

December 6, 2021

Northborough Conservation Commission  
63 Main Street  
Northborough, MA 01532

Re: Revised Site Plans and Stormwater Management Documentation  
DEP File # 247-1202  
190 Howard Street

Dear Northborough Conservation Commission:

Goddard Consulting, LLC (Goddard) is pleased to submit revised site plans and stormwater management documentation on behalf of Bethany Sepe in support of the Notice of Intent (NOI) application for DEP File #247-1202. The revisions to the site plans come in response to the concerns raised by the Northborough Conservation Commission at the previous public hearing held for this project on September 13, 2021. A stormwater management design has been incorporated into the proposed project to ensure no impacts are incurred on downgradient resource areas from the proposed project.

The original and two copies of this report and site plan have been submitted for your review, along with a digital submittal. A list of enclosed documents is as follows:

- *Stormwater Management Documentation, 190 Howard Street, Northborough, Massachusetts, Connorstone Engineering Inc, 12/2/2021*
- *Site Plan: Proposed Stormwater Plan of 190 Howard Street in Northborough, MA Connorstone Engineering Inc, 12/2/2021*

### **Plan Revisions**

The following changes have been made to the site plans:

- The general quantity of trees to remain within each paddock have been shown on the plan to give a general sense of how much mature vegetative cover will remain in each paddock after the initial clearing (see Photo 1).
- The size of each paddock has been added to the plan. It should be noted that the pasture and paddock sizes were designed so that the Applicant will comply with the Northborough Board of Health's Horse and Stable Regulations. Reducing pasture area posed a risk of providing inadequate space for the horses and not complying with the aforementioned regulations.
- A stable has been added directly adjacent to the existing barn to provide shelter for the horses. This stable is outside of the 100-foot Buffer Zone.
- Two berms have been added to the plan. Please see *Stormwater Management Documentation* from Connorstone Engineering Inc (dated 12/2/2021) for a thorough explanation on the design and intent of stormwater management for the site.
  - A 6" berm has been proposed at the southern extent of the pastures for the purpose of preventing stormwater flow from entering the paddock area.

Stormwater will be directed into a mature woodland cover type just within the 100-foot Buffer Zone.

- A 2'-3' berm is proposed downgradient of the proposed paddocks just outside the 25-foot Buffer Zone. The berm's intent is to create a stormwater basin/rain garden to control both peak rate of runoff and volume of runoff from the pasture and paddock areas. Existing vegetation will remain in the basins. The berms construction will avoid tree removal for trees greater than 6" in diameter.



**Photo 1.** An example of one of the trees to remain in the pasture space. Large diameter trees with a dominant canopy were chosen as the trees to remain.

## **DEP Comments**

DEP provided the following technical comment:

*Clearing should be done in a way that takes care to not destabilize the slope to BVW. The Commission may want to consider 10.53(1) and that "the potential for adverse impacts to the Resource Areas from work in the Buffer Zone may increase with the extent of work..." in its review.*

The Applicant has addressed this comment by:

- Providing a construction sequence on the site plan to ensure the appropriate erosion and sediment controls are installed prior to any construction and to ensure stormwater management features are constructed prior to significant clearing and grubbing.
- Providing Sedimentation & Erosion Control Methods and Procedures on the site plan to ensure the downgradient resource areas are not impacted by sedimentation and erosion during construction.
- Constructing stormwater management features between the pastures and the downgradient resource areas to control both peak rate of runoff and volume of runoff from the pasture and paddock areas during construction and after project completion.
- Rotating pastures throughout the year to prevent one paddock from becoming over-used. The rotation will shift the horses out of a paddock before vegetative cover is lost. The wet paddock allows horses to roam during rainy days when the grass pastures are vulnerable to being excessively trampled and muddied.

## **Conclusion**

Goddard Consulting believes that the Applicant's effort to provide appropriate stormwater management to the project design will ensure the long-term success of the project. Goddard does not anticipate that the proposed project will have any adverse impacts on the interests identified in the Wetlands Protection Act or Northborough Wetlands Bylaw. The project meets all regulatory compliance standards under the Wetlands Protection Act and the Town of Northborough Wetlands Bylaw, therefore, Goddard Consulting respectfully requests that the Northborough Conservation Commission issues an Order of Conditions approving the proposed project. Please feel free to contact us if you have any questions.

Sincerely,  
**Goddard Consulting, LLC**



**Mitch Maslanka**  
*Wetland Scientist*

CC: Bethany Sepe, 190 Howard Street, Northborough, MA 01532

# Stormwater Management Documentation

## 190 Howard Street

### Northborough, Massachusetts

*December 2, 2021*

Prepared by:  
Connorstone Engineering, Inc.  
10 Southwest Cutoff  
Northborough, MA

#### Project Description / Summary

The subject site consists of a 9.2 acre parcel with an address of 190 Howard Street. The parcel has frontage on both Howard Street and Washburn Street. The existing conditions include a single family home with outbuildings and driveway access to Howard Street. The proposed project would include construction of two paddocks and three pasture areas for keeping horses.

The attached Stormwater Mitigation Plan has been prepared to address concerns related to runoff from the pasture/paddock area leading to the large wetland at the base of the property. The wetland runs along the rear property lines of the residential lots on Washburn Street and generally flows to the south. The proposed plan and associated analysis is focused on the Pasture/Paddock areas upgradient of this wetland.

The proposed stormwater management plan has been designed to control both the peak rate of runoff and volume of runoff from the pasture and paddock areas. The proposed design includes a shallow stormwater basin / rain garden to be constructed along the down gradient edge of the pastures. This basin would be created by installing a small (2' tall) earth berm along the 25 foot no disturb zone. This would allow the bottom of basin to remain in its natural vegetated state and reduce the required clearing or land disturbance. The basin would also provide water quality treatment equivalent to just over 1-inch times the entire pasture areas.

Based upon discussion with the owner, the pastures would be under rotation to limit the grazing and preserve the vegetated condition. However, as a conservative design approach, the calculations have assumed the pasture areas to be heavily grazed with less than 50% vegetation (hydrologically 'poor' condition).

The following summary tables present the existing and proposed condition rates and volumes of runoff from the proposed work area tributary to the downgradient wetland.

	<b>2-Year Storm Existing (Proposed)</b>	<b>10-Year Storm Existing (Proposed)</b>	<b>25-Year Storm Existing (Proposed)</b>	<b>100-Year Storm Existing (Proposed)</b>
Rate of Runoff	0.1 cfs (0.0 cfs)	0.9 cfs (0.3 cfs)	1.5 cfs (0.8 cfs)	2.7 cfs (2.5 cfs)
Volume of Runoff	0.02 ac-ft (0.00 ac-ft)	0.08 ac-ft (0.06 ac-ft)	0.13 ac-ft (0.11 ac-ft)	0.22 ac-ft (0.22 ac-ft)

## Hydrologic Model

The Hydrologic Model output has been attached to this report.

The pre- and post-development stormwater runoff has been analyzed using HydroCAD 9.10, which is a stormwater modeling computer program utilizing a collection of techniques for the generation and routing of hydrographs, including Soil Conservation Service (SCS) Technical Release No. 20 (TR-20) and SCS Technical Release 55 (TR-55), *Urban Hydrology for Small Watersheds*. Rainfall depths for the design storms were taken from the most recent NOAA Atlas 14 for Northborough, MA. A copy of the point precipitation data is included in the model output section of this report. The rainfall depths used in the calculations are listed below:

<u>Return Period</u>	<u>Inches</u>
2 year	3.3
10 year	5.0
25 year	6.1
100year	7.8

The Natural Resource Conservation Service has mapped the soils on site as "Chatfield Hollis Rock Outcrop," which is classified as Hydrologic Soil Group B. Limitations with this soil would include areas of shallow ledge and groundwater. The mapping agrees with knowledge of the site and visual inspection showing wetlands and surface rocks. Hydrologic soil group B was utilized in the design calculations.

### Water Quality Volume Summary

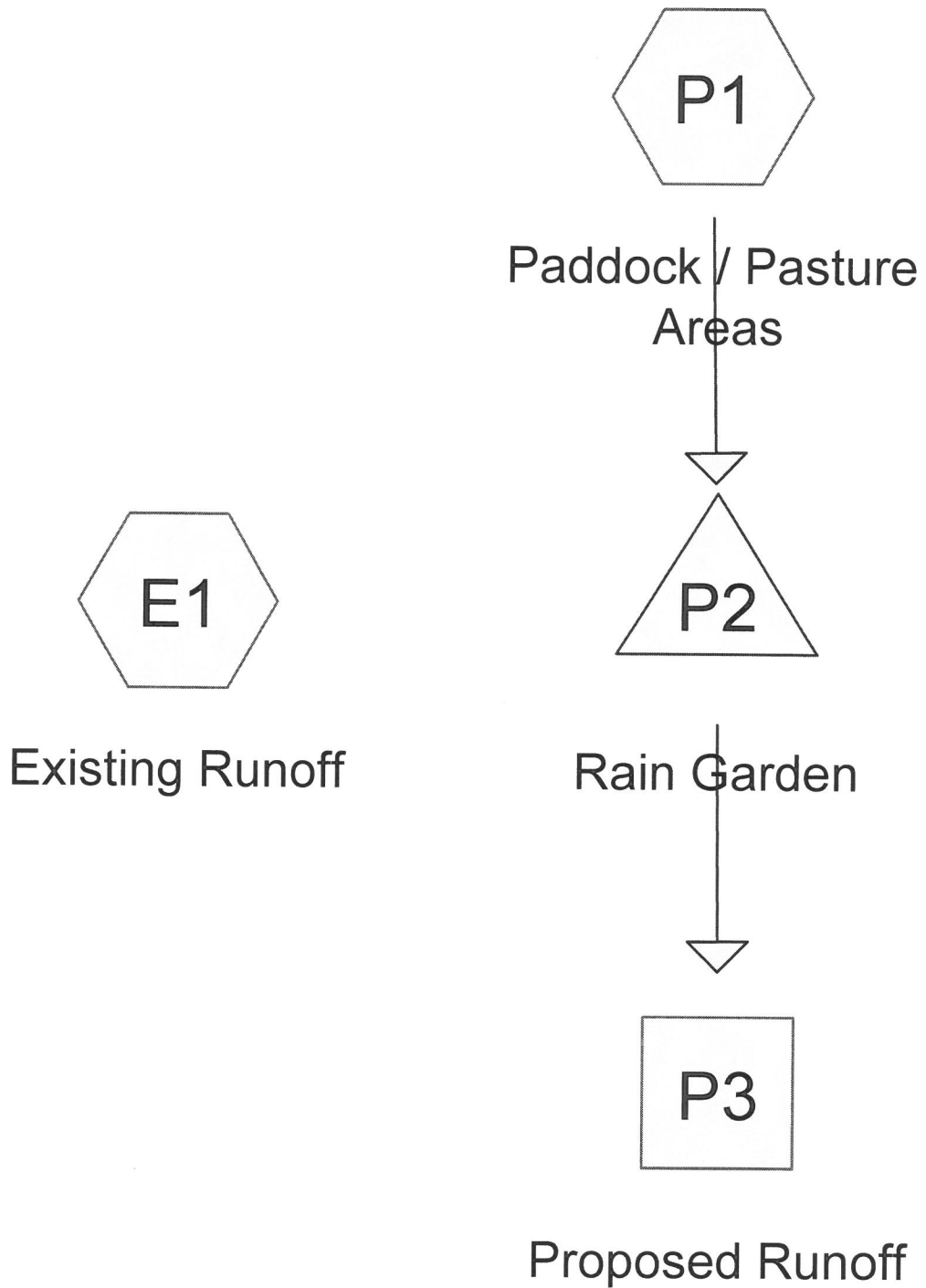
Proposed Paddock Areas = 23,890 sq. ft.

Design Water Quality Volume = (1-inch) x 23,890 s.f. = 1,990 c.f.

Proposed Water Quality Volume = 2,020 c.f. (volume below outlet)

Prepared By:  
Connorstone Engineering, Inc.







POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

[PF\\_tabular](#) | [PF\\_graphical](#) | [Maps & aeriels](#)

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)<sup>1</sup>

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.347 (0.266-0.445)	0.409 (0.313-0.525)	0.511 (0.390-0.657)	0.595 (0.451-0.770)	0.711 (0.523-0.959)	0.799 (0.577-1.10)	0.889 (0.624-1.27)	0.987 (0.662-1.45)	1.12 (0.727-1.71)	1.23 (0.781-1.91)
10-min	0.492 (0.377-0.630)	0.580 (0.444-0.744)	0.724 (0.552-0.931)	0.843 (0.639-1.09)	1.01 (0.741-1.36)	1.13 (0.817-1.56)	1.26 (0.884-1.80)	1.40 (0.938-2.05)	1.59 (1.03-2.42)	1.75 (1.11-2.71)
15-min	0.579 (0.443-0.742)	0.682 (0.522-0.875)	0.851 (0.649-1.10)	0.991 (0.752-1.28)	1.18 (0.872-1.60)	1.33 (0.961-1.83)	1.48 (1.04-2.11)	1.65 (1.10-2.41)	1.87 (1.21-2.85)	2.06 (1.30-3.19)
30-min	0.782 (0.599-1.00)	0.923 (0.706-1.18)	1.15 (0.879-1.48)	1.34 (1.02-1.74)	1.61 (1.18-2.17)	1.81 (1.30-2.49)	2.01 (1.41-2.87)	2.24 (1.50-3.28)	2.55 (1.65-3.87)	2.80 (1.77-4.34)
60-min	0.985 (0.754-1.26)	1.16 (0.890-1.49)	1.45 (1.11-1.87)	1.70 (1.29-2.19)	2.03 (1.49-2.74)	2.28 (1.65-3.14)	2.54 (1.79-3.63)	2.83 (1.90-4.14)	3.22 (2.09-4.90)	3.54 (2.24-5.49)
2-hr	1.22 (0.944-1.56)	1.47 (1.13-1.87)	1.87 (1.44-2.39)	2.20 (1.68-2.84)	2.66 (1.98-3.58)	3.00 (2.19-4.14)	3.37 (2.39-4.82)	3.79 (2.55-5.52)	4.40 (2.86-6.65)	4.92 (3.12-7.57)
3-hr	1.40 (1.08-1.78)	1.69 (1.31-2.15)	2.17 (1.67-2.76)	2.56 (1.97-3.29)	3.11 (2.32-4.18)	3.51 (2.57-4.83)	3.95 (2.82-5.65)	4.46 (3.01-6.48)	5.22 (3.39-7.86)	5.86 (3.73-8.99)
6-hr	1.78 (1.39-2.25)	2.17 (1.69-2.74)	2.79 (2.16-3.53)	3.30 (2.55-4.21)	4.01 (3.01-5.37)	4.54 (3.35-6.21)	5.11 (3.67-7.28)	5.78 (3.92-8.36)	6.80 (4.43-10.2)	7.66 (4.89-11.7)
12-hr	2.28 (1.79-2.86)	2.75 (2.16-3.46)	3.54 (2.76-4.46)	4.18 (3.25-5.31)	5.08 (3.88-6.74)	5.74 (4.25-7.80)	6.45 (4.78-8.92)	7.29 (4.96-10.5)	8.55 (5.60-12.7)	9.62 (6.15-14.6)
24-hr	2.70 (2.14-3.38)	3.29 (2.59-4.11)	4.24 (3.33-5.31)	5.03 (3.93-6.34)	6.11 (4.64-8.08)	6.92 (5.16-9.35)	7.79 (5.66-11.0)	8.82 (6.02-12.6)	10.4 (6.82-15.3)	11.7 (7.52-17.6)
2-day	2.99 (2.38-3.71)	3.67 (2.92-4.56)	4.79 (3.79-5.97)	5.72 (4.50-7.16)	6.99 (5.35-9.21)	7.94 (5.96-10.7)	9.08 (6.57-12.6)	10.2 (7.00-14.5)	12.2 (8.02-17.8)	13.9 (8.92-20.7)
3-day	3.22 (2.58-3.99)	3.96 (3.16-4.90)	5.16 (4.11-6.41)	6.16 (4.87-7.69)	7.54 (5.79-9.89)	8.55 (6.44-11.5)	9.65 (7.10-13.5)	11.0 (7.56-15.6)	13.1 (8.66-19.2)	14.9 (9.64-22.2)
4-day	3.46 (2.77-4.27)	4.23 (3.39-5.22)	5.49 (4.38-6.80)	6.53 (5.18-8.14)	7.97 (6.13-10.4)	9.03 (6.82-12.1)	10.2 (7.50-14.2)	11.6 (7.97-16.3)	13.8 (9.11-20.1)	15.7 (10.1-23.2)
7-day	4.14 (3.34-5.09)	4.97 (4.01-6.11)	6.33 (5.08-7.81)	7.46 (5.95-9.24)	9.01 (6.96-11.7)	10.2 (7.69-13.5)	11.4 (8.40-15.7)	12.9 (8.89-18.0)	15.1 (10.0-21.9)	17.0 (11.0-25.1)
10-day	4.82 (3.90-5.90)	5.68 (4.59-6.96)	7.10 (5.72-8.73)	8.27 (6.62-10.2)	9.89 (7.66-12.8)	11.1 (8.41-14.6)	12.4 (9.11-17.0)	13.9 (9.61-19.3)	16.1 (10.7-23.2)	17.9 (11.6-26.3)
20-day	6.87 (5.60-8.37)	7.80 (6.35-9.50)	9.32 (7.56-11.4)	10.6 (8.52-13.0)	12.3 (9.57-15.7)	13.6 (10.3-17.7)	15.0 (11.0-20.1)	16.4 (11.4-22.7)	18.4 (12.3-26.3)	20.0 (13.0-29.1)
30-day	8.59 (7.03-10.4)	9.55 (7.81-11.6)	11.1 (9.06-13.6)	12.4 (10.1-15.2)	14.2 (11.1-18.0)	15.6 (11.9-20.2)	17.0 (12.4-22.6)	18.4 (12.9-25.3)	20.2 (13.5-28.7)	21.5 (14.0-31.3)
45-day	10.7 (8.80-12.9)	11.7 (9.62-14.2)	13.4 (10.9-16.2)	14.7 (12.0-18.0)	16.6 (13.0-20.9)	18.1 (13.8-23.2)	19.5 (14.3-25.7)	20.8 (14.6-28.5)	22.5 (15.1-31.8)	23.6 (15.4-34.1)
60-day	12.5 (10.3-15.0)	13.5 (11.1-16.3)	15.2 (12.5-18.4)	16.7 (13.6-20.3)	18.6 (14.6-23.3)	20.2 (15.4-25.7)	21.6 (15.8-28.3)	22.9 (16.1-31.2)	24.4 (16.4-34.4)	25.4 (16.6-36.6)

<sup>1</sup> Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS). Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values. Please refer to NOAA Atlas 14 document for more information.







**Summary for Subcatchment E1: Existing Runoff**

Runoff = 0.13 cfs @ 12.40 hrs, Volume= 0.02 af, Depth> 0.24"

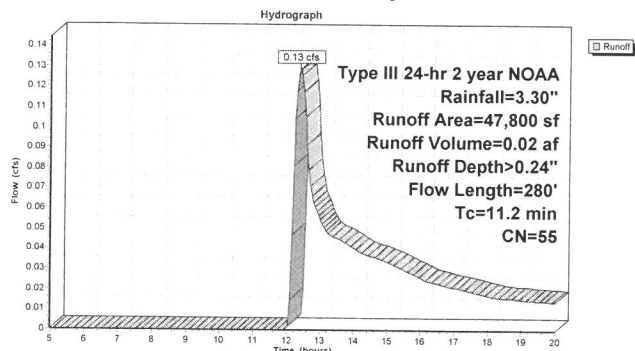
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 2 year NOAA Rainfall=3.30"

Area (sf)	CN	Description
47,800	55	Woods, Good, HSG B
47,800		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	50	0.0600	0.11		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.30"
3.4	230	0.0500	1.12		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
11.2	280	Total			

**Subcatchment E1: Existing Runoff**



**Summary for Subcatchment P1: Paddock / Pasture Areas**

Runoff = 0.94 cfs @ 12.13 hrs, Volume= 0.07 af, Depth> 0.80"

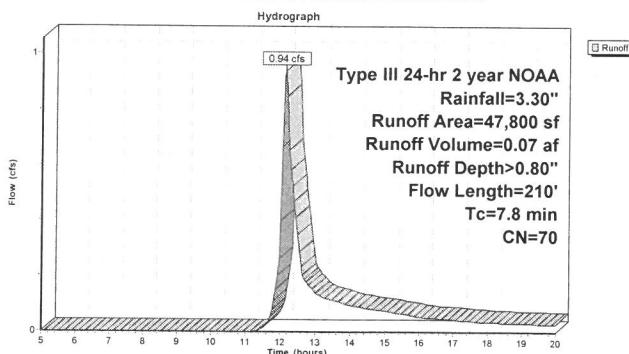
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 2 year NOAA Rainfall=3.30"

Area (sf)	CN	Description
12,055	61	>75% Grass cover, Good, HSG B
23,890	79	Pasture/grassland/range, Poor, HSG B
11,855	61	Crushed Stone / Sand Surface
47,800	70	Weighted Average
47,800		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	50	0.0400	0.14		Sheet Flow, Grass: Dense n= 0.240 P2= 3.30"
1.7	160	0.0500	1.57		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
7.8	210	Total			

**Subcatchment P1: Paddock / Pasture Areas**

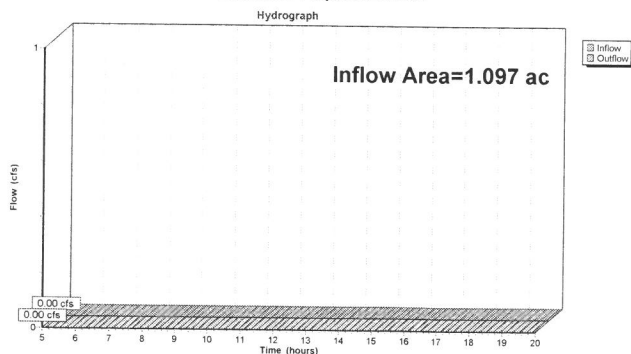


**Summary for Reach P3: Proposed Runoff**

Inflow Area = 1.097 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2 year NOAA event  
 Inflow = 0.00 cfs @ 5.00 hrs, Volume= 0.00 af  
 Outflow = 0.00 cfs @ 5.00 hrs, Volume= 0.00 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 P3: Proposed Runoff**



**Summary for Pond P2: Rain Garden**

Inflow Area = 1.097 ac, 0.00% Impervious, Inflow Depth > 0.80" for 2 year NOAA event  
 Inflow = 0.94 cfs @ 12.13 hrs, Volume= 0.07 af  
 Outflow = 0.09 cfs @ 14.36 hrs, Volume= 0.05 af, Atten= 91%, Lag= 133.8 min  
 Discarded = 0.09 cfs @ 14.36 hrs, Volume= 0.05 af  
 Primary = 0.00 cfs @ 5.00 hrs, Volume= 0.00 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Peak Elev= 326.85' @ 14.36 hrs Surf.Area= 2,976 sf Storage= 1,533 cf

Plug-Flow detention time= 193.3 min calculated for 0.05 af (72% of inflow)  
 Center-of-Mass det. time= 123.9 min (952.0 - 828.1)

Volume	Invert	Avail. Storage	Storage Description
#1	326.00'	6,375 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf. Area (sq-ft)	Inc. Store (cubic-feet)	Cum. Store (cubic-feet)
326.00	650	0	0
327.00	3,400	2,025	2,025
328.00	5,300	4,350	6,375

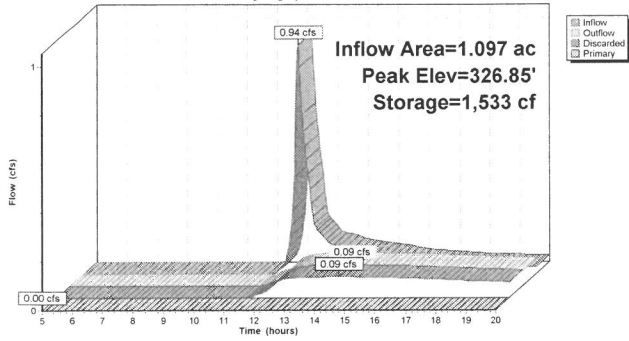
Device	Routing	Invert	Outlet Devices
#1	Discarded	326.00'	1.020 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 324.00'
#2	Primary	327.50'	4.0' long x 2.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32
#3	Primary	327.00'	4.0" Round Culvert X 2.00 L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 327.00' / 326.75' S= 0.0250 /' Cc= 0.900 n= 0.012

Discarded OutFlow Max=0.09 cfs @ 14.36 hrs HW=326.85' (Free Discharge)  
 1=Exfiltration (Controls 0.09 cfs)

Primary OutFlow Max=0.00 cfs @ 5.00 hrs HW=326.00' (Free Discharge)  
 2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)  
 3=Culvert (Controls 0.00 cfs)

**Pond P2: Rain Garden**

Hydrograph



**Summary for Subcatchment E1: Existing Runoff**

Runoff = 0.88 cfs @ 12.19 hrs, Volume= 0.08 af, Depth> 0.92"

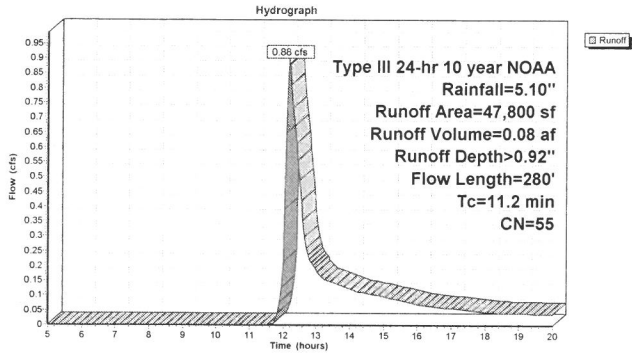
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 10 year NOAA Rainfall=5.10"

Area (sf)	CN	Description
47,800	55	Woods, Good, HSG B
47,800		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	50	0.0600	0.11		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.30"
3.4	230	0.0500	1.12		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
11.2	280	Total			

**Subcatchment E1: Existing Runoff**



**Summary for Subcatchment P1: Paddock / Pasture Areas**

Runoff = 2.48 cfs @ 12.12 hrs, Volume= 0.18 af, Depth> 1.94"

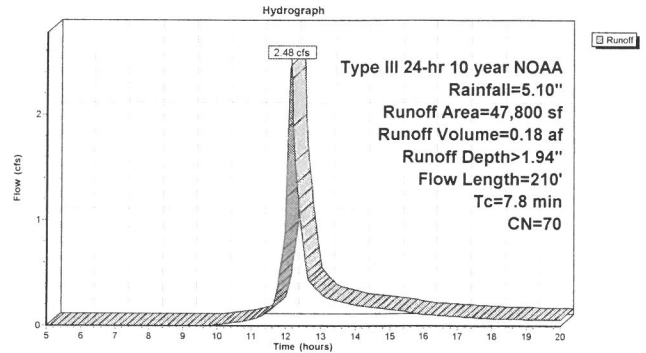
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 10 year NOAA Rainfall=5.10"

Area (sf)	CN	Description
12,055	61	>75% Grass cover, Good, HSG B
23,890	79	Pasture/grassland/range, Poor, HSG B
11,855	61	Crushed Stone / Sand Surface
47,800	70	Weighted Average
47,800		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	50	0.0400	0.14		Sheet Flow, Grass: Dense n= 0.240 P2= 3.30"
1.7	160	0.0500	1.57		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
7.8	210	Total			

**Subcatchment P1: Paddock / Pasture Areas**

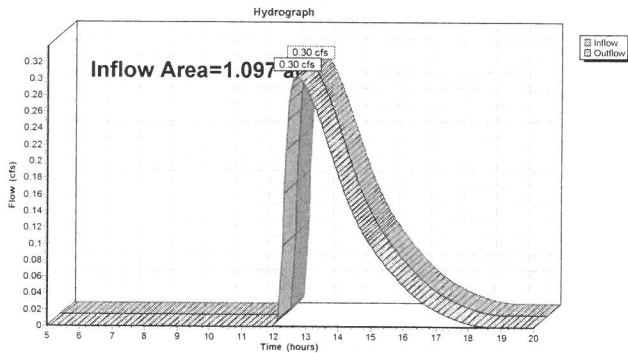


**Summary for Reach P3: Proposed Runoff**

Inflow Area = 1.097 ac, 0.00% Impervious, Inflow Depth = 0.63" for 10 year NOAA event  
 Inflow = 0.30 cfs @ 12.67 hrs, Volume= 0.06 af  
 Outflow = 0.30 cfs @ 12.67 hrs, Volume= 0.06 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 P3: Proposed Runoff**



**Summary for Pond P2: Rain Garden**

Inflow Area = 1.097 ac, 0.00% Impervious, Inflow Depth > 1.94" for 10 year NOAA event  
 Inflow = 2.48 cfs @ 12.12 hrs, Volume= 0.18 af  
 Outflow = 0.43 cfs @ 12.67 hrs, Volume= 0.14 af, Atten= 82%, Lag= 33.1 min  
 Discarded = 0.13 cfs @ 12.67 hrs, Volume= 0.08 af  
 Primary = 0.30 cfs @ 12.67 hrs, Volume= 0.06 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Peak Elev= 327.37' @ 12.67 hrs Surf.Area= 4,112 sf Storage= 3,433 cf

Plug-Flow detention time= 142.1 min calculated for 0.14 af (76% of inflow)  
 Center-of-Mass det. time= 82.6 min ( 890.7 - 808.0 )

Volume	Invert	Avail.Storage	Storage Description
#1	326.00'	6,375 cf	Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
326.00	650	0	0
327.00	3,400	2,025	2,025
328.00	5,300	4,350	6,375

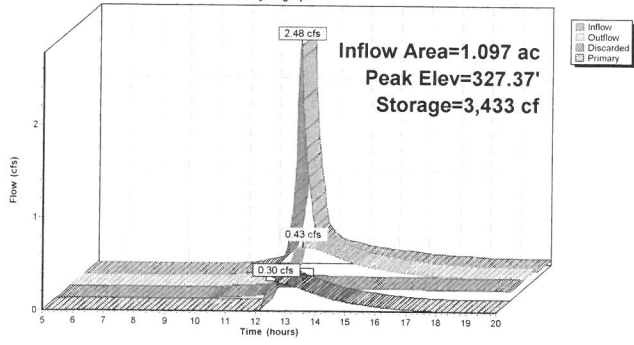
Device	Routing	Invert	Outlet Devices
#1	Discarded	326.00'	1.020 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 324.00'
#2	Primary	327.50'	4.0' long x 2.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32
#3	Primary	327.00'	4.0" Round Culvert X 2.00 L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 327.00' / 326.75' S= 0.0250' /' Cc= 0.900 n= 0.012

Discarded OutFlow Max=0.13 cfs @ 12.67 hrs HW=327.37' (Free Discharge)  
 1=Exfiltration (Controls 0.13 cfs)

Primary OutFlow Max=0.30 cfs @ 12.67 hrs HW=327.37' (Free Discharge)  
 2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)  
 3=Culvert (Inlet Controls 0.30 cfs @ 1.73 fps)

Pond P2: Rain Garden

Hydrograph



**Summary for Subcatchment E1: Existing Runoff**

Runoff = 1.49 cfs @ 12.18 hrs, Volume= 0.13 af, Depth> 1.42"

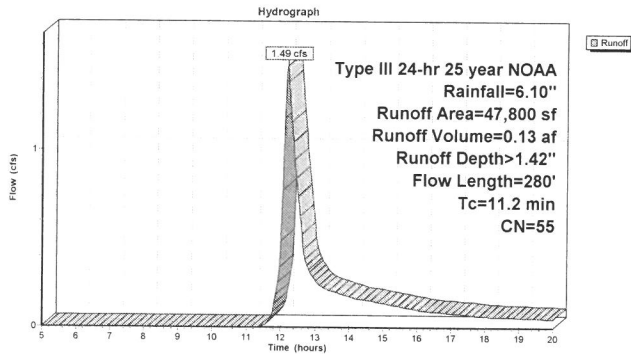
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 25 year NOAA Rainfall=6.10"

Area (sf)	CN	Description
47,800	55	Woods, Good, HSG B
47,800		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	50	0.0600	0.11		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.30"
3.4	230	0.0500	1.12		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
11.2	280	Total			

**Subcatchment E1: Existing Runoff**



**Summary for Subcatchment P1: Paddock / Pasture Areas**

Runoff = 3.42 cfs @ 12.12 hrs, Volume= 0.24 af, Depth> 2.67"

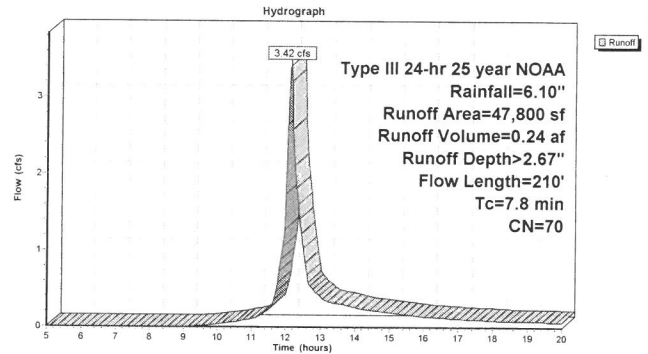
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 25 year NOAA Rainfall=6.10"

Area (sf)	CN	Description
12,055	61	>75% Grass cover, Good, HSG B
23,890	79	Pasture/grassland/range, Poor, HSG B
11,855	61	Crushed Stone / Sand Surface
47,800	70	Weighted Average
47,800		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	50	0.0400	0.14		Sheet Flow, Grass: Dense n= 0.240 P2= 3.30"
1.7	160	0.0500	1.57		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
7.8	210	Total			

**Subcatchment P1: Paddock / Pasture Areas**

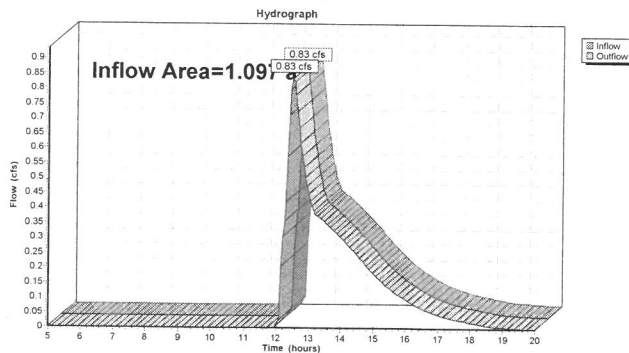


**Summary for Reach P3: Proposed Runoff**

Inflow Area = 1.097 ac, 0.00% Impervious, Inflow Depth > 1.23" for 25 year NOAA event  
 Inflow = 0.83 cfs @ 12.51 hrs, Volume= 0.11 af  
 Outflow = 0.83 cfs @ 12.51 hrs, Volume= 0.11 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 P3: Proposed Runoff**



**Summary for Pond P2: Rain Garden**

Inflow Area = 1.097 ac, 0.00% Impervious, Inflow Depth > 2.67" for 25 year NOAA event  
 Inflow = 3.42 cfs @ 12.12 hrs, Volume= 0.24 af  
 Outflow = 0.99 cfs @ 12.51 hrs, Volume= 0.20 af, Atten= 71%, Lag= 23.9 min  
 Discarded = 0.15 cfs @ 12.51 hrs, Volume= 0.09 af  
 Primary = 0.83 cfs @ 12.51 hrs, Volume= 0.11 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Peak Elev= 327.61' @ 12.51 hrs Surf.Area= 4,566 sf Storage= 4,470 cf

Plug-Flow detention time= 120.2 min calculated for 0.20 af (81% of inflow)  
 Center-of-Mass det. time= 68.5 min ( 869.4 - 800.9 )

Volume	Invert	Avail. Storage	Storage Description
#1	326.00'	6,375 cf	Custom Stage Data (Prismatic) Listed below (Recalc)

Elevation (feet)	Surf. Area (sq-ft)	Inc. Store (cubic-feet)	Cum. Store (cubic-feet)
326.00	650	0	0
327.00	3,400	2,025	2,025
328.00	5,300	4,350	6,375

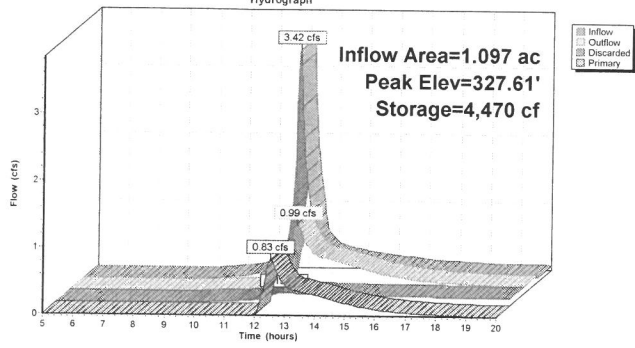
Device	Routing	Invert	Outlet Devices
#1	Discarded	326.00'	1.020 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 324.00'
#2	Primary	327.50'	4.0' long x 2.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32 4.0" Round Culvert X 2.00 L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Inverts= 327.00' / 326.75' S= 0.0250 /' Cc= 0.900 n= 0.012
#3	Primary	327.00'	

Discarded OutFlow Max=0.15 cfs @ 12.51 hrs HW=327.61' (Free Discharge)  
 1=Exfiltration (Controls 0.15 cfs)

Primary OutFlow Max=0.83 cfs @ 12.51 hrs HW=327.61' (Free Discharge)  
 2=Broad-Crested Rectangular Weir (Weir Controls 0.39 cfs @ 0.85 fps)  
 3=Culvert (Inlet Controls 0.44 cfs @ 2.54 fps)

Pond P2: Rain Garden

Hydrograph



**Summary for Subcatchment E1: Existing Runoff**

Runoff = 2.71 cfs @ 12.17 hrs, Volume= 0.22 af, Depth> 2.41"

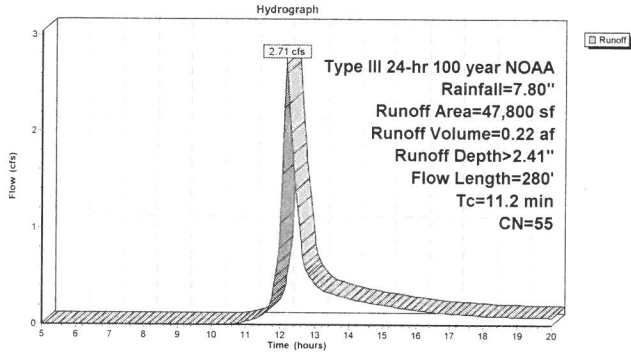
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 100 year NOAA Rainfall=7.80"

Area (sf)	CN	Description
47,800	55	Woods, Good, HSG B
47,800		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.8	50	0.0600	0.11		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 3.30"
3.4	230	0.0500	1.12		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
11.2	280	Total			

**Subcatchment E1: Existing Runoff**



**Summary for Subcatchment P1: Paddock / Pasture Areas**

Runoff = 5.13 cfs @ 12.11 hrs, Volume= 0.37 af, Depth> 4.00"

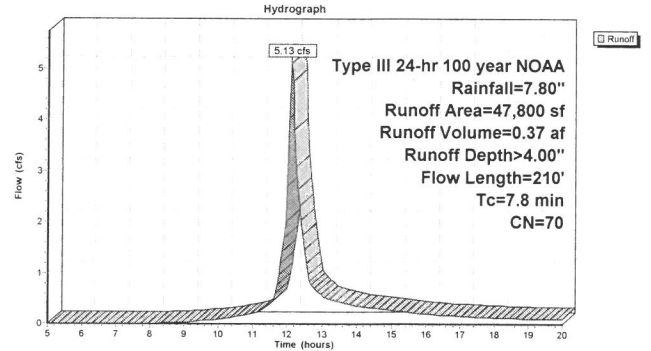
Runoff by SCS TR-20 method, UH=SCS, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Type III 24-hr 100 year NOAA Rainfall=7.80"

Area (sf)	CN	Description
12,055	61	>75% Grass cover, Good, HSG B
23,890	79	Pasture/grassland/range, Poor, HSG B
11,855	61	Crushed Stone / Sand Surface
47,800	70	Weighted Average
47,800		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	50	0.0400	0.14		Sheet Flow, Grass: Dense n= 0.240 P2= 3.30"
1.7	160	0.0500	1.57		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
7.8	210	Total			

**Subcatchment P1: Paddock / Pasture Areas**

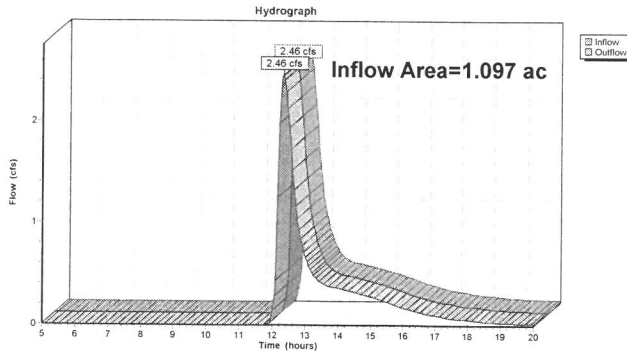


**Summary for Reach P3: Proposed Runoff**

Inflow Area = 1.097 ac, 0.00% Impervious, Inflow Depth > 2.40" for 100 year NOAA event  
 Inflow = 2.46 cfs @ 12.31 hrs, Volume= 0.22 af  
 Outflow = 2.46 cfs @ 12.31 hrs, Volume= 0.22 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 P3: Proposed Runoff**



**Summary for Pond P2: Rain Garden**

Inflow Area = 1.097 ac, 0.00% Impervious, Inflow Depth > 4.00" for 100 year NOAA event  
 Inflow = 5.13 cfs @ 12.11 hrs, Volume= 0.37 af  
 Outflow = 2.63 cfs @ 12.31 hrs, Volume= 0.31 af, Atten= 49%, Lag= 11.8 min  
 Discarded = 0.17 cfs @ 12.31 hrs, Volume= 0.10 af  
 Primary = 2.46 cfs @ 12.31 hrs, Volume= 0.22 af

Routing by Stor-Ind method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs  
 Peak Elev= 327.83' @ 12.31 hrs Surf.Area= 4,968 sf Storage= 5,478 cf

Plug-Flow detention time= 93.0 min calculated for 0.31 af (86% of inflow)  
 Center-of-Mass det. time= 51.4 min ( 843.2 - 791.8 )

Volume	Invert	Avail.Storage	Storage	Description
#1	326.00'	6,375 cf		Custom Stage Data (Prismatic) Listed below (Recalc)
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	
326.00	650	0	0	
327.00	3,400	2,025	2,025	
328.00	5,300	4,350	6,375	

Device	Routing	Invert	Outlet Devices
#1	Discarded	326.00'	1.020 in/hr Exfiltration over Surface area Conductivity to Groundwater Elevation = 324.00'
#2	Primary	327.50'	4.0' long x 2.0' breadth Broad-Crested Rectangular Weir 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 Coef. (English) 2.54 2.61 2.61 2.60 2.66 2.70 2.77 2.89 2.88 2.85 3.07 3.20 3.32
#3	Primary	327.00'	4.0" Round Culvert X 2.00 L= 10.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 327.00' / 326.75' S= 0.0250' /' Cc= 0.900 n= 0.012

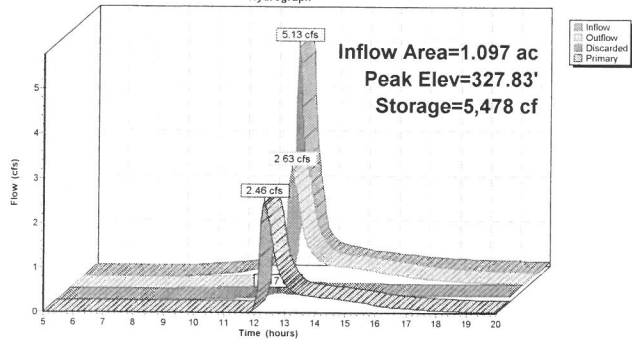
Discarded OutFlow Max=0.17 cfs @ 12.31 hrs HW=327.82' (Free Discharge)  
 1=Exfiltration ( Controls 0.17 cfs)

Primary OutFlow Max=2.44 cfs @ 12.31 hrs HW=327.82' (Free Discharge)  
 2=Broad-Crested Rectangular Weir (Weir Controls 1.91 cfs @ 1.47 fps)  
 3=Culvert (Inlet Controls 0.54 cfs @ 3.08 fps)



Pond P2: Rain Garden

Hydrograph



Soil Map—Worcester County, Massachusetts, Northeastern Part



Soil Map may not be valid at this scale.

Map Scale: 1:1,240 if printed on A landscape (11" x 8.5") sheet.


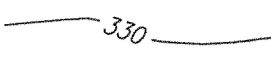
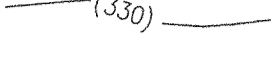
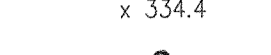



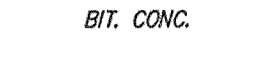
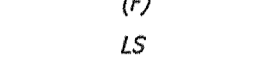
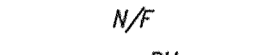
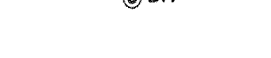




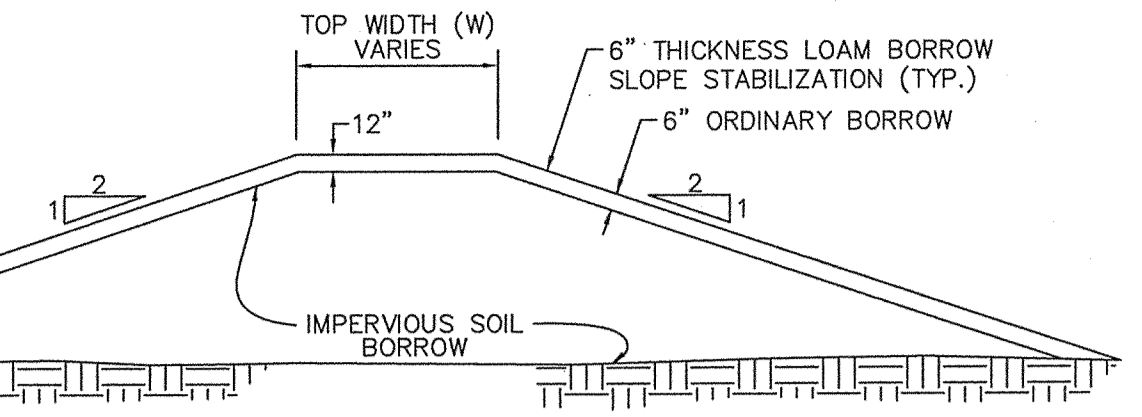
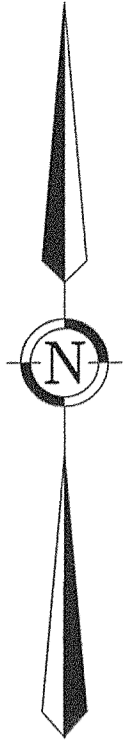
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

## Map Unit Legend

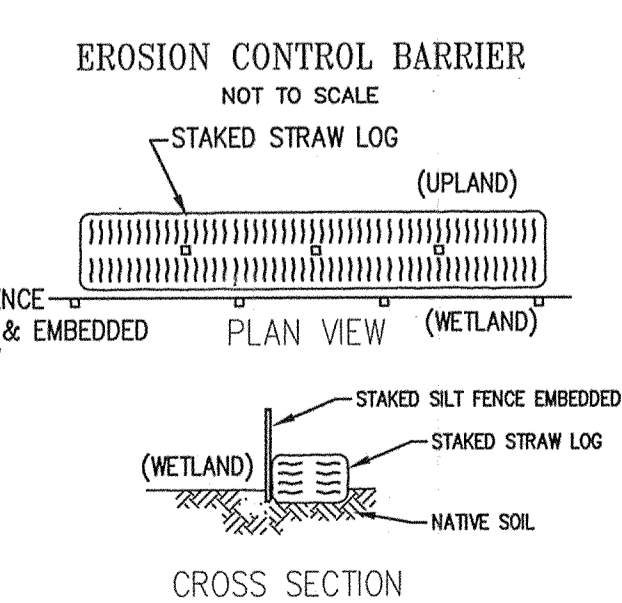
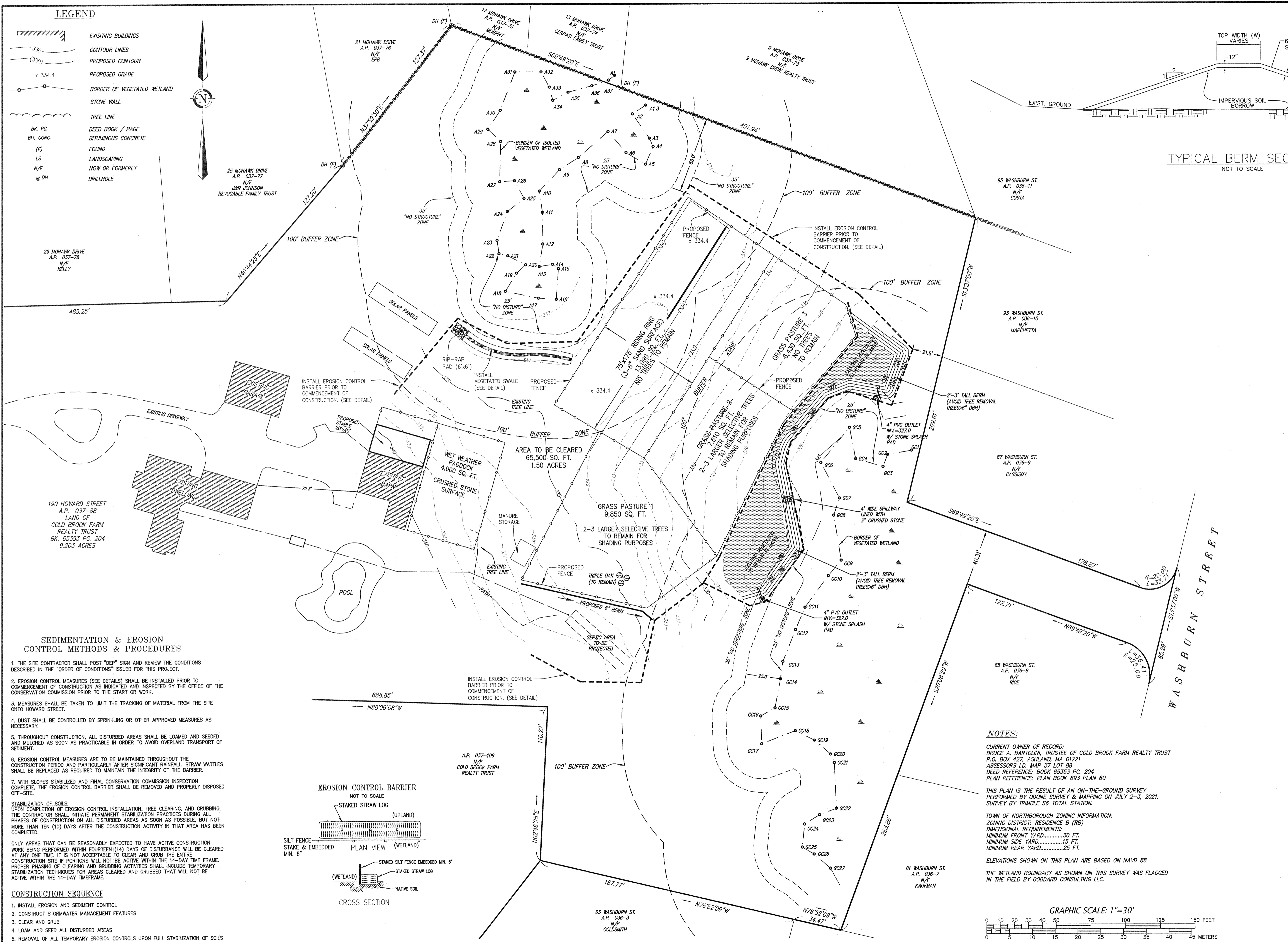
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
71A	Ridgebury fine sandy loam, 0 to 3 percent slopes, extremely stony	0.8	14.3%
102C	Chatfield-Hollis-Rock outcrop complex, 0 to 15 percent slopes	4.9	85.7%
<b>Totals for Area of Interest</b>		<b>5.7</b>	<b>100.0%</b>

**LEGEND**

-  EXISTING BUILDINGS
-  CONTOUR LINES
-  PROPOSED CONTOUR
-  PROPOSED GRADE
-  BORDER OF VEGETATED WETLAND
-  STONE WALL
-  TREE LINE
-  BK. PG.
-  BIT. CONC.
-  (F)
-  LS
-  N/F
-  DH
- DEED BOOK / PAGE
- BITUMINOUS CONCRETE
- FOUND
- LANDSCAPING
- NOW OR FORMERLY
- DRILLHOLE



TYPICAL BERM SECTION  
NOT TO SCALE



**SEDIMENTATION & EROSION CONTROL METHODS & PROCEDURES**

1. THE SITE CONTRACTOR SHALL POST "DEP" SIGN AND REVIEW THE CONDITIONS DESCRIBED IN THE "ORDER OF CONDITIONS" ISSUED FOR THIS PROJECT.
2. EROSION CONTROL MEASURES (SEE DETAILS) SHALL BE INSTALLED PRIOR TO COMMENCEMENT OF CONSTRUCTION AS INDICATED AND INSPECTED BY THE OFFICE OF THE CONSERVATION COMMISSION PRIOR TO THE START OR WORK.
3. MEASURES SHALL BE TAKEN TO LIMIT THE TRACKING OF MATERIAL FROM THE SITE ONTO HOWARD STREET.
4. DUST SHALL BE CONTROLLED BY SPRINKLING OR OTHER APPROVED MEASURES AS NECESSARY.
5. THROUGHOUT CONSTRUCTION, ALL DISTURBED AREAS SHALL BE LOAMED AND SEEDED AND MULCHED AS SOON AS PRACTICABLE IN ORDER TO AVOID OVERLAND TRANSPORT OF SEDIMENT.
6. EROSION CONTROL MEASURES ARE TO BE MAINTAINED THROUGHOUT THE CONSTRUCTION PERIOD AND PARTICULARLY AFTER SIGNIFICANT RAINFALL. STRAW WATTLES SHALL BE REPLACED AS REQUIRED TO MAINTAIN THE INTEGRITY OF THE BARRIER.
7. WITH SLOPES STABILIZED AND FINAL CONSERVATION COMMISSION INSPECTION COMPLETE, THE EROSION CONTROL BARRIER SHALL BE REMOVED AND PROPERLY DISPOSED OFF-SITE.

**STABILIZATION OF SOILS**  
UPON COMPLETION OF EROSION CONTROL INSTALLATION, TREE CLEARING, AND GRUBBING, THE CONTRACTOR SHALL INITIATE PERMANENT STABILIZATION PRACTICES DURING ALL PHASES OF CONSTRUCTION ON ALL DISTURBED AREAS AS SOON AS POSSIBLE, BUT NOT MORE THAN TEN (10) DAYS AFTER THE CONSTRUCTION ACTIVITY IN THAT AREA HAS BEEN COMPLETED.

ONLY AREAS THAT CAN BE REASONABLY EXPECTED TO HAVE ACTIVE CONSTRUCTION WORK BEING PERFORMED WITHIN FOURTEEN (14) DAYS OF DISTURBANCE WILL BE CLEARED AT ANY ONE TIME. IT IS NOT ACCEPTABLE TO CLEAR AND GRUB THE ENTIRE CONSTRUCTION SITE IF PORTIONS WILL NOT BE ACTIVE WITHIN THE 14-DAY TIME FRAME. PROPER PHASING OF CLEARING AND GRUBBING ACTIVITIES SHALL INCLUDE TEMPORARY STABILIZATION TECHNIQUES FOR AREAS CLEARED AND GRUBBED THAT WILL NOT BE ACTIVE WITHIN THE 14-DAY TIMEFRAME.

**CONSTRUCTION SEQUENCE**

1. INSTALL EROSION AND SEDIMENT CONTROL
2. CONSTRUCT STORMWATER MANAGEMENT FEATURES
3. CLEAR AND GRUB
4. LOAM AND SEED ALL DISTURBED AREAS
5. REMOVAL OF ALL TEMPORARY EROSION CONTROLS UPON FULL STABILIZATION OF SOILS

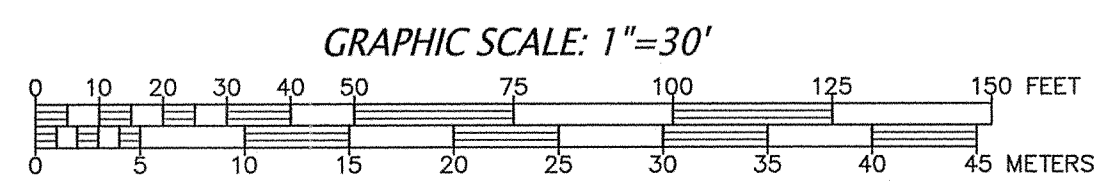
**NOTES:**

CURRENT OWNER OF RECORD:  
BRUCE A. BARTOLINI, TRUSTEE OF COLD BROOK FARM REALTY TRUST  
P.O. BOX 427, ASHLAND, MA 01721  
ASSESSORS I.D. MAP 37 LOT 88  
DEED REFERENCE: BOOK 65353 PG. 204  
PLAN REFERENCE: PLAN BOOK 693 PLAN 60

THIS PLAN IS THE RESULT OF AN ON-THE-GROUND SURVEY PERFORMED BY ODONE SURVEY & MAPPING ON JULY 2-3, 2021. SURVEY BY TRIMBLE S6 TOTAL STATION.

TOWN OF NORTHBOROUGH ZONING INFORMATION:  
ZONING DISTRICT: RESIDENCE B (RB)  
DIMENSIONAL REQUIREMENTS:  
MINIMUM FRONT YARD.....30 FT.  
MINIMUM SIDE YARD.....15 FT.  
MINIMUM REAR YARD.....25 FT.

ELEVATIONS SHOWN ON THIS PLAN ARE BASED ON NAVD 88  
THE WETLAND BOUNDARY AS SHOWN ON THIS SURVEY WAS FLAGGED IN THE FIELD BY GODDARD CONSULTING LLC.



OWNERS:  
COLD BROOK FARM REALTY TRUST  
190 HOWARD STREET  
NORTHBOROUGH, MA

**CONNORSTONE ENGINEERING INC.**  
CIVIL ENGINEERS AND LAND SURVEYORS  
10 SOUTHWEST CUTOFF, SUITE 7  
NORTHBOROUGH, MASSACHUSETTS 01532  
PHONE: 508-393-9727 FAX: 508-393-5242

**PROPOSED STORMWATER PLAN OF 190 HOWARD STREET IN NORTHBOROUGH, MA**

REVISED:	DESCRIPTION:
DRAWN BY: REM	CHECK BY: VC
DATE: DECEMBER 2, 2021	
SCALE: 1"=30' SHEET 1 OF 1.	