ALAN ENGINEERING, L.L.C.
288 Littleton Road, Suite 31
Westford, MA 01886
(978) 577-6444
alan.eng@verizon.net

June 28, 2016

Scott Seaver
Seaver Construction, Inc.
215 Lexington Street
Woburn, MA 01801

Ref: Drainage Analysis
47 Spy Pond Lane – Lot 2
Arlington, MA

Dear Mr. Seaver:

Alan Engineering has prepared the following drainage analysis of the proposed house on Lot 2 at 47 Spy Pond Lane in Arlington, MA.

This analysis compares runoff generated from the existing site to the runoff that will be generated from the site after the construction of the new house. In accordance with the requirements of the Arlington Conservation Commission the 10-year, 25-year, and 100-year storm events were analyzed. The storm events were 24-hour rainfalls with a Type III rainfall distribution. The rainfall amounts were based on the “Cornell Study”.

The proposed lot will contain 8,784 square feet of land. Under the existing conditions the lot contains 2,406 square feet of impervious area. The proposed site will contain a total of 2,588 square feet of impervious area.

The increase in impervious area will result in an increase in the rate and volume of runoff. In order to mitigate the increase a subsurface roof drain infiltration system is proposed. A roof gutter and downspout system will collect all roof runoff and discharge it into a subsurface system located at the rear of the proposed house. The system will collect and recharge a portion of the roof runoff that is slightly greater than the increase in runoff volume generated by the proposed site development. The result is a decrease in both the peak rate and total volume of runoff from the site. The results of the analysis are summarized in the table below.

Test pits were excavated on the lot on June 28, 2016 to determine the permeability of the soil and the depth to groundwater. All test pits had approximately 5 feet of fill above the original ground. The underlying native soil is fine sand. A percolation test yielded a rate of 1 minute per inch. This is indicative of hydrologic soil group (HSG) A. The estimated seasonal high groundwater ranged from 54 inches to 66 inches below the ground surface in 3 of the 4 test holes, and 90 inches below the ground surface in the higher of the 4 test holes.

Comparative Hydrologic Summary

47 Spy Pond Lane - Lot 2

Arlington, MA

June 28, 2016

10 Year Storm - 4.80 inches

Point of Analysis	Pre-Development		Post Development	
	Peak Rate (c.f.s.)	Volume (ac-ft)	Peak Rate (c.f.s.)	Volume (ac-ft)
Total Runoff	0.05	0.008	0.01	0.003

50 Year Storm - 7.06 inches

Point of Analysis	Pre-Development		Post Development	
	Peak Rate (c.f.s.)	Volume (ac-ft)	Peak Rate (c.f.s.)	Volume (ac-ft)
Total Runoff	0.29	0.024	0.13	0.013

100 Year Storm - 8.48 inches

Point of Analysis	Pre-Development		Post Development	
	Peak Rate (c.f.s.)	Volume (ac-ft)	Peak Rate (c.f.s.)	Volume (ac-ft)
Total Runoff	0.49	0.037	0.25	0.023

Please feel free to contact me with any questions or comments.

Very truly yours,

ALAN ENGINEERING, L.L.C.

Mark A. Sleger, P.E.
Manager

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ALAN ENGINEERING, L.L.C.

SOIL EVALUATION REPORT

Job Number 1140 Client SEAVER CONSTRUCTION
Site Address 47 SPY POND LANE Town ARLINGTON

Current Use RESIDENTIAL
Site Description SINGLE FAMILY RESIDENCE
Land Form GROUND MORRAINE
Vegetation LAWN
Water Supply TOWN

Deep Hole No AE-1 Date 6/28/2016
Soil Evaluator M. SLEGER Temperature 65°
Local Official N/A Weather CLOUDY - LIGHT RAIN

Horizon	Depth	Classification	Color	Comments
FILL	0-54"	SANDY LOAM	—	SOME GRAVEL
C	54-126	FINE SAND	10YR 5/4	

Seepage	Standing	Mottling	Color	ESHWT	Roots	Refusal
108"	—	60"	2.5Y 6/3	60"	72"	—

Deep Hole No AE-2

Horizon	Depth	Classification	Color	Comments
FILL	0-60"	SANDY FILL	—	MOTTLING IN SAND FILL
A	60-69"	SANDY LOAM	10YR 2/2	
B	69-78"	FINE SAND	10YR 4/6	
C	78-120	FINE SAND	10YR 5/4	

Seepage	Standing	Mottling	Color	ESHWT	Roots	Refusal
108"	108"	54"		54"	78"	—

Deep Hole No AE-3

Horizon	Depth	Classification	Color	Comments
FILL	0-60"	SANDY FILL	—	
C1	60"-138"	FINE SAND	10YR 5/4	

Seepage	Standing	Mottling	Color	ESHWT	Roots	Refusal
—	—	90"	2.5Y 6/3	90"	96"	—

Deep Hole No AE-4

Horizon	Depth	Classification	Color	Comments
FILL	0-66"	SANDY FILL		
C1	66-114"	FINE SAND	10YR 5/4	

Seepage	Standing	Mottling	Color	ESHWT	Roots	Refusal
—	—	66"	2.5Y 6/3	66"		

ALAN ENGINEERING, L.L.C.

SOIL EVALUATION REPORT

Job Number 1140 Client SCAUER CONST.

Site Address 47 SPY POND LANE Town ARLINGTON

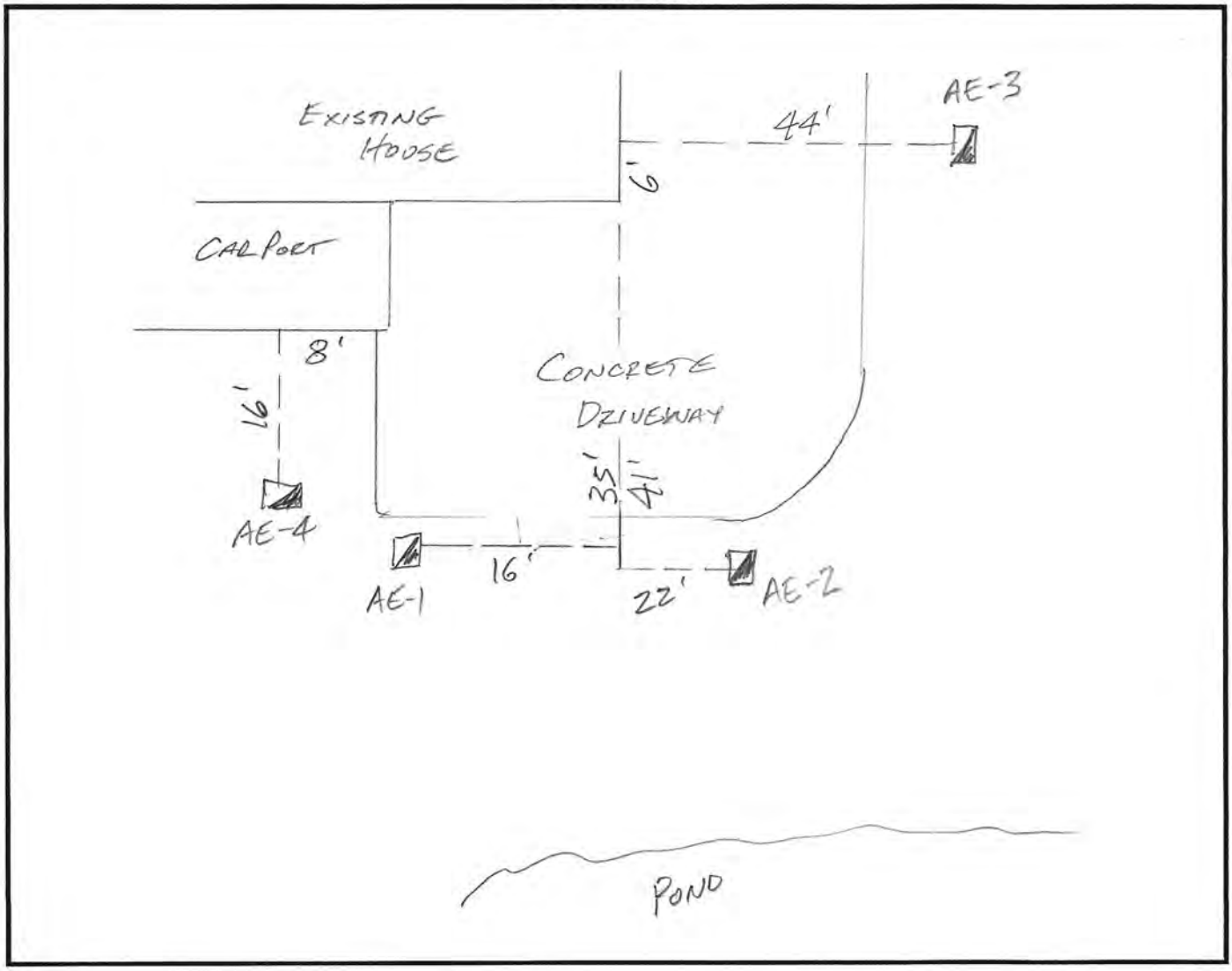
PERCOLATION TESTS

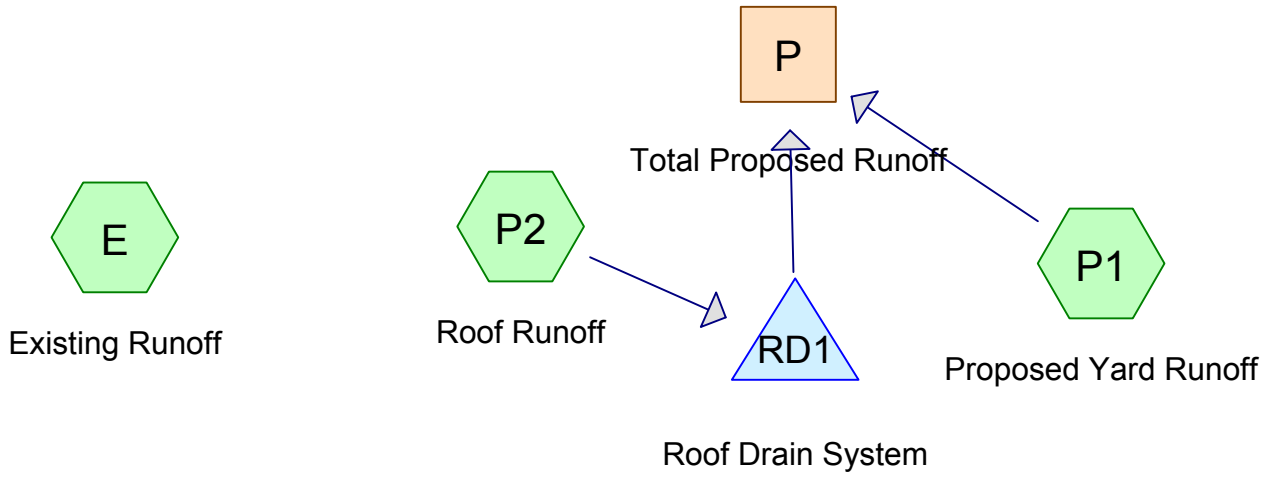
Soil Evaluator M. SLEGER Date 6/28/2016 Temperature 65°

Local Official N/A Weather LIGHT RAIN

Deep Hole No	AE-1				
Depth to Bottom	84"				
Soil Classification	FINE SAND				
Start Pre Soak	9:02				
Start of Test - 12"	9:17				
Time at 9"	9:21				
Time at 6"	9:24				
Time from 9" to 6"	3 MIN				
Percolation Rate	1 MIN/INCH				

SITE SKETCH





Subcat Reach Pond Link

Routing Diagram for Lot 2 Drainage Analysis
Prepared by ALAN Engineering, L.L.C.

Summary for Subcatchment E: Existing Runoff

Runoff = 0.05 cfs @ 12.14 hrs, Volume= 0.008 af, Depth> 0.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Storm Rainfall=4.80"

Area (sf)	CN	Adj	Description
2,406	98		Unconnected pavement, HSG A
6,378	39		>75% Grass cover, Good, HSG A
8,784	55	47	Weighted Average, UI Adjusted
6,378			72.61% Pervious Area
2,406			27.39% Impervious Area
2,406			100.00% Unconnected

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

Summary for Subcatchment P1: Proposed Yard Runoff

Runoff = 0.01 cfs @ 12.39 hrs, Volume= 0.003 af, Depth> 0.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Storm Rainfall=4.80"

Area (sf)	CN	Adj	Description
588	98		Unconnected pavement, HSG A
6,196	39		>75% Grass cover, Good, HSG A
6,784	44	42	Weighted Average, UI Adjusted
6,196			91.33% Pervious Area
588			8.67% Impervious Area
588			100.00% Unconnected

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

Summary for Subcatchment P2: Roof Runoff

Runoff = 0.22 cfs @ 12.07 hrs, Volume= 0.017 af, Depth> 4.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Storm Rainfall=4.80"

Area (sf)	CN	Description
2,000	98	Roofs, HSG A
2,000		100.00% Impervious Area

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

Summary for Reach P: Total Proposed Runoff

Inflow Area = 0.202 ac, 29.46% Impervious, Inflow Depth > 0.20" for 10-Year Storm event
Inflow = 0.01 cfs @ 12.39 hrs, Volume= 0.003 af
Outflow = 0.01 cfs @ 12.39 hrs, Volume= 0.003 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond RD1: Roof Drain System

Inflow Area = 0.046 ac,100.00% Impervious, Inflow Depth > 4.56" for 10-Year Storm event
Inflow = 0.22 cfs @ 12.07 hrs, Volume= 0.017 af
Outflow = 0.05 cfs @ 11.72 hrs, Volume= 0.017 af, Atten= 78%, Lag= 0.0 min
Discarded = 0.05 cfs @ 11.72 hrs, Volume= 0.017 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 270.02' @ 12.46 hrs Surf.Area= 262 sf Storage= 153 cf

Plug-Flow detention time= 14.3 min calculated for 0.017 af (100% of inflow)
Center-of-Mass det. time= 14.2 min (761.5 - 747.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	269.00'	198 cf	**11.25'W x 23.25'L x 2.54'H Field A** 665 cf Overall - 169 cf Embedded = 496 cf x 40.0% Voids
#2A	269.50'	169 cf	**Cultec R-150XLHD** x 6 Inside #1 Effective Size= 29.8"W x 18.0"H => 2.65 sf x 10.25'L = 27.2 cf Overall Size= 33.0"W x 18.5"H x 11.00'L with 0.75' Overlap Row Length Adjustment= +0.75' x 2.65 sf x 3 rows
		367 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	269.00'	**8.270 in/hr Exfiltration over Horizontal area**
#2	Primary	271.00'	**4.0" Round Culvert X 2.00** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 271.00' / 270.90' S= 0.0200 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.09 sf

Discarded OutFlow Max=0.05 cfs @ 11.72 hrs HW=269.03' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=269.00' (Free Discharge)
↑—**2=Culvert** (Controls 0.00 cfs)

Summary for Subcatchment E: Existing Runoff

Runoff = 0.29 cfs @ 12.09 hrs, Volume= 0.024 af, Depth> 1.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Storm Rainfall=7.06"

Area (sf)	CN	Adj	Description
2,406	98		Unconnected pavement, HSG A
6,378	39		>75% Grass cover, Good, HSG A
8,784	55	47	Weighted Average, UI Adjusted
6,378			72.61% Pervious Area
2,406			27.39% Impervious Area
2,406			100.00% Unconnected

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

Summary for Subcatchment P1: Proposed Yard Runoff

Runoff = 0.13 cfs @ 12.11 hrs, Volume= 0.013 af, Depth> 1.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Storm Rainfall=7.06"

Area (sf)	CN	Adj	Description
588	98		Unconnected pavement, HSG A
6,196	39		>75% Grass cover, Good, HSG A
6,784	44	42	Weighted Average, UI Adjusted
6,196			91.33% Pervious Area
588			8.67% Impervious Area
588			100.00% Unconnected

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

Summary for Subcatchment P2: Roof Runoff

Runoff = 0.33 cfs @ 12.07 hrs, Volume= 0.026 af, Depth> 6.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 50-Year Storm Rainfall=7.06"

Area (sf)	CN	Description
2,000	98	Roofs, HSG A
2,000		100.00% Impervious Area

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

Summary for Reach P: Total Proposed Runoff

Inflow Area = 0.202 ac, 29.46% Impervious, Inflow Depth > 0.79" for 50-Year Storm event
Inflow = 0.13 cfs @ 12.11 hrs, Volume= 0.013 af
Outflow = 0.13 cfs @ 12.11 hrs, Volume= 0.013 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond RD1: Roof Drain System

Inflow Area = 0.046 ac,100.00% Impervious, Inflow Depth > 6.82" for 50-Year Storm event
Inflow = 0.33 cfs @ 12.07 hrs, Volume= 0.026 af
Outflow = 0.05 cfs @ 11.63 hrs, Volume= 0.026 af, Atten= 85%, Lag= 0.0 min
Discarded = 0.05 cfs @ 11.63 hrs, Volume= 0.026 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 270.88' @ 12.54 hrs Surf.Area= 262 sf Storage= 296 cf

Plug-Flow detention time= 31.7 min calculated for 0.026 af (100% of inflow)
Center-of-Mass det. time= 31.6 min (773.1 - 741.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	269.00'	198 cf	**11.25'W x 23.25'L x 2.54'H Field A** 665 cf Overall - 169 cf Embedded = 496 cf x 40.0% Voids
#2A	269.50'	169 cf	**Cultec R-150XLHD** x 6 Inside #1 Effective Size= 29.8"W x 18.0"H => 2.65 sf x 10.25'L = 27.2 cf Overall Size= 33.0"W x 18.5"H x 11.00'L with 0.75' Overlap Row Length Adjustment= +0.75' x 2.65 sf x 3 rows
		367 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	269.00'	**8.270 in/hr Exfiltration over Horizontal area**
#2	Primary	271.00'	**4.0" Round Culvert X 2.00** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 271.00' / 270.90' S= 0.0200 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.09 sf

Discarded OutFlow Max=0.05 cfs @ 11.63 hrs HW=269.03' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.05 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=269.00' (Free Discharge)
↑—**2=Culvert** (Controls 0.00 cfs)

Summary for Subcatchment E: Existing Runoff

Runoff = 0.49 cfs @ 12.09 hrs, Volume= 0.037 af, Depth> 2.21"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Storm Rainfall=8.48"

Area (sf)	CN	Adj	Description
2,406	98		Unconnected pavement, HSG A
6,378	39		>75% Grass cover, Good, HSG A
8,784	55	47	Weighted Average, UI Adjusted
6,378			72.61% Pervious Area
2,406			27.39% Impervious Area
2,406			100.00% Unconnected

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

Summary for Subcatchment P1: Proposed Yard Runoff

Runoff = 0.25 cfs @ 12.09 hrs, Volume= 0.022 af, Depth> 1.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Storm Rainfall=8.48"

Area (sf)	CN	Adj	Description
588	98		Unconnected pavement, HSG A
6,196	39		>75% Grass cover, Good, HSG A
6,784	44	42	Weighted Average, UI Adjusted
6,196			91.33% Pervious Area
588			8.67% Impervious Area
588			100.00% Unconnected

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

Summary for Subcatchment P2: Roof Runoff

Runoff = 0.40 cfs @ 12.07 hrs, Volume= 0.032 af, Depth> 8.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Storm Rainfall=8.48"

Area (sf)	CN	Description
2,000	98	Roofs, HSG A
2,000		100.00% Impervious Area

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

Summary for Reach P: Total Proposed Runoff

Inflow Area = 0.202 ac, 29.46% Impervious, Inflow Depth > 1.40" for 100-Year Storm event
Inflow = 0.25 cfs @ 12.09 hrs, Volume= 0.023 af
Outflow = 0.25 cfs @ 12.09 hrs, Volume= 0.023 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond RD1: Roof Drain System

Inflow Area = 0.046 ac,100.00% Impervious, Inflow Depth > 8.23" for 100-Year Storm event
Inflow = 0.40 cfs @ 12.07 hrs, Volume= 0.032 af
Outflow = 0.14 cfs @ 12.30 hrs, Volume= 0.032 af, Atten= 64%, Lag= 13.9 min
Discarded = 0.05 cfs @ 11.59 hrs, Volume= 0.030 af
Primary = 0.09 cfs @ 12.30 hrs, Volume= 0.002 af

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 271.16' @ 12.30 hrs Surf.Area= 262 sf Storage= 328 cf

Plug-Flow detention time= 33.0 min calculated for 0.032 af (100% of inflow)
Center-of-Mass det. time= 32.9 min (772.0 - 739.1)

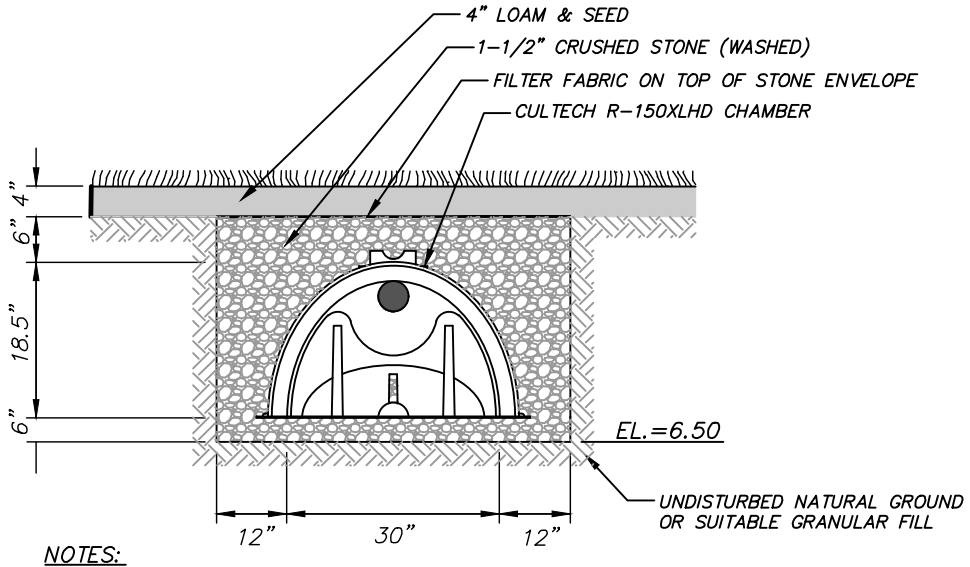
Volume	Invert	Avail.Storage	Storage Description
#1A	269.00'	198 cf	**11.25'W x 23.25'L x 2.54'H Field A** 665 cf Overall - 169 cf Embedded = 496 cf x 40.0% Voids
#2A	269.50'	169 cf	**Cultec R-150XLHD** x 6 Inside #1 Effective Size= 29.8"W x 18.0"H => 2.65 sf x 10.25'L = 27.2 cf Overall Size= 33.0"W x 18.5"H x 11.00'L with 0.75' Overlap Row Length Adjustment= +0.75' x 2.65 sf x 3 rows
		367 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	269.00'	**8.270 in/hr Exfiltration over Horizontal area**
#2	Primary	271.00'	**4.0" Round Culvert X 2.00** L= 5.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 271.00' / 270.90' S= 0.0200 '/' Cc= 0.900 n= 0.010 PVC, smooth interior, Flow Area= 0.09 sf

Discarded OutFlow Max=0.05 cfs @ 11.59 hrs HW=269.03' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.05 cfs)

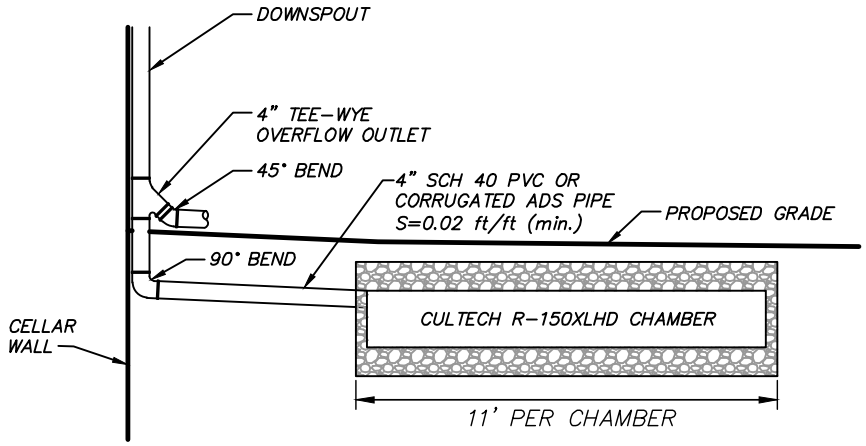
Primary OutFlow Max=0.09 cfs @ 12.30 hrs HW=271.16' (Free Discharge)
↑**2=Culvert** (Inlet Controls 0.09 cfs @ 1.09 fps)



NOTES:
REMOVE ALL TOP AND SUBSOIL AND ANY ORGANIC OR OTHERWISE UNSUITABLE MATERIAL TO A DEPTH OF 2 FEET BENEATH STONE.

ROOF DRAIN LEACHING CHAMBER

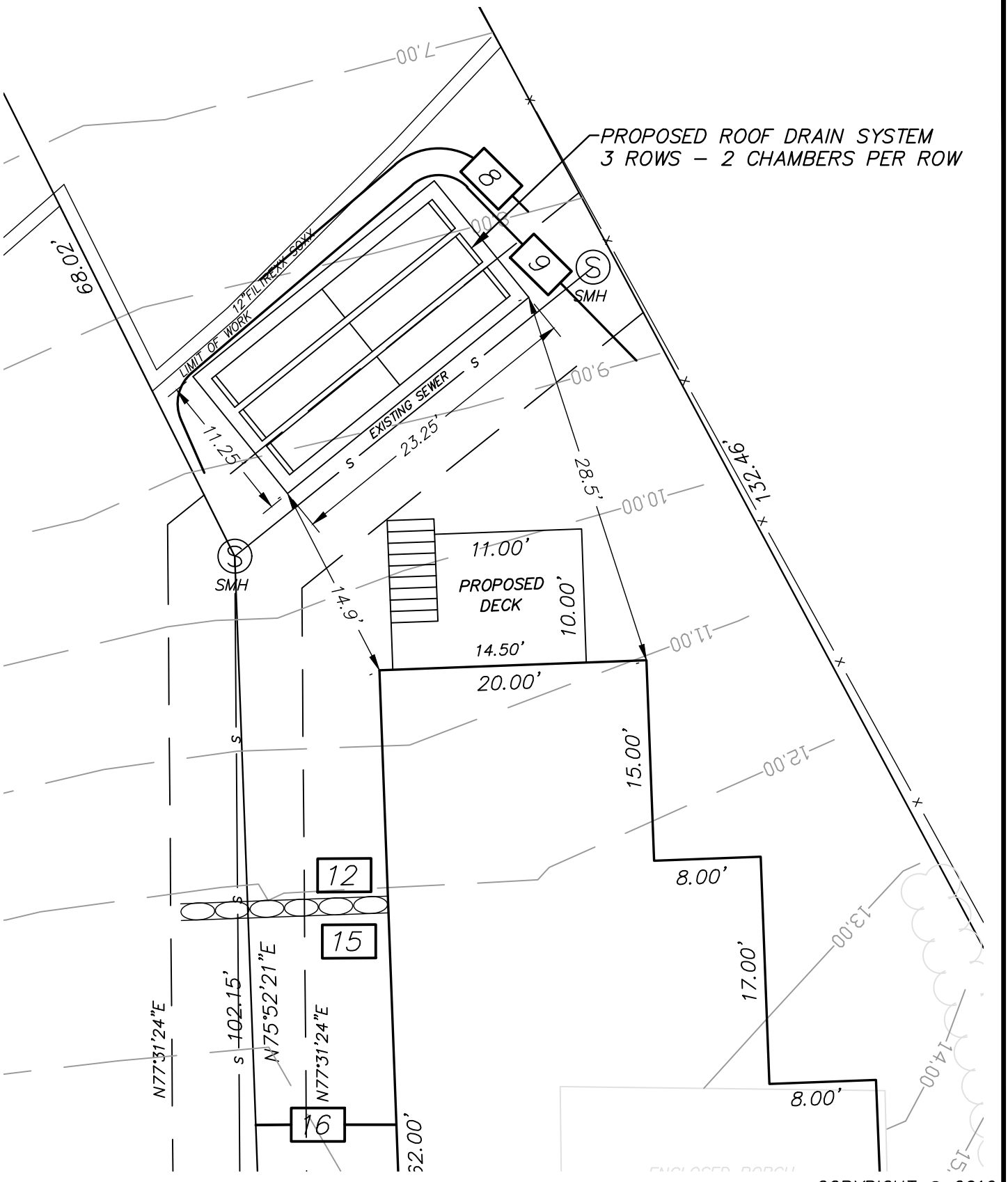
NOT TO SCALE



ROOF DRAIN DETAIL

NOT TO SCALE

ROOF DRAIN DETAIL 47 SPY POND LANE LOT 2 ARLINGTON, MA	ALAN ENGINEERING, L.L.C. 288 LITTLETON ROAD, SUITE 31 WESTFORD, MA 01886	JOB NO. 1140 JUNE 28, 2016 SCALE: AS SHOWN	DWG NO SHEET 1 of 2



ROOF DRAIN DETAIL 47 SPY POND LANE LOT 2 ARLINGTON, MA	ALAN ENGINEERING, L.L.C. 288 LITTLETON ROAD, SUITE 31 WESTFORD, MA 01886	JOB NO. 1140 JUNE 28, 2016 SCALE: 1" = 10'	DWG NO SHEET 2 of 2