STORMWATER ANALYSIS & CALCULATIONS REPORT

for

43 ESTABROOK AVENUE GRAFTON, MASSACHUSETTS

(PILOT SOLAR DEVELOPMENT)

Prepared for:

Estabrook Valley, LLC
111 Huntington Avenue
Boston, Massachusetts 02199

Prepared by:

Meridian Associates, Inc.
500 Cummings Center, Suite 5950
Beverly, Massachusetts 01915
(978) 299-0447

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MERIDIAN ASSOCIATES

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- TR 20 SCS Unit Hydrograph Procedure
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SOURCE OF DATA

- Technical Report No. 20
- Technical Report No. 55
- Technical Paper No. 40
- Field Survey by Meridian Associates, Inc.
- Soil Testing by Meridian Associates, Inc.
- Massachusetts Stormwater Handbook February 2008

REPORT SUMMARY:

Calculation Objective

The purpose of this drainage analysis is to design a stormwater management system that will not increase peak rates of stormwater runoff that will flow offsite from pre to post development at the selected design points during the 2, 10, and 100-year design storm events.

The following analysis is separated into existing conditions and proposed conditions for ease of comparison. Drainage maps have been incorporated into this report to depict existing and proposed watershed areas and subcatchments for the site.

Classification of Soils:

The drainage class of the various soil types on the locus property has been categorized by applying the information provided by the soil maps prepared by the United States Department of Agriculture, National Resource Conservation Service (hereon referred to as the USDA NRCS). Based upon the USDA NRCS Soil Maps, four (4) soil groups exist within the subcatchment areas that are used throughout this drainage analysis. The four different soil types are as follows:

- Paxton Fine Sandy Loam, 3-8% Slopes, Very Stony, Hydrological Soil Group C;
- Paxton Fine Sandy Loam, 8-15% Slopes, Very Stony, Hydrological Soil Group C;
- Woodbridge Fine Sandy Loam, 0-8% slopes, Extremely Stony, Hydrological Soil Group C;
- Woodbridge Fine Sandy Loam, 3-8% slopes, Extremely Stony, Hydrological Soil Group C;

Paxton Fine Sandy Loam, 3-8% Slopes

This unit consists of very deep, strongly sloping, well-drained soil on drumlin and drumlin like areas. Parent material is Coarse-loamy lodgment till derived from gneiss, granite, and/or schist. The permeability of this soil is moderate in the subsoil and slow or very slow in the substratum.

Paxton Fine Sandy Loam, 18-15% Slopes

This unit consists of deep, moderately steep, well-drained soil on drumlins. Seasonal high groundwater is typically found at depths of 18-37" below the existing grade. Parent material is coarse-loamy lodgment till derived from gneiss, granite, and/or schist. The permeability of this soil is moderate in the subsoil and slow or very slow in the substratum.

Woodbridge Fine Sandy Loam, 0-8% slopes, Extremely Stony

This unit consists of very deep, gently sloping, moderately well-drained soil on the tops of drumlins and on glacial till uplands. Seasonal high groundwater is typically found at depths of 19-27" below the existing grade. Parent material is coarse-loamy lodgment till derived from gneiss, granite, and/or schist. The permeability of this soil is moderate in the subsoil and slow or very slow in the substratum.

Woodbridge Fine Sandy Loam, 3-8% slopes

This unit consists of very deep, gently sloping, moderately well-drained soil on the tops of drumlins and on glacial till uplands. Seasonal high groundwater is typically found at depths of 19-27" below the existing grade. Parent material is coarse-loamy lodgment till derived from gneiss, granite, and/or schist. The permeability of this soil is moderate in the subsoil and slow or very slow in the substratum.

Selection of Storm Events

The storm event rainfall frequencies have been selected based upon the Massachusetts Stormwater Guidelines requirements. Storm event rainfall data has been compiled from Technical Release No. 55, Urban Hydrology for Small Watersheds, 2nd Edition, prepared by the U.S. Soil Conservation Service. Rainfall frequency data has been provided as follows:

Frequency (Years)	Rainfall [24 hour event (inches)]
2	3.0
10	4.5
100	6.5

Existing Site Overview

The project area is bordered by undeveloped land to the east and west with agricultural fields to the south with agricultural fields and solar farms to the north on the opposite side of Estabrook Avenue. The majority of the area included within the drainage analysis currently slopes west to east and east to west toward two existing resource areas. The stormwater runoff patterns established within the pre-development conditions are based on existing topography, which indicates that the runoff flows to one (1) of two (2) design points, which are listed below:

- Design Point #1 **(DP1)** is the existing wetland located to the north of Estabrook Avenue.
- Design Point #2 **(DP2)** is the existing gravel drive on the western portion of the parcel.

The existing site has been broken into two (2) subcatchments as depicted on the Pre-Development Drainage Plan. The following summarizes the various hydraulic conditions and areas comprising the pre-hydrologic model:

- **Subcatchment SC1 –** This is denoted as SC1 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists of wooded land, meadow grass and scrub vegetation. Stormwater runoff generated in this subcatchment flows to the existing wetland to the north of Estabrook Avenue. **(DP1)**. Additionally runoff from the outlets of the existing stormwater management system for Phase II of the solar development (located to the north) was modeled as contributing to to the existing wetland to the north of Estabrook Avenue. **(DP1)**.

- **Subcatchment SC2 –** This is denoted as SC2 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists of wooded land and meadow grass. Stormwater runoff generated in this subcatchment flows to the existing gravel drive located to the west of the proposed project **(DP2)**.

Proposed Site Overview

The proposed project is comprised of the development of a solar electric generating facility, the construction of a gravel access road, gravel trench, inverter/transformer stations, interconnection equipment, electrical conduit, new utility poles and risers, fencing, gates, and associated seeding and stabilization. The existing runoff patterns will be maintained with limited selective grading. The proposed solar facility will be installed using a screw and/or post system which minimizes impact on the existing topography and reduces the need for excess earthwork.

A drainage system consisting of a gravel trench is proposed to provide water quality treatment for the gravel access drive. Additionally, peak rates of stormwater runoff in the proposed conditions will not result in an increase in the 2, 10, and 100-year storm events at the selected design points.

The proposed site has been broken into subcatchments as depicted on the Post-Development Drainage Plan. The following summarizes the various hydraulic conditions and areas comprising the post-hydrologic model.

- **Subcatchment SC101 –** This is denoted as SC101 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists of wooded land, meadow grass and "Solar Farm Seed Mix" grassed areas and "Wetmix" grassed areas, portions of the gravel drive and a concrete pad. Stormwater runoff generated in this subcatchment flows to the existing wetland to the north of Estabrook Avenue. **(DP1)**. Additionally runoff from the outlets of the existing stormwater management system for Phase II of the solar development (located to the north) was modeled as contributing to to the existing wetland to the north of Estabrook Avenue. **(DP1)**.

- **Subcatchment S201 –** This is denoted as S201 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists of meadow grass and "Solar Farm Seed Mix" grassed areas and "Wetmix" grassed areas along with portions of the gravel drive. Stormwater runoff generated in this subcatchment flows to the existing gravel drive located to the west of the proposed project **(DP2)**.

- **Subcatchment S202 –** This is denoted as S202 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists of meadow grass and "Solar Farm Seed Mix" grassed areas and "Wetmix" grassed areas along with portions of the gravel drive. Stormwater runoff generated in this subcatchment flows to a proposed stone infiltration trench that overflows towards the existing gravel drive located to the west of the proposed project **(DP2)**.

The following Table demonstrates the peak flows and volumes resulting from the stormwater analysis described in this report.

STORMWATER ANALYSIS

Summary of Flows at Design Point 1

Storm Event	Existing Conditions (Pre) Peak Flow (CFS)	Proposed Conditions (Post) Peak Flow (CFS)
2-Year (3.00 in./hr.)	3.69	3.69
10-Year (4.50 in./hr.)	9.71	9.71
100-Year (6.50 in./hr.)	29.88	29.88

Summary of Flows at Design Point 2

Storm Event	Existing Conditions (Pre) Peak Flow (CFS)	Proposed Conditions (Post) Peak Flow (CFS)
2-Year (3.00 in./hr.)	0.81	0.70
10-Year (4.50 in./hr.)	2.12	1.83
100-Year (6.50 in./hr.)	5.95	5.81

* CFS – Cubic Feet Per Second

Conclusion

The calculations demonstrate that the proposed development will not result in an increase in the peak rate of stormwater runoff for the 2-year, 10-year, or 100-year 24-hour storm events at the selected design points.

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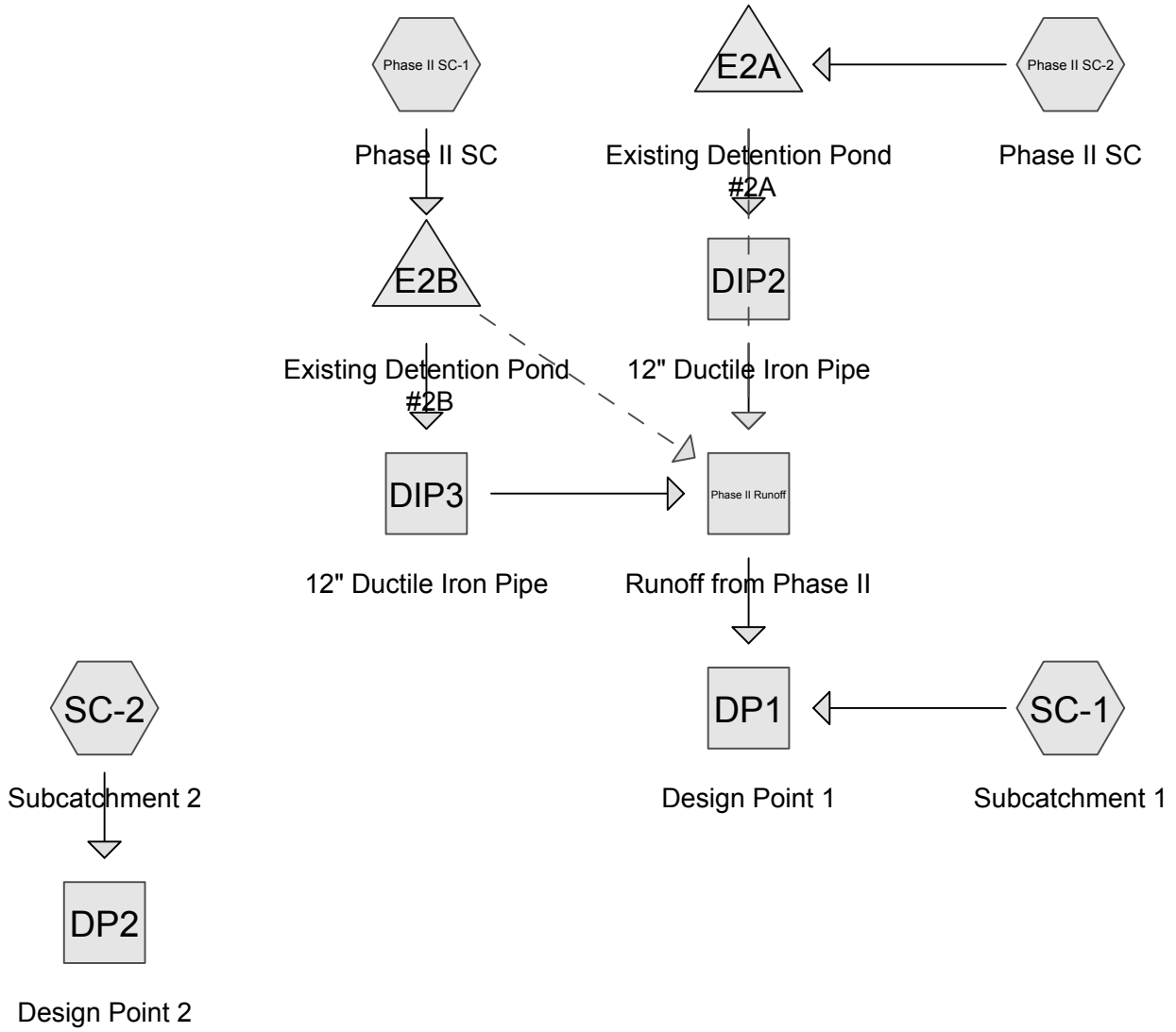
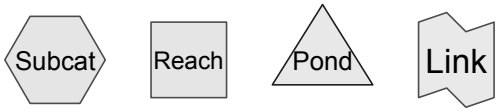
EXISTING CONDITIONS
STORMWATER CALCULATIONS





Routing Diagram for 6108_PRE
Prepared by Meridian Associates, Printed 6/25/2018
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Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
4,743	65	Brush/Scrub Vegetation, Good, HSG C (SC-1)
45,693	70	Woods, Good, HSG C (Phase II SC-1, Phase II SC-2, SC-1, SC-2)
535,117	71	Meadow, non-grazed, HSG C (Phase II SC-1, Phase II SC-2, SC-1, SC-2)
141	89	Gravel Access, HSG C (Phase II SC-2)
22,098	89	Proposed Gravel Drive, HSG C (Phase II SC-1, Phase II SC-2)
607,792	**72**	**TOTAL AREA**

Summary for Subcatchment Phase II SC-1: Phase II SC

Runoff = 2.14 cfs @ 12.33 hrs, Volume= 11,289 cf, Depth= 0.73"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-C Rainfall=2.86"

	Area (sf)	CN	Description
*	7,806	89	Proposed Gravel Drive, HSG C
	4,395	70	Woods, Good, HSG C
	174,371	71	Meadow, non-grazed, HSG C
	186,572	72	Weighted Average
	186,572		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 3.10"
8.1	858	0.0640	1.77		**Shallow Concentrated Flow, Shallow Concentrated Flow** Short Grass Pasture Kv= 7.0 fps
20.6	908	Total			

Summary for Subcatchment Phase II SC-2: Phase II SC

Runoff = 1.82 cfs @ 12.26 hrs, Volume= 8,721 cf, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-C Rainfall=2.86"

	Area (sf)	CN	Description
*	14,292	89	Proposed Gravel Drive, HSG C
	116,379	71	Meadow, non-grazed, HSG C
	4,648	70	Woods, Good, HSG C
*	141	89	Gravel Access, HSG C
	135,460	73	Weighted Average
	135,460		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	50	0.0300	0.08		**Sheet Flow, Sheet Flow** Grass: Bermuda n= 0.410 P2= 3.10"
5.9	660	0.0700	1.85		**Shallow Concentrated Flow, Shallow Concentrated Flow** Short Grass Pasture Kv= 7.0 fps
16.8	710	Total			

Summary for Subcatchment SC-1: Subcatchment 1

Runoff = 3.69 cfs @ 12.11 hrs, Volume= 13,309 cf, Depth= 0.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-C Rainfall=2.86"

	Area (sf)	CN	Description
	198,088	71	Meadow, non-grazed, HSG C
	31,617	70	Woods, Good, HSG C
*	4,743	65	Brush/Scrub Vegetation, Good, HSG C
	234,448	71	Weighted Average
	234,448		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. Engineering Practice**

Summary for Subcatchment SC-2: Subcatchment 2

Runoff = 0.81 cfs @ 12.11 hrs, Volume= 2,913 cf, Depth= 0.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-C Rainfall=2.86"

Area (sf)	CN	Description
46,279	71	Meadow, non-grazed, HSG C
5,033	70	Woods, Good, HSG C
51,312	71	Weighted Average
51,312		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. Engineering Practice**

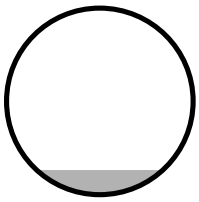
Summary for Reach DIP2: 12" Ductile Iron Pipe

Inflow Area = 135,460 sf, 0.00% Impervious, Inflow Depth = 0.19" for 2-C event
Inflow = 0.25 cfs @ 13.00 hrs, Volume= 2,169 cf
Outflow = 0.25 cfs @ 13.00 hrs, Volume= 2,169 cf, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.05 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.59 fps, Avg. Travel Time= 0.3 min

Peak Storage= 2 cf @ 13.00 hrs
Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 6.66 cfs

12.0" Round Pipe
n= 0.011 Steel, smooth
Length= 40.0' Slope= 0.0250 '/'
Inlet Invert= 485.00', Outlet Invert= 484.00'



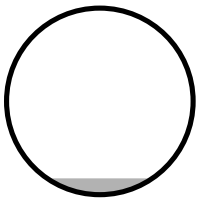
Summary for Reach DIP3: 12" Ductile Iron Pipe

Inflow Area = 186,572 sf, 0.00% Impervious, Inflow Depth = 0.08" for 2-C event
Inflow = 0.11 cfs @ 14.60 hrs, Volume= 1,216 cf
Outflow = 0.11 cfs @ 14.61 hrs, Volume= 1,216 cf, Atten= 0%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.13 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.31 fps, Avg. Travel Time= 0.3 min

Peak Storage= 1 cf @ 14.61 hrs
Average Depth at Peak Storage= 0.09'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 6.66 cfs

12.0" Round Pipe
n= 0.011 Steel, smooth
Length= 40.0' Slope= 0.0250 '/'
Inlet Invert= 485.00', Outlet Invert= 484.00'



Summary for Reach DP1: Design Point 1

Inflow Area = 556,480 sf, 0.00% Impervious, Inflow Depth = 0.36" for 2-C event
Inflow = 3.69 cfs @ 12.11 hrs, Volume= 16,694 cf
Outflow = 3.69 cfs @ 12.11 hrs, Volume= 16,694 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach DP2: Design Point 2

Inflow Area = 51,312 sf, 0.00% Impervious, Inflow Depth = 0.68" for 2-C event
Inflow = 0.81 cfs @ 12.11 hrs, Volume= 2,913 cf
Outflow = 0.81 cfs @ 12.11 hrs, Volume= 2,913 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach Phase II Runoff: Runoff from Phase II

Inflow Area = 322,032 sf, 0.00% Impervious, Inflow Depth = 0.13" for 2-C event
Inflow = 0.27 cfs @ 13.73 hrs, Volume= 3,384 cf
Outflow = 0.27 cfs @ 13.73 hrs, Volume= 3,384 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Pond E2A: Existing Detention Pond #2A

Inflow Area =	135,460 sf,	0.00% Impervious,	Inflow Depth =	0.77"	for 2-C event
Inflow =	1.82 cfs @	12.26 hrs,	Volume=	8,721 cf	
Outflow =	0.42 cfs @	13.00 hrs,	Volume=	8,721 cf,	Atten= 77%, Lag= 44.3 min
Discarded =	0.17 cfs @	13.00 hrs,	Volume=	6,553 cf	
Primary =	0.25 cfs @	13.00 hrs,	Volume=	2,169 cf	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0 cf	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 487.01' @ 13.00 hrs Surf.Area= 7,102 sf Storage= 3,151 cf

Plug-Flow detention time= 208.7 min calculated for 8,715 cf (100% of inflow)
Center-of-Mass det. time= 208.9 min (1,092.0 - 883.2)

Volume	Invert	Avail.Storage	Storage Description
#1	486.00'	20,288 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
486.00	1,910	277.7	0	0	1,910
486.50	1,910	277.7	955	955	2,049
487.00	7,084	380.0	2,112	3,067	7,406
488.00	8,702	421.3	7,879	10,946	10,069
489.00	9,996	441.9	9,342	20,288	11,549

Device	Routing	Invert	Outlet Devices
#1	Discarded	486.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	486.80'	**6.0" Vert. 6" Orifice in Riser X 2.00** C= 0.600
#3	Primary	487.80'	**12.0" Horiz. 12" Perforated Riser Pipe** C= 0.600 Limited to weir flow at low heads
#4	Secondary	488.75'	**20.0' long x 17.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.17 cfs @ 13.00 hrs HW=487.01' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.17 cfs)

Primary OutFlow Max=0.25 cfs @ 13.00 hrs HW=487.01' (Free Discharge)
├─**2=6" Orifice in Riser** (Orifice Controls 0.25 cfs @ 1.57 fps)
└─**3=12" Perforated Riser Pipe** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=486.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond E2B: Existing Detention Pond #2B

Inflow Area =	186,572 sf,	0.00% Impervious,	Inflow Depth =	0.73"	for 2-C event
Inflow =	2.14 cfs @	12.33 hrs, Volume=	11,289 cf		
Outflow =	0.28 cfs @	14.60 hrs, Volume=	11,289 cf,	Atten= 87%,	Lag= 136.7 min
Discarded =	0.17 cfs @	14.60 hrs, Volume=	10,073 cf		
Primary =	0.11 cfs @	14.60 hrs, Volume=	1,216 cf		
Secondary =	0.00 cfs @	0.00 hrs, Volume=	0 cf		

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 486.93' @ 14.60 hrs Surf.Area= 7,045 sf Storage= 5,159 cf

Plug-Flow detention time= 327.4 min calculated for 11,281 cf (100% of inflow)
Center-of-Mass det. time= 327.5 min (1,217.9 - 890.4)

Volume	Invert	Avail.Storage	Storage Description
#1	486.00'	24,627 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
486.00	5,081	472.0	0	0	5,081
486.50	5,081	472.0	2,541	2,541	5,317
487.00	7,373	502.4	3,096	5,636	7,687
488.00	9,525	529.0	8,426	14,062	9,930
489.00	11,640	554.6	10,565	24,627	12,203

Device	Routing	Invert	Outlet Devices
#1	Discarded	486.00'	**1.020 in/hr Exfiltration over Wetted area**
#2	Primary	486.80'	**6.0" Vert. 6" Orifice in Riser X 2.00** C= 0.600
#3	Primary	487.80'	**12.0" Horiz. 12" Perforated Riser Pipe** C= 0.600 Limited to weir flow at low heads
#4	Secondary	488.75'	**20.0' long x 17.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.17 cfs @ 14.60 hrs HW=486.93' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.17 cfs)

Primary OutFlow Max=0.11 cfs @ 14.60 hrs HW=486.93' (Free Discharge)
├─**2=6" Orifice in Riser** (Orifice Controls 0.11 cfs @ 1.25 fps)
└─**3=12" Perforated Riser Pipe** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=486.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Subcatchment Phase II SC-1: Phase II SC

Runoff = 5.45 cfs @ 12.30 hrs, Volume= 26,139 cf, Depth= 1.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-C Rainfall=4.31"

	Area (sf)	CN	Description
*	7,806	89	Proposed Gravel Drive, HSG C
	4,395	70	Woods, Good, HSG C
	174,371	71	Meadow, non-grazed, HSG C
	186,572	72	Weighted Average
	186,572		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 3.10"
8.1	858	0.0640	1.77		**Shallow Concentrated Flow, Shallow Concentrated Flow** Short Grass Pasture Kv= 7.0 fps
20.6	908	Total			

Summary for Subcatchment Phase II SC-2: Phase II SC

Runoff = 4.50 cfs @ 12.24 hrs, Volume= 19,795 cf, Depth= 1.75"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-C Rainfall=4.31"

	Area (sf)	CN	Description
*	14,292	89	Proposed Gravel Drive, HSG C
	116,379	71	Meadow, non-grazed, HSG C
	4,648	70	Woods, Good, HSG C
*	141	89	Gravel Access, HSG C
	135,460	73	Weighted Average
	135,460		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	50	0.0300	0.08		**Sheet Flow, Sheet Flow** Grass: Bermuda n= 0.410 P2= 3.10"
5.9	660	0.0700	1.85		**Shallow Concentrated Flow, Shallow Concentrated Flow** Short Grass Pasture Kv= 7.0 fps
16.8	710	Total			

Summary for Subcatchment SC-1: Subcatchment 1

Runoff = 9.70 cfs @ 12.10 hrs, Volume= 31,460 cf, Depth= 1.61"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-C Rainfall=4.31"

	Area (sf)	CN	Description
	198,088	71	Meadow, non-grazed, HSG C
	31,617	70	Woods, Good, HSG C
*	4,743	65	Brush/Scrub Vegetation, Good, HSG C
	234,448	71	Weighted Average
	234,448		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. Engineering Practice**

Summary for Subcatchment SC-2: Subcatchment 2

Runoff = 2.12 cfs @ 12.10 hrs, Volume= 6,885 cf, Depth= 1.61"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-C Rainfall=4.31"

Area (sf)	CN	Description
46,279	71	Meadow, non-grazed, HSG C
5,033	70	Woods, Good, HSG C
51,312	71	Weighted Average
51,312		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. Engineering Practice**

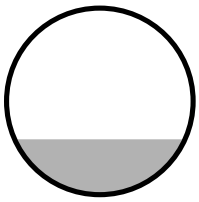
Summary for Reach DIP2: 12" Ductile Iron Pipe

Inflow Area = 135,460 sf, 0.00% Impervious, Inflow Depth = 1.00" for 10-C event
Inflow = 1.28 cfs @ 12.72 hrs, Volume= 11,254 cf
Outflow = 1.28 cfs @ 12.72 hrs, Volume= 11,254 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.54 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.18 fps, Avg. Travel Time= 0.2 min

Peak Storage= 8 cf @ 12.72 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 6.66 cfs

12.0" Round Pipe
n= 0.011 Steel, smooth
Length= 40.0' Slope= 0.0250 '/'
Inlet Invert= 485.00', Outlet Invert= 484.00'



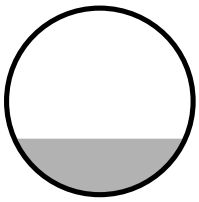
Summary for Reach DIP3: 12" Ductile Iron Pipe

Inflow Area = 186,572 sf, 0.00% Impervious, Inflow Depth = 0.87" for 10-C event
Inflow = 1.30 cfs @ 12.91 hrs, Volume= 13,529 cf
Outflow = 1.30 cfs @ 12.91 hrs, Volume= 13,529 cf, Atten= 0%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.58 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.48 fps, Avg. Travel Time= 0.2 min

Peak Storage= 8 cf @ 12.91 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 6.66 cfs

12.0" Round Pipe
n= 0.011 Steel, smooth
Length= 40.0' Slope= 0.0250 '/'
Inlet Invert= 485.00', Outlet Invert= 484.00'



Summary for Reach DP1: Design Point 1

Inflow Area = 556,480 sf, 0.00% Impervious, Inflow Depth = 1.21" for 10-C event
Inflow = 9.71 cfs @ 12.10 hrs, Volume= 56,243 cf
Outflow = 9.71 cfs @ 12.10 hrs, Volume= 56,243 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach DP2: Design Point 2

Inflow Area = 51,312 sf, 0.00% Impervious, Inflow Depth = 1.61" for 10-C event
Inflow = 2.12 cfs @ 12.10 hrs, Volume= 6,885 cf
Outflow = 2.12 cfs @ 12.10 hrs, Volume= 6,885 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach Phase II Runoff: Runoff from Phase II

Inflow Area = 322,032 sf, 0.00% Impervious, Inflow Depth = 0.92" for 10-C event
Inflow = 2.56 cfs @ 12.82 hrs, Volume= 24,783 cf
Outflow = 2.56 cfs @ 12.82 hrs, Volume= 24,783 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Pond E2A: Existing Detention Pond #2A

Inflow Area =	135,460 sf,	0.00% Impervious,	Inflow Depth =	1.75"	for 10-C event
Inflow =	4.50 cfs @	12.24 hrs,	Volume=	19,795 cf	
Outflow =	1.46 cfs @	12.72 hrs,	Volume=	19,795 cf,	Atten= 67%, Lag= 28.5 min
Discarded =	0.19 cfs @	12.72 hrs,	Volume=	8,542 cf	
Primary =	1.28 cfs @	12.72 hrs,	Volume=	11,254 cf	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0 cf	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 487.51' @ 12.72 hrs Surf.Area= 7,882 sf Storage= 6,854 cf

Plug-Flow detention time= 137.0 min calculated for 19,782 cf (100% of inflow)
Center-of-Mass det. time= 137.3 min (995.1 - 857.7)

Volume	Invert	Avail.Storage	Storage Description
#1	486.00'	20,288 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
486.00	1,910	277.7	0	0	1,910
486.50	1,910	277.7	955	955	2,049
487.00	7,084	380.0	2,112	3,067	7,406
488.00	8,702	421.3	7,879	10,946	10,069
489.00	9,996	441.9	9,342	20,288	11,549

Device	Routing	Invert	Outlet Devices
#1	Discarded	486.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	486.80'	**6.0" Vert. 6" Orifice in Riser X 2.00** C= 0.600
#3	Primary	487.80'	**12.0" Horiz. 12" Perforated Riser Pipe** C= 0.600 Limited to weir flow at low heads
#4	Secondary	488.75'	**20.0' long x 17.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.19 cfs @ 12.72 hrs HW=487.51' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.19 cfs)

Primary OutFlow Max=1.28 cfs @ 12.72 hrs HW=487.51' (Free Discharge)
├─**2=6" Orifice in Riser** (Orifice Controls 1.28 cfs @ 3.25 fps)
└─**3=12" Perforated Riser Pipe** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=486.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond E2B: Existing Detention Pond #2B

Inflow Area = 186,572 sf, 0.00% Impervious, Inflow Depth = 1.68" for 10-C event
Inflow = 5.45 cfs @ 12.30 hrs, Volume= 26,139 cf
Outflow = 1.51 cfs @ 12.91 hrs, Volume= 26,139 cf, Atten= 72%, Lag= 36.2 min
Discarded = 0.21 cfs @ 12.91 hrs, Volume= 12,610 cf
Primary = 1.30 cfs @ 12.91 hrs, Volume= 13,529 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 487.52' @ 12.91 hrs Surf.Area= 8,466 sf Storage= 9,780 cf

Plug-Flow detention time= 205.4 min calculated for 26,121 cf (100% of inflow)
Center-of-Mass det. time= 205.7 min (1,069.7 - 864.0)

Volume	Invert	Avail.Storage	Storage Description
#1	486.00'	24,627 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
486.00	5,081	472.0	0	0	5,081
486.50	5,081	472.0	2,541	2,541	5,317
487.00	7,373	502.4	3,096	5,636	7,687
488.00	9,525	529.0	8,426	14,062	9,930
489.00	11,640	554.6	10,565	24,627	12,203

Device	Routing	Invert	Outlet Devices
#1	Discarded	486.00'	**1.020 in/hr Exfiltration over Wetted area**
#2	Primary	486.80'	**6.0" Vert. 6" Orifice in Riser X 2.00** C= 0.600
#3	Primary	487.80'	**12.0" Horiz. 12" Perforated Riser Pipe** C= 0.600 Limited to weir flow at low heads
#4	Secondary	488.75'	**20.0' long x 17.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.21 cfs @ 12.91 hrs HW=487.52' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.21 cfs)

Primary OutFlow Max=1.30 cfs @ 12.91 hrs HW=487.52' (Free Discharge)
├─**2=6" Orifice in Riser** (Orifice Controls 1.30 cfs @ 3.31 fps)
└─**3=12" Perforated Riser Pipe** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=486.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Subcatchment Phase II SC-1: Phase II SC

Runoff = 15.03 cfs @ 12.29 hrs, Volume= 70,130 cf, Depth= 4.51"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-C Rainfall=7.79"

	Area (sf)	CN	Description
*	7,806	89	Proposed Gravel Drive, HSG C
	4,395	70	Woods, Good, HSG C
	174,371	71	Meadow, non-grazed, HSG C
	186,572	72	Weighted Average
	186,572		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 3.10"
8.1	858	0.0640	1.77		**Shallow Concentrated Flow, Shallow Concentrated Flow** Short Grass Pasture Kv= 7.0 fps
20.6	908	Total			

Summary for Subcatchment Phase II SC-2: Phase II SC

Runoff = 12.13 cfs @ 12.23 hrs, Volume= 52,201 cf, Depth= 4.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-C Rainfall=7.79"

	Area (sf)	CN	Description
*	14,292	89	Proposed Gravel Drive, HSG C
	116,379	71	Meadow, non-grazed, HSG C
	4,648	70	Woods, Good, HSG C
*	141	89	Gravel Access, HSG C
	135,460	73	Weighted Average
	135,460		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	50	0.0300	0.08		**Sheet Flow, Sheet Flow** Grass: Bermuda n= 0.410 P2= 3.10"
5.9	660	0.0700	1.85		**Shallow Concentrated Flow, Shallow Concentrated Flow** Short Grass Pasture Kv= 7.0 fps
16.8	710	Total			

Summary for Subcatchment SC-1: Subcatchment 1

Runoff = 27.20 cfs @ 12.09 hrs, Volume= 85,912 cf, Depth= 4.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-C Rainfall=7.79"

	Area (sf)	CN	Description
	198,088	71	Meadow, non-grazed, HSG C
	31,617	70	Woods, Good, HSG C
*	4,743	65	Brush/Scrub Vegetation, Good, HSG C
	234,448	71	Weighted Average
	234,448		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. Engineering Practice**

Summary for Subcatchment SC-2: Subcatchment 2

Runoff = 5.95 cfs @ 12.09 hrs, Volume= 18,803 cf, Depth= 4.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-C Rainfall=7.79"

Area (sf)	CN	Description
46,279	71	Meadow, non-grazed, HSG C
5,033	70	Woods, Good, HSG C
51,312	71	Weighted Average
51,312		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. Engineering Practice**

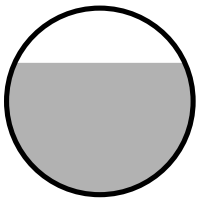
Summary for Reach DIP2: 12" Ductile Iron Pipe

Inflow Area = 135,460 sf, 0.00% Impervious, Inflow Depth = 3.65" for 100-C event
Inflow = 5.66 cfs @ 12.56 hrs, Volume= 41,163 cf
Outflow = 5.65 cfs @ 12.57 hrs, Volume= 41,163 cf, Atten= 0%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 9.51 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.60 fps, Avg. Travel Time= 0.1 min

Peak Storage= 24 cf @ 12.57 hrs
Average Depth at Peak Storage= 0.71'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 6.66 cfs

12.0" Round Pipe
n= 0.011 Steel, smooth
Length= 40.0' Slope= 0.0250 '/'
Inlet Invert= 485.00', Outlet Invert= 484.00'



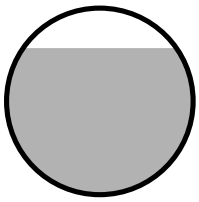
Summary for Reach DIP3: 12" Ductile Iron Pipe

Inflow Area = 186,572 sf, 0.00% Impervious, Inflow Depth = 3.45" for 100-C event
Inflow = 6.39 cfs @ 12.61 hrs, Volume= 53,617 cf
Outflow = 6.40 cfs @ 12.61 hrs, Volume= 53,617 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 9.65 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 5.09 fps, Avg. Travel Time= 0.1 min

Peak Storage= 27 cf @ 12.61 hrs
Average Depth at Peak Storage= 0.79'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 6.66 cfs

12.0" Round Pipe
n= 0.011 Steel, smooth
Length= 40.0' Slope= 0.0250 '/'
Inlet Invert= 485.00', Outlet Invert= 484.00'



Summary for Reach DP1: Design Point 1

Inflow Area = 556,480 sf, 0.00% Impervious, Inflow Depth = 3.92" for 100-C event
Inflow = 29.88 cfs @ 12.10 hrs, Volume= 181,730 cf
Outflow = 29.88 cfs @ 12.10 hrs, Volume= 181,730 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach DP2: Design Point 2

Inflow Area = 51,312 sf, 0.00% Impervious, Inflow Depth = 4.40" for 100-C event
Inflow = 5.95 cfs @ 12.09 hrs, Volume= 18,803 cf
Outflow = 5.95 cfs @ 12.09 hrs, Volume= 18,803 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach Phase II Runoff: Runoff from Phase II

Inflow Area = 322,032 sf, 0.00% Impervious, Inflow Depth = 3.57" for 100-C event
Inflow = 13.51 cfs @ 12.61 hrs, Volume= 95,818 cf
Outflow = 13.51 cfs @ 12.61 hrs, Volume= 95,818 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Pond E2A: Existing Detention Pond #2A

Inflow Area = 135,460 sf, 0.00% Impervious, Inflow Depth = 4.62" for 100-C event
Inflow = 12.13 cfs @ 12.23 hrs, Volume= 52,201 cf
Outflow = 5.88 cfs @ 12.56 hrs, Volume= 52,201 cf, Atten= 52%, Lag= 19.6 min
Discarded = 0.22 cfs @ 12.56 hrs, Volume= 11,038 cf
Primary = 5.66 cfs @ 12.56 hrs, Volume= 41,163 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 488.57' @ 12.56 hrs Surf.Area= 9,432 sf Storage= 16,135 cf

Plug-Flow detention time= 88.3 min calculated for 52,165 cf (100% of inflow)
Center-of-Mass det. time= 88.7 min (918.2 - 829.6)

Volume	Invert	Avail.Storage	Storage Description
#1	486.00'	20,288 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
486.00	1,910	277.7	0	0	1,910
486.50	1,910	277.7	955	955	2,049
487.00	7,084	380.0	2,112	3,067	7,406
488.00	8,702	421.3	7,879	10,946	10,069
489.00	9,996	441.9	9,342	20,288	11,549

Device	Routing	Invert	Outlet Devices
#1	Discarded	486.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	486.80'	**6.0" Vert. 6" Orifice in Riser X 2.00** C= 0.600
#3	Primary	487.80'	**12.0" Horiz. 12" Perforated Riser Pipe** C= 0.600 Limited to weir flow at low heads
#4	Secondary	488.75'	**20.0' long x 17.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.22 cfs @ 12.56 hrs HW=488.57' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.22 cfs)

Primary OutFlow Max=5.65 cfs @ 12.56 hrs HW=488.57' (Free Discharge)
├─**2=6" Orifice in Riser** (Orifice Controls 2.33 cfs @ 5.94 fps)
└─**3=12" Perforated Riser Pipe** (Orifice Controls 3.32 cfs @ 4.23 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=486.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond E2B: Existing Detention Pond #2B

Inflow Area =	186,572 sf,	0.00% Impervious,	Inflow Depth =	4.51"	for 100-C event
Inflow =	15.03 cfs @	12.29 hrs,	Volume=	70,130 cf	
Outflow =	8.14 cfs @	12.61 hrs,	Volume=	70,130 cf,	Atten= 46%, Lag= 19.6 min
Discarded =	0.28 cfs @	12.61 hrs,	Volume=	15,475 cf	
Primary =	6.39 cfs @	12.61 hrs,	Volume=	53,617 cf	
Secondary =	1.48 cfs @	12.61 hrs,	Volume=	1,038 cf	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 488.84' @ 12.61 hrs Surf.Area= 11,289 sf Storage= 22,800 cf

Plug-Flow detention time= 117.2 min calculated for 70,082 cf (100% of inflow)
Center-of-Mass det. time= 117.6 min (952.8 - 835.3)

Volume	Invert	Avail.Storage	Storage Description
#1	486.00'	24,627 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
486.00	5,081	472.0	0	0	5,081
486.50	5,081	472.0	2,541	2,541	5,317
487.00	7,373	502.4	3,096	5,636	7,687
488.00	9,525	529.0	8,426	14,062	9,930
489.00	11,640	554.6	10,565	24,627	12,203

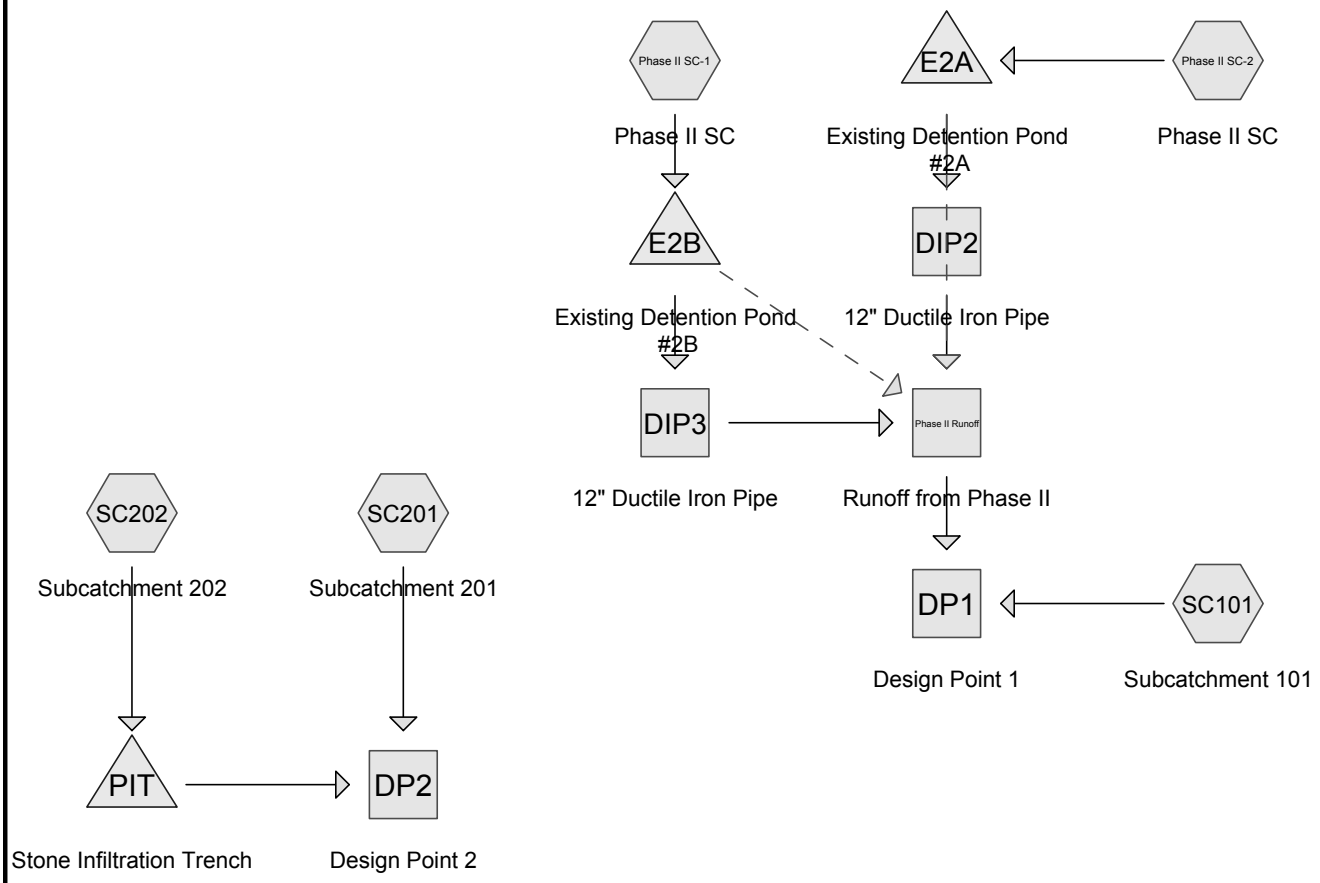
Device	Routing	Invert	Outlet Devices
#1	Discarded	486.00'	**1.020 in/hr Exfiltration over Wetted area**
#2	Primary	486.80'	**6.0" Vert. 6" Orifice in Riser X 2.00** C= 0.600
#3	Primary	487.80'	**12.0" Horiz. 12" Perforated Riser Pipe** C= 0.600 Limited to weir flow at low heads
#4	Secondary	488.75'	**20.0' long x 17.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

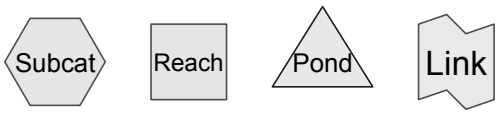
Discarded OutFlow Max=0.28 cfs @ 12.61 hrs HW=488.84' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.28 cfs)

Primary OutFlow Max=6.38 cfs @ 12.61 hrs HW=488.84' (Free Discharge)
├─**2=6" Orifice in Riser** (Orifice Controls 2.53 cfs @ 6.44 fps)
└─**3=12" Perforated Riser Pipe** (Orifice Controls 3.85 cfs @ 4.91 fps)

Secondary OutFlow Max=1.42 cfs @ 12.61 hrs HW=488.84' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Weir Controls 1.42 cfs @ 0.80 fps)

PROPOSED CONDITIONS
STORMWATER CALCULATIONS





Routing Diagram for 6108_POST
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Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
36,197	70	Woods, Good, HSG C (Phase II SC-1, Phase II SC-2, SC101)
543,554	71	Meadow, non-grazed, HSG C (Phase II SC-1, Phase II SC-2, SC101, SC201, SC202)
141	89	Gravel Access, HSG C (Phase II SC-2)
1,201	89	Proposed Grave Drive, HSG C (SC202)
1,100	89	Proposed Gravel Drive (SC201)
25,379	89	Proposed Gravel Drive, HSG C (Phase II SC-1, Phase II SC-2, SC101)
220	98	Concrete Pad (SC101)
607,792	**72**	**TOTAL AREA**

Summary for Subcatchment Phase II SC-1: Phase II SC

Runoff = 2.14 cfs @ 12.33 hrs, Volume= 11,289 cf, Depth= 0.73"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-C Rainfall=2.86"

	Area (sf)	CN	Description
*	7,806	89	Proposed Gravel Drive, HSG C
	4,395	70	Woods, Good, HSG C
	174,371	71	Meadow, non-grazed, HSG C
	186,572	72	Weighted Average
	186,572		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 3.10"
8.1	858	0.0640	1.77		**Shallow Concentrated Flow, Shallow Concentrated Flow** Short Grass Pasture Kv= 7.0 fps
20.6	908	Total			

Summary for Subcatchment Phase II SC-2: Phase II SC

Runoff = 1.82 cfs @ 12.26 hrs, Volume= 8,721 cf, Depth= 0.77"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-C Rainfall=2.86"

	Area (sf)	CN	Description
*	14,292	89	Proposed Gravel Drive, HSG C
	116,379	71	Meadow, non-grazed, HSG C
	4,648	70	Woods, Good, HSG C
*	141	89	Gravel Access, HSG C
	135,460	73	Weighted Average
	135,460		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	50	0.0300	0.08		**Sheet Flow, Sheet Flow** Grass: Bermuda n= 0.410 P2= 3.10"
5.9	660	0.0700	1.85		**Shallow Concentrated Flow, Shallow Concentrated Flow** Short Grass Pasture Kv= 7.0 fps
16.8	710	Total			

Summary for Subcatchment SC101: Subcatchment 101

Runoff = 3.69 cfs @ 12.11 hrs, Volume= 13,309 cf, Depth= 0.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-C Rainfall=2.86"

	Area (sf)	CN	Description
	203,793	71	Meadow, non-grazed, HSG C
*	3,281	89	Proposed Gravel Drive, HSG C
*	220	98	Concrete Pad
	27,154	70	Woods, Good, HSG C
	234,448	71	Weighted Average
	234,228		99.91% Pervious Area
	220		0.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. Engineering Practice**

Summary for Subcatchment SC201: Subcatchment 201

Runoff = 0.70 cfs @ 12.11 hrs, Volume= 2,515 cf, Depth= 0.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-C Rainfall=2.86"

	Area (sf)	CN	Description
	43,206	71	Meadow, non-grazed, HSG C
*	1,100	89	Proposed Gravel Drive
	44,306	71	Weighted Average
	44,306		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. Engineering Practice**

Summary for Subcatchment SC202: Subcatchment 202

Runoff = 0.14 cfs @ 12.10 hrs, Volume= 479 cf, Depth= 0.82"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-C Rainfall=2.86"

	Area (sf)	CN	Description
	5,805	71	Meadow, non-grazed, HSG C
*	1,201	89	Proposed Grave Drive, HSG C
	7,006	74	Weighted Average
	7,006		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. Engineering Practice**

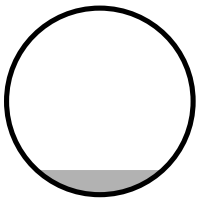
Summary for Reach DIP2: 12" Ductile Iron Pipe

Inflow Area = 135,460 sf, 0.00% Impervious, Inflow Depth = 0.19" for 2-C event
Inflow = 0.25 cfs @ 13.00 hrs, Volume= 2,169 cf
Outflow = 0.25 cfs @ 13.00 hrs, Volume= 2,169 cf, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.05 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.59 fps, Avg. Travel Time= 0.3 min

Peak Storage= 2 cf @ 13.00 hrs
Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 6.66 cfs

12.0" Round Pipe
n= 0.011 Steel, smooth
Length= 40.0' Slope= 0.0250 '/'
Inlet Invert= 485.00', Outlet Invert= 484.00'



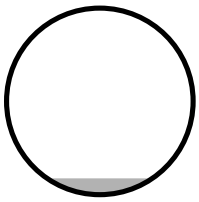
Summary for Reach DIP3: 12" Ductile Iron Pipe

Inflow Area = 186,572 sf, 0.00% Impervious, Inflow Depth = 0.08" for 2-C event
Inflow = 0.11 cfs @ 14.60 hrs, Volume= 1,216 cf
Outflow = 0.11 cfs @ 14.61 hrs, Volume= 1,216 cf, Atten= 0%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.13 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 2.31 fps, Avg. Travel Time= 0.3 min

Peak Storage= 1 cf @ 14.61 hrs
Average Depth at Peak Storage= 0.09'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 6.66 cfs

12.0" Round Pipe
n= 0.011 Steel, smooth
Length= 40.0' Slope= 0.0250 '/'
Inlet Invert= 485.00', Outlet Invert= 484.00'



Summary for Reach DP1: Design Point 1

Inflow Area = 556,480 sf, 0.04% Impervious, Inflow Depth = 0.36" for 2-C event
Inflow = 3.69 cfs @ 12.11 hrs, Volume= 16,694 cf
Outflow = 3.69 cfs @ 12.11 hrs, Volume= 16,694 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach DP2: Design Point 2

Inflow Area = 51,312 sf, 0.00% Impervious, Inflow Depth = 0.59" for 2-C event
Inflow = 0.70 cfs @ 12.11 hrs, Volume= 2,515 cf
Outflow = 0.70 cfs @ 12.11 hrs, Volume= 2,515 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach Phase II Runoff: Runoff from Phase II

Inflow Area = 322,032 sf, 0.00% Impervious, Inflow Depth = 0.13" for 2-C event
Inflow = 0.27 cfs @ 13.73 hrs, Volume= 3,384 cf
Outflow = 0.27 cfs @ 13.73 hrs, Volume= 3,384 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Pond E2A: Existing Detention Pond #2A

Inflow Area =	135,460 sf,	0.00% Impervious,	Inflow Depth =	0.77"	for 2-C event
Inflow =	1.82 cfs @	12.26 hrs,	Volume=	8,721 cf	
Outflow =	0.42 cfs @	13.00 hrs,	Volume=	8,721 cf,	Atten= 77%, Lag= 44.3 min
Discarded =	0.17 cfs @	13.00 hrs,	Volume=	6,553 cf	
Primary =	0.25 cfs @	13.00 hrs,	Volume=	2,169 cf	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0 cf	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 487.01' @ 13.00 hrs Surf.Area= 7,102 sf Storage= 3,151 cf

Plug-Flow detention time= 208.7 min calculated for 8,715 cf (100% of inflow)
Center-of-Mass det. time= 208.9 min (1,092.0 - 883.2)

Volume	Invert	Avail.Storage	Storage Description
#1	486.00'	20,288 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
486.00	1,910	277.7	0	0	1,910
486.50	1,910	277.7	955	955	2,049
487.00	7,084	380.0	2,112	3,067	7,406
488.00	8,702	421.3	7,879	10,946	10,069
489.00	9,996	441.9	9,342	20,288	11,549

Device	Routing	Invert	Outlet Devices
#1	Discarded	486.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	486.80'	**6.0" Vert. 6" Orifice in Riser X 2.00** C= 0.600
#3	Primary	487.80'	**12.0" Horiz. 12" Perforated Riser Pipe** C= 0.600 Limited to weir flow at low heads
#4	Secondary	488.75'	**20.0' long x 17.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.17 cfs @ 13.00 hrs HW=487.01' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.17 cfs)

Primary OutFlow Max=0.25 cfs @ 13.00 hrs HW=487.01' (Free Discharge)
├─**2=6" Orifice in Riser** (Orifice Controls 0.25 cfs @ 1.57 fps)
└─**3=12" Perforated Riser Pipe** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=486.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond E2B: Existing Detention Pond #2B

Inflow Area =	186,572 sf,	0.00% Impervious,	Inflow Depth =	0.73"	for 2-C event
Inflow =	2.14 cfs @	12.33 hrs,	Volume=	11,289 cf	
Outflow =	0.28 cfs @	14.60 hrs,	Volume=	11,289 cf,	Atten= 87%, Lag= 136.7 min
Discarded =	0.17 cfs @	14.60 hrs,	Volume=	10,073 cf	
Primary =	0.11 cfs @	14.60 hrs,	Volume=	1,216 cf	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0 cf	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 486.93' @ 14.60 hrs Surf.Area= 7,045 sf Storage= 5,159 cf

Plug-Flow detention time= 327.4 min calculated for 11,281 cf (100% of inflow)
Center-of-Mass det. time= 327.5 min (1,217.9 - 890.4)

Volume	Invert	Avail.Storage	Storage Description
#1	486.00'	24,627 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
486.00	5,081	472.0	0	0	5,081
486.50	5,081	472.0	2,541	2,541	5,317
487.00	7,373	502.4	3,096	5,636	7,687
488.00	9,525	529.0	8,426	14,062	9,930
489.00	11,640	554.6	10,565	24,627	12,203

Device	Routing	Invert	Outlet Devices
#1	Discarded	486.00'	**1.020 in/hr Exfiltration over Wetted area**
#2	Primary	486.80'	**6.0" Vert. 6" Orifice in Riser X 2.00** C= 0.600
#3	Primary	487.80'	**12.0" Horiz. 12" Perforated Riser Pipe** C= 0.600 Limited to weir flow at low heads
#4	Secondary	488.75'	**20.0' long x 17.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.17 cfs @ 14.60 hrs HW=486.93' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.17 cfs)

Primary OutFlow Max=0.11 cfs @ 14.60 hrs HW=486.93' (Free Discharge)
├─**2=6" Orifice in Riser** (Orifice Controls 0.11 cfs @ 1.25 fps)
└─**3=12" Perforated Riser Pipe** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=486.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond PIT: Stone Infiltration Trench

Inflow Area = 7,006 sf, 0.00% Impervious, Inflow Depth = 0.82" for 2-C event
Inflow = 0.14 cfs @ 12.10 hrs, Volume= 479 cf
Outflow = 0.02 cfs @ 12.74 hrs, Volume= 479 cf, Atten= 83%, Lag= 38.4 min
Discarded = 0.02 cfs @ 12.74 hrs, Volume= 479 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 0.41' @ 12.74 hrs Surf.Area= 850 sf Storage= 138 cf

Plug-Flow detention time= 48.3 min calculated for 479 cf (100% of inflow)
Center-of-Mass det. time= 48.3 min (917.8 - 869.5)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	680 cf	**5.00'W x 170.00'L x 2.00'H Prismatoid** 1,700 cf Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	2.00'	**100.0' long x 5.0' 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 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#2	Discarded	0.00'	**1.020 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.02 cfs @ 12.74 hrs HW=0.41' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Subcatchment Phase II SC-1: Phase II SC

Runoff = 5.45 cfs @ 12.30 hrs, Volume= 26,139 cf, Depth= 1.68"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-C Rainfall=4.31"

	Area (sf)	CN	Description
*	7,806	89	Proposed Gravel Drive, HSG C
	4,395	70	Woods, Good, HSG C
	174,371	71	Meadow, non-grazed, HSG C
	186,572	72	Weighted Average
	186,572		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 3.10"
8.1	858	0.0640	1.77		**Shallow Concentrated Flow, Shallow Concentrated Flow** Short Grass Pasture Kv= 7.0 fps
20.6	908	Total			

Summary for Subcatchment Phase II SC-2: Phase II SC

Runoff = 4.50 cfs @ 12.24 hrs, Volume= 19,795 cf, Depth= 1.75"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-C Rainfall=4.31"

	Area (sf)	CN	Description
*	14,292	89	Proposed Gravel Drive, HSG C
	116,379	71	Meadow, non-grazed, HSG C
	4,648	70	Woods, Good, HSG C
*	141	89	Gravel Access, HSG C
	135,460	73	Weighted Average
	135,460		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	50	0.0300	0.08		**Sheet Flow, Sheet Flow** Grass: Bermuda n= 0.410 P2= 3.10"
5.9	660	0.0700	1.85		**Shallow Concentrated Flow, Shallow Concentrated Flow** Short Grass Pasture Kv= 7.0 fps
16.8	710	Total			

Summary for Subcatchment SC101: Subcatchment 101

Runoff = 9.70 cfs @ 12.10 hrs, Volume= 31,460 cf, Depth= 1.61"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-C Rainfall=4.31"

	Area (sf)	CN	Description
	203,793	71	Meadow, non-grazed, HSG C
*	3,281	89	Proposed Gravel Drive, HSG C
*	220	98	Concrete Pad
	27,154	70	Woods, Good, HSG C
	234,448	71	Weighted Average
	234,228		99.91% Pervious Area
	220		0.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. Engineering Practice**

Summary for Subcatchment SC201: Subcatchment 201

Runoff = 1.83 cfs @ 12.10 hrs, Volume= 5,945 cf, Depth= 1.61"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-C Rainfall=4.31"

	Area (sf)	CN	Description
	43,206	71	Meadow, non-grazed, HSG C
*	1,100	89	Proposed Gravel Drive
	44,306	71	Weighted Average
	44,306		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. Engineering Practice**

Summary for Subcatchment SC202: Subcatchment 202

Runoff = 0.33 cfs @ 12.10 hrs, Volume= 1,067 cf, Depth= 1.83"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-C Rainfall=4.31"

	Area (sf)	CN	Description
	5,805	71	Meadow, non-grazed, HSG C
*	1,201	89	Proposed Grave Drive, HSG C
	7,006	74	Weighted Average
	7,006		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. Engineering Practice**

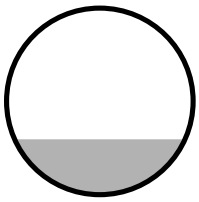
Summary for Reach DIP2: 12" Ductile Iron Pipe

Inflow Area = 135,460 sf, 0.00% Impervious, Inflow Depth = 1.00" for 10-C event
Inflow = 1.28 cfs @ 12.72 hrs, Volume= 11,254 cf
Outflow = 1.28 cfs @ 12.72 hrs, Volume= 11,254 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.54 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.18 fps, Avg. Travel Time= 0.2 min

Peak Storage= 8 cf @ 12.72 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 6.66 cfs

12.0" Round Pipe
n= 0.011 Steel, smooth
Length= 40.0' Slope= 0.0250 '/'
Inlet Invert= 485.00', Outlet Invert= 484.00'



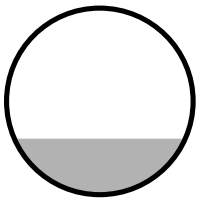
Summary for Reach DIP3: 12" Ductile Iron Pipe

Inflow Area = 186,572 sf, 0.00% Impervious, Inflow Depth = 0.87" for 10-C event
Inflow = 1.30 cfs @ 12.91 hrs, Volume= 13,529 cf
Outflow = 1.30 cfs @ 12.91 hrs, Volume= 13,529 cf, Atten= 0%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.58 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.48 fps, Avg. Travel Time= 0.2 min

Peak Storage= 8 cf @ 12.91 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 6.66 cfs

12.0" Round Pipe
n= 0.011 Steel, smooth
Length= 40.0' Slope= 0.0250 '/'
Inlet Invert= 485.00', Outlet Invert= 484.00'



Summary for Reach DP1: Design Point 1

Inflow Area = 556,480 sf, 0.04% Impervious, Inflow Depth = 1.21" for 10-C event
Inflow = 9.71 cfs @ 12.10 hrs, Volume= 56,243 cf
Outflow = 9.71 cfs @ 12.10 hrs, Volume= 56,243 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach DP2: Design Point 2

Inflow Area = 51,312 sf, 0.00% Impervious, Inflow Depth = 1.39" for 10-C event
Inflow = 1.83 cfs @ 12.10 hrs, Volume= 5,945 cf
Outflow = 1.83 cfs @ 12.10 hrs, Volume= 5,945 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach Phase II Runoff: Runoff from Phase II

Inflow Area = 322,032 sf, 0.00% Impervious, Inflow Depth = 0.92" for 10-C event
Inflow = 2.56 cfs @ 12.82 hrs, Volume= 24,783 cf
Outflow = 2.56 cfs @ 12.82 hrs, Volume= 24,783 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Pond E2A: Existing Detention Pond #2A

Inflow Area =	135,460 sf,	0.00% Impervious,	Inflow Depth =	1.75"	for 10-C event
Inflow =	4.50 cfs @	12.24 hrs,	Volume=	19,795 cf	
Outflow =	1.46 cfs @	12.72 hrs,	Volume=	19,795 cf,	Atten= 67%, Lag= 28.5 min
Discarded =	0.19 cfs @	12.72 hrs,	Volume=	8,542 cf	
Primary =	1.28 cfs @	12.72 hrs,	Volume=	11,254 cf	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0 cf	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 487.51' @ 12.72 hrs Surf.Area= 7,882 sf Storage= 6,854 cf

Plug-Flow detention time= 137.0 min calculated for 19,782 cf (100% of inflow)
Center-of-Mass det. time= 137.3 min (995.1 - 857.7)

Volume	Invert	Avail.Storage	Storage Description
#1	486.00'	20,288 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
486.00	1,910	277.7	0	0	1,910
486.50	1,910	277.7	955	955	2,049
487.00	7,084	380.0	2,112	3,067	7,406
488.00	8,702	421.3	7,879	10,946	10,069
489.00	9,996	441.9	9,342	20,288	11,549

Device	Routing	Invert	Outlet Devices
#1	Discarded	486.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	486.80'	**6.0" Vert. 6" Orifice in Riser X 2.00** C= 0.600
#3	Primary	487.80'	**12.0" Horiz. 12" Perforated Riser Pipe** C= 0.600 Limited to weir flow at low heads
#4	Secondary	488.75'	**20.0' long x 17.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.19 cfs @ 12.72 hrs HW=487.51' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.19 cfs)

Primary OutFlow Max=1.28 cfs @ 12.72 hrs HW=487.51' (Free Discharge)
├─**2=6" Orifice in Riser** (Orifice Controls 1.28 cfs @ 3.25 fps)
└─**3=12" Perforated Riser Pipe** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=486.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond E2B: Existing Detention Pond #2B

Inflow Area = 186,572 sf, 0.00% Impervious, Inflow Depth = 1.68" for 10-C event
Inflow = 5.45 cfs @ 12.30 hrs, Volume= 26,139 cf
Outflow = 1.51 cfs @ 12.91 hrs, Volume= 26,139 cf, Atten= 72%, Lag= 36.2 min
Discarded = 0.21 cfs @ 12.91 hrs, Volume= 12,610 cf
Primary = 1.30 cfs @ 12.91 hrs, Volume= 13,529 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 487.52' @ 12.91 hrs Surf.Area= 8,466 sf Storage= 9,780 cf

Plug-Flow detention time= 205.4 min calculated for 26,121 cf (100% of inflow)
Center-of-Mass det. time= 205.7 min (1,069.7 - 864.0)

Volume	Invert	Avail.Storage	Storage Description
#1	486.00'	24,627 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
486.00	5,081	472.0	0	0	5,081
486.50	5,081	472.0	2,541	2,541	5,317
487.00	7,373	502.4	3,096	5,636	7,687
488.00	9,525	529.0	8,426	14,062	9,930
489.00	11,640	554.6	10,565	24,627	12,203

Device	Routing	Invert	Outlet Devices
#1	Discarded	486.00'	**1.020 in/hr Exfiltration over Wetted area**
#2	Primary	486.80'	**6.0" Vert. 6" Orifice in Riser X 2.00** C= 0.600
#3	Primary	487.80'	**12.0" Horiz. 12" Perforated Riser Pipe** C= 0.600 Limited to weir flow at low heads
#4	Secondary	488.75'	**20.0' long x 17.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.21 cfs @ 12.91 hrs HW=487.52' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.21 cfs)

Primary OutFlow Max=1.30 cfs @ 12.91 hrs HW=487.52' (Free Discharge)
├─**2=6" Orifice in Riser** (Orifice Controls 1.30 cfs @ 3.31 fps)
└─**3=12" Perforated Riser Pipe** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=486.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond PIT: Stone Infiltration Trench

Inflow Area =	7,006 sf,	0.00% Impervious,	Inflow Depth =	1.83"	for 10-C event
Inflow =	0.33 cfs @	12.10 hrs,	Volume=	1,067 cf	
Outflow =	0.03 cfs @	13.42 hrs,	Volume=	1,067 cf,	Atten= 91%, Lag= 79.4 min
Discarded =	0.03 cfs @	13.42 hrs,	Volume=	1,067 cf	
Primary =	0.00 cfs @	0.00 hrs,	Volume=	0 cf	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 1.28' @ 13.42 hrs Surf.Area= 850 sf Storage= 435 cf

Plug-Flow detention time= 148.6 min calculated for 1,067 cf (100% of inflow)
Center-of-Mass det. time= 148.6 min (993.6 - 845.0)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	680 cf	**5.00'W x 170.00'L x 2.00'H Prismatoid** 1,700 cf Overall x 40.0% Voids

Device	Routing	Invert	Outlet Devices
#1	Primary	2.00'	**100.0' long x 5.0' 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 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#2	Discarded	0.00'	**1.020 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.03 cfs @ 13.42 hrs HW=1.28' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=0.00' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Subcatchment Phase II SC-1: Phase II SC

Runoff = 15.03 cfs @ 12.29 hrs, Volume= 70,130 cf, Depth= 4.51"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-C Rainfall=7.79"

	Area (sf)	CN	Description
*	7,806	89	Proposed Gravel Drive, HSG C
	4,395	70	Woods, Good, HSG C
	174,371	71	Meadow, non-grazed, HSG C
	186,572	72	Weighted Average
	186,572		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.5	50	0.0200	0.07		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 3.10"
8.1	858	0.0640	1.77		**Shallow Concentrated Flow, Shallow Concentrated Flow** Short Grass Pasture Kv= 7.0 fps
20.6	908	Total			

Summary for Subcatchment Phase II SC-2: Phase II SC

Runoff = 12.13 cfs @ 12.23 hrs, Volume= 52,201 cf, Depth= 4.62"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-C Rainfall=7.79"

	Area (sf)	CN	Description
*	14,292	89	Proposed Gravel Drive, HSG C
	116,379	71	Meadow, non-grazed, HSG C
	4,648	70	Woods, Good, HSG C
*	141	89	Gravel Access, HSG C
	135,460	73	Weighted Average
	135,460		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.9	50	0.0300	0.08		**Sheet Flow, Sheet Flow** Grass: Bermuda n= 0.410 P2= 3.10"
5.9	660	0.0700	1.85		**Shallow Concentrated Flow, Shallow Concentrated Flow** Short Grass Pasture Kv= 7.0 fps
16.8	710	Total			

Summary for Subcatchment SC101: Subcatchment 101

Runoff = 27.20 cfs @ 12.09 hrs, Volume= 85,912 cf, Depth= 4.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-C Rainfall=7.79"

	Area (sf)	CN	Description
	203,793	71	Meadow, non-grazed, HSG C
*	3,281	89	Proposed Gravel Drive, HSG C
*	220	98	Concrete Pad
	27,154	70	Woods, Good, HSG C
	234,448	71	Weighted Average
	234,228		99.91% Pervious Area
	220		0.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. Engineering Practice**

Summary for Subcatchment SC201: Subcatchment 201

Runoff = 5.14 cfs @ 12.09 hrs, Volume= 16,236 cf, Depth= 4.40"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-C Rainfall=7.79"

	Area (sf)	CN	Description
	43,206	71	Meadow, non-grazed, HSG C
*	1,100	89	Proposed Gravel Drive
	44,306	71	Weighted Average
	44,306		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. Engineering Practice**

Summary for Subcatchment SC202: Subcatchment 202

Runoff = 0.87 cfs @ 12.09 hrs, Volume= 2,766 cf, Depth= 4.74"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-C Rainfall=7.79"

	Area (sf)	CN	Description
	5,805	71	Meadow, non-grazed, HSG C
*	1,201	89	Proposed Grave Drive, HSG C
	7,006	74	Weighted Average
	7,006		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. Engineering Practice**

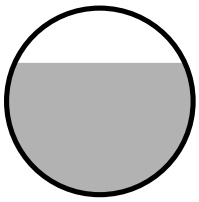
Summary for Reach DIP2: 12" Ductile Iron Pipe

Inflow Area = 135,460 sf, 0.00% Impervious, Inflow Depth = 3.65" for 100-C event
Inflow = 5.66 cfs @ 12.56 hrs, Volume= 41,163 cf
Outflow = 5.65 cfs @ 12.57 hrs, Volume= 41,163 cf, Atten= 0%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 9.51 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.60 fps, Avg. Travel Time= 0.1 min

Peak Storage= 24 cf @ 12.57 hrs
Average Depth at Peak Storage= 0.71'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 6.66 cfs

12.0" Round Pipe
n= 0.011 Steel, smooth
Length= 40.0' Slope= 0.0250 '/'
Inlet Invert= 485.00', Outlet Invert= 484.00'



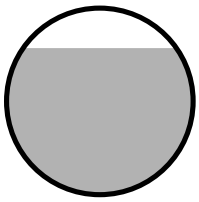
Summary for Reach DIP3: 12" Ductile Iron Pipe

Inflow Area = 186,572 sf, 0.00% Impervious, Inflow Depth = 3.45" for 100-C event
Inflow = 6.39 cfs @ 12.61 hrs, Volume= 53,617 cf
Outflow = 6.40 cfs @ 12.61 hrs, Volume= 53,617 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 9.65 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 5.09 fps, Avg. Travel Time= 0.1 min

Peak Storage= 27 cf @ 12.61 hrs
Average Depth at Peak Storage= 0.79'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 6.66 cfs

12.0" Round Pipe
n= 0.011 Steel, smooth
Length= 40.0' Slope= 0.0250 '/'
Inlet Invert= 485.00', Outlet Invert= 484.00'



Summary for Reach DP1: Design Point 1

Inflow Area = 556,480 sf, 0.04% Impervious, Inflow Depth = 3.92" for 100-C event
Inflow = 29.88 cfs @ 12.10 hrs, Volume= 181,730 cf
Outflow = 29.88 cfs @ 12.10 hrs, Volume= 181,730 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach DP2: Design Point 2

Inflow Area = 51,312 sf, 0.00% Impervious, Inflow Depth = 4.00" for 100-C event
Inflow = 5.81 cfs @ 12.13 hrs, Volume= 17,113 cf
Outflow = 5.81 cfs @ 12.13 hrs, Volume= 17,113 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Reach Phase II Runoff: Runoff from Phase II

Inflow Area = 322,032 sf, 0.00% Impervious, Inflow Depth = 3.57" for 100-C event
Inflow = 13.51 cfs @ 12.61 hrs, Volume= 95,818 cf
Outflow = 13.51 cfs @ 12.61 hrs, Volume= 95,818 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Pond E2A: Existing Detention Pond #2A

Inflow Area =	135,460 sf,	0.00% Impervious,	Inflow Depth =	4.62"	for 100-C event
Inflow =	12.13 cfs @	12.23 hrs,	Volume=	52,201 cf	
Outflow =	5.88 cfs @	12.56 hrs,	Volume=	52,201 cf,	Atten= 52%, Lag= 19.6 min
Discarded =	0.22 cfs @	12.56 hrs,	Volume=	11,038 cf	
Primary =	5.66 cfs @	12.56 hrs,	Volume=	41,163 cf	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0 cf	

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 488.57' @ 12.56 hrs Surf.Area= 9,432 sf Storage= 16,135 cf

Plug-Flow detention time= 88.3 min calculated for 52,165 cf (100% of inflow)
Center-of-Mass det. time= 88.7 min (918.2 - 829.6)

Volume	Invert	Avail.Storage	Storage Description
#1	486.00'	20,288 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
486.00	1,910	277.7	0	0	1,910
486.50	1,910	277.7	955	955	2,049
487.00	7,084	380.0	2,112	3,067	7,406
488.00	8,702	421.3	7,879	10,946	10,069
489.00	9,996	441.9	9,342	20,288	11,549

Device	Routing	Invert	Outlet Devices
#1	Discarded	486.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	486.80'	**6.0" Vert. 6" Orifice in Riser X 2.00** C= 0.600
#3	Primary	487.80'	**12.0" Horiz. 12" Perforated Riser Pipe** C= 0.600 Limited to weir flow at low heads
#4	Secondary	488.75'	**20.0' long x 17.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.22 cfs @ 12.56 hrs HW=488.57' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.22 cfs)

Primary OutFlow Max=5.65 cfs @ 12.56 hrs HW=488.57' (Free Discharge)
├─**2=6" Orifice in Riser** (Orifice Controls 2.33 cfs @ 5.94 fps)
└─**3=12" Perforated Riser Pipe** (Orifice Controls 3.32 cfs @ 4.23 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=486.00' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond E2B: Existing Detention Pond #2B

Inflow Area = 186,572 sf, 0.00% Impervious, Inflow Depth = 4.51" for 100-C event
Inflow = 15.03 cfs @ 12.29 hrs, Volume= 70,130 cf
Outflow = 8.14 cfs @ 12.61 hrs, Volume= 70,130 cf, Atten= 46%, Lag= 19.6 min
Discarded = 0.28 cfs @ 12.61 hrs, Volume= 15,475 cf
Primary = 6.39 cfs @ 12.61 hrs, Volume= 53,617 cf
Secondary = 1.48 cfs @ 12.61 hrs, Volume= 1,038 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 488.84' @ 12.61 hrs Surf.Area= 11,289 sf Storage= 22,800 cf

Plug-Flow detention time= 117.2 min calculated for 70,082 cf (100% of inflow)
Center-of-Mass det. time= 117.6 min (952.8 - 835.3)

Volume	Invert	Avail.Storage	Storage Description
#1	486.00'	24,627 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
486.00	5,081	472.0	0	0	5,081
486.50	5,081	472.0	2,541	2,541	5,317
487.00	7,373	502.4	3,096	5,636	7,687
488.00	9,525	529.0	8,426	14,062	9,930
489.00	11,640	554.6	10,565	24,627	12,203

Device	Routing	Invert	Outlet Devices
#1	Discarded	486.00'	**1.020 in/hr Exfiltration over Wetted area**
#2	Primary	486.80'	**6.0" Vert. 6" Orifice in Riser X 2.00** C= 0.600
#3	Primary	487.80'	**12.0" Horiz. 12" Perforated Riser Pipe** C= 0.600 Limited to weir flow at low heads
#4	Secondary	488.75'	**20.0' long x 17.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 Coef. (English) 2.68 2.70 2.70 2.64 2.63 2.64 2.64 2.63

Discarded OutFlow Max=0.28 cfs @ 12.61 hrs HW=488.84' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.28 cfs)

Primary OutFlow Max=6.38 cfs @ 12.61 hrs HW=488.84' (Free Discharge)
├─**2=6" Orifice in Riser** (Orifice Controls 2.53 cfs @ 6.44 fps)
└─**3=12" Perforated Riser Pipe** (Orifice Controls 3.85 cfs @ 4.91 fps)

Secondary OutFlow Max=1.42 cfs @ 12.61 hrs HW=488.84' (Free Discharge)
└─**4=Broad-Crested Rectangular Weir** (Weir Controls 1.42 cfs @ 0.80 fps)

Summary for Pond PIT: Stone Infiltration Trench

Inflow Area = 7,006 sf, 0.00% Impervious, Inflow Depth = 4.74" for 100-C event
Inflow = 0.87 cfs @ 12.09 hrs, Volume= 2,766 cf
Outflow = 1.52 cfs @ 12.15 hrs, Volume= 2,766 cf, Atten= 0%, Lag= 3.5 min
Discarded = 0.04 cfs @ 12.13 hrs, Volume= 1,890 cf
Primary = 1.49 cfs @ 12.15 hrs, Volume= 877 cf

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 2.03' @ 12.15 hrs Surf.Area= 850 sf Storage= 680 cf

Plug-Flow detention time= 149.7 min calculated for 2,764 cf (100% of inflow)
Center-of-Mass det. time= 149.8 min (967.2 - 817.4)

Volume	Invert	Avail.Storage	Storage Description
#1	0.00'	680 cf	**5.00'W x 170.00'L x 2.00'H Prismatoid** 1,700 cf Overall x 40.0% Voids

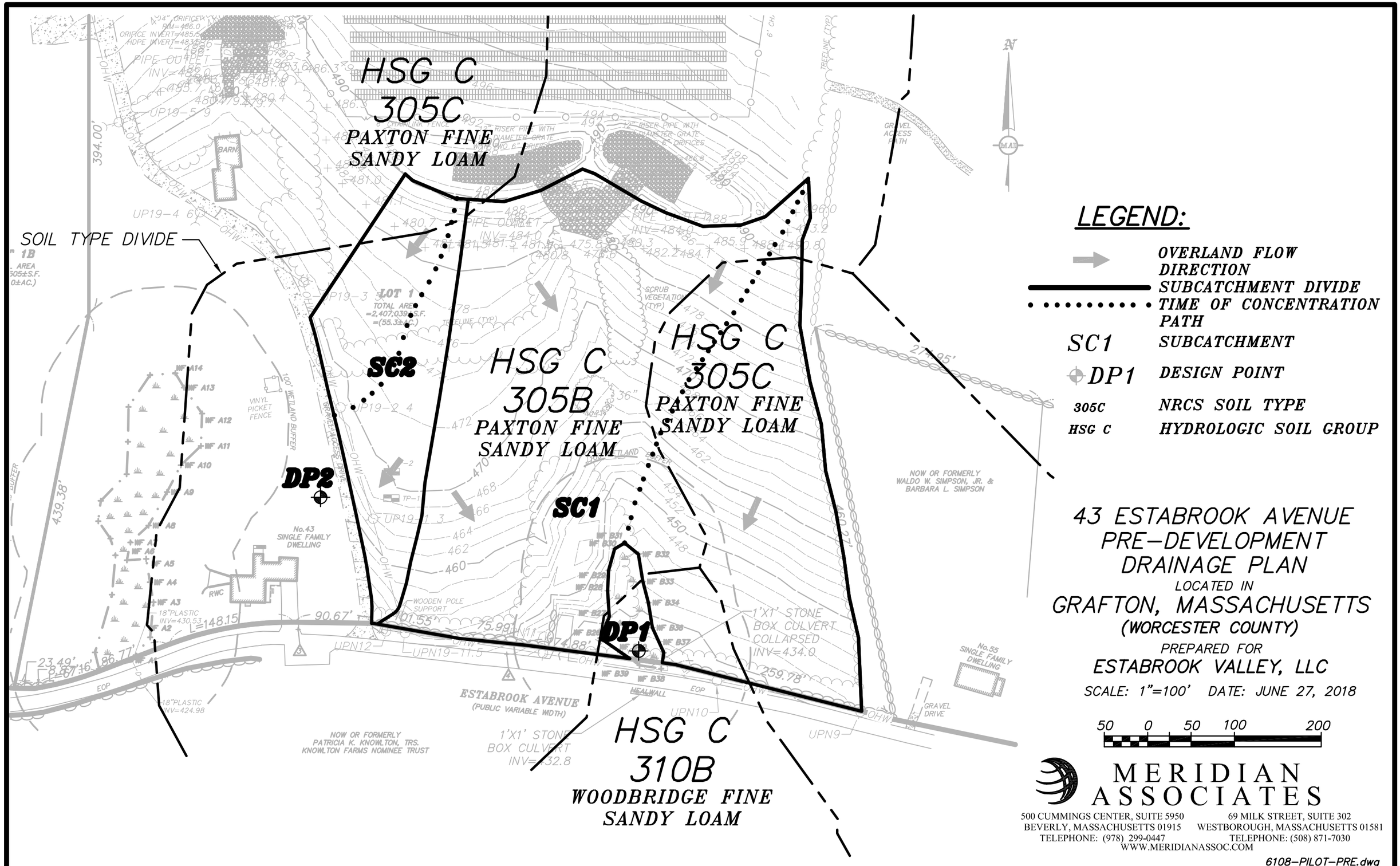
Device	Routing	Invert	Outlet Devices
#1	Primary	2.00'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#2	Discarded	0.00'	**1.020 in/hr Exfiltration over Wetted area**

Discarded OutFlow Max=0.04 cfs @ 12.13 hrs HW=2.02' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.04 cfs)

Primary OutFlow Max=1.44 cfs @ 12.15 hrs HW=2.03' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 1.44 cfs @ 0.43 fps)

APPENDIX

PRE-DEVELOPMENT
DRAINAGE PLAN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305C
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SC2
HSG C
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PAXTON FINE
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305C
PAXTON FINE
SANDY LOAM
DP2
SC1
DP1
HSG C
310B
WOODBRIDGE FINE
SANDY LOAM
ESTABROOK AVENUE
(PUBLIC VARIABLE WIDTH)
NOW OR FORMERLY
PATRICIA K. KNOWLTON, TRS.
KNOWLTON FARMS NOMINEE TRUST
NOW OR FORMERLY
WALDO W. SIMPSON, JR. &
BARBARA L. SIMPSON
No.43
SINGLE FAMILY
DWELLING
No.55
SINGLE FAMILY
DWELLING
LOT 1
TOTAL AREA
=2,407,039 S.F.
=(55.3±AC.)
1'X1' STONE
BOX CULVERT
COLLAPSED
INV=434.0
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BOX CULVERT
INV=432.8
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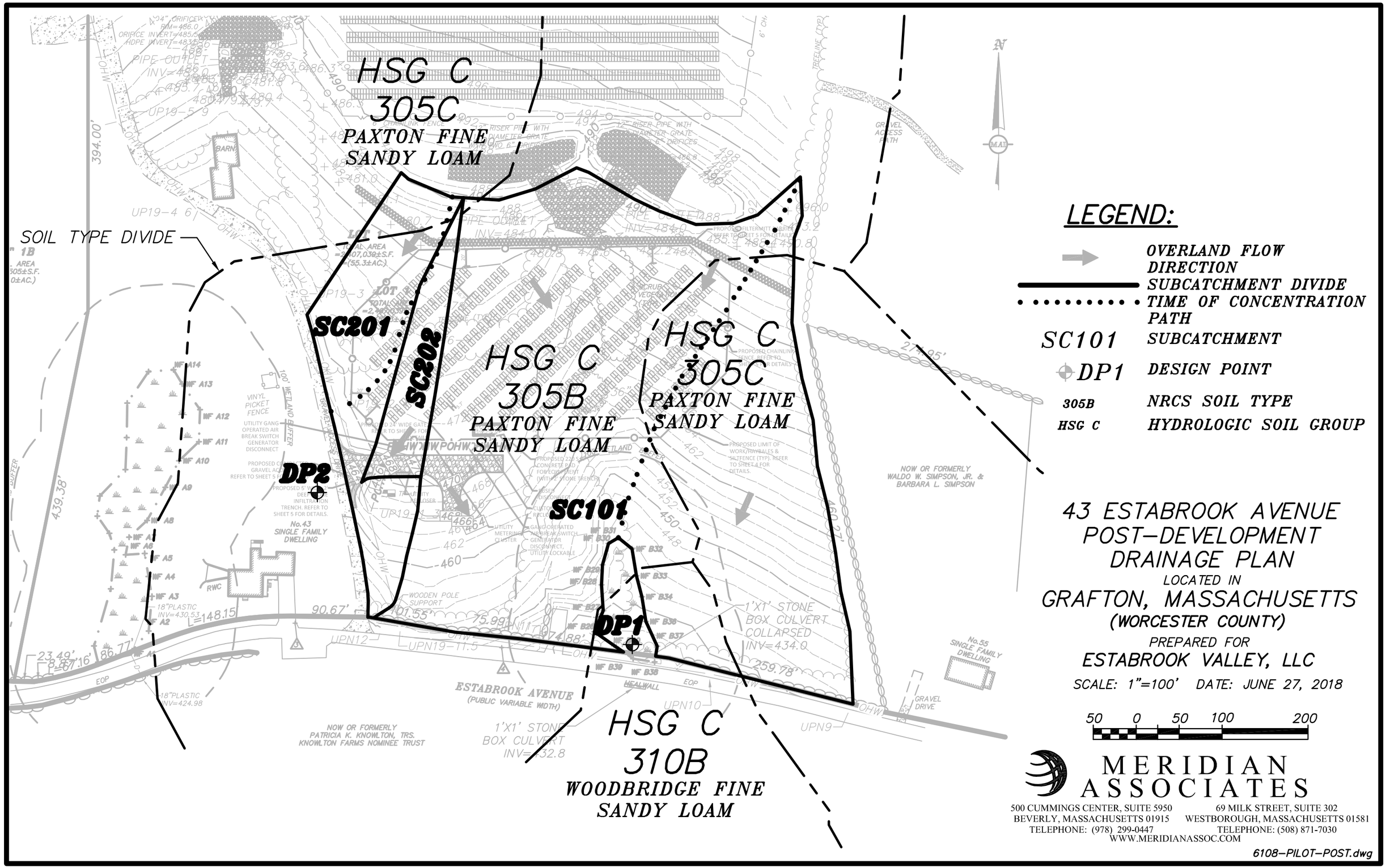
INV=430.53
18"PLASTIC
INV=424.98
100' WETLAND BUFFER
VINYL
PICKET
FENCE
GRAVEL
DRIVE
GRAVEL
ACCESS
PATH
BARN
RWC
HEADWALL
WOODEN POLE
SUPPORT
LEGEND:
OVERLAND FLOW
DIRECTION
SUBCATCHMENT DIVIDE
TIME OF CONCENTRATION
PATH
SC1 SUBCATCHMENT
DP1 DESIGN POINT
305C NRCS SOIL TYPE
HSG C HYDROLOGIC SOIL GROUP
43 ESTABROOK AVENUE
PRE-DEVELOPMENT
DRAINAGE PLAN
LOCATED IN
GRAFTON, MASSACHUSETTS
(WORCESTER COUNTY)
PREPARED FOR
ESTABROOK VALLEY, LLC
SCALE: 1"=100' DATE: JUNE 27, 2018
50 0 50 100 200
MERIDIAN
ASSOCIATES
500 CUMMINGS CENTER, SUITE 5950
BEVERLY, MASSACHUSETTS 01915
TELEPHONE: (978) 299-0447
69 MILK STREET, SUITE 302
WESTBOROUGH, MASSACHUSETTS 01581
TELEPHONE: (508) 871-7030
WWW.MERIDIANASSOC.COM
6108-PILOT-PRE.dwg

POST-DEVELOPMENT DRAINAGE PLAN


HSG C
305C
PAXTON FINE
SANDY LOAM
SOIL TYPE DIVIDE
SC201
SC202
HSG C
305B
PAXTON FINE
SANDY LOAM
HSG C
305C
PAXTON FINE
SANDY LOAM
DP2
SC101
DP1
HSG C
310B
WOODBRIDGE FINE
SANDY LOAM
ESTABROOK AVENUE
(PUBLIC VARIABLE WIDTH)
NOW OR FORMERLY
PATRICIA K. KNOWLTON, TRS.
KNOWLTON FARMS NOMINEE TRUST
NOW OR FORMERLY
WALDO W. SIMPSON, JR. &
BARBARA L. SIMPSON
No.43
SINGLE FAMILY
DWELLING
No.55
SINGLE FAMILY
DWELLING
1'X1' STONE
BOX CULVERT
COLLAPSED
INV=434.0
1'X1' STONE
BOX CULVERT
INV=432.8
18"PLASTIC
INV=430.53
18"PLASTIC
INV=424.98
HEADWALL
GRAVEL
DRIVE
N
LEGEND:
OVERLAND FLOW DIRECTION
SUBCATCHMENT DIVIDE
TIME OF CONCENTRATION PATH
SC101 SUBCATCHMENT
DP1 DESIGN POINT
305B NRCS SOIL TYPE
HSG C HYDROLOGIC SOIL GROUP
43 ESTABROOK AVENUE
POST-DEVELOPMENT
DRAINAGE PLAN
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6108-PILOT-POST.dwg

OPERATION & MAINTENANCE PROGRAM

OPERATION AND MAINTENANCE PROGRAM
for
A PROPOSED STORMWATER MANAGEMENT SYSTEM
located at
43 ESTABROOK AVENUE
GRAFTON, MASSACHUSETTS

Prepared for:

Estabrook Valley, LLC
111 Huntington Avenue
Boston, Massachusetts 02199

Prepared by:

Meridian Associates, Inc.
500 Cummings Center, Suite 5950
Beverly, Massachusetts 01915
(978) 299-0447

June 26, 2018

Project Name: Knowlton Farms Pilot Solar Development
43 Estabrook Avenue
Grafton, Ma 01519

Owner Name: Patricia K. Knowlton, Trustee - Knowlton Farms Nominee Trust
43 Estabrook Avenue
Grafton, Ma 01519

Party Responsible for Maintenance During Construction: Estabrook Valley, LLC
111 Huntington Avenue
Boston, Massachusetts 02199

Party Responsible for Maintenance After Construction: Estabrook Valley, LLC
111 Huntington Avenue
Boston, Massachusetts 02199

Erosion and Sedimentation Control Measures during Construction Activities

Haybales

Staked haybales will be installed upgradient of the resource areas as depicted on the Erosion & Sediment Control Plan. The haybales shall be installed prior to the commencement of any work on-site and in accordance with the design plans. An additional supply of haybales shall be on-site to replace and/or repair any haybales that have been disturbed or are in poor condition. The line of haybales shall be inspected and maintained on a weekly basis and after every major storm event (2-year or greater) during construction. No construction activities are to occur beyond the haybale line at any time. Deposited sediments shall be removed when the volume of the deposition reaches approximately one-half the height of the hay bale.

Temporary Diversion Swales

Swales shall be checked weekly and after every major storm event during construction for rilling, gullying, erosion and debris removal.

Gravel Access Drive & Temporary Construction Parking Areas

The gravel access drive and temporary construction parking areas shall be inspected weekly. The access drive should be inspected for ruts, channelized drainage, gullying and sedimentation. Repairs to the drive and parking areas shall be made with new clean stone, and shall be compacted into place. Large ruts may be filled with larger stone and set in place with dense grade material, then overlain by new crushed stone.

Stockpiles

All unused debris, soil, and other material shall be stockpiled in locations of relatively flat grades, away from any trees identified to be saved and upgradient of the haybales. Stockpile side slopes shall not be greater than 2:1. All stockpiles shall be surrounded by a row of haybales, and shall be placed outside the 100 foot buffer to any bordering vegetated wetland. Surrounding haybales shall be inspected and maintained on a daily basis.

Surface Stabilization

Once the forested areas have been cleared and grubbed, the entire area will be tilled following the installation of the array; areas of exposed soils will be seeded with the *Solar Farm Seed Mix* provided by Ersnt Conservation Seeds. This seed mix contains a variety of low-growing, low-maintenance fescues that will stabilize the ground surface.

Construction Tracking Pad

Construction tracking pads shall be installed at the designated entrances/exits to the site at Cape Road and on both sides of the wetland crossing, as shown on the Erosion & Sediment Control plans to reduce the amount of sediment transported off site. The construction tracking pads shall be inspected weekly.

Removal of Sediment and Erosion Controls

At the completion of construction activities and after receiving approval from the Town of Mendon, all physical sediment and erosion controls shall be removed from the site. The areas where the controls have been removed shall be seeded and stabilized immediately upon removal.

Long-Term Inspection and Maintenance Measures after Construction

Erosion Control

Eroded sediments can adversely affect the performance of the stormwater management system. Eroding or barren areas should be immediately re-vegetated.

Gravel Access Drive

The gravel access drive shall be inspected bi-annually and after every major storm event for ruts, channelized drainage, gullying and sedimentation. Repairs to the drive shall be made with new clean stone, and shall be compacted into place. Large ruts may be filled with larger stone and set in place with dense grade material, then overlain by new crushed stone.

Debris and Litter Removal

Trash may collect in the BMP's, potentially causing clogging of the facilities. All debris and litter shall be removed when necessary, and after each storm event. Sediment and debris collected from vacuuming and/or sweeping should be disposed of at a permitted waste disposal facility. Avoid disposing of this material on site, where it could be washed into the proposed detention basin.

Solar Farm Seed Mix Grass Mowing

Grass shall be inspected annually and maintenance mowing shall occur as needed. All lawn mowing to take place will be done with a mulch mower so grass clippings will not be an issue.

Good Housekeeping Practices (in accordance with Standard 10 of the Stormwater Management Handbook to prevent illicit discharges)

Provisions for storing paints, cleaners, automotive waste and other potentially hazardous household waste products inside or under cover

- All materials on site will be stored inside in a neat, orderly, manner in their appropriate containers with the original manufacturer's label.
- Only store enough material necessary. Whenever possible, all of a product shall be used up before disposing of container.
- Manufacturer, local, and State recommendations for proper use and disposal shall be followed.

Vehicle washing controls

- A commercial car wash shall be used when possible. Car washes treat and/or recycle water.

- Cars shall be washed on gravel, grass, or other permeable surfaces to allow filtration to occur.
- Use biodegradable soaps.
- A water hose with a nozzle that automatically turns off when left unattended.

Requirements for routine inspection and maintenance of stormwater BMPs
See Inspection and Maintenance Measures after Construction.

Spill prevention and response plans
Spill Control Practices shall be in conformance with the guidelines set forth in the National Pollutant Discharge Elimination System (NPDES) Stormwater Pollution Prevention Plan (SWPPP)

Provisions for maintenance of lawns, gardens, and other landscaped areas
- Grass shall not be cut shorter than 2 to 3 inches and mulch clipping should be left on lawn as a natural fertilizer.
- Use low volume water approaches such as drip-type or sprinkler systems. Water plants only when needed to enhance root growth and avoid runoff problems.
- The use of mulch shall be utilized where possible. Mulch helps retain water and prevents erosion.

Requirements for storage and use of fertilizers, herbicides and pesticides
- Fertilizers used will be applied only in the minimum amounts recommended by the manufacturer. Once applied, fertilizer will be worked into the soil to limit exposure to storm water. Storage will be in a covered shed. The contents of any partially used bags of fertilizer will be transferred to a sealable plastic bin to avoid spills.
- Do not fertilize before a rainstorm.
- Consider using organic fertilizers. They release nutrients more slowly.
- Pesticides shall be applied on lawns and gardens only when necessary and applied only in the minimum amounts recommended by the manufacturer.

Pet waste management
- Scoop up and seal pet wastes in a plastic bag. Dispose of properly, in the garbage.

Provisions for operation and management of septic systems

Not Applicable

Provisions for solid waste management
- All solid waste shall be disposed of or recycled in accordance with local town regulations.

Snow disposal and plowing plans relative to Resource Area
- Snow shall be plowed and stored on gravel, grass, or other permeable surfaces to allow filtration to occur.

- Once snow melts all sand salt and debris shall be extracted from surface and properly disposed of.
- Snow shall not be disposed of in any resource area or waterbody.
- Avoid disposing snow on top of storm drain catchbasins or stormwater drainage swale.

Winter Road Salt and/or Sand use and storage restrictions

- Salt storage piles should be located outside the 100-year buffer zone and shall be covered at all times.
- The amount of road salt applied should be regulated to prevent over salting of roadways and increasing runoff concentrations. Alternative materials, such as sand or gravel, should be used in especially sensitive areas.

Roadway and Parking Lot sweeping schedule

- Pavement sweeping shall be conducted at a frequency of not less than once per year.
- Removal of any accumulated sand, grit, and debris from driveway after the snow melts shall be completed shortly after snow melts for the season.

Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL

Not Applicable

Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan

To be determined by the owner.

List of Emergency contacts for implementing Long-Term Pollution Prevention Plan

To be determined by the owner.

STORMWATER MANAGEMENT
CONSTRUCTION PHASE

INSPECTION SCHEDULE AND EVALUATION CHECKLIST

PROJECT LOCATION: 43 Estabrook Avenue, Grafton, Massachusetts **WEATHER:** _____

Inspection Date	*Inspector*	*Area Inspected*	*Required Inspection Frequency if BMP*	*Comments*	*Recommendation*	*Follow-up Inspection Required (yes/no)*
		Haybales	*Weekly and After Major Storm Events*			
		Construction Tracking Pads	*Weekly and After Major Storm Events*			
		Gravel Access Drive and Temporary Parking Areas	*Weekly and After Major Storm Events*			
		Temporary Diversion Swales	*Weekly and After Major Storm Events*			

(1) Refer to the Massachusetts Stormwater Handbook, Volume Two: Stormwater Technical Handbook (February 2008) for recommendations regarding frequency for inspection and maintenance of specific BMP's.
(2) Inspections to be conducted by a qualified professional such as an environmental scientist or civil engineer.

Limited or no use of sodium chloride salts, fertilizers or pesticides recommended.
Other notes: (Include deviations from: Con. Comm. Order of Conditions, PB Approval, Construction Sequence and Approved Plan)
Stormwater Control Manager: _____

STORMWATER MANAGEMENT
AFTER CONSTRUCTION

INSPECTION SCHEDULE AND EVALUATION CHECKLIST

PROJECT LOCATION: 43 Estabrook Avenue, Grafton, Massachusetts **WEATHER:**_____

Inspection Date	*Inspector*	*Area Inspected*	*Required Inspection Frequency if BMP*	*Comments*	*Recommendation*	*Follow-up Inspection Required (yes/no)*
		Gravel Access Drive	*Bi-annually and After Major Storm Event*			

(1) Refer to the Massachusetts Stormwater Handbook, Volume Two: Stormwater Technical Handbook (February 2008) for recommendations regarding frequency for inspection and maintenance of specific BMP's.
(2) Inspections to be conducted by a qualified professional such as an environmental scientist or civil engineer.

Limited or no use of sodium chloride salts, fertilizers or pesticides recommended.
Other notes: (Include deviations from: Con. Comm. Order of Conditions, PB Approval, Construction Sequence and Approved Plan)
Stormwater Control Manager: _____

STORMWATER MANAGEMENT STANDARDS

Stormwater Management Standards

Project Narrative:

This site is located at 43 Estabrook Avenue in Grafton, Massachusetts on an undeveloped parcel of land. The area is comprised of mostly grassed meadow surrounded by forest and low lying resource areas. The land currently slopes from north to south toward Estabrook Avenue and an existing wetland resource area. Elevations on the site range from 480 at the northern portion of the proposed array to an elevation of approximately 440 along Estabrook Avenue.

The proposed project is comprised of the development of the existing land into a solar energy generating facility. The existing runoff patterns onsite will be maintained with limited selective grading. The proposed solar facility will be installed using a screw and post system providing low impact development on the existing topography of the locus area.

The proposed project is comprised of the development of a solar electric generating facility, the construction of a gravel access road, inverter/transformer stations, interconnection equipment, electrical conduit, new utility poles and risers, fencing, gates, and associated seeding and stabilization.

The solar energy generating facility has been designed and incorporated into the existing topography in order to manage stormwater runoff in an appropriate and responsible manner.

The following are the DEP Stormwater Standards as outlined in the Wetlands Regulations:

Standard 1: No new stormwater conveyances may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

The existing project topography directs the stormwater runoff from the area of the proposed work across the site toward either an existing wetland or to an existing gravel drive. There currently is no treatment of stormwater prior to discharge to these locations. The proposed conditions will not have a point source discharge and will direct stormwater in the same general patterns as the existing conditions, across proposed "solar farm mix" and wooded areas prior to discharging toward the design points.

Standard 2: Peak Rate Attenuation - Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. This standard may be waived for discharges to land subject to coastal storm flowage as defined in 310 CMR 10.04.

For the purpose of analyzing pre and post development stormwater peak rates of runoff, two (2) design points have been selected based on existing topographic conditions and

was used for both the pre and the post calculations. Comparison values for pre and post development stormwater peak rates are given for the design points only.

The storm events used to calculate peak runoff rates for pre and post construction conditions have been selected based upon the Massachusetts Stormwater Guidelines requirements. Full detail of peak rate attenuation along with supplemental stormwater calculations utilizing HydroCAD as well as pre and post drainage site plans can be found in the appendix of this report. The details of this report show that the peak rates of runoff for the 2-year, 10-year and 100 year events have been matched or reduced from pre to post conditions.

The hydrologic calculations from HydroCAD has been included in the "Stormwater Analysis & Calculations Report".

Proposed Design Point and Subcatchment Areas

The proposed project is comprised of the development of a solar electric generating facility, the construction of a gravel access road, inverter/transformer stations, interconnection equipment, electrical conduit, new utility poles and risers, fencing, gates, and associated seeding and stabilization. The existing runoff patterns will be maintained with limited selective grading. The proposed solar facility will be installed using a screw and/or post system which minimizes impact on the existing topography and reduces the need for excess earthwork.

A drainage system consisting of a stone infiltration trench is proposed to provide water quality treatment for the gravel access drive. Additionally, peak rates of stormwater runoff in the proposed conditions will not result in an increase in the 2, 10, and 100-year storm events at the selected design points.

The proposed site has been broken into subcatchments as depicted on the Post-Development Drainage Plan. The following summarizes the various hydraulic conditions and areas comprising the post-hydrologic model.

- **Subcatchment SC101 –** This is denoted as SC101 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists of wooded land, meadow grass and "Solar Farm Seed Mix" grassed areas and "Wetmix" grassed areas, portions of the gravel drive and a concrete pad. Stormwater runoff generated in this subcatchment flows to the existing wetland to the north of Estabrook Avenue. **(DP1)**. Additionally runoff from the outlets of the existing stormwater management system for Phase II of the solar development (located to the north) was modeled as contributing to to the existing wetland to the north of Estabrook Avenue. **(DP1)**.

- **Subcatchment S201 –** This is denoted as S201 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists of meadow grass and "Solar Farm Seed Mix" grassed areas and "Wetmix" grassed areas along with

portions of the gravel drive. Stormwater runoff generated in this subcatchment flows to the existing gravel drive located to the west of the proposed project **(DP2)**.

- **Subcatchment S202 –** This is denoted as S202 on the accompanying Pre-Development Drainage Plan. The subcatchment area consists of meadow grass and "Solar Farm Seed Mix" grassed areas and "Wetmix" grassed areas along with portions of the gravel drive. Stormwater runoff generated in this subcatchment flows to a proposed stone infiltration trench that overflows towards the existing gravel drive located to the west of the proposed project **(DP2)**.

The following Table demonstrates the peak flows and volumes resulting from the stormwater analysis described in this report.

STORMWATER ANALYSIS

Summary of Flows at Design Point 1

Storm Event	Existing Conditions (Pre) Peak Flow (CFS)	Proposed Conditions (Post) Peak Flow (CFS)
2-Year (3.00 in./hr.)	3.69	3.69
10-Year (4.50 in./hr.)	9.71	9.71
100-Year (6.50 in./hr.)	29.88	29.88

Summary of Flows at Design Point 2

Storm Event	Existing Conditions (Pre) Peak Flow (CFS)	Proposed Conditions (Post) Peak Flow (CFS)
2-Year (3.00 in./hr.)	0.81	0.70
10-Year (4.50 in./hr.)	2.12	1.83
100-Year (6.50 in./hr.)	5.95	5.81

∗ CFS – Cubic Feet Per Second

The table above outline the results of the hydrologic model. As required by Standard #2, the project has adequately attenuated for potential increase in peak stormwater flows.

Standard 3: Recharge - Loss of annual recharge to groundwater shall be eliminated or minimized…at a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This standard is met when the stormwater management system is designed to infiltrate the required recharge volume in accordance with the Mass Stormwater Handbook.

Meridian Associates reviewed soils data from the United States Department of Agriculture Natural Resources Conservation Service and determined that onsite depth to groundwater can range from eighteen (18) inches to thirty-seven (37) inches. The majority of the onsite soils are in the Hydraulic Soil Group C. With that said, the amount of groundwater recharge that would be required is negligible.

Standard 4: Water Quality – Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). The standard is met with pollution prevention plans, stormwater BMP's sized to capture required water quality volume, and pretreatment measures.

The project proposes a minimal amount of impervious area (220 s.f.) for the concrete equipment pads. Therefore, with the stormwater traveling over hundreds of feet of naturally vegetated land cover prior to discharging to the existing wetlands will accommodate for any minor TSS needed to be removed. The amount of TSS removal that would be required is negligible.

Standard 5: Land Uses with Higher Potential Pollutant Loads (LUHPPLs) – Source control and pollution prevention shall be implemented in accordance with the Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable.

Stormwater Standard 5 is not applicable to this project. The proposed development will not subject the site to higher potential pollutant loads as defined in the Massachusetts Department of Environmental Protection Wetlands and Water Quality Regulations.

LUHPPLs are identified in 310 CMR 22.20B(2) and C(2)(a)-(k) and (m) and CMR 22.21(2)(a)(1)-(8) and (b)(1)-(6), areas within a site that are the location of activities that are subject to an individual National Pollutant Discharge Elimination System (NPDES) permit or the NPDES Multi-sector General Permit; auto fueling facilities, exterior fleet storage areas, exterior vehicle service and equipment cleaning areas; marinas and boatyards; parking lots with high-intensity-use; confined disposal facilities and disposal sites.

Standard 6: Critical Areas – Stormwater discharges to critical areas require the use of specific source control and pollution prevention measures and specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas.

Stormwater Standard 6 is not applicable to this project given that proposed stormwater does not discharge near a critical area. Critical areas being Outstanding Resource Waters and Special Resource Waters as designated in 314 CMR 4.0, recharge areas for public water supplies as defined in 310 CMR 22.02, bathing beaches as defined in 105 CMR 445.000, cold-water fisheries and shellfish growing areas as defined in 314 CMR 9.02 and 310 CMR 10.04. The existing wetlands and river are not considered critical areas therefore Standard #6 does not apply to this project.

Standard 7: Redevelopments – A redevelopment project is required to meet Standards 1-6 only to the maximum extent practicable. Remaining standards shall be met as well as the project shall improve the existing conditions.

Stormwater Standard 7 is not applicable to this project. Within the Stormwater Management Handbook (volume 1 chapter 1 page 20), the definition of a redevelopment project includes, "development, rehabilitation, expansion and phased projects on previously developed sites, provided the redevelopment results in no net increase in impervious area".

This project will not result in a reduction of impervious area in the proposed conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan shall be implemented.

An *Operation and Maintenance Program* is included with this report. The program details the construction period operation and maintenance plan and sequencing for pollution prevention measures and erosion and sedimentation controls. Locations of erosion control measures for the project are depicted on the site plan set accompanying this report.

Standard 9: A long term Operation and Maintenance Plan shall be implemented.

An *Operation and Maintenance Program for a Proposed Stormwater Management System* is included with this report. The long term operation and maintenance section of the program provides details and the schedule for routine and non-routine maintenance tasks to be implemented at the completion of the project.

Standard 10: Prohibition of Illicit Discharges – Illicit discharges to the stormwater management system are prohibited.

Illicit discharges to the stormwater management system are discharges that are not entirely comprised of stormwater. Discharges to the stormwater management system from the following activities or facilities are permissible: Firefighting, water line flushing, landscape irrigation, uncontaminated groundwater, potable water sources, foundation drains, air conditioning condensation, footing drains, individual resident car washing, flows from riparian habitats and wetlands, dechlorinated water from swimming pools, water used for street washing and water used to clean residential buildings without detergents. All other illicit discharges are prohibited.

There are no known illicit discharges anticipated through the completion of this project. During construction and post construction procedures are provided to dissipate the potential for illicit discharges to the drainage system. Post construction preventions of illicit discharges are described in the Operation and Maintenance Program under the Good Housekeeping Practices section of the report.

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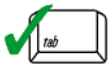
CHECKLIST FOR
STORMWATER REPORT

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

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[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

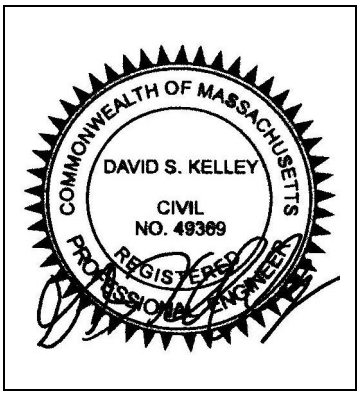
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



David S. Kelley 06/26/18

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☒ New development

☐ Redevelopment

☐ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☐ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☐ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☒ Other (describe): Low Impact Design screw & post racking system

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☐ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☐ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☐ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☐ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☐ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☐ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☐ The BMP is sized (and calculations provided) based on:

- ☐ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☐ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☒ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☐ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☐ Redevelopment portion of mix of new and redevelopment.

☒ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☐ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

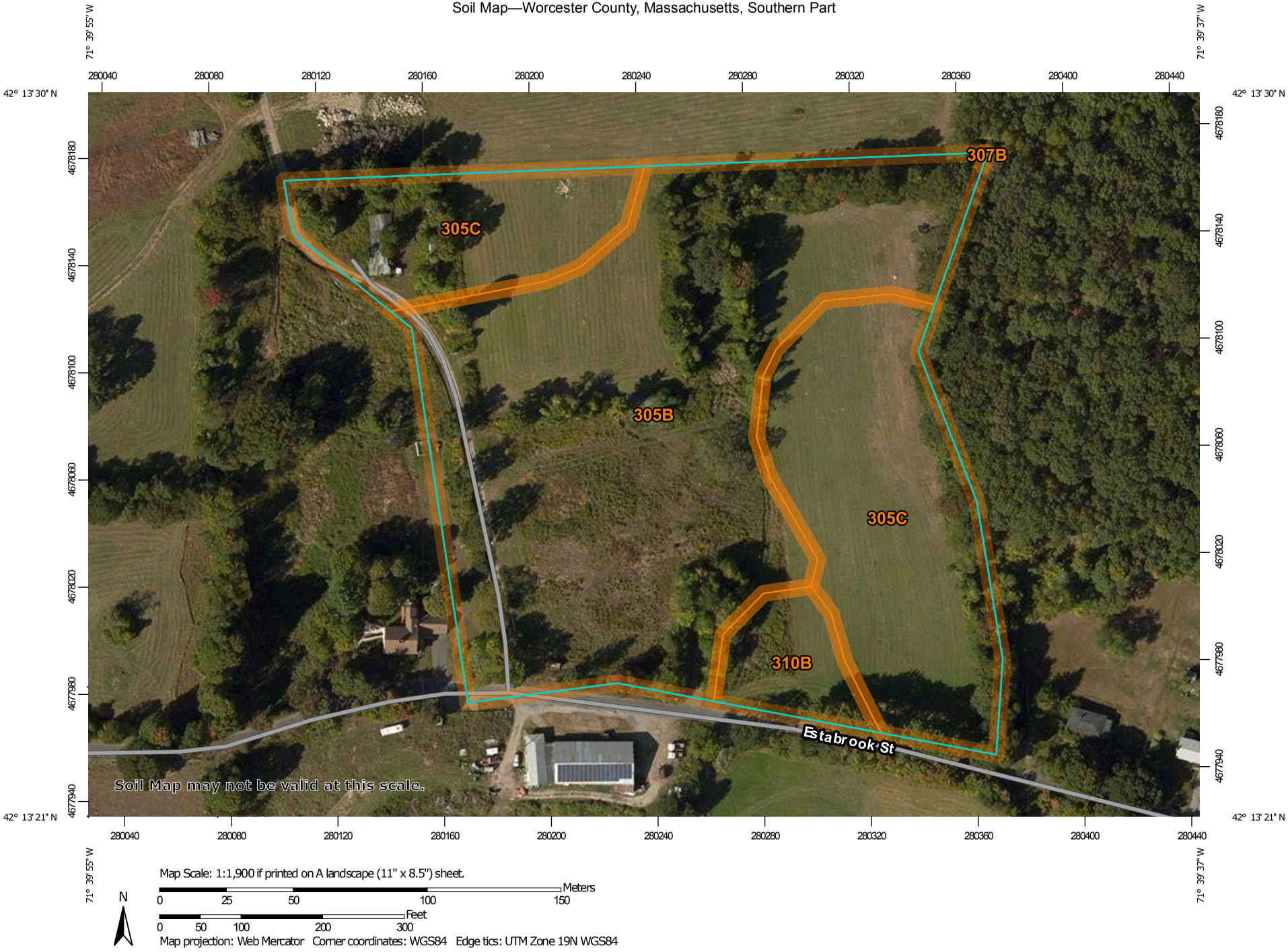
☐ An Illicit Discharge Compliance Statement is attached;

☒ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

USDA NATURAL RESOURCE CONSERVATION SERVICE

NATIONAL COOPERATIVE SOIL SURVEY

Soil Map—Worcester County, Massachusetts, Southern Part



Map Scale: 1:1,900 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 25 50 100 150

Feet: 0 50 100 200 300

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

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

Special Point Features

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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:
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, Southern Part
Survey Area Data: Version 10, Oct 6, 2017

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.

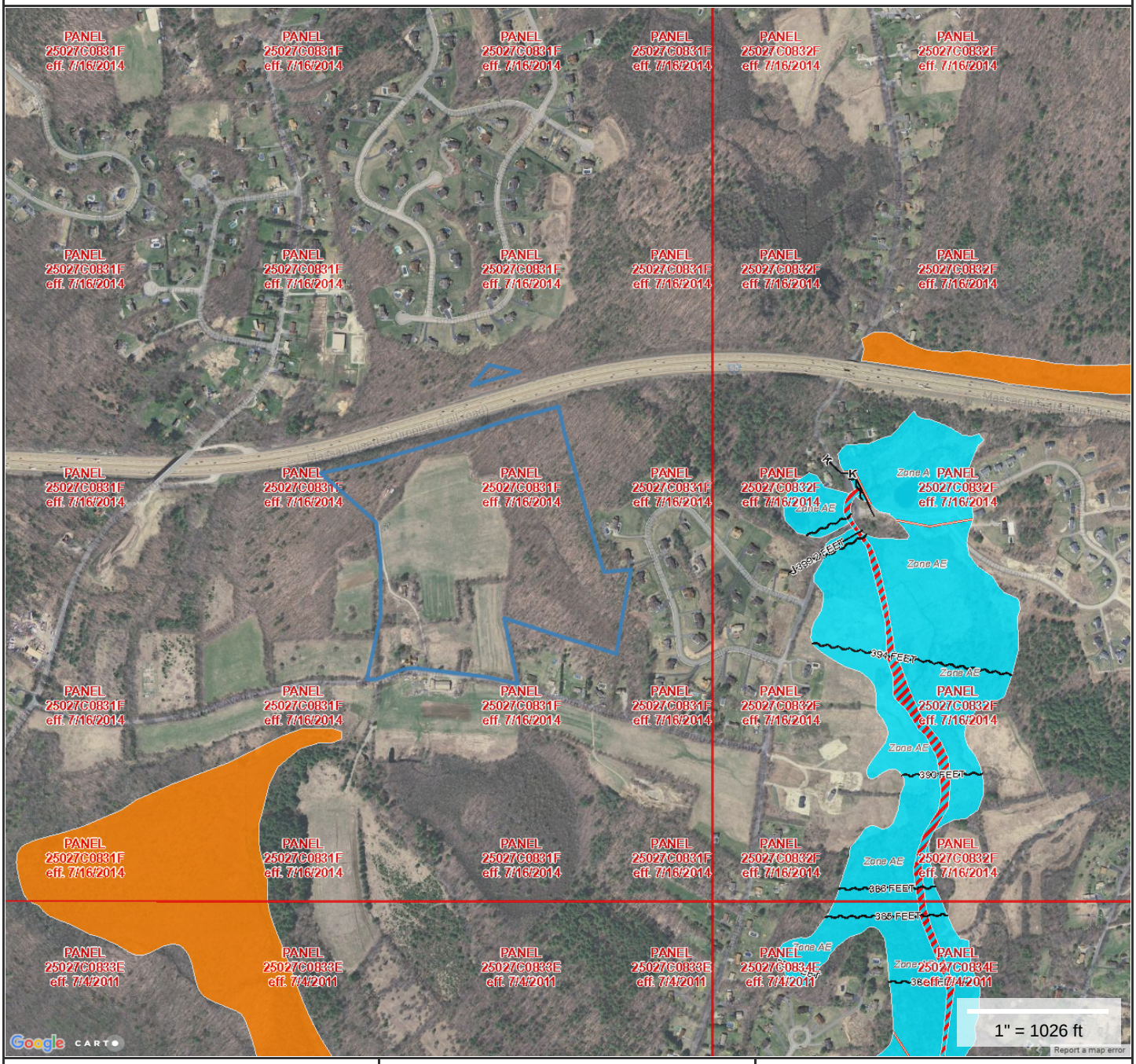
Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
305B	Paxton fine sandy loam, 3 to 8 percent slopes	6.3	59.3%
305C	Paxton fine sandy loam, 8 to 15 percent slopes	3.8	35.8%
307B	Paxton fine sandy loam, 0 to 8 percent slopes, extremely stony	0.0	0.0%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	0.5	4.9%
Totals for Area of Interest		**10.6**	**100.0%**

FEDERAL EMERGENCY MANAGEMENT AGENCY

FLOOD INSURANCE RATE MAP

6108-PILOT Firmette



Property Information

Property ID	110/049.0-0000-0001.A
Location	43 ESTABROOK AVENUE
Owner	KNOWLTON PATRICIA K TRUSTEE

MAP FOR REFERENCE ONLY
NOT A LEGAL DOCUMENT

Town of Grafton, MA makes no claims and no warranties, expressed or implied, concerning the validity or accuracy of the GIS data presented on this map.

Parcels updated 4/1/2018
Properties updated 4/1/2018