GRAZ Engineering, L.L.C.

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

Transmittal

To: Planning Board
Company: Town of Leicester
Address: 3 Washburn Square
City/State: Leicester, MA 01524

Subject: Revised Oak Bluff Lane Definitive Plans
Date: March 5, 2019
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**

2	**copies**	**Oak Bluff Lane Definitive Subdivision Revision Letter dated 3/5/19**
2	**copies**	**Revised Oak Bluff Lane Definitive Subdivision Plans dated 3/5/19 (Full Size Plans)**
4	**copies**	**Revised Oak Bluff Lane Definitive Subdivision Plans dated 3/5/19 (11" x 17" Plans)**
2	**copies**	**Revised Stormwater & Hydrology & Stormwater Documents dated 3/5/19**
2	**copies**	**Vehicle Tracking Worksheet Plan dated 3/5/19**
2	**copies**	**Intersection Sight Distance Worksheet dated 3/5/19**
1	**CD**	**Revised PDF Digital Copy of Submittal Materials dated 3/5/19**
	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.

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March 5, 2019

Michelle Buck, Planner
Leicester Planning Board
3 Washburn Square
Leicester, MA 01524

Subject: Oak Bluff Lane
Definitive Subdivision Revision 1

Dear Ms. Buck:

GRAZ Engineering, L.L.C. (GRAZ) has received and reviewed the following letters regarding technical review and comments of the proposed Oak Bluff Lane Definitive Subdivision to be located off Baldwin Street.

- Quinn Engineering, Inc. (QEI), dated December 24, 2018 by Mr. Kevin Quinn, P.E.
- Leicester Board of Health, dated December 5, 2018
- Leicester Highway Department, dated December 18, 2018
- Leicester Police Department, dated January 2, 2019
- Leicester Town Planner, dated January 10, 2019

On behalf of Central Land Development Corp. (Matt Schold) and in response to the above noted letters and subsequent comments received during the Leicester Planning Board (LPB) public hearings to date, GRAZ submits the following item-by-item responses and the revised subdivision plans for final review and approval of the LPB. For simplicity, GRAZ will provide comment on only the items for which revisions have been made for this submittal.

Quinn Engineering, Inc. Letter

Waiver Requests:

Waive §V,A,1,(f): To permit roadway centerline radius of curvature of less than 200 feet. Plans propose radii of 100 feet in one location and 170 feet in another.

The curbing radii have been revised in two locations: namely at the both curb returns at the intersection of the proposed roadway with Baldwin Street and also at the curb return from the main roadway as it enters the cul-de-sac. The attached vehicle tracking plan indicates that the proposed large bus vehicle that will be servicing the roadway daily during the school year can maneuver the roadway with the proposed centerline radii of 100 & 170 feet respectively with the above noted curb return revisions. Note that the curb return radii at Baldwin Street have been designed as a result of providing adequate turning radii for the buses while also trying to minimize the Oak Bluff Lane "throat" onto Baldwin Street as recommended by the Police Chief and the Highway Department.

Waive §VI,E,(3): To waive the installation of required street lights.

In accordance with the comments of the LPB during the public hearing process, the plans have been revised to depict the locations of proposed Lot/Street lights that shall be installed on the individual lots as well as indicating that a street light shall be installed on the relocated utility pole at that intersection of Oak Bluff Lane with Baldwin Street.

Waive §VI,L: To waive the installation of street trees.

In accordance with the comments of the LPB during the public hearing process, the plans have been revised to depict the locations of proposed street trees.

Comments:

1) *Subdivision plans do not assess intersection sight distance: Definitive Subdivision should provide field-verified sight distances on Baldwin Street, and information indicating the required sight distance, based on AASHTO or Massachusetts Highway Department.*

   The current Oak Bluff Lane intersection at Baldwin Street provides an easterly Intersection Sight Distance (ISD) of ±324 feet and a Stopping Sight Distance (SSD) of ±313 feet. The proposed curb cut for Oak Bluff Lane provides an easterly ISD of ±272 feet and a SSD of ±260 feet. Based on the AASHTO & Mass Highways guidelines for the currently posted speed limit of 35 mph on Baldwin Street and accounting for the ±6% downgrade approach to the intersection, this would require an ISD of ±182 feet and a SSD of ±280 feet. Although both distances are in approximation to the standard requirements, given the close proximity (±170 feet) from the intersection of Baldwin Street with Salminen Drive and the existing horizontal & vertical alignment of Baldwin Street, consideration should be given to posting this area at 25 MPH. It is our understanding based on discussions with the Highway Superintendent that this speed reduction may be considered by the Police Department.

2) *On Sheet 8 of 8, on the Fire Cistern Detail, the suction line transitions from 6" dia. SCH40 steel pipe to 6" FRP. It is recommended that the suction line be continuous steel pipe, to minimize the need for joints. The Board may wish to seek input from Fire Chief Wilson on this question.*

   The detail for the suction line connections were prepared at the recommendation of the tank manufacturer, but the Fire Chief will be solicited to determine the Fire Departments preference on this connection.

5) *In the design of both infiltration basins, based on the soil test results, it appears that less than 2 foot separation to groundwater table has been provided, as required by Massachusetts Stormwater Management Policy.*

   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. This pond has been maintained as originally designed due to that existing site topography and the adjacent wetlands. The northern pond (#71P) and its associated sediment forebay has 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).

6) *At the drainage outfall downgrade from Infiltration Basin 71P, HDPE culvert outlets to a flared end section (FES). We recommend that the Flared End Section piece be manufactured of concrete, not HDPE. Concrete stands up to the elements better than HDPE, and better withstands impacts.*

   The FES has been revised to be a reinforced concrete unit.

I trust that this information will assist the Planning Board in their finalization of the "Decision" and "Conditions of Approval" of the Applicant's application for "Definitive Subdivision Approval". Should you have any other questions or require additional information prior to the next 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

TABLE OF PRE AND POST TOTAL FLOWS FOR ANALYSIS POINTS OF 2, 10, 25, & 100 YR STORMS (CFS)				
	2	*10*	*25*	*100*
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*

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)

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**

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)

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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).

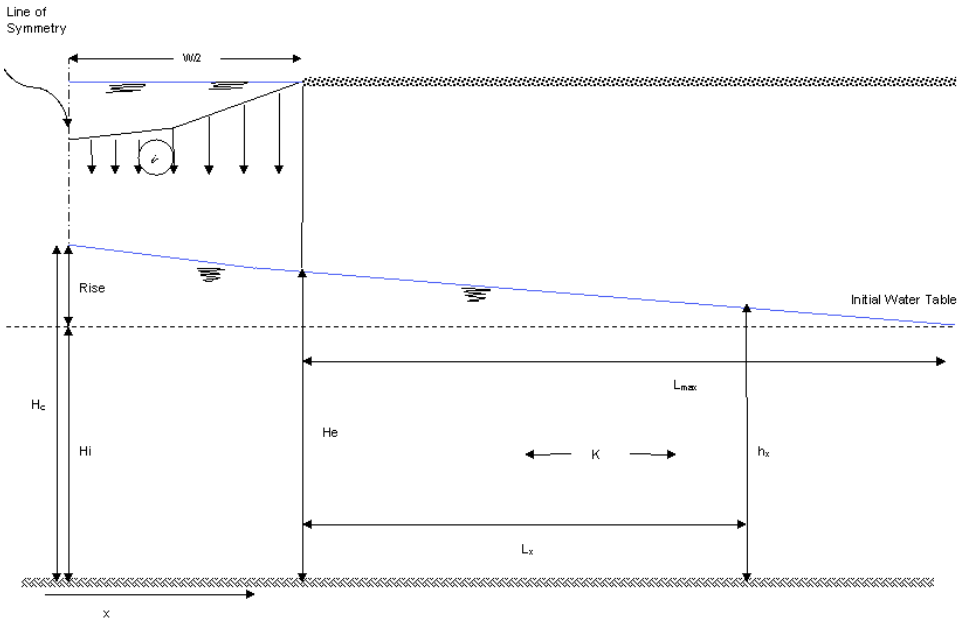

Figure 1. General Layout and Configuration of Mounding under Recharge Strip (Zomorodi, 2005)

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

967 ft^2 year 365 days

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

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

Equation for Maximum Lateral Distance Extent (Zomorodi, 2005)

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

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

$$Rv = \frac{F"HSGC" \times A1}{12 \text{ in./ft.}} + \frac{F"HSGD" \times A2}{12 \text{ in./ft.}} = 993 \text{ Cu.Ft.}$$

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 (Ft.)	Surface Area (Sq.Ft.)	Inc. Storage (Cu. Ft.)	Cum. Storage (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:

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

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

$$\text{Time drawdown} = \frac{2{,}385}{\frac{0.27}{12 \text{ in./ft.}} * 2{,}571} = 41 \text{ hours}$$

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