STORMWATER MANAGEMENT REPORT

Common Driveway
at 105 Vaughn Hill Rd.
Bolton, MA

October 19, 2017

Prepared For:
Whitehorse Builders
456 Newtown Rd.
Littleton, MA 01460

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1.0 Project Narrative

1.1 Site Description

The site is located on Vaughn Hill Road in Bolton, MA, owned by Ruth E. Danon. The site is approximately 10.7 acres, currently listed as Assessor's Map 7.B, Parcel 36, as shown on the Town of Bolton on-line GIS, and lies within the Residential Zoning District.

The site is currently developed with a house and gravel driveway.The watershed area consists of a mix of wooded upland.

The site is sloped from east to west, at approximately 10 to 15 %.

There are no known wetland areas on the site.

The on-site soils include two main types: Chatfield-Hollis Rock complex (Hydrologic Group 'D') and Paxton (Hydrologic Group 'C').

1.2 Project Description

The proposed project includes the construction of three houses, a common driveway and associated utilities, including on-site sewage disposal systems.

To mitigate developmental impacts, drainage devices have been incorporated into the design. They include roadside swales, a detention basin and limited site clearing. These fulfill the requirements of Massachusetts DEP Stormwater Policy and the Town of Bolton Stormwater requirements.

The proposed open detention basin would provide control of runoff going toward the existing roadway, as well as water quality control, removing silt and sediment.

The peak flows were calculated for the 10-year storm events under existing and proposed conditions.

2.0 Methodology

2.1 Hydrologic Model Description - Software

The drainage analysis was performed using the Soil Conservation Service (SCS) TR-55 and TR-20 methodologies and the computer program HydroCAD v10 by *HydroCAD Software Solutions, LLC.*

2.2 Design Storms

In accordance with the Town of Bolton Common Driveway requirements, the analysis was performed on the 10-year frequency rainfall events. The events were based on the 24-hour Type-III duration storm.

2.3 Time of Concentration

The 'time of concentration' (T_c) for each watershed was determined by finding the time necessary for runoff to travel from the most hydraulically distant point in the watershed to the point of concentration. The travel path was drawn based on the topography and the time was calculated using the TR-55 Method and HydroCAD. A minimum T_c of 6.0 minutes was used.

2.4 Curve Numbers

Curve numbers were developed for each of the different use categories and hydrologic soil group types within each sub-area. The curve numbers were based on the SCS TR-55 methodology and are included in the HydroCAD input and output found in the Attachments.

2.5 Rainfall Depth

Rainfall depths were acquired from Technical Paper 40, "The Rainfall Frequency Atlas of the United States". Rainfall events for the 2, 10 and 100-year storms were analyzed.

The rainfall depth for Worcester County, Massachusetts was used in the calculations:

Storm Event	**Rainfall Depth**
10-Year	4.5 - inches

3.0 Pollution Prevention and Erosion Controls

Construction period pollution prevention and erosion and sedimentation control measures will be implemented at the project site to control construction related impacts during construction and land disturbance activities. The general contractor for the project will be responsible for implementation of the construction period controls.

The project will disturb more than one acre of land during the construction process and will therefore require a NPDES Construction General Permit issued by the Environmental Protection Agency, as well as a local Stormwater Management Permit issued by the Town of Westford.

Erosion and sedimentation controls will be employed to prevent the erosion and transport of sediment into resource areas during the earthwork and construction phases of the project. Erosion and sedimentation control measures will be installed prior to site excavation or disturbance and will be maintained throughout the construction period.

Below is a description of some of the erosion and sediment control measures that will be employed at the project.

Silt Fence and Straw Wattles

Prior to any ground disturbance, a professional engineer or land surveyor will confirm that a barrier of staked straw wattles and silt fence is in place at the down gradient limit of work in accordance with the site plan. The barrier will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site. The silt fence is a semi-permeable barrier made of a synthetic porous fabric which provides additional protection when used with straw wattles. When necessary, additional silt fence barriers will be installed immediately down gradient of erosion-prone areas, such as the base of steep exposed slopes and around the base of stockpiles, throughout the construction phase of the project. The barriers will be entrenched into the substrate to prevent underflow.

The erosion control barriers will be inspected weekly and after every storm event. Any sediment that collects behind the barriers will be removed and will be either reused at the site or disposed of at a suitable offsite location. Any damaged sections of silt fence or wattles will be repaired or replaced. The underside of the straw wattles will be kept in close contact with the earth and reset as necessary. Straw wattles and silt fences will be maintained and cleaned until slopes have healthy stands of grass.

Dust Control

Fugitive dust from large areas of unstabilized soil can be a problem during construction. On dry and windy days when dust generation is a concern, a water truck will traverse the site and spray water as necessary to prevent dust from forming.

Slope Stabilization

The smallest practicable area of land will be exposed at a time. A temporary vegetative cover will be established on areas of exposed soils (including stockpiles) that remain inactive and unstabilized for a period of more than 30 days for slopes, and in the case of inclement weather. The seeded surfaces will be covered with a layer of hay mulch or hydro mulch.

Upon completion of final grading, any areas not covered by pavement, other forms of stabilization, or other methods of landscaping, will be seeded with an erosion control seed mix. On slopes 4:1 and steeper, loamed and seeded areas will be mulched with hay to prevent erosion prior to germination of the seed. After disturbed areas have been stabilized, the temporary erosion control measures will be removed and accumulated sediment will be removed and disposed of to an appropriate location.

MATERIAL MANAGEMENT PRACTICES

The following material management practices will be used to reduce the risk of spills or other accidental exposure of materials and substances to stormwater runoff. These include good housekeeping practices and guidelines for the handling of hazardous products. The following good housekeeping practices will be followed on-site during the construction period:

- An effort will be made to store only enough product required to do the job.
- All materials stored on-site will be stored in a neat, orderly manner in their appropriate containers, and (if possible) under a roof or other enclosure.
- Products will be kept in their original containers with the original manufacturer's label.
- Substances will not be mixed with one another unless recommended by the manufacturer.
- Whenever possible, all of a product will be used before disposing of the container.
- Manufacturer's recommendations for proper use and disposal will be followed.
- The site superintendent will inspect the storage area daily to ensure proper use and disposal of materials on-site.

Hazardous Products:

These practices will be used to reduce the risks associated with hazardous materials. Material Safety Data Sheets (MSDS) for each substance with hazardous properties that is used on the job site will be obtained and used for the proper management of potential wastes that may result from these products. An MSDS will be posted in the immediate area where such product is used and another copy of each MSDS will be maintained in the SWPPP file at the job site construction trailer office. Hazardous fuels or other potential contaminants shall not be stored on site. Each employee who must handle a substance with hazardous properties will be instructed on the use of MSDS sheets and the specific information in the applicable MSDS for the product they are using, particularly regarding spill control techniques.

- Products will be kept in original containers unless they are not re-sealable
- Original labels and material safety data will be retained; they contain important product information
- If surplus product must be disposed of, manufacturer's or local and State recommended methods for proper disposal will be followed.

Hazardous Waste

All hazardous waste material will be disposed of by the Contractor in the manner specified by local, state, and/or federal regulations and by the manufacturer of such products. Site personnel will be instructed in these practices by the job site superintendent, who will also be responsible for seeing that these practices are followed.

Solid and Construction Wastes

All waste materials will be collected and stored in accordance with state and federal law in an appropriately covered container and/or securely lidded metal dumpster.

All trash and construction debris from the site will be transported off site. No construction waste materials will be buried on site. All personnel will be instructed regarding the correct procedures for waste disposal.

Sanitary Wastes

All sanitary waste will be collected from the portable units as required to maintain proper operation and sanitary conditions of these units. All maintenance work on portable sanitation units shall be performed by a licensed portable facility provider in complete compliance with local and state regulations.

All sanitary waste units will be located in an area where the likelihood of the unit contributing to storm water discharges is negligible. If required, additional BMPs must be implemented, such as sandbags around the base, to prevent wastes from contributing to storm water discharges.

PRODUCT SPECIFIC PRACTICES

The following product-specific practices will be followed on-site. Recommendations are provided for petroleum products, fertilizers, solvents, paints, and other hazardous substances.

Petroleum Products

All on-site vehicles will be monitored for leaks and will receive regular preventive maintenance to reduce the chance of leakage. Petroleum products will be stored in tightly sealed containers that are clearly labeled. Any asphalt substances used on-site will be applied according to manufacturer's recommendations.

Fertilizers

Fertilizers will be applied only in the minimal amounts recommended by the manufacturer. Once applied, the fertilizer will be worked into the soil to limit exposure to stormwater. Storage will be in a covered area; and the contents of any partially used bags will be transferred to a sealable, plastic bin to avoid spills.

Solvents, Paints, and other Hazardous Substances

All containers will be tightly sealed and stored when not required for use. Excess materials will not be discharged to the storm sewer system, but will be properly disposed of according to manufacturer's instructions or state and local regulations. No storage will occur within 100 feet of a resource area.

SPILL CONTROL/NOTIFICATION PRACTICES

In addition to the good housekeeping and material management practices discussed above, the following practices will be followed for spill control, notification and cleanup.

- Manufacturer's recommended methods for spill cleanup will be clearly posted and site personnel will be informed of the procedures and the location of the information and cleanup supplies.
- Materials and equipment necessary for spill cleanup will be kept in the material storage area on-site. Equipment and materials will include, but will not be limited to: Shovels, wheel

barrows, brooms, dust pans, mops, rags, gloves, goggles, kitty litter or Speedi-Dry, sand, sawdust, and plastic and metal trash containers specifically designated for this purpose.

- All spills will be cleaned up immediately after discovery.
- The spill area will be kept well ventilated and personnel will wear protective clothing to prevent injury from contact with a hazardous substance.
- Spills of toxic or hazardous material in excess of reportable quantities, as established in the Massachusetts Contingency Plan (MCP), will be reported to the Massachusetts Department of Environmental Protection Division of Hazardous Waste [(617) 292-5851 or (978) 661-7679].
- The construction superintendent responsible for the daily operations will be the spill prevention and cleanup coordinator. He will designate at least three other site personnel to receive spill prevention and cleanup training. These individuals will each become responsible for a particular phase of prevention and cleanup. The names of the responsible spill personnel will be posted in the material storage area and in the on-site office trailer.

Operation and Maintenance Plan:

The goal of the operation and maintenance plan is to protect resources in the region that may be affected by the activities at the site. Water quality treatment measures and the implementation of Best Management Practices (BMP's) for structural controls will result in the treatment of site stormwater and the removal of a minimum of 80 percent of the total suspended solids (TSS) load in runoff prior to discharge from the site, consistent with Massachusetts DEP's TSS removal standard. Since the project is classified as new development, the project is subject to the Stormwater Management Standards for Standard 9.

The stormwater management system will be owned by the landowner, who will be responsible for operation and maintenance. The estimated annual operation and maintenance budget is expected to be about $ 500.

STRUCTURAL POLLUTANT CONTROLS

The proposed stormwater management system is designed to protect runoff water quality through the removal of sediment and pollutants. Structural pollutant controls used to separate and capture stormwater pollutants are described below.

Vegetated Areas Maintenance

Although not a structural component of the drainage system, the maintenance of vegetated areas may affect the functioning of stormwater management practices. This includes the health/density of vegetative cover and activities such as the application and disposal of lawn and garden care products, disposal of leaves and yard trimmings.

Detention Basin

The stormwater management system includes a Detention Basin, which can remove up to 75% of the total suspended solids (TSS).

Regular maintenance is essential for the proper functioning of the Detention Basin. Cleaning includes removal of accumulated oil, grease and sediment. The Basin should be checked at a minimum, twice per year. Silt and sediment build-up on the bottom should be cleaned and removed from the site in Spring and Fall. When the basin is dry, the vegetation (typically lawn) should be cut and kept free of debris during the growing season.

Vaughn Hill Rd.
Bolton, MA

MAINTENANCE LOG

LandTech Consultants
Vaughn Hill Rd.
Bolton, MA

Best Management Practice	Action	Date Completed	Comments	Completed By	Action	Date Completed	Comments	Completed By
Swale – Inspect or clean deep sump basins at least four times per year and at the end of the foliage and snow removal seasons. Sediments must also be removed four times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin.	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Clean				Clean			
	Clean				Clean			
	Clean				Clean			
Detention Basin – Visually inspect twice per year, and after every major storm for first three months of operation. If sediment is observed, clean system to remove any built-up sediment.	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Clean				Clean			
	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Inspect				Inspect			
	Clean				Clean			

4.0 Calculations

The peak flows were calculated for the 10-year storm events under proposed conditions. The following Table shows a comparison between existing and proposed conditions of the peak rates of runoff from the development area to the discharge points.

Summary of Peak Flows

Point of Analysis	10-Year Storm	Predevelopment Rate (CFS)	Postdevelopment Rate (CFS)
Tax Map 7B035		6.00	5.21
Vaughn Hill Rd.		13.99	11.55

Peak Discharge Runoff Volumes

The peak flows were calculated for the 10-year storm events under proposed conditions. The following Table represents a comparison between existing and proposed conditions of the peak runoff volumes from the redevelopment area to the discharge points.

EXISTING CONDITIONS

Calculations were performed to ensure that there would be no increase in flow to the discharge area (wetland).

A brief description of the drainage area follows (see Table 1 for drainage areas).

Drainage Area Descriptions

Existing Drainage Area 1 is approximately 153,623 sf, consisting of wooded upland. Runoff from this area flows overland to the abutting property (Tax Map 7.B-35). It is designated as Area 1 on the Pre and Post-Development Drainage Plans and HydroCAD analysis.

Existing Drainage Area 2 is approximately 313,607 sf, consisting of wooded upland. It is designated as Area 2 on the Pre and Post-Development Drainage Plans and HydroCad analysis.

Existing Drainage Area Summary

The following table (Table 1) summarizes the existing drainage areas, including the pertinent information used for hydrologic analysis:

Table 1 – Existing Conditions Drainage Area Characteristics Summary

SUBCATCHMENT	AREA (sf)	WEIGHTED CURVE NUMBER	Tc (min.)
1	153,623	73	13.6
2	313,607	75	12.0

Peak Discharge Runoff Rates

The existing peak flow rates of stormwater runoff, tributary to the design point, were calculated for the 2, 10 and 100-year storm events. Results are shown above.

PROPOSED CONDITIONS

Consistent with the pre-development runoff patterns, runoff from the proposed development would be routed to the existing wetland system that surrounds the site.

The subsurface infiltration system has been designed to treat the runoff from the proposed developed area.

The drainage design is described in further detail in the following sections. Proposed Drainage Area Characteristics are described in the Table below.

Drainage Area Descriptions

Drainage Area 1 is approximately 153,623 square feet, draining to the abutting property (Tax Map 7B-35). It consists of a mix of lawn, roof and driveway. It is designated as Area 1 on the Pre and Post-Development Drainage Plans and HydroCAD analysis.

Drainage Area 2 is 78,774 sf, draining to Vaughn Hill Road. It consists of wooded upland, designated as Area 2 on the Post-Development Drainage Plans and HydroCAD analysis.

Drainage Area 3 is 209,215 sf, draining to the proposed driveway swale. It consists of wooded upland, roof and gravel driveway.

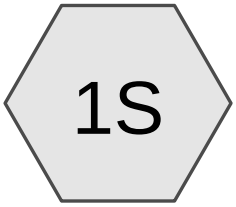
Drainage Area 4 is 25,200 sf, draining into the propose detention basin. It consists of grass.

Proposed Drainage Area Summary

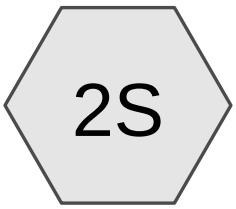
Table 2 – Proposed Conditions Drainage Area Characteristics Summary

SUBCATCHMENT	AREA (sf)	WEIGHTED CURVE NUMBER	Tc (min.)
1	153,623	70	13.6
2	78,774	74	12.0
3	209,215	79	6.0
4	25,200	80	6

*The minimum time of concentration (Tc) used is 6.0 min.



Flows to Map 7B-35



Flows to Vaughn Hill Rd.

Subcat Reach Pond Link

Routing Diagram for 17-179 Predevelopment
Prepared by {enter your company name here}, Printed 10/20/2017

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 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 1S: Flows to Map 7B-35 Runoff Area=153,623 sf 0.81% Impervious Runoff Depth>1.74"
Flow Length=950' Slope=0.1000 '/' Tc=13.6 min CN=73 Runoff=6.00 cfs 0.512 af

Subcatchment 2S: Flows to Vaughn Hill Rd. Runoff Area=313,607 sf 1.17% Impervious Runoff Depth>1.89"
Flow Length=800' Slope=0.1000 '/' Tc=12.0 min CN=75 Runoff=13.99 cfs 1.135 af

Total Runoff Area = 10.726 ac Runoff Volume = 1.648 af Average Runoff Depth = 1.84"
98.95% Pervious = 10.613 ac 1.05% Impervious = 0.113 ac

Summary for Subcatchment 1S: Flows to Map 7B-35

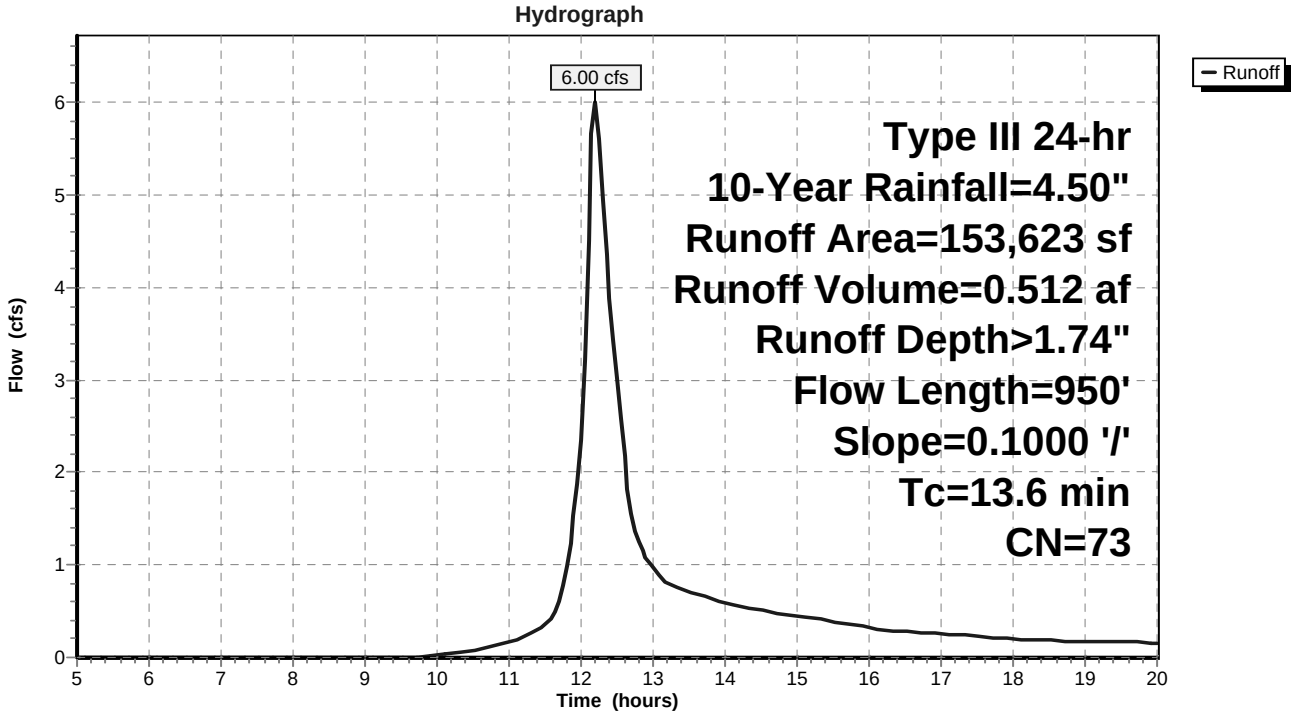
Runoff = 6.00 cfs @ 12.20 hrs, Volume= 0.512 af, Depth> 1.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
200	96	Gravel surface, HSG C
1,250	98	Roofs, HSG C
152,173	73	Woods, Fair, HSG C
153,623	73	Weighted Average
152,373		99.19% Pervious Area
1,250		0.81% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	25	0.1000	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
9.8	925	0.1000	1.58		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
13.6	950	Total			

Subcatchment 1S: Flows to Map 7B-35



Summary for Subcatchment 2S: Flows to Vaughn Hill Rd.

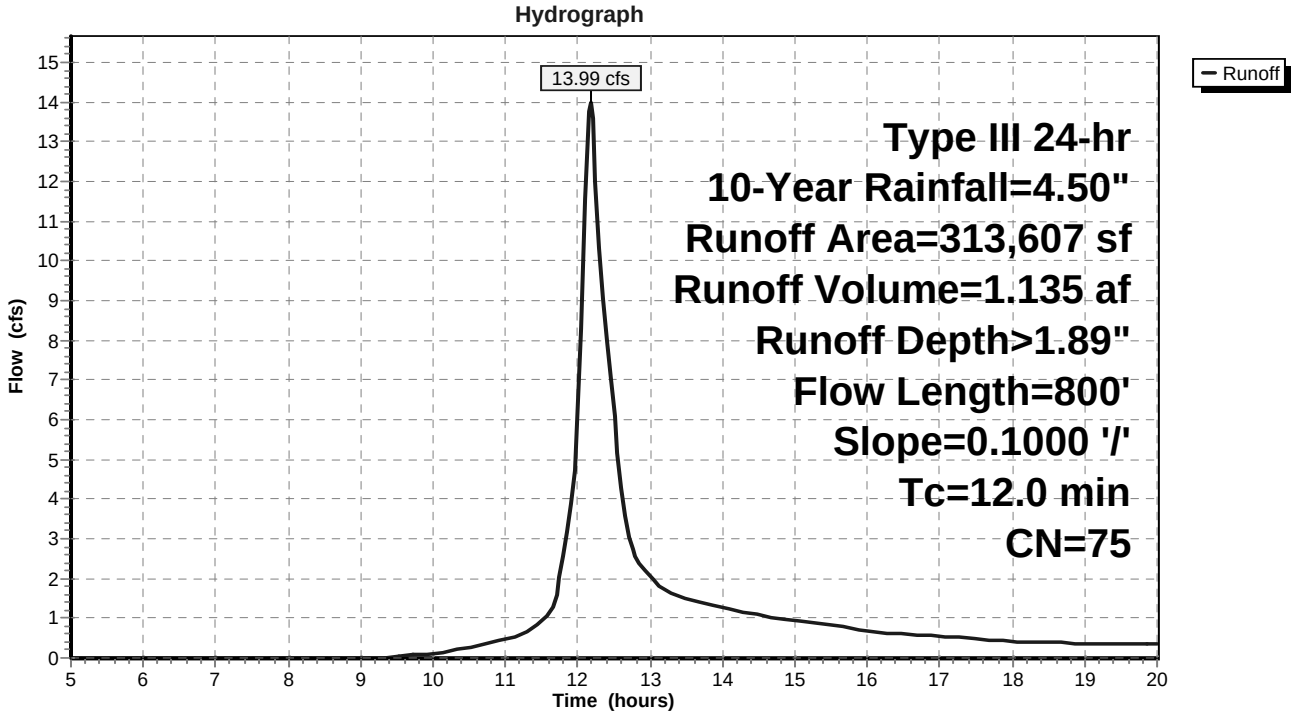
Runoff = 13.99 cfs @ 12.17 hrs, Volume= 1.135 af, Depth> 1.89"

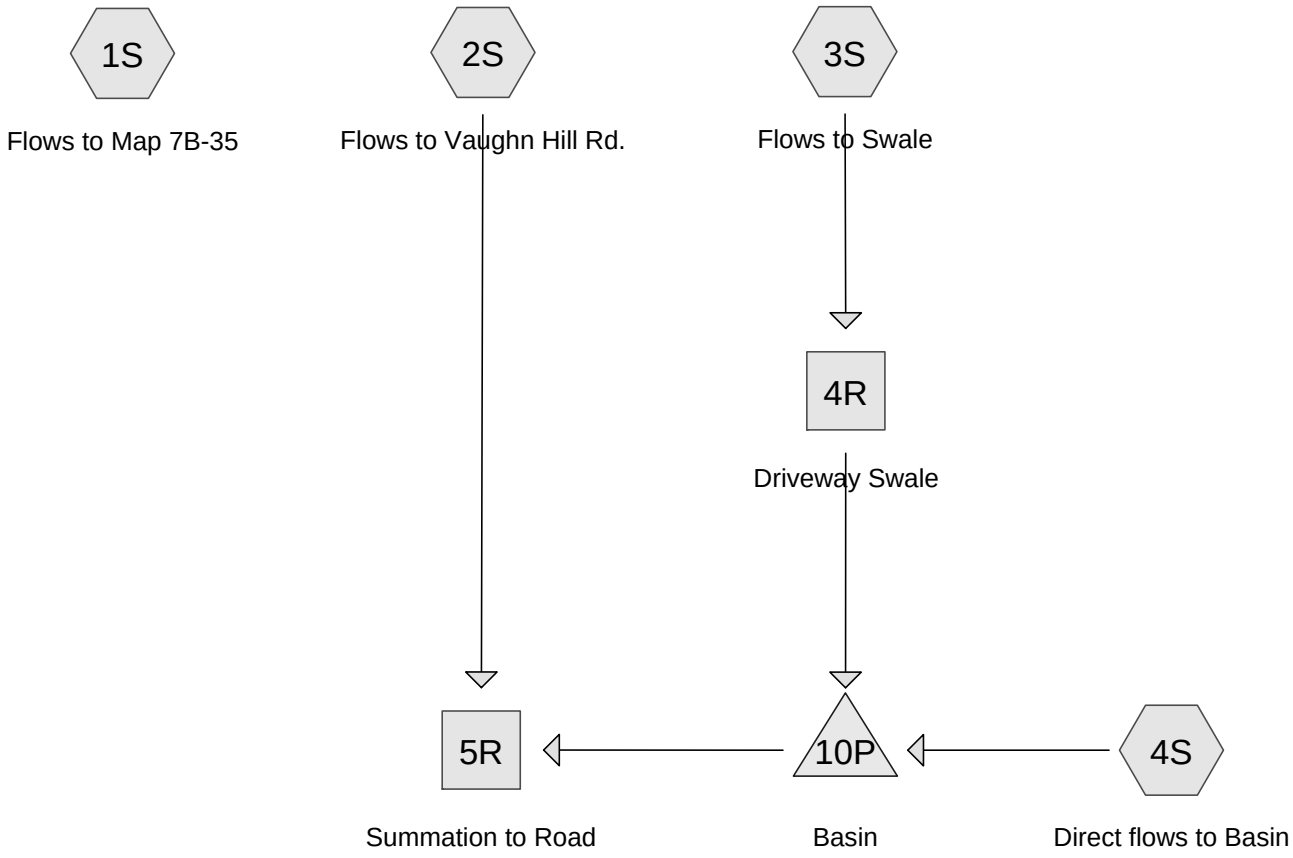
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
3,670	98	Roofs, HSG C
11,600	96	Gravel surface, HSG C
237,537	73	Woods, Fair, HSG C
60,800	79	Woods, Fair, HSG D
313,607	75	Weighted Average
309,937		98.83% Pervious Area
3,670		1.17% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	25	0.1000	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
8.2	775	0.1000	1.58		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.0	800	Total			

Subcatchment 2S: Flows to Vaughn Hill Rd.





Subcat Reach Pond Link

Routing Diagram for 17-179 Postdevelopment-V2
Prepared by {enter your company name here}, Printed 10/20/2017

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 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 1S: Flows to Map 7B-35 Runoff Area=153,623 sf 0.81% Impervious Runoff Depth>1.53"
Flow Length=950' Slope=0.1000 '/' Tc=13.6 min CN=70 Runoff=5.21 cfs 0.450 af

Subcatchment 2S: Flows to Vaughn Hill Rd. Runoff Area=98,774 sf 0.00% Impervious Runoff Depth>1.89"
Flow Length=800' Slope=0.1000 '/' Tc=12.0 min CN=75 Runoff=4.41 cfs 0.358 af

Subcatchment 3S: Flows to Swale Runoff Area=209,215 sf 2.39% Impervious Runoff Depth>2.21"
Flow Length=225' Slope=0.1000 '/' Tc=6.0 min CN=79 Runoff=13.12 cfs 0.885 af

Subcatchment 4S: Direct flows to Basin Runoff Area=5,200 sf 0.00% Impervious Runoff Depth>2.29"
Flow Length=175' Tc=6.0 min CN=80 Runoff=0.34 cfs 0.023 af

Reach 4R: Driveway Swale Avg. Flow Depth=0.59' Max Vel=12.35 fps Inflow=13.12 cfs 0.885 af
n=0.030 L=200.0' S=0.2500 '/' Capacity=165.08 cfs Outflow=12.99 cfs 0.885 af

Reach 5R: Summation to Road Inflow=17.10 cfs 1.263 af
Outflow=17.10 cfs 1.263 af

Pond 10P: Basin Peak Elev=458.21' Storage=2,250 cf Inflow=13.33 cfs 0.908 af
15.0" Round Culvert n=0.010 L=10.0' S=0.0500 '/' Outflow=12.97 cfs 0.906 af

Total Runoff Area = 10.717 ac Runoff Volume = 1.716 af Average Runoff Depth = 1.92"
98.66% Pervious = 10.573 ac 1.34% Impervious = 0.143 ac

Summary for Subcatchment 1S: Flows to Map 7B-35

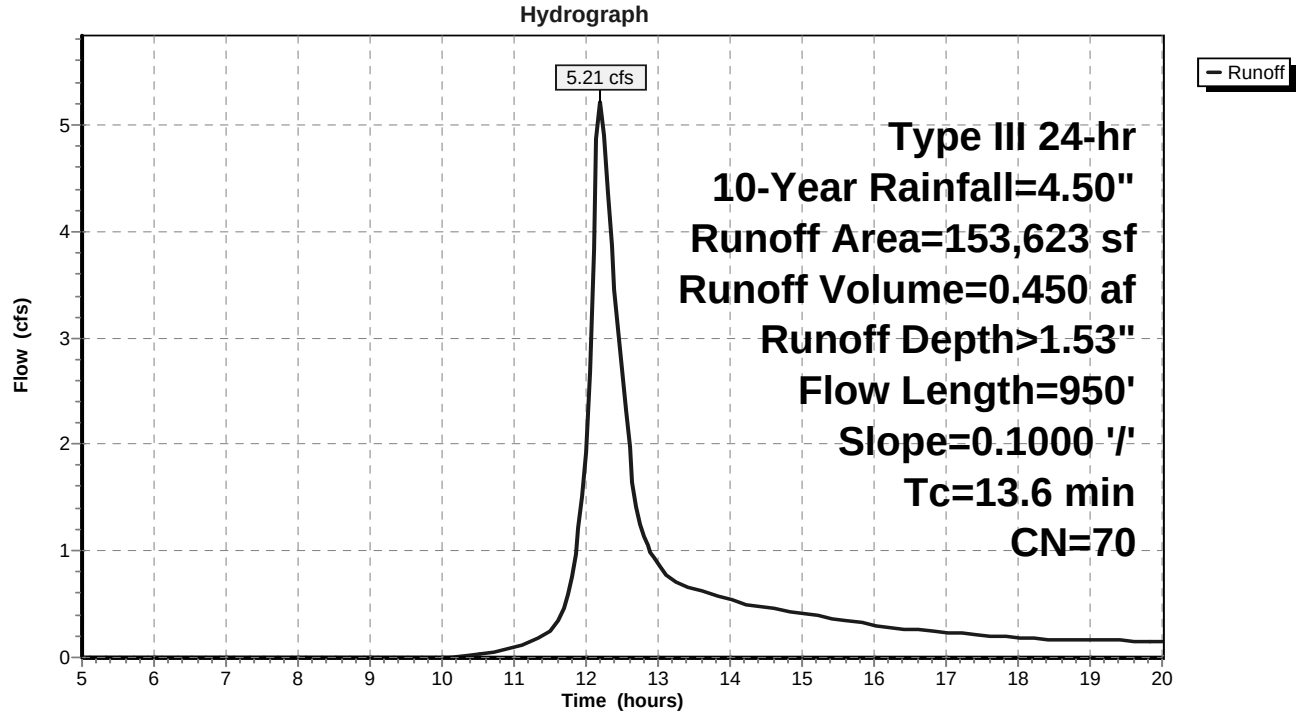
Runoff = 5.21 cfs @ 12.20 hrs, Volume= 0.450 af, Depth> 1.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
200	96	Gravel surface, HSG C
1,250	98	Roofs, HSG C
152,173	70	Woods, Good, HSG C
153,623	70	Weighted Average
152,373		99.19% Pervious Area
1,250		0.81% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	25	0.1000	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
9.8	925	0.1000	1.58		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
13.6	950	Total			

Subcatchment 1S: Flows to Map 7B-35



Summary for Subcatchment 2S: Flows to Vaughn Hill Rd.

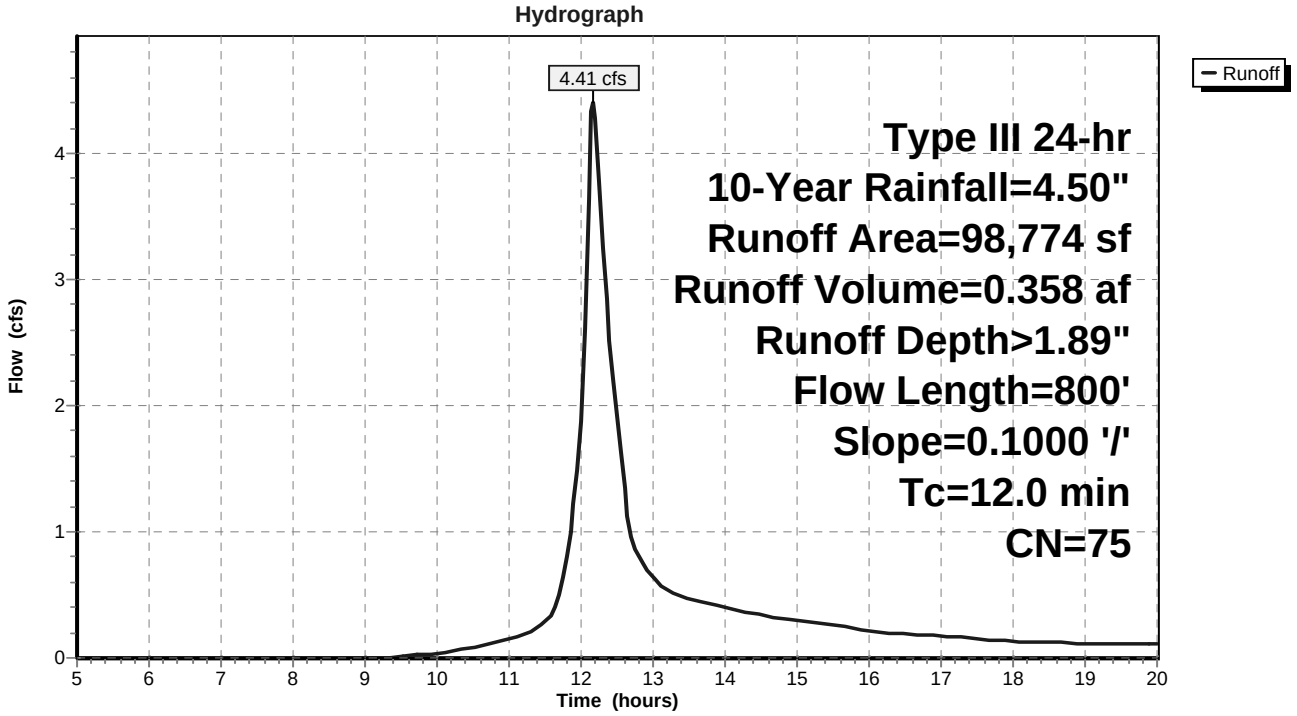
Runoff = 4.41 cfs @ 12.17 hrs, Volume= 0.358 af, Depth> 1.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
5,600	96	Gravel surface, HSG C
45,237	70	Woods, Good, HSG C
47,937	77	Woods, Good, HSG D
98,774	75	Weighted Average
98,774		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	25	0.1000	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
8.2	775	0.1000	1.58		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
12.0	800	Total			

Subcatchment 2S: Flows to Vaughn Hill Rd.



Summary for Subcatchment 3S: Flows to Swale

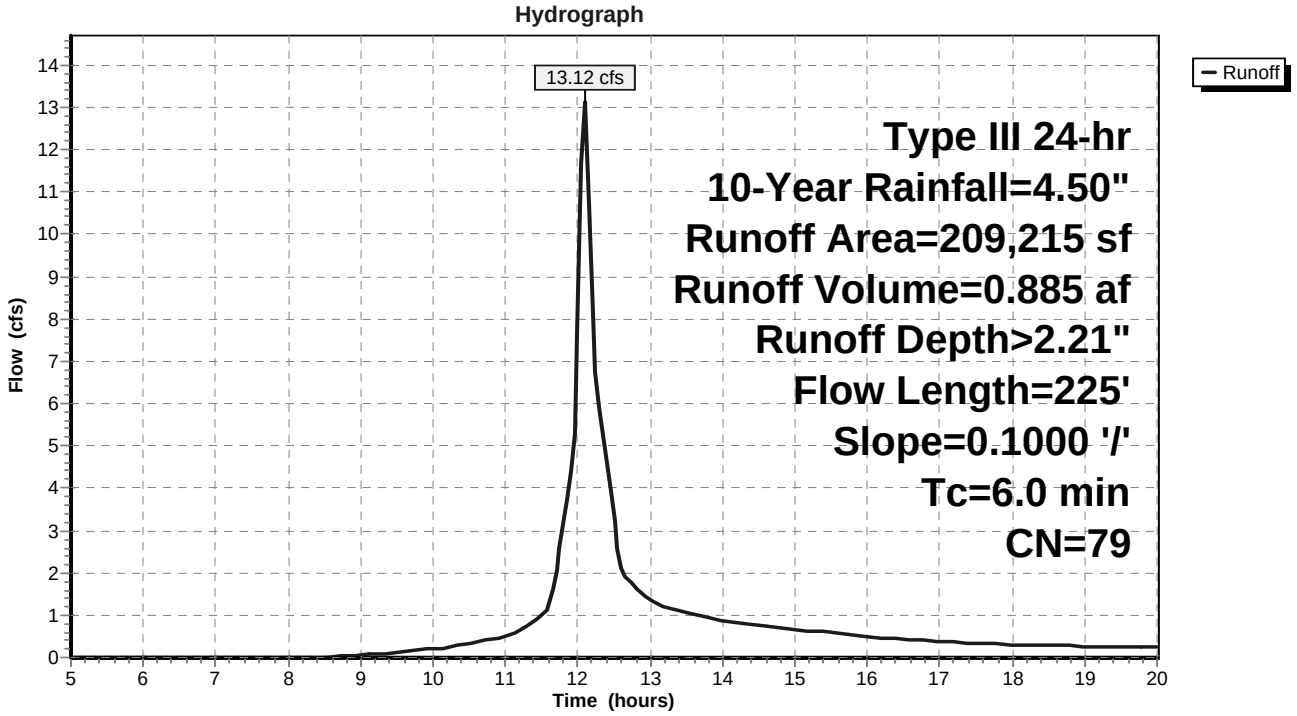
Runoff = 13.12 cfs @ 12.09 hrs, Volume= 0.885 af, Depth> 2.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
5,000	98	Roofs, HSG C
12,500	96	Gravel surface, HSG D
20,000	80	>75% Grass cover, Good, HSG D
14,500	74	>75% Grass cover, Good, HSG C
157,215	77	Woods, Good, HSG D
209,215	79	Weighted Average
204,215		97.61% Pervious Area
5,000		2.39% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.8	25	0.1000	0.11		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.10"
0.7	200	0.1000	4.74		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
4.5	225	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 3S: Flows to Swale



Summary for Subcatchment 4S: Direct flows to Basin

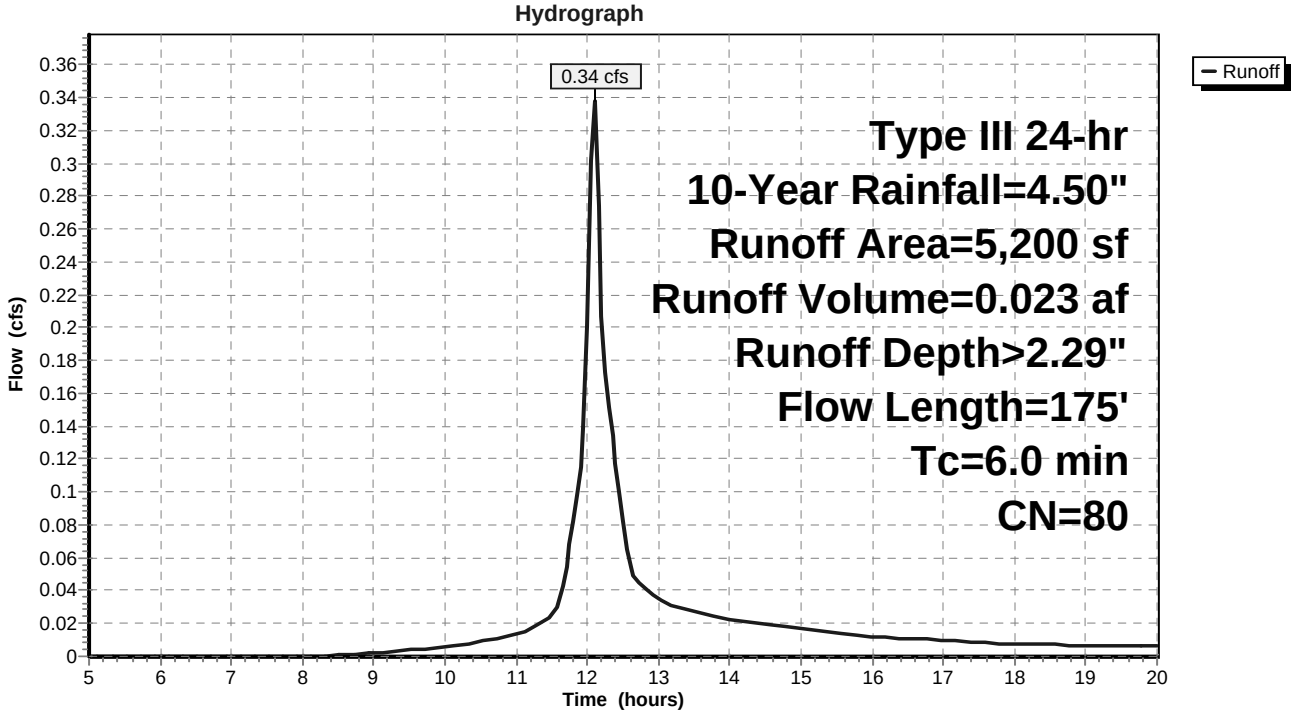
Runoff = 0.34 cfs @ 12.09 hrs, Volume= 0.023 af, Depth> 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.50"

Area (sf)	CN	Description
5,200	80	>75% Grass cover, Good, HSG D
5,200		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	25	0.3000	0.37		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.3	150	0.4000	9.49		**Shallow Concentrated Flow,** Grassed Waterway Kv= 15.0 fps
1.4	175	Total, Increased to minimum Tc = 6.0 min			

Subcatchment 4S: Direct flows to Basin



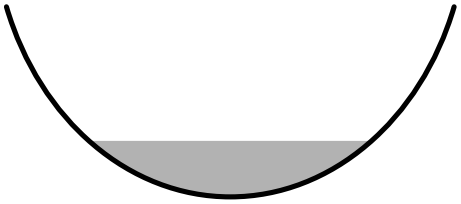
Summary for Reach 4R: Driveway Swale

Inflow Area = 4.803 ac, 2.39% Impervious, Inflow Depth > 2.21" for 10-Year event
Inflow = 13.12 cfs @ 12.09 hrs, Volume= 0.885 af
Outflow = 12.99 cfs @ 12.10 hrs, Volume= 0.885 af, Atten= 1%, Lag= 0.4 min

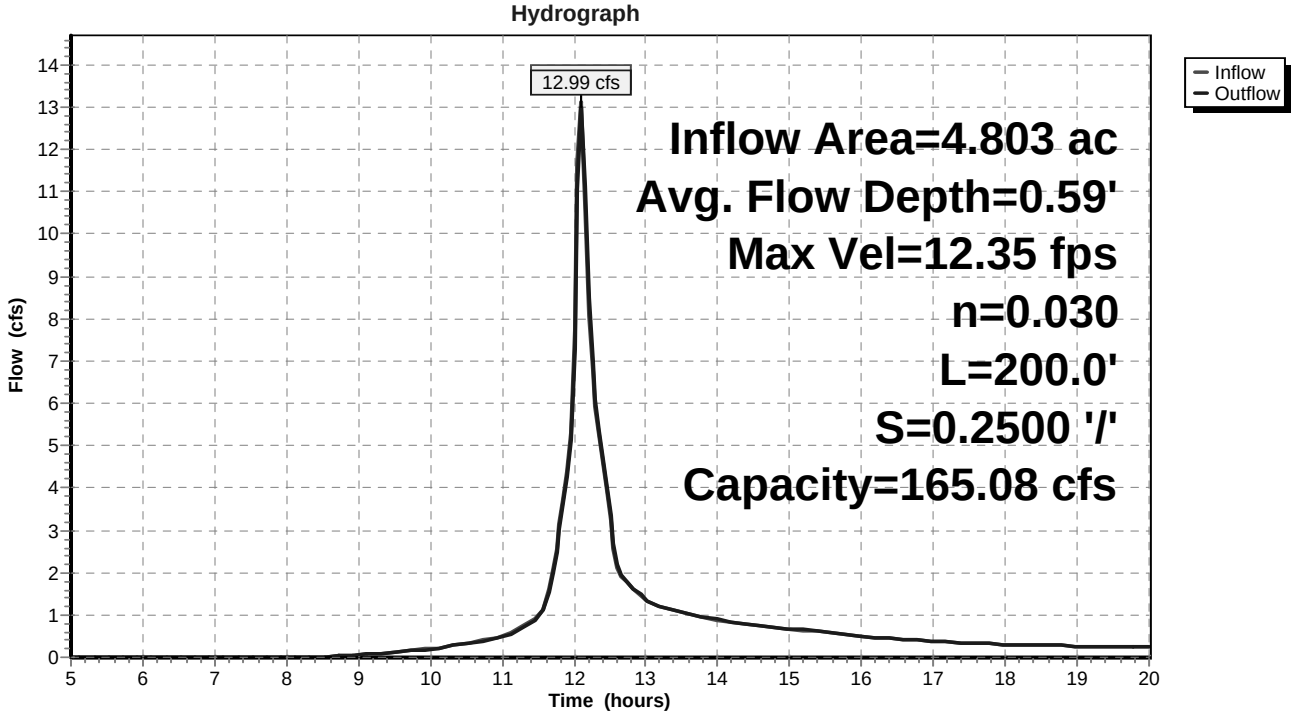
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 12.35 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 4.77 fps, Avg. Travel Time= 0.7 min

Peak Storage= 213 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.59'
Bank-Full Depth= 2.00' Flow Area= 6.7 sf, Capacity= 165.08 cfs

5.00' x 2.00' deep Parabolic Channel, n= 0.030 Earth, grassed & winding
Length= 200.0' Slope= 0.2500 '/'
Inlet Invert= 498.00', Outlet Invert= 448.00'



Reach 4R: Driveway Swale

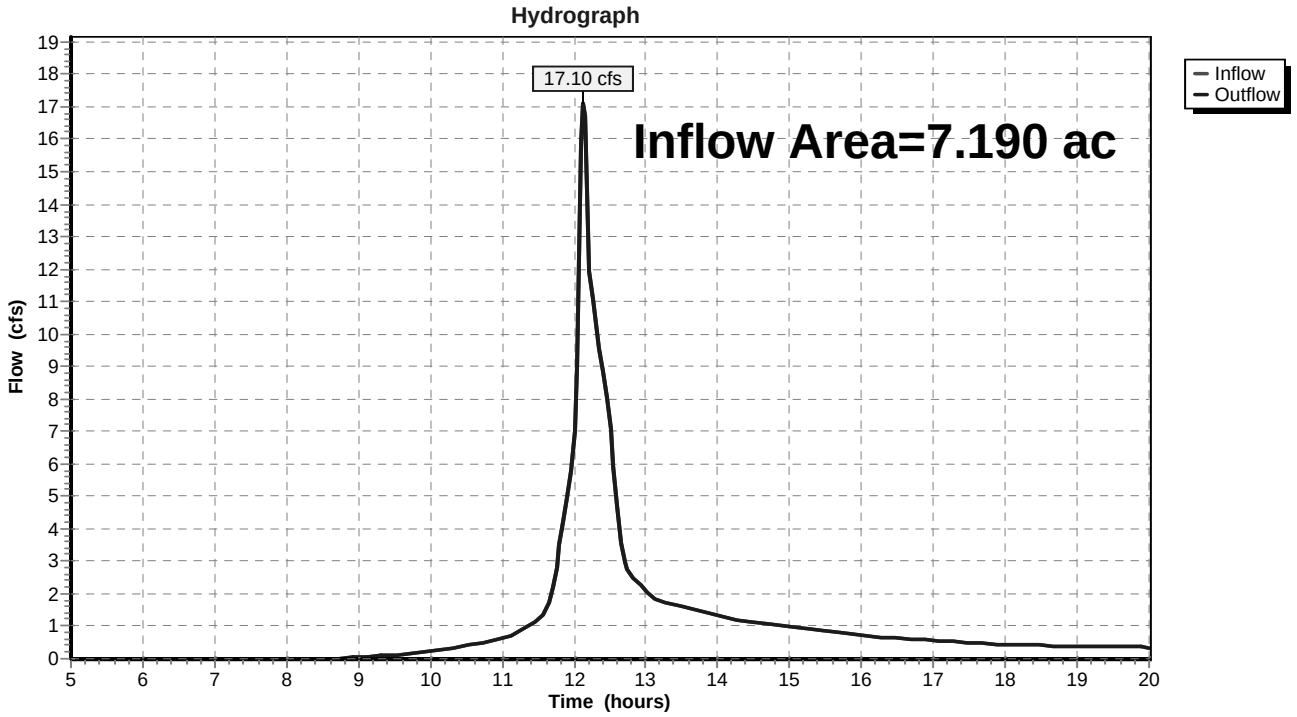


Summary for Reach 5R: Summation to Road

Inflow Area = 7.190 ac, 1.60% Impervious, Inflow Depth > 2.11" for 10-Year event
Inflow = 17.10 cfs @ 12.13 hrs, Volume= 1.263 af
Outflow = 17.10 cfs @ 12.13 hrs, Volume= 1.263 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

Reach 5R: Summation to Road



Summary for Pond 10P: Basin

Inflow Area = 4.922 ac, 2.33% Impervious, Inflow Depth > 2.21" for 10-Year event
Inflow = 13.33 cfs @ 12.10 hrs, Volume= 0.908 af
Outflow = 12.97 cfs @ 12.13 hrs, Volume= 0.906 af, Atten= 3%, Lag= 1.5 min
Primary = 12.97 cfs @ 12.13 hrs, Volume= 0.906 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 458.21' @ 12.13 hrs Surf.Area= 1,200 sf Storage= 2,250 cf

Plug-Flow detention time= 3.9 min calculated for 0.903 af (99% of inflow)
Center-of-Mass det. time= 3.0 min (796.6 - 793.5)

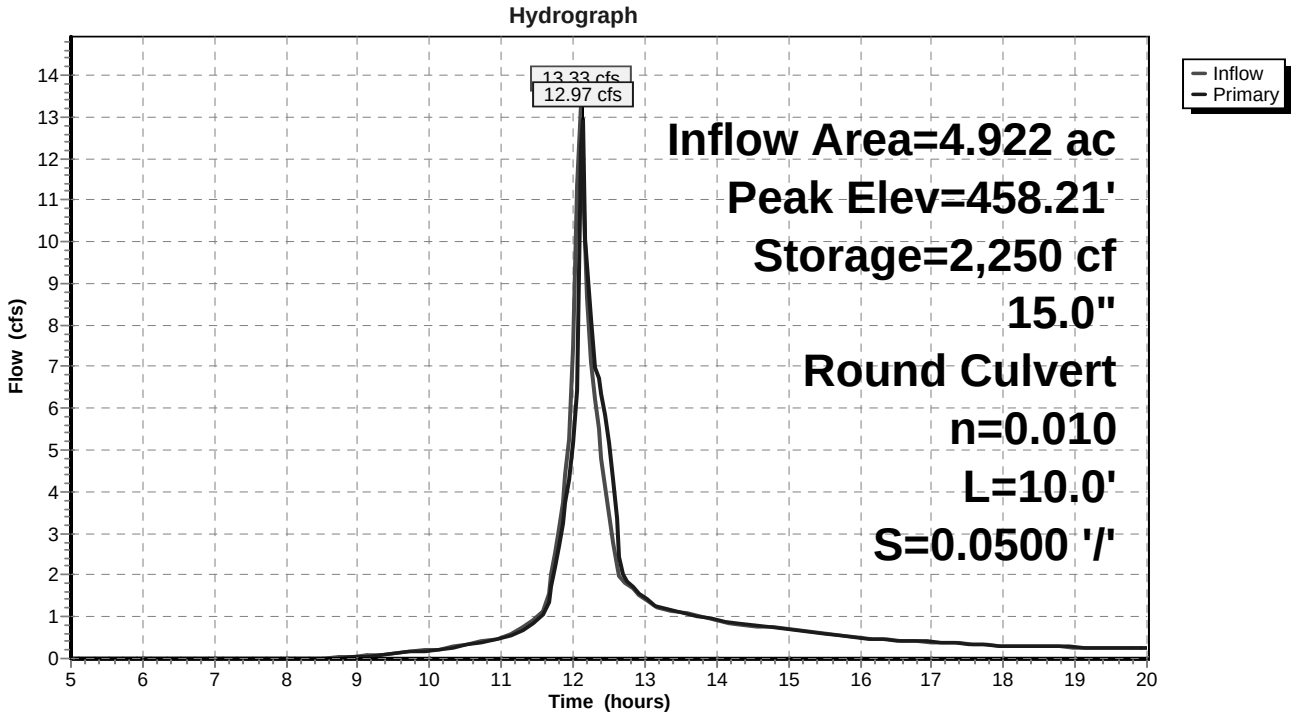
Volume	Invert	Avail.Storage	Storage Description
#1	450.00'	2,250 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
450.00	300	0	0
452.00	900	1,200	1,200
453.00	1,200	1,050	2,250

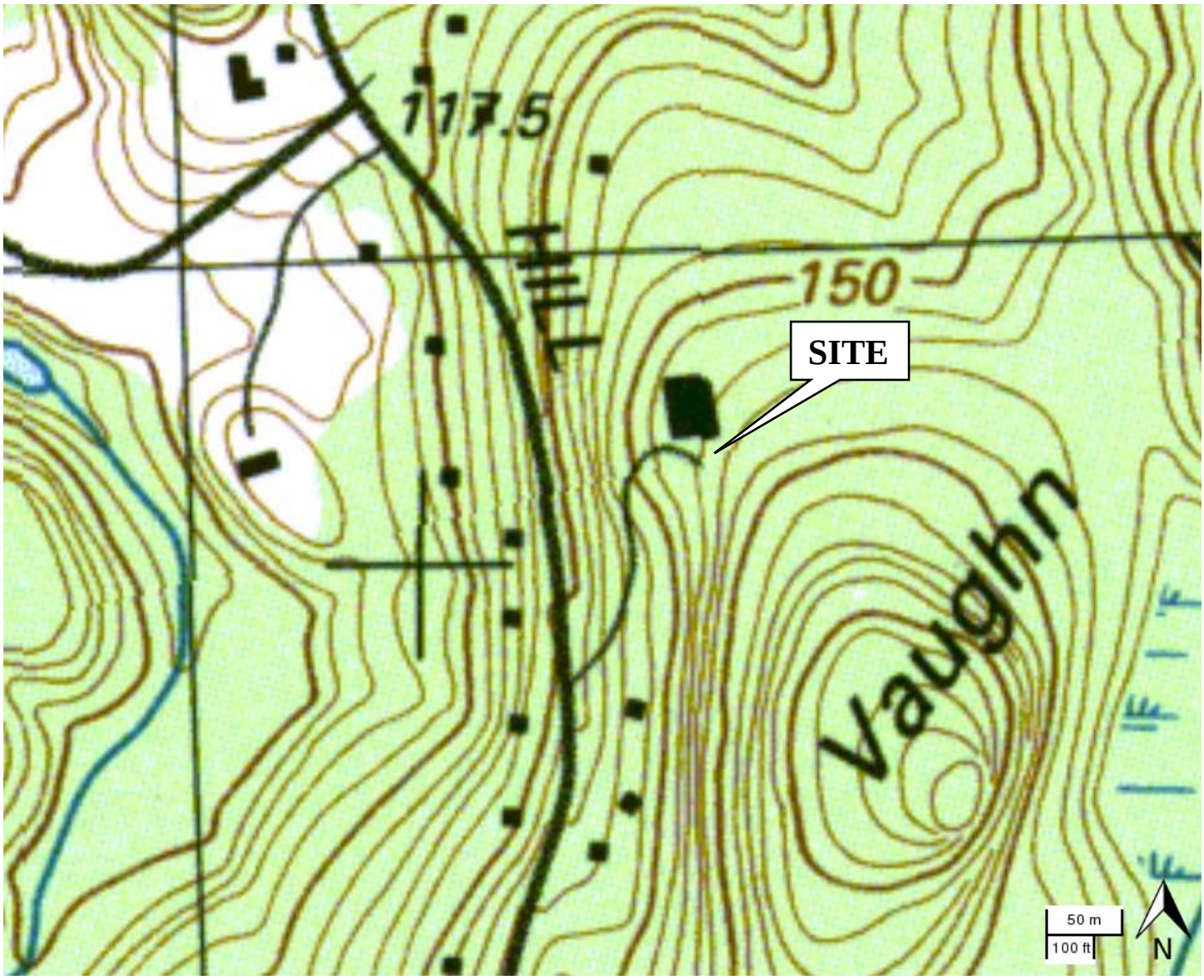
Device	Routing	Invert	Outlet Devices
#1	Primary	450.00'	**15.0" Round Culvert** L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 450.00' / 449.50' S= 0.0500 '/' Cc= 0.900 n= 0.010, Flow Area= 1.23 sf

Primary OutFlow Max=12.36 cfs @ 12.13 hrs HW=457.65' (Free Discharge)
1=Culvert (Inlet Controls 12.36 cfs @ 10.07 fps)

Pond 10P: Basin



5.1 USGS LOCUS MAP



USGS LOCUS MAP

Vaughn Hill Road
Bolton, MA

LandTech Consultants
Engineering / Planning / Surveying / Permitting

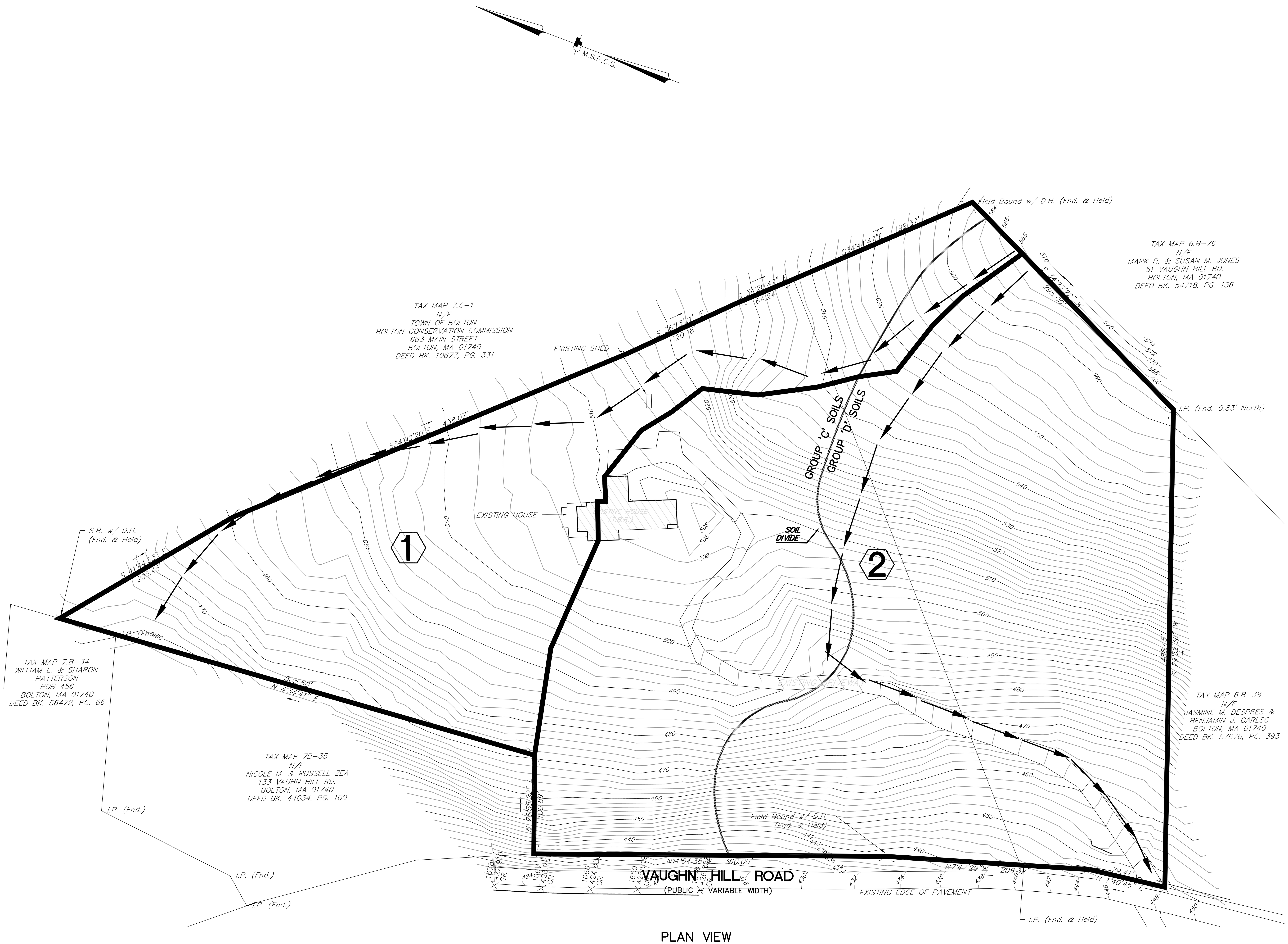
515 Groton Road, Westford, MA 01886
Ph: (978) 692-6100 - landtechinc.com

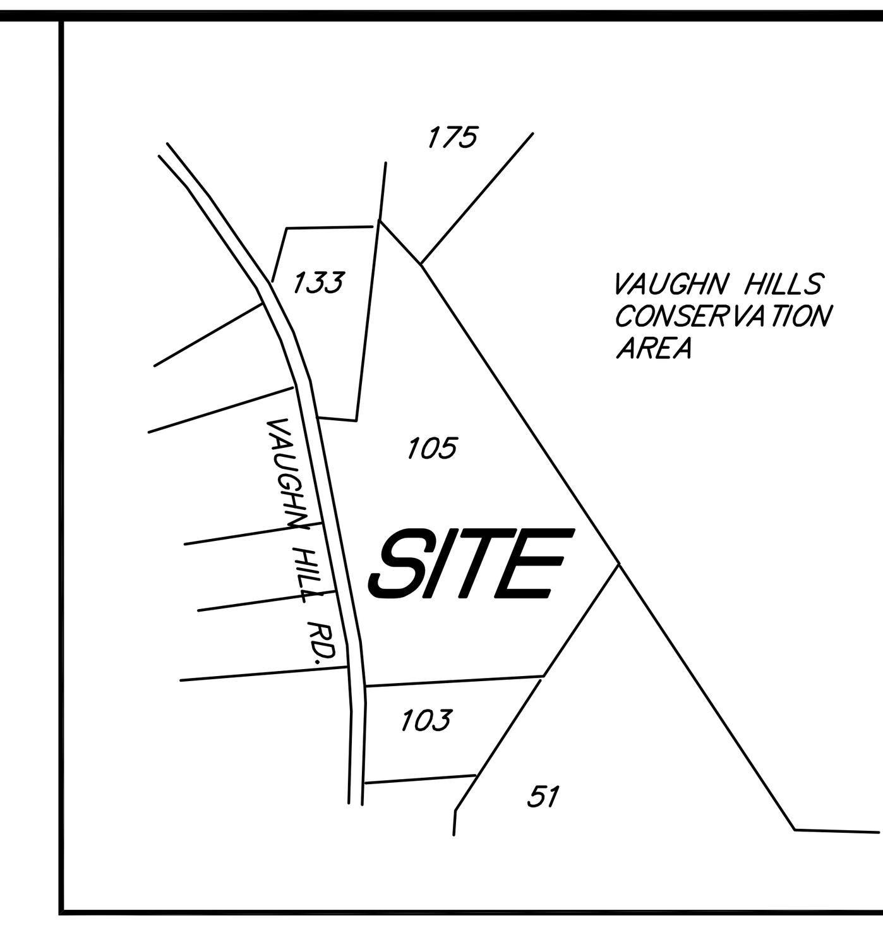
Prepared for: Whitehorse Builders
456 Newtown Rd.
Littleton, MA 01460

Draft: ASK

Job No. 17-179

Existing Watershed Map





LOCUS MAP
SCALE: NTS

LEGEND

DRILL HOLE FOUND	D.H. Fnd.
STONE BOUND FOUND	S.B. Fnd.
CONCRETE BOUND FOUND	C.B. Fnd.
IRON PIPE FOUND	I.P. Fnd

DATE	REVISION	BY

PREPARED FOR:
105 VAUGHN HILL RD.
BOLTON, MA

DESIGN ASK | DRAFT ASK | CHECK MR

EXISTING DRAINAGE MAP
105 VAUGHN HILL ROAD
BOLTON, MA

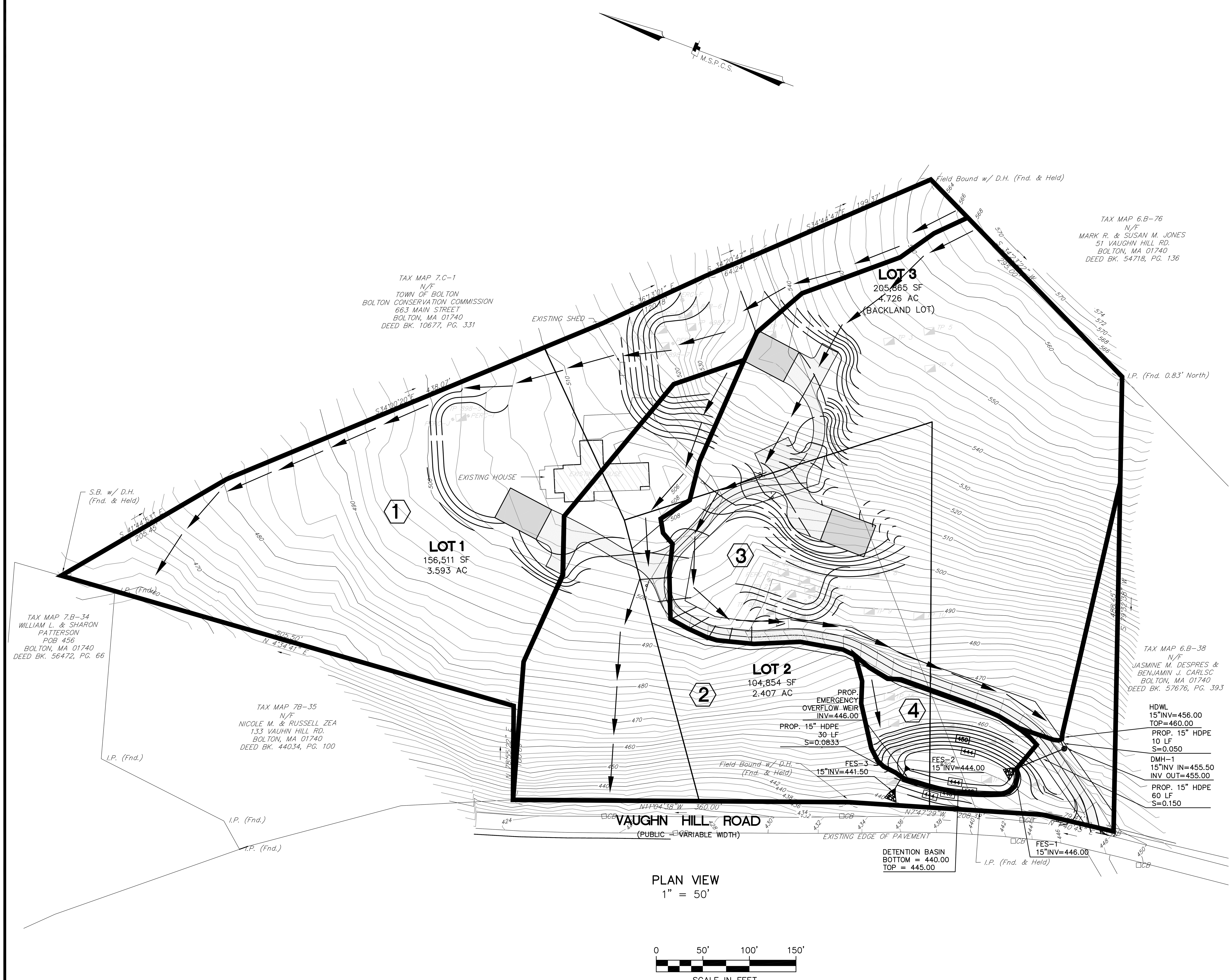
SCALE: 1"=1" = 50'
SEPTEMBER 1, 2017

LandTech Consultants
Engineering/Design/Surveying/Permitting
515 Groton Road, - Westford, MA 01886
Ph: (978) 692-6100 - landtechinc.com

JOB NO. 17-179
DWG. NO. 17179DP
SHEET DP

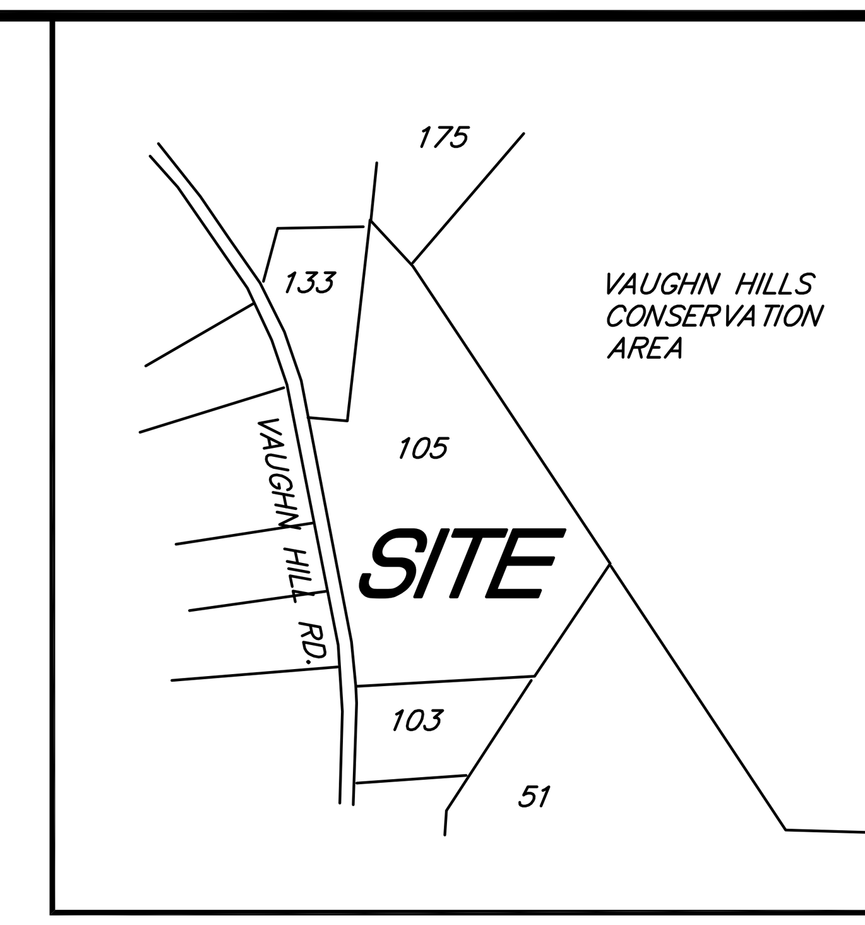
P:\17\17-179\Drawings\Preliminary\17-179 Driveway Plan-Profile.dwg, 10/20/2017 11:16:24 AM

Proposed Watershed Map



PLAN VIEW
1" = 50'

0 50' 100' 150'
SCALE IN FEET



LOCUS MAP
SCALE: NTS

LEGEND

DRILL HOLE FOUND	◉ D.H. Fnd.
STONE BOUND FOUND	S.B. Fnd.
CONCRETE BOUND FOUND	C.B. Fnd.
IRON PIPE FOUND	I.P. Fnd

DEED REFERENCES:

DEED BOOK 44979, PAGE 9, W.D.R.D.
DEED BOOK 53670, PAGE 328, W.D.R.D.

PLAN REFERENCES:

PLAN BOOK 301, PLAN 91, W.D.R.D.
PLAN BOOK 320, PLAN 114, W.D.R.D.
PLAN BOOK 426, PLAN 64, W.D.R.D.
PLAN BOOK 343, PLAN 76, W.D.R.D.

ASSESSOR'S REFERENCE:

MAP 7B, LOT 7.B-36

RECORD OWNER:

RUTH E. DANON

SURVEY NOTES:

BOUNDARY AND TOPOGRAPHIC INFORMATION SHOWN HEREON IS BASED ON AN ON-THE-GROUND SURVEY PERFORMED BY LANDTECH CONSULTANTS IN AUGUST OF 2017 BY LANDTECH CONSULTANTS, INC.

THE BEARINGS AND DISTANCES AND THE COORDINATES THEY ARE BASED ON SHOWN ON THIS PLAN ARE IN U.S. SURVEY FEET IN THE MA. STATE PLANE COORDINATE SYSTEM REFERENCED TO THE NORTH AMERICAN DATUM OF 1983 (NAD83), CORS ADJUSTMENT (NA2011/GEOID 12A) AS DETERMINED BY GPS OBSERVATIONS PERFORMED IN AUGUST OF 2017 UTILIZING MAINE TECHNICAL SOURCE RTK GPS NETWORK.

THE VERTICAL DATUM FOR THIS PROJECT IS REFERENCED TO THE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88), CORS ADJUSTMENT (NA2011/GEOID 12A) AS DETERMINED BY REDUNDANT GPS OBSERVATIONS PERFORMED IN AUGUST OF 2017 UTILIZING THE MAINE TECHNICAL SOURCE RTK GPS NETWORK.

BOUNDARY INFORMATION SHOWN HEREON IS BASED ON INFORMATION OBTAINED FROM THE PUBLIC RECORDS. A TITLE SEARCH WAS NOT PERFORMED ON THE SUBJECT PARCEL.

ZONING:

1. PARCEL ZONED 'RESIDENTIAL"
2. BUILDING SETBACKS:

	RESIDENTIAL LOT:	BACKLAND LOT:
FRONT YARD:	50'	50'
SIDE YARD:	20'	50'
REAR YARD:	20'	50'

3. THIS PLAN IS TO CREATE A COMMON DRIVEWAY – IN ACCORDANCE WITH BOLTON DRIVEWAY BYLAW 2.4.1.2 – FOR LOTS 1–3. THE PROPOSED EASEMENT IS TO ALLOW ACCESS & EGRESS FROM THOSE LOTS.
4. A MAINTENANCE AGREEMENT WILL BE REQUIRED BETWEEN THE OWNERS OF THE HOMES ON LOTS 1–3. SUCH AGREEMENT IS TO BE RECORDED WITH ASSOCIATED DEEDS.
5. A SPECIAL PERMIT WAS GRANTED BY BOLTON PLANNING BOARD ON THIS DATE:

NOTES:

1. THE COMMON DRIVEWAY SHOWN IS SUBJECT TO AN AGREEMENT, RECORDED IN THE W.D.R.D.
2. A MAINTENANCE ASSOCIATION AGREEMENT IS TO BE SUBMITTED TO, AND APPROVED BY, THE BOLTON PLANNING BOARD.
3. SEE SHEET 2 FOR DETAIL, SECTION AND PROFILE VIEWS.
4. FOR GRADING AT HOUSE LOCATIONS AND SEPTIC SYSTEMS, SEE THE APPROVED SUBSURFACE DISPOSAL SYSTEM PLANS.

DATE	REVISION	BY

PREPARED FOR:
105 VAUGHN HILL RD.
BOLTON, MA

DESIGN	DRAFT	CHECK
ASK	ASK	MR

POSTDEVELOPMENT DRAINAGE
105 VAUGHN HILL ROAD
BOLTON, MA

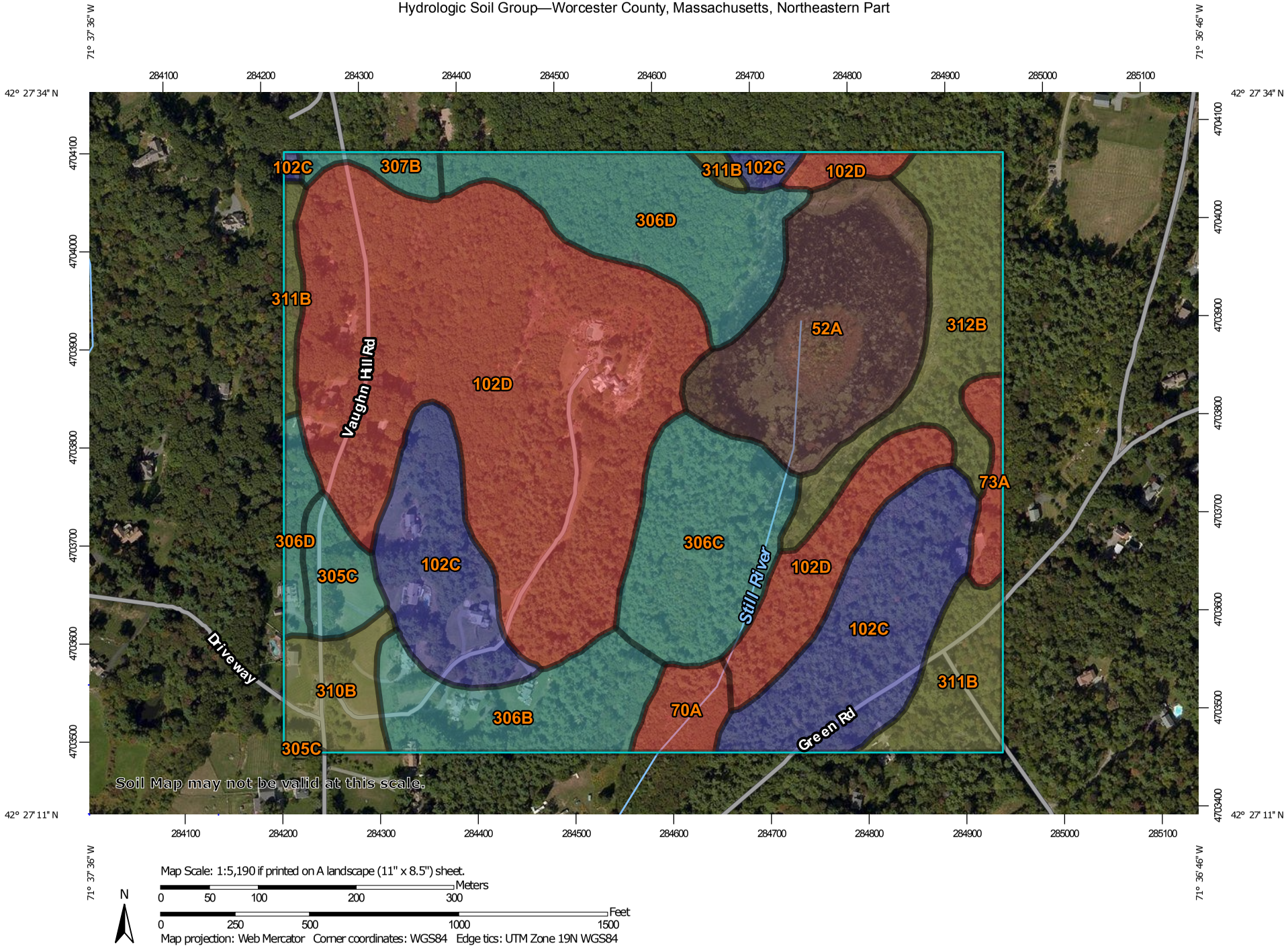
SCALE: 1"=50'
SEPTEMBER 1, 2017

LandTech Consultants
Engineering/Design/Surveying/Permitting
515 Groton Road, – Westford, MA 01886
Ph: (978) 692-6100 – landtechinc.com

JOB NO. 17-179
DWG. NO. 17179DP
SHEET DP

5.2 SOILS INFORMATION

NRCS Soils Report (from NRCS Website)



Map Scale: 1:5,190 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 250 500 1000 1500

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Lines

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Soil Rating Points

A

A/D

B

B/D

C

C/D

D

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:20,000.

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

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

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

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

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

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

Soil Survey Area: Worcester County, Massachusetts, Northeastern Part
Survey Area Data: Version 11, Sep 14, 2016

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

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

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

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
52A	Freetown muck, 0 to 1 percent slopes	B/D	11.7	10.4%
70A	Ridgebury fine sandy loam, 0 to 3 percent slopes	D	1.8	1.6%
73A	Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony	D	1.4	1.3%
102C	Chatfield-Hollis-Rock outcrop complex, 0 to 15 percent slopes	B	16.0	14.3%
102D	Chatfield-Hollis-Rock outcrop complex, 15 to 35 percent slopes	D	38.1	34.0%
305C	Paxton fine sandy loam, 8 to 15 percent slopes	C	2.1	1.9%
306B	Paxton fine sandy loam, 0 to 8 percent slopes, very stony	C	6.2	5.6%
306C	Paxton fine sandy loam, 8 to 15 percent slopes, very stony	C	8.2	7.3%
306D	Paxton fine sandy loam, 15 to 25 percent slopes, very stony	C	10.0	8.9%
307B	Paxton fine sandy loam, 0 to 8 percent slopes, extremely stony	C	1.0	0.9%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	C/D	3.0	2.7%
311B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	C/D	5.0	4.5%
312B	Woodbridge fine sandy loam, 0 to 8 percent slopes, extremely stony	C/D	7.3	6.5%
Totals for Area of Interest			**111.8**	**100.0%**

Description

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

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

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

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

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

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

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

Rating Options

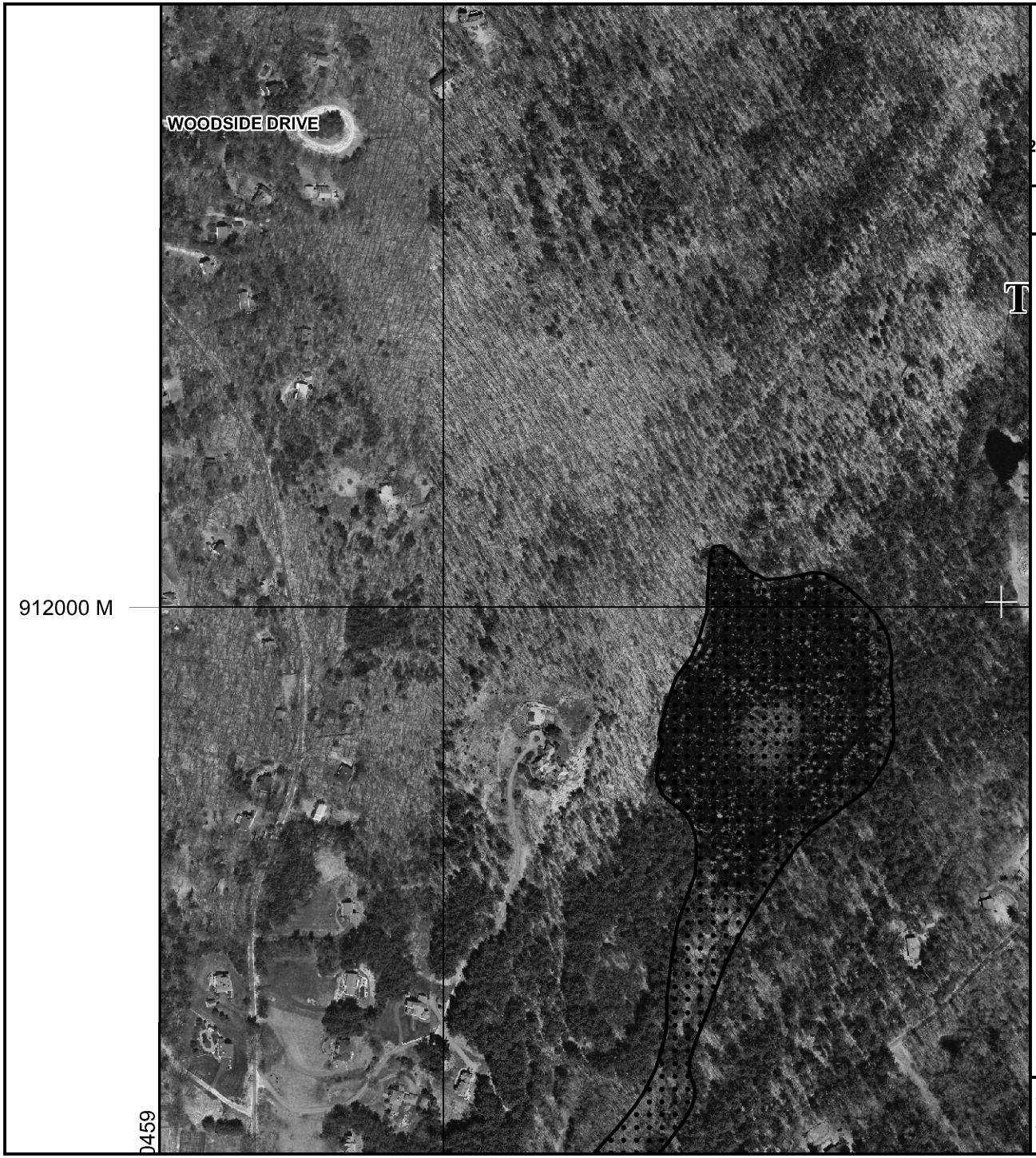
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

5.2 FIRM

Flood Insurance Rate Map (from FEMA Website)



MAP SCALE 1" = 500'

250 0 500 1000

FEET

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0478F

FIRM

FLOOD INSURANCE RATE MAP

WORCESTER COUNTY, MASSACHUSETTS

(ALL JURISDICTIONS)

PANEL 478 OF 1075

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
BOLTON, TOWN OF	250296	0478	F
HARVARD, TOWN OF	250308	0478	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER
25027C0478F

MAP REVISED
JULY 16, 2014

Federal Emergency Management Agency

TSS Removal Calcs

LandTech Consultants
Engineering/Design/Surveying/Permitting
515 Groton Road, – Westford, MA 01886
Ph: (978) 692–6100 – landtechinc.com

Project:	*35 & 37 Main St.*
Location:	*N.Reading, MA*
Calculated By:	*ASK*
Checked By:	*MAW*
Date:	*4/17/2017*
Revised Date:	

TOTAL SUSPENDED SOLIDS (TSS) REMOVAL WORKSHEET

Legend: = TSS Removal Rate Prior to Treatment

Treatment Train 3: **Pavement to Water Quality Swale - South**

	A BMP	B TSS Removal Rate	C Starting TSS Load	D Amount Removed (BxC)	E Remaining Load (C-D)	F TSS Removal Rate
PRETREATMENT	Drainage Channel	0.00	1.00	0.00	1.00	0%

	A BMP	B TSS Removal Rate	C Starting TSS Load	D Amount Removed (BxC)	E Remaining Load (C-D)	F TSS Removal Rate
TREATMENT	Infiltration Basin	0.80	1.00	0.80	0.20	80%