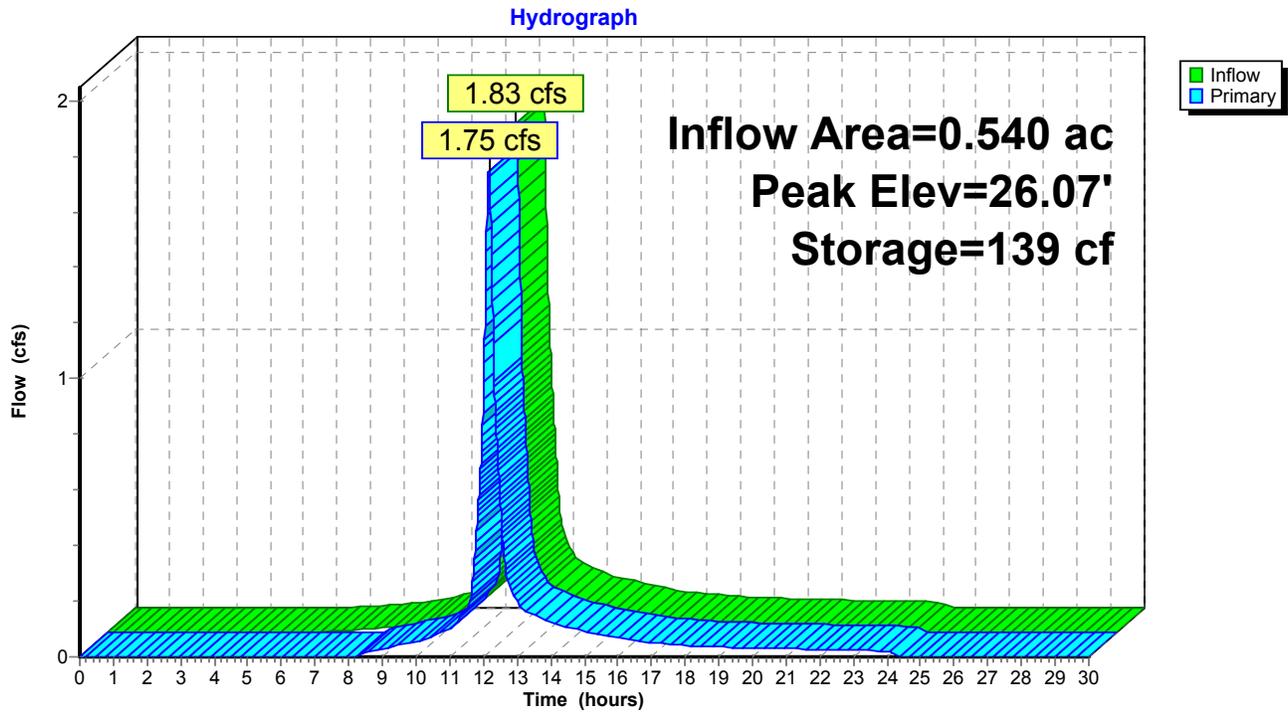
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
27.00	289	0	0
27.70	506	278	278

Device	Routing	Invert	Outlet Devices
#1	Primary	24.00'	<b>8.0" Round Culvert</b> L= 19.3' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 24.00' / 23.81' S= 0.0098 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf
#2	Device 1	25.00'	<b>0.27 cfs Exfiltration X 264.00 when above 25.00'</b>
#3	Primary	27.20'	<b>10.0' long x 6.0' breadth Broad-Crested Rectangular Weir X 2.00</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

**Primary OutFlow** Max=1.75 cfs @ 12.16 hrs HW=26.07' (Free Discharge)

- 1=Culvert (Inlet Controls 1.75 cfs @ 5.02 fps)
- 2=Exfiltration (Passes 1.75 cfs of 71.28 cfs potential flow)
- 3=Broad-Crested Rectangular Weir ( Controls 0.00 cfs)

**Pond 1P: SAND FILTER BASIN (SFB)**



**VW Wellfleet 6-Post**

Type III 24-hr 10-Year Rainfall=4.80"

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**Summary for Pond 2P: BIORETENTION AREA**

Inflow Area = 0.540 ac, 5.31% Impervious, Inflow Depth = 3.25" for 10-Year event  
 Inflow = 1.75 cfs @ 12.16 hrs, Volume= 0.146 af  
 Outflow = 1.70 cfs @ 12.19 hrs, Volume= 0.146 af, Atten= 3%, Lag= 1.8 min  
 Discarded = 0.01 cfs @ 12.19 hrs, Volume= 0.006 af  
 Primary = 1.69 cfs @ 12.19 hrs, Volume= 0.139 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 22.45' @ 12.19 hrs Surf.Area= 264 sf Storage= 129 cf

Plug-Flow detention time= 8.2 min calculated for 0.146 af (100% of inflow)  
 Center-of-Mass det. time= 7.4 min ( 820.3 - 813.0 )

Volume	Invert	Avail.Storage	Storage Description
#1	20.50'	165 cf	<b>6.00'W x 44.00'L x 2.50'H Prismaoid</b> 660 cf Overall x 25.0% Voids
#2	23.00'	806 cf	<b>Custom Stage Data (Conic)</b> Listed below (Recalc)
		971 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
23.00	189	0	0	189
24.00	402	289	289	410
25.00	641	517	806	662

Device	Routing	Invert	Outlet Devices
#1	Discarded	20.50'	<b>2.410 in/hr Exfiltration over Wetted area from 20.50' - 23.00'</b> Excluded Wetted area = 264 sf
#2	Primary	20.50'	<b>8.0" Round Culvert</b> L= 39.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 20.50' / 20.11' S= 0.0100 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf
#3	Device 2	24.00'	<b>6.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 2	21.25'	<b>0.27 cfs Exfiltration X 264.00 when above 21.25'</b>

**Discarded OutFlow** Max=0.01 cfs @ 12.19 hrs HW=22.45' (Free Discharge)  
 ↳1=Exfiltration (Exfiltration Controls 0.01 cfs)

**Primary OutFlow** Max=1.69 cfs @ 12.19 hrs HW=22.45' (Free Discharge)  
 ↳2=Culvert (Inlet Controls 1.69 cfs @ 4.83 fps)  
 ↳3=Orifice/Grate ( Controls 0.00 cfs)  
 ↳4=Exfiltration (Passes 1.69 cfs of 71.28 cfs potential flow)

**VW Wellfleet 6-Post**

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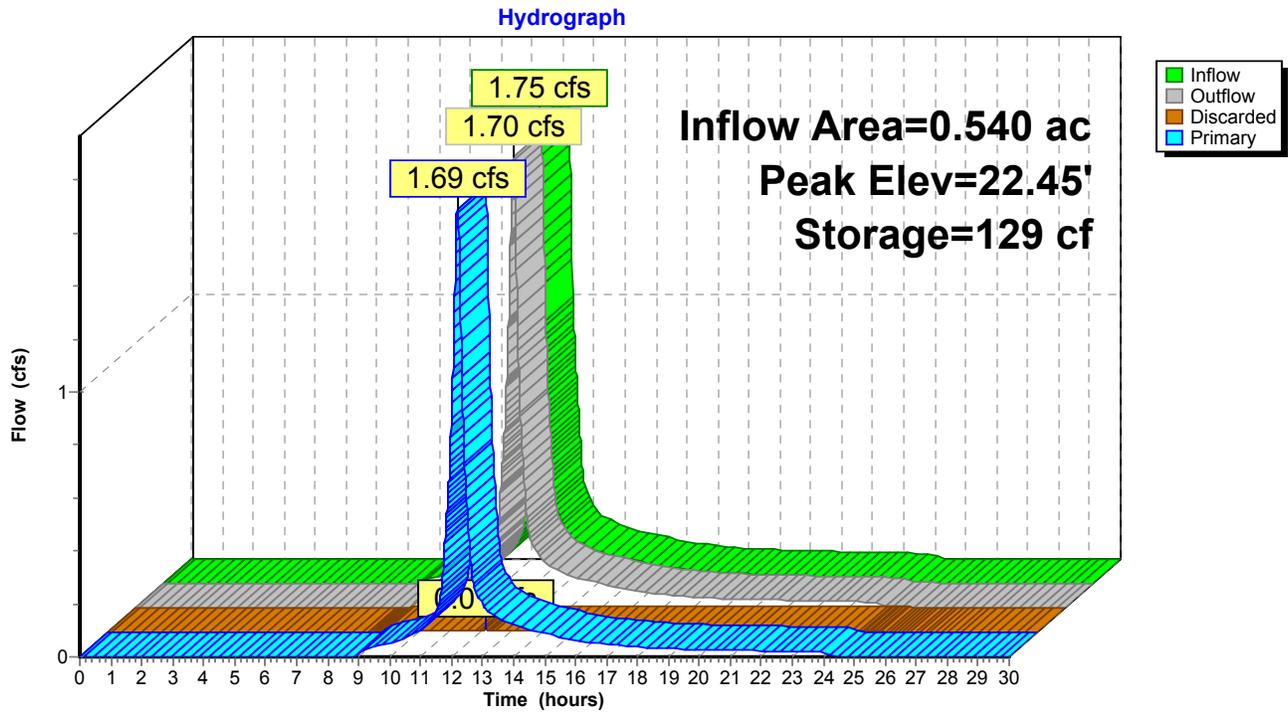
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Type III 24-hr 10-Year Rainfall=4.80"

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**Pond 2P: BIORETENTION AREA**



**VW Wellfleet 6-Post**

Type III 24-hr 100-Year Rainfall=7.10"

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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 Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment P-1: AREA TRIBUTARY TO** Runoff Area=23,510 sf 5.31% Impervious Runoff Depth=5.46"  
Flow Length=183' Tc=9.4 min CN=86 Runoff=2.98 cfs 0.246 af

**Subcatchment P-2: REMAINING** Runoff Area=9,205 sf 0.00% Impervious Runoff Depth=2.00"  
Flow Length=98' Tc=10.3 min CN=53 Runoff=0.39 cfs 0.035 af

**Reach DP 10: DP 10 - SE CORNER OF PROPERTY** Inflow=2.64 cfs 0.272 af  
Outflow=2.64 cfs 0.272 af

**Pond 1P: SAND FILTER BASIN (SFB)** Peak Elev=27.26' Storage=287 cf Inflow=2.98 cfs 0.246 af  
Outflow=2.97 cfs 0.244 af

**Pond 2P: BIORETENTION AREA** Peak Elev=23.79' Storage=373 cf Inflow=2.97 cfs 0.244 af  
Discarded=0.02 cfs 0.008 af Primary=2.28 cfs 0.236 af Outflow=2.30 cfs 0.244 af

**Total Runoff Area = 0.751 ac Runoff Volume = 0.281 af Average Runoff Depth = 4.49"**  
**96.18% Pervious = 0.722 ac 3.82% Impervious = 0.029 ac**

**VW Wellfleet 6-Post**

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Type III 24-hr 100-Year Rainfall=7.10"

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**Summary for Subcatchment P-1: AREA TRIBUTARY TO SFB**

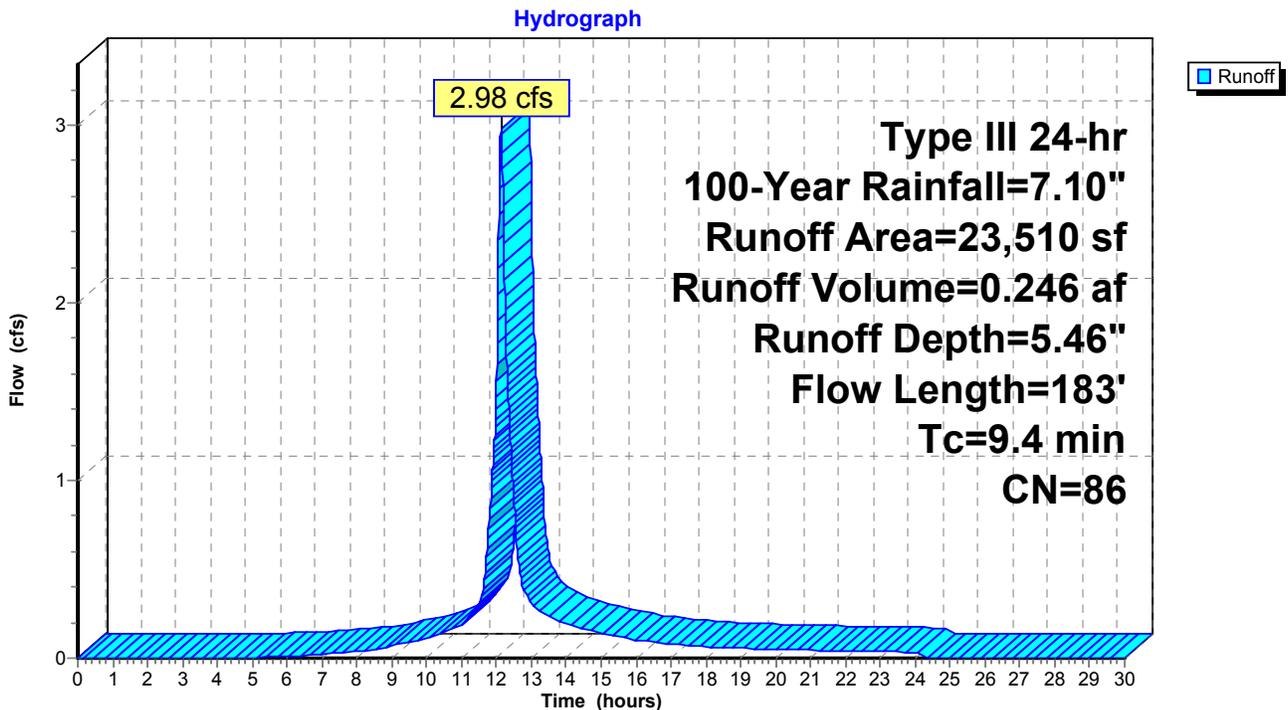
Runoff = 2.98 cfs @ 12.13 hrs, Volume= 0.246 af, Depth= 5.46"

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 100-Year Rainfall=7.10"

Area (sf)	CN	Description
1,249	98	Roofs, HSG A
5,144	49	50-75% Grass cover, Fair, HSG A
17,117	96	Gravel surface, HSG A
23,510	86	Weighted Average
22,261		94.69% Pervious Area
1,249		5.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.6	74	0.0160	0.14		<b>Sheet Flow, Over Gravel A-B</b> Grass: Short n= 0.150 P2= 3.10"
0.8	103	0.0200	2.28		<b>Shallow Concentrated Flow, Over Gravel B-C</b> Unpaved Kv= 16.1 fps
0.0	6	0.3333	4.04		<b>Shallow Concentrated Flow, Vegetated Slope C-D</b> Short Grass Pasture Kv= 7.0 fps
9.4	183	Total			

**Subcatchment P-1: AREA TRIBUTARY TO SFB**



**VW Wellfleet 6-Post**

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Type III 24-hr 100-Year Rainfall=7.10"

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**Summary for Subcatchment P-2: REMAINING POST-CONSTRUCTION TRIBUTARY AREA**

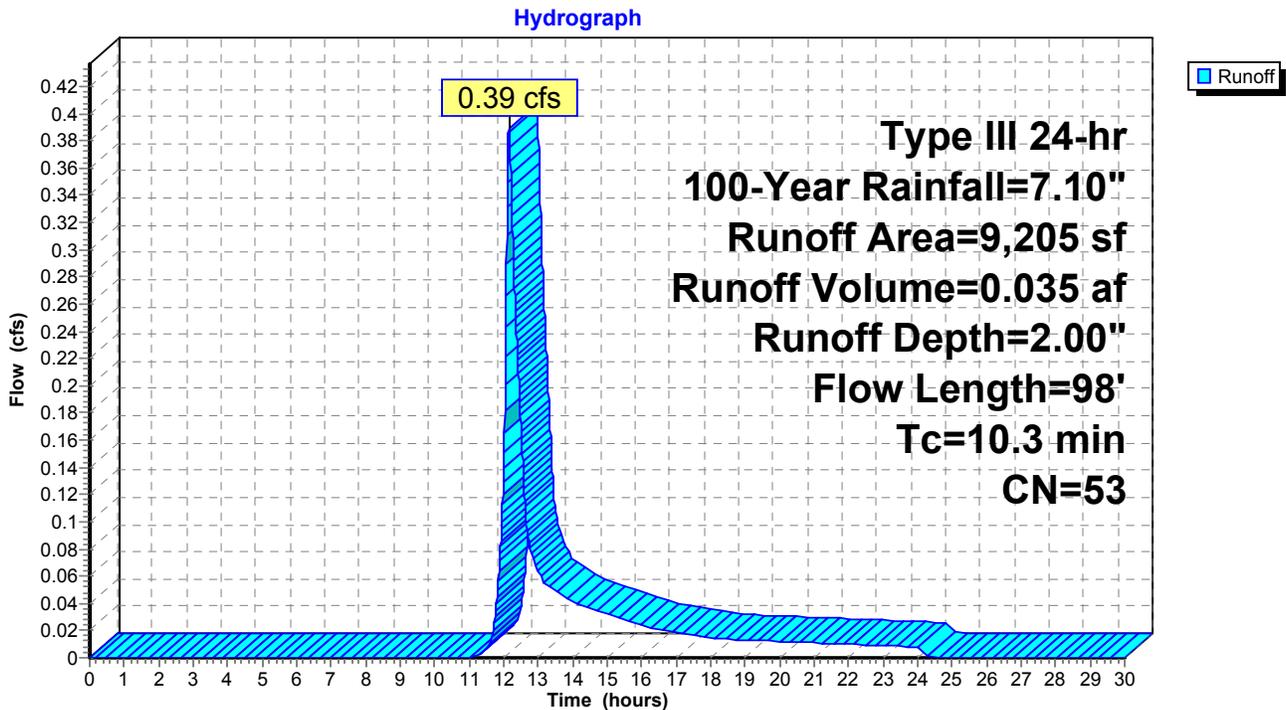
Runoff = 0.39 cfs @ 12.16 hrs, Volume= 0.035 af, Depth= 2.00"

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 100-Year Rainfall=7.10"

Area (sf)	CN	Description
6,357	49	50-75% Grass cover, Fair, HSG A
1,030	96	Gravel surface, HSG A
1,818	43	Woods/grass comb., Fair, HSG A
9,205	53	Weighted Average
9,205		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0	50	0.0050	0.08		<b>Sheet Flow, Over Gravel A-B</b> Grass: Short n= 0.150 P2= 3.10"
0.1	14	0.0600	3.94		<b>Shallow Concentrated Flow, Over Gravel B-C</b> Unpaved Kv= 16.1 fps
0.2	34	0.2500	2.50		<b>Shallow Concentrated Flow, Wooded Area C-D</b> Woodland Kv= 5.0 fps
10.3	98	Total			

**Subcatchment P-2: REMAINING POST-CONSTRUCTION TRIBUTARY AREA**

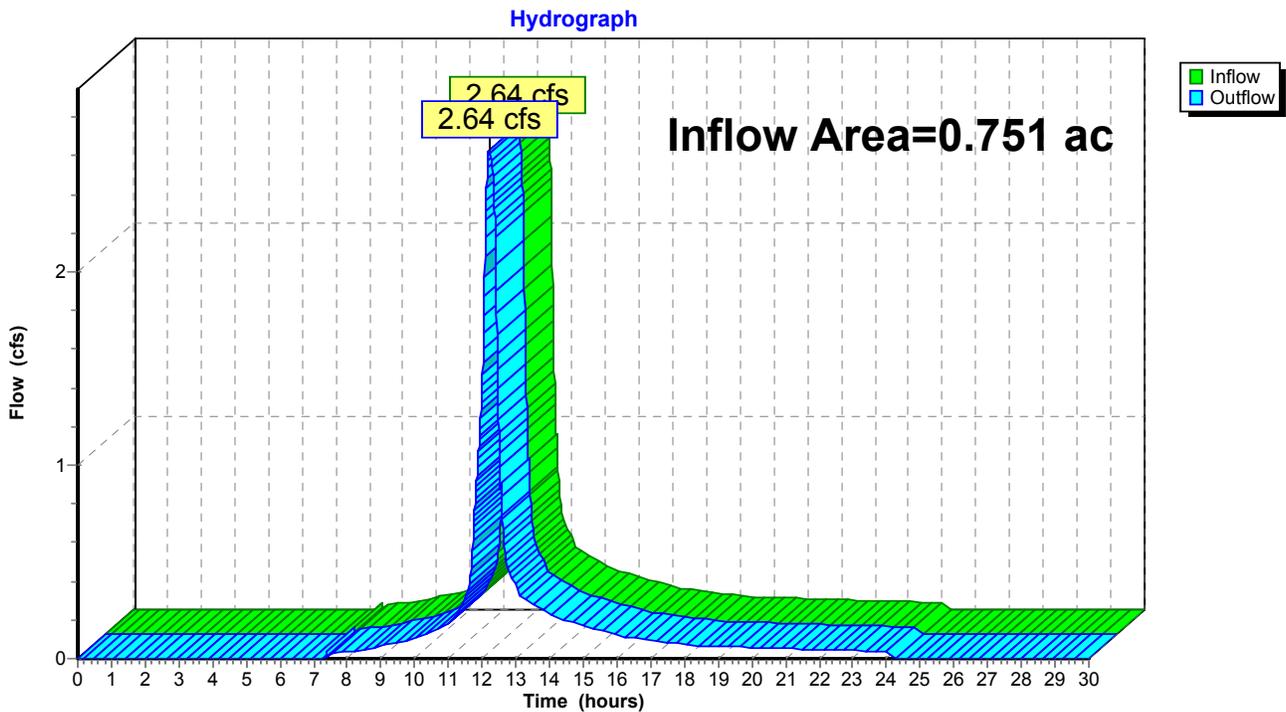


**Summary for Reach DP 10: DP 10 - SE CORNER OF PROPERTY**

Inflow Area = 0.751 ac, 3.82% Impervious, Inflow Depth = 4.34" for 100-Year event  
Inflow = 2.64 cfs @ 12.20 hrs, Volume= 0.272 af  
Outflow = 2.64 cfs @ 12.20 hrs, Volume= 0.272 af, Atten= 0%, Lag= 0.0 min

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

**Reach DP 10: DP 10 - SE CORNER OF PROPERTY**



**VW Wellfleet 6-Post**

Type III 24-hr 100-Year Rainfall=7.10"

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**Summary for Pond 1P: SAND FILTER BASIN (SFB)**

Inflow Area = 0.540 ac, 5.31% Impervious, Inflow Depth = 5.46" for 100-Year event  
 Inflow = 2.98 cfs @ 12.13 hrs, Volume= 0.246 af  
 Outflow = 2.97 cfs @ 12.14 hrs, Volume= 0.244 af, Atten= 0%, Lag= 0.8 min  
 Primary = 2.97 cfs @ 12.14 hrs, Volume= 0.244 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 27.26' @ 12.14 hrs Surf.Area= 638 sf Storage= 287 cf

Plug-Flow detention time= 7.1 min calculated for 0.244 af (99% of inflow)  
 Center-of-Mass det. time= 3.1 min ( 798.0 - 794.9 )

Volume	Invert	Avail.Storage	Storage Description
#1	24.00'	201 cf	<b>4.00'W x 67.00'L x 3.00'H Prismatoid</b> 804 cf Overall x 25.0% Voids
#2	27.00'	278 cf	<b>Custom Stage Data (Prismatic)</b> Listed below (Recalc)
		479 cf	Total Available Storage

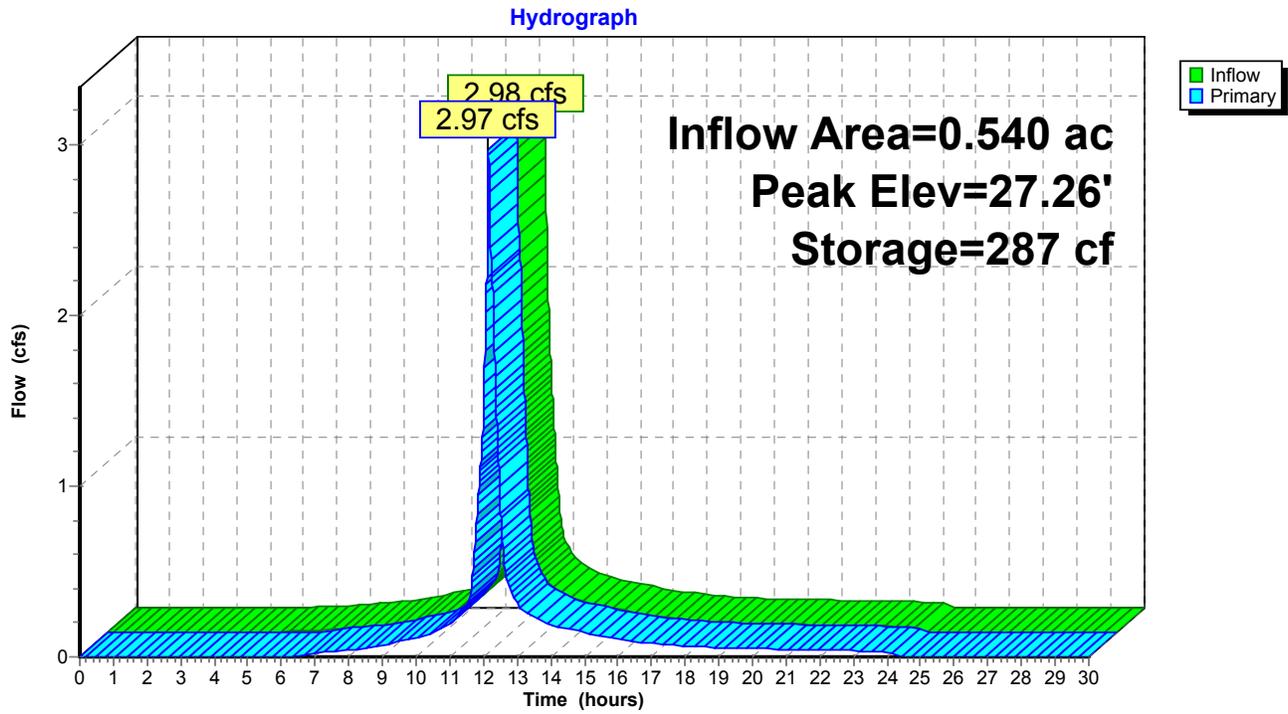
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
27.00	289	0	0
27.70	506	278	278

Device	Routing	Invert	Outlet Devices
#1	Primary	24.00'	<b>8.0" Round Culvert</b> L= 19.3' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 24.00' / 23.81' S= 0.0098 '/' Cc= 0.900 n= 0.013, Flow Area= 0.35 sf
#2	Device 1	25.00'	<b>0.27 cfs Exfiltration X 264.00 when above 25.00'</b>
#3	Primary	27.20'	<b>10.0' long x 6.0' breadth Broad-Crested Rectangular Weir X 2.00</b> Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83

**Primary OutFlow** Max=2.96 cfs @ 12.14 hrs HW=27.26' (Free Discharge)

- 1=Culvert (Inlet Controls 2.27 cfs @ 6.50 fps)
- 2=Exfiltration (Passes 2.27 cfs of 71.28 cfs potential flow)
- 3=Broad-Crested Rectangular Weir (Weir Controls 0.69 cfs @ 0.58 fps)

**Pond 1P: SAND FILTER BASIN (SFB)**



**VW Wellfleet 6-Post**

Type III 24-hr 100-Year Rainfall=7.10"

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**Summary for Pond 2P: BIORETENTION AREA**

Inflow Area = 0.540 ac, 5.31% Impervious, Inflow Depth = 5.43" for 100-Year event  
 Inflow = 2.97 cfs @ 12.14 hrs, Volume= 0.244 af  
 Outflow = 2.30 cfs @ 12.22 hrs, Volume= 0.244 af, Atten= 22%, Lag= 4.9 min  
 Discarded = 0.02 cfs @ 12.11 hrs, Volume= 0.008 af  
 Primary = 2.28 cfs @ 12.22 hrs, Volume= 0.236 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs  
 Peak Elev= 23.79' @ 12.22 hrs Surf.Area= 614 sf Storage= 373 cf

Plug-Flow detention time= 5.7 min calculated for 0.244 af (100% of inflow)  
 Center-of-Mass det. time= 5.3 min ( 803.3 - 798.0 )

Volume	Invert	Avail.Storage	Storage Description
#1	20.50'	165 cf	<b>6.00'W x 44.00'L x 2.50'H Prismaoid</b> 660 cf Overall x 25.0% Voids
#2	23.00'	806 cf	<b>Custom Stage Data (Conic)</b> Listed below (Recalc)
		971 cf	Total Available Storage

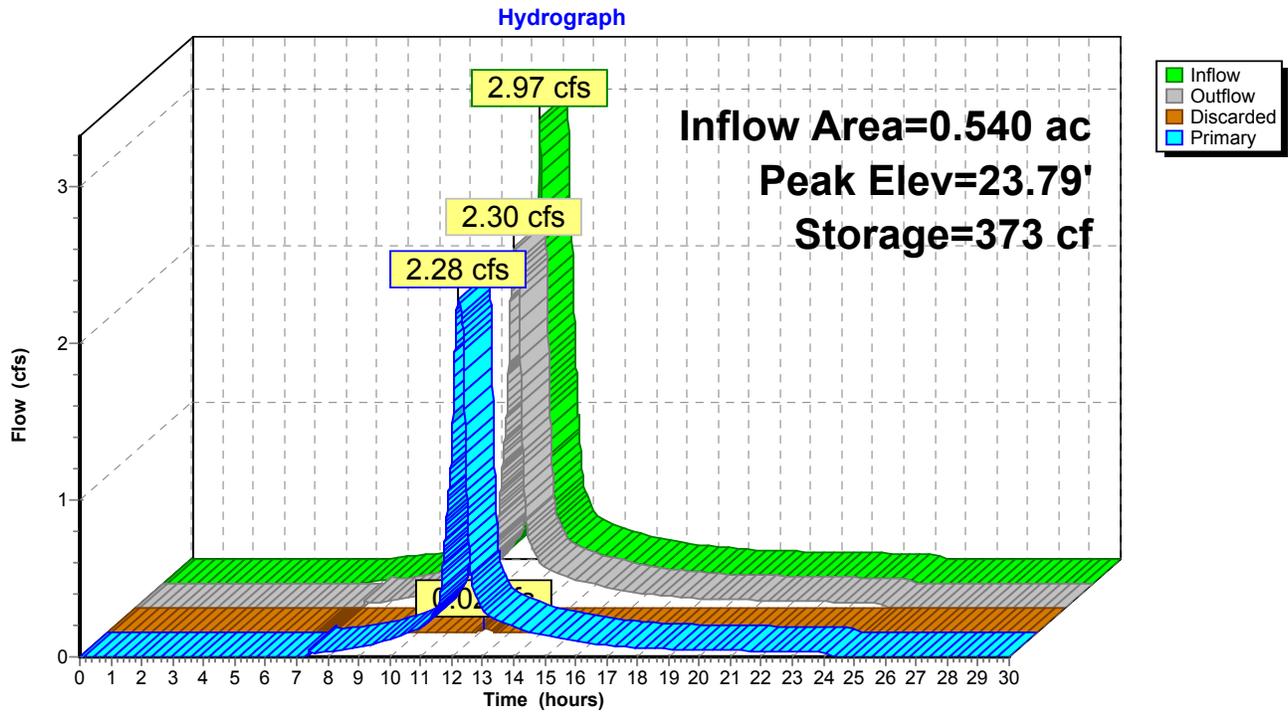
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
23.00	189	0	0	189
24.00	402	289	289	410
25.00	641	517	806	662

Device	Routing	Invert	Outlet Devices
#1	Discarded	20.50'	<b>2.410 in/hr Exfiltration over Wetted area from 20.50' - 23.00'</b> Excluded Wetted area = 264 sf
#2	Primary	20.50'	<b>8.0" Round Culvert</b> L= 39.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 20.50' / 20.11' S= 0.0100 '/ Cc= 0.900 n= 0.013, Flow Area= 0.35 sf
#3	Device 2	24.00'	<b>6.0" Horiz. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 2	21.25'	<b>0.27 cfs Exfiltration X 264.00 when above 21.25'</b>

**Discarded OutFlow** Max=0.02 cfs @ 12.11 hrs HW=23.04' (Free Discharge)  
 ↳1=Exfiltration (Exfiltration Controls 0.02 cfs)

**Primary OutFlow** Max=2.28 cfs @ 12.22 hrs HW=23.78' (Free Discharge)  
 ↳2=Culvert (Inlet Controls 2.28 cfs @ 6.53 fps)  
 ↳3=Orifice/Grate ( Controls 0.00 cfs)  
 ↳4=Exfiltration (Passes 2.28 cfs of 71.28 cfs potential flow)

**Pond 2P: BIORETENTION AREA**



## **Section 4**

---

# ***Stormwater Management Calculations***

## RECHARGE TO GROUNDWATER

The calculation for the *Required Recharge Volume* is done using the equations in the 2008 Massachusetts Stormwater Handbook. The *Required Recharge Volume* equals a depth of runoff corresponding to the soil type times the new impervious areas covering that soil type at the post development site. The *Required Recharge Volume* is based on the *Static* method. The infiltration BMP proposed is a bioretention area.

$Rv = F \times \text{impervious area}$  (Equation 1) Volume 3, Ch 1, page 15

$Rv = \text{Required Recharge Volume}$ , expressed in cubic feet, cubic yards, or acre-feet

$F = \text{Target Depth Factor}$  associated with each Hydrologic Soil Group (HSG)

*Impervious Area* = concrete pads, tower, & shelter roof =

**~1,249 sf (imp% = 1,249 sf/3,249 sf = 38% considering compound only)**

$F$  for A soils = 0.60 inches (Table 2.3.2) Volume 3, Ch 1, page 16

$F$  for B soils = 0.35 inches

$F$  for C soils = 0.25 inches

$F$  for D soils = 0.10 inches

Using the formula above, the following table shows the site's proposed impervious surface area overlying particular Hydrologic Soil Groups and the calculated *Required Recharge Volume*. The NRCS soil report for the site and infiltration BMP location shows coarse sand. The corresponding Hydrologic Soil Group is estimated as HSG A and an  $F$  value of 0.60 inches (or 0.05 feet) was used.

$Rv = F \times \text{impervious area} = 0.05' \times 1,249 \text{ sf} = \mathbf{63 \text{ cf}}$  (A Soils)

The proposed site has all impervious surface stormwater runoff directed to infiltration BMPs near compound area – no adjustment required.

## WATER QUALITY VOLUME

The following calculation summarizes the tributary area and 1" equivalent water quality volume generated. The compound generates runoff for pretreatment by the sand filter basin before discharge to the bioretention area.

WQV = WQD x Impervious Area

WQV = Water Quality Volume

WQD = Water Quality Depth, 0.5" or 1" if critical area

Impervious Area = impervious tributary to treatment train

WQVCompound = 1" / (12"/') x 1249 sf = **104 cf**

Volume provided in sand filter basin above ground = **278 cf** (See HydroCAD Calculations)

**278 cf > 104 cf Therefore OK**

**EVALUATION OF INFILTRATION FEASIBILITY**

**Table 1 – Infiltration Feasibility**

<b>Criteria</b>	<b>Status</b>
Infiltration rate greater than or equal to 0.17 inches/hour	Infiltration rate is estimated at 2.41 inches/hour from Rawl’s Loamy Sand. Record test-hole data associated with the on-site septic system also confirm the infiltration rate; however, it shall confirmed by proxy boring.
Soils have a clay content of less than 20% and a silt/clay content of less than 40%	Coarse sand meets criteria
Infiltration on slopes less than 6%	Bioretention area graded with 0% slope
Bottom of infiltration must be separated at least 2 feet from groundwater	Groundwater estimated at >80” depth from surface based upon NRCS. Trench is limited to 2.5 ft depth to provide 2’ offset with seasonal high gw. Record test-hole data state that gw was not encountered within 12’ below grade. Seasonal gw elevation to be confirmed by subsurface exploration.
Facility located 100 feet from a well	No known wells within 100’
Maximum contributing area less than 5 acres	Tributary Area = 0.54 acres
Setback 20 feet down-gradient from structures	Downgradient of structures.

Determine the required surface area of trench to meet the design constraints.

$$SurfaceArea_{Trench} = \frac{WQv}{(nD + kT / 12)} \quad \text{Maryland Department of Natural Resources 1984}$$

Where:

*WQv = Water Quality Volume = 104 cf > Required Recharge Volume = 63 cf, use 104 cf*

*k = Saturated Hydraulic Conductivity, in/hr = 2.41in/hr*

*T = Fill Time, hours, 2 hours*

*d = Trench Depth, ft, 2.5 feet*

*n = Porosity, 25%*

$$SurfaceArea_{Trench} = \frac{(104)}{(0.25 * 2.5 + 2.41 * 2 / 12" / ')}$$

Surface Area Trench = 102 sf

Available Width = 6 ft

Minimum Length = 17 ft

Length Provided = **44 ft > 17 ft – OK**

Confirm depth to bedrock and groundwater during boring to be conducted for design of tower foundation.

## **BIORETENTION AREA VOLUME AVAILABLE**

Based on calculations from the HydroCAD model, the storage volume for the bioretention area allows 165 cf of stormwater to be infiltrated within the void space and additional storage is available below the top of the berm.

### **Total Storage volume available for Recharge**

Voids in Trench = 44'x6'x2.5' X 25% voids = 165 cf > **63 cf** Rv and **104 cf** WQV - OK

## **DRAWDOWN TIME**

Below are the drawdown time calculations for the subsurface infiltration structure systems proposed on the site. The calculations use *K* values of 2.41 inches per hour as shown on the Rawl's table (Chapter 1 page 22) for Textural Class Loamy Sand in the HydroCAD model.

$$Time_{drawdown} = \frac{V}{(K)(Bottom\ Area)} \quad \text{Volume 3, Ch 1, pages 25}$$

Where:

*V* = Storage Volume \*

*K* = Saturated Hydraulic Conductivity, Rawls Rate

*Bottom Area* = Bottom Area of Recharge Structure

\* The Storage Volume was assumed to be the storage available in the bioretention area with 25% void spaces in the sand.

$$Time_{drawdown} = \frac{(44' \times 6' \times 2.5' \times 25\%)}{(2.41''/12''/')(44' \times 6')}$$

*Time hrs drawdown* = 3.1 hours

Bioretention Area Drain Down Time Calc **4** hrs

Infiltration Trench Drain Down Time Calc @ 2.41 in/hr	<b>4</b>	hrs
Infiltration Trench Drain Down Time Calc @ 1.02 in/hr	<b>8</b>	hrs

The calculations show that the trench will drawdown within the required 72 hours between storm events.

# RIP RAP PAD DESIGN

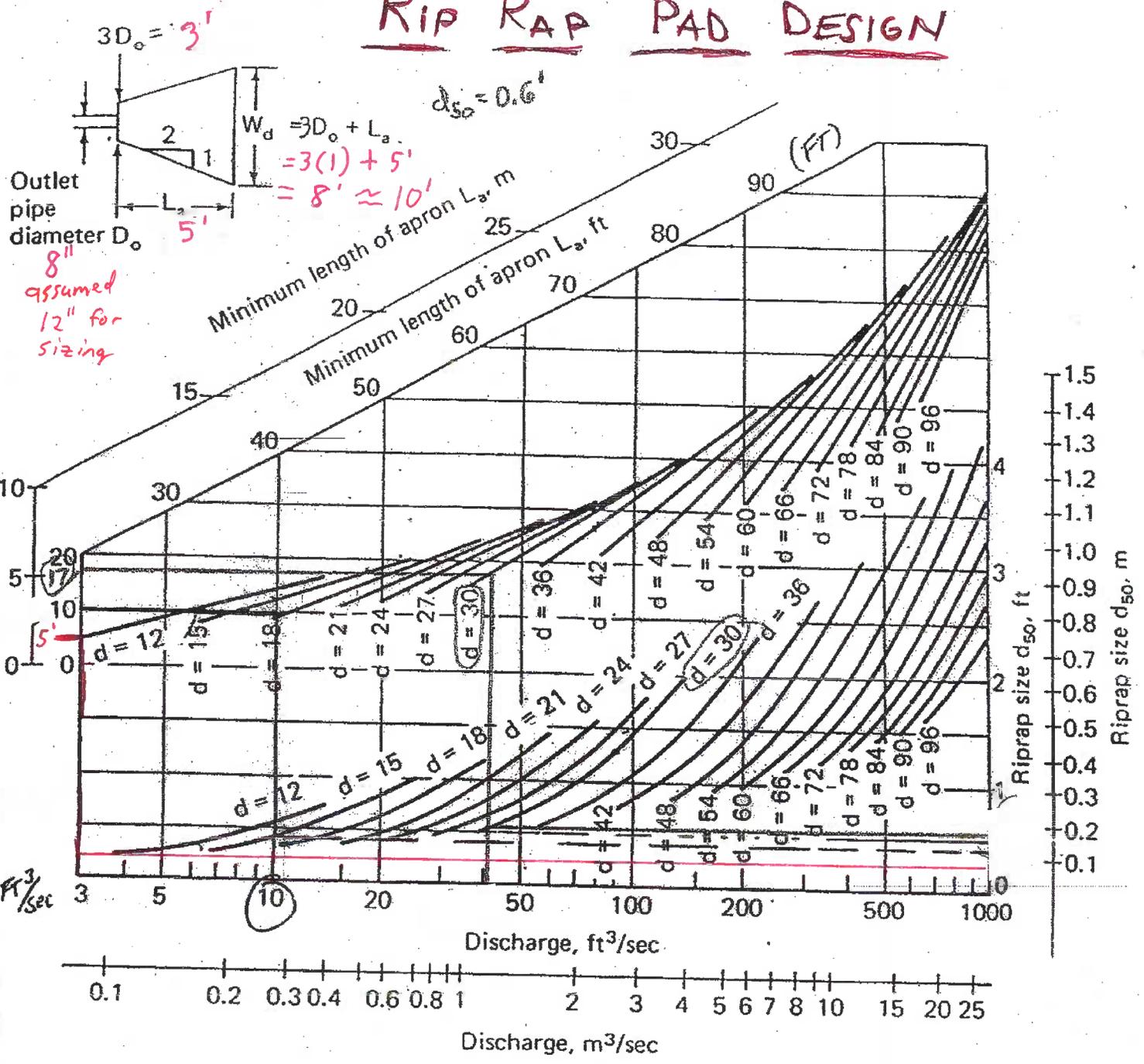
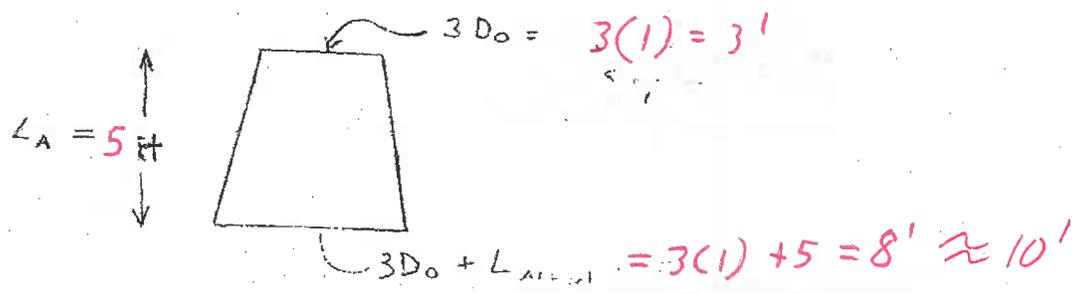


Fig. 7.45 Design of riprap outlet protection from a round pipe flowing full; minimum tailwater conditions. (6, 14)

- Ex.  $Q = 3$  cfs  $2.3$  assumed  $8''$  assumed  
 OUTLET =  $12'' \varnothing$
- a.) By Chart Min. Size Stone =  $0.25$  FT ( $6'' \pm$ )
- b.) Min Length Apron =  $10$  FT



**INSTRUCTIONS:**

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

Version 1, Automated: Mar. 4, 2008

Location: Wellfleet 6 - Tower Compound Runoff

B	C	D	E	F
BMP <sup>1</sup>	TSS Removal Rate <sup>1</sup>	Starting TSS Load*	Amount Removed (C*D)	Remaining Load (D-E)
Sand Filter	0.80	1.00	0.80	0.20
Bioretention Area	0.90	0.20	0.18	0.02
	0.00	0.02	0.00	0.02
	0.00	0.02	0.00	0.02
	0.00	0.02	0.00	0.02

**Total TSS Removal =** 98%

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

Project: Wellfleet 6 (VW-MA-0057)

Prepared By: **BLM**

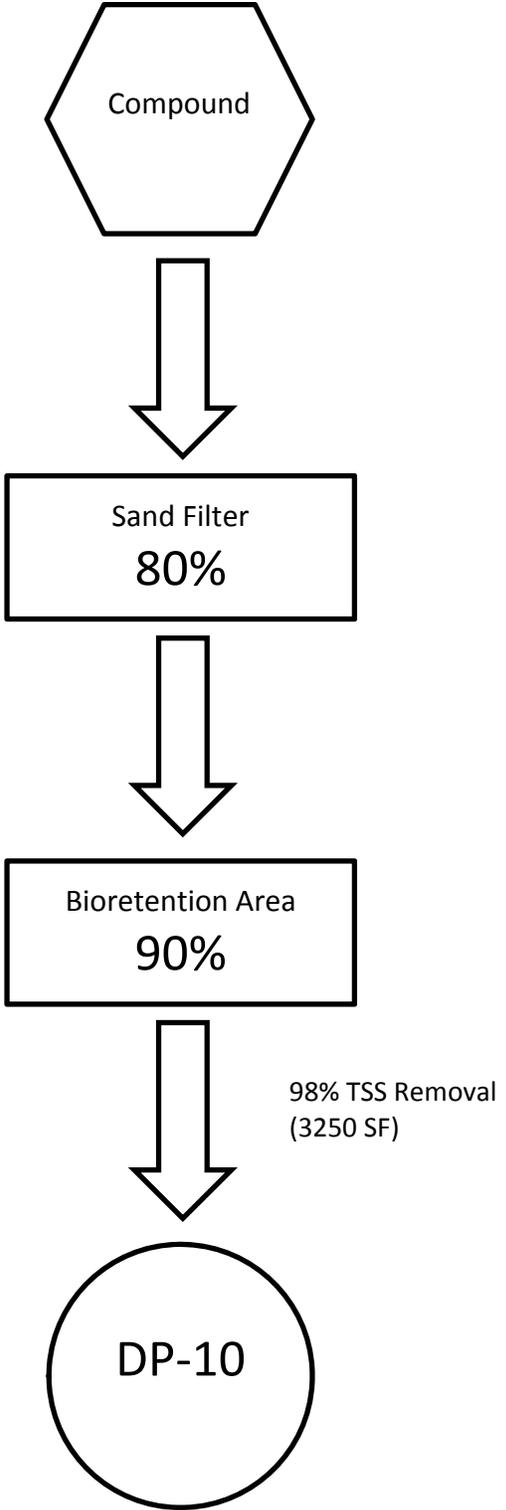
Date: **10/16/2014**

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

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

**BMP TREATMENT TRAIN**

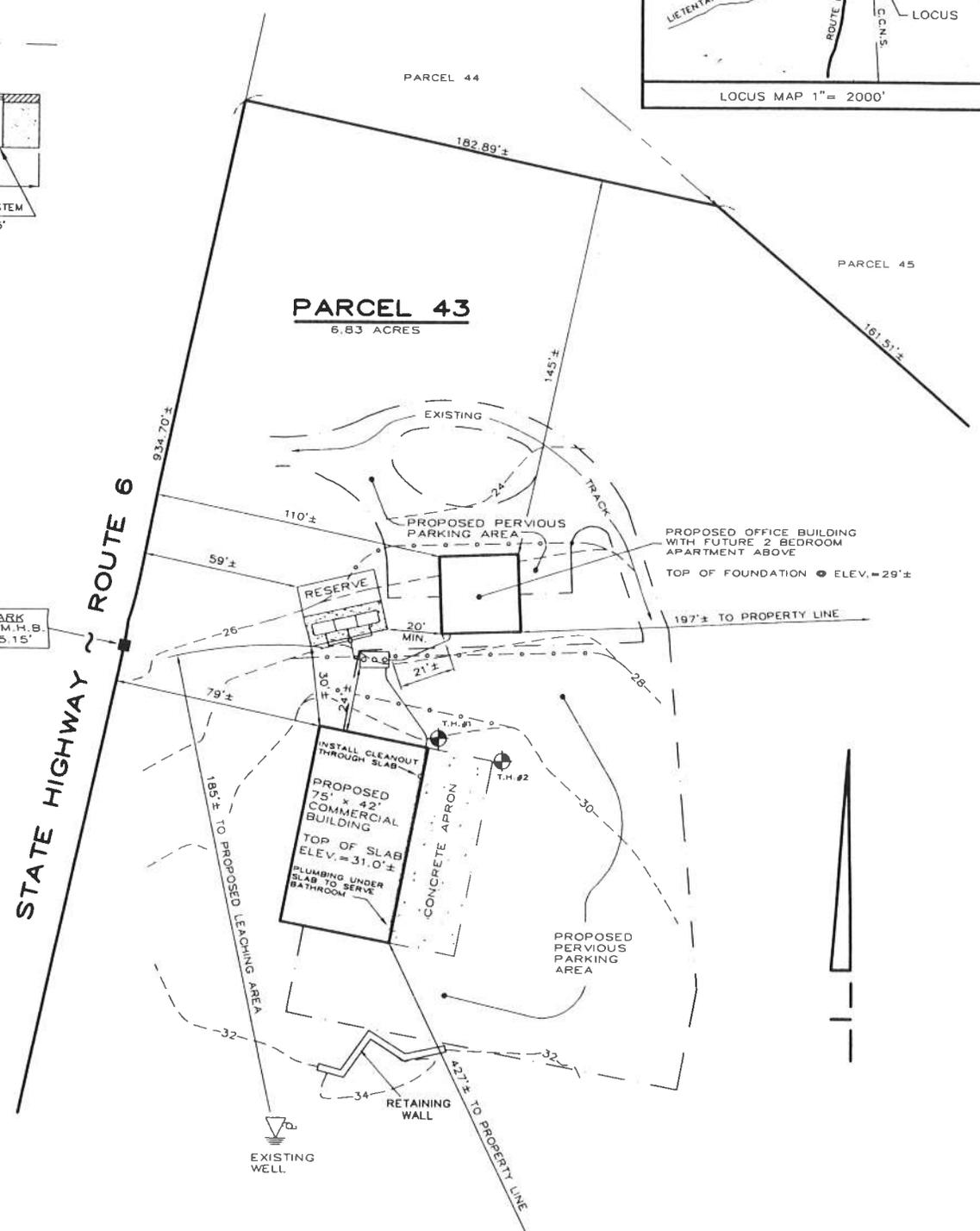
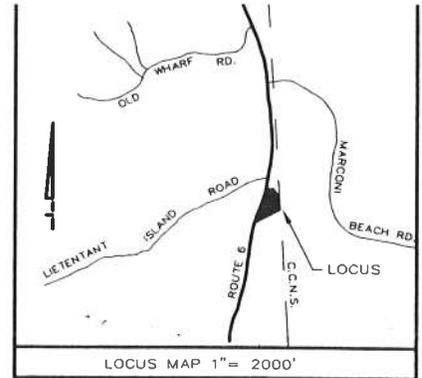
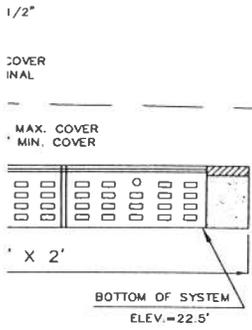


***Section 5***

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***Soil Data***

PROPOSED LEACHING AREA IS TO BE INSTALLED OR IN PART UNDER A PARKING OR DRIVEWAY COMPONENTS ARE TO BE INSTALLED AND A VENT PROVIDED TO THE SURFACE IN ACCORDANCE WITH 310 CMR 15.241.



10/24/01  
DATE

**East Cape Engineering, Inc.**  
CIVIL ENGINEERS  
LAND SURVEYORS  
# 44 Route 28, Orleans, Mass.  
(508) 255-7120

**SITE PLAN  
SEWAGE SYSTEM DESIGN**

LOCUS: 724 ROUTE 6  
WELLFLEET, MA

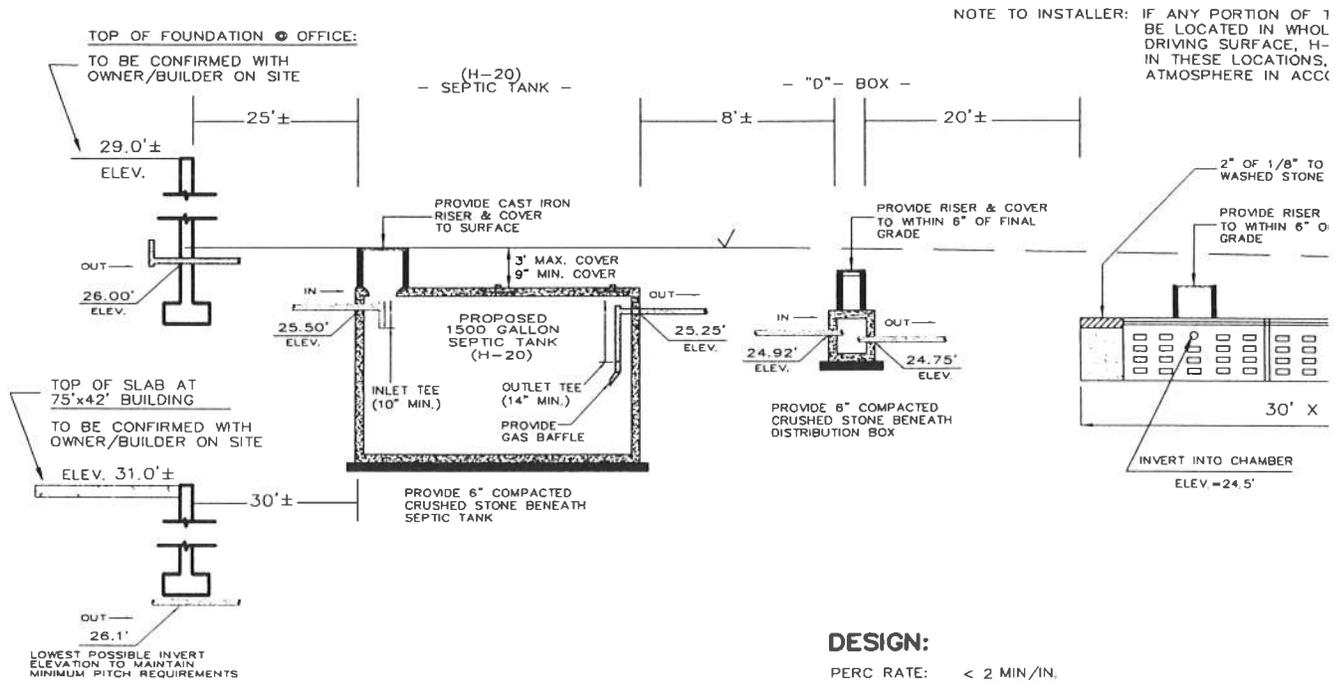
REF: ASSESSOR'S MAP 42, PARCEL 43

PREPARED FOR: CAPE COD DISPOSAL CO.

BOARD OF HEALTH  
WELLFLEET, MA

SCALE: 1" = 30'    DATE: 10/24/01    DWG: 01199SPL  
01-199

# PROFILE OF PROPOSED SYSTEM

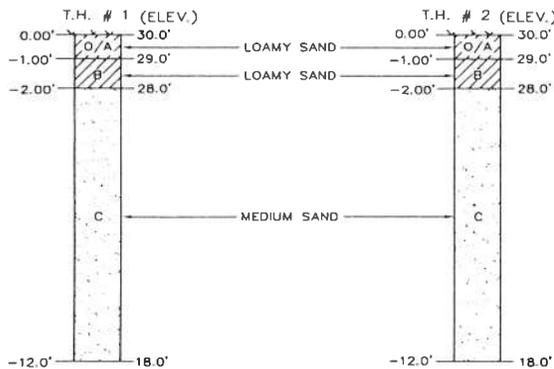


## TEST HOLE LOG

TEST BY CHRISTOPHER S. WICKSON S.E.  
EAST CAPE ENGINEERING, INC.

EMILY BEEBE  
TOWN OF WELLFLEET  
HEALTH DEPARTMENT

TEST DATE 10/15/01



NO WATER ENCOUNTERED

NO WATER ENCOUNTERED

## DESIGN:

PERC RATE: < 2 MIN/IN.

### FLOW RATE COMPUTATIONS

75' x 42' COMMERCIAL BUILDING

USE: INDUSTRIAL PLANT WITHOUT CAFETERIA

5 EMPLOYEES @ 15 GAL./DAY PER EMPLOYEE = 75 G

30' x 30' BUILDING

USE #1: OFFICE SPACE

1000 S.F. @ 75 GAL./1000 S.F. = 75 G

USE #2: FUTURE 2 BEDROOM APARTMENT

110 GAL. PER BEDROOM @ 2 BEDROOMS = 220 G

TOTAL DAILY DESIGN FLOW = 370 G

### SYSTEM COMPONENT SIZING COMPUTATIONS

SEPTIC TANK:  $(370)2 = 740$  G/D

REQ'D SEPTIC TANK SIZE: USE 1500 GAL.

### LEACH FACILITY:

SIDEWALL:  $2(30+12)(2) = 168$ S.F.  $(0.74) = 124$  G/D

BOTTOM:  $(30)(12) = 360$ S.F.  $(0.74) = 266$  G/D

TOTAL: 528S.F. 390 G/D

USE: 500 GALLON LEACHING DRYWELLS WITH 3/4" TO 1-1/2" DOUBLE WASHED STONE TO EFFECTIVE SIZE 30 X 12' X 2'.

ALTERNATE- USE (8'X4'X1') FLOW DIFFUSERS WITH 3/4" TO 1-1/2" DOUBLE WASHED STONE TO EFFECTIVE SIZE 30' X 12' X 2'.

ALTERNATE- USE INFILTRATOR MODEL 3050 LEACHING CHAMBERS WITH 3/4" TO 1-1/2" DOUBLE WASHED STONE TO EFFECTIVE SIZE 30' X 12' X 2'.

## NOTES:

- DATUM (MSL)± TAKEN FROM WELLFLEET QUADRANGLE MAP
- MUNICIPAL WATER IS NOT AVAILABLE
- PIPE PITCH: 1/8" PER FOOT MINIMUM
- DESIGN LOADING FOR ALL PRE-CAST UNITS: AASHTO-H-10-44, H-20-44 WHERE VEHICLE LOADS ARE ANTICIPATED OR WHEN SUBJECT TO 4 FT. OR MORE OF COVER.
- MINIMUM GROUND COVER OVER ALL SEWAGE LEACHING FACILITIES: (0.75) FT.
- THIS DESIGN DOES NOT PROVIDE FOR THE INSTALLATION OF GARBAGE GRINDERS.
- ALL UNSUITABLE MATERIAL WITHIN 5 FT. IN ALL DIRECTIONS FROM THE LEACHING FACILITY SHALL BE REMOVED & REPLACED WITH CLEAN, MEDIUM SAND.
- CONSTRUCTION DETAILS TO BE IN ACCORDANCE WITH COMM. OF MASS. STATE ENVIRONMENTAL CODE TITLE 5.
- CONTRACTOR TO NOTIFY DIG-SAFE PRIOR TO CONSTRUCTION. (1-888-DIG-SAFE)
- NO KNOWN WELLS EXIST WITHIN 100' OF PROPOSED LEACHING AREA.
- NO KNOWN SEPTIC SYSTEM EXIST WITHIN 100' OF EXISTING WELL.
- THIS SITE PLAN IS INTENDED FOR SEWAGE SYSTEM DESIGN PURPOSES ONLY. UNDER NO CIRCUMSTANCES ARE BEARINGS, DISTANCES, OR FEATURES SHOWN TO BE USED TO ESTABLISH PROPERTY LINES.

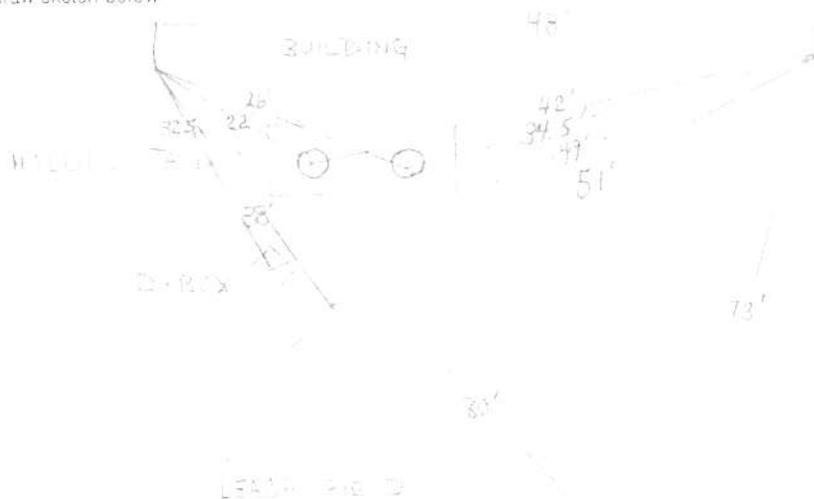
*Timothy J. Brady*  
TIMOTHY J. BRADY P.E., A.S.

APPROVED \_\_\_\_\_ DATE \_\_\_\_\_

TOWN OF WELFLEET  
AS-BUILT CARDS

STREET ADDRESS: 724 RT 6 LOT # 25  
OWNER'S NAME: DONALD HORTON PERMIT NO 04-79  
INSTALLER: ROBERT B OUK CO. DATE INSTALLED: 12/03/04  
INSPECTOR: EM DATE INSPECTED: 12/16/04

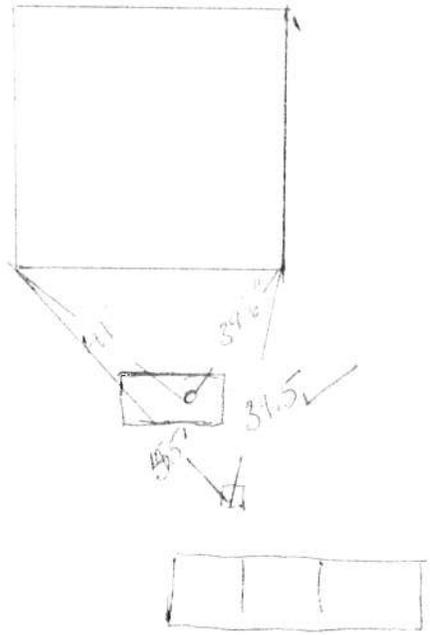
\*Please draw sketch below



TOWN OF WELLFLEET  
AS-BUILT CARDS

STREET ADDRESS 724 RT 6 LOT # P 43  
OWNER'S NAME Douglas Horton PERMIT NO \_\_\_\_\_  
INSTALLER Murphy-Rickerson DATE INSTALLED 12/2/02  
INSPECTOR EM DATE INSPECTED 12/17/02

\*Please draw sketch below.





United States  
Department of  
Agriculture

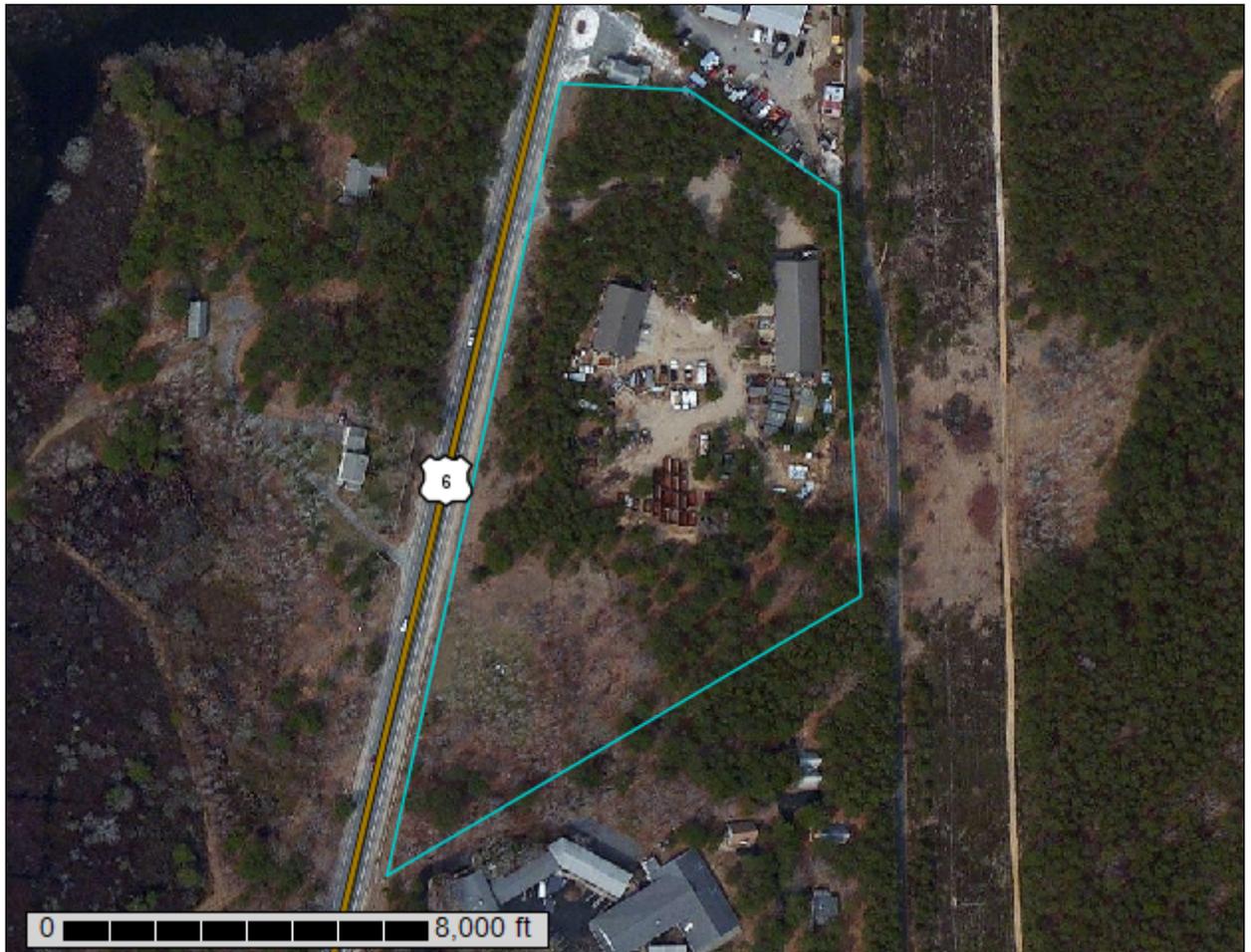
**NRCS**

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 Barnstable County, Massachusetts

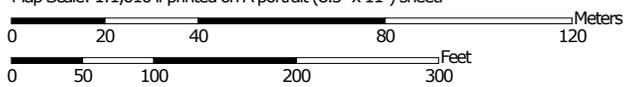
## Varsity Wireless - Wellfleet 6



# Custom Soil Resource Report Soil Map



Map Scale: 1:1,610 if printed on A portrait (8.5" x 11") sheet.



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

## MAP INFORMATION

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

**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: <http://websoilsurvey.nrcs.usda.gov>  
 Coordinate System: Web Mercator (EPSG:3857)

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

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

Soil Survey Area: Barnstable County, Massachusetts  
 Survey Area Data: Version 10, Dec 5, 2013

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

Date(s) aerial images were photographed: Mar 30, 2011—Oct 8, 2011

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 LEGEND

 Area of Interest (AOI)	 Spoil Area
 Soil Map Unit Polygons	 Stony Spot
 Soil Map Unit Lines	 Very Stony Spot
 Soil Map Unit Points	 Wet Spot
 Special Point Features	 Other
 Blowout	 Special Line Features
 Borrow Pit	<b>Water Features</b>
 Clay Spot	 Streams and Canals
 Closed Depression	<b>Transportation</b>
 Gravel Pit	 Rails
 Gravelly Spot	 Interstate Highways
 Landfill	 US Routes
 Lava Flow	 Major Roads
 Marsh or swamp	 Local Roads
 Mine or Quarry	<b>Background</b>
 Miscellaneous Water	 Aerial Photography
 Perennial Water	
 Rock Outcrop	
 Saline Spot	
 Sandy Spot	
 Severely Eroded Spot	
 Sinkhole	
 Slide or Slip	
 Sodic Spot	

## Map Unit Legend

Barnstable County, Massachusetts (MA001)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
252B	Carver coarse sand, 3 to 8 percent slopes	6.7	100.0%
<b>Totals for Area of Interest</b>		<b>6.7</b>	<b>100.0%</b>

## 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.

## Custom Soil Resource Report

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.

## Barnstable County, Massachusetts

### 252B—Carver coarse sand, 3 to 8 percent slopes

#### Map Unit Setting

*National map unit symbol:* 98qd  
*Elevation:* 0 to 1,000 feet  
*Mean annual precipitation:* 37 to 50 inches  
*Mean annual air temperature:* 45 to 55 degrees F  
*Frost-free period:* 120 to 240 days  
*Farmland classification:* Not prime farmland

#### Map Unit Composition

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

#### Description of Carver

##### Setting

*Landform:* Outwash plains  
*Landform position (two-dimensional):* Shoulder  
*Landform position (three-dimensional):* Riser  
*Down-slope shape:* Convex  
*Across-slope shape:* Convex  
*Parent material:* Sandy glaciofluvial deposits; loose sandy glaciofluvial deposits

##### Typical profile

*H1 - 0 to 7 inches:* coarse sand  
*H2 - 7 to 17 inches:* coarse sand  
*H3 - 17 to 64 inches:* coarse sand

##### Properties and qualities

*Slope:* 3 to 8 percent  
*Depth to restrictive feature:* More than 80 inches  
*Natural drainage class:* Excessively drained  
*Runoff class:* Very low  
*Capacity of the most limiting layer to transmit water (Ksat):* Very high (20.00 to 99.90 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water storage in profile:* Low (about 3.0 inches)

##### Interpretive groups

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

#### Minor Components

##### Hinckley

*Percent of map unit:* 6 percent

##### Merrimac

*Percent of map unit:* 6 percent

## Custom Soil Resource Report

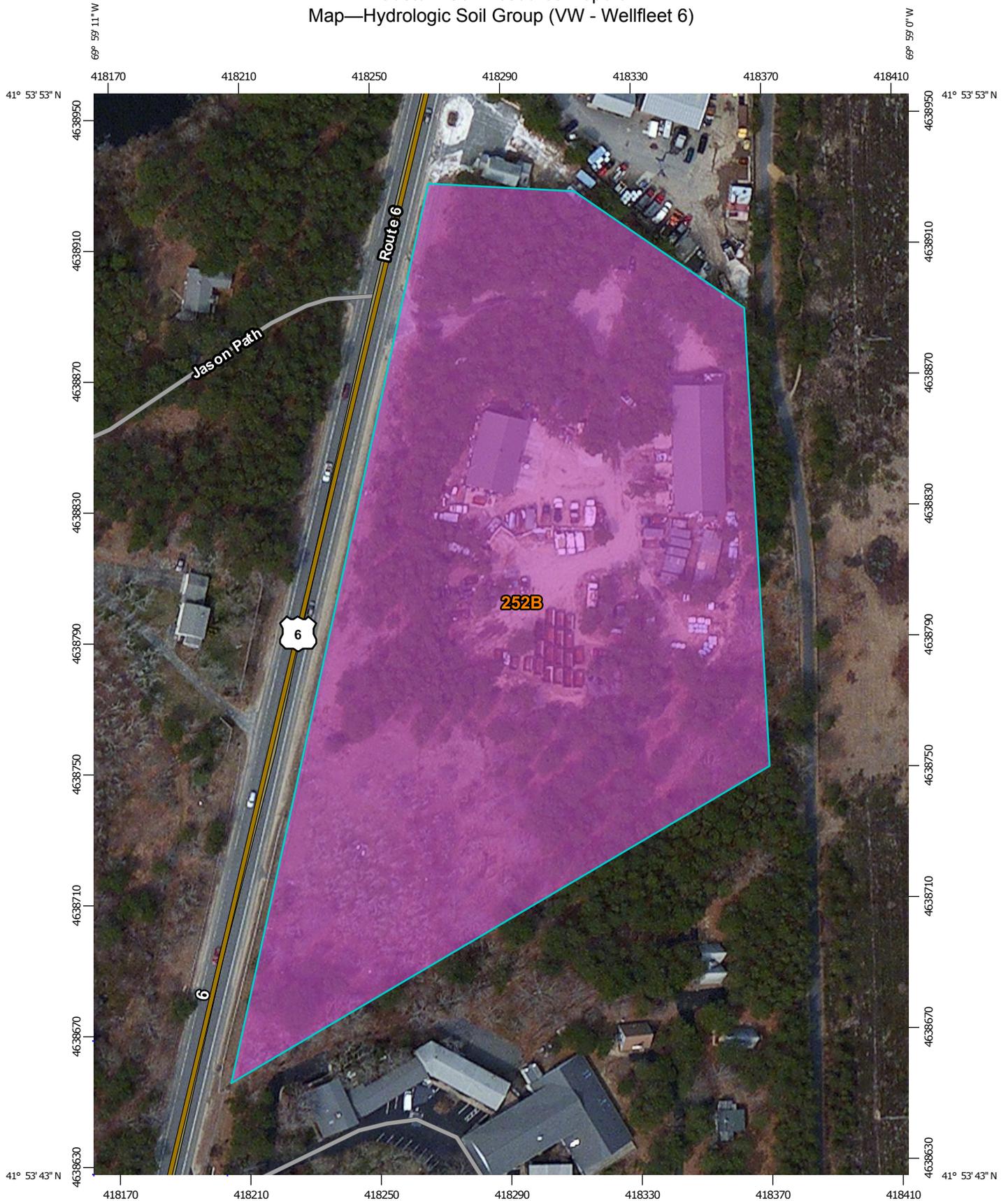
### **Eastchop**

*Percent of map unit: 4 percent*

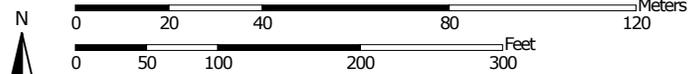
### **Enfield**

*Percent of map unit: 4 percent*

Custom Soil Resource Report  
Map—Hydrologic Soil Group (VW - Wellfleet 6)



Map Scale: 1:1,610 if printed on A portrait (8.5" x 11") sheet.



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

## MAP INFORMATION

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

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

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

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Soil Survey Area: Barnstable County, Massachusetts  
 Survey Area Data: Version 10, Dec 5, 2013

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

Date(s) aerial images were photographed: Mar 30, 2011—Oct 8, 2011

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 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

**Table—Hydrologic Soil Group (VW - Wellfleet 6)**

Hydrologic Soil Group— Summary by Map Unit — Barnstable County, Massachusetts (MA001)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
252B	Carver coarse sand, 3 to 8 percent slopes	A	6.7	100.0%
<b>Totals for Area of Interest</b>			<b>6.7</b>	<b>100.0%</b>

**Rating Options—Hydrologic Soil Group (VW - Wellfleet 6)**

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff:* None Specified

*Tie-break Rule:* Higher

**Water Features**

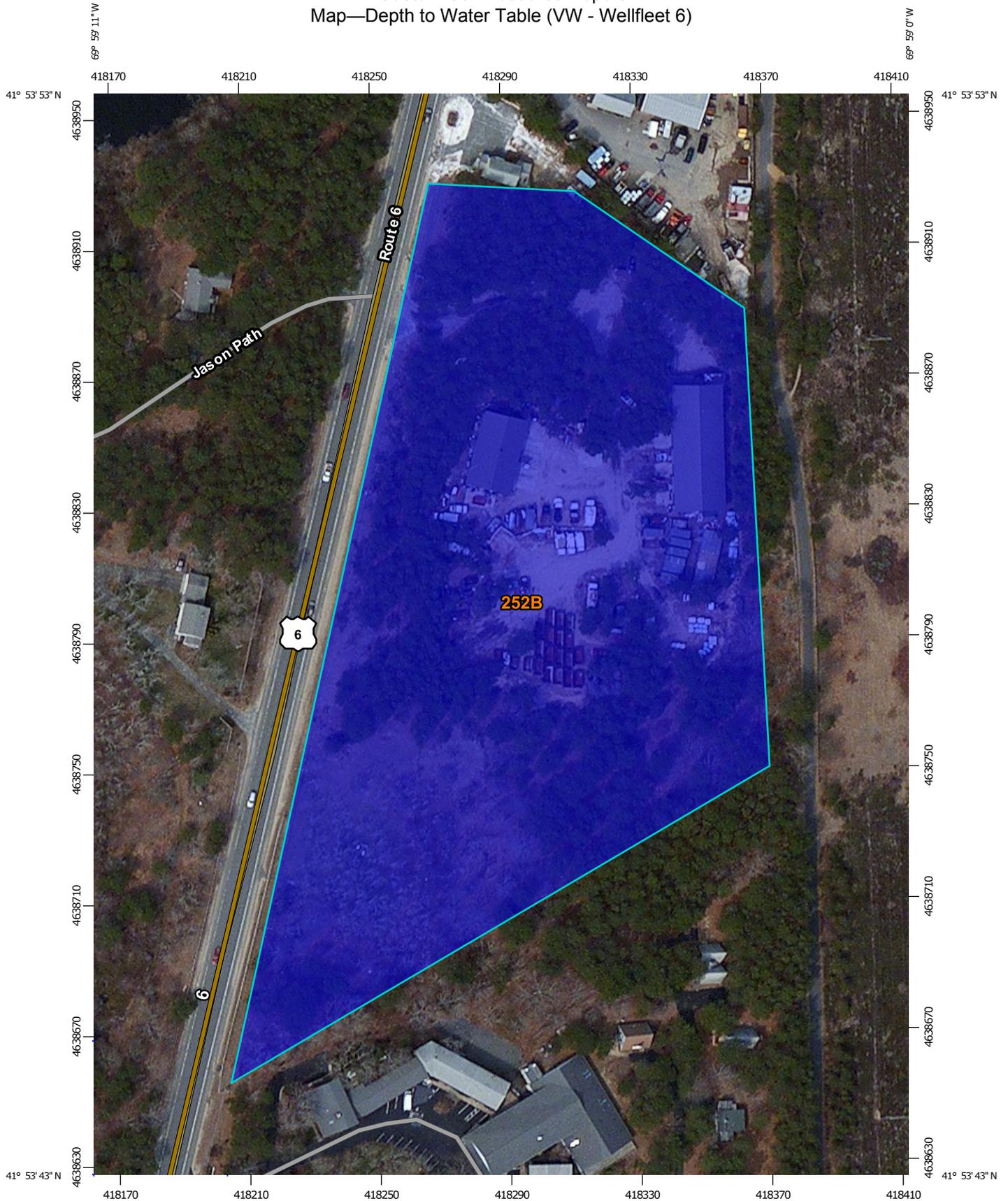
Water Features include ponding frequency, flooding frequency, and depth to water table.

**Depth to Water Table (VW - Wellfleet 6)**

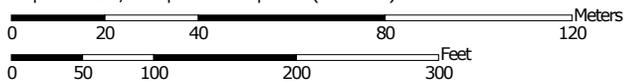
"Water table" refers to a saturated zone in the soil. It occurs during specified months. Estimates of the upper limit are based mainly on observations of the water table at selected sites and on evidence of a saturated zone, namely grayish colors (redoximorphic features) in the soil. A saturated zone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

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

Custom Soil Resource Report  
Map—Depth to Water Table (VW - Wellfleet 6)



Map Scale: 1:1,610 if printed on A portrait (8.5" x 11") sheet.



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

## MAP INFORMATION

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Date(s) aerial images were photographed: Mar 30, 2011—Oct 8, 2011

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 LEGEND

Area of Interest (AOI)  Not rated or not available

Area of Interest (AOI)

Soils

Soil Rating Polygons

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Lines

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200
- Not rated or not available

Soil Rating Points

- 0 - 25
- 25 - 50
- 50 - 100
- 100 - 150
- 150 - 200
- > 200

Water Features

Streams and Canals

Transportation

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

Background

Aerial Photography

**Table—Depth to Water Table (VW - Wellfleet 6)**

<b>Depth to Water Table— Summary by Map Unit — Barnstable County, Massachusetts (MA001)</b>				
<b>Map unit symbol</b>	<b>Map unit name</b>	<b>Rating (centimeters)</b>	<b>Acres in AOI</b>	<b>Percent of AOI</b>
252B	Carver coarse sand, 3 to 8 percent slopes	>200	6.7	100.0%
<b>Totals for Area of Interest</b>			<b>6.7</b>	<b>100.0%</b>