GRAZ Engineering, L.L.C.

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323 West Lake Road • Fitzwilliam, NH 03447 • Telephone (603) 585-6959 • Fax (603) 585-6960

Transmittal

To:	Conservation Commission	**Subject:**	Revised Oak Bluff Lane Definitive Plans
Company:	Town of Leicester		
Address:	3 Washburn Square	**Date:**	March 7, 2019
City/State:	Leicester, MA 01524	**Transmitted:** ☐ Mail ☐ Fax ☑ Hand	

☑ **For Your Approval**	☑ **Which You requested**
☑ **For Your Review**	☐ **Approved**
☐ **For Your Signature**	☐ **Approved As Noted**
☑ **For Your Information**	☐ **Revise And Resubmit**
☐ **For Your Files**	☐ **Not Approved**

1	copies	**DEP Oak Bluff Lane Definitive Subdivision Revision Letter dated 3/7/19**
1	copies	**Revised Oak Bluff Lane Definitive Subdivision Plans dated 3/5/19 (Full Size Plans)**
2	copies	**Revised Stormwater & Hydrology & Stormwater Documents dated 3/5/19**
1	CD	**Revised PDF Digital Copy of Submittal Materials dated 3/5/19**
	copies	
	copies	
	copies	
	copies	
	copies	

Comments: Enclosed are the revised plans and associated documentation for the Oak Bluff Lane Definitive Subdivision located off from Baldwin Street.

Should you have any questions or require any additional information, please call my cell at 508-769-9084.

Respectfully yours,
GRAZ Engineering, L.L.C.

Brian MacEwen, P.L.S., E.I.T.
Project Manager

cc: Matt Schold, Applicant/Owner

GRAZ Engineering, L.L.C.

March 7, 2019

Judith Schmitz
Massachusetts DEP
8 New Bond Street
Worcester, MA 01606

Subject: Oak Bluff Lane
             Definitive Subdivision Revision 1

Dear Ms. Schmitz:

GRAZ Engineering, L.L.C. (GRAZ) has received and reviewed your email comments dated January 9, 2019 regarding the proposed Oak Bluff Lane Definitive Subdivision to be located off Baldwin Street dated.

On behalf of Central Land Development Corp. (Matt Schold) and in response to your comments and the subsequent comments received during the Leicester Planning Board (LPB) and Leicester Conservation Commission public hearings to date, GRAZ submits the following item-by-item responses and the revised subdivision plans and associated documentation for your files.

DEP Comments:

Isolated vegetated wetlands B and C should be shown on the site plans if they are located within the footprint of the proposed project. Although these areas may not be jurisdictional under the Massachusetts Wetlands Protection Act, filling of isolated vegetated wetlands may require 401 Water Quality Certification.

> **The isolated wetlands B and C are not located within the footprint of this proposed project and are not impacted by the work proposed under this project and therefore it is not necessary to depict these wetlands on plans. These isolate wetlands are located approximately 470-feet to the west of the nearest point of this proposed project near the easterly side of Lake Avenue in Spencer.**

Construction of the stormwater basins (southern stormwater basin and forebay, and northern forebay) that intercept groundwater is not recommended since maintaining the capacity of these basins relies on a functioning subdrain..

> **Pond (#54P) adjacent to the wetlands along Baldwin Street was designed as wet detention pond with no allowance for infiltration due to the groundwater table elevation. As originally designed, the sediment forebay (#55P) is designed to provide a groundwater separation of ±2.4-feet (proposed basin bottom = 866.8 versus groundwater elevation of 864.4). This forebay and pond have been maintained as originally designed due to that existing site topography, the proximity of the adjacent wetlands, and in an effort to minimize site grading while maintaining the existing footprint/alignment of the existing gravel road for the proposed roadway alignment.**

> **The northern pond (#71P) and its associated sediment forebay have been revised to provide ±2.8-feet of separation from the estimated seasonal high groundwater table elevation at the critical upgradient side of the basin. This provides sufficient separation from the groundwater table accounting for the groundwater mounding at that location due to the basin (see mounding analysis).**

Will the Basin 71P subdrain interfere with the infiltration functions of the basin? *The inspection, evaluation and potential replacement of the detention basin subdrains is not included in the O & M plan. In addition, the subdrains may not contribute to draining the basins after storm events during period of high groundwater.*

> **The subdrains in Basins 54P and 71P are designed strictly for maintenance drawdown and as such have been designed with a shut-off valve.**

Recharge calculations provided to meet Stormwater Standard 3 do not include the presence of groundwater intercepting the Basin 70P forebay, nor are mounding calculations provided for either basin. Calculations are not provided to demonstrate that Basin 54P drains within 72 hours of a storm event.

>**The recharge calculations for Basin 70P forebay have been revised to reflect the proposed grading that provide ±2.8-feet of groundwater separation as required by the standard.**

Subcatchments 30 and 31 do not fully meet Stormwater Standard 4. Can additional BMPs be provided to fully comply with the Massachusetts Stormwater Standards?

>**Due to the existing site topography, the proximity of the adjacent wetlands, and in an effort to minimize site grading while maintaining the existing footprint/alignment of the existing gravel road for the proposed roadway alignment other than the pea gravel stone diaphragm along the westerly edge of the roadway entrance, the proposed grassed swale with check dams, and the sediment forebay (55P), there are no other additional BMP's that could be feasibly or economically cited at this location to provide full compliance with the Standards.**

I trust that this information clarifies the comments that you had relative to the original subdivision submittal. Should you have any other questions or require additional information please email me as soon as possible.

Respectfully yours,

GRAZ Engineering, L.L.C.

Brian MacEwen, P.L.S., E.I.T.   Paul Grasewicz, P.E., P.L.S.
Project Manager

BCM/PFG/bcm

cc: Matt Schold, Central Land Development Corp.
         Paul Grasewicz, GRAZ Engineering, LLC

	2	10	25	100
TABLE OF PRE AND POST TOTAL FLOWS FOR ANALYSIS POINTS OF 2, 10, 25, & 100 YR STORMS (CFS)				
PRE (1P)	*6.53*	*15.36*	*20.59*	*30.54*
POST (50P)	*6.49*	*14.95*	*20.51*	*29.23*
PRE (3S)	*7.32*	*17.99*	*24.37*	*34.42*
POST (72P)	*6.83*	*17.43*	*24.18*	*34.23*
PRE (4S)	*0.64*	*1.62*	*2.21*	*3.14*
POST (41S)	*0.51*	*1.35*	*1.85*	*2.65*
PRE (5S)	*0.13*	*0.34*	*0.46*	*0.66*
POST (34S)	*0.12*	*0.32*	*0.44*	*0.63*

Post-Development   *Type III 24-hr 2 yr Rainfall=3.00"*

Time span=1.00-24.00 hrs, dt=0.01 hrs, 2301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 43S: Subcatchment 43   Runoff Area=25,261 sf 0.00% Impervious Runoff Depth>1.19"
Flow Length=244' Tc=5.0 min CN=79 Runoff=0.82 cfs 2,499 cf

Subcatchment 44S: Subcatchment 44   Runoff Area=406,918 sf 6.01% Impervious Runoff Depth>0.85"
Flow Length=811' Slope=0.0650 '/' Tc=13.0 min CN=73 Runoff=6.83 cfs 28,967 cf

Pond 69P: DMH6   Peak Elev=873.66' Inflow=1.85 cfs 5,633 cf
15.0" Round Culvert n=0.012 L=156.2' S=0.0109 '/' Outflow=1.85 cfs 5,633 cf

Pond 70P: Sediment Forebay 70P   Peak Elev=870.75' Storage=750 cf Inflow=1.85 cfs 5,633 cf
Discarded=0.00 cfs 265 cf Primary=1.79 cfs 4,795 cf Secondary=0.00 cfs 0 cf Outflow=1.79 cfs 5,060 cf

Pond 71P: Infiltration Basin 71P   Peak Elev=870.29' Storage=3,636 cf Inflow=2.60 cfs 7,294 cf
Discarded=0.02 cfs 899 cf Primary=0.24 cfs 3,767 cf Secondary=0.00 cfs 0 cf Outflow=0.26 cfs 4,666 cf

Pond 72P: Stiles Lake   Inflow=6.83 cfs 32,733 cf
Primary=6.83 cfs 32,733 cf

Pond 73P: DMH7   Peak Elev=871.92' Inflow=1.85 cfs 5,633 cf
15.0" Round Culvert n=0.012 L=9.6' S=0.0104 '/' Outflow=1.85 cfs 5,633 cf

Summary for Subcatchment 43S: Subcatchment 43

Runoff   =   0.82 cfs @ 12.08 hrs, Volume=   2,499 cf, Depth> 1.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 yr Rainfall=3.00"

Area (sf)	CN	Description
5,424	96	Gravel surface, HSG C
19,837	74	>75% Grass cover, Good, HSG C
25,261	79	Weighted Average
25,261		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	244		0.81		**Direct Entry,**

Summary for Subcatchment 44S: Subcatchment 44

Runoff   =   6.83 cfs @ 12.20 hrs, Volume=   28,967 cf, Depth> 0.85"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2 yr Rainfall=3.00"

	Area (sf)	CN	Description
*	24,436	98	Pavement & Roofs, HSG C
	3,694	96	Gravel surface, HSG C
	75,817	74	>75% Grass cover, Good, HSG C
	5,317	80	>75% Grass cover, Good, HSG D
	297,654	70	Woods, Good, HSG C
	406,918	73	Weighted Average
	382,482		93.99% Pervious Area
	24,436		6.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.0	811	0.0650	1.04		**Lag/CN Method,**

Summary for Pond 69P: DMH6

Inflow Area =   43,070 sf, 43.75% Impervious, Inflow Depth > 1.57"   for 2 yr event
Inflow   =   1.85 cfs @ 12.08 hrs, Volume=   5,633 cf
Outflow   =   1.85 cfs @ 12.08 hrs, Volume=   5,633 cf, Atten= 0%, Lag= 0.0 min
Primary   =   1.85 cfs @ 12.08 hrs, Volume=   5,633 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 873.66' @ 12.08 hrs
Flood Elev= 876.40'

Device	Routing	Invert	Outlet Devices
#1	Primary	872.90'	**15.0" Round Culvert**
			L= 156.2' CPP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 872.90' / 871.20' S= 0.0109 '/' Cc= 0.900
			n= 0.012, Flow Area= 1.23 sf

Primary OutFlow Max=1.84 cfs @ 12.08 hrs HW=873.66' TW=871.92' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 1.84 cfs @ 2.35 fps)

Summary for Pond 70P: Sediment Forebay 70P

Inflow Area = 43,070 sf, 43.75% Impervious, Inflow Depth > 1.57" for 2 yr event
Inflow = 1.85 cfs @ 12.08 hrs, Volume= 5,633 cf
Outflow = 1.79 cfs @ 12.09 hrs, Volume= 5,060 cf, Atten= 3%, Lag= 1.1 min
Discarded = 0.00 cfs @ 12.09 hrs, Volume= 265 cf
Primary = 1.79 cfs @ 12.09 hrs, Volume= 4,795 cf
Secondary = 0.00 cfs @ 1.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 870.75' @ 12.09 hrs Surf.Area= 776 sf Storage= 750 cf
Flood Elev= 873.30' Surf.Area= 1,522 sf Storage= 3,302 cf

Plug-Flow detention time= 72.3 min calculated for 5,060 cf (90% of inflow)
Center-of-Mass det. time= 22.9 min (843.8 - 820.9)

Volume	Invert	Avail.Storage	Storage Description
#1	869.50'	3,302 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
869.50	435	0	0
870.00	559	249	249
871.00	848	704	952
872.00	1,165	1,007	1,959
873.00	1,522	1,344	3,302

Device	Routing	Invert	Outlet Devices
#1	Primary	870.50'	**143.1 deg x 4.0' long x 1.50' rise Sharp-Crested Vee/Trap Weir**
			Cv= 2.47 (C= 3.09)
#2	Secondary	872.00'	**12.0' long x 1.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00
			2.50 3.00
			Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31
			3.30 3.31 3.32
#3	Discarded	869.50'	**0.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.00 cfs @ 12.09 hrs HW=870.75' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=1.78 cfs @ 12.09 hrs HW=870.75' TW=869.63' (Dynamic Tailwater)
└─**1=Sharp-Crested Vee/Trap Weir** (Weir Controls 1.78 cfs @ 1.50 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=869.50' TW=868.50' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 71P: Infiltration Basin 71P

Inflow Area =		68,331 sf, 27.58% Impervious,	Inflow Depth >	1.28"	for 2 yr event	
Inflow	=	2.60 cfs @ 12.09 hrs,	Volume=		7,294 cf	
Outflow	=	0.26 cfs @ 13.04 hrs,	Volume=		4,666 cf,	Atten= 90%, Lag= 57.2 min
Discarded =		0.02 cfs @ 13.04 hrs,	Volume=		899 cf	
Primary	=	0.24 cfs @ 13.04 hrs,	Volume=		3,767 cf	
Secondary =		0.00 cfs @ 1.00 hrs,	Volume=		0 cf	

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 870.29' @ 13.04 hrs Surf.Area= 3,411 sf Storage= 3,636 cf
Flood Elev= 873.30' Surf.Area= 11,664 sf Storage= 21,023 cf

Plug-Flow detention time= 233.8 min calculated for 4,664 cf (64% of inflow)
Center-of-Mass det. time= 130.4 min (972.3 - 842.0)

Volume	Invert	Avail.Storage	Storage Description
#1	868.50'	21,023 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
868.50	0	0	0
869.00	1,015	254	254
869.50	2,765	945	1,199
870.00	3,166	1,483	2,682
871.00	4,010	3,588	6,270
872.00	6,156	5,083	11,353
873.00	7,450	6,803	18,156
873.30	11,664	2,867	21,023

Device	Routing	Invert	Outlet Devices
#1	Primary	862.20'	**12.0" Round Culvert** L= 69.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 862.20' / 858.00' S= 0.0609 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	869.80'	**30.0 deg x 1.30' rise Sharp-Crested Vee/Trap Weir X 2.00** Cv= 2.61 (C= 3.26)
#3	Device 1	871.60'	**1.2" x 7.3" Horiz. Orifice/Grate X 3.00 columns** X 11 rows C= 0.600 in 25.7" x 25.7" Grate (44% open area) Limited to weir flow at low heads
#4	Secondary	871.60'	**170.5 deg x 5.0' long x 1.00' rise Sharp-Crested Vee/Trap Weir**

Cv= 2.46 (C= 3.08)
#5   Discarded   868.50'   **0.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.02 cfs @ 13.04 hrs HW=870.29' (Free Discharge)
└─**5=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=0.24 cfs @ 13.04 hrs HW=870.29' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.24 cfs of 10.42 cfs potential flow)
　├─**2=Sharp-Crested Vee/Trap Weir** (Weir Controls 0.24 cfs @ 1.83 fps)
　└─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=868.50' TW=0.00' (Dynamic Tailwater)
└─**4=Sharp-Crested Vee/Trap Weir** (Controls 0.00 cfs)

Summary for Pond 72P: Stiles Lake

Inflow Area =   475,249 sf,   9.11% Impervious, Inflow Depth > 0.83"   for 2 yr event
Inflow   =   6.83 cfs @ 12.20 hrs, Volume=   32,733 cf
Primary   =   6.83 cfs @ 12.20 hrs, Volume=   32,733 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond 73P: DMH7

Inflow Area =   43,070 sf, 43.75% Impervious, Inflow Depth > 1.57"   for 2 yr event
Inflow   =   1.85 cfs @ 12.08 hrs, Volume=   5,633 cf
Outflow   =   1.85 cfs @ 12.08 hrs, Volume=   5,633 cf, Atten= 0%, Lag= 0.0 min
Primary   =   1.85 cfs @ 12.08 hrs, Volume=   5,633 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 871.92' @ 12.08 hrs
Flood Elev= 874.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	871.10'	**15.0" Round Culvert** L= 9.6' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 871.10' / 871.00' S= 0.0104 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf

Primary OutFlow Max=1.84 cfs @ 12.08 hrs HW=871.92' TW=870.75' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.84 cfs @ 3.06 fps)

Post-Development   *Type III 24-hr   10 yr   Rainfall=4.50"*

Time span=1.00-24.00 hrs, dt=0.01 hrs, 2301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 43S: Subcatchment 43   Runoff Area=25,261 sf   0.00% Impervious   Runoff Depth>2.37"
                                        Flow Length=244'   Tc=5.0 min   CN=79   Runoff=1.68 cfs   4,998 cf

Subcatchment 44S: Subcatchment 44   Runoff Area=406,918 sf   6.01% Impervious   Runoff Depth>1.89"
            Flow Length=811'   Slope=0.0650 '/'   Tc=13.0 min   CN=73   Runoff=16.28 cfs   64,087 cf

Pond 69P: DMH6   Peak Elev=874.04'   Inflow=3.36 cfs   10,249 cf
               15.0" Round Culvert   n=0.012   L=156.2'   S=0.0109 '/'   Outflow=3.36 cfs   10,249 cf

Pond 70P: Sediment Forebay 70P   Peak Elev=870.86'   Storage=838 cf   Inflow=3.36 cfs   10,249 cf
     Discarded=0.01 cfs   292 cf   Primary=3.29 cfs   9,380 cf   Secondary=0.00 cfs   0 cf   Outflow=3.29 cfs   9,672 cf

Pond 71P: Infiltration Basin 71P   Peak Elev=870.84'   Storage=5,635 cf   Inflow=4.94 cfs   14,377 cf
    Discarded=0.02 cfs   987 cf   Primary=1.54 cfs   10,560 cf   Secondary=0.00 cfs   0 cf   Outflow=1.56 cfs   11,547 cf

Pond 72P: Stiles Lake   Inflow=17.43 cfs   74,647 cf
                                            Primary=17.43 cfs   74,647 cf

Pond 73P: DMH7   Peak Elev=872.30'   Inflow=3.36 cfs   10,249 cf
            15.0" Round Culvert   n=0.012   L=9.6'   S=0.0104 '/'   Outflow=3.36 cfs   10,249 cf

Summary for Subcatchment 43S: Subcatchment 43

Runoff   =   1.68 cfs @ 12.08 hrs, Volume=   4,998 cf, Depth> 2.37"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 yr Rainfall=4.50"

Area (sf)	CN	Description
5,424	96	Gravel surface, HSG C
19,837	74	>75% Grass cover, Good, HSG C
25,261	79	Weighted Average
25,261		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	244		0.81		**Direct Entry,**

Summary for Subcatchment 44S: Subcatchment 44

Runoff   =   16.28 cfs @ 12.18 hrs, Volume=   64,087 cf, Depth> 1.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10 yr Rainfall=4.50"

	Area (sf)	CN	Description
*	24,436	98	Pavement & Roofs, HSG C
	3,694	96	Gravel surface, HSG C
	75,817	74	>75% Grass cover, Good, HSG C
	5,317	80	>75% Grass cover, Good, HSG D
	297,654	70	Woods, Good, HSG C
	406,918	73	Weighted Average
	382,482		93.99% Pervious Area
	24,436		6.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.0	811	0.0650	1.04		**Lag/CN Method,**

Summary for Pond 69P: DMH6

Inflow Area =		43,070 sf, 43.75% Impervious,	Inflow Depth > 2.86"	for 10 yr event
Inflow	=	3.36 cfs @ 12.07 hrs,	Volume=	10,249 cf
Outflow	=	3.36 cfs @ 12.07 hrs,	Volume=	10,249 cf, Atten= 0%, Lag= 0.0 min
Primary	=	3.36 cfs @ 12.07 hrs,	Volume=	10,249 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 874.04' @ 12.07 hrs
Flood Elev= 876.40'

Device	Routing	Invert	Outlet Devices
#1	Primary	872.90'	**15.0" Round Culvert** L= 156.2' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 872.90' / 871.20' S= 0.0109 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf

Primary OutFlow Max=3.35 cfs @ 12.07 hrs HW=874.03' TW=872.30' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 3.35 cfs @ 2.86 fps)

Summary for Pond 70P: Sediment Forebay 70P

Inflow Area =   43,070 sf, 43.75% Impervious, Inflow Depth > 2.86"   for 10 yr event
Inflow   =   3.36 cfs @   12.07 hrs, Volume=   10,249 cf
Outflow   =   3.29 cfs @   12.09 hrs, Volume=   9,672 cf, Atten= 2%, Lag= 0.9 min
Discarded = 0.01 cfs @   12.09 hrs, Volume=   292 cf
Primary   =   3.29 cfs @   12.09 hrs, Volume=   9,380 cf
Secondary =   0.00 cfs @   1.00 hrs, Volume=   0 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 870.86' @ 12.09 hrs   Surf.Area= 808 sf   Storage= 838 cf
Flood Elev= 873.30'   Surf.Area= 1,522 sf   Storage= 3,302 cf

Plug-Flow detention time= 48.3 min calculated for 9,668 cf (94% of inflow)
Center-of-Mass det. time= 17.7 min (823.9 - 806.2)

Volume	Invert	Avail.Storage	Storage Description
#1	869.50'	3,302 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
869.50	435	0	0
870.00	559	249	249
871.00	848	704	952
872.00	1,165	1,007	1,959
873.00	1,522	1,344	3,302

Device	Routing	Invert	Outlet Devices
#1	Primary	870.50'	**143.1 deg x 4.0' long x 1.50' rise Sharp-Crested Vee/Trap Weir** Cv= 2.47 (C= 3.09)
#2	Secondary	872.00'	**12.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#3	Discarded	869.50'	**0.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.01 cfs @ 12.09 hrs HW=870.86' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=3.28 cfs @ 12.09 hrs HW=870.86' TW=870.43' (Dynamic Tailwater)
└─**1=Sharp-Crested Vee/Trap Weir** (Weir Controls 3.28 cfs @ 1.78 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=869.50' TW=868.50' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 71P: Infiltration Basin 71P

Inflow Area =		68,331 sf, 27.58% Impervious,	Inflow Depth > 2.52" for 10 yr event
Inflow =	4.94 cfs @ 12.08 hrs,	Volume=	14,377 cf	
Outflow =	1.56 cfs @ 12.39 hrs,	Volume=	11,547 cf,	Atten= 68%, Lag= 18.6 min
Discarded =	0.02 cfs @ 12.39 hrs,	Volume=	987 cf	
Primary =	1.54 cfs @ 12.39 hrs,	Volume=	10,560 cf	
Secondary =	0.00 cfs @ 1.00 hrs,	Volume=	0 cf	

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 870.84' @ 12.39 hrs Surf.Area= 3,874 sf Storage= 5,635 cf
Flood Elev= 873.30' Surf.Area= 11,664 sf Storage= 21,023 cf

Plug-Flow detention time= 145.4 min calculated for 11,542 cf (80% of inflow)
Center-of-Mass det. time= 71.5 min (895.4 - 824.0)

Volume	Invert	Avail.Storage	Storage Description
#1	868.50'	21,023 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
868.50	0	0	0
869.00	1,015	254	254
869.50	2,765	945	1,199
870.00	3,166	1,483	2,682
871.00	4,010	3,588	6,270
872.00	6,156	5,083	11,353
873.00	7,450	6,803	18,156
873.30	11,664	2,867	21,023

Device	Routing	Invert	Outlet Devices
#1	Primary	862.20'	**12.0" Round Culvert** L= 69.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 862.20' / 858.00' S= 0.0609 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	869.80'	**30.0 deg x 1.30' rise Sharp-Crested Vee/Trap Weir X 2.00** Cv= 2.61 (C= 3.26)
#3	Device 1	871.60'	**1.2" x 7.3" Horiz. Orifice/Grate X 3.00 columns** X 11 rows C= 0.600 in 25.7" x 25.7" Grate (44% open area) Limited to weir flow at low heads
#4	Secondary	871.60'	**170.5 deg x 5.0' long x 1.00' rise Sharp-Crested Vee/Trap Weir**

Cv= 2.46 (C= 3.08)
#5   Discarded   868.50'   **0.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.02 cfs @ 12.39 hrs HW=870.84' (Free Discharge)
└─**5=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=1.54 cfs @ 12.39 hrs HW=870.84' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 1.54 cfs of 10.79 cfs potential flow)
  ├─**2=Sharp-Crested Vee/Trap Weir** (Weir Controls 1.54 cfs @ 2.66 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=868.50' TW=0.00' (Dynamic Tailwater)
└─**4=Sharp-Crested Vee/Trap Weir** (Controls 0.00 cfs)

Summary for Pond 72P: Stiles Lake

Inflow Area =   475,249 sf,   9.11% Impervious, Inflow Depth > 1.88"   for 10 yr event
Inflow   =   17.43 cfs @   12.19 hrs, Volume=   74,647 cf
Primary   =   17.43 cfs @   12.19 hrs, Volume=   74,647 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond 73P: DMH7

Inflow Area =   43,070 sf, 43.75% Impervious, Inflow Depth > 2.86"   for 10 yr event
Inflow   =   3.36 cfs @   12.07 hrs, Volume=   10,249 cf
Outflow   =   3.36 cfs @   12.07 hrs, Volume=   10,249 cf, Atten= 0%, Lag= 0.0 min
Primary   =   3.36 cfs @   12.07 hrs, Volume=   10,249 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 872.30' @ 12.07 hrs
Flood Elev= 874.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	871.10'	**15.0" Round Culvert**
			L= 9.6' CPP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 871.10' / 871.00' S= 0.0104 '/' Cc= 0.900
			n= 0.012, Flow Area= 1.23 sf

Primary OutFlow Max=3.35 cfs @ 12.07 hrs HW=872.30' TW=870.86' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 3.35 cfs @ 3.54 fps)

Time span=1.00-24.00 hrs, dt=0.01 hrs, 2301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 43S: Subcatchment 43   Runoff Area=25,261 sf 0.00% Impervious Runoff Depth>3.06"
Flow Length=244' Tc=5.0 min CN=79 Runoff=2.16 cfs 6,439 cf

Subcatchment 44S: Subcatchment 44   Runoff Area=406,918 sf 6.01% Impervious Runoff Depth>2.51"
Flow Length=811' Slope=0.0650 '/' Tc=13.0 min CN=73 Runoff=21.88 cfs 85,143 cf

Pond 69P: DMH6   Peak Elev=874.33' Inflow=4.19 cfs 12,840 cf
15.0" Round Culvert n=0.012 L=156.2' S=0.0109 '/' Outflow=4.19 cfs 12,840 cf

Pond 70P: Sediment Forebay 70P   Peak Elev=871.07' Storage=1,011 cf Inflow=4.19 cfs 12,840 cf
Discarded=0.01 cfs 303 cf Primary=3.92 cfs 11,958 cf Secondary=0.00 cfs 0 cf Outflow=3.92 cfs 12,261 cf

Pond 71P: Infiltration Basin 71P   Peak Elev=871.06' Storage=6,504 cf Inflow=6.08 cfs 18,397 cf
Discarded=0.03 cfs 1,036 cf Primary=2.48 cfs 14,447 cf Secondary=0.00 cfs 0 cf Outflow=2.51 cfs 15,483 cf

Pond 72P: Stiles Lake   Inflow=24.18 cfs 99,590 cf
Primary=24.18 cfs 99,590 cf

Pond 73P: DMH7   Peak Elev=872.53' Inflow=4.19 cfs 12,840 cf
15.0" Round Culvert n=0.012 L=9.6' S=0.0104 '/' Outflow=4.19 cfs 12,840 cf

Summary for Subcatchment 43S: Subcatchment 43

Runoff   =   2.16 cfs @ 12.07 hrs, Volume=   6,439 cf, Depth> 3.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 yr Rainfall=5.30"

	Area (sf)	CN	Description
	5,424	96	Gravel surface, HSG C
	19,837	74	>75% Grass cover, Good, HSG C
	25,261	79	Weighted Average
	25,261		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	244		0.81		**Direct Entry,**

Summary for Subcatchment 44S: Subcatchment 44

Runoff   =   21.88 cfs @ 12.18 hrs, Volume=   85,143 cf, Depth> 2.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 25 yr Rainfall=5.30"

	Area (sf)	CN	Description
*	24,436	98	Pavement & Roofs, HSG C
	3,694	96	Gravel surface, HSG C
	75,817	74	>75% Grass cover, Good, HSG C
	5,317	80	>75% Grass cover, Good, HSG D
	297,654	70	Woods, Good, HSG C
	406,918	73	Weighted Average
	382,482		93.99% Pervious Area
	24,436		6.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.0	811	0.0650	1.04		**Lag/CN Method,**

Summary for Pond 69P: DMH6

Inflow Area =   43,070 sf, 43.75% Impervious, Inflow Depth > 3.58"   for 25 yr event
Inflow   =   4.19 cfs @ 12.07 hrs, Volume=   12,840 cf
Outflow   =   4.19 cfs @ 12.07 hrs, Volume=   12,840 cf, Atten= 0%, Lag= 0.0 min
Primary   =   4.19 cfs @ 12.07 hrs, Volume=   12,840 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 874.33' @ 12.07 hrs
Flood Elev= 876.40'

Device	Routing	Invert	Outlet Devices
#1	Primary	872.90'	**15.0" Round Culvert**
			L= 156.2' CPP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 872.90' / 871.20' S= 0.0109 '/' Cc= 0.900
			n= 0.012, Flow Area= 1.23 sf

Primary OutFlow Max=4.18 cfs @ 12.07 hrs HW=874.33' TW=872.53' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 4.18 cfs @ 3.40 fps)

Summary for Pond 70P: Sediment Forebay 70P

Inflow Area =		43,070 sf, 43.75% Impervious, Inflow Depth > 3.58" for 25 yr event			
Inflow	=	4.19 cfs @ 12.07 hrs, Volume=	12,840 cf		
Outflow	=	3.92 cfs @ 12.08 hrs, Volume=	12,261 cf, Atten= 6%, Lag= 0.3 min		
Discarded =		0.01 cfs @ 12.29 hrs, Volume=	303 cf		
Primary	=	3.92 cfs @ 12.08 hrs, Volume=	11,958 cf		
Secondary =		0.00 cfs @ 1.00 hrs, Volume=	0 cf		

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 871.07' @ 12.29 hrs Surf.Area= 870 sf Storage= 1,011 cf
Flood Elev= 873.30' Surf.Area= 1,522 sf Storage= 3,302 cf

Plug-Flow detention time= 41.8 min calculated for 12,261 cf (95% of inflow)
Center-of-Mass det. time= 16.4 min (817.0 - 800.6)

Volume	Invert	Avail.Storage	Storage Description
#1	869.50'	3,302 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
869.50	435	0	0
870.00	559	249	249
871.00	848	704	952
872.00	1,165	1,007	1,959
873.00	1,522	1,344	3,302

Device	Routing	Invert	Outlet Devices
#1	Primary	870.50'	**143.1 deg x 4.0' long x 1.50' rise Sharp-Crested Vee/Trap Weir**
			Cv= 2.47 (C= 3.09)
#2	Secondary	872.00'	**12.0' long x 1.0' breadth Broad-Crested Rectangular Weir**
			Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00
			2.50 3.00
			Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31
			3.30 3.31 3.32
#3	Discarded	869.50'	**0.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.01 cfs @ 12.29 hrs HW=871.07' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=3.68 cfs @ 12.08 hrs HW=870.92' TW=870.74' (Dynamic Tailwater)
└─**1=Sharp-Crested Vee/Trap Weir** (Weir Controls 3.68 cfs @ 1.65 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=869.50' TW=868.50' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 71P: Infiltration Basin 71P

Inflow Area =   68,331 sf, 27.58% Impervious, Inflow Depth > 3.23" for 25 yr event
Inflow   =   6.08 cfs @ 12.08 hrs, Volume=   18,397 cf
Outflow =   2.51 cfs @ 12.29 hrs, Volume=   15,483 cf, Atten= 59%, Lag= 13.1 min
Discarded =   0.03 cfs @ 12.29 hrs, Volume=   1,036 cf
Primary   =   2.48 cfs @ 12.29 hrs, Volume=   14,447 cf
Secondary =   0.00 cfs @   1.00 hrs, Volume=   0 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 871.06' @ 12.29 hrs Surf.Area= 4,133 sf Storage= 6,504 cf
Flood Elev= 873.30' Surf.Area= 11,664 sf Storage= 21,023 cf

Plug-Flow detention time= 125.3 min calculated for 15,483 cf (84% of inflow)
Center-of-Mass det. time= 60.6 min (877.9 - 817.4)

Volume	Invert	Avail.Storage	Storage Description
#1	868.50'	21,023 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
868.50	0	0	0
869.00	1,015	254	254
869.50	2,765	945	1,199
870.00	3,166	1,483	2,682
871.00	4,010	3,588	6,270
872.00	6,156	5,083	11,353
873.00	7,450	6,803	18,156
873.30	11,664	2,867	21,023

Device	Routing	Invert	Outlet Devices
#1	Primary	862.20'	**12.0" Round Culvert** L= 69.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 862.20' / 858.00' S= 0.0609 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	869.80'	**30.0 deg x 1.30' rise Sharp-Crested Vee/Trap Weir X 2.00** Cv= 2.61 (C= 3.26)
#3	Device 1	871.60'	**1.2" x 7.3" Horiz. Orifice/Grate X 3.00 columns** X 11 rows C= 0.600 in 25.7" x 25.7" Grate (44% open area) Limited to weir flow at low heads
#4	Secondary	871.60'	**170.5 deg x 5.0' long x 1.00' rise Sharp-Crested Vee/Trap Weir**

**Post-Development**   *Type III 24-hr 25 yr Rainfall=5.30"*

Cv= 2.46 (C= 3.08)
#5   Discarded   868.50'   **0.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.03 cfs @ 12.29 hrs HW=871.06' (Free Discharge)
└─**5=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=2.48 cfs @ 12.29 hrs HW=871.06' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 2.48 cfs of 10.93 cfs potential flow)
  ├─**2=Sharp-Crested Vee/Trap Weir** (Weir Controls 2.48 cfs @ 2.93 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=868.50' TW=0.00' (Dynamic Tailwater)
└─**4=Sharp-Crested Vee/Trap Weir** (Controls 0.00 cfs)

Summary for Pond 72P: Stiles Lake

Inflow Area =   475,249 sf,   9.11% Impervious, Inflow Depth > 2.51"   for 25 yr event
Inflow   =   24.18 cfs @   12.18 hrs, Volume=   99,590 cf
Primary   =   24.18 cfs @   12.18 hrs, Volume=   99,590 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond 73P: DMH7

Inflow Area =   43,070 sf, 43.75% Impervious, Inflow Depth > 3.58"   for 25 yr event
Inflow   =   4.19 cfs @   12.07 hrs, Volume=   12,840 cf
Outflow   =   4.19 cfs @   12.07 hrs, Volume=   12,840 cf, Atten= 0%, Lag= 0.0 min
Primary   =   4.19 cfs @   12.07 hrs, Volume=   12,840 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 872.53' @ 12.07 hrs
Flood Elev= 874.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	871.10'	**15.0" Round Culvert**
			L= 9.6' CPP, projecting, no headwall, Ke= 0.900
			Inlet / Outlet Invert= 871.10' / 871.00' S= 0.0104 '/' Cc= 0.900
			n= 0.012, Flow Area= 1.23 sf

Primary OutFlow Max=4.18 cfs @ 12.07 hrs HW=872.53' TW=870.92' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 4.18 cfs @ 3.40 fps)

Time span=1.00-24.00 hrs, dt=0.01 hrs, 2301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 43S: Subcatchment 43   Runoff Area=25,261 sf 0.00% Impervious   Runoff Depth>4.13"
Flow Length=244' Tc=5.0 min CN=79 Runoff=2.90 cfs 8,685 cf

Subcatchment 44S: Subcatchment 44   Runoff Area=406,918 sf 6.01% Impervious   Runoff Depth>3.50"
Flow Length=811' Slope=0.0650 '/' Tc=13.0 min CN=73 Runoff=30.69 cfs 118,636 cf

Pond 69P: DMH6   Peak Elev=874.89' Inflow=5.44 cfs 16,826 cf
15.0" Round Culvert n=0.012 L=156.2' S=0.0109 '/' Outflow=5.44 cfs 16,826 cf

Pond 70P: Sediment Forebay 70P   Peak Elev=871.37' Storage=1,286 cf Inflow=5.44 cfs 16,826 cf
Discarded=0.01 cfs 317 cf Primary=4.66 cfs 15,928 cf Secondary=0.00 cfs 0 cf Outflow=4.66 cfs 16,245 cf

Pond 71P: Infiltration Basin 71P   Peak Elev=871.36' Storage=7,855 cf Inflow=7.55 cfs 24,612 cf
Discarded=0.03 cfs 1,109 cf Primary=3.60 cfs 20,483 cf Secondary=0.00 cfs 0 cf Outflow=3.63 cfs 21,592 cf

Pond 72P: Stiles Lake   Inflow=34.23 cfs 139,119 cf
Primary=34.23 cfs 139,119 cf

Pond 73P: DMH7   Peak Elev=873.09' Inflow=5.44 cfs 16,826 cf
15.0" Round Culvert n=0.012 L=9.6' S=0.0104 '/' Outflow=5.44 cfs 16,826 cf

Summary for Subcatchment 43S: Subcatchment 43

Runoff   =   2.90 cfs @ 12.07 hrs, Volume=   8,685 cf, Depth> 4.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 yr Rainfall=6.50"

Area (sf)	CN	Description
5,424	96	Gravel surface, HSG C
19,837	74	>75% Grass cover, Good, HSG C
25,261	79	Weighted Average
25,261		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0	244		0.81		**Direct Entry,**

Summary for Subcatchment 44S: Subcatchment 44

Runoff   =   30.69 cfs @ 12.18 hrs, Volume=   118,636 cf, Depth> 3.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100 yr Rainfall=6.50"

	Area (sf)	CN	Description
*	24,436	98	Pavement & Roofs, HSG C
	3,694	96	Gravel surface, HSG C
	75,817	74	>75% Grass cover, Good, HSG C
	5,317	80	>75% Grass cover, Good, HSG D
	297,654	70	Woods, Good, HSG C
	406,918	73	Weighted Average
	382,482		93.99% Pervious Area
	24,436		6.01% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.0	811	0.0650	1.04		**Lag/CN Method,**

Summary for Pond 69P: DMH6

Inflow Area =   43,070 sf, 43.75% Impervious, Inflow Depth > 4.69"   for 100 yr event
Inflow   =   5.44 cfs @ 12.07 hrs, Volume=   16,826 cf
Outflow   =   5.44 cfs @ 12.07 hrs, Volume=   16,826 cf, Atten= 0%, Lag= 0.0 min
Primary   =   5.44 cfs @ 12.07 hrs, Volume=   16,826 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 874.89' @ 12.07 hrs
Flood Elev= 876.40'

Device	Routing	Invert	Outlet Devices
#1	Primary	872.90'	**15.0" Round Culvert** L= 156.2' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 872.90' / 871.20' S= 0.0109 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf

Primary OutFlow Max=5.43 cfs @ 12.07 hrs HW=874.88' TW=873.08'   (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 5.43 cfs @ 4.43 fps)

Summary for Pond 70P: Sediment Forebay 70P

Inflow Area =	43,070 sf, 43.75% Impervious, Inflow Depth > 4.69" for 100 yr event		
Inflow =	5.44 cfs @ 12.07 hrs, Volume=	16,826 cf	
Outflow =	4.66 cfs @ 12.08 hrs, Volume=	16,245 cf, Atten= 14%, Lag= 0.2 min
Discarded =	0.01 cfs @ 12.25 hrs, Volume=	317 cf	
Primary =	4.66 cfs @ 12.08 hrs, Volume=	15,928 cf	
Secondary =	0.00 cfs @ 1.00 hrs, Volume=	0 cf	

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 871.37' @ 12.25 hrs   Surf.Area= 965 sf   Storage= 1,286 cf
Flood Elev= 873.30'   Surf.Area= 1,522 sf   Storage= 3,302 cf

Plug-Flow detention time= 35.1 min calculated for 16,238 cf (97% of inflow)
Center-of-Mass det. time= 15.0 min (808.9 - 793.8)

Volume	Invert	Avail.Storage	Storage Description
#1	869.50'	3,302 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
869.50	435	0	0
870.00	559	249	249
871.00	848	704	952
872.00	1,165	1,007	1,959
873.00	1,522	1,344	3,302

Device	Routing	Invert	Outlet Devices
#1	Primary	870.50'	**143.1 deg x 4.0' long x 1.50' rise Sharp-Crested Vee/Trap Weir** Cv= 2.47 (C= 3.09)
#2	Secondary	872.00'	**12.0' long x 1.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 Coef. (English) 2.69 2.72 2.75 2.85 2.98 3.08 3.20 3.28 3.31 3.30 3.31 3.32
#3	Discarded	869.50'	**0.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.01 cfs @ 12.25 hrs HW=871.37' (Free Discharge)
└─**3=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=3.27 cfs @ 12.08 hrs HW=871.14' TW=871.10' (Dynamic Tailwater)
└─**1=Sharp-Crested Vee/Trap Weir** (Weir Controls 3.27 cfs @ 0.86 fps)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=869.50' TW=868.50' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 71P: Infiltration Basin 71P

Inflow Area =   68,331 sf, 27.58% Impervious, Inflow Depth > 4.32"   for 100 yr event
Inflow   =   7.55 cfs @ 12.07 hrs, Volume=   24,612 cf
Outflow   =   3.63 cfs @ 12.25 hrs, Volume=   21,592 cf, Atten= 52%, Lag= 10.4 min
Discarded =   0.03 cfs @ 12.25 hrs, Volume=   1,109 cf
Primary   =   3.60 cfs @ 12.25 hrs, Volume=   20,483 cf
Secondary =   0.00 cfs @   1.00 hrs, Volume=   0 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 871.36' @ 12.25 hrs   Surf.Area= 4,784 sf   Storage= 7,855 cf
Flood Elev= 873.30'   Surf.Area= 11,664 sf   Storage= 21,023 cf

Plug-Flow detention time= 106.9 min calculated for 21,582 cf (88% of inflow)
Center-of-Mass det. time= 52.3 min (861.7 - 809.4)

Volume	Invert	Avail.Storage	Storage Description
#1	868.50'	21,023 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
868.50	0	0	0
869.00	1,015	254	254
869.50	2,765	945	1,199
870.00	3,166	1,483	2,682
871.00	4,010	3,588	6,270
872.00	6,156	5,083	11,353
873.00	7,450	6,803	18,156
873.30	11,664	2,867	21,023

| Device	Routing	Invert	Outlet Devices
#1	Primary	862.20'	**12.0" Round Culvert** L= 69.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 862.20' / 858.00' S= 0.0609 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	869.80'	**30.0 deg x 1.30' rise Sharp-Crested Vee/Trap Weir X 2.00** Cv= 2.61 (C= 3.26)
#3	Device 1	871.60'	**1.2" x 7.3" Horiz. Orifice/Grate X 3.00 columns** X 11 rows C= 0.600 in 25.7" x 25.7" Grate (44% open area) Limited to weir flow at low heads
#4	Secondary	871.60'	**170.5 deg x 5.0' long x 1.00' rise Sharp-Crested Vee/Trap Weir**

Cv= 2.46 (C= 3.08)
#5   Discarded   868.50'   **0.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.03 cfs @ 12.25 hrs HW=871.36' (Free Discharge)
└─**5=Exfiltration** (Exfiltration Controls 0.03 cfs)

Primary OutFlow Max=3.60 cfs @ 12.25 hrs HW=871.36' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 3.60 cfs of 11.13 cfs potential flow)
  ├─**2=Sharp-Crested Vee/Trap Weir** (Orifice Controls 3.60 cfs @ 3.98 fps)
  └─**3=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 1.00 hrs HW=868.50' TW=0.00' (Dynamic Tailwater)
└─**4=Sharp-Crested Vee/Trap Weir** (Controls 0.00 cfs)

Summary for Pond 72P: Stiles Lake

Inflow Area =   475,249 sf, 9.11% Impervious, Inflow Depth > 3.51" for 100 yr event
Inflow   =   34.23 cfs @ 12.18 hrs, Volume=   139,119 cf
Primary   =   34.23 cfs @ 12.18 hrs, Volume=   139,119 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond 73P: DMH7

Inflow Area =   43,070 sf, 43.75% Impervious, Inflow Depth > 4.69" for 100 yr event
Inflow   =   5.44 cfs @ 12.07 hrs, Volume=   16,826 cf
Outflow   =   5.44 cfs @ 12.07 hrs, Volume=   16,826 cf, Atten= 0%, Lag= 0.0 min
Primary   =   5.44 cfs @ 12.07 hrs, Volume=   16,826 cf

Routing by Dyn-Stor-Ind method, Time Span= 1.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 873.09' @ 12.07 hrs
Flood Elev= 874.50'

Device	Routing	Invert	Outlet Devices
#1	Primary	871.10'	**15.0" Round Culvert** L= 9.6' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 871.10' / 871.00' S= 0.0104 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf

Primary OutFlow Max=5.43 cfs @ 12.07 hrs HW=873.08' TW=871.13' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 5.43 cfs @ 4.43 fps)

March 5, 2019

Oak Bluff Lane Definitive Subdivision
Mounding Analysis for Revised Pond #71P

The following mounding analysis is based on the equations set forth in the "Simplified Solutions for Groundwater Mounding Under Stormwater Infiltration Facilities" by Kaveh Zomorodi (2005).
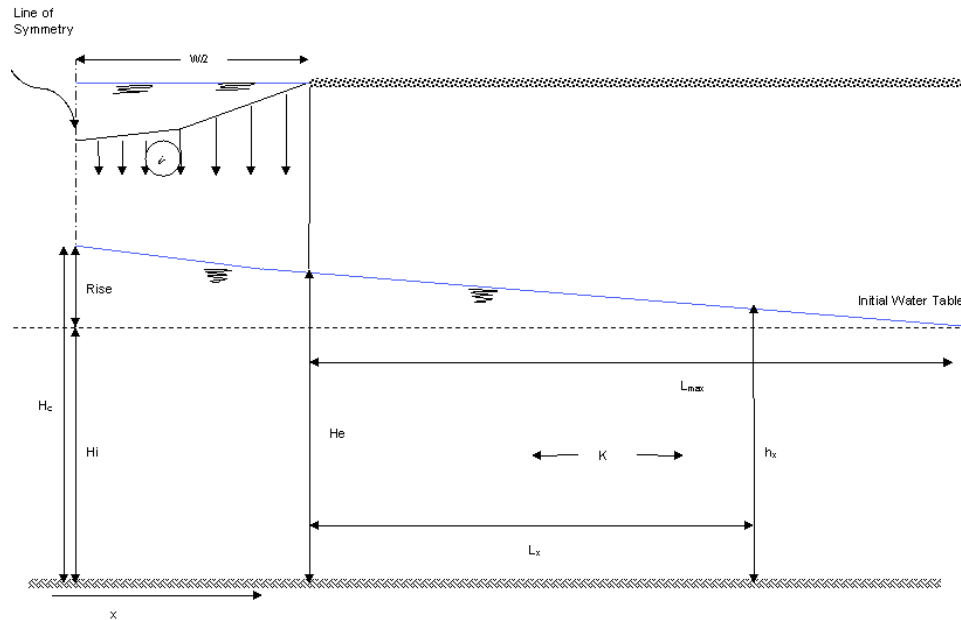

Figure 1. General Layout and Configuration of Mounding under Recharge Strip (Zomorodi, 2005)

The parameters for the mounding analysis are as follows:

$H_c - H_i$ = maximum mound rise at centerline of trench, (ft)

i = average recharge rate in the facility, (ft/day)

W = infiltration basin width, (ft)

K = horizontal saturated hydraulic conductivity of the saturated layer, (ft/day)

H_e = maximum saturated thickness at the edge of channel, (ft)

L_x = any arbitrary distance from the channel edge, (ft)

L_{max} = maximum distance of influence of the mound beyond which mound rise is negligible, ((ft)

h_x = thickness of saturated layer at distance L_x, (ft)

The parameters for the proposed drainage infiltration basin are as follows:

i = 0.02 ft/day (see calculation below)

W = ±16 ft

K = 0.72 ft/day (see attached NRCS Web Soil Survey data, 2.55 micrometers per second)

Calculations for i:

R_{avg} = average rainfall in Leicester = 48 inches (Worcester, MA)

V_1 = system storage volume for 1 inch rainfall depth = 147 ft^3

A_{bt} = bottom surface area of infiltration basin (Sand Bottom Elev. 863.7) = 967 ft^2

Therefore: $i = \dfrac{147 \text{ ft}^3}{} \quad \dfrac{48 \text{ storms}}{} \quad \dfrac{\text{year}}{} = 0.02 \text{ ft/day}$

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$$967 \text{ ft}^2 \quad\quad \text{year} \quad\quad 365 \text{ days}$$

Equation 3 for Mound Rise at center of Trench (Zomorodi, 2005)

$$(H_c - H_i) = \frac{0.86\ (i)\ (W)}{(K - i)} = \frac{0.86\ (0.02)\ (16.0)}{(0.72 - 0.02)} = \mathbf{0.4\ ft}$$

Equation for Maximum Lateral Distance Extent (Zomorodi, 2005)

$$L_{max} = \frac{1.72\ (K)\ (W)}{(K - i)} - \frac{W}{4(K)} = \frac{1.72\ (0.72)\ (16.0)}{(0.72 - 0.02)} - \frac{16.0}{4(0.72)} = \mathbf{22.8\ ft}$$

Based on the above calculations, the predicted groundwater mound rise under the centerline of the proposed infiltration basin (Pond #71P) is 0.4 ft. The high side of the basin bottom has been set at existing grade (869.5). The separation between the bottom of the proposed infiltration basin and the estimated high groundwater table at this location is approximately 2.8 feet (TP-71P, ESHGWT = 34"). Therefore with the predicted groundwater mound rise, there will be ±2.4 feet of separation between the bottom of the basin at the high side of the basin and the high point of the groundwater mound rise.

In addition, the maximum lateral distance extent of 22.8 feet would be within the outer shoulder of the infiltration basin access drive which has a design elevation of 873.3 feet so there would be no issue with breakout and bank erosion due to the minimal mounding effects of the proposed infiltration basin.

Should you have any other questions or require additional information prior to the meeting please call me as soon as possible.

Respectfully yours,
GRAZ Engineering, L.L.C.

Brian MacEwen, P.L.S., E.I.T.
Project Manager   Paul Grasewicz, P.E., P.L.S.

BCM/PFG/bcm

cc: Matt Schold, Central Land Development Corp.
           Paul Grasewicz, GRAZ Engineering, LLC

Site Recharge to Groundwater　　　　　　　　　　*"Static Method"*

Soil type:　　　　　　　　　　　　　　　 **C** 　　　　　　 Rawls Rate: 　 0.27 　 In./Hr.
Impervious Area (A1):　　　　　　　 42,408 　s.f.

Soil type:　　　　　　　　　　　　　　　 **D**
Impervious Area (A2):　　　　　　　 13,114 　s.f.

Hydrologic Group	Target Depth Factor (F)	
A	0.60	inches
B	0.35	inches
C	0.25	inches
D	0.1	inches

Determine the required recharge volume:

Rv = F x impervious area

Rv = Required Recharge Volume
F = Target Depth Factor

	F"HSGC" x A1		F"HSGD" x A2			
Rv =	10,602	+	1,311	=	993	Cu.Ft.
	12 in. / ft.		12 in. / ft.			

From Hydrocad determine the elevation that will hold back the required recharge volume:

Below is a excerpt from the stage storage table of Infiltration Pond 71P.
Required Site Rv= 　993　　　　　　Cu.Ft., the minimum low level outlet required = 　869.39

Stage Storage Volumes

Elevation	Surface Area	Inc. Storage	Cum. Storage		
(Ft.)	(Sq.Ft.)	(Cu. Ft.)	(Cu. Ft.)		
868.5	0	0	0		
869	1,015	254	254	869.39	El. At Rv Min.
869.5	2,765	945	1,199		
870	3,166	1,483	2,682	2385	Rv at LLO
871	4,010	3,588	6,270		
872	6,156	5,083	11,353		
873	7,450	6,803	18,156		
873.3	11,664	2,867	21,023		

The Low Level Outlet (LLO) has been designed at elevation: 　869.80

Determine if the infiltration BMP will drain completely within 72 hours:

Time drawdown = $\dfrac{Rv}{(K)\ (Bottom\ Area)}$

Rv = Storage Volume at Low Level Outlet (LLO) Elevation
K = Saturated Hydraulic Conductivity (Rawls Rate)
Bottom area = Bottom surface area not including sidewall

Time drawdown =	2,385			=	41	hours
	0.27	*	2,571			
	12 in. / ft.					

Result is satisfactory for design purposes	41	hrs. < 72 hrs.