Flood Impact Analysis and Stormwater Management
Farm Road Homes
65 Farm Road, Sherborn, MA

September 28, 2023
October 4, 2023
February 14, 2024

Prepared for:

Felix Partners Farm Road development, LLC
177 Lake St.
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Prepared by:

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1.0 Introduction

Existing Conditions

The project site is a 40B residential development located at 65 Farm Road in Sherborn, MA. The existing site contains 14 acres of land, consisting of 0.94 acres of wetland and 13.06 acres of upland. The upland area, where horse stables and open space are surrounded by woods, can be accessed via a gravel driveway (see Table 1 for details). The site is bordered by conservation land to the east, north, northwest, residential houses to the southwest, and Farm Road to the south.

Proposed Conditions

The proposed Farm Road Homes project will see the upland area repurposed for the development of a 32 unit neighborhood (16 single family homes and 8 duplexes). The units will be accessible from Farm Road via a paved road and individual drives. A network of paved sidewalks and walkways is also proposed (see Table 1 for details).

Table 1. Project Site Condition Summary

General Site Condition	Land Condition	**Land Break down**	Acres	Sq.Ft	Coverage, %
		Total Area	14.00	609702	-
	Unusable land	Wetland (Unusable)	0.94	40990	6.7%
	Usable land	Upland	13.06	568711	93.3%
Existing Conditions	**Disturbed**	Total	4.42	192531	31.6%
	Impervious	**Subtotal**	0.33	14400.00	2.4%
		Building (House & Porch)	0.04	1765	0.3%
		Gravel Road & Drive	0.29	12635	2.1%
		Sidewalk & Walkway	0.00	0	0.0%
	Pervious (usable OS)	Lawn/meadow	4.09	178131	29.2%
	Undisturbed	**Total**	9.58	417171	68.4%
	Usable OS	Upland Woods	8.64	376180	61.7%
	Unusable OS	Wetlands	0.94	40990	6.7%
	Total Usable OS	Lawn/landscape/woods	12.73	554311	90.9%
Proposed Conditions	**Disturbed**	**Total**	6.57	286284	47.0%
	Impervious	**Subtotal**	2.22	96856.09	15.9%
		Building (House & Porch)	1.12	48918	8.0%
		Paved (Road & Drive)	0.92	40180	6.6%
		Sidewalk & Walkway	0.18	7758	1.3%
	Pervious (usable OS)	Lawn/landscape	4.35	189428	31.1%
	Undisturbed	**Total**	7.42	323418	53.0%
	Usable OS	Upland Woods	6.48	282427	46.3%
	Unusable OS	Wetlands	0.94	40990	6.7%
	Total Usable OS	Lawn/landscape/woods	10.83	471855	77.4%

The site has very permeable sandy soils. In regards to surface hydrology, the site drains from north to south and southwest. See Figure 1 for USGS site locus map and Figure 2 for NRCS soil map. The proposed development will create 2.683 acres (about 17.43 percent) of impervious area of road, driveway and walk to houses. The design employs LID using uncurbed driveway with crushed stone shoulder and grass swale and recharge basins. The development area will be surrounded by open space wooded area.

Table 1b. Land use in the watershed of study

	Land Uses (Acres)		Impervious area (ac)		
Subbasin	Existing	Proposed	Existing	Proposed	Increment
Roof	0.153	1.069	0.153	1.069	0.916
Pave	0.650	1.614	0.650	1.614	0.964
Pervious	14.589	12.709			
Total	15.392	15.392	0.803	2.683	1.880
Imperviousness (%)			5.22	17.43	

The property is shaped irregular. No stormwater management system existed on site for existing condition. The runoff mostly drains from north to south and southwest to BVW on the southwest and IVW on the southeast. Two small areas will drain north and northeast to conservation land. Five design control points are chosen to compare and to design the onsite stormwater management system:

- Control Point 1: to west BVW, stormwater management system include infiltration Basin A, grass swale, two oil/grit separators
- Control Pond 2: to 53 Farm Road Driveway culvert by swales and an infiltration basin B2
- Control Point 3: to southeast IVW by water quality swales, two infiltration basins (B1, C)
- Control Point 4: to middle east by maintaining existing land condition and crushed stone bedding for solar panel area if installed to mimic the runoff of existing condition.
- Control Pond 5: to north by maintaining existing land condition and crushed stone bedding for solar panel area if installed to mimic the runoff of existing condition.

The proposed drainage system will be designed to mimic the existing surface drainage pattern. The goal is to maintain or reduce the runoff peaks and volumes for up to 100-year storm events for proposed conditions to be equal or less than the existing conditions.

Upon request of project proponent, Fenix Partners Farm Road Development, LLC, Creative Land & Water Engineering, LLC (CLAWE) devised the flood control and stormwater management plan for the site to satisfy the requirements of the ten DEP stormwater management standards. This report presents the results.

2.0 Flood Condition Analyses and Flood Control

There are no flood control or stormwater management structures under the existing conditions at the project site. Based on the drainage pattern, the control points for flood control calculations are described in section 1.0. The following is a summary of the existing and proposed land uses within the study area. More detailed land used breakdown can be found in Appendix A.

Table 1c. Land use table in the watershed

Condition	Land Use	Area				
		Total	HSG A	HSG B	HGS C	HSG D
		acre	acre	acre	acre	acre
Existing	Roof	0.15	0.00	0.06	0.00	0.09
	Drive/Park	0.24	0.06	0.09	0.00	0.09
	Walk/Patio/etc.	0.41	0.00	0.17	0.05	0.18
	Lawn	4.40	0.04	0.98	1.51	1.86
	Woods	10.19	0.79	2.20	0.07	7.13
	Total	15.39	0.89	3.51	1.64	9.36
Proposed	Roof	1.07	0.00	0.42	0.18	0.48
	Drive/Park	1.18	0.06	0.44	0.25	0.43
	Walk/Patio/etc.	0.44	0.00	0.14	0.08	0.22
	Lawn	5.55	0.04	1.37	0.63	3.50
	Woods	7.16	0.79	1.14	0.51	4.73
	Total	15.39	0.89	3.51	1.64	9.36

The NRCS soil survey map (Figure 2) are used for runoff calculations. A total of forty-two (47) deep hole soil test pits were excavated on the site to collect groundwater and soil permeability data for the stormwater management and septic system design (see site plan for locations) Our field soil testing showed the soil is gravely medium loamy sand to medium sand, well drained soil. Soil groups ranging from Hydrologic Class A soils to ledge outcrop D soil in overall site with estimated high groundwater depth 3-20 ft with percolation rates under <2 mpi to 7 mpi. See soil logs for details. Detailed soil log can be found in Appendix D.

For the proposed conditions, the flood control will be achieved by four infiltration basins distributed relatively evenly through the project site with roadside exfiltration and water swales for better distribution of runoff. The roadway (common drive) are county side without curb instead 12” 3” stone apron set 12” deep to pretreat and reduce runoff. In most of the site, the runoff from driveway will be pretreated by roadside grass swales with inlet leaching catch basin to promote groundwater recharge through the site. More pretreatments for paved areas to the infiltration trenches are proved by two sets of distribution manhole and oil/grit separators. Figure 3d is a schematic diagram for the drainage system. The drainage divide and details of the infiltration trench, distribution manhole, oil/grit separator, and can be found in figures 3 to 8.

More details of the design features can be found on the engineering plan by Creative Land & Water Engineering, LLC updated February 14, 2024.

The flood conditions under both existing and proposed conditions are summarized in Table 2. Detailed data and calculations area presented in Appendices A and B.

As indicated in Tables 2, 2a, and 3, the results of flood control are satisfactory to our design goals.

Table 2 Summary of Peak Runoffs Leaving the Project Site

Condition	Sub-watershed	Peak Runoffs (cfs)					Runoff Volume (ac-ft)				
		2-year	10-year	25-year	50-yar	100-year	2-year	10-year	25-year	50-yar	100-year
Existing-	CP1 (AE)	9.95	22.82	31.62	38.28	45.65	0.93	2.05	2.82	3.41	4.07
	CP2 (BE)	1.39	3.76	5.46	6.79	8.31	0.14	0.32	0.45	0.55	0.67
	CP3 (CE)	3.86	9.14	12.77	15.53	18.61	0.34	0.76	1.05	1.27	1.53
	CP4 (DE)	0.24	0.56	0.77	0.93	1.11	0.02	0.04	0.06	0.07	0.09
	CP5 (EE)	0.29	0.63	0.86	1.03	1.21	0.03	0.06	0.08	0.09	0.11
Proposed-with flood control	CP1 (APb, AP-1, AP-2, AP-3, AP-4,AP-5,AP-6,AP-7)	4.8	13.04	22.14	29.25	37.09	0.73	1.85	2.62	3.22	3.89
	CP2 (BPb, B2P-1,B2P-2)	1.13	2.66	3.75	4.6	5.54	0.11	0.23	0.31	0.43	0.57
	CP3 (CPb, CP-1, CP-2, CP-3,B1P-1)	0.73	5.41	9.04	11.38	13.69	0.07	0.27	0.43	0.55	0.69
	CP4 (DE)	0.16	0.38	0.53	0.64	0.76	0.01	0.03	0.04	0.05	0.06
	CP5 (EE)	0.15	0.32	0.44	0.53	0.62	0.01	0.03	0.04	0.04	0.05

Table 2a Summary runoff peak and volume change

Control Point	Change in Peak Runoffs (%)					Change in Runoff Volume (%)				
	2-year	10-year	25-year	50-yar	100-year	2-year	10-year	25-year	50-yar	100-year
Cntrlp1	-51.8%	-42.9%	-30.0%	-23.6%	-18.8%	-21.5%	-9.8%	-7.1%	-5.6%	-4.4%
Cntrlp2	-18.7%	-29.3%	-31.3%	-32.3%	-33.3%	-21.4%	-28.1%	-31.1%	-21.8%	-14.9%
Cntrlp3	-81.1%	-40.8%	-29.2%	-26.7%	-26.4%	-79.4%	-64.5%	-59.0%	-56.7%	-54.9%
Cntrlp4	-33.3%	-32.1%	-31.2%	-31.2%	-31.5%	-50.0%	-25.0%	-33.3%	-28.6%	-33.3%
Cntrlp5	-48.3%	-49.2%	-48.8%	-48.5%	-48.8%	-66.7%	-50.0%	-50.0%	-55.6%	-54.5%
Mini	-18.7%	-29.3%	-29.2%	-23.6%	-18.8%	-21.4%	-9.8%	-7.1%	-5.6%	-4.4%
Max	-81.1%	-49.2%	-48.8%	-48.5%	-48.8%	-79.4%	-64.5%	-59.0%	-56.7%	-54.9%

Table 3. Summary of Peak Elevations

Basin	2-yr	10-yr	25-yr	50-yr	100-yr	Top of Berm, ft	Static Vol, cf
BASIN A	210.10	210.86	211.16	211.32	211.48	212.50	8432.00
BSIN B1	216.93	217.20	217.29	217.35	217.41	218.50	2743.00
BSIN B2	207.25	209.54	210.21	210.52	210.87	212.50	12775.00
BSIN C1	219.93	220.22	220.31	220.37	220.42	221.50	1944.00

Table 4. Summary of Basin Recharge for 100-year storm event

Basin	Rech	Vol, ac-ft	Vol. cf
BASIN A	rech A	0.22	9583.2
BSIN B1	rech B1	0.35	15246
BSIN B2	rech B2	0.16	6969.6
BSIN C1	rech c1	0.28	12196.8

3.0 Stormwater Management

This section demonstrates that the drainage design satisfies all ten DEP stormwater management standards.

Standard #1: Untreated Stormwater

No untreated stormwater from the proposed project area will be discharged to downgradient areas for the proposed conditions. Runoff from paved area will be adequately treated before overflowing to downgradient area. The treatment train includes deep sump catchbasins equipped with oil traps, modified manhole, oil/grit separator, grass swales, and infiltration basin. LID uses driveway side stoned apron and grass swale and infiltration combination to minimize flow and erosion. The infiltration basins are designed to infiltrate and manage runoff up to a 100-year storm event that scattered fairly uniformly through the site.

Standard #2: Post-Development Peak Discharge Rates

Stormwater controls have been designed for 2, 10, 25, 50, and 100-year storms according to both state and the Town Sherborn regulations. The post-development peak discharge rates with flood control do not exceed pre-development rates on the site at the downgradient discharge points. See Tables 2 for details.

Standard #3: Recharge to Groundwater

The soils on the site are hydrologic class A to D soils based NRCS soil map and *in-situ* soil evaluations. The required infiltration will be 0.6 inches of runoff per storm from increased impervious areas in HSG A soil, and 0.35" in B soil, 0.25 inches in HSG C soil, and 0.1" in HSG D soils. Based on the soil conditions in the proposed impervious areas, the required recharge volume is calculated as 2256 ft^3. The recharge basins as designed has a total capacity a 100-yr storm of 8.26" rain, 44967 ft^3 . The basins have a static storage volume of 25894 ft^3 , which is more than 10 times of the required recharge volume and satisfies Standard 3. The system can recharge all runoff volume up to a 100-year storm. See Appendix C for details.

Hydrological soil group	A soil (0.6)	B Soil (0.35")	C Soil	D Soil	Total	Provided capacity
DEP required GW recharge (in):	0.6	0.35	0.25	0.1		
Impervious area (acres):	0.058	0.997	0.500	1.128	2.68	
DEP required GW recharge volume, cf:	126.00	1266.83	453.78	409.40	**2256.01**	**48690.24**

Standard # 4: Water Quality

(a) Water Quality Volume. 1.0" water quality rule applies to this site. The water quality treatment volume for runoff from paved roadway is pretreated by stone filter apron, grass swales, catch basin and/or distribution manhole for large flow bypass, and first flush to oil/grit separator, and the infiltration trench. The water quality volume in the system is more than 44396 ft^3 under static storage level. much larger than the required 9738. 60 ft^3 based on 1-inch rule over total impervious area given the onsite well water supply condition. The driveway runoff will be shed off to grassed channel/swale as LID that will benefit water quality. However, no credit was claimed.

Site Conditions	Water quality rule	1	inches
	Impervious area	WQV req.	WQV provided
	acres	cu. ft	cu. ft
existing	0.803	none	none
Proposed	2.683	9738.6017	48690.24

(b) TSS Removal. The BMPs used for the proposed project to enhance water quality include: grassed swales (with mechanism for better infiltration), deep sump catch basins with oil trap, oil/grit separator with modified distribution manhole to treat the first flush and improve the TSS removal rate, and infiltration basins for the common driveway. Therefore, based on the large recharge volume of runoff and sediment settling dynamics analysis, the TSS removal rate for the paved area could reach 95%. However, the current DEP stormwater management handbook only allows 25% TSS removal for water quality unit regardless its design capacity under current version. Using the DEP pre-determined TSS removal credit, the system will have 44% pretreatment TSS removal prior going to the infiltration basins and the overall TSS removal rate will be 80% as allowed for infiltration basins. See the attached calculation sheets in Appendix C for details.

Standard # 5: Higher Potential Pollutant Loads

The proposed land use will not have higher potential pollutant loads. Given the large volume for stormwater treatment, the site should have a lower pollutant load compared with the existing conditions. See Appendix C for details. Oil traps will be added to the on-site catch basin.

Standard #6: Protection of Critical Areas

The site does not contain or in the vicinity of any of the critical resource areas as listed below:

- Surface drinking water supplies, certified vernal pools, Areas of Critical Environmental Concern;
- Shellfish growing areas;
- Public swimming beaches;
- Cold water fisheries.

The proposed stormwater management facilities will promote groundwater recharge and mimic existing water treatment quality.

Standard #7: Redevelopment Projects

The proposed project is not a redevelopment. The proposed stormwater management will meet all ten DEP stormwater standards (2008). As proposed, the project will provide better water quality and mitigated flood impact to downgradient properties and resource area.

Standard #8: Erosion/Sediment Control

Staked wattles and silt fences will be installed at the downgradient limit of work before any excavation starts. Six-inch thick of 3”-4” crushed trap rocks underlain with Mirafi 140N should be spread at the entrance of the proposed common driveway to the project site to prevent mud from escaping the site during construction. Any sediment tracked to Farm Road should be swept promptly. See details in the plans and Appendix E.

Standard #9: Long-term Operation/Maintenance Plan

See Appendix E for details.

Standard #10: Illicit Discharges

There are no existing illicit discharges into stormwater system and there will be no illicit discharges under 310 CMR 10.04 will be allowed for proposed conditions. This is emphasized in the Operation and Maintenance Plan and the Illicit Discharge Statement signed by the project proponent.

3.1 Groundwater Mounding Analysis

Due to the restriction of the land grading, four stormwater basins only have 2-3 ft separation from the estimated seasonal high groundwater. As required by the DEP stormwater management handbook, Vol. 3 Ch. 1. P 28, groundwater mounding analysis using Hantush Method is conducted to show that the Basins will be dewatered within 72 hours after a 100-year storm event. The recharge volume for a 100-year storm is used to conduct the mounding analysis to be conservative. The analysis showed that the mounding height after three days will be retreated below bottom of the basin for all basins. The mounding analysis is summarized in Table 4. Detailed of the mounding analysis is presented in Appendix G.

Table 4. Summary of Groundwater Mounding Analysis

Parameters	Stormwater - 100 Year					Note
Recharge area	Basin A	Basin B1	Basin B2	Basin C		All Basins will be dewatered in less than three days.
Dimension, Length, ft	152	132	77.03	111		
Dimension, Width, ft	46.09	19.20	28.95	21.00		
Area, sq. ft	7006.00	2534.00	2230.00	2331.00		
Recharge Vol. Cu ft (per day or event)	9583	15246	6969	12196		
Duration, day	1	1	1	1		
Recharge rate, cu ft/day/sq. ft	1.37	6.02	3.13	5.23		
Dewater time, day	3	3	3	3		
GW Separation, ft	2.63	2.21	3.77	6.25		
Distance to wetland, ft	167	50	291	60		
Maximum mounding height, ft	4.52	3.64	2.5	2.82		
Estimated effective Max MH, ft	**3.008**	**2.496**	**2.5**	**2.82**		
Impact mounding height by other systems, ft	**0**	**0**	**0**	**0**		
Combined Mound height, ft	**4.52**	**3.64**	**2.5**	**2.82**		
3-day residual height, ft	2.49	0.27	0.36	0.17		
5-day residual height, ft	**1.75**	**0.1**	**0.2**	**0.05**		
Estimated effective 3d MH, ft	**2.49**	**0.45**	**0.36**	**0.17**		
Estimated effective 5d MH, ft	**1.75**	**0.15**	**0.2**	**0.26**		
Bottom of Basin, ft	**208**	**215.5**	**204.5**	**219**		
Top of stones, ft						
EHGW, ft	205.37	213.29	200.73	212.75		
	average					
Bottom aquifer, ft	**190.87**	**198.29**	**186.23**	**197.75**		
3 day elevation, ft	**207.86**	**213.56**	**201.09**	**212.92**		
Flood routing elev, ft	211.46	217.41	210.87	220.42		
Top of grade, ft	212.5	218.5	212.5	221.5		
Aquafer depth, ft	14.5	15	14.5	15		
Hydraulic Conductivity, ft/day	4.51	38.00	42.70	57.43		

* mounded water tables for stormwater management area are at 3-day.

4.0 Summary

Flood control and stormwater management have been designed to meet the latest stormwater BMPs standards. The design satisfies all ten stormwater management standards as required in the MA DEP Stormwater Management Regulation and Sherborn by-law. Here are some of the highlights:

- Proposed peak flows and runoff volumes for 2-year to 100-year storm events will not exceed the values for existing conditions using the latest NOAA Atlast 14.0.
- The system mimics natural hydrological patterns by using LID development.
- Overall Total suspended solids (TSS) removal rate will be 89% per DEP SWMH pre-determined value for the BMP structures and will likely higher based on our design analysis, which can reach 98% ;
- The capacity for water quality treatment and groundwater recharge exceeds DEP requirements even based on the static storage volume.
- Groundwater Mounding analysis has been conducted to show that the infiltration trenches will be dewater within 72 hours.

Figures


Source: MGIS:
42.24051° N
71.35776° W
Site Locus
Legend
Zone IIs
IWPAs
Potential Vernal Pools
NHESP Priority Habitats of Rare Species
NHESP Estimated Habitats of Rare Wildlife
NHESP Certified Vernal Pools
Areas of Critical Environmental Concern ACECs
Tax Parcels for Query
STREET
FARM
Mount Misery
CONRAIL
MAIN
Sherborn
Cem
BM 51.9
Farm
Figure 1: USGS Locus Map
Project: 65 Farm Road
Sherborn - Massachusetts
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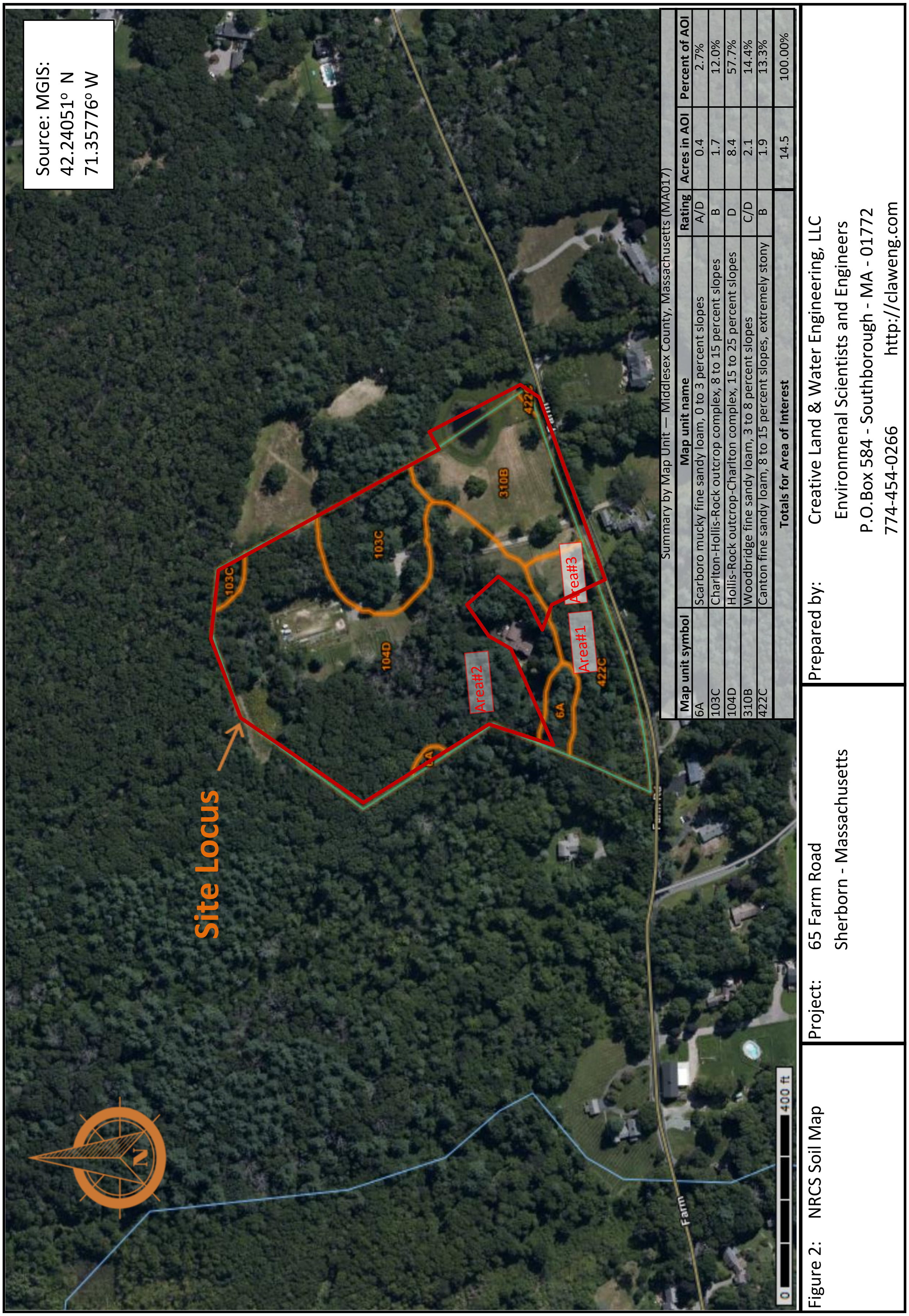


Summary by Map Unit — Middlesex County, Massachusetts (MA017)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
6A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	A/D	0.4	2.7%
103C	Charlton-Hollis-Rock outcrop complex, 8 to 15 percent slopes	B	1.7	12.0%
104D	Hollis-Rock outcrop-Charlton complex, 15 to 25 percent slopes	D	8.4	57.7%
310B	Woodbridge fine sandy loam, 3 to 8 percent slopes	C/D	2.1	14.4%
422C	Canton fine sandy loam, 8 to 15 percent slopes, extremely stony	B	1.9	13.3%
Totals for Area of Interest			14.5	100.00%

Figure 3a: Watershed divide: Existing Condition (see plan)

Figure 3b: Watershed divide: Proposed Condition (see plan)

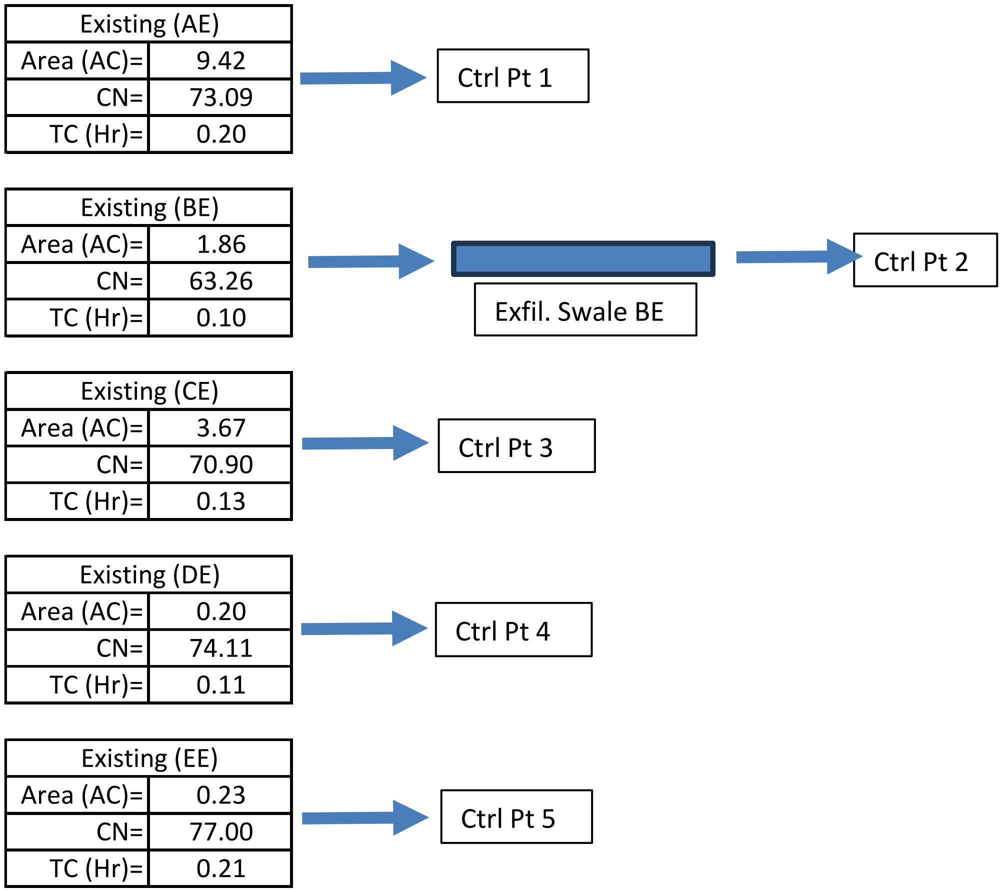


Figure 3c. Schematic layout of the existing drainage system

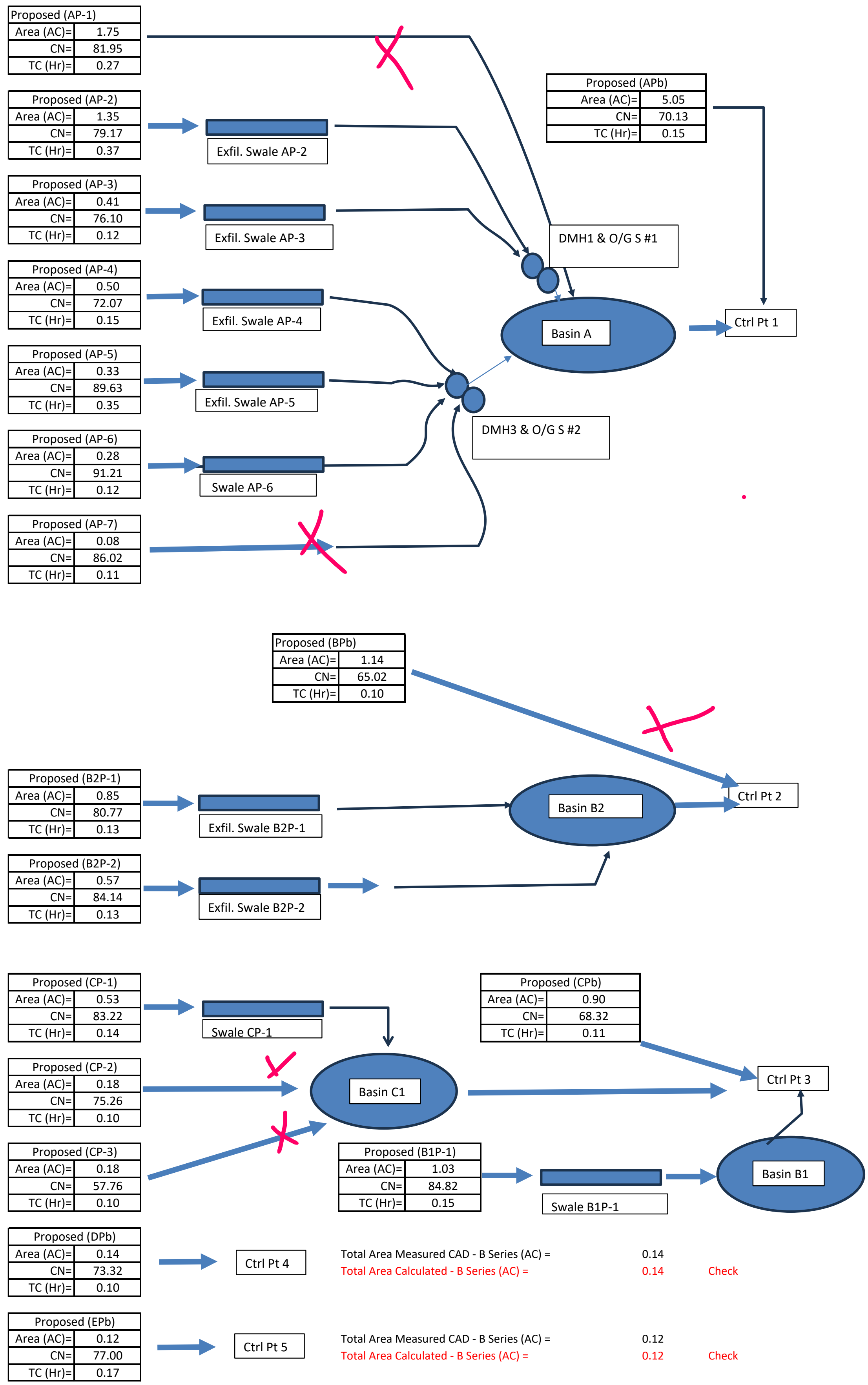


Figure 3d. Schematic layout of the proposed drainage system

Flow Distribution Design in the Front Parking Lot

	65 Farm Road, Sherborn, MA	Revision:		
Project:	DMH#1 - distribution MH	**Date:**	9/28/2023	
By:	Creative Land & Water Eng. LLC	**Cal. by:**	dsw	
		Chk by:		

Bottom of manhole:	225.25 ft	**Rev.**		
INV of Inflow pipes (12"):	226.25 ft			
INV of Orifice to O/G :	226.1 ft	Opening dia.:	4 in	
INV of O.V.F. Weir:	226.50 ft	Weir bottom width (Cipoletti):	1 ft	
INV of O.V.F Pipe:	225.5 ft	OVF pipe dia.:	1.25 ft	
INV of Orifice from O/G:	225.65 ft		15 in	

Treatment Flow Design Storm (0.5" or 1"): 1"

Component	Designed flow (cfs)	Elev. (ft)	Head (ft)	Designed Treatment Capacity (cfs)	Treatment ratio
Treatment Device:		226.50	0.23	0.20	1
Overflow weir:	0.2	226.50	0		
Total				0.20	

Overflow Flow Design Storm: 100-year

Component	Design flow (cfs)	Elev. (ft)	Head (ft)	Cal. Flow (cfs)	Treatment ratio
Treatment Device:		227.3	1.03	0.43	0.15
Overflow weir:	6	227.3	0.8	2.41	
Total				2.84	
Overflow pipe sizing:		227.10	1.60	6.30	

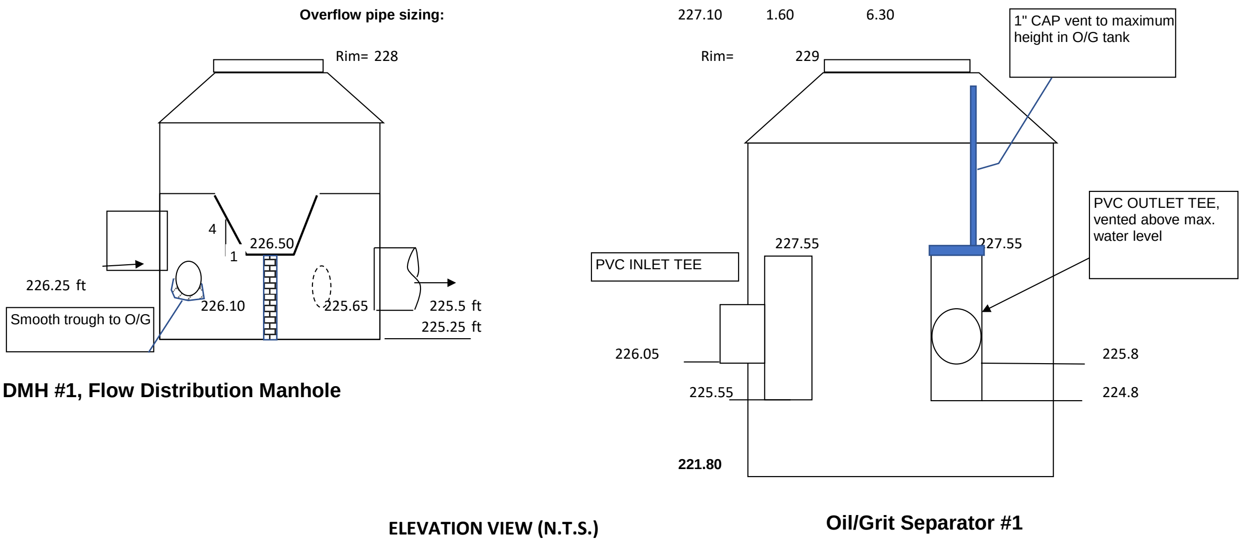


Figure 4a: Flow Distribution Design – DMH#1 and OGS #1 roadway. (see plan)

Flow Distribution Design in the Front Parking Lot

	65 Farm Road, Sherborn, MA	Revision:	
Project:	DMH#1 - distribution MH	**Date:**	9/28/2023
By:	Creative Land & Water Eng. LLC	**Cal. by:**	dsw
		Chk by:	
		Rev.	

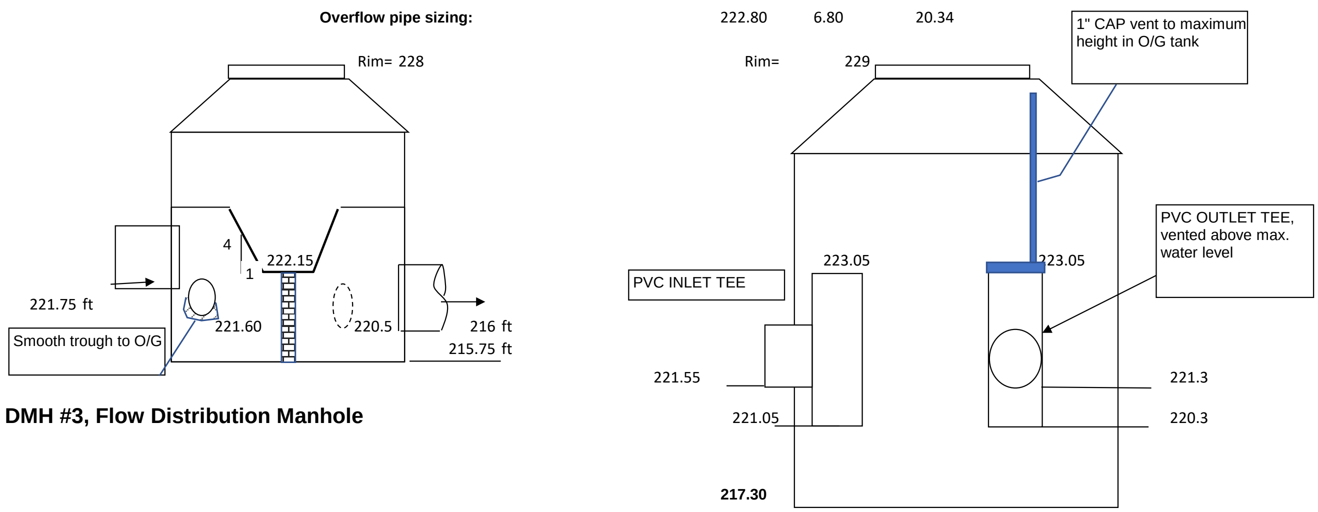
Bottom of manhole:	215.75 ft			
INV of Inflow pipes (12"):	221.75 ft			
INV of Orifice to O/G :	221.6 ft	Opening dia.:	4 in	
INV of O.V.F. Weir:	222.15 ft	Weir bottom width (Cipoletti):	1 ft	
INV of O.V.F Pipe:	216 ft	OVF pipe dia.:	1.25 ft	
INV of Orifice from O/G:	220.5 ft		15 in	

Treatment Flow Design Storm (0.5" or 1"): 1"

Component	Designed flow (cfs)	Elev. (ft)	Head (ft)	Designed Treatment Capacity (cfs)	Treatment ratio
Treatment Device:		222.15	0.38	0.26	1
Overflow weir:	0.25	222.15	0		
Total				0.26	

Overflow Flow Design Storm: 100-year

Component	Design flow (cfs)	Elev. (ft)	Head (ft)	Cal. Flow (cfs)	Treatment ratio
Treatment Device:		223	1.23	0.47	0.15
Overflow weir:	2	223	0.85	2.64	
Total				3.10	
Overflow pipe sizing:		222.80	6.80	20.34	



ELEVATION VIEW (N.T.S.)

Oil/Grit Separator #2

Figure 4b: Flow Distribution Design – DMH#3 and OGS #2 roadway. (see plan)

Figure 5: Storage Indication Table _ Basin A

dsw

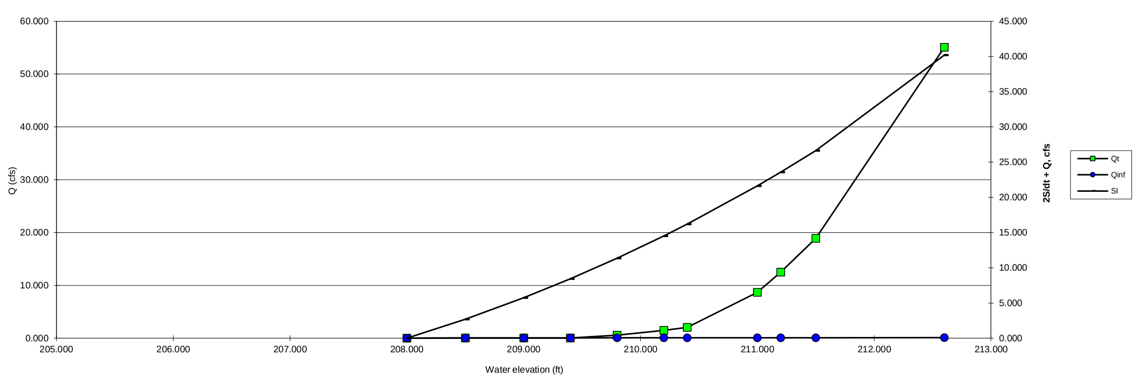
Outflow Analysis and Storage Indication

Basin A

Location:	65 Farm Rd Sherborn, MA			By:	dsw	Date:	7/26/2023
				Chkd:		Date:	
				Job No.:	J269-12	Sheet:	1 of 4
100-year elevation, ft	211.48			100-year flood storage, ac-ft:	0.6069	Area, sf	10440.77
dt (sec.)	60			Upper perimeter (ft):	447	Lower perimeter (ft)	316
Broad-crested weir width (ft):	0.5	Rawls	yes	Upper Permeability (ft/s):	9.44E-06	Slope (H:V):	3.00
Broad-crested weir length (ft):	4	Emergency BCW length (ft):	5	Lower permeability(ft/s):	9.44E-06	Inf. safety factor:	1
Weir crest elevation (ft):	210.4	Weir crest elevation (ft):	212	Total infil. depth (ft):	4	Starting INV (ft):	208
Pipe 1 Dia. (ft)	1.5			Pipe 2 Dia. (ft)	1.5	Slot width (in.):	7
Pipe 1 INV (ft):	213			Pipe 2 INV (ft):	230	Slot INV (ft):	209.4
				EHGW (ft):	204		

Elevation ft	Total Q cfs	2S/dt + Q cfs	Qinf cfs	Inf head ft	Head 1 ft	Qpipe 1 cfs	Head 2 ft	Qpipe 2 cfs	Head, weir-e ft	Qweir-e cfs	Head, weir-p ft	Qweir-p cfs	Head-slot ft	Qslot cfs	Pond area sq. ft	Storage 1000 cu. ft	Dewater hrs.
208.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5095	0.000	0.000
208.500	0.054	90.395	0.054	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	5753	2.710	27.713
209.000	0.061	191.713	0.061	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	6411	5.750	42.411
209.400	0.066	281.131	0.066	1.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	7006	8.432	54.172
209.800	0.574	378.987	0.072	1.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.200	0.502	7601	11.352	56.706
210.200	1.499	485.422	0.078	2.200	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.400	1.421	8230	14.518	57.554
210.400	2.067	541.961	0.081	2.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500	1.986	8562	16.197	57.816
211.000	8.697	729.708	0.090	3.000	0.000	0.000	0.000	0.000	0.600	5.661	0.000	0.000	0.800	2.946	9559	21.630	58.096
211.200	12.509	798.465	0.094	3.200	0.000	0.000	0.000	0.000	0.800	9.213	0.000	0.000	0.900	3.202	9926	23.579	58.147
211.500	18.920	906.882	0.099	3.500	0.000	0.000	0.000	0.000	1.100	15.268	0.000	0.000	1.050	3.553	10478	26.639	58.201
212.600	55.056	1394.916	0.135	4.600	0.000	0.000	0.000	0.000	2.200	43.334	0.600	6.971	1.900	4.615	14269	40.196	58.303

Storage-Indication Curve



elev ft	Stor ac-ft	Dis cfs	infil cfs
208.000	0.00000	0.000	0.000
208.500	0.06222	0.054	0.054
209.000	0.13199	0.061	0.061
209.400	0.19357	0.066	0.066
209.800	0.26062	0.574	0.072
210.200	0.33328	1.499	0.078
210.400	0.37183	2.067	0.081
211.000	0.49656	8.697	0.090
211.200	0.54129	12.509	0.094
211.500	0.61154	18.920	0.099
212.600	0.92277	55.056	0.135
0.000	0.000	0.000	0.000

Figure : Rating Curve and Storage-Indication Curve

Outflow Structure Analysis - Slotted Weir Version 1.2 (c) Designed and Maintained by Desheng Wang, Ph.D., P.E., Creative Land & Water Engineering, LLC.

dsw

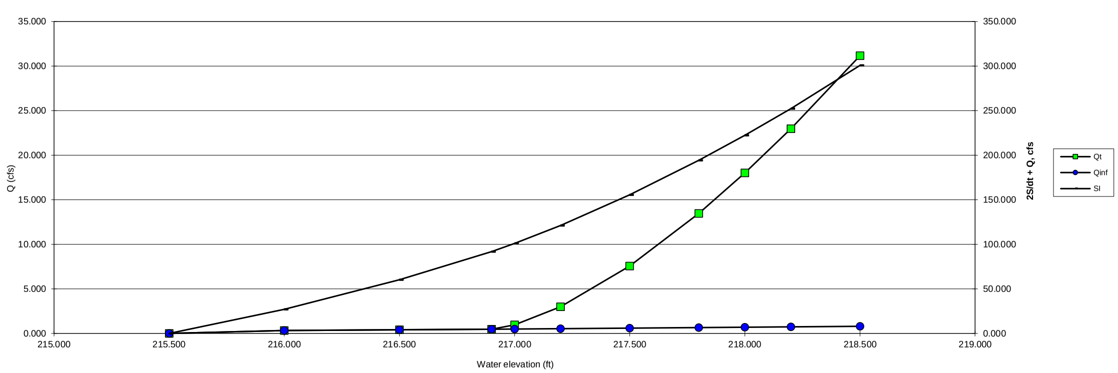
Outflow Analysis and Storage Indication

Basin B1

Location:	65 Farm Rd			By:	dsw	Date:	7/26/2023
	Sherborn, MA			Chkd:		Date:	
				Job No.:	J269-12	Sheet:	2 of 4
100-year elevation, ft	217.41			100-year flood storage, ac-ft:	0.0957	Area, sf	3038.37
dt (sec.)	60			Upper perimeter (ft):	319	Lower perimeter (ft)	203
Broad-crested weir width (ft):	0.5	Rawls	yes	Upper Permeability (ft/s):	0.000191	Slope (H:V):	3
Broad-crested weir length (ft):	2	Emergency BCW length (ft):	5	Lower permeability(ft/s):	0.000191	Inf. safety factor:	1
Weir crest elevation (ft):	230	Weir crest elevation (ft):	216.9	Total infil. depth (ft):	2	Starting INV (ft):	
Pipe 1 Dia. (ft)	1.5			Pipe 2 Dia. (ft)	0	Slot width (in.):	2
Pipe 1 INV (ft):	230			Pipe 2 INV (ft):	230	Slot INV (ft):	230
				EHGW (ft):	214		

Elevation ft	Total Q cfs	2S/dt + Q cfs	Qinf cfs	Inf head ft	Head 1 ft	Qpipe 1 cfs	Head 2 ft	Qpipe 2 cfs	Head, weir-e ft	Qweir-e cfs	Head, weir-p ft	Qweir-p cfs	Head-slot ft	Qslot cfs	Pond area sq. ft	Storage 1000 cu. ft	Dewater hrs.
215.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1424	0.000	0.000
216.000	0.342	27.043	0.342	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1787	0.801	1.301
216.500	0.422	60.300	0.422	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2202	1.796	2.025
216.900	0.485	91.911	0.485	1.400	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2534	2.743	2.605
217.000	0.975	100.986	0.501	1.500	0.000	0.000	0.000	0.000	0.000	0.000	0.100	0.474	0.000	0.000	2617	3.000	2.703
217.200	3.005	121.144	0.540	1.700	0.000	0.000	0.000	0.000	0.000	0.000	0.300	2.465	0.000	0.000	2823	3.544	2.779
217.500	7.571	155.464	0.599	2.000	0.000	0.000	0.000	0.000	0.000	0.000	0.600	6.971	0.000	0.000	3131	4.437	2.826
217.800	13.466	194.196	0.658	2.300	0.000	0.000	0.000	0.000	0.000	0.000	0.900	12.807	0.000	0.000	3439	5.422	2.852
218.000	18.003	222.341	0.698	2.500	0.000	0.000	0.000	0.000	0.000	0.000	1.100	17.305	0.000	0.000	3644	6.130	2.865
218.200	22.972	252.317	0.739	2.700	0.000	0.000	0.000	0.000	0.000	0.000	1.300	22.233	0.000	0.000	3859	6.880	2.875
218.500	31.158	300.685	0.800	3.000	0.000	0.000	0.000	0.000	0.000	0.000	1.600	30.358	0.000	0.000	4180	8.086	2.887

Storage-Indication Curve



elev ft	Stor ac-ft	Dis cfs	infil cfs
215.500	0.00000	0.000	0.000
216.000	0.01839	0.342	0.342
216.500	0.04124	0.422	0.422
216.900	0.06297	0.485	0.485
217.000	0.06888	0.975	0.501
217.200	0.08136	3.005	0.540
217.500	0.10185	7.571	0.599
217.800	0.12447	13.466	0.658
218.000	0.14073	18.003	0.698
218.200	0.15795	22.972	0.739
218.500	0.18562	31.158	0.800
0.000	0.000	0.000	0.000

Figure : Rating Curve and Storage-Indication Curve

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Figure 6: Storage Indication Table - Basin B1

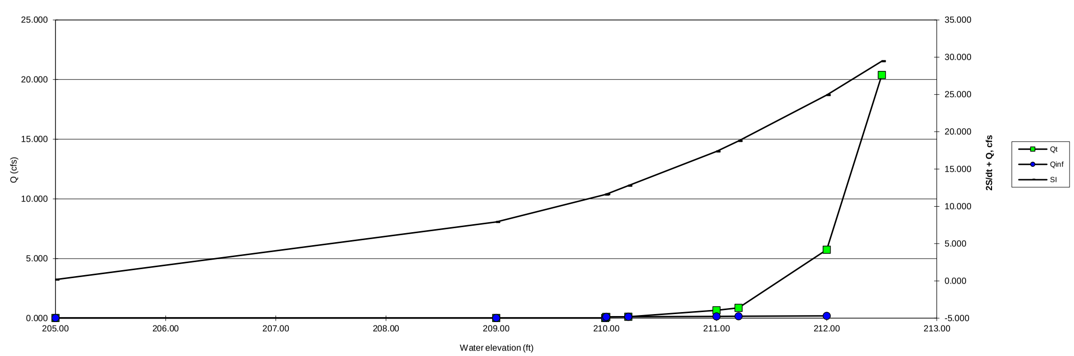
Outflow Analysis and Storage Indication

Basin B2

Location:	65 Farm Rd Sherborn, MA			By: Chkd: Job No.:	dsw J269-12	Date: Date: Sheet:	7/26/2023 1 of 4
100-year elevation, ft	210.87			100-year flood storage, ac-ft:	0.3814	Area, sf	2740.94
dt (sec.)	60			Upper perimeter (ft):	447	Lower perimeter (ft)	316
Broad-crested weir width (ft):	0.5	Rawls	yes	Upper Permeability (ft/s):	5.58E-05	Slope (H:V):	3.00
Broad-crested weir length (ft):	4	Emergency BCW length (ft):	5	Lower permeability(ft/s):	5.58E-05	Inf. safety factor:	1
Weir crest elevation (ft):	211.5	Weir crest elevation (ft):	212	Total infil. depth (ft):	2	Starting INV (ft):	204.5
Pipe 1 Dia. (ft)	1.5			Pipe 2 Dia. (ft)	1.5	Slot width (in.):	2.5
Pipe 1 INV (ft):	213			Pipe 2 INV (ft):	213	Slot INV (ft):	210.2
				EHGW (ft):	200.73		

Elevation	Total Q	2S/dt + Q	Qinf	Inf head	Head 1	Qpipe 1	Head 2	Qpipe 2	Head, weir-e	Qweir-e	Head, weir-p	Qweir-p	Head-slot	Qslot	Pond area	Storage	Dewater
ft	cfs	cfs	cfs	ft	ft	cfs	ft	cfs	ft	cfs	ft	cfs	ft	cfs	sq. ft	1000 cu. ft	hrs.
204.50	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	154	0.000	0.000
204.99	0.022	5.891	0.022	0.490	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	154	0.176	4.543
205.00	0.022	6.020	0.0216	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	177	0.180	4.592
209.00	0.022	263.971	0.0218	4.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1581	7.918	103.647
209.99	0.022	386.247	0.0219	5.490	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1595	11.587	150.361
210.00	0.116	387.767	0.1159	5.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2078	11.630	150.533
210.20	0.124	425.961	0.1244	5.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2230	12.775	153.181
211.00	0.666	579.243	0.1584	6.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.400	0.508	2840	17.357	156.402
211.20	0.877	626.755	0.1674	6.700	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.500	0.709	3001	18.776	156.913
212.00	5.738	836.517	0.2035	7.500	0.000	0.000	0.000	0.000	0.500	4.136	0.000	0.000	0.900	1.398	3647	24.923	157.429
212.50	20.387	1002.961	0.2322	8.000	0.000	0.000	0.000	0.000	1.000	13.177	0.500	5.303	1.400	1.675	4162	29.477	157.526

Storage-Indication Curve



elev	Stor	Dis	infil
ft	ac-ft	cfs	cfs
204.500	0.00000	0.0000	0.0000
204.990	0.00404	0.0215	0.0215
205.000	0.00413	0.0216	0.0216
209.000	0.18178	0.0218	0.0218
209.990	0.26599	0.0219	0.0219
210.000	0.26698	0.1159	0.1159
210.200	0.29328	0.1244	0.1244
211.000	0.39847	0.6660	0.1584
211.200	0.43105	0.8768	0.1674
212.000	0.57216	5.7379	0.2035
212.500	0.67670	20.3871	0.2322
0.000	0.000	0.000	0.000

Figure : Rating Curve and Storage-Indication Curve

w Structure Analysis - Slotted Weir Version 1.2 (c) Designed and Maintained by Desheng Wang, Ph.D., P.E., Creative Land & Water Engineering, LLC.

Figure 7. Storage Indication Table - Basin B2

Figure 8. Storage Indication Table - Basin C

dsw

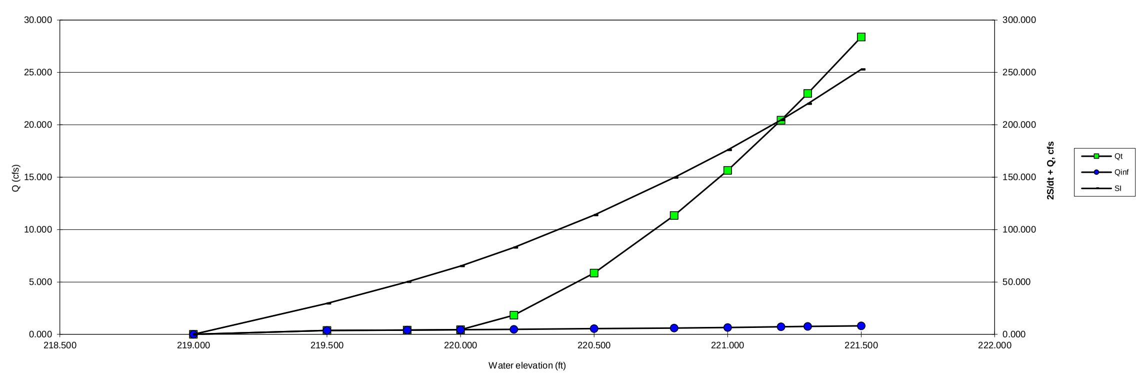
Outflow Analysis and Storage Indication

Basin C

Location:	65 Farm Rd			By:	dsw	Date:	7/26/2023
	Sherborn, MA			Chkd:		Date:	
				Job No.:	J269-12	Sheet:	4 of 4
100-year elevation, ft	220.42			100-year flood storage, ac-ft:	0.0695	Area, sf	2780.24
dt (sec.)	60			Upper perimeter (ft):	278	Lower perimeter (ft)	174
Broad-crested weir width (ft):	0.5	Rawls	yes	Upper Permeability (ft/s):	0.000191	Slope (H:V):	3
Broad-crested weir length (ft):	3	Emergency BCW length (ft):	5	Lower permeability(ft/s):	0.000191	Inf. safety factor:	1
Weir crest elevation (ft):	222	Weir crest elevation (ft):	220	Total infil. depth (ft):	2	Starting INV (ft):	179.25
Pipe 1 Dia. (ft)	1.5			Pipe 2 Dia. (ft)	1.5	Slot width (in.):	4
Pipe 1 INV (ft):	222			Pipe 2 INV (ft):	222	Slot INV (ft):	222
				EHGW (ft):	215		

Elevation ft	Total Q cfs	2S/dt + Q cfs	Qinf cfs	Inf head ft	Head 1 ft	Qpipe 1 cfs	Head 2 ft	Qpipe 2 cfs	Head, weir-e ft	Qweir-e cfs	Head, weir-p ft	Qweir-p cfs	Head-slot ft	Qslot cfs	Pond area sq. ft	Storage 1000 cu. ft	Dewater hrs.
219.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1561	0.000	0.000
219.500	0.372	29.534	0.372	0.500	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1946	0.875	1.305
219.800	0.417	50.179	0.417	0.800	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2177	1.493	1.740
220.000	0.446	65.230	0.446	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	2331	1.944	2.030
220.200	1.829	82.859	0.487	1.200	0.000	0.000	0.000	0.000	0.000	0.000	0.200	1.342	0.000	0.000	2545	2.431	2.149
220.500	5.852	113.919	0.549	1.500	0.000	0.000	0.000	0.000	0.000	0.000	0.500	5.303	0.000	0.000	2866	3.242	2.208
220.800	11.343	149.661	0.610	1.800	0.000	0.000	0.000	0.000	0.000	0.000	0.800	10.733	0.000	0.000	3187	4.150	2.237
221.000	15.651	175.925	0.651	2.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	15.000	0.000	0.000	3401	4.808	2.251
221.200	20.439	204.585	0.721	2.200	0.000	0.000	0.000	0.000	0.000	0.000	1.200	19.718	0.000	0.000	3764	5.524	2.262
221.300	22.989	219.982	0.755	2.300	0.000	0.000	0.000	0.000	0.000	0.000	1.300	22.233	0.000	0.000	3945	5.910	2.267
221.500	28.381	252.876	0.825	2.500	0.000	0.000	0.000	0.000	0.000	0.000	1.500	27.557	0.000	0.000	4308	6.735	2.276

Storage-Indication Curve



elev ft	Stor ac-ft	Dis cfs	infil cfs
219.000	0.00000	0.000	0.000
219.500	0.02008	0.372	0.372
219.800	0.03427	0.417	0.417
220.000	0.04462	0.446	0.446
220.200	0.05581	1.829	0.487
220.500	0.07443	5.852	0.549
220.800	0.09526	11.343	0.610
221.000	0.11038	15.651	0.651
221.200	0.12682	20.439	0.721
221.300	0.13567	22.989	0.755
221.500	0.15461	28.381	0.825
0.000	0.000	0.000	0.000

Figure : Rating Curve and Storage-Indication Curve

Outflow Structure Analysis - Slotted Weir Version 1.2 (c) Designed and Maintained by Desheng Wang, Ph.D., P.E., Creative Land & Water Engineering, LLC.

Appendix A: HYDROLOGICAL ANALYSIS AND ROAD DRAINAGE CALCULATIONS

Computer Model HEC-HMS was used for the calculations of peak flow, unit hydrograph. The input data are summarized in Table A-1.

Table A-1 Summary of Input Parameter

Sub-watershed	Area (Acre)	Area(Mi²)	CN	Imp.(%)	I	TC (Hr)	Lag (Min.)
Existing (AE)	9.42	0.01472	73.09	4.31	0.736	0.20	7.37
Existing (BE)	1.86	0.00290	63.26	9.87	1.162	0.10	3.60
Existing (CE)	3.67	0.00574	70.90	5.82	0.821	0.13	4.75
Existing (DE)	0.20	0.00032	74.11	0.00	0.699	0.11	4.04
Existing (EE)	0.23	0.00037	77.00	0.00	0.597	0.21	7.64
Total	15.392	0.02405	-				
Proposed (APb)	5.05	0.00789	70.13	3.98	0.852	0.15	5.36
Proposed (AP-1)	1.75	0.00273	81.95	12.41	0.441	0.27	9.61
Proposed (AP-2)	1.35	0.00211	79.17	12.45	0.526	0.37	13.46
Proposed (AP-3)	0.41	0.00064	76.10	3.73	0.628	0.12	4.28
Proposed (AP-4)	0.50	0.00078	72.07	10.74	0.775	0.15	5.29
Proposed (AP-5)	0.33	0.00052	89.63	64.88	0.231	0.35	12.68
Proposed (AP-6)	0.28	0.00044	91.21	65.73	0.193	0.12	4.37
Proposed (AP-7)	0.08	0.00012	86.02	67.63	0.325	0.11	4.06
Proposed (BPb)	1.14	0.00178	65.02	16.12	1.076	0.10	3.60
Proposed (B1P-1)	1.03	0.00160	84.82	37.17	0.358	0.15	5.45
Proposed (B2P-1)	0.85	0.00133	80.77	44.96	0.476	0.13	4.84
Proposed (B2P-2)	0.57	0.00089	84.14	49.20	0.377	0.13	4.53
Proposed (CPb)	0.90	0.00141	68.32	0.10	0.927	0.11	4.00
Proposed (CP-1)	0.53	0.00083	83.22	50.44	0.403	0.14	5.08
Proposed (CP-2)	0.18	0.00029	75.26	41.86	0.657	0.10	3.60
Proposed (CP-3)	0.18	0.00028	57.76	0.00	1.462	0.10	3.60
Proposed (DPb)	0.14	0.00022	73.32	0.00	0.728	0.10	3.60
Proposed (EPb)	0.12	0.00018	77.00	0.00	0.597	0.17	6.05
Total	15.39	0.02405	-				
Meteorological Model			Method: SCS Hypothetical Storm				
			Storm Selection: Type III				
			1" Storm Event (Inch): 1				
			2-Year 24-Hour Rainfall Depth (Inch):				3.36
			10-Year 24-Hour Rainfall Depth (Inch):				5.25
			25-Year 24-Hour Rainfall Depth (Inch):				6.43
			50-year 24-hour rainfall depth (inch):				7.3
			100-Year 24-Hour Rainfall Depth (Inch):				8.25

Table A-2. Summary of Land uses

Watershed	Land Use (Acre)					
	Roof	Driveway / Park	Walk / Patio / Etc.	Lawn	Woods	Total
Existing (AE)	0.07	0.14	0.20	1.50	7.52	9.42
Existing (BE)	0.05	0.11	0.02	0.67	1.00	1.86
Existing (CE)	0.03	0.00	0.18	2.23	1.23	3.67
Existing (DE)	0.00	0.00	0.00	0.00	0.20	0.20
Existing (EE)	0.00	0.00	0.00	0.00	0.23	0.23
Total	0.15	0.24	0.41	4.40	10.19	**15.39**
Proposed (APb)	0.05	0.14	0.01	1.10	3.74	5.050
Proposed (AP-1)	0.11	0.03	0.08	1.36	0.17	1.747
Proposed (AP-2)	0.06	0.11	0.01	0.21	0.98	1.353
Proposed (AP-3)	0.01	0.00	0.00	0.04	0.36	0.412
Proposed (AP-4)	0.05	0.00	0.00	0.15	0.30	0.501
Proposed (AP-5)	0.05	0.12	0.04	0.12	0.00	0.332
Proposed (AP-6)	0.08	0.10	0.01	0.10	0.00	0.285
Proposed (AP-7)	0.04	0.01	0.00	0.03	0.00	0.078
Proposed (BPb)	0.05	0.11	0.02	0.50	0.46	1.138
Proposed (B1P-1)	0.09	0.25	0.04	0.55	0.09	1.026
Proposed (B2P-1)	0.22	0.08	0.09	0.44	0.03	0.851
Proposed (B2P-2)	0.08	0.10	0.10	0.27	0.02	0.570
Proposed (CPb)	0.00	0.00	0.00	0.35	0.56	0.905
Proposed (CP-1)	0.13	0.09	0.04	0.26	0.00	0.529
Proposed (CP-2)	0.03	0.03	0.01	0.07	0.04	0.185
Proposed (CP-3)	0.00	0.00	0.00	0.01	0.17	0.177
Proposed (DPb)	0.00	0.00	0.00	0.00	0.14	0.139
Proposed (EPb)	0.00	0.00	0.00	0.00	0.12	0.115
Total	1.069	1.175	0.439	5.547	7.162	**15.39**

Detailed land use table, calculation sheets of CN and TC, and output report of HEC-HMS are on the following pages.

Creative Land & Water Engineering, LLC Environmental Scientists and Engineers P.O. Box 584 - Southborough - MA - 01772 774-454-0266 www.claweng.com			**Subject:**	SCS Modified Soil Cover Complex Method	
			Project:	Farm Road Homes	
			Location:	65 Farm Rd, Sherborn, MA	
			Job No.:	7/18/2023	
Sub-Basin:	AE	Analysis By:	FA	Date:	7/21/2023
Condition:	Existing	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.069	6.76
2	Drive/Park	A,B,C,D	98	0.137	13.47
3	Walk/Patio/ Etc	A,B,C,D	98	0.199	19.55
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.019	0.73
2	Woods	A	30	0.721	21.63
3	Lawn	B	61	0.138	8.44
4	Woods	B	55	0.570	31.35
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	1.344	107.50
8	Woods	D	77	6.224	479.29
			Total :	9.422	688.72
			Average CN:		73.09
			Imperviousness (%):		**4.31**

Sub-Basin:	BE	Analysis By:	FA	Date:	7/21/2023
Condition:	Existing	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.055	5.38
2	Drive/Park	A,B,C,D	98	0.105	10.31
3	Walk/Patio/ Etc	A,B,C,D	98	0.023	2.28
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.023	0.88
2	Woods	A	30	0.066	1.98
3	Lawn	B	61	0.419	25.57
4	Woods	B	55	0.834	45.87
5	Lawn	C	74	0.175	12.95
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.053	4.27
8	Woods	D	77	0.105	8.05
			Total :	1.858	117.54
			Average CN:		63.26
			Imperviousness (%):		**9.87**

Sub-Basin:	CE	Analysis By:	FA	Date:	7/21/2023
Condition:	Existing	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.029	2.86
2	Drive/Park	A,B,C,D	98	0.000	0.00
3	Walk/Patio/ Etc	A,B,C,D	98	0.185	18.08
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.426	25.97
4	Woods	B	55	0.771	42.42
5	Lawn	C	74	1.338	98.99
6	Woods	C	70	0.069	4.86
7	Lawn	D	80	0.466	37.30
8	Woods	D	77	0.389	29.96
			Total :	3.673	260.45
			Average CN:		70.90
			Imperviousness (%):		**5.82**

Sub-Basin:	DE	Analysis By:	FA	Date:	7/21/2023
Condition:	Existing	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.000	0.00
2	Drive/Park	A,B,C,D	98	0.000	0.00
3	Walk/Patio/ Etc	A,B,C,D	98	0.000	0.00
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.000	0.00
4	Woods	B	55	0.027	1.47
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.000	0.00
8	Woods	D	77	0.177	13.63
			Total :	0.204	15.10
			Average CN:		74.11
			Imperviousness (%):		**0.00**

Sub-Basin:	EE	Analysis By:	FA	Date:	7/21/2023
Condition:	Existing	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.000	0.00
2	Drive/Park	A,B,C,D	98	0.000	0.00
3	Walk/Patio/ Etc	A,B,C,D	98	0.000	0.00
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.000	0.00
4	Woods	B	55	0.000	0.00
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.000	0.00
8	Woods	D	77	0.234	18.03
			Total :	0.234	18.03
			Average CN:		77.00
			Imperviousness (%):		**0.00**

Creative Land & Water Engineering, LLC Environmental Scientists and Engineers P.O. Box 584 - Southborough - MA - 01772 774-454-0266 www.claweng.com			**Subject:**	SCS Modified Soil Cover Complex Method	
			Project:	Farm Road Homes	
			Location:	65 Farm Rd, Sherborn, MA	
			Job No.:	7/18/2023	
Sub-Basin:	APb	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.054	5.31
2	Drive/Park	A,B,C,D	98	0.137	13.47
3	Walk/Patio/ Etc	A,B,C,D	98	0.009	0.89
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.019	0.73
2	Woods	A	30	0.721	21.63
3	Lawn	B	61	0.018	1.11
4	Woods	B	55	0.327	18.00
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	1.068	85.41
8	Woods	D	77	2.696	207.63
			Total :	5.050	354.19
			Average CN:		70.13
			Imperviousness (%):		**3.98**

Sub-Basin:	AP-1	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.113	11.12
2	Drive/Park	A,B,C,D	98	0.026	2.52
3	Walk/Patio/ Etc	A,B,C,D	98	0.078	7.62
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.000	0.00
4	Woods	B	55	0.000	0.00
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	1.365	109.18
8	Woods	D	77	0.166	12.76
			Total :	1.747	143.20
			Average CN:		81.95
			Imperviousness (%):		**12.41**

Sub-Basin:	AP-2	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.056	5.50
2	Drive/Park	A,B,C,D	98	0.107	10.50
3	Walk/Patio/ Etc	A,B,C,D	98	0.005	0.50
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.000	0.00
4	Woods	B	55	0.055	3.04
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.208	16.64
8	Woods	D	77	0.921	70.93
			Total :	1.353	107.12
			Average CN:		79.17
			Imperviousness (%):		**12.45**

Sub-Basin:	AP-3	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.011	1.07
2	Drive/Park	A,B,C,D	98	0.000	0.00
3	Walk/Patio/ Etc	A,B,C,D	98	0.004	0.43
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.000	0.00
4	Woods	B	55	0.037	2.01
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.038	3.06
8	Woods	D	77	0.321	24.74
			Total :	0.412	31.32
			Average CN:		76.10
			Imperviousness (%):		**3.73**

Sub-Basin:	AP-4	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.052	5.11
2	Drive/Park	A,B,C,D	98	0.000	0.00
3	Walk/Patio/ Etc	A,B,C,D	98	0.002	0.16
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.079	4.84
4	Woods	B	55	0.115	6.33
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.067	5.36
8	Woods	D	77	0.186	14.30
			Total :	0.501	36.11
			Average CN:		72.07
			Imperviousness (%):		**10.74**

Sub-Basin:	AP-5	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.055	5.37
2	Drive/Park	A,B,C,D	98	0.124	12.15
3	Walk/Patio/ Etc	A,B,C,D	98	0.036	3.56
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.036	2.18
4	Woods	B	55	0.000	0.00
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.081	6.46
8	Woods	D	77	0.000	0.00
			Total :	0.332	29.72
			Average CN:		89.63
			Imperviousness (%):		**64.88**

Sub-Basin:	AP-6	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.079	7.77
2	Drive/Park	A,B,C,D	98	0.101	9.86
3	Walk/Patio/ Etc	A,B,C,D	98	0.007	0.71
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.009	0.57
4	Woods	B	55	0.000	0.00
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.088	7.05
8	Woods	D	77	0.000	0.00
			Total :	0.285	25.96
			Average CN:		91.21
			Imperviousness (%):		**65.73**

Sub-Basin:	AP-7	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.037	3.66
2	Drive/Park	A,B,C,D	98	0.014	1.40
3	Walk/Patio/ Etc	A,B,C,D	98	0.001	0.08
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.025	1.53
4	Woods	B	55	0.000	0.00
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.000	0.00
8	Woods	D	77	0.000	0.00
			Total :	0.078	6.67
			Average CN:		86.02
			Imperviousness (%):		**67.63**

Sub-Basin:	BPb	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.055	5.38
2	Drive/Park	A,B,C,D	98	0.105	10.31
3	Walk/Patio/ Etc	A,B,C,D	98	0.023	2.28
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.023	0.88
2	Woods	A	30	0.066	1.98
3	Lawn	B	61	0.419	25.57
4	Woods	B	55	0.317	17.42
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.053	4.27
8	Woods	D	77	0.077	5.90
			Total :	1.138	73.99
			Average CN:		65.02
			Imperviousness (%):		**16.12**

Sub-Basin:	B1P-1	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.093	9.14
2	Drive/Park	A,B,C,D	98	0.252	24.72
3	Walk/Patio/ Etc	A,B,C,D	98	0.036	3.50
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.012	0.74
4	Woods	B	55	0.000	0.00
5	Lawn	C	74	0.234	17.31
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.304	24.34
8	Woods	D	77	0.094	7.25
			Total :	1.026	87.01
			Average CN:		84.82
			Imperviousness (%):		**37.17**

Sub-Basin:	B2P-1	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.215	21.09
2	Drive/Park	A,B,C,D	98	0.080	7.81
3	Walk/Patio/ Etc	A,B,C,D	98	0.088	8.60
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.266	16.20
4	Woods	B	55	0.008	0.44
5	Lawn	C	74	0.156	11.53
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.021	1.66
8	Woods	D	77	0.018	1.42
			Total :	0.851	68.74
			Average CN:		80.77
			Imperviousness (%):		**44.96**

Sub-Basin:	B2P-2	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.083	8.14
2	Drive/Park	A,B,C,D	98	0.101	9.86
3	Walk/Patio/ Etc	A,B,C,D	98	0.097	9.47
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.109	6.62
4	Woods	B	55	0.018	0.97
5	Lawn	C	74	0.031	2.27
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.133	10.61
8	Woods	D	77	0.000	0.00
			Total :	0.570	47.94
			Average CN:		84.14
			Imperviousness (%):		**49.20**

Sub-Basin:	CPb	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.000	0.00
2	Drive/Park	A,B,C,D	98	0.000	0.00
3	Walk/Patio/ Etc	A,B,C,D	98	0.001	0.09
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.170	10.37
4	Woods	B	55	0.049	2.72
5	Lawn	C	74	0.171	12.65
6	Woods	C	70	0.509	35.63
7	Lawn	D	80	0.004	0.34
8	Woods	D	77	0.000	0.00
			Total :	0.905	61.81
			Average CN:		68.32
			Imperviousness (%):		**0.10**

Sub-Basin:	CP-1	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.130	12.71
2	Drive/Park	A,B,C,D	98	0.094	9.23
3	Walk/Patio/ Etc	A,B,C,D	98	0.043	4.23
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.152	9.29
4	Woods	B	55	0.000	0.00
5	Lawn	C	74	0.035	2.60
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.075	6.00
8	Woods	D	77	0.000	0.00
			Total :	0.529	44.06
			Average CN:		83.22
			Imperviousness (%):		**50.44**

Sub-Basin:	CP-2	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.035	3.40
2	Drive/Park	A,B,C,D	98	0.034	3.32
3	Walk/Patio/ Etc	A,B,C,D	98	0.009	0.85
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.070	4.24
4	Woods	B	55	0.038	2.08
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.000	0.00
8	Woods	D	77	0.000	0.00
			Total :	0.185	13.91
			Average CN:		75.26
			Imperviousness (%):		**41.86**

Sub-Basin:	CP-3	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.000	0.00
2	Drive/Park	A,B,C,D	98	0.000	0.00
3	Walk/Patio/ Etc	A,B,C,D	98	0.000	0.00
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.010	0.58
4	Woods	B	55	0.148	8.15
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.000	0.00
8	Woods	D	77	0.020	1.52
			Total :	0.177	10.25
			Average CN:		57.76
			Imperviousness (%):		**0.00**

Sub-Basin:	DPb	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.000	0.00
2	Drive/Park	A,B,C,D	98	0.000	0.00
3	Walk/Patio/ Etc	A,B,C,D	98	0.000	0.00
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.000	0.00
4	Woods	B	55	0.023	1.28
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.000	0.00
8	Woods	D	77	0.116	8.90
			Total :	0.139	10.18
			Average CN:		73.32
			Imperviousness (%):		**0.00**

Sub-Basin:	EPb	Analysis By:	FA	Date:	7/21/2023
Condition:	Proposed	Checked By:		Date:	
Storm Frequency:		2-Year	10-Year	25-Year	100-Year
24-hour rainfall (in):		3.36	5.25	6.43	8.25
Impervious Area:	Land Use	Soil Group	CN	Area (acres)	Area x CN
1	Roof	A,B,C,D	98	0.000	0.00
2	Drive/Park	A,B,C,D	98	0.000	0.00
3	Walk/Patio/ Etc	A,B,C,D	98	0.000	0.00
4					
5					
6					
Pervious area:					
1	Lawn	A	39	0.000	0.00
2	Woods	A	30	0.000	0.00
3	Lawn	B	61	0.000	0.00
4	Woods	B	55	0.000	0.00
5	Lawn	C	74	0.000	0.00
6	Woods	C	70	0.000	0.00
7	Lawn	D	80	0.000	0.00
8	Woods	D	77	0.115	8.86
			Total :	0.115	8.86
			Average CN:		77.00
			Imperviousness (%):		**0.00**

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	Project:	Farm Road Homes	**Job No.:**	J269-12
	Location:	65 Farm Road, Sherborn, MA		

Sub-Basin:	AE	**Analysis By:**	FA	Date	7/18/2023
Condition:	Existing	**Checked By:**		Date	
Time (Hrs):	0.20	through subarea			
	0.20	to be used			

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Woods - Light Underbrush				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.4				
3. Flow length, L (total L <= 300 ft)..	Ft.	50				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0278				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.1758	0		=	0.176

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Woods		
8. Flow length, L	Ft.			644.86		
9. Watercourse slope, s	Ft./Ft.			0.1498		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	6.193		
11. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.029	=	0.029

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)						
13. Flow length, L	Ft.					
14. Watercourse slope, s	Ft./Ft.					
15. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	0.000		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.					
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0	0	0		
19. Channel slope, s	Ft./Ft.					
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.00	0	0		
22. Flow length, L	Ft.					
23. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24 Surface description (Table 3-1)................................						
25. Bottom width, B.................................	ft					
26. Side slope (H:V)..................................						
27. Design depth, D	ft					
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.000	0.000	0.000		
29. Channel slope, s	Ft./Ft.					
30. Manning's roughness coeff., n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.000	0.000	0.000		
32. Flow length, L	Ft.	0.000	0.000	0.000		
33. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)		Hour			=	0.20

Creative Land & Water Engineering, LLC Environmental Scientists and Engineers P.O. Box 584 - Southborough - MA - 01772 774-454-0266 www.claweng.com	**Subject:**	**Time of Concentration (Tc) or Travel Timel (Tt)**		
	Project:	Farm Road Homes	**Job No.:**	J269-12
	Location:	65 Farm Road, Sherborn, MA		

Sub-Basin: BE **Analysis By:** FA Date 7/18/2023
Condition: Existing **Checked By:** Date
Time (Hrs): 0.09 through subarea
0.10 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Lawn - Dense Grasses				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.24				
3. Flow length, L (total L <= 300 ft)...	Ft.	50				
4. Two-yr 24-hr rainfall, P2...	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0864				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.0742	0		=	0.074

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Woods		
8. Flow length, L	Ft.			76.33		
9. Watercourse slope, s	Ft./Ft.			0.3233		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	9.098		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0023	=	0.002

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)		Lawn				
13. Flow length, L	Ft.	15.39				
14. Watercourse slope, s	Ft./Ft.	0.0650				
15. Average velocity, V (figure 3-1)	Ft./S	4.078501935	0	0		
16. Tt = L/3600V Computer Tt	Hr.	0.001	0.000	0.000	=	0.001

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.	2.00				
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0.5	0	0		
19. Channel slope, s	Ft./Ft.	0.0237				
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	13.13	0	0		
22. Flow length, L	Ft.	24.09				
23. Tt = L/3600V Computer Tt	Hr.	0.001	0.000	0.000	=	0.001

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24 Surface description (Table 3-1)................................						
25. Bottom width, B.................................	ft	2.000				
26. Side slope (H:V)..................................		2				
27. Design depth, D	ft	0.500				
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.354	0.000	0.000		
29. Channel slope, s	Ft./Ft.	0.0393				
30. Manning's roughness coeff. for channels, n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	5.914	0.000	0.000		
32. Flow length, L	Ft.	234.11	0.000	0.000		
33. Tt = L/3600V Computer Tt	Hr.	0.011	0.000	0.000	=	0.011
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)		Hour			=	0.09

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Subject:	**Time of Concentration (Tc) or Travel Timel (Tt)**			
Project:	Farm Road Homes	**Job No.:**		J269-12
Location:	65 Farm Road, Sherborn, MA			

Sub-Basin: CE **Analysis By:** FA Date 7/18/2023
Condition: Existing **Checked By:** Date
Time (Hrs): 0.13 through subarea
0.13 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Lawn - Dense Grasses				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.24				
3. Flow length, L (total L <= 300 ft)...	Ft.	50				
4. Two-yr 24-hr rainfall, P2...	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0398				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.1012	0		=	0.101

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Lawn		
8. Flow length, L	Ft.			339.59		
9. Watercourse slope, s	Ft./Ft.			0.0368		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	3.067		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0308	=	0.031

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)						
13. Flow length, L	Ft.					
14. Watercourse slope, s	Ft./Ft.					
15. Average velocity, V (figure 3-1)	Ft./S	0	0	0		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.					
18. Hydraulic radius, r=a/Pw Computer r	Ft.		0	0		
19. Channel slope, s	Ft./Ft.					
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.00	0	0		
22. Flow length, L	Ft.					
23. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24 Surface description (Table 3-1)................................						
25. Bottom width, B.................................	ft					
26. Side slope (H:V).................................						
27. Design depth, D	ft					
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.000	0.000	0.000		
29. Channel slope, s	Ft./Ft.					
30. Manning's roughness coeff. for channels, n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.000	0.000	0.000		
32. Flow length, L	Ft.		0.000	0.000		
33. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)		Hour			=	0.13

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	Project:	Farm Road Homes	**Job No.:**		J269-12	
	Location:	65 Farm Road, Sherborn, MA				

Sub-Basin: DE **Analysis By:** FA Date 7/18/2023
Condition: Existing **Checked By:** Date
Time (Hrs): 0.11 through subarea
0.11 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Woods - Light Underbrush				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.4				
3. Flow length, L (total L <= 300 ft)...	Ft.	50				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0918				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.1090	0		=	0.109

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Woods		
8. Flow length, L	Ft.			68.73		
9. Watercourse slope, s	Ft./Ft.			0.1302		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	5.774		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0033	=	0.003

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)						
13. Flow length, L	Ft.					
14. Watercourse slope, s	Ft./Ft.					
15. Average velocity, V (figure 3-1)	Ft./S	0	0	0		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.					
18. Hydraulic radius, r=a/Pw Computer r	Ft.		0	0		
19. Channel slope, s	Ft./Ft.					
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.00	0	0		
22. Flow length, L	Ft.					
23. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24 Surface description (Table 3-1)................................						
25. Bottom width, B.................................	ft					
26. Side slope (H:V)..................................						
27. Design depth, D	ft					
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.000	0.000	0.000		
29. Channel slope, s	Ft./Ft.					
30. Manning's roughness coeff. for channels, n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.000	0.000	0.000		
32. Flow length, L	Ft.		0.000	0.000		
33. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)		Hour			=	0.11

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Subject:	Time of Concentration (Tc) or Travel Timel (Tt)			
Project:	Farm Road Homes	**Job No.:**		J269-12
Location:	65 Farm Road, Sherborn, MA			

Sub-Basin: EE **Analysis By:** FA Date 7/18/2023
Condition: Existing **Checked By:** Date
Time (Hrs): 0.21 through subarea
0.21 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Woods - Light Underbrush				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.4				
3. Flow length, L (total L <= 300 ft)..	Ft.	50				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0200				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.2006	0		=	0.201

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Woods		
8. Flow length, L	Ft.			60.15		
9. Watercourse slope, s	Ft./Ft.			0.0081		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	1.444		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0116	=	0.012

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)						
13. Flow length, L	Ft.					
14. Watercourse slope, s	Ft./Ft.					
15. Average velocity, V (figure 3-1)	Ft./S	0	0	0		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.					
18. Hydraulic radius, r=a/Pw Computer r	Ft.		0	0		
19. Channel slope, s	Ft./Ft.					
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.00	0	0		
22. Flow length, L	Ft.					
23. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24 Surface description (Table 3-1)................................						
25. Bottom width, B.................................	ft					
26. Side slope (H:V)..................................						
27. Design depth, D	ft					
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.000	0.000	0.000		
29. Channel slope, s	Ft./Ft.					
30. Manning's roughness coeff. for channels, n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.000	0.000	0.000		
32. Flow length, L	Ft.		0.000	0.000		
33. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)		Hour			=	0.21

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Subject:	**Time of Concentration (Tc) or Travel Timel (Tt)**			
Project:	Farm Road Homes	**Job No.:**		J269-12
Location:	65 Farm Road, Sherborn, MA			

Sub-Basin: APb (Bypass) **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.15 through subarea
0.15 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Woods - Light Underbrush				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.4				
3. Flow length, L (total L <= 300 ft)...	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0534				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.1354	0		=	0.135

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Woods		
8. Flow length, L	Ft.			392.80		
9. Watercourse slope, s	Ft./Ft.			0.2527		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	8.043		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0136	=	0.014

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)						
13. Flow length, L	Ft.					
14. Watercourse slope, s	Ft./Ft.					
15. Average velocity, V (figure 3-1)	Ft./S	0	0	0		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.					
18. Hydraulic radius, r=a/Pw Computer r	Ft.		0	0		
19. Channel slope, s	Ft./Ft.					
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.00	0	0		
22. Flow length, L	Ft.					
23. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24 Surface description (Table 3-1)................................						
25. Bottom width, B.................................	ft					
26. Side slope (H:V)..................................						
27. Design depth, D	ft					
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.000	0.000	0.000		
29. Channel slope, s	Ft./Ft.					
30. Manning's roughness coeff. for channels, n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.000	0.000	0.000		
32. Flow length, L	Ft.		0.000	0.000		
33. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)		Hour			=	0.15

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	Project:	Farm Road Homes	Job No.:		J269-12
	Location:	65 Farm Road, Sherborn, MA			

Sub-Basin: AP-1 **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.27 through subarea
0.27 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)...............................		Lawn - Dense Grasses				
2. Manning's Roughness Coef., n (Table 3-1).................		0.24				
3. Flow length, L (total L <= 300 ft)..	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0039				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.2564	0		=	0.256

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Lawn		
8. Flow length, L	Ft.			202.75		
9. Watercourse slope, s	Ft./Ft.			0.1081		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	5.261		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0107	=	0.011

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)						
13. Flow length, L	Ft.					
14. Watercourse slope, s	Ft./Ft.					
15. Average velocity, V (figure 3-1)	Ft./S	0	0	0		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.					
18. Hydraulic radius, r=a/Pw Computer r	Ft.		0	0		
19. Channel slope, s	Ft./Ft.					
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.00	0	0		
22. Flow length, L	Ft.					
23. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)						
25. Bottom width, B.................................	ft					
26. Side slope (H:V)..................................						
27. Design depth, D	ft					
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.000	0.000	0.000		
29. Channel slope, s	Ft./Ft.					
30. Manning's roughness coeff. for channels, n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.000	0.000	0.000		
32. Flow length, L	Ft.		0.000	0.000		
33. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)		Hour			=	0.27

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Subject:	**Time of Concentration (Tc) or Travel Timel (Tt)**		
Project:	Farm Road Homes	**Job No.:**	J269-12
Location:	65 Farm Road, Sherborn, MA		

Sub-Basin: AP-2 **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.37 through subarea
0.37 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)...............................		Woods - Light Underbrush				
2. Manning's Roughness Coef., n (Table 3-1).................		0.4				
3. Flow length, L (total L <= 300 ft)..	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2...	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0050				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.3493	0		=	0.349

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)		Paved		Woods		
8. Flow length, L	Ft.	96.74		118.57		
9. Watercourse slope, s	Ft./Ft.	0.0109		0.3289		
10. Average velocity, V (figure 3-1)	Ft./S	2.117	0.000	9.176		
11. Tt = L/3600V Computer Tt	Hr.	0.0127	0.0000	0.0036	=	0.016

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)		Lawn	Riprap			
13. Flow length, L	Ft.	53.96	25.34			
14. Watercourse slope, s	Ft./Ft.	0.0593	0.1579			
15. Average velocity, V (figure 3-1)	Ft./S	3.896359328	6.356918932	0		
16. Tt = L/3600V Computer Tt	Hr.	0.004	0.001	0.000	=	0.005

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.	1.00	1.25			
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0.25	0.3125	0		
19. Channel slope, s	Ft./Ft.	0.0124	0.0272			
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	5.98	10.30	0		
22. Flow length, L	Ft.	20.18	18.35			
23. Tt = L/3600V Computer Tt	Hr.	0.001	0.000	0.000	=	0.001

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)		Riprap				
25. Bottom width, B.................................	ft	2.000				
26. Side slope (H:V)..................................		2				
27. Design depth, D	ft	0.500				
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.354	0.000	0.000		
29. Channel slope, s	Ft./Ft.	0.2044				
30. Manning's roughness coeff. for channels, n		0.035	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	9.633	0.000	0.000		
32. Flow length, L	Ft.	63.61	0.00	0.00		
33. Tt = L/3600V Computer Tt	Hr.	0.002	0.000	0.000	=	0.002
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)		Hour			=	0.37

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	Project:	Farm Road Homes	**Job No.:**		J269-12
	Location:	65 Farm Road, Sherborn, MA			

Sub-Basin:	AP-3		**Analysis By:**	FA	Date 7/18/2023
Condition:	Proposed		**Checked By:**		Date
Time (Hrs):	0.12	through subarea			
	0.12	to be used			

Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Woods - Light Underbrush				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.4				
3. Flow length, L (total L <= 300 ft)..	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.1264				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.0960	0		=	0.096

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Woods		
8. Flow length, L	Ft.			87.3500		
9. Watercourse slope, s	Ft./Ft.			0.3112		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	8.925		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0027	=	0.003

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)		Lawn	Riprap			
13. Flow length, L	Ft.	76.6900	25.3400			
14. Watercourse slope, s	Ft./Ft.	0.0489	0.1579			
15. Average velocity, V (figure 3-1)	Ft./S	3.538068587	6.356918932	0		
16. Tt = L/3600V Computer Tt	Hr.	0.006	0.001	0.000	=	0.007

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.	1.00	1.25			
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0.25	0.3125	0		
19. Channel slope, s	Ft./Ft.	0.0100	0.0272			
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	5.37	10.30	0		
22. Flow length, L	Ft.	210.1900	18.3500			
23. Tt = L/3600V Computer Tt	Hr.	0.011	0.000	0.000	=	0.011

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)		Riprap				
25. Bottom width, B.................................	ft	2.000				
26. Side slope (H:V)..................................		2				
27. Design depth, D	ft	0.500				
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.354	0.000	0.000		
29. Channel slope, s	Ft./Ft.	0.2044				
30. Manning's roughness coeff. for channels, n		0.035	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	9.633	0.000	0.000		
32. Flow length, L	Ft.	63.61	0.00	0.00		
33. Tt = L/3600V Computer Tt	Hr.	0.002	0.000	0.000	=	0.002
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)		Hour			=	0.12

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Subject:	**Time of Concentration (Tc) or Travel Timel (Tt)**			
Project:	Farm Road Homes	**Job No.:**		J269-12
Location:	65 Farm Road, Sherborn, MA			

Sub-Basin: AP-4 **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.15 through subarea
0.15 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)...............................		Woods - Light Underbrush				
2. Manning's Roughness Coef., n (Table 3-1).................		0.4				
3. Flow length, L (total L <= 300 ft)..	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0784				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.1162	0		=	0.116

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Woods		
8. Flow length, L	Ft.			105.40		
9. Watercourse slope, s	Ft./Ft.			0.307		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	8.871		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0033	=	0.003

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)		Lawn				
13. Flow length, L	Ft.	7.55				
14. Watercourse slope, s	Ft./Ft.	0.163				
15. Average velocity, V (figure 3-1)	Ft./S	6.458015195	0	0		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.	1.00	1.00	1.25		
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0.25	0.25	0.3125		
19. Channel slope, s	Ft./Ft.	0.0050	0.0128	0.0614		
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	3.80	6.09	15.45		
22. Flow length, L	Ft.	80.13	97.29	32.59		
23. Tt = L/3600V Computer Tt	Hr.	0.006	0.004	0.001	=	0.011

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)		Lawn	Riprap			
25. Bottom width, B.................................	ft	2.000	2			
26. Side slope (H:V)..................................		2	2			
27. Design depth, D	ft	0.500	0.5			
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.354	0.354	0.000		
29. Channel slope, s	Ft./Ft.	0.0039	0.0554			
30. Manning's roughness coeff. for channels, n		0.025	0.035			
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	1.871	5.015	0.000		
32. Flow length, L	Ft.	68.64	108.32	0.00		
33. Tt = L/3600V Computer Tt	Hr.	0.010	0.006	0.000	=	0.016
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)				Hour	=	0.15

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Subject:	Time of Concentration (Tc) or Travel Timel (Tt)			
Project:	Farm Road Homes	**Job No.:**		J269-12
Location:	65 Farm Road, Sherborn, MA			

Sub-Basin: AP-5 **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.35 through subarea
0.35 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Lawn - Dense Grasses				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.24				
3. Flow length, L (total L <= 300 ft)...	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0022				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.3223	0		=	0.322

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)		Paved		Lawn		
8. Flow length, L	Ft.	35.39		26.49		
9. Watercourse slope, s	Ft./Ft.	0.023		0.0094		
10. Average velocity, V (figure 3-1)	Ft./S	3.055	0.000	1.554		
11. Tt = L/3600V Computer Tt	Hr.	0.0032	0.0000	0.0047	=	0.008

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)						
13. Flow length, L	Ft.					
14. Watercourse slope, s	Ft./Ft.					
15. Average velocity, V (figure 3-1)	Ft./S	0	0	0		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.	1.00	1.00	1.25		
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0.25	0.25	0.3125		
19. Channel slope, s	Ft./Ft.	0.0094	0.0128	0.0614		
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	5.21	6.09	15.45		
22. Flow length, L	Ft.	15.94	97.29	32.59		
23. Tt = L/3600V Computer Tt	Hr.	0.001	0.004	0.001	=	0.006

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)		Lawn	Riprap			
25. Bottom width, B.................................	ft	2	2			
26. Side slope (H:V)..................................		2	2			
27. Design depth, D	ft	0.500	0.5			
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.354	0.354	0.000		
29. Channel slope, s	Ft./Ft.	0.0190	0.0554			
30. Manning's roughness coeff. for channels, n		0.025	0.035			
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	4.108	5.015	0.000		
32. Flow length, L	Ft.	147.10	108.32			
33. Tt = L/3600V Computer Tt	Hr.	0.010	0.006	0.000	=	0.016
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)				Hour	=	0.35

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	Project:	Farm Road Homes	Job No.:	J269-12
	Location:	65 Farm Road, Sherborn, MA		

Sub-Basin: AP-6 **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.12 through subarea
0.12 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Lawn - Dense Grasses				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.24				
3. Flow length, L (total L <= 300 ft)..	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0312				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.1116	0		=	0.112

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)		Paved		Lawn		
8. Flow length, L	Ft.	28.68		30.55		
9. Watercourse slope, s	Ft./Ft.	0.0359		0.0363		
10. Average velocity, V (figure 3-1)	Ft./S	3.851	0.000	3.050		
11. Tt = L/3600V Computer Tt	Hr.	0.0021	0.0000	0.0028	=	0.005

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)						
13. Flow length, L	Ft.					
14. Watercourse slope, s	Ft./Ft.					
15. Average velocity, V (figure 3-1)	Ft./S	0	0	0		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.	1.00	1.25			
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0.25	0.3125	0		
19. Channel slope, s	Ft./Ft.	0.0493	0.0614			
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	11.93	15.45	0.00		
22. Flow length, L	Ft.	2.03	32.59			
23. Tt = L/3600V Computer Tt	Hr.	0.000	0.001	0.000	=	0.001

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)		Riprap				
25. Bottom width, B.................................	ft	2				
26. Side slope (H:V)..................................		2				
27. Design depth, D	ft	0.500				
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.354	0.000	0.000		
29. Channel slope, s	Ft./Ft.	0.0554				
30. Manning's roughness coeff. for channels, n		0.025				
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	7.021	0.000	0.000		
32. Flow length, L	Ft.	108.32				
33. Tt = L/3600V Computer Tt	Hr.	0.004	0.000	0.000	=	0.004
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)				Hour	=	0.12

Creative Land & Water Engineering, LLC **Environmental Scientists and Engineers** **P.O. Box 584 - Southborough - MA - 01772** **774-454-0266 www.claweng.com**	**Subject:**	**Time of Concentration (Tc) or Travel Timel (Tt)**			
	Project:	Farm Road Homes	**Job No.:**		J269-12
	Location:	65 Farm Road, Sherborn, MA			

Sub-Basin: AP-7 **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.11 through subarea
0.11 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Lawn - Dense Grasses				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.24				
3. Flow length, L (total L <= 300 ft)...	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0392				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.1018	0		=	0.102
Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Lawn		
8. Flow length, L	Ft.			12.55		
9. Watercourse slope, s	Ft./Ft.			0.1227		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	5.605		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0006	=	0.001
Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)						
13. Flow length, L	Ft.					
14. Watercourse slope, s	Ft./Ft.					
15. Average velocity, V (figure 3-1)	Ft./S	0	0	0		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000
Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.	1.00	1.00	1.25		
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0.25	0.25	0.3125		
19. Channel slope, s	Ft./Ft.	0.0088	0.0128	0.0614		
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	5.04	6.09	15.45		
22. Flow length, L	Ft.	17.07	97.29	32.59		
23. Tt = L/3600V Computer Tt	Hr.	0.001	0.004	0.001	=	0.006
Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)		Lawn				
25. Bottom width, B..................................	ft	2				
26. Side slope (H:V)..................................		2				
27. Design depth, D	ft	0.5				
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.354	0.000	0.000		
29. Channel slope, s	Ft./Ft.	0.0554				
30. Manning's roughness coeff. for channels, n		0.025				
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	7.021	0.000	0.000		
32. Flow length, L	Ft.	108.32				
33. Tt = L/3600V Computer Tt	Hr.	0.004	0.000	0.000	=	0.004
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)				Hour	=	0.11

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	Project:	Farm Road Homes	**Job No.:**		J269-12
	Location:	65 Farm Road, Sherborn, MA			

Sub-Basin: BPb (Bypass) **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.09 through subarea
0.10 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Lawn - Dense Grasses				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.24				
3. Flow length, L (total L <= 300 ft)...	Ft.	50				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0864				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.0742	0		=	0.074

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Woods		
8. Flow length, L	Ft.			76.33		
9. Watercourse slope, s	Ft./Ft.			0.3233		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	9.098		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0023	=	0.002

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)		Lawn				
13. Flow length, L	Ft.	15.39				
14. Watercourse slope, s	Ft./Ft.	0.0650				
15. Average velocity, V (figure 3-1)	Ft./S	4.078501935	0	0		
16. Tt = L/3600V Computer Tt	Hr.	0.001	0.000	0.000	=	0.001

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.	2.00				
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0.5	0	0		
19. Channel slope, s	Ft./Ft.	0.0237				
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	13.13	0	0		
22. Flow length, L	Ft.	24.09				
23. Tt = L/3600V Computer Tt	Hr.	0.001	0.000	0.000	=	0.001

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24 Surface description (Table 3-1)................................						
25. Bottom width, B..................................	ft	2.000				
26. Side slope (H:V)..................................		2				
27. Design depth, D	ft	0.500				
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.354	0.000	0.000		
29. Channel slope, s	Ft./Ft.	0.0393				
30. Manning's roughness coeff. for channels, n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	5.914	0.000	0.000		
32. Flow length, L	Ft.	234.11	0.000	0.000		
33. Tt = L/3600V Computer Tt	Hr.	0.011	0.000	0.000	=	0.011
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)		Hour			=	0.09

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Subject:	Time of Concentration (Tc) or Travel Timel (Tt)
Project:	Farm Road Homes
Job No.:	J269-12
Location:	65 Farm Road, Sherborn, MA

Sub-Basin: B1P-1 **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.15 through subarea
0.15 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Lawn - Dense Grasses				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.24				
3. Flow length, L (total L <= 300 ft)..	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0272				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.1179	0		=	0.118

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)		Paved		Lawn		
8. Flow length, L	Ft.	141.31		55.58		
9. Watercourse slope, s	Ft./Ft.	0.0098		0.0090		
10. Average velocity, V (figure 3-1)	Ft./S	2.015	0.000	1.518		
11. Tt = L/3600V Computer Tt	Hr.	0.0195	0.0000	0.0102	=	0.030

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)		Lawn				
13. Flow length, L	Ft.	4.88				
14. Watercourse slope, s	Ft./Ft.	0.0799				
15. Average velocity, V (figure 3-1)	Ft./S	4.52	0.00	0.00		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.					
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0	0	0		
19. Channel slope, s	Ft./Ft.					
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.00	0.00	0.00		
22. Flow length, L	Ft.					
23. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)		Lawn				
25. Bottom width, B.................................	ft	2				
26. Side slope (H:V)..................................		2				
27. Design depth, D	ft	0.5				
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.354	0.000	0.000		
29. Channel slope, s	Ft./Ft.	0.0376				
30. Manning's roughness coeff. for channels, n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	5.785	0.000	0.000		
32. Flow length, L	Ft.	76.04				
33. Tt = L/3600V Computer Tt	Hr.	0.004	0.000	0.000	=	0.004
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)				Hour	=	0.15

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Subject:	**Time of Concentration (Tc) or Travel Timel (Tt)**
Project:	Farm Road Homes
Job No.:	J269-12
Location:	65 Farm Road, Sherborn, MA

Sub-Basin: B2P-1 **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.13 through subarea
0.13 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Lawn - Dense Grasses				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.24				
3. Flow length, L (total L <= 300 ft)..	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0276				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.1172	0		=	0.117

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)						
8. Flow length, L	Ft.					
9. Watercourse slope, s	Ft./Ft.					
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	0.000		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0000	=	0.000

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)						
13. Flow length, L	Ft.					
14. Watercourse slope, s	Ft./Ft.					
15. Average velocity, V (figure 3-1)	Ft./S	0.00	0.00	0.00		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.					
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0	0	0		
19. Channel slope, s	Ft./Ft.					
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.00	0.00	0.00		
22. Flow length, L	Ft.					
23. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)		Lawn				
25. Bottom width, B.................................	ft	2				
26. Side slope (H:V)..................................		2				
27. Design depth, D	ft	0.5				
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.354	0.000	0.000		
29. Channel slope, s	Ft./Ft.	0.0289				
30. Manning's roughness coeff. for channels, n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	5.073	0.000	0.000		
32. Flow length, L	Ft.	315.31				
33. Tt = L/3600V Computer Tt	Hr.	0.017	0.000	0.000	=	0.017
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)				Hour	=	0.13

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	Project:	Farm Road Homes	**Job No.:**		J269-12
	Location:	65 Farm Road, Sherborn, MA			

Sub-Basin: B2P-2 **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.13 through subarea
0.13 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)...............................		Woods - Light Underbrush				
2. Manning's Roughness Coef., n (Table 3-1).................		0.4				
3. Flow length, L (total L <= 300 ft)...	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.2104				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.0783	0		=	0.078

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)		Paved		Lawn		
8. Flow length, L	Ft.	43.29		113.63		
9. Watercourse slope, s	Ft./Ft.	0.0208		0.0635		
10. Average velocity, V (figure 3-1)	Ft./S	2.930	0.000	4.033		
11. Tt = L/3600V Computer Tt	Hr.	0.0041	0.0000	0.0078	=	0.012

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)						
13. Flow length, L	Ft.					
14. Watercourse slope, s	Ft./Ft.					
15. Average velocity, V (figure 3-1)	Ft./S	0.00	0.00	0.00		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.	1.00				
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0.25	0	0		
19. Channel slope, s	Ft./Ft.	0.0118				
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	5.85	0.00	0.00		
22. Flow length, L	Ft.	147.97				
23. Tt = L/3600V Computer Tt	Hr.	0.007	0.000	0.000	=	0.007

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)		Lawn	Lawn			
25. Bottom width, B.................................	ft	2	2			
26. Side slope (H:V)..................................		2	2			
27. Design depth, D	ft	0.5	0.5			
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.354	0.354	0.000		
29. Channel slope, s	Ft./Ft.	0.0236	0.0303			
30. Manning's roughness coeff. for channels, n		0.025	0.025			
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	4.586	5.193	0.000		
32. Flow length, L	Ft.	237.35	263.97			
33. Tt = L/3600V Computer Tt	Hr.	0.014	0.014	0.000	=	0.028
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)				Hour	=	0.13

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	Project:	Farm Road Homes	Job No.:	J269-12
	Location:	65 Farm Road, Sherborn, MA		

Sub-Basin: CPb (Bypass) **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.11 through subarea
0.11 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Lawn - Dense Grasses				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.24				
3. Flow length, L (total L <= 300 ft)...	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0352				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.1063	0		=	0.106

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Lawn		
8. Flow length, L	Ft.			53.31		
9. Watercourse slope, s	Ft./Ft.			0.0356		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	3.021		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0049	=	0.005

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)						
13. Flow length, L	Ft.					
14. Watercourse slope, s	Ft./Ft.					
15. Average velocity, V (figure 3-1)	Ft./S	0.00	0.00	0.00		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.					
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0	0	0		
19. Channel slope, s	Ft./Ft.					
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.00	0.00	0.00		
22. Flow length, L	Ft.					
23. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)						
25. Bottom width, B..................................	ft					
26. Side slope (H:V)..................................						
27. Design depth, D	ft					
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.000	0.000	0.000		
29. Channel slope, s	Ft./Ft.					
30. Manning's roughness coeff. for channels, n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.000	0.000	0.000		
32. Flow length, L	Ft.					
33. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)				Hour	=	0.11

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	Project:	Farm Road Homes	**Job No.:**	J269-12
	Location:	65 Farm Road, Sherborn, MA		

Sub-Basin: CP-1 **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.14 through subarea
0.14 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Lawn - Dense Grasses				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.24				
3. Flow length, L (total L <= 300 ft)..	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0206				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.1317	0		=	0.132

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Lawn		
8. Flow length, L	Ft.			33.93		
9. Watercourse slope, s	Ft./Ft.			0.0139		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	1.883		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0050	=	0.005

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)						
13. Flow length, L	Ft.					
14. Watercourse slope, s	Ft./Ft.					
15. Average velocity, V (figure 3-1)	Ft./S	0.00	0.00	0.00		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.					
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0	0	0		
19. Channel slope, s	Ft./Ft.					
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.00	0.00	0.00		
22. Flow length, L	Ft.					
23. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)		Lawn				
25. Bottom width, B.................................	ft	2				
26. Side slope (H:V).................................		2				
27. Design depth, D	ft	0.5				
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.354	0.000	0.000		
29. Channel slope, s	Ft./Ft.	0.0237				
30. Manning's roughness coeff. for channels, n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	4.591	0.000	0.000		
32. Flow length, L	Ft.	73.88				
33. Tt = L/3600V Computer Tt	Hr.	0.004	0.000	0.000	=	0.004
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)				Hour	=	0.14

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	Project:	Farm Road Homes	**Job No.:**		J269-12
	Location:	65 Farm Road, Sherborn, MA			

Sub-Basin: CP-2 **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.07 through subarea
0.10 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)...............................		Lawn - Dense Grasses				
2. Manning's Roughness Coef., n (Table 3-1).................		0.24				
3. Flow length, L (total L <= 300 ft)...	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.2616				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.0477	0		=	0.048

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Lawn		
8. Flow length, L	Ft.			119.11		
9. Watercourse slope, s	Ft./Ft.			0.0296		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	2.754		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0120	=	0.012

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)		Riprap				
13. Flow length, L	Ft.	8.17				
14. Watercourse slope, s	Ft./Ft.	0.1530				
15. Average velocity, V (figure 3-1)	Ft./S	6.26	0.00	0.00		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.0004

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.	1.00	1.25			
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0.25	0.3125	0		
19. Channel slope, s	Ft./Ft.	0.0131	0.0104			
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	6.16	6.35	0.00		
22. Flow length, L	Ft.	26.68	86.94			
23. Tt = L/3600V Computer Tt	Hr.	0.001	0.004	0.000	=	0.005

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)						
25. Bottom width, B.................................	ft					
26. Side slope (H:V)..................................						
27. Design depth, D	ft					
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.000	0.000	0.000		
29. Channel slope, s	Ft./Ft.					
30. Manning's roughness coeff. for channels, n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.000	0.000	0.000		
32. Flow length, L	Ft.					
33. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)				Hour	=	0.07

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	Project:	Farm Road Homes	**Job No.:**		J269-12
	Location:	65 Farm Road, Sherborn, MA			

Sub-Basin: CP-3 **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.09 through subarea
0.10 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Lawn - Dense Grasses				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.24				
3. Flow length, L (total L <= 300 ft)...	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.1088				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.0677	0		=	0.068

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Lawn		
8. Flow length, L	Ft.			42.21		
9. Watercourse slope, s	Ft./Ft.			0.0867		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	4.711		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0025	=	0.002

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)		Woods	Lawn	Riprap		
13. Flow length, L	Ft.	54.84	123.66	8.17		
14. Watercourse slope, s	Ft./Ft.	0.1823	0.1577	0.153		
15. Average velocity, V (figure 3-1)	Ft./S	6.83	6.35	6.26		
16. Tt = L/3600V Computer Tt	Hr.	0.002	0.005	0.000	=	0.0080

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.	1.00	1.25			
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0.25	0.3125	0		
19. Channel slope, s	Ft./Ft.	0.0300	0.0104			
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	9.31	6.35	0.00		
22. Flow length, L	Ft.	136.78	86.94			
23. Tt = L/3600V Computer Tt	Hr.	0.004	0.004	0.000	=	0.008

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)						
25. Bottom width, B.................................	ft					
26. Side slope (H:V)..................................						
27. Design depth, D	ft					
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.000	0.000	0.000		
29. Channel slope, s	Ft./Ft.					
30. Manning's roughness coeff. for channels, n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.000	0.000	0.000		
32. Flow length, L	Ft.					
33. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)				Hour	=	0.09

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Subject:	**Time of Concentration (Tc) or Travel Timel (Tt)**
Project:	Farm Road Homes
Job No.:	J269-12
Location:	65 Farm Road, Sherborn, MA

Sub-Basin: DPb (Bypass) **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.10 through subarea
0.10 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Woods - Light Underbrush				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.4				
3. Flow length, L (total L <= 300 ft)...	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2..	In.	3.36				
5. Land slope, s	Ft./Ft.	0.1206				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.0978	0		=	0.098

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Woods		
8. Flow length, L	Ft.			2.98		
9. Watercourse slope, s	Ft./Ft.			0.2987		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	8.744		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0001	=	0.0001

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)						
13. Flow length, L	Ft.					
14. Watercourse slope, s	Ft./Ft.					
15. Average velocity, V (figure 3-1)	Ft./S	0.00	0.00	0.00		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.					
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0	0	0		
19. Channel slope, s	Ft./Ft.					
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.00	0.00	0.00		
22. Flow length, L	Ft.					
23. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)						
25. Bottom width, B.................................	ft					
26. Side slope (H:V)..................................						
27. Design depth, D	ft					
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.000	0.000	0.000		
29. Channel slope, s	Ft./Ft.					
30. Manning's roughness coeff. for channels, n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.000	0.000	0.000		
32. Flow length, L	Ft.					
33. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)				Hour	=	0.10

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Subject:	**Time of Concentration (Tc) or Travel Timel (Tt)**			
Project:	Farm Road Homes	**Job No.:**		J269-12
Location:	65 Farm Road, Sherborn, MA			

Sub-Basin: EPb (Bypass) **Analysis By:** FA Date 7/18/2023
Condition: Proposed **Checked By:** Date
Time (Hrs): 0.17 through subarea
0.17 to be used
Notes: Space for as many as two segments per flow type can be used for each worksheet.
Include a map, schematic, or description of flow segments.

Sheet Flow (Applicable to TC Only)						
1. Surface description (Table 3-1)................................		Woods - Light Underbrush				
2. Manning's Roughness Coef., n (Table 3-1)..................		0.4				
3. Flow length, L (total L <= 300 ft)..	Ft.	50.00				
4. Two-yr 24-hr rainfall, P2...	In.	3.36				
5. Land slope, s	Ft./Ft.	0.0416				
6. Tt = 0.007 (nL)^0.8/P2^0.5 s^0.4 Compute Tt	Hr.	0.1497	0		=	0.150

Shallow Concentrated Flow		Reach 1 - Paved	Reach 2 - Paved	Reach 3 - Unpaved		
7. Surface description (Lawn, Woods, ETC)				Woods		
8. Flow length, L	Ft.			99.13		
9. Watercourse slope, s	Ft./Ft.			0.0089		
10. Average velocity, V (figure 3-1)	Ft./S	0.000	0.000	1.508		
11. Tt = L/3600V Computer Tt	Hr.	0.0000	0.0000	0.0183	=	0.0183

Shallow Concentrated Flow		Reach 4 - Unpaved	Reach 5 - Unpaved	Reach 6 - Unpaved		
12. Surface description (Lawn, Woods, ETC)						
13. Flow length, L	Ft.					
14. Watercourse slope, s	Ft./Ft.					
15. Average velocity, V (figure 3-1)	Ft./S	0.00	0.00	0.00		
16. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Pipe		Reach 1	Reach 2	Reach 3		
17. Diameter, D	Ft.					
18. Hydraulic radius, r=a/Pw Computer r	Ft.	0	0	0		
19. Channel slope, s	Ft./Ft.					
20. Manning's roughness coeff., n		0.011	0.011	0.011		
21. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.00	0.00	0.00		
22. Flow length, L	Ft.					
23. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000

Channel flow - Open Trapezoid		Reach 1	Reach 2	Reach 3		
24. Surface description (Lawn, Woods, ETC)						
25. Bottom width, B..................................	ft					
26. Side slope (H:V)..................................						
27. Design depth, D	ft					
28. Hydraulic radius, r=a/Pw Computer r	Ft.	0.000	0.000	0.000		
29. Channel slope, s	Ft./Ft.					
30. Manning's roughness coeff. for channels, n		0.025	0.025	0.025		
31. V = 1.49 r^(2/3) s^(1/2) / n Compute V	Ft/S	0.000	0.000	0.000		
32. Flow length, L	Ft.					
33. Tt = L/3600V Computer Tt	Hr.	0.000	0.000	0.000	=	0.000
34. Watershed or subarea Tc or Tt (add Tr in steps 6, 11, 16, 23, and 33)				Hour	=	0.17

Appendix B: FLOOD ROUTING CALCULATIONS FOR STORAGE AREAS

On the following pages, are the results of flood routing calculations by Storage-Indication method. We prefer this classical technique to the short cut methods because the assumptions for the short cut methods are often violated in real drainage areas.

The computation is carried out by HEC-HMS.

Table B.1. Land used table

Condition	Land Use	Area				
		Total	HSG A	HSG B	HGS C	HSG D
		acre	acre	acre	acre	acre
Existing	Roof	0.15	0.00	0.06	0.00	0.09
	Drive/Park	0.24	0.06	0.09	0.00	0.09
	Walk/Patio/etc.	0.41	0.00	0.17	0.05	0.18
	Lawn	4.40	0.04	0.98	1.51	1.86
	Woods	10.19	0.79	2.20	0.07	7.13
	Total	15.39	0.89	3.51	1.64	9.36
Proposed	Roof	1.07	0.00	0.42	0.18	0.48
	Drive/Park	1.18	0.06	0.44	0.25	0.43
	Walk/Patio/etc.	0.44	0.00	0.14	0.08	0.22
	Lawn	5.55	0.04	1.37	0.63	3.50
	Woods	7.16	0.79	1.14	0.51	4.73
	Total	15.39	0.89	3.51	1.64	9.36

Table B.2. Summary of Peak Runoffs Leaving the Project Site

Condition	*Sub-watershed*	*Peak Runoffs (cfs)*					*Runoff Volume (ac-ft)*				
		2-year	*10-year*	*25-year*	*50-yar*	*100-year*	*2-year*	*10-year*	*25-year*	*50-yar*	*100-year*
Existing-	*CP1 (AE)*	9.95	22.82	31.62	38.28	45.65	0.93	2.05	2.82	3.41	4.07
	CP2 (BE)	1.39	3.76	5.46	6.79	8.31	0.14	0.32	0.45	0.55	0.67
	CP3 (CE)	3.86	9.14	12.77	15.53	18.61	0.34	0.76	1.05	1.27	1.53
	CP4 (DE)	0.24	0.56	0.77	0.93	1.11	0.02	0.04	0.06	0.07	0.09
	CP5 (EE)	0.29	0.63	0.86	1.03	1.21	0.03	0.06	0.08	0.09	0.11
Proposed-with flood control	*CP1 (APb, AP-1, AP-2, AP-3, AP-4,AP-5,AP-6,AP-7)*	4.8	12.95	21.87	28.97	36.91	0.72	1.83	2.6	3.2	3.87
	CP2 (BPb, B2P-1,B2P-2)	1.13	2.66	3.75	4.6	5.54	0.11	0.23	0.31	0.43	0.57
	CP3 (CPb, CP-1, CP-2, CP-3,B1P-1)	0.73	5.41	9.04	11.38	13.69	0.07	0.27	0.43	0.55	0.69
	CP4 (DE)	0.16	0.38	0.53	0.64	0.76	0.01	0.03	0.04	0.05	0.06
	CP5 (EE)	0.15	0.32	0.44	0.53	0.62	0.01	0.03	0.04	0.04	0.05

Table B.2a. Summary runoff peak and volume change

Control Point	Change in Peak Runoffs (%)					Change in Runoff Volume (%)				
	2-year	10-year	25-year	50-yar	100-year	2-year	10-year	25-year	50-yar	100-year
Cntrlp1	-51.8%	-43.3%	-30.8%	-24.3%	-19.1%	-22.6%	-10.7%	-7.8%	-6.2%	-4.9%
Cntrlp2	-18.7%	-29.3%	-31.3%	-32.3%	-33.3%	-21.4%	-28.1%	-31.1%	-21.8%	-14.9%
Cntrlp3	-81.1%	-40.8%	-29.2%	-26.7%	-26.4%	-79.4%	-64.5%	-59.0%	-56.7%	-54.9%
Cntrlp4	-33.3%	-32.1%	-31.2%	-31.2%	-31.5%	-50.0%	-25.0%	-33.3%	-28.6%	-33.3%
Cntrlp5	-48.3%	-49.2%	-48.8%	-48.5%	-48.8%	-66.7%	-50.0%	-50.0%	-55.6%	-54.5%
Mini	-18.7%	-29.3%	-29.2%	-24.3%	-19.1%	-21.4%	-10.7%	-7.8%	-6.2%	-4.9%
Max	-81.1%	-49.2%	-48.8%	-48.5%	-48.8%	-79.4%	-64.5%	-59.0%	-56.7%	-54.9%

Table B.3. Summary of Peak Elevations

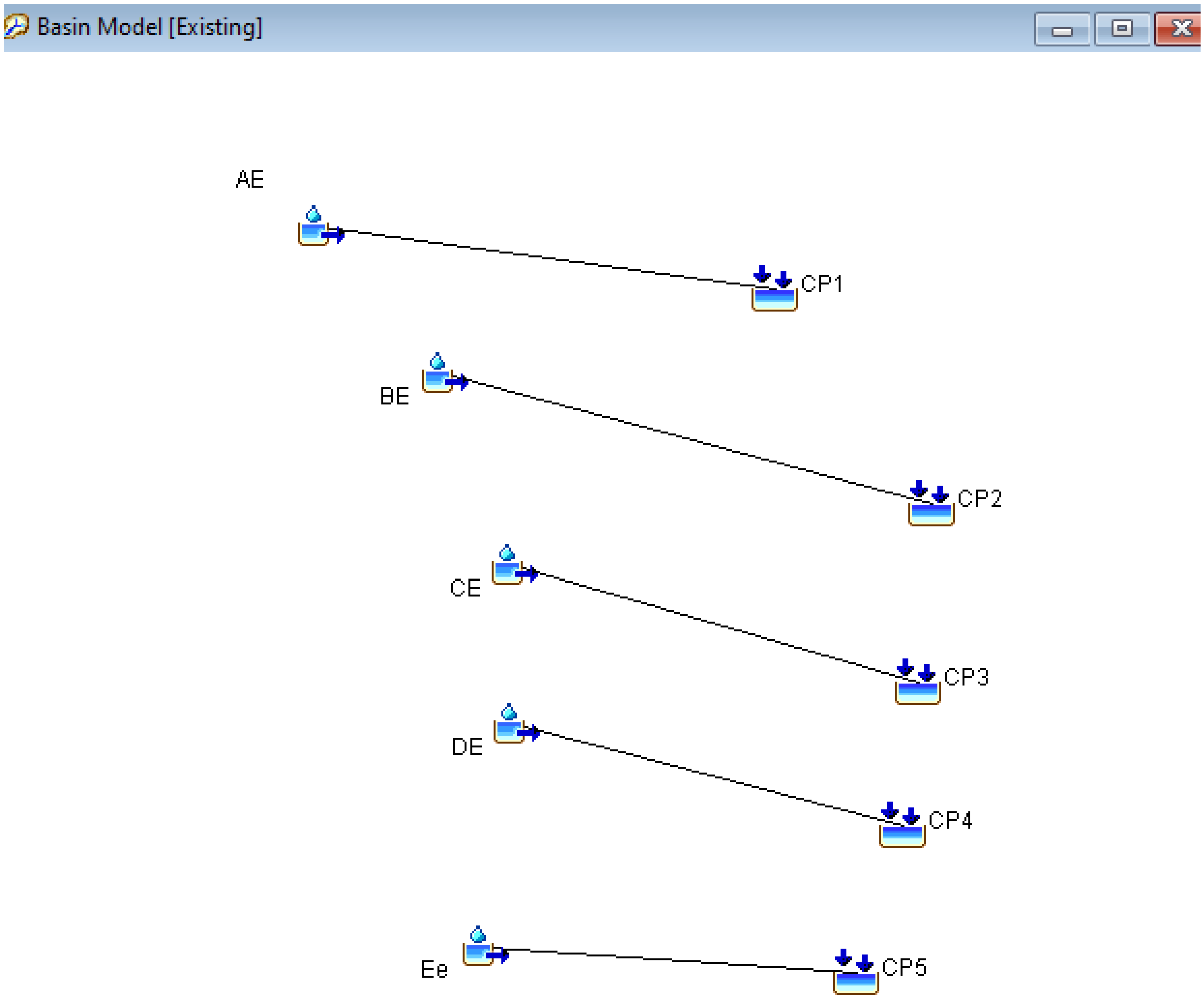
Basin	2-yr	10-yr	25-yr	50-yr	100-yr
BASIN A	210.080	210.850	211.160	211.320	211.470
BSIN B1	216.930	217.200	217.290	217.350	217.410
BSIN B2	207.250	209.540	210.210	210.520	210.870
BSIN C1	219.930	220.220	220.310	220.370	220.420

Table B.4. Summary of Basin Recharge for 100-year storm event

Basin	Rech	Vol, ac-ft	Vol. cf
BASIN A	rech A	0.22	9583.2
BSIN B1	rech B1	0.35	15246
BSIN B2	rech B2	0.16	6969.6
BSIN C1	rech c1	0.28	12196.8

HECHMS Glogbal Summary Table

Existing				2-yr		10-yr		25-yr		50-yr		100yr	
Watershed	Area, sq mi			Peak, cfs	Vol., ac-ft	Peak, cfs	Vol., ac-ft	Peak, cfs	Vol., ac-ft	Peak, cfs	Vol., ac-ft	Peak, cfs	Vol., ac-ft
AE	0.01472			9.95	0.93	22.82	2.05	31.62	2.82	38.28	3.41	45.65	4.07
BE	0.0029			1.39	0.14	3.76	0.32	5.46	0.45	6.79	0.55	8.31	0.67
CE	0.00574			3.86	0.34	9.14	0.76	12.77	1.05	15.53	1.27	18.61	1.53
CP1	0.01472			9.95	0.93	22.82	2.05	31.62	2.82	38.28	3.41	45.65	4.07
CP2	0.0029			1.39	0.14	3.76	0.32	5.46	0.45	6.79	0.55	8.31	0.67
CP3	0.00574			3.86	0.34	9.14	0.76	12.77	1.05	15.53	1.27	18.61	1.53
CP4	0.00032			0.24	0.02	0.56	0.04	0.77	0.06	0.93	0.07	1.11	0.09
CP5	0.00037			0.29	0.03	0.63	0.06	0.86	0.08	1.03	0.09	1.21	0.11
DE	0.00032			0.24	0.02	0.56	0.04	0.77	0.06	0.93	0.07	1.11	0.09
Ee	0.00037			0.29	0.03	0.63	0.06	0.86	0.08	1.03	0.09	1.21	0.11
Proposed		1"		2yr		10-yr		25-yr		50-yr		100-yr	
APb	0.00789	2.22	0.23	4.8	0.43	11.75	0.43	16.63	1.39	20.35	1.69	24.5	2.04
AP-1	0.00273	1.71	0.17	2.76	0.27	5.26	0.27	6.86	0.67	8.04	0.79	9.33	0.93
AP-2	0.00211	1.01	0.12	1.7	0.19	3.37	0.19	4.46	0.49	5.27	0.58	6.16	0.68
AP-3	0.00064	0.3	0.03	0.56	0.05	1.21	0.05	1.64	0.13	1.97	0.16	2.32	0.19
AP-4	0.00078	0.32	0.03	0.59	0.05	1.32	0.05	1.81	0.15	2.19	0.18	2.6	0.22
AP-5	0.00052	0.5	0.06	0.7	0.08	1.13	0.08	1.4	0.17	1.6	0.19	1.82	0.22
AP-6	0.00044	0.57	0.05	0.78	0.07	1.25	0.07	1.55	0.14	1.76	0.16	2	0.19
AP-7	0.00012	0.15	0.01	0.21	0.02	0.34	0.02	0.42	0.04	0.48	0.04	0.54	0.05
BASN A	0.00734	0.26	0.26	1.21	0.48	7.06	0.48	11.67	1.43	15.05	1.72	18.39	2.05
BPb	0.00178	0.56	0.06	1.13	0.11	2.66	0.11	3.75	0.31	4.6	0.38	5.54	0.45
BSN B1	0.0016	0.42	0.1	0.62	0.16	2.96	0.16	4.42	0.41	5.29	0.48	6.16	0.56
BSN B2	0.00222	0.02	0.06	0.02	0.07	0.02	0.07	0.13	0.12	0.34	0.19	0.58	0.27
BSN C1	0.0014	0.38	0.08	0.44	0.12	2.11	0.12	3.31	0.3	4.06	0.36	4.82	0.42
B1P-1	0.0016	1.56	0.14	2.3	0.21	3.99	0.21	5.05	0.46	5.83	0.53	6.67	0.61
B2P-1	0.00133	1.26	0.12	1.87	0.17	3.26	0.17	4.15	0.37	4.81	0.43	5.53	0.5
B2P-2	0.00089	0.95	0.09	1.37	0.12	2.33	0.12	2.93	0.26	3.37	0.3	3.85	0.35
CPb	0.00141	0.29	0.03	0.73	0.06	1.97	0.06	2.85	0.22	3.53	0.28	4.29	0.34
CP-1	0.00083	0.86	0.08	1.24	0.11	2.11	0.11	2.67	0.24	3.07	0.28	3.52	0.32
CP-2	0.00029	0.24	0.02	0.37	0.03	0.67	0.03	0.87	0.07	1.02	0.09	1.18	0.1
CP-3	0.00028	0.01	0	0.04	0.01	0.23	0.01	0.37	0.03	0.49	0.04	0.62	0.05
CtrlP 1	0.01523	2.22	0.3	4.8	0.72	12.95	0.72	21.87	2.6	28.97	3.2	36.91	3.87
CtrlP 2	0.004	0.56	0.06	1.13	0.11	2.66	0.11	3.75	0.31	4.6	0.43	5.54	0.57
CtrlP 3	0.00441	0.29	0.03	0.73	0.07	5.41	0.07	9.04	0.43	11.38	0.55	13.69	0.69
CtrlP 4	0.00022	0.08	0.01	0.16	0.01	0.38	0.01	0.53	0.04	0.64	0.05	0.76	0.06
CtrlP 5	0.00018	0.08	0.01	0.15	0.01	0.32	0.01	0.44	0.04	0.53	0.04	0.62	0.05
div A	0.00734	0.19	0.07	1.13	0.28	6.97	0.28	11.58	1.22	14.96	1.51	18.29	1.83
div B1	0.0016	0	0	0.13	0	2.42	0	3.86	0.12	4.72	0.16	5.57	0.2
div B2	0.00222	0	0	0	0	0	0	0.01	0	0.2	0.05	0.43	0.12
div c1	0.0014	0	0	0	0	1.62	0	2.8	0.08	3.54	0.11	4.28	0.14
DPb	0.00022	0.08	0.01	0.16	0.01	0.38	0.01	0.53	0.04	0.64	0.05	0.76	0.06
EPb	0.00018	0.08	0.01	0.15	0.01	0.32	0.01	0.44	0.04	0.53	0.04	0.62	0.05
Reach-AP2	0.00211	0.99	0.09	1.67	0.16	3.34	0.16	4.42	0.45	5.23	0.54	6.11	0.64
Reach-AP3	0.00064	0.28	0.01	0.54	0.03	1.18	0.03	1.61	0.1	1.93	0.13	2.29	0.16
Reach-AP4	0.00078	0.24	0.01	0.52	0.02	1.24	0.02	1.73	0.09	2.1	0.12	2.51	0.15
Reach-AP5	0.00052	0.4	0.02	0.6	0.03	1.02	0.03	1.29	0.08	1.49	0.1	1.7	0.11
Reach-AP6	0.00044	0.53	0.02	0.74	0.04	1.2	0.04	1.5	0.09	1.71	0.11	1.95	0.13
Reach-AP7	0.00012	0.11	0	0.16	0.01	0.29	0.01	0.38	0.02	0.44	0.02	0.5	0.02
Reach-B1F	0.0016	1.53	0.1	2.27	0.16	3.95	0.16	5	0.41	5.78	0.48	6.62	0.56
Reach-B2F	0.00133	1.12	0.04	1.72	0.07	3.09	0.07	3.97	0.22	4.62	0.27	5.34	0.32
Reach-B2F	0.00089	0.73	0.02	1.14	0.04	2.08	0.04	2.66	0.11	3.09	0.13	3.57	0.16
Reach-CP-	0.00083	0.82	0.05	1.21	0.08	2.08	0.08	2.63	0.2	3.04	0.23	3.48	0.27
rech A	0	0.07	0.19	0.08	0.2	0.09	0.2	0.09	0.21	0.1	0.22	0.1	0.22
rech B1	0	0.42	0.1	0.49	0.16	0.54	0.16	0.56	0.29	0.57	0.32	0.58	0.35
rech B2	0	0.02	0.06	0.02	0.07	0.02	0.07	0.12	0.12	0.14	0.14	0.15	0.16
rech c1	0	0.38	0.08	0.44	0.12	0.49	0.12	0.51	0.22	0.52	0.25	0.53	0.28



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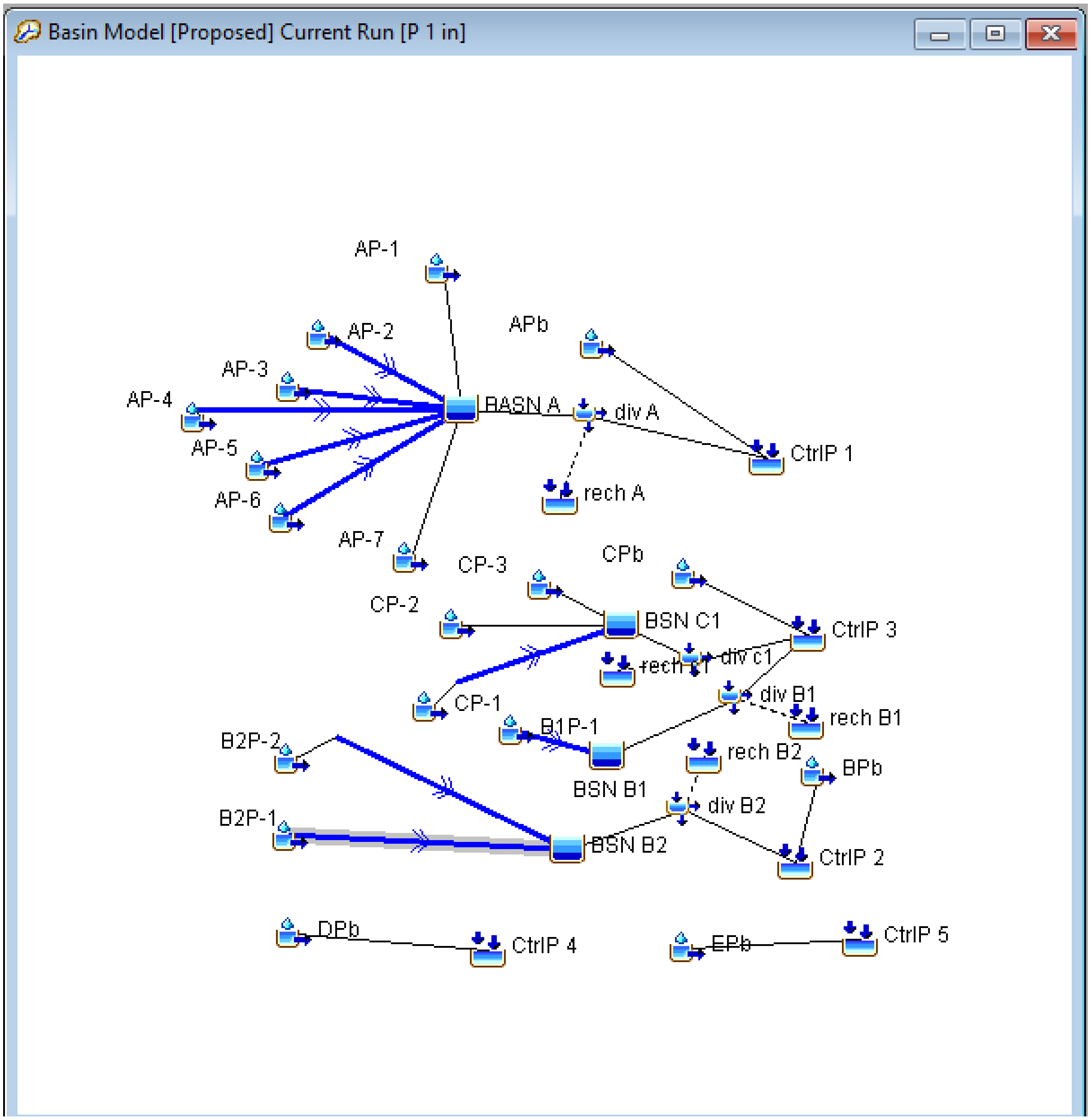
Farm rd ex 100yr.html	9/28/2023 10:38 P...	Microsoft Edg...	1,925 KB

Above Output reports can be made available upon request to save space. See previous a global summary table.



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Farm rd prop 100yr.html	2/15/2024 1:11 PM	Microsoft Edg...	7,691 KB

Above Output reports can be made available upon request to save space. See previous a global summary table.

Appendix C: CALCULATIONS OF STORMWATER QUALITY CONTROL[1]

1. Infiltration Pond

In current Best Management Practices, extended infiltration ponds are one of the most widely used methods. We have used the most recent studies (Schueler 1987, 1992, Urbonas and Stahre 1993) on stormwater quality control by extended infiltration ponds (EDP) to calculate nutrient load. The results are used as a basis for the designs of sediment forebays and water treatment pools. Information on pollutant concentration from runoff (EPA 1983) is used. Pollutant loads from predevelopment and postdevelopment are calculated and compared. Removal efficiency is calculated based on long-term average results from typical basins, U.S. EPA (1986), and adapted to reflect modifications of Walker (1986) and short term dynamic effect. A generalized formula is provided in the following (Wang and Carr 1996):

$$Pr = Prmax\left(1 - \frac{1}{1+Vi^{np}}\right) .\mathrm{fr} \qquad (1)$$

in which, Pr = pollutant removal rate (%);

Prmax = maximum pollutant removal rate (%);
Vi = ratio of designed water treatment volume to the runoff volume from mean storm (about 0.5 inches rainfall);
np = power coefficient, 1.4 is used in this study.
fr = residence time coefficient to reflect the dynamic effect.

$$fr = 1 - [1 + \frac{V_s t}{nh}]^{-n} \qquad (2)$$

where, n = turbulence or short circuiting constant (Fair and Geyer 1954), n = 1 for poor performance, n = 3 for good performance, n >5 for very good, and n = 4 for ideal performance;
Vs = effective settling velocity, ft/hr.
t = residence time, hr;
h = average depth of the pond, ft.

Some Prmax values for some pollutants are summarized here:

Pollutant	Prmax (%)
TSS	100
BOD, COD, Zn,Cu	45
TP	70
TN	50
Pb	95

These removal rates do not include the effect of swales or sediment sumps in catch basins. Removal

[1] Water Quality Module of Stormwater Analysis Version 1.0 © 1996, by Desheng Wang, Ph.D., P.E.,

rates of trace metals can be different due to the form of the metal. The particulate forms of metals are easy to remove. The soluble forms of metals are usually more difficult to remove. However, significant parts of soluble metals appear to adsorb to sediment particles and settle out of the water column. 60% removal rate was estimated in a case when 80% of zinc is in soluble form (Schueler 1987). The following table shows the removal rates of selected pollutants for a typical extended infiltration pond with a water treatment volume of 2.5 times the average runoff volume.

Table A.1: Fact Sheet of Standard Extended Infiltration Ponds (SEDP) (Schueler 1987, 1992)

Contaminant	Removal Efficiency (%)	Remarks
TSS	78	Total suspended solids
TN	41	Total nitrogen
TP	51	Total phosphorus
BOD	40	Biological oxygen demand
COD	40	Chemical oxygen demand
Pb	72	Lead
Zn	40	Zinc
Cu	40	Copper
HCs	60	Hydrocarbons*
Bact	70	Bacteria*

* Based on field studies by EPA (1981), Grizzard et al. (1986).

The SEDP requires that a pond volume equal the runoff volume of a rainfall event with exceedance frequency 90%.

The summary of calculations is presented below.

Standard Pond Volume (Treatment Volume, in acre-ft) (Schueler 1987, 1992):

$$Vp=[(P)(Pj)(Rv)/12]A \qquad (3)$$

Total Pollutant Load in lbs:

$$L=[(P)(Pj)(Rv)/12](A)\ (C)\ (2.72) \qquad (4)$$

where, P=Rainfall depth (inches); Pj=correction factor, equals the accumulative frequency of rainfall events; Rv=runoff coefficient, =0.05 + 0.009I; I= Imperviousness (%); A = watershed area (Acre); L= pollutant load (lbs); C = pollutant concentration (mg/l).

Sediment forebay is designed to hold 5 years accumulation of TSS. Once a year or once every two years cleanup of the forebay is recommended. In addition, 24 hrs or longer infiltration time is recommended to achieve predicted removal rate (Schueler 1987, Urbonas and Stahre 1993). Most coarse particles are supposed to be trapped by sediment forebay. For a given site condition, the area of the forebay can be determined by the following equation which was derived by the Washington State Department of Ecology from the Camp-Hazen equation (Washington State Department of Ecology, 1992 and Chen, 1975):

$$A_s = -(\frac{Q_o}{\omega}) * Ln(1 - E) \quad (5), \quad \text{where:}$$

A_s = sediment forebay or basin surface area (ft^2);

E = target removal efficiency of suspended solids;

ω = particle settling velocity; for target particle size (silt) use settling velocity = 0.0004 ft/sec for a site with imperviousness larger or equal to 75% and 0.0003 ft/sec for imperviousness < 75%;

Q_o = rate of outflow form the basin; which is equal to the water quality volume divided by the infiltration time (t_d).

Besides the above mentioned pollutants, it has been reported that an order of magnitude reduction in bacterial counts after 32 hours of infiltration occurs (Whipple and Hunter 1981). Also, about 60 - 70% removal of hydrocarbons was reported over the same interval.

In addition to the pond attenuation abilities, marshes are used to provide extra treatment and purification for the water passing through them. Tables A.2 and A.3 provide average removal rates for selected pollutants from typical marshes.

Table A.2 Uptake Potentials of Cattail (Typha latifolia) Marshes (Chan et al 1982)

Contaminant	Uptake (lbs/acre/yr)
TP	9.7 to 358.7
TN	456.3 to 2340.7
Cu	0.32
Zn	0.53
Mn	12.16

Table A.3 Uptake Potentials and Removal Rate of Free Water Surface Marshes (Reed 1990)

Contaminant	Uptake (lbs/acre/yr)	Removal Rate (%)
TSS	125 to 49,508	61 to 95
TP	19.2 to 400.6	31 to 80
TN	215 to 430.6	43 to 93
BOD	220 to 20,764	49 to 95

2. Catch Basins

Catch basins are to be equipped with sediment sumps and oil/grease traps. Regularly maintained and cleaned catch basins can remove significant amounts of pollutants. Table A.4 presents an average removal rate of selected pollutants from catch basin sumps (Aronson et al 1983).

Table A.4 Average Removal Rates of Catch Basins for Selected Contaminants

Contaminant	Average Removal Rate (%)
TSS	58
TN	17
P	4
TM	50

* P = Phosphates; TM = Total metals.

References:

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[2] Reed, S. C. (1990). "*Natural Systems for Wastewater Treatment - Manual of Practice FD-16,"* Water Pollution Control Federation.

[3] Shueler, T. (1987) *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs,* Dept. of Environmental Programs, Metropolitan Washington Council of Governments, Washington D. C.

[4] Shueler, T. (1992) *Design of Stormwater Wetland Systems: Guidelines for Creating Diverse and Effective Stormwater Wetland Systems in the Mid-Atlantic Region*, Anacostia Restoration Team, Dept. of Environmental Programs, Metropolitan Washington Council of Governments, Washington D. C.

[5] Urbonas, Ben, and Stahre, Peter (1993) *Stormwater --Best Management Practices and Infiltration for Water Quality, Drainage, and CSO Management*, PTR Prentice Hall, Englewood Cliffs, New Jersey.

[6] Walker, W. (1986). "*Phosphorus Removal by Urban Runoff Infiltration Basins,"* Presented at Lake and Reservoir Management Conference: Influence on Nonpoint Source Pollutants. North American Lake Management Society, Portland, Oregon, November 5-8, 1986.

[7] Wang, D. S., and Carr, B. J. (1996). "Pollutant Removal Rates for Stormwater Infiltration Ponds," Proceedings of 1996 AIH Conference, Boston.

[8] Claytor, R. A., and Schueler, T. T. (1996) *Design of Stormwater Filtering Systems*, the Center for Watershed Protection, Silver Spring, MD 20910.

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Subject: Groundwater Recharge, Water Quality Calcs., 65 Farm Road
Location: Sherborn, MA
revision by:
By: dsw
Chkd:
Job No.: J269-12
Date: **8/27/2023**
Date:
Date:
Sheet: 1
Rev. 2/14/2024

1. Land Use Break Down Land Uses (Acres)

	Subbasin	Existing	Proposed	Existing	Proposed	Increment
1	Roof	0.153	1.069	0.153	1.069	0.916
2	Pave	0.650	1.614	0.650	1.614	0.964
3	Pervious	14.589	12.709			
	Total	15.392	15.392	0.803	2.683	1.880
	Imperviousness (%)			5.22	17.43	

2. Groundwater Recharge

Dry wells (2)

Infiltration time (hrs):	6						
Diameter (ft):	6	width (ft):		Depth (ft):	6	Pipe dia. (in):	
Storage volume (cu.ft):							
Infil. rate (cfs):							
Infiltration volume (cu.ft):		0					
Total volume (cu ft) :		0					
Impervious area (acres):	A soil	B Soil	C Soil	D Soil	Total		
					0 acres	Provided	
DEP required GW recharge volume:					**0** cu. ft	larger than	**0** cu. ft OK!

Crushed Gravel

			Basins				
Infiltration time (hrs):	6		Basin A	Basin B1	Basin B2	Basin C	Total
At elevation (ft):		out INV	209.4	216.9	210.2	220	
Static Storage volume (cu.ft):			7006.00	2743	12775	1944	**24468**
Infil. rate (cfs):			6.60E-02	0.485	0.1244	0.446	
Infiltration volume (cu.ft):			1425.6	10476	2687.04	9633.6	**24222.24**
Total volume (cu ft) :			8431.6	13219	15462.04	11577.6	**48690.24**

Hydrological soil group	A soil (0.6)	B Soil (0.:	C Soil	D Soil	Total			
DEP required GW recharge (in):	0.6	0.35	0.25	0.1				
Impervious area (acres):	0.058	0.997	0.500	1.128	2.68 acres		Provided	
DEP required GW recharge volume:	126.00	1266.83	453.78	409.40	**2256.01** cu. ft	less than	**48690.24** cu. ft	OK!

Infiltration trenches:

		Trench						
Infiltration time (hrs):	6	Trench 1	Trench 2	Trench 3	Trench 4	Trench 5	Trench 6	Total
Depth (ft):								
Storage volume (cu.ft):								**0**
Infil. rate (cfs):								
Infiltration volume (cu.ft):		0	0	0	0	0	0	**0**
Total volume (cu ft) :		0	0	0	0	0	0	**0**

Impervious area (acres):	A soil	B Soil	C Soil	D Soil	Total			
					0.000 acres		Provided	
DEP required GW recharge volume:					**0** cu. ft	less than	**0** cu. ft	OK!

An Average Storm Event Runoff:

Precipitation (in):	0.7	
Total Impervious area (acres):	2.68	
Runoff Volume (cu. ft):	**6817.02**	This is a conservative average groundwater recharge volume for a average rain event.
Total infiltration capacity(cu.ft):	48690.24	larger than 6817.0212 cu. ft OK !

Conclusion 1: Therefore, the pratical average groundwater recharge compensation will be **6817.0212** cu.ft. larger than **2256.01** cu.ft as DEP required.

3. Average Site TSS Removal Rate

	Subbasin	Area (acres)	TSS removal (%)	A x TSS	
1	Basin A	4.698	89	418.0864	mixed
2	Basin B1	1.024	90	92.16	mixed
3	Basin B2	1.421	90	127.872	mixed
4	Basin C	0.896	90		mixed
	Total	7.142		638.1184	
	Total average removal rate		89.34 %		

Conclusion 2: The average total suspended solid removal rate is 89.34 % better than existing conditions

4. Water Quality Volume

Water quality rule 1 inches

Site Conditions	Impervious area	WQV req.	WQV provided	
	acres	cu. ft	cu. ft	
existing	0.803	none	none	
Proposed	2.683	9738.6017	48690.24	OK!

Conclusion 3: Therefore, the total stormwater quality volume for proposed condition will be **48690.24** cu.ft. larger than **9738.6017** cu.ft as DEP required.

DSW

CALCULATIONS OF STORMWATER QUALITY CONTROL

revision:

Project:	**Homes at Farm Road**	Street:	Farm Road	User:	DSW	Date:	27-Sep-23
Site:	**65 Farm Road**	Town:	**Sherborn**			Job:	J269-12
County:	**Middlesex**	State:	**MA**	Check:		Sheet:	1 of 1

Input Report:

P=Rainfall depth (inches): Pj=Correction factor: 0.9000

Event	1.250
Annual	45.000

C=Concentration (mg/l):

	Resid. (R)	Comm. (C)	Nonurban (N)	Constr. (S)	User define(U)
TSS	101.0000	69.0000	70.0000	10000.0000	505.0000
TN	1.9000	1.1800	0.9650		9.5000
TP	0.3830	0.2010	0.1210		1.9150
BOD	10.0000	9.3000	9.0000		50.0000
COD	73.0000	57.0000	40.0000		365.0000
Pb	0.1440	0.1040	0.0300		0.7200
Zn	0.1350	0.2260	0.1950		0.6750
Cu	0.0330	0.0290	0.0300		0.1650

I=Imperviousness (%):

Pre-Development	5.220
Post-Development	17.430

Watershed condition:

Pre-Development	R
Post-Development	N

A=Watershed area (Acres):

Pre-Development	15.392
Post-Development	15.392

Designed Pond:

Volume (ac-ft)	1.019	Mean depth (ft):	7.500
Area (Acres)	0.364	Eff. sett. vel. (ft/hr):	1.600
Residence Time (hrs)	72.000	Turbulence factor:	5.000

Forebay Trap Efficiciency (%) 25.000

Output Report:

	Predevelopment	Postdevelopment
Site Condition:	Residential	Nonurban
Rv=	0.097	0.21
Standard Vp (Ac-ft):	0.140	0.30
Effective treatment ratio:		8.54
Min. Sediment Forebay (cu. ft):		4414.40
Sediment Forebay area (sq. ft.)	1000.000	1000.00
Sediment forebay depth (ft)	2.000	4.41
Residence time coef.:		1.00

Annual Nutrients (lbs/yr):	Predevelopment	Postdevelopment Before treated	Postdevelopment After treatment	Removal efficiency (%) Predicted *	Conc. (mg/l) Predicated
TSS	1384.017	2046.130	98.602	95.181	3.373
TN	26.036	28.207	14.783	47.591	0.506
TP	5.248	3.537	1.180	66.627	0.040
BOD	137.031	263.074	150.395	42.831	5.145
COD	1000.329	1169.217	668.424	42.831	22.867
Pb	1.973	0.877	0.084	90.422	0.003
Zn	1.850	5.700	3.259	42.831	0.111
Cu	0.452	0.877	0.501	42.831	0.017

*After average results from U.S. EPA (1986), and adapted to reflect modifications of Walker (1986).

Nutrient Removal by Plant Uptake**

Contaminant	Uptake (lbs/acre/yr)	Ave uptake (lbs/yr)	Ave. removal (%)	Reference Total Removal (%)
TSS	125 to 49508	9029.879	78.000	98.940
TN	215 to 430.6	117.456	68.000	83.229
TP	19.2 to 400.6	76.375	55.500	85.149
BOD	220 to 20764	3817.681	72.000	83.993

* *After average results from Reed (1990).

Water Quality Module of Stormwater Analysis Version 1.3 (c) by Desheng Wang, Ph.D., P.E., 1998, Carr Research Laboratory, Inc., 251 West Central Street, D-36, Natick, MA 01760

TSS Removal Calcualtion Worksheet

					Revised:			
Project:	Farm Road Homes		Designed by:	dsw	Date:	27-Sep-23	Sheet:	1 of 1
Location:	65 Farm Road		chkd by:		Date:		Job:	J269-12
	Basin A		revision:		Date:	2/14/2024		

A	B	C	D	E
BMP*	TSS Removal Rate	Starting TSS	Amount Removed (BxC)	Remaining Load (C - D)
DSCB	0.25	1	0.25	0.75
Oil/grit seperator	0.25	0.75	0.1875	0.5625
Infiltration Trench	0.8	0.5625	0.45	0.1125

Total TSS Removal= 0.89

* WQS = water quality swale; WQI = water Qality inlet; EDB = extended detention basin.
DSCB = deep sump catch basin; SW = sweeping; DW=drywell; IT = infiltration trench.
FB = sediment Forebay; CW = constructed wetland, RB = retention basin, WB = wet basin
IB = Infiltration Basin
Reference: MADEP (2008) Stormwater Management, Volume I & II.
** Rate calculated based on DEP default

TSS Removal Calcualtion Worksheet

				Revised:			
Project:	Farm Road Homes	Designed by:	dsw	Date:	27-Sep-23	Sheet:	1 of 1
Location:	65 Farm Road	chkd by:		Date:		Job:	J269-12
	Basin B1, B2, C	revision:		Date:			

A BMP*	B TSS Removal Rate	C Starting TSS	D Amount Removed (BxC)	E Remaining Load (C - D)
Grass channel	0.5	1	0.5	0.5
IT	0.8	0.5	0.4	0.1

Total TSS Removal= 0.90

* WQS = water quality swale; WQI = water Qality inlet; EDB = extended detention basin.
DSCB = deep sump catch basin; SW = sweeping; DW=drywell; IT = infiltration trench.
FB = sediment Forebay; CW = constructed wetland, RB = retention basin, WB = wet basin
IB = Infiltration Basin, GC = grass channels

Reference: MADEP (2008) Stormwater Management, Volume I & II.

Flow Distribution Design in the Front Parking Lot

	65 Farm Road, Sherborn, MA	Revision:	
Project:	DMH#1 - distribution MH	**Date:**	9/28/2023
By:	Creative Land & Water Eng. LLC	**Cal. by:**	dsw
		Chk by:	

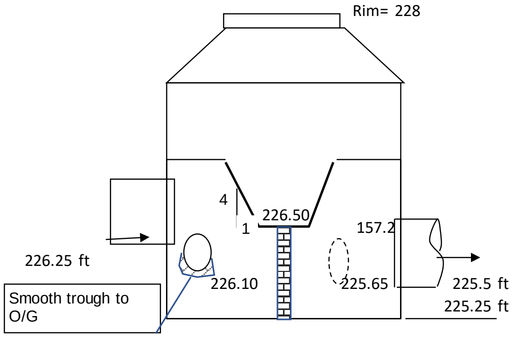
Bottom of manhole:	225.25 ft	**Rev.**	
INV of Inflow pipes (12"):	226.25 ft		
INV of Orifice to O/G :	226.1 ft	Opening dia.:	4 in
INV of O.V.F. Weir:	226.50 ft	Weir bottom width (Cipoletti):	1 ft
INV of O.V.F Pipe:	225.5 ft	OVF pipe dia.:	1.25 ft
INV of Orifice from O/G:	225.65 ft		15 in

Treatment Flow Design Storm (0.5" or 1"): 1"

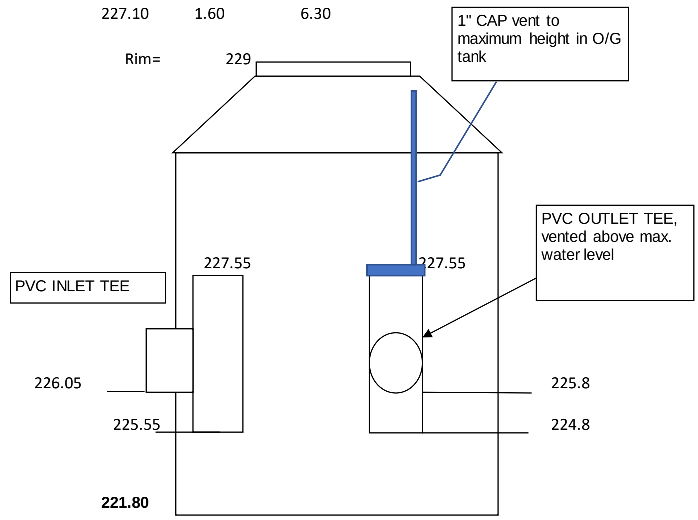
Component	Designed flow (cfs)	Elev. (ft)	Head (ft)	Designed Treatment Capacity (cfs)	Treatment ratio
Treatment Device:		226.50	0.23	0.20	1
Overflow weir:	0.2	226.50	0		
Total				0.20	

Overflow Flow Design Storm: 100-year

Component	Design flow (cfs)	Elev. (ft)	Head (ft)	Cal. Flow (cfs)	Treatment ratio
Treatment Device:		227.3	1.03	0.43	0.15
Overflow weir:	6	227.3	0.8	2.41	
Total				2.84	
Overflow pipe sizing:		227.10	1.60	6.30	



DMH #1, Flow Distribution Manhole



ELEVATION VIEW (N.T.S.)

Oil/Grit Separator #1

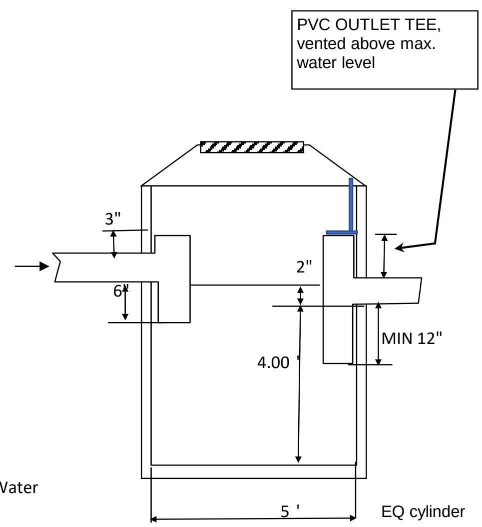
TSS Removal Calculations for Water Quality Inlet or Oil/Grit Separator

Project:	Oil-Grit Separator #1	65 Farm Road, Sherborn, MA					
User:	DSW		Date:	9/28/2023	Revision:		
	Creative Land & Water Engineering, LLC						
Impervious Area:	0.120 acres	Target TSS removal:	80.00%	O/G volume			
Treatment Standard:	1 in	Initial Tank volume:	78.51 cu. ft.	587 gallon	Dia	5 ft	
Treatment Volume:	435.6 cu. ft.	Initial depth:	4.00 ft	Dimension	Depth	4 ft	
Total TSS Factor (NJ DEP):	0.8	End depth:	2 ft		Interior		
Total TSS Factor (Sand):	0.85	O.V.F treatment ratio:	0.23				

	Particle size* d, μm	Distribution %	Specific Gravity	Settling Velocity Vs, ft/s	Effective Depth h, ft	Effective Treatment Time Td, min.	Average Dynamic Removal Rate %	Weighted Removal Rate	Total with CB
NJ DEP									
	1	5	2.65	0.0012	3	259.54	83.81%	4.19	
	4	15	2.65	0.0012	3	259.54	83.81%	12.57	
	29	25	2.65	0.0025	3	259.54	84.59%	21.15	
	75	15	2.65	0.0133	3	259.54	84.60%	12.69	
	175	30	2.65	0.0619	3	259.54	84.60%	25.38	
	375	5	2.65	0.1953	3	259.54	84.60%	4.23	
	750	5	2.65	0.4266	3	259.54	84.60%	4.23	
Average								**84.44%**	**88.33%**
	150	60	2.65	0.0475	3	259.54	88.45%	53.07	
Sand	400	20	2.65	0.2123	3	259.54	88.45%	17.69	
	2000	20	2.65	0.9417	3	259.54	88.45%	17.69	
								88.45%	

*Particle size distribution according to NJDEP (clay, silt, sand)

Removal rate = $1 - e^{-(Vs/h)Td}$



Assumption: 0.5" first flush contains 80-85% of the total TSS in runoff
1.0" runoff contains 90-95% of the total TSS in runoff
Bypass for above design flow should be provided to avoid resuspension.

Trt. Vol. / TSS Size	Treatment Factors 05"	1"
NJ DEP	0.8	0.9
Sand	0.85	0.95
OVFT	0.3	0.2

References:

Wang, D. and J. Carr (1996). "Pollutant Removal Rates for Stormwater Detention Ponds," Hydrology and Hydrogeology of Urban and Urbanization Areas, American Institute of Hydrology, pp. ABMP12-21.

Urbonas, Ben, and Stahre, Peter (1993). Stormwater - Best Management Practices and Detention for Water Quality, Drainage, and CSO Management, PTR Prentice Hall, Englewood Cliffs, New Jersey.

U.S. EPA (1986) Methodology for Analysis of Detention Basins for Control of Urban Runoff Quality, Nonpoint Source Branch, Office of Water, Washington, D.C., EPA -440-5-87-001.

Flow Distribution Design in the Front Parking Lot

	65 Farm Road, Sherborn, MA	Revision:	
Project:	DMH#1 - distribution MH	**Date:**	9/28/2023
By:	Creative Land & Water Eng. LLC	**Cal. by:**	dsw
		Chk by:	
		Rev.	

Bottom of manhole:	215.75 ft		
INV of Inflow pipes (12"):	221.75 ft		
INV of Orifice to O/G :	221.6 ft	Opening dia.:	4 in
INV of O.V.F. Weir:	222.15 ft	Weir bottom width (Cipoletti):	1 ft
INV of O.V.F Pipe:	216 ft	OVF pipe dia.:	1.25 ft
INV of Orifice from O/G:	220.5 ft		15 in

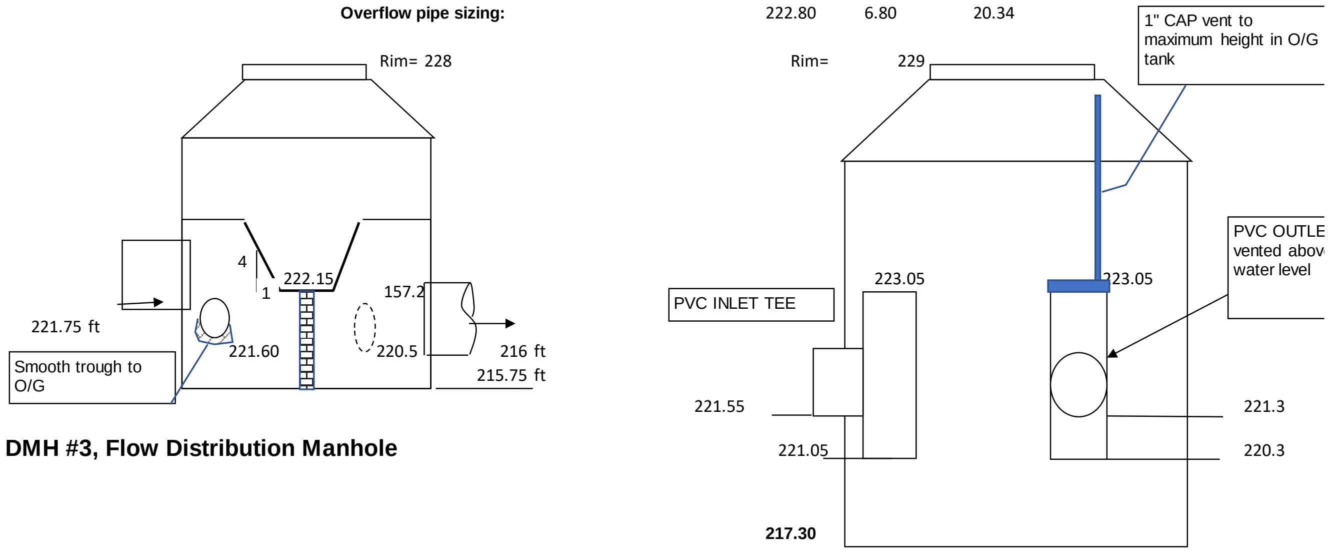
Treatment Flow Design Storm (0.5" or 1"): 1"

Component	Designed flow (cfs)	Elev. (ft)	Head (ft)	Designed Treatment Capacity (cfs)	Treatment ratio
Treatment Device:		222.15	0.38	0.26	1
Overflow weir:	0.25	222.15	0		
Total				0.26	

Overflow Flow Design Storm: 100-year

Component	Design flow (cfs)	Elev. (ft)	Head (ft)	Cal. Flow (cfs)	Treatment ratio
Treatment Device:		223	1.23	0.47	0.15
Overflow weir:	2	223	0.85	2.64	
Total				3.10	

Overflow pipe sizing: 222.80 6.80 20.34



ELEVATION VIEW (N.T.S.)

Oil/Grit Separator #2

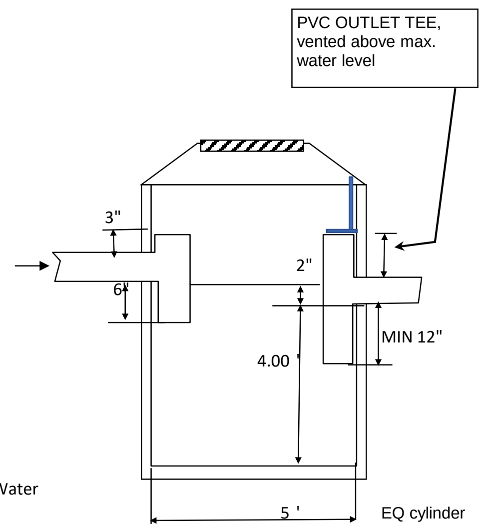
TSS Removal Calculations for Water Quality Inlet or Oil/Grit Separator

Project:	Oil-Grit Separator #2	65 Farm Road, Sherborn, MA					
User:	DSW		Date:	9/28/2023 Revision:			
	Creative Land & Water Engineering, LLC						
Impervious Area:	0.280 acres	Target TSS removal:	80.00%	O/G volume			
Treatment Standard:	1 in	Initial Tank volume:	78.51 cu. ft.	587 gallon	Dia	5 ft	
Treatment Volume:	1016.4 cu. ft.	Initial depth:	4.00 ft	Dimension	Depth	4 ft	
Total TSS Factor (NJ DEP):	0.8	End depth:	2 ft		Interior		
Total TSS Factor (Sand):	0.85	O.V.F treatment ratio:	0.23				

	Particle size* d, µm	Distribution %	Specific Gravity	Settling Velocity Vs, ft/s	Effective Depth h, ft	Effective Treatment Time Td, min.	Average Dynamic Removal Rate %	Weighted Removal Rate	Total with CB
NJ DEP									
	1	5	2.65	0.0012	3	111.23	73.18%	3.66	
	4	15	2.65	0.0012	3	111.23	73.18%	10.98	
	29	25	2.65	0.0025	3	111.23	83.29%	20.82	
	75	15	2.65	0.0133	3	111.23	84.60%	12.69	
	175	30	2.65	0.0619	3	111.23	84.60%	25.38	
	375	5	2.65	0.1953	3	111.23	84.60%	4.23	
	750	5	2.65	0.4266	3	111.23	84.60%	4.23	
Average								**81.99%**	**86.49%**
	150	60	2.65	0.0475	3	111.23	88.45%	53.07	
Sand	400	20	2.65	0.2123	3	111.23	88.45%	17.69	
	2000	20	2.65	0.9417	3	111.23	88.45%	17.69	
								88.45%	

*Particle size distribution according to NJDEP (clay, silt, sand)

Removal rate = $1 - e^{-(Vs/h)Td}$



Assumption: 0.5" first flush contains 80-85% of the total TSS in runoff
1.0" runoff contains 90-95% of the total TSS in runoff
Bypass for above design flow should be provided to avoid resuspension.

Trt. Vol. / TSS Size	Treatment Factors 05"	1"
NJ DEP	0.8	0.9
Sand	0.85	0.95
OVFT	0.3	0.2

References:

Wang, D. and J. Carr (1996). "Pollutant Removal Rates for Stormwater Detention Ponds," Hydrology and Hydrogeology of Urban and Urbanization Areas, American Institute of Hydrology, pp. ABMP12-21.
Urbonas, Ben, and Stahre, Peter (1993). Stormwater - Best Management Practices and Detention for Water Quality, Drainage, and CSO Management, PTR Prentice Hall, Englewood Cliffs, New Jersey.
U.S. EPA (1986) Methodology for Analysis of Detention Basins for Control of Urban Runoff Quality, Nonpoint Source Branch, Office of Water, Washington, D.C., EPA -440-5-87-001.

APPENDIX D: INFILTRATION CALCULATIONS

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This appendix presents the calculation method for an infiltration rate. The whole method includes: effective infiltration area, infiltration rate, and water quality benefit. It is noted that infiltration facilities should only be used in very permeable soils.

1.0 Effective Infiltration Area

To keep an infiltration facility functioning, the most important thing is to prevent sediment from entering the effective infiltration area. It is recommended that storm runoff be pretreated by sediment sumps before be discharged to the infiltration facility. If a basin does become severely clogged, partial or complete replacement of the structure may be required [1]. It is recommended that for an infiltration facility such as an infiltration basin/trench, only the sides of the basin/trench should be used as the effective infiltration area. The reason for this is that the bottom eventually is sealed by the accumulation of sediments. For a recharge galley or infiltration basin/trench filled with crushed stone, the bottom area can be counted as part of the effective area, providing there is a sump with access for sediment removal.

2.0 Design of the Basin/trench

There are two aspects to consider in the design of an infiltration basin/trench: one is the function in reducing runoff peak flow; the other is stormwater quality control. Water quality control is controlled by the volume of the basin/trench. The peak flow is controlled by the infiltration rate of the basin/trench. The infiltration rate of a basin/trench is determined by the on-site soil condition and the size of the basin/trench.

2.1 Volume of the Basin/trench

To maximize the pollutant attenuation, the volume of the infiltration basin/trench can be designed as large as possible. However, studies (Griffin et al., 1980; MD WRA, 1986) showed that a great port of pollutant loads is delivered during the early part of storms or the first flush of the storm. The first flush storm is the runoff due to the first half of an inch of rain. To store this part of runoff is the key to achieve better stormwater quality. Two basic rules are commonly used to determine the basin/trench volume for water quality benefit. The first rule is to size the basin/trench storage volume as 0.5 inches of runoff volume per impervious acre in the contributing watershed (MD WPA, 1986), using

$$V = 0.5 * A * Imp$$

where, V = Volume of the porous of the basin/trench (ac-in);
A = Watershed area (acre);
Imp = fraction of site imperviousness.

The second rule is to size the basin/trench so that it is capable of storing runoff produced from a one inch storm over the contributing watershed (Schueler 1987), using

$$V = 1.0\, R_v\, A$$

where, R_v = Runoff coefficient, R_v=0.05+0.009 (I); I = the percent of site imperviousness.

The expected pollutant removal rate for a basin/trench with this design volume is presented in the following table.

Table A.1: Estimated Long-term Pollutant Removal Rate (%) for Full Exfiltration Basin (Shueler 1987)

Pollutant	Removal Rate	
	Rule 1	**Rule 2**
Sediment	75%	90%
Total Phosphorus	50-55%	60-70%
Total Nitrogen	45-55%	55-60%
Trace Metals	75-80%	85-90%
BOD	70%	80%
Bacteria	75%	90%

If catch basins are all equipped with sediment sumps, the final pollutant removal rates are expected higher for both rules. Table A.2 presents average removal rates for selected pollutants from catch basin sumps (Aronson et al 1983).

Table A.4 Average Removal Rates of Catch Basins for Selected Contaminants

Contaminant	Average Removal Rate (%)
TSS	58
TN	17
P	4
TM	50

* P = Phosphates; TM = Total metals.

2.2 Infiltration Rate

It is important to know that there is an unsaturated zone underneath an infiltration basin/trench. However, it is not necessary to have this zone for infiltration to take place. In case of on-site sewage disposal design, this unsaturated zone is important for bio-treatment of waste water. In general, a 2 to 5 ft. separation from the water table to the bottom of the basin/trench is recommended or required by state regulations (Finnemore, 1993). It is not necessary to have such a zone for a stormwater recharge basin/trench. The calculation method here is based on the permeability test which can be used for both saturated infiltration flow and flow penetration into the water table [4]. The separation required by DEP is to assure that the basin can be dewater in 72 hours with groundwater mounding impact, which will discussed in the groundwater mounding part.

One of the most common on-site constant head test [4] uses the following formula to calculate soil

$$k = \frac{Q}{5.5rH}$$

permeability:
where, k = permeability,
Q = constant rate of flow into the test hole,
r = internal radius of casing, and
H = differential head of water.

This formula requires that the aquifer thickness underneath the pipe should be larger than 10r. From this formula, we can conclude that for a given soil condition, the infiltration rate will be proportional to the free water depth in the basin/trench. The most effective depth of free water in the basins/trenches was found to be four feet. Significantly lesser or greater depths resulted in reduced rates of infiltration, the former because of inadequate entrance head and the latter because of increasing weight-compaction of the soil (Baumann, 1965). Based on this formula, we can calculate the infiltration rate through bottom surface Q_1 can be calculated in the following ways.

For a circular surface:

$$Q_1 = 5.5\ rHk$$

For a rectangular surface with width B and length L, the above formula can be modified to account for the change in shape (Wang 1999):

$$Q_1 = 3.50\ kHB(0.5 + L/2B)$$

The infiltration rate through side surface Q_2 is calculated by Darcy's formula assuming the hydraulic gradient equals 1.0 [3] and assuming that the recharge galley does not penetrate the water table.

$$Q_2 = k\ A_s$$

Where, A_s = side surface area of the basin/trench, = $2BrH$ for a circular section; = $2(B+L)H$ for a rectangular section.

The total infiltration rate is the summation of rates through bottom surface and side surfaces:

$$Q = Q_1 + Q_2$$

3.0 Overflow Structure

Overflow structures should be installed at the end of the recharge basins/trenches. Typical overflow structures are weirs. It is recommended that the overflow water leaves as sheet flow to the downgradient area to avoid possible erosion. Wells of small diameters should also be installed in the ends of each for dual purposes of (a) measurement of the distance to and sampling of ground water and (b) aiding in the expulsion of air as the mound rises. Trapped air may cause slow infiltration, especially when there is a large separation between the basin/trench and the normal water table.

4.0 Summary

This appendix presents the design method of an infiltration basin/trench. The design criteria include water flood control and water quality management. For a given hydrological condition (runoff hydrograph), the size of the basin/trench can be easily determined by the formulas given in this appendix. A computer program is designed to carry out the computations. Flood routing can be further applied to a determined larger flood when overflows may occur.

References:

[1] Shueler, T. (1987) *Controlling Urban Runoff: A Practical Manual for Planning and Designing Urban BMPs*, Dept. of Environmental Programs, Metropolitan Washington Council of Governments, Washington D. C.

[2] Shueler, T. (1992) *Design of Stormwater Wetland Systems: Guidelines for Creating Diverse and Effective Stormwater Wetland Systems in the Mid-Atlantic Region*, Anacostia Restoration Team, Dept. of Environmental Programs, Metropolitan Washington Council of Governments, Washington D. C.

[3] Urbonas, Ben, and Stahre, Peter (1993) *Stormwater --Best Management Practices and Infiltration for Water Quality, Drainage, and CSO Management*, PTR Prentice Hall, Englewood Cliffs, New Jersey.

[4] U.S. D. I. (1974) *Earth Manual - A Water Resources Technical Publication*, Washington, D.C.

[5] "Underground Disposal of Storm Water Runoff Design Guidelines Manual," U.S. Dept. of Transportation, Federal Highway Administration, Offices of Research and Development Implementation Division (HDV-21) FHWA-TS-80-218, February 1980.

[6] Todd, David K. (1980) *Groundwater Hydrology*, 2nd Edition, John Wiley & Sons, New York.

[7] Finnemore, J. (1993) "Estimation of Groundwater Mounding Beneath Septic Drain Fields," *Ground Water*, Assoc. of Ground Water Scientists and Engineers, Vol. 31, No. 6, 884-889.

[8] Finnemore, J. (1983) "Ground-water Mounding due to on-site Sewage Disposal," J. of Irrigation and Drainage Engineering, Vol. 109, No. 2, 199-210.

[9] Hantush, M. S. (1967) "Growth and Decay of Groundwater-Mounds in Response to Uniform Percolation," *Water Resources Research*, Vol. 3, No. 1, First Quarter, 1967, 227-234.

[10] Marino, M. A. (1967) "Hele-Shaw Model Study of the Growth and Decay of Groundwater Ridges," *J. of Geophysical Research*, Vol. 72, No. 4, 1195-1205.

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[12] Williams, J. and Willey, R. E. (1967) "Northern Part Ten Mile and Taunton River Basins," Massachusetts Basic-data Report No. 10, Ground-water Series, USGS.

[13] Wang, D. S. (1999). "A simple mathematical model for infiltration BMP design," Proceeding of Fourth USA/CIS Joint Conference: Hydrologic Issues of the 21st Century: Ecology, Environment and Human Health, November 7-10, 1999, San Francisco, CA, p117.

Between April 2021 and January 2024, we evaluated thirty nine (39) soil test pits throughout the site to collect soil, groundwater and ledge information. In addition, we had done eight (8) deep hole soil evaluation in the proposed septic leaching field, which are presented in separate septic design plan. Soils on site were found in general very permeable with percolation rate ranging from less than 2 mpi to 7 mpi at 65 Farm Road. In the northwest and northeast area, there are significant ledge outcrops and will not be develop and not tested. The soil evaluation is summarized in Table D.1. Detailed soil logs are presented in the updated design plan sheets 15 and 16. The testing confirmed NRCS soil rating well. Given that the percolation rates in tested pits range from less than 2 mpi to 7 mpi at the project site, it is ranging 8.57 in/hr to 30 in/hr. Soil samples were also taken from each basin area for grain size distribution analysis to determine the soil texture. The infiltration rate of Rawl's table for confirmed soil texture was used and adjusted with groundwater mounding for the basin final design as shown in Table D.2.

Table D.1 Stormwater and Roadway Soil Testing Summary

Date	Test Pit	G.S. Elev. Surveyed (Ft)	Estimated HGW (Ft)	Estimated HGW Elev (Ft)	Soil Texture, C layer	Depth to Ledge measured (Ft)	Testpit Location	Notes
4/21/2021	55-9N	215.25	10	205.25	L.S.	10+	Stormwater Basin A	
1/3/2024	S-A1	208.00	2.5	205.50	L.S.	6+	Stormwater Basin A	
4/21/2021	65-10C	217.53	14+	206.78	L.S.	14+	Basin B2 Slope	Perc rate = 7 MPI
4/20/2021	65-10D	212.90	14	200.73	L.S.	14+	Stormwater Basin B-2	Perc rate <2MPI
1/3/2024	SWTP 1	216.79	3.5	213.29	M.S.	6+	Stormwater Basin B-1	Hand augered to 42"
1/3/2024	SWTP 2	217.25	4.5	212.75	Co.M.L.S.	6+	Stormwater Basin C	
4/4/2023	SWTP 3	224.50	10+	214.50	L.S.	10	Yard	Weathered ledge. No water obs'd
4/4/2023	SWTP 5	215.50	10+	205.50	M.L.S.	10+	Back Slope	
4/3/2023	SWTP 6	226.75	4	222.75	M.L.S.	5		Weathered ledge
4/4/2023	TP Unit 1/2	214.45	4	210.45	L.S.-M.S.	7+	House	
4/4/2023	TP Unit 3/4	215.67	4	211.67	M.S.	8	House	
4/4/2023	TP Unit 5/6 (1)	217.34	5.5	211.84	M.S.	8	House	Weathered ledge
4/4/2023	TP Unit 5/6 (2)	216.29	4	212.29	M.S.-L.S.	6'/ 5'	House	ledge is sloped
	Dug Well	216.40	10.75	205.65	L.S.	13	House	Dug Well
11/9/2021	DHTP 4-1	222.86	10	215.24	S.L.-L.S.	10+	Unit 1 driveway	
11/9/2021	DHTP 4-2	217.92	11.5	208.80	S.L.-L.S.	12	House	Perc rate = 5 MPI
4/20/2021	65-10	215.87	9.67	206.20	L.S.	12	House	Weathered ledge
4/20/2021	65-10A	220.60	10	211.93	M.L.S.	12.5	House	Weathered ledge. Perc rate= 4 MPI
3/29/2023	TP R1	216.48	3	213.48	M.S-.L.S.	3.5+	Road	Auguer test
3/29/2023	TP R2	216.67	3	213.67	M.L.S.	3.83+	Road	Auguer test
4/3/2023	TP R3	219.71	4	215.71	M.L.S.	4	Road	Weathered ledge. No water obs'd
4/3/2023	TP R4	224.50	3.5	221.00	S.L.	3.5	Road Edge	Weathered ledge. No water obs'd
4/3/2023	TP R5	218.06	4.67	213.39	S.L.-L.S.	8	Road	Ledge
4/3/2023	TP R6	223.60	7	216.60	L.S.	7	Road	Weathered ledge. No water obs'd
4/3/2023	TP R7	227.75	6	221.75	L.S.	6.67	Road	Weathered ledge. No water obs'd
4/4/2023	TP R 8/10	229.30	6	223.30	M.L.S.	7	Road Edge/Driveway	Weathered ledge. No water obs'd
4/3/2023	TP R8	227.80	5	222.80	M.L.S.	5	Road	Weathered ledge. No water obs'd
4/4/2023	TP R9	228.30	9	219.30	M.L.S.	9	Road	Weathered ledge. No water obs'd
4/3/2023	TP R10	228.20	5	223.20	M.L.S.	6	Road	Weathered ledge
4/3/2023	TP R11	230.75	6	224.75	F.M.S.	8	Road	Weathered ledge
4/3/2023	TP R12	235.75	4	231.75	S.L.	6+	Road	
4/3/2023	TP R13	231.00	2.33	228.67	Broken Ledge	4	Road	Weathered ledge
4/3/2023	TP R14	231.00	4	227.00	F.M.S.	9.5	Road	Weathered ledge
4/3/2023	TP Unit 22/23	231.00	5	226.00	Co.M.L.S.	10+	Between house 22 & 23	
4/4/2023	TP Unit 26/27	232.50	7	225.50	L.S.	7	Back yard of unit 26	Weathered ledge
4/3/2023	TP 65-5	226.8	6	220.80	L.S.	6	House	Broken Ledge. No water obs'd
11/10/2021	SL-TP1	212.3	6+	206.3	L.S.	6+	Slope	
11/10/2021	SL-TP2	218.3	9+	209.3	M.L.S.	9+	Edge of Access Road	
11/10/2021	SL-TP3	221.53	10	211.53	Co.M.L.S.	11.33+	Yard	
11/10/2021	SL-TP4	221.41	10	213.79	M.L.S.	10+	Yard	

Table D.2. Soil texture analysis and infiltration rate

Soil Sample	Location	Sand, silt, and Clay compsition				Soil texture per USDA	Rawl's rate, in/hr
		Sand % 0.05-2 mm	Silt % 0.002-0.05mm	Clay % <0.002mm	Total %		
S1	lower edge of SAS	92.53	5.6	1.87	100	medium sand	8.27
S2	upper edge of SAS	73.66	24.56	1.78	100	medium loamy sand	2.41
SA1	Stormwater Basin A	66.1	30.5	3.4	100	medium sand loam	1.02
SB-1	Stormwater Basin B-1	97.91	2.09	0	100	fine medium sand	8.27
SB-2	Stormwater Basin B-2	75.64	22.86	1.5	100	medium loamy sand	2.41
SC	Stormwater Basin C	91.46	6.71	1.83	100	medium sand	8.27

The Rawl's infiltration rate used for stormwater basin design is a default conservative value to be used as the DEP accepted common practice.

Appendix E: OPERATION AND MAINTENANCE PLAN FOR STORMWATER BMPs

	During Construction	Post-construction
BMB Owner:	Fenix Partners Farm Road Development, LLC Robert W. Murchison, Manager 177 Lake Street, Sherborn, MA 01770 C. 617-308-1961. e-mail: bob.murchison@me.com	Fenix Partners Farm Road Development, LLC Robert W. Murchison, Manager 177 Lake Street, Sherborn, MA 01770 C. 617-308-1961. e-mail: bob.murchison@me.com
Party of Plan Responsibility:	Fenix Partners Farm Road Development, LLC Robert W. Murchison, Manager 177 Lake Street, Sherborn, MA 01770 C. 617-308-1961. e-mail: bob.murchison@me.com	Fenix Partners Farm Road Development, LLC Robert W. Murchison, Manager 177 Lake Street, Sherborn, MA 01770 C. 617-308-1961. e-mail: bob.murchison@me.com
Signature		

The stormwater management system is depicted in the engineering plan by Creative Land & Water Engineering, LLC: Stormwater Management Plan, The Farm Road Homes, September 28, 2023, updated February 14, 2024.

Illicit discharges into stormwater management system per 310 CMR 1.04 are perpetually prohibited and agreed to be implemented by the owner. No sewer pipes or floor drains will be connected to the drainage network. All wastewater will be connected to a dedicated private onsite septic system as approved.

Personnel Training – All contracted personnel retained for work on site will be given a copy of this Plan and will receive training in applicable practices and implementation to prevent pollutants from entering the stormwater system

The plan includes ***Housekeeping and Reporting, Routine Operation and Maintenance (long-term pollution source control, pavement sweeping, landscaping, stormwater structure) Emergency Action or Accidental Spill Plan, Mosquito Control in sumps.*** *A typical O&M recording form is also created for reference use.*

Housekeeping and Reporting

The property owner or designated property manager will be responsible for carrying out this operation and maintenance, i.e., long-term pollution prevention plan. All maintenance conducted shall be recorded and the records shall be kept on site for at least 3 year for auditing by approving authorities or relevant **Town officials**. See attached record forms for reference.

Routine Operation and Maintenance

Sediment and Erosion Control

1. During construction, **weekly or biweekly** inspection of erosion control straw wattles/hay bales and silt fences should be conducted by a qualified staff of the responsible party or an independent sediment and erosion control expert hired by the responsible party. Any displaced straw wattles or broken siltation fences should be restored or repaired immediately. All silt fences and straw wattles shall be installed at minimum **30 feet** from wetlands or 5 feet from the property line unless permitted by Sherborn Conservation Commission.

Long-term Pollution Source Control

2. All potential pollution materials shall be stored properly inside and under cover
    a. Fuel (other than in vehicles or equipment), if any, will be stored for machinery or motor use in fire proof cabinet and inspected routinely
    b. Fertilizers, herbicides, and pesticides, if any, will be stored inside in secured cabinet or bins
    c. House cleaning chemical(s) shall be stored in secured cabinet(s)
    d. De-icing materials, if any, shall be waterproof covered, or stored inside.
    e. Snow shall be plowed and stored in vegetated area or dedicated parking spaces where runoff from snowmelt will be collected and treated by the parking lot drainage system. In case of large snow storm, excessive snow can be trucked off site and disposed in the *permitted facilities* .
    f. All hazardous materials (battery, light bulbs, etc.) shall be recycled or disposed in accordance with the State and Town requirements.
    g. Pet waste, if any, shall be collected and disposed properly in accordance with **Town** policy. **No pet wastes shall be dumped in the drainage system.** Residents and visitors will be encouraged to pick up after their pets with signage along lawn areas

Pavement Sweeping/General Landscape Maintenance

3. The driveway and parking lot shall be swept quarterly (by high efficiency vacuum sweeper or regenerative air sweeper) or monthly (Mechanical weeper, rotary broom), or per the Town of Sherborn standard practice.
4. During growing season, the lawn and landscaping for each house will be mowed and maintained weekly or biweekly depending on the growth and weather condition. All landscape debris will be removed from lawn or landscaping and parking area and disposed of off site or used for compost.
5. The use of fertilizers shall be limited to slow-release, low nitrogen granular fertilizers.

Drainage/Stormwater Structure(s)

6. a)The catch basins and oil/grit separators, discharge level spreaders should be inspected at least four times per year and at the end of the foliage and snow removal seasons. Sediment must be removed four times a year or whenever the **depth of deposits is greater than or equal to one half the depth from the lowest pipe invert in the basin.** Catch basin sediment should be cleaned by clamshell buckets or vacuum truck. Debris over the level spreader shall be cleaned up. b) Oil/Grit separator should be inspected monthly and cleanout at least twice per year or as needed per inspection. c) All polluted water or sediments removed from the system should be disposed of in accordance with all applicable local, state and federal laws and regulations. d) The regular manholes shall be inspected annually to check if any settlement and damage for repair. All accumulated sediment and debris in the subsurface infiltration structures and level spreaders should be removed and disposed. Note and repair any erosion or low spots observed on level spreaders. **After the construction completed**, the observation port of the infiltration trenches, distribution manholes, oil/grit separators and the discharge level spreaders should also be inspected at least four times a year for the first year following the catch basin inspection schedule, which can be reduced to annual after have a

understanding of the operation condition as expected. The parking lot will be swept twice a year: one before hurricane season, the other in the spring after snowmelt, or per the **Town of Sherborn** standard practice.

7. Install oil trap elbows in all deep sump catchbasins. It is recommended that the vertical length of the oil trap below the outlet invert be at least 12 inches. All catch basins shall be protected with filter fabric during construction time to prevent siltation to infiltration trenches.

Emergency Reaction or Accidental Spill Plan

In case of an accident in the parking lot or driveways, where significant gasoline or other petroleum products are released, the following procedure must be followed.

Step. 1. First of all, plug the outlet pipe from the catch basin to the manhole and the outlet pipe from the manhole to infiltration trench. Immediately notify **Sherborn** Fire Department, Board of Health, Conservation Commission, and the Mass. Department of Environmental Protection (DEP). **Sherborn** is in the Northeast Region of DEP, and their main office is presently at 205B Lowell Street, Wilmington, Massachusetts 01887 and their phone number is (978)694-3200.

Step 2. If any of those three agencies so direct, a clean up firm shall be immediately contacted. If the materials have remained trapped in the catch basin and manhole, then the catch basin shall be pumped out. If the volume of the spill is such that materials have flowed out of the catch basin sump or the trench, then corrective actions will be extended to the receiving **water** and beyond. For an oil release in excess of on site storage capacity, a floating boom shall be used to prevent oil release from spreading in any receiving area. For materials which are partially soluble in water, e.g., components of gasoline, then DEP or clean-up firm recommendations shall be followed. These might include, but are not limited to (1) pumping out the entire trench, (2) air stripping, or (3) excavation of an interceptor basin to allow air stripping in the downgradient soils. Since the technology of containment and control is steadily advancing, clean-up and recovery technology shall be specified on site just after the spill.

Mosquito Control in Sumps

In general, mosquito breeding occurs in standing water that lasts five days or more. The catch basin during high groundwater season may have standing water. Thus mosquito control may be needed. In case of mosquitoes breeding in the catch basin, there are many methods available to control them including biological control and chemical control. Biological controls are preferred since the biological controls specifically target mosquito larvae and are harmless to humans, unlike many chemicals even at standard does. It is not recommended any chemicals be used in the inlet box or the catch basins due to their frequent flushing and water quality issues in the receiving waters. The following is the recommended biological control.

Bacillus thuringiensis israeliensus (Bti) is an effective control for mosquitoes and flies and is widely used in various forms in U.S. This is a bacterium, which kills larvae of target insects. Commercial Bti is considered safe to add to drinking water (WRRI 1989) and is available at most hardware stores.

Cost Estimation

The cost of cleaning up each catch basin and oil/grit separator is estimated to be $100 per unit; No significant sediment is expected in the manholes and outflow control box. Checking and clean debris in the distribution manhole is the expected maintenance, which shall cost no more than $50 each time if any. The total estimated cost for each clean up is $2600 as detailed in the following:

Annual Maintenance Budget

BMPs/SWCM	Cost per item	Quantity	Total	Note
Road/Parking sweeping	$300.00	2	$600	About 1600 ft common driveway
Storm water basin/outlet	$300.00	4	$1,200	Mowing embankment
Sediment forebays	$400	4	$1,600	
Catchbasin	$200.00	13	$2,600	No permit or inspection fee included
Distribution manhole	$100.00	2	$200	Inspection fee
Oil/grit separator	$200.00	2	$400	cleanup
Others – inspection –level spreader	$50	1	$50	
Roof grit trap MH	$100	0	$0	
Swale	$100	5	$500	
Regular DMH	$100	2	$200	
General insp and report	100	35	$3,500	Inspection and report
Total			$10,850.00	

Notes: 1) World sweeper $300 per road mile for mechanical sweeping
2) Cleanup may not be needed each time depending on how much sediment is caught in the OGS and CBs.

Summary

The maintenance steps outlined above are sufficient to prevent sediment accumulation from affecting the long term performance of the BMP system. If maintenance is not conducted, then the detention basin and catch basin will be filled up with sediment, which will impede the function of stormwater treatment. Routine maintenance is the most cost-effective in the long run.

If you have any questions about the plan, please feel free to contact us.

Sincerely,

Creative Land & Water Engineering, LLC
by

Desheng Wang, Ph.D. P.E.
Senior Environmental/Hydraulic Engineer

Operation/Maintenance Form

Project Site: Farm Road Homes
Operator: **Date of O/M:**

BMPs	Location	Description of Maintenance
Street Parking sweeping		**Note sediment condition, clean as needed**
Basin A: **Mowing** **Forebay clean** **Outlet and level spreader**	**See plan**	**Mow twice a year, remove clip and debris on outflow structure and spillway, clean forebay if the storage is half full** **Clean leaves and debris on outlet and spreader surface.** Note and repair any erosion or low spots observed on level spreaders.
Basin B1: **Mowing** **Forebay clean** **Outlet spillway**		
Basin B2: **Mowing** **Forebay clean** **Outlet and spillway**		
Basin C: **Mowing** **Forebay clean** **Outlet and spillway**		
Catchbasins: **CB1** **CB2** **CB3** **CB4** **CB5** **CB6** **CB7** **CB8** **CB9** **CB10** **CB11** **CB12** **CB13**		**Check sediment depth and floating materials**
OGS #1 and DMH: **Distribution manhole** **Oil-grit separator**		**Check sediment and oil trapped and clean as needed, check Manhole once a year for structural integrity**
OGS #2 and DMH: **Distribution manhole** **Oil-grit separator**		
Roof runoff grit trap (0)		**Check sediment level and clean as needed**
Swale: **Swale 1:** **Swale 2:** **Swale 3:** **Swae 4:**		**Mow regularly, biweekly**

Swale 5:		
Regular DMH: **DMH 1** **DMH 2**		**Check for any cover damage or paving settlement, repair as needed**
Other discretion items		**Any uncovered in above**

Notes: 1) Sediment deposit depth and other pollutants shall be recorded in structural BMPs for record, such as, 12" of sediment is cleaned out of the Catchbasin #. 2)The O/M staff can expand the form on separate sheet for different BMPs items. 3) Inspections shall be conducted four times for the first year after construction as spelled out in the plan and can be reduced to annual after gaining understanding of the site operation conditions as expected.

References:

[1] J. McLean (1995) “Mosquitoes in Constructed Wetlands -- A Management Bugaboo,” Watershed Protection Techniques, Vol. 1, No. 4, Center for Watershed Protection, 203-208.

[2] Water Resources Research Institute (1989) Report No. 247: Proceedings of Workshop on Management of Aquatic Weeds and Mosquitoes in Impoundments, March 14-15, 1989 UNC Charlotte.

[3] Mian, L. S., Mulla, M. S., and Wilson, B. A. (1986) “Studies of Potential Biological Control Agents of Immature Mosquitoes in Sewage Wastewater in Southern California,” J. Am. Mosquito Control Assoc. 2(3), 329-335.

[4] MA DEP *Stormwater Management Standards - Stormwater Management Handbook*, 2008

Stormwater Pollution Prevention Plan
For Construction Activities
at
65 Farm Road, Sherborn, MA

September 28, 2023

Prepared for:

Robert W. Murchison, Manager
Fenix Partners Farm Road Development, LLC
177 Lake Street, Sherborn, MA 01770
C. 617-308-1961

Prepared by:

Creative Land & Water Engineering, LLC
P.O. Box 584
Southborough, MA 01772
Tel. 508-281-1694

SITE DESCRIPTION			
Project Name and Location (Latitude, Longitude, or Address)	**Farm Road Homes, Sherborn, MA** **42.24051º N** **-71.35776º W**	Owner Name and Address:	Robert W. Murchison, Manager Fenix Partners Farm Road Development, LLC 177 Lake Street, Sherborn, MA 01770 C. 617-308-1961
Description: (Purpose and Types of Soil Disturbing Activities)			
A residential subdivision development consisting of 32 total units (16 single family units and 8 duplex units). . Soil disturbing activities will include installation of a stabilized construction entrance; installation of erosion control line; clearing and grubbing; stabilization of rough drive and parking lot with gravel; excavation for infiltration trenches, utilities, building foundations; construction of driveways, and buildings; grading; and preparation for final planting and seeding. The underlying subsoils at the site are Scarboro mucky fine sandy loam (HSG A), Charlton-Hollis-Rock Outcrop complex (HSG B), Hollis-Rock outcrop-Charlton complex (HSG D), Woodbridge fine sandy loam (HSG C), and Canton fine sandy loam (HSG based on NRCS soil survey and on-site inspection.			
Runoff Coefficient:	The final coefficient of runoff for the site will be c = 0.30.		
Site Area:	The site is 14 acres. About 6.58 acres will be disturbed by construction activities.		
Sequence of Major Activities			

The order of activities will be as follows:

1. Install stabilized construction entrance.
2. Install erosion control line.
3. Clear & grub for overall site preparation
4. Excavate infiltration trenches; temporarily seed these areas
5. Excavate foundation hole and install foundations.
6. Install roadway & associated utilities (i.e. retaining walls, sewer, water, catch basins, & conveyance pipes).
7. Complete grading for driveway, parking lot; install subbase and binder in driveway and parking lot.
8. Install infiltration trenches.
9. Construct the four houses.
10. Stabilize exposed soils & stockpiles within 14 days of last construction activity in a given area.
11. Complete grading for landscape area permanently seed and plant.
12. Complete final paving.
13. Remove accumulated sediment from sediment forebay, infiltration basin, catch basins, distribution manhole
14. Clean all catch basins and install hoods. .

When all construction is complete and all exposed soils are stabilized, remove erosion control line. Reseed any areas disturbed by its removal.

Name of Receiving Waters:	**Charles River**

CONTROLS

Erosion and Sediment Controls

Stabilization Practices

Temporary Stabilization – Silt fence and/or straw wattles or hay bales containing no invasive plants shall be installed along the downgradient of disturbed area. Sediment basins can be installed in area of natural flow concentrates. Silt bag or equal protection measures shall be installed in catch basins in the existing roadway receiving runoff from the project site. The soil stockpiles and disturbed portions of the site where construction activity temporarily ceases for at least 21 days will be stabilized with temporary seed and mulch no later than 14 days from the last construction activity in that area. The temporary seed shall be hydroseeded or hand spread with Rye (grain) applied at the rate of 120 pounds per acre. Prior seeding, 2,000 pounds of ground agricultural limestone and 1,000 pounds of 10-10-10 fertilizer shall be applied to each acre to be stabilized. If hand spread seeding applied, each area shall be mulched with 4,000 pounds per acre of straw. The straw mulch is to be tacked into place by a disk with blades set nearly straight. Areas of the site which are to be paved will be temporarily stabilized by applying geotextile and stone sub-base until bituminous pavement can be applied.

Permanent Stabilization – Disturbed portions of the site where construction activities permanently cease shall be stabilized with permanent seed no later than 14 days after the last construction activity by hydroseeding and landscaping planting and mulching.

Structural Practices

Flow diverting dikes, swales, and sediment basins will be installed where is needed to retain sediment on site.

Storm Water Management

Stormwater management will be achieved by road drainage system (catchbasins, manholes, and pipes), **four stormwater basins** with oil/grit separator or grass swale pretreatment.

OTHER CONTROLS

Waste Disposal:

Waste Materials
Construction debris will be stored in dumpster and disposed in accordance with applied local, state and federal regulations.

Hazardous Waste
All hazardous waste materials will be disposed of in the manner specified by local or state regulations or by the manufacturer. Site personnel will be instructed in these practices and **a dedicated personnel/General contractor** , the individual who manages day-to-day site operations, will be responsible for seeing that these practices are followed by qualified subcontractors certified by OHSA.

Sanitary Waste
All sanitary waste will be collected by the portable units and managed by certified sanitary waste management contractor.

Offsite Vehicle Tracking:

A stabilized construction entrance will be provided to help reduce vehicle tracking of sediments. The paved street adjacent to the site entrance will be swept daily to remove any excess mud, dirt or rock tracked from the site. Dump trucks hauling material from the construction site will be covered with a tarpaulin.

TIMING OF CONTROLS/MEASURES

As indicated in the Sequence of Major Activities. Sediment and erosion control measures and devices will be constructed prior to clearing or grading of any other portions of the site. Areas where construction activity ceases for more than 21 days will be stabilized with a temporary seed and mulch within 14 days of the last disturbance. Once construction ceases permanently in an area, it will be stabilized with permanent seed and mulch. After the entire site is stabilized, the accumulated sediment will be removed from the sediment basin/trap and all measures will be removed.

CERTIFICATION OF COMPLIANCE WITH FEDERL, STATE, AND LOCAL REGULATIONS

The storm water pollution prevention plan reflects requirements for storm water management and erosion and sediment control. To ensure compliance, this plan was prepared in accordance with the MA DEP Stormwater Management Policy and the requirements of National Pollution Discharge Elimination System (NPDES).

MAINTENANCE/INSPECTION PROCEDURES

Erosion and Sediment Control Inspection and Maintenance Practices

These are the inspection and maintenance practices that will be used to maintain erosion and sediment controls.

- Less than one half of the site will be denuded at one time.
- All control measures will be inspected at least once each week and following any storm event of 0.5 inches or greater.
- All measures will be maintained in good working order; if a repair is necessary, it will be initiated within 24 hours of report.
- Built up sediment will be removed from silt fence when it has reached one third the height of the fence.
- Silt fence will be inspected for depth of sediment, tears, to see if the fabric is securely attached to the fence posts, and to see that the fence posts are firmly in the ground.
- The sediment basin will be inspected for depth, and built up sediment will be removed when it reaches 10 percent of the design capacity or at the end of the job.
- Diversion dike will be inspected and any breaches promptly repaired.

- Temporary and permanent seeding and planting will be inspected for bare spots, washouts, and healthy growth.

- A maintenance inspection report will be made after each inspection. A copy of the report form to be completed by the inspector is attached.

- Designated site superintendent, will select three individuals who will be responsible for inspections, maintenance and repair activities, and filling out the inspection and maintenance report.

- Personnel selected for inspection and maintenance responsibilities will receive training from the dedicated **expert consultant.** They will be trained in all the inspection and maintenance practices necessary for keeping the erosion and sediment controls used onsite in good working order.

Non-Storm Water Discharges

If any of the following non-storm water discharges would occur from the site during the construction period:

- Water from water line flushing.

- Pavement wash waters (where no spills or leaks of toxic or hazardous materials have occurred).

- Uncontaminated groundwater (from dewatering excavation).

All non-storm water discharges should be directed to the sediment basin prior to discharge.

INVENTORY FOR POLLUTION PREVENTION PLAN

The materials of substances listed below are expected to be present onsite during construction:

- Concrete
- Detergents
- Paints
- Metal materials
- Tar or bituminous concrete
- Fertilizers
- Petroleum Based Products
- Cleaning Solvents
- Wood
- Masonry Block
- Roofing Shingles

SPILL PREVENTION

Material Management Practices

The following are the material management practices that will be used to reduce the risk of spills or other exposure of materials and substances to storm water runoff.

Good Housekeeping:

The following good housekeeping practices will be followed onsite during the construction project.

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

Hazardous Products:

These practices are used to reduce the risks associated with hazardous materials.

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

Product Specific Practices

The following specific practices will be followed onsite:

Petroleum Products:

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

Fertilizers:

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.

Paints:

All containers will be tightly sealed and stored when not required for use. Excess paint will not be discharged to the storm sewer system but will be properly disposed of according to manufacturers' instructions or state and local regulations.

Concrete Trucks:
Concrete trucks will not be allowed to wash out or discharge surplus concrete or drum wash water without proper treatment. Capturing and filtering the rinsate will be provided before discharge.
Spill Control Practices
In addition to the good housekeeping and material management practices discussed in the previous sections of this plan, the following practices will be followed for spill prevention and cleanup: • Manufacturers' recommended methods for spill cleanup will be clearly posted and site personnel will be made aware of the procedures and the location of the information and cleanup supplies. • Materials and equipment necessary for spill cleanup will be kept in the material storage area onsite. Equipment and materials will include but not be limited to brooms, dust pans, mops, rags, gloves, goggles, kitty litter, sand, sawdust, and plastic and metal trash containers specifically for this purpose. • All spills will be cleaned up immediately after discovery. • The spill area will be kept well ventilated and personnel will wear appropriate protective clothing to prevent injury from contact with a hazardous substance. • Spills of toxic of hazardous material will be reported to the appropriate state or local government agency, regardless of the size. • The spill prevention plan will be adjusted to include measures to prevent this type of spill from reoccurring and how to clean up the spill if there is another one. A description of the spill, what caused it, and the cleanup measures will also be included. • The site superintendent responsible for the day-to-day site operations will be the spill prevention and cleanup coordinator. He/she will designate at least three other site personnel who will receive spill prevention and cleanup training. These individuals will each become responsible for a particular phase of prevention and cleanup. The names of responsible spill personnel will be posted in the material storage area and in the office trailer onsite.

POLLUTION PREVENTION PLAN CERTIFICATION

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signed: Desheng Wang

Desheng Wang, Ph.D., P.E.
Creative Land&Water Engineering, LLC
P.O. Box 584
Southborough, MA 01772
Tel. 508281-1694

Date:10/4/2023

CONTRACTOR'S CERTIFICATION

I certify under penalty of law that I understand the terms and conditions of the general National Pollutant Discharge Elimination System (NPDES) permit that authorizes the storm water discharges associated with industrial activity from the construction site identified as part of this certification.

Signature	For	Responsible for
R W M (signature) Bob Murchinson Date: 2/14/2024	Robert W. Murchison, Manager Fenix Partners Farm Road Development, LLC 177 Lake Street, Sherborn, MA 01770 C. 617-308-1961	General Contractor Temporary and Permanent Stabilization Stabilized Construction Entrance, Earth Dikes, Sediment Basin

Inspection Report – Farm Road Homes
EPA Tracking Number:
DEP File #:

The report shall be completed Within 24 hours of completing each inspection

Purpose

This Inspection Report presents our field inspection results required in Part 4.6 of the CGP, and the Order of Conditions issued by Sherborn Conservation Commission, MA dated xxxx. You must retain in your records copies of all inspection reports in accordance with the requirements in Part 4.7 of the 2022 CGP. These reports must be retained for at least **3 years** from the date your permit coverage expires or is terminated.

Overview of Inspection Requirements

This Construction operation is covered under the 2022 CGP and subject to the following requirements in Part 4:

Inspection Frequency *(see Part 4.2)*
We will conduct inspections either:

- Once every 7 calendar days; or
- Once every 14 calendar days and within 24 hours of a storm event of 0.25 inches or greater.

The inspection frequency may be increased if the site discharges to a sensitive water. See Part 4.3. The inspection frequency may be decreased to account for stabilized areas, or drought-stricken conditions, or for frozen conditions. See Part 4.4.

Areas to Be Inspected *(see Part 4.5)*
During each inspection, the following areas will be inspected:

- Cleared, graded, or excavated areas of the site;
- Stormwater controls (e.g., perimeter controls, sediment basins, inlets, exit points etc.) and pollution prevention practices (e.g., pollution prevention practices for vehicle fueling/maintenance and washing, construction product storage, handling, and disposal, etc.) at the site;
- Material, waste, or borrow areas covered by the permit, and equipment storage and maintenance areas;
- Areas where stormwater flows within the site;
- Stormwater discharge points; and
- Areas where stabilization has been implemented.

Inspection Checklist *(see Part 4.6)*
During our site inspection, we are required to check:

- Whether stormwater controls or pollution prevention practices require maintenance or corrective action, or whether new or modified controls are required;
- For the presence of conditions that could lead to spills, leaks, or other pollutant accumulations and discharges;
- Whether there are visible signs of erosion and sediment accumulation at points of discharge and to the channels and streambanks that are in the immediate vicinity of the discharge;
- If a stormwater discharge is occurring at the time of the inspection, whether there are obvious, visual signs of pollutant discharges; and
- If any permit violations have occurred on the site.

Summary of Inspection Findings

General Information (see reverse for instructions)					
Name of Project	**Farm Road Homes**	**CGP Tracking No.**		**Inspection Date**	
Inspector Name, Title & Contact Information	Desheng Wang – Environmental Monitor, EPA certified CGP Inspector Creative Land & Water Engineering, LLC, P.O. Box 584, Southborough, MA 01772 Tel. 774-454-0266, Email: deshengw@yahoo.com or desheng@claweng.com				
Present Phase of Construction					
Inspection Location (if multiple inspections are required, specify location where this inspection is being conducted)					

Inspection Frequency *(Note: you may be subject to different inspection frequencies in different areas of the site. Check all that apply.)*

Standard Frequency: ☐ Weekly ☐ Every 14 days and within 24 hours of a 0.25" rain

Increased Frequency: ☐ Every 7 days and within 24 hours of a 0.25" rain (for areas of sites discharging to sediment or nutrient-impaired waters or to waters designated as Tier 2, Tier 2.5, or Tier 3)

Reduced Frequency:
- ☐ Once per month (for stabilized areas)
- ☐ Once per month and within 24 hours of a 0.25" rain (for arid, semi-arid, or drought-stricken areas during seasonally dry periods or during drought)
- ☐ Once per month (for frozen conditions where earth-disturbing activities are being conducted)

Was this inspection triggered by a 0.25" storm event? ☐ Yes ☐ No

If yes, how did you determined whether a 0.25" storm event has occurred?

☐ Rain gauge on site ☐ Weather station representative of site. Specify weather station source:

Total rainfall amount that triggered the inspection (in inches)**:**

Unsafe Conditions for Inspection

Did you determine that any portion of your site was unsafe for inspection per CGP Part 4.7.1? ☐ Yes ☐ No

If "yes", complete the following:
- Describe the conditions that prevented you from conducting the inspection in this location:
- Location(s) where conditions were found:

Condition and Effectiveness of Erosion and Sediment (E&S) Controls (CGP Part 2.1) (see reverse for instructions)				
Type/Location of E&S Control **[Add an additional sheet if necessary]**	**Repairs or Other Maintenance Needed?***	**Corrective Action Required?***	**Date on Which Maintenance or Corrective Action First Identified?**	**Notes**
1. Entrance	☐Yes ☐No	☐Yes ☐No		
2. Siltfence/socks/wattles	☐Yes ☐No	☐Yes ☐No		
3. Sediment trap (stoage, overflow …)	☐Yes ☐No	☐Yes ☐No		
4. Mulch over exposed area	☐Yes ☐No	☐Yes ☐No		
5.	☐Yes ☐No	☐Yes ☐No		
6.	☐Yes ☐No	☐Yes ☐No		
7.	☐Yes ☐No	☐Yes ☐No		
8.	☐Yes ☐No	☐Yes ☐No		
9.	☐Yes ☐No	☐Yes ☐No		
10.	☐Yes ☐No	☐Yes ☐No		

*** Note:** The permit differentiates between conditions requiring repairs and maintenance, and those requiring corrective action. The permit requires maintenance in order to keep controls in effective operating condition and requires repairs if controls are not operating as intended. Corrective actions are triggered only for specific, more serious conditions, which include: 1) A required stormwater control was never installed, was installed incorrectly, or not in accordance with the requirements in Part 2 and/or 3; 2) You become aware that the stormwater controls you have installed and are maintaining are not effective enough for the discharge to meet applicable water quality standards or applicable requirements in Part 3.1; 3) One of the prohibited discharges in Part 2.3.6 is occurring or has occurred; or 4) EPA requires corrective actions as a result of a permit violation found during an inspection carried out under Part 4.2. If a condition on your site requires a corrective action, you must also fill out a corrective action form found at www.epa.gov/npdes/stormwater/swppp. See Part 5 of the permit for more information.

Condition and Effectiveness of Pollution Prevention (P2) Practices (CGP Part 2.3) (see reverse for instructions)				
Type/Location of P2 Practices **[Add an additional sheet if necessary]**	**Repairs or Other Maintenance Needed?***	**Corrective Action Required?***	**Date on Which Maintenance or Corrective Action First Identified?**	**Notes**
1. Storage area	☐Yes ☐No	☐Yes ☐No		
2. Fueling area	☐Yes ☐No	☐Yes ☐No		
3. Wash discharge area	☐Yes ☐No	☐Yes ☐No		
4.	☐Yes ☐No	☐Yes ☐No		
5.	☐Yes ☐No	☐Yes ☐No		
6.	☐Yes ☐No	☐Yes ☐No		
7.	☐Yes ☐No	☐Yes ☐No		
8.	☐Yes ☐No	☐Yes ☐No		
9.	☐Yes ☐No	☐Yes ☐No		
10.	☐Yes ☐No	☐Yes ☐No		

*** Note:** The permit differentiates between conditions requiring repairs and maintenance, and those requiring corrective action. The permit requires maintenance in order to keep controls in effective operating condition and requires repairs if controls are not operating as intended. Corrective actions are triggered only for specific, more serious conditions, which include: 1) A required stormwater control was never installed, was installed incorrectly, or not in accordance with the requirements in Part 2 and/or 3; 2) You become aware that the stormwater controls you have installed and are maintaining are not effective enough for the discharge to meet applicable water quality standards or applicable requirements in Part 3.1; 3) One of the prohibited discharges in Part 2.3.1 is occurring or has occurred; or 4) EPA requires corrective actions as a result of a permit violation found during an inspection carried out under Part 4.2. If a condition on your site requires a corrective action, you must also fill out a corrective action form found at www.epa.gov/npdes/stormwater/swppp. See Part 5 of the permit for more information.

Stabilization of Exposed Soil (CGP Part 2.2) (see reverse for instructions)			
Stabilization Area **[Add an additional sheet if necessary]**	**Stabilization Method**	**Have You Initiated Stabilization?**	**Notes**
1. Entrance		☐ YES ☐ NO If yes, provide date:	
2. Stormwater infiltration trenches		☐ YES ☐ NO If yes, provide date:	
3. Buffer zone		☐ YES ☐ NO If yes, provide date:	
4. Parking lot		☐ YES ☐ NO If yes, provide date:	
5.		☐ YES ☐ NO If yes, provide date:	

Description of Discharges (CGP Part 4.1.6.6) (see reverse for instructions)	
Was a stormwater discharge or other discharge occurring from any part of your site at the time of the inspection? ☐ Yes ☐ No **If "yes", provide the following information for each point of discharge:**	
Discharge Location **[Add an additional sheet if necessary]**	**Observations**
1. Sediment trap	Describe the discharge: At points of discharge and the channels and banks of surface waters in the immediate vicinity, are there any visible signs of erosion and/or sediment accumulation that can be attributed to your discharge? ☐ Yes ☐ No If yes, describe what you see, specify the location(s) where these conditions were found, and indicate whether modification, maintenance, or corrective action is needed to resolve the issue:
2. Silt fence or silt socks, straw wattles	Describe the discharge: At points of discharge and the channels and banks of surface waters in the immediate vicinity, are there any visible signs of erosion and/or sediment accumulation that can be attributed to your discharge? ☐ Yes ☐ No If yes, describe what you see, specify the location(s) where these conditions were found, and indicate whether modification, maintenance, or corrective action is needed to resolve the issue:

Contractor or Subcontractor Certification and Signature (see reverse for instructions)
"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations." **Signature of Contractor or Subcontractor:** ______________________ **Date:** **Printed Name and Affiliation:** ______________________

Certification and Signature by Permittee (see reverse for instructions)
"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations." **Signature of Permittee or "Duly Authorized Representative":** Desheng Wang **Date: 10/4/2023** **Printed Name and Affiliation:** **Desheng Wang, Creative Land & Water Engineering, LLC**

- The signed and dated written authorization is attached here and included in the SWPPP. A copy must be submitted to EPA, if requested.

Delegation of Authority

I, __Bob Murchinson_ (name), hereby designate the person or specifically described position below to be a duly authorized representative for the purpose of overseeing compliance with environmental requirements, including the Construction General Permit, at the ___65 Farm Road, Sherborn, MA 01746________________ construction site. The designee is authorized to sign any reports, stormwater pollution prevention plans and all other documents required by the permit.

__Desheng Wang, Ph.D., P.E. - Environmental Monitor
_Creative Land & Water Engineering, LLC
_________P.O. Box 584__________________
_______Southboro, MA 01772___ _________
_Tel. 774-454-0266 Email: deshengw@yahoo.com___

By signing this authorization, I confirm that I meet the requirements to make such a designation as set forth in Appendix I of EPA's Construction General Permit (CGP), and that the designee above meets the definition of a "duly authorized representative" as set forth in Appendix I.

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Name: **Bob Murchinson**

Company: Robert W. Murchison, Manager
Fenix Partners Farm Road Development, LLC
177 Lake Street, Sherborn, MA 01770
C. 617-308-1961

Manager

Signature: ____________________

Date: **9/27/2023**

Appendix G: Groundwater Mounding Analysis

This Appendix contains the detailed groundwater mounding analysis results by Hantush method, which is a commonly used conservative method for groundwater mounding analysis permitted by MA DEP. It is a three-dimensional model assuming homogeneous aquifer and flat groundwater table. Given only one average aquifer depth can be imputed and the site is highly variable in topography. On one hand it is hard to come up one aquifer depth, on the other hand, the sloped land would reduce the overall groundwater mounding height. It is our best professional opinion that the aquifer depth can be based on the well drilling data in the nearby area of the project site. See Table G.1 for details. To be conservative, the nearby well drilling log at 53 Farm road of aquifer depth of 14.5 ft is used for Basin A and Basin B2 and the SAS area. The depth of the onsite pond at normal high-water is about 15 ft, which is used for Basin B1 and Basin C. All these numbers are within the range of MGIS surficial geology map (up to 50 ft). It should be noted that aquifer depth for mounding analysis in the model should not be the depth limited inside of each pond as the mounding is impacted by area hundreds feet around it.

Hydraulic conductivity is another important parameter and very challenge to be determined.
As we discussed, there were over 40 deep hole soil evaluations done at the project site. Where we found good depth of soil, the soil textures are mostly loamy sand and medium sand. Soils like the one found at the site tend to have two different hydraulic conductivities, vertical hydraulic conductivity Kv, and horizontal hydraulic conductivity, Kh. The vertical Kv will have more impact on the total infiltration rate while Kh will have more impact on the total mounding height. Kh is normally found 5-10 times or more of Kv. Applying Rawl’s infiltration rate as vertical hydraulic conductivity and 5 times of Rawl’s as horizontal hydraulic conductivity, the conservative hydraulic conductivity for each area can be found in Tabel G.2a. Except for Basin B2 area, all Rawl’s horizontal hydraulic conductivities are higher than what we used based on a balanced consideration of a few other methods.

Soil samples were taken from all stormwater basin areas. The soil particle size distribution was used to estimate the hydraulic conductivity. We also referenced the typical saturated hydraulic conductivities in silty sand and sand soil. The percolation rate may not be used but it is a good reference of the soil hydraulic conductivity. The percolation rates in tested pits range from less than 2 mpi to 7 mpi at the project site, it is equivalent to 8.57 in/hr to 30 in/hr. The Rawl’s rate of 8.27 in/hour is used for infiltration design for sand, 2.41 in/hr for loamy sand, and 1.02 in/hour for loamy sand. We have found the onsite rock is weathered in Basin B2 and had percolation less than 2 mpi (30 in/hr). Basin A area has percolation in about 5 mpi. Basin B1 had a medium sand soil. Basin C is also tested medium sand. The design permeability or hydraulic conductivity determined by a balanced consideration of the data analyzed as shown in Table G.2.

The mounding analysis results are shown in Table G.3 for the stormwater basins. It showed that the basins will be dewatered in less than 3 days to meet the stormwater management handbook recommended dewatering time after a 100-year storm event. Based on our onsite soil testing and monitoring of the site, it is our professional opinion that the mounding and dewatering analysis is reasonably conservatively done given the anisotropic soil and highly variable topographic conditions of the site.

Table G.1 Summary of nearby well drilling data for aquifer depth determination

Location	Date drilled	Well depth, ft	Well Cap, gpm	Gravel depth, ft	Water depth, ft	GW correction, ft	unconsolidated Aq. Depth, ft	Note
49 Farm Rd*	10/25/2005	400	10	25	5	2	22	Similar el. with SAS on opposite of Wetland
53 Farm Rd	11/15/2021	300	11	18	5.5	2	14.5	Similar ele with SAS on the same side of wetland
55 Farm Rd	5/20/1980	520	10	17				30+ ft above SAS on the same side of wetland
64 Farm Rad	1980s			15			15	Man-made pond in 1980s

*Water level is estimated based on offsite observation and onsite soil testing, which could be higher.

Table G.2. Summary of hydraulic conductivity analysis data

Soil Sample	Location	estimated K, ft/day	Average K, ft/day	Typical K for silt/sand*	Design K	Soil texture per USDA
S1	lower edge of SAS	29-850	439	153	24	medium sand
S2	upper edge of SAS	4.39-76	40	28		medium loamy sand
SA1**	Stormwater Basin A	0.52-8.5	4.51	28	4.51	medium sand loam
SB-1	Stormwater Basin B-1	37.84-1437.17	737	153	37.84	fine medium sand
SB-2	Stormwater Basin B-2	7.80-76.54	42.17	28	42.7	medium loamy sand
SC	Stormwater Basin C	57.43-1028	543.21	153	57.43	medium sand

* Ameratunga, Jay, Sivakugan, N., and Das, B. M. Correlations of soil and rock properties in geotechnical engineering, Springer 2016.

** Sample SA1 was taken wet and could be containated with more finer particles.

** SB-2 had percolation rate less than 2 mpi

Table G.2a Comparison of hydraulic conductivities estimated by different methods

Kv per Rawl's, ft/day	Kh=5Kv per Rawl's, ft/day	Typical K for silt/sand*	Design K, ft/day
16.54	82.7	153	24
4.82	24.1	28	
2.04	10.2	28	4.51
16.54	82.7	153	37.84
4.82	24.1	28	42.7
16.54	82.7	153	57.43

Table G.3. Summary of Groundwater Mounding Analysis

Parameters	Stormwater - 100 Year					Note
Recharge area	Basin A	Basin B1	Basin B2	Basin C		All Basins will be dewatered in less than three days.
Dimension, Length, ft	152	132	77.03	111		
Dimension, Width, ft	46.09	19.20	28.95	21.00		
Area, sq. ft	7006.00	2534.00	2230.00	2331.00		
Recharge Vol. Cu ft (per day or event)	9583	15246	6969	12196		
Duration, day	1	1	1	1		
Recharge rate, cu ft/day/sq. ft	1.37	6.02	3.13	5.23		
Dewater time, day	3	3	3	3		
GW Separation, ft	2.63	2.21	3.77	6.25		
Distance to wetland, ft	167	50	291	60		
Maximum mounding height, ft	4.52	3.64	2.5	2.82		
Estimated effective Max MH, ft	**3.008**	**2.496**	**2.5**	**2.82**		
Impact mounding height by other systems, ft	**0**	**0**	**0**	**0**		
Combined Mound height, ft	**4.52**	**3.64**	**2.5**	**2.82**		
3-day residual height, ft	2.49	0.27	0.36	0.17		
5-day residual height, ft	**1.75**	**0.1**	**0.2**	**0.05**		
Estimated effective 3d MH, ft	**2.49**	**0.45**	**0.36**	**0.17**		
Estimated effective 5d MH, ft	**1.75**	**0.15**	**0.2**	**0.26**		
Bottom of Basin, ft	**208**	**215.5**	**204.5**	**219**		
Top of stones, ft						
EHGW, ft	205.37	213.29	200.73	212.75		
	average					
Bottom aquifer, ft	**190.87**	**198.29**	**186.23**	**197.75**		
3 day elevation, ft	**207.86**	**213.56**	**201.09**	**212.92**		
Flood routing elev, ft	211.46	217.41	210.87	220.42		
Top of grade, ft	212.5	218.5	212.5	221.5		
Aquafer depth, ft	14.5	15	14.5	15		
Hydraulic Conductivity, ft/day	4.51	38.00	42.70	57.43		

* mounded water tables for stormwater management area are at 3-day.