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CIVIL ENGINEERING - LAND DEVELOPMENT - SITE PLANS - STORMWATER MANAGEMENT

Stormwater Management Report
For Land Use Commissions Submittals
Avery Brook Homes Subdivision,
Stoddards Warf Road, Ledyard, Connecticut

May 20, 2024

EXISTING CONDITIONS: Reference is made to the following Plan Set: "Plan Showing Resubdivision Property of Avery Brook Homes LLC 96, 98 and 100 Stoddards Wharf Road, A.K.A. Connecticut Route 214 Ledyard, Connecticut" Scales as Shown , March 2024, By Dieter & Gardner, Gales Ferry, CT. The property is located on the north side of Stoddards Wharf Road approximately one quarter mile east of the intersection of Whalehead Road and Stoddards Wharf Road. The property is wooded. The property drains primarily to the east and north.

STORMWATER MANAGEMENT: The Rational Method was used to analyze stormwater runoff in accordance with the Town of Ledyard's Ordinance Regulating the Management of Stormwater Runoff. This proposal will not increase the peak rate of runoff from the property nor will it increase the potential for downstream flooding. A Pre-Development versus Post- Development analysis is provided on Page 4 of the attached calculations,

WATER QUALITY: The Connecticut D.E.E.P. 2004 Stormwater Quality Manual (SWQM) defines the Water Quality Volume (WQV) as the volume of runoff from a one-inch rainfall event. SWQM Paragraph 7.4.1 states: "In the northeastern U.S., the 90 percent rainfall event is equal to approximately one inch, which is consistent with the recommended WQV sizing criteria for Connecticut." Therefore, by treating the WQV, the proposal effectively meets the requirements of the SWQM.

The subsoil throughout the property consists of sand and gravel with no evidence of seasonally high ground water. The soil conditions are excellent for infiltrating storm water. Therefore, roof runoff from each of the proposed homes will have an infiltration area, sized to hold and infiltrate the WQV thereby providing groundwater recharge per the SWQM guidelines. Surface water runoff is measurably reduced by infiltrating clean roof runoff back into the groundwater.

Runoff from roadway pavement drains to low-point catch basins and then piped to underground retention/infiltration areas where it is held and infiltrated into the subsoil. Proposed driveways will be gravel and stone to provide additional infiltration. Stormwater runoff leaves the property as sheet flow over wide areas. There are no point-discharges or channelized flows to cause erosion.

CONCLUSION: The proposed development meets the requirements of the Connecticut D.E.E.P. 2004 Stormwater Quality Manual and will not have adverse effects on down-gradient properties. This proposal will not increase the peak rate of runoff from the property nor will it increase the potential for downstream flooding and is in keeping with the policies and goals of the Ledyard Planning and Zoning Commission.

Submitted by:
LBM Engineering, LLC
John R. Martucci, P.E.

PREPARED BY	DATE PREPARED	LBM Engineering, LLC	JOB NUMBER	PAGE NUMBER
JRM	3/2024	11 HALLY LANE COLCHESTER, CONNECTICUT 06415 TEL: (860)-416-9809 EMAIL: JOHN@LBMENGINEERING.COM		1
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AVERY BROOK - DRAINAGE

AREA A — SEE RATIONAL METHOD NOTE ON PAGE 3

I = 5.5"/HR

PAVEMENT

16,395 SF — 290' x 11' = 3190 SF — 0.07 AC — TO CB2

0.38 AC.

0.38 AC − 0.07 = 0.31 AC. OVERLAND

Q_{25} = 0.31 x 0.21 x 5.5 = 0.4 CFS

POST DEVELOPMENT: PAVEMENT WILL GO TO CB1 AND THEN TO RETENTION AREA 1. REMAINDER WILL SHEET FLOW OFF

AREA B

30,900 SF = 0.71 AC

PAVEMENT

290'x11' = 3190 SF = 0.07 AC

TO RETENTION AREA 1

0.71 AC − 0.07 AC = 0.64 AC OVERLAND

2 HOUSES − 0.04 AC — 0.60 AC O'LAND

PAVT	0.07 x 0.95 =	0.067	
O'LAND	0.60 x 0.21 =	0.126	
		0.193	0.193/0.67 = 0.29 (WEIGHTED C)

Q_{25} = 0.67 x 0.29 x 5.5 = 1.1 CFS

AREA C

83,740 SF = 1.92 AC − (6 HOUSES) 0.12 AC

1.8 ACRES O'LAND

Q_{25} = 1.8 x 0.21 x 5.5 = 2.1 CFS

ROOF RUNOFF

ROOF RUNOFF FROM EACH LOT WILL BE INFILTRATED

36'x24' = 864 FT² — 864/12 = 72 FT³/INCH

(0.02 Ac.)

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AREA D

49,342 SF = 1.13 AC − 10,600 SF PAVEMENT = 0.24 AC

1.13 AC − (0.24 + (4 HOUSES) + 0.08 AC) = 0.81 AC O'LAND

0.24 × 0.95 = 0.228

0.81 × 0.21 = 0.170

0.398 WEIGHTED "C"

0.398 / 1.05 = 0.38

0.38 × 1.05 × 5.5 = 2.2 CFS

AREA E

17,680 SF = 0.41 AC − (1 HOUSE) 0.02 AC = 0.39 AC O'LAND

0.39 × 0.21 × 5.5 = 0.5 CFS

AREA F

21,620 SF = 0.50 AC − (1 HOUSE) 0.02 AC = 0.48 AC O'LAND

0.48 × 0.21 × 5.5 = 0.6 CFS

AREA G

54,165 SF = 1.24 AC − (4 HOUSES) 0.08 AC = 1.16 AC O'LAND

Q_{25} 1.16 × 0.21 × 5.5 = 1.3 CFS

TO CB1

10 MIN T_c 25 YR INTENSITY = 5.5 "/HR

O'LAND RUNOFF C FOR TYPE A SOIL 0.21 (CONSERVATIVE)
FOR PAVEMENT 0.95

AREA B		A x C
PAVT	0.07 x 0.95 =	0.067
O'LAND	0.60 x 0.21 =	0.126

(0.067 + 0.126) / 0.67 AC
WEIGHTED C = 0.288

Q TO CB1 = 0.67 x 0.288 x 5.5 = 1.06 CFS

TO CB2

10 MIN T_c 25 YR I = 5.5 "/HR

A = 290' x 11' = 3190 SF = 0.07 AC

Q = C x I x A C = 0.95 A = 0.07 Ac A x C = 0.07 x 0.95
= 0.066

Q = 0.066 x 5.5 "/HR = 0.4 CFS

RATIONAL METHOD NOTE: RATIONAL METHOD WAS USED TO COMPUTE PEAK RATES OF RUNOFF. DRAINAGE AREAS ARE SMALL (< 2 ACRES)

Q_{25} = C I A C PAVEMENT = 0.95 C OVERLAND = 0.21
T_c = 10 MIN. I = 5.5 "/HR

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J. MARTUCCI	5/2024	11 HALLY LANE COLCHESTER, CONNECTICUT 06415 TEL: (860)-416-9809 EMAIL: JOHN@LBMENGINEERING.COM		4
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PRE VS. POST PEAK RATE OF RUNOFF COMPARISON

100 YR RAINFALL / C OVERLAND = 0.21 / 10 MIN T_c / I = 6.5"/HR

AREA A
PRE 0.38 AC × 0.21 × 6.5 = 0.52 CFS
POST FLOWS TO INFILTRATION AREA 1

AREA B
PRE 0.71 AC × 0.21 × 6.5 = 0.97 CFS
POST FLOWS TO INFLTN AREA 1
INFILTRATION AREA 1 POST INFLOW = 2.03 CFS OUTFLOW 0.25 CFS

AREA C
PRE 1.92 AC × 0.21 × 6.5 = 2.62 CFS
POST (REMOVE HOUSES) 1.80 AC × 0.21 × 6.5 = 2.46 CFS

AREA D
PRE 1.13 AC × 0.21 × 6.5 = 1.54 CFS
POST FLOWS TO INFLTN AREA 2: INFLOW 2.46 CFS
OUTFLOW 1.19 CFS

AREA E
PRE 0.41 AC × 0.21 × 6.5 = 0.56 CFS
POST 0.39 AC × 0.21 × 6.5 = 0.53 CFS

AREA F
PRE 0.50 AC × 0.21 × 6.5 = 0.68 CFS
POST 0.48 AC × 0.21 × 6.5 = 0.65 CFS

AREA G
PRE 1.24 AC × 0.21 × 6.5 = 1.69 CFS
POST 1.16 AC × 0.21 × 6.5 = 1.58 CFS

PEAK OFF PROPERTY: A + B + C + D + E + F + G

PRE 0.52 + 0.97 + 2.62 + 1.54 + 0.56 + 0.68 + 1.69 = 8.58 CFS

INF AREA 1 OUT

POST 0.25 + 2.46 + 1.19 + 0.53 + 0.65 + 1.58 = 6.66 CFS

CONCLUSION: THE PROPOSAL WILL NOT INCREASE PEAK RATE OF RUNOFF FROM THE PROPERTY.

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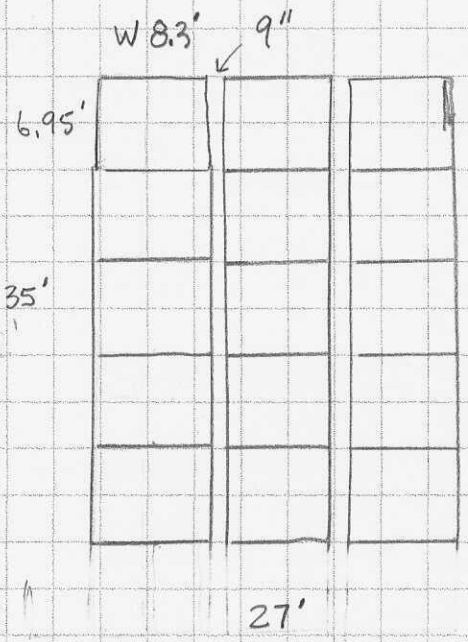
STORMTECH UNDERGROUND RETENTION AREAS



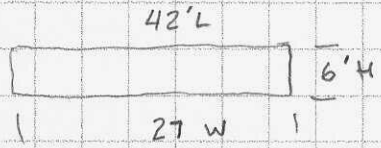
15 STORMTECH MC 7200

INSTALLED STORAGE

267 FT³ / CHAMBER

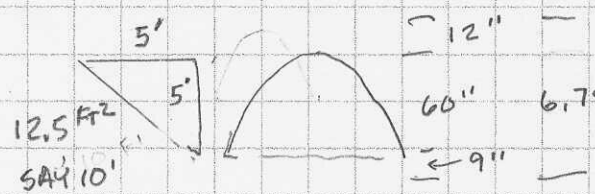
267 × 15 = 4005

TOTAL STORAGE 4005 + 245 = 4250 FT³



TOTAL VOL. 35 × 27 × 6 = 5670

4250/5670 = 75% VOIDS



267 FT³ EACH INSTALLED CHAMBER

10' × 35' EACH SIDE

10' × 35' × 2 = 700 FT³ × 35% VOIDS 245 FT³

4250 / 6 = 708.3' PER FT OF DEPTH

INFILTRATION 1

Subcat Reach Pond Link

Routing Diagram for BASIN 1
Prepared by LBM Engineering LLC, Printed 5/20/2024
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Summary for Subcatchment 1AB: AREA B

Runoff = 2.03 cfs @ 0.17 hrs, Volume= 2,737 cf, Depth= 0.71"
Routed to Pond 2P : INFILTRATION 1

Runoff by Rational method, Rise/Fall=1.0/2.5 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
CT-Ledyard 100-yr Duration=15 min, Inten=6.12 in/hr

Area (ac)	C	Description	Land Use
0.310	0.21	overland Area A	
0.600	0.21	overland Area B	
0.150	0.95	Pavement	
1.060	0.31	Weighted Average	
0.910		85.85% Pervious Area	
0.150		14.15% Impervious Area	

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

Summary for Pond 2P: INFILTRATION 1

Inflow Area = 46,174 sf, 14.15% Impervious, Inflow Depth = 0.71" for 100-yr event
Inflow = 2.03 cfs @ 0.17 hrs, Volume= 2,737 cf
Outflow = 0.25 cfs @ 0.62 hrs, Volume= 81 cf, Atten= 88%, Lag= 26.8 min
Primary = 0.25 cfs @ 0.62 hrs, Volume= 81 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 143.06' @ 0.62 hrs Storage= 2,689 cf

Plug-Flow detention time= 36.6 min calculated for 80 cf (3% of inflow)
Center-of-Mass det. time= 22.1 min (39.3 - 17.2)

Volume	Invert	Avail.Storage	Storage Description
#1	138.00'	3,188 cf	**Custom Stage Data** Listed below 4,250 cf Overall x 75.0% Voids

Elevation (feet)	Cum.Store (cubic-feet)
138.00	0
139.00	708
140.00	1,417
141.00	2,125
142.00	2,833
143.00	3,542
144.00	4,250

Device	Routing	Invert	Outlet Devices
#1	Primary	143.00'	**6.0' 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

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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

Primary OutFlow Max=0.24 cfs @ 0.62 hrs HW=143.06' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.24 cfs @ 0.67 fps)

INFILTRATION 2

Subcat Reach Pond Link

Routing Diagram for BASIN 2
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Summary for Subcatchment 2 D: 2 AREA D

Runoff = 2.46 cfs @ 0.17 hrs, Volume= 3,324 cf, Depth= 0.87"
Routed to Pond 3P : INFILTRATION 2

Runoff by Rational method, Rise/Fall=1.0/2.5 xTc, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
CT-Ledyard 100-yr Duration=15 min, Inten=6.12 in/hr

Area (ac)	C	Description	Land Use
0.810	0.21	Overland Area D	
0.240	0.95	Pavement Area E	
1.050	0.38	Weighted Average	
0.810		77.14% Pervious Area	
0.240		22.86% Impervious Area	

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.0					**Direct Entry, Direct Input - Small Areas**

Summary for Pond 3P: INFILTRATION 2

Inflow Area = 45,738 sf, 22.86% Impervious, Inflow Depth = 0.87" for 100-yr event
Inflow = 2.46 cfs @ 0.17 hrs, Volume= 3,324 cf
Outflow = 1.19 cfs @ 0.47 hrs, Volume= 667 cf, Atten= 52%, Lag= 17.8 min
Primary = 1.19 cfs @ 0.47 hrs, Volume= 667 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-3.00 hrs, dt= 0.01 hrs
Peak Elev= 143.18' @ 0.47 hrs Storage= 2,750 cf

Plug-Flow detention time= 25.1 min calculated for 665 cf (20% of inflow)
Center-of-Mass det. time= 14.4 min (31.6 - 17.2)

Volume	Invert	Avail.Storage	Storage Description
#1	138.00'	3,188 cf	**Custom Stage Data** Listed below 4,250 cf Overall x 75.0% Voids

Elevation (feet)	Cum.Store (cubic-feet)
138.00	0
139.00	708
140.00	1,417
141.00	2,125
142.00	2,833
143.00	3,542
144.00	4,250

Device	Routing	Invert	Outlet Devices
#1	Primary	143.00'	**6.0' 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

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3.30 3.31 3.32

Primary OutFlow Max=1.19 cfs @ 0.47 hrs HW=143.18' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 1.19 cfs @ 1.13 fps)

The final element to be factored into the determination of runoff coefficients is the land slope. As the slope of the drainage basin increases, the selected C value should also increase. This is caused by the fact that as the slope of the drainage area increases, the velocity of overland and channel flow will increase allowing less opportunity for water to infiltrate the ground surface. Thus, more of the rainfall will become runoff from the drainage area.

In summary, it should be reiterated that in assigning a value to the runoff coefficient for use in the rational method, the engineer must rely heavily on experience and judgement.

Table 6-3 Recommended Coefficient Of Runoff For Pervious Surfaces By Selected Hydrologic Soil Groupings And Slope Ranges

Slope	A	B	C	D
Flat (0 - 1%)	0.04-0.09	0.07-0.12	0.11-0.16	0.15-0.20
Average (2 - 6%)	0.09-0.14 USE 0.21	0.12-0.17	0.16-0.21	0.20-0.25
Steep (Over 6%)	0.13-0.18	0.18-0.24	0.23-0.31	0.28-0.38

TYPE A SOIL AVERAGE SLOPE USED 0.21 TO BE CONSERVATIVE

Source: Storm Drainage Design Manual, Erie and Niagara Counties Regional Planning Board.

Table 6-4 Recommended Coefficient Of Runoff Values For Various Selected Land Uses

Description of Area		Runoff Coefficients
Business: Downtown areas		0.70-0.95
Neighborhood areas		0.50-0.70
Residential:	Single-family areas	0.30-0.50
	Multi units, detached	0.40-0.60
	Multi units, attached	0.60-0.75
	Suburban	0.25-0.40
Residential (0.5 ha (1.2 ac) lots or more)		0.30-0.45
Apartment dwelling areas		0.50-0.70
Industrial:	Light areas	0.50-0.80
	Heavy areas	0.60-0.90
Parks, cemeteries		0.10-0.25
Playgrounds		0.20-0.40
Railroad yard areas		0.20-0.40
Unimproved areas		0.10-0.30

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Appendix B - Rainfall

RAINFALL – DURATION – FREQUENCY RELATIONSHIPS FOR CONNECTICUT

DURATION	RETURN FREQUENCY (Years)					
	2	5	10	25	50	100
Min	RAINFALL IN MM (INCHES)					
5	9.1(0.36)	11.4(0.45)	13.0(0.51)	15.2(0.60)	17.2(0.67)	18.5(0.73)
15	18.3(0.72)	22.6(0.89)	25.9(1.02)	30.5(1.20)	34.0(1.34)	37.6(1.48)
60	33.0(1.3)	43.2(1.7)	50.8(2.00)	58.4(2.30)	65.3(2.57)	71.1(2.80)
Hrs						
2	40.6(1.60)	54.6(2.15)	63.5(2.50)	72.4(2.85)	82.6(3.25)	91.4(3.60)
3	44.5(1.75)	61.0(2.40)	69.9(2.75)	82.6(3.25)	90.2(3.55)	101.6(4.00)
6	59.7(2.35)	74.9(2.95)	87.6(3.45)	101.6(4.00)	115.6(4.55)	127.0(5.00)
12	69.9(2.75)	90.2(3.55)	101.6(4.00)	123.2(4.85)	135.9(5.35)	152.4(6.00)
24	82.6(3.25)	106.7(4.20)	125.7(4.95)	146.1(5.75)	161.3(6.35)	177.8(7.00)
	24 HOUR RAINFALL BY COUNTY					
Fairfield	83.8(3.3)	109.2(4.3)	127.0(5.0)	144.8(5.7)	162.6(6.4)	182.9(7.2)
Hartford	81.3(3.2)	104.1(4.1)	119.4(4.7)	139.7(5.5)	157.5(6.2)	175.3(6.9)
Litchfield	81.3(3.2)	104.1(4.1)	119.4(4.7)	139.7(5.5)	157.5(6.2)	177.8(7.0)
Middlesex	83.8(3.3)	106.7(4.2)	127.0(5.0)	142.2(5.6)	160.0(6.3)	180.3(7.1)
New Haven	83.8(3.3)	106.7(4.2)	127.0(5.0)	142.2(5.6)	160.0(6.3)	180.3(7.1)
New London	86.4(3.4)	109.2(4.3)	127.0(5.0)	144.8(5.7)	160.0(6.3)	180.3(7.1)
Tolland	81.3(3.2)	104.1(4.1)	121.9(4.8)	139.7(5.5)	157.5(6.2)	175.3(6.9)
Windham	81.3(3.2)	106.7(4.2)	121.9(4.8)	139.7(5.5)	157.5(6.2)	175.3(6.9)

Sources:

1. "Rainfall Frequency Atlas of the United States", Technical Paper No. 40, U.S. Department of Commerce, Weather Bureau.
2. NOAA Technical Memorandum "NWS Hydro-35", June 1977, U.S. Department of Commerce, National Weather Service.

Table B-1

		RAINFALL INTENSITY (in/hr)					
DURATION (min)	DURATION (hr)	2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
5	0.08	4.6	5.5	6.0	6.7	7.3	7.8
6	0.10	4.4	5.2	5.8	6.5	7.0	7.5
7	0.12	4.2	5.0	5.5	6.2	6.8	7.2
8	0.13	4.0	4.8	5.3	6.0	6.5	7.0
9	0.15	3.8	4.6	5.1	5.7	6.2	6.7
10	0.17	3.6	4.3	4.8	5.5	6.0	6.5
11	0.18	3.4	4.2	4.7	5.3	5.8	6.3
12	0.20	3.3	4.0	4.5	5.1	5.6	6.1
13	0.22	3.1	3.8	4.3	5.0	5.4	5.9
14	0.23	3.0	3.7	4.2	4.8	5.3	5.7
15	0.25	2.8	3.5	4.0	4.6	5.1	5.5
16	0.27	2.8	3.5	3.9	4.5	5.0	5.4
17	0.28	2.7	3.4	3.8	4.4	4.9	5.4
18	0.30	2.7	3.3	3.8	4.4	4.8	5.3
19	0.32	2.6	3.2	3.7	4.3	4.7	5.2
20	0.33	2.5	3.2	3.6	4.2	4.6	5.1
21	0.35	2.5	3.1	3.5	4.1	4.5	5.0
22	0.37	2.4	3.0	3.4	4.0	4.4	4.9
23	0.38	2.3	2.9	3.4	3.9	4.3	4.8
24	0.40	2.3	2.9	3.3	3.8	4.2	4.7
25	0.42	2.2	2.8	3.2	3.7	4.2	4.6
26	0.43	2.2	2.7	3.1	3.7	4.1	4.5
27	0.45	2.1	2.7	3.0	3.6	4.0	4.4
28	0.47	2.0	2.6	3.0	3.5	3.9	4.3
29	0.48	2.0	2.5	2.9	3.4	3.8	4.2
30	0.50	1.9	2.4	2.8	3.3	3.7	4.1

Rainfall Intensity/Duration/Frequency Relationship for Connecticut (English Units)
Table B-2.1