STORMWATER MANAGEMENT REPORT

FOR

A PROPOSED RESIDENTIAL SUBDIVISION
Donahue Lane
NEWBURYPORT, MASSACHUSETTS

Prepared for:
13 North Adams, LLC
9 Pasture Lane
Bedford, NH 03110

Prepared by:

Design Consultants, Inc.
120 Middlesex Avenue, Suite 20
Somerville, Massachusetts 02145-1104

Project 2014-128
March 18, 2015
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1.0 PROJECT DESCRIPTION

The proposed project consists of two new single-family homes, cul-de-sac (hammerhead) roadway, storm water management measures, and associated utilities.

The proposed homes will be served by new underground electric, water, gas and sewer originating from Toppans Lane.

The project will disturb approximately 0.9 acres of land and construction is expected to begin in the fall of 2015 and take approximately 1 year to build.

2.0 EXISTING CONDITIONS:

The existing site condition is primarily a wooded/grass combination in fair condition, with a home and in-ground swimming pool. A single family home with impervious and gravel areas occupies the southeastern corner. An in-ground swimming pool and sheds are also on the property to the west of the home. Some wooded areas also follow along the northern and southern site boundaries. Soils on the land appear to be mostly class C, with an area of class A soils in the northern corner of the study area. Curve numbers and infiltrations rates for C soils were primarily used in this analysis.

Total parcel area is 64,500 ft^2, with approximately 26,000 ft^2 of that area being at least partially wooded. The site is bounded to the west by the Avita nursing facility, and to the east by Toppans Lane. Colonial Heights condominiums are located to the south of the site, and Anna Jaques Hospital lies to the north/northeast.

The entire site drains in a southeasterly direction, with slopes increasing from approximately 2% to 10% at the southeast end of the site. There is approx. thirty (30) feet of topographic relief across the site.

Field test pits conducted in the general area during the permitting process for the Avita nursing facility just north of the boundary of Lot 4. These locations are shown on the existing conditions plan, along with groundwater elevations. Further soil testing will need to be performed on the project property. The previous tests found that the underlying soils consisted of silt loam with indication of seasonal high groundwater within 2.3 feet of surface grade.

3.0 PROPOSED CONDITIONS:

The project consists of the construction of two (2) single family homes with a hammerhead cul-de-sac roadway and associated utilities and landscaping. Bituminous concrete will be used for the roadway and driveways. The existing home, swimming pool, and sheds on the property will be removed, and storm water management measures will be incorporated into the site to mitigate the runoff from the 2, 10, and 100-year rainfall events. Ground cover will be lawn, with some street trees proposed.

Stormwater management will be handled by the use of 2 surface detention basins and a roadside infiltration trench with a perforated HDPE pipe, eventually connecting into the municipal stormwater system in Toppans Lane. Runoff from a large portion of the property will be routed into these basins

mostly overland, with the proposed roadway being routed into the infiltration trench which is connected to the detention basins. The proposed roadway will be superelevated to drain into the trench, avoiding the need for catch basin structures in the roadway. The detention basins will have outlet pipes to mitigate the smaller storm events and allow the basins to slowly drain after rainfall ends. Exfiltration will occur in the shallow trench only, but due to the poor soils encountered on the site, an exfiltration rate of only 0.27 in/hr was factored into the calculations. Due to the relatively high groundwater elevations, surface ponds were used in place of subsurface measures. This should make maintenance simpler for the future home owners.

The drainage system has been designed so there will be no increase in runoff peak rates from the subject site once the project is complete. Runoff towards the Design Point will be below the current rates.

4.0 ANALYSIS:

The proposed drainage system was analyzed for the 2, 10, & 100-year storm events (see included calculations) to ensure that with even the most extreme storm, the proposed project would not have a negative impact on the surrounding area. The project area was analyzed in both the pre-development and the post-development conditions at the southern property limits (Design Point #1). The tables below summarize the pre and post-development runoff rates and volumes at the Design Point:

Design Point #1

2-Year Storm / 3.10" rainfall event

	Rate of Runoff (cfs)	Volume of Runoff (AF)
Pre-development	**2.28**	**0.208**
Post-development	**2.27**	**0.208**
Percent Change	**0.4%**	**0%**

10-Year Storm / 4.7" rainfall event

	Rate of Runoff (cfs)	Volume of Runoff (AF)
Pre-development	**5.31**	**0.450**
Post-development	**5.23**	**0.442**
Percent Change	**1.5%**	**3.5%**

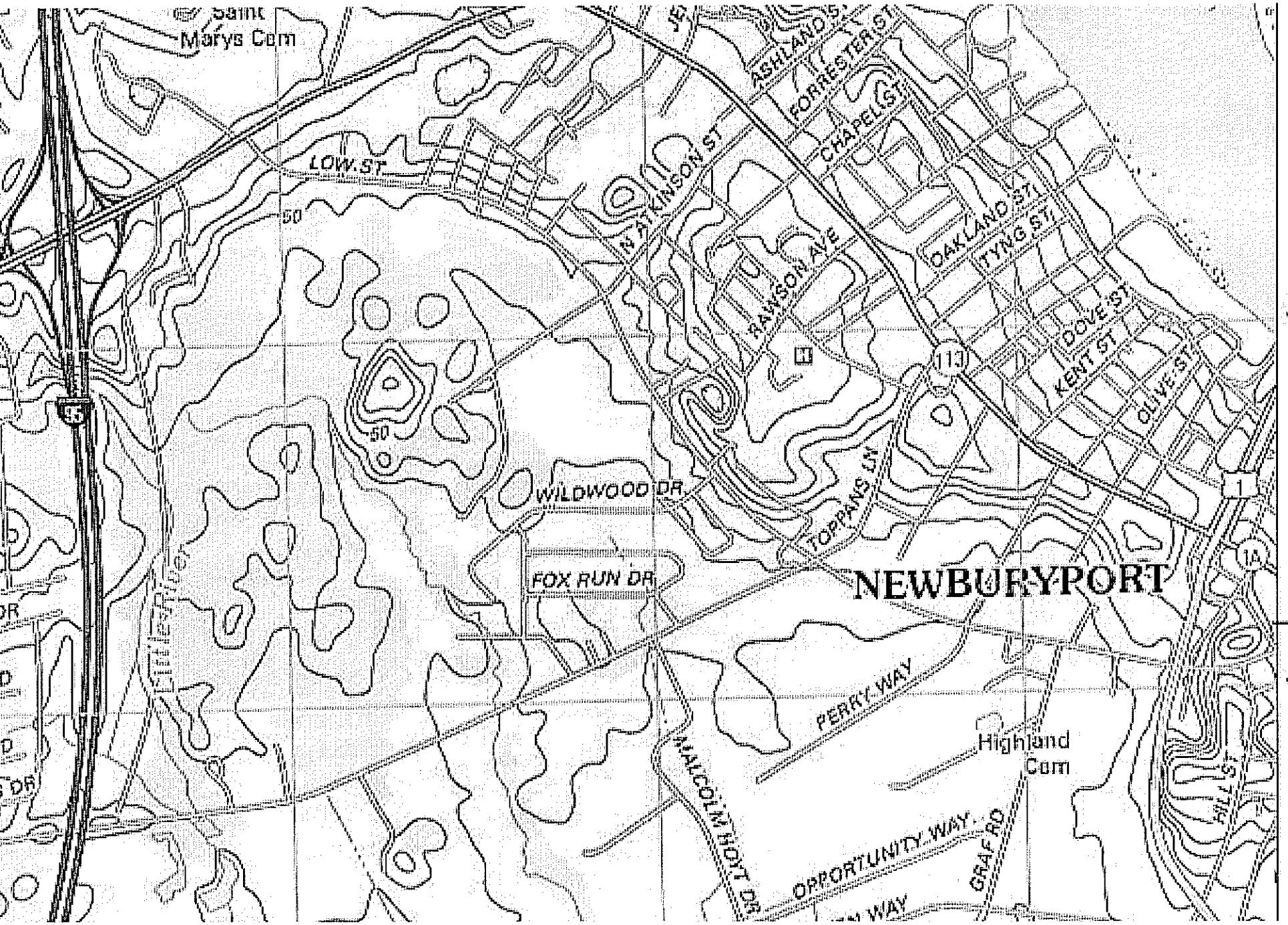
100-Year Storm / 8.3" rainfall event

	Rate of Runoff (cfs)	Volume of Runoff (AF)
Pre-development	**13.21**	**1.101**
Post-development	**13.03**	**1.078**
Percent Change	**4.1%**	**2.9%**

5.0 CONCLUSION:

The proposed project will disturb approximately 1.0 acres of land and result in two single-family homes being constructed. This drainage analysis examined the extreme 100 year flood storm to ensure that there would be no flooding caused downstream by the project. Existing soil conditions were examined by field inspection and previously-performed test pits in the area.

The design and analysis of the project and stormwater management plan has been consistent with MassDEP stormwater treatment and groundwater recharge techniques and guidelines. By reducing runoff through the use of surface detention basins, drainage trench, and improved ground cover, this drainage design will help to ensure that the project will not be detrimental to the environment and the surrounding properties.


Saint
Marys Cem
LOW ST
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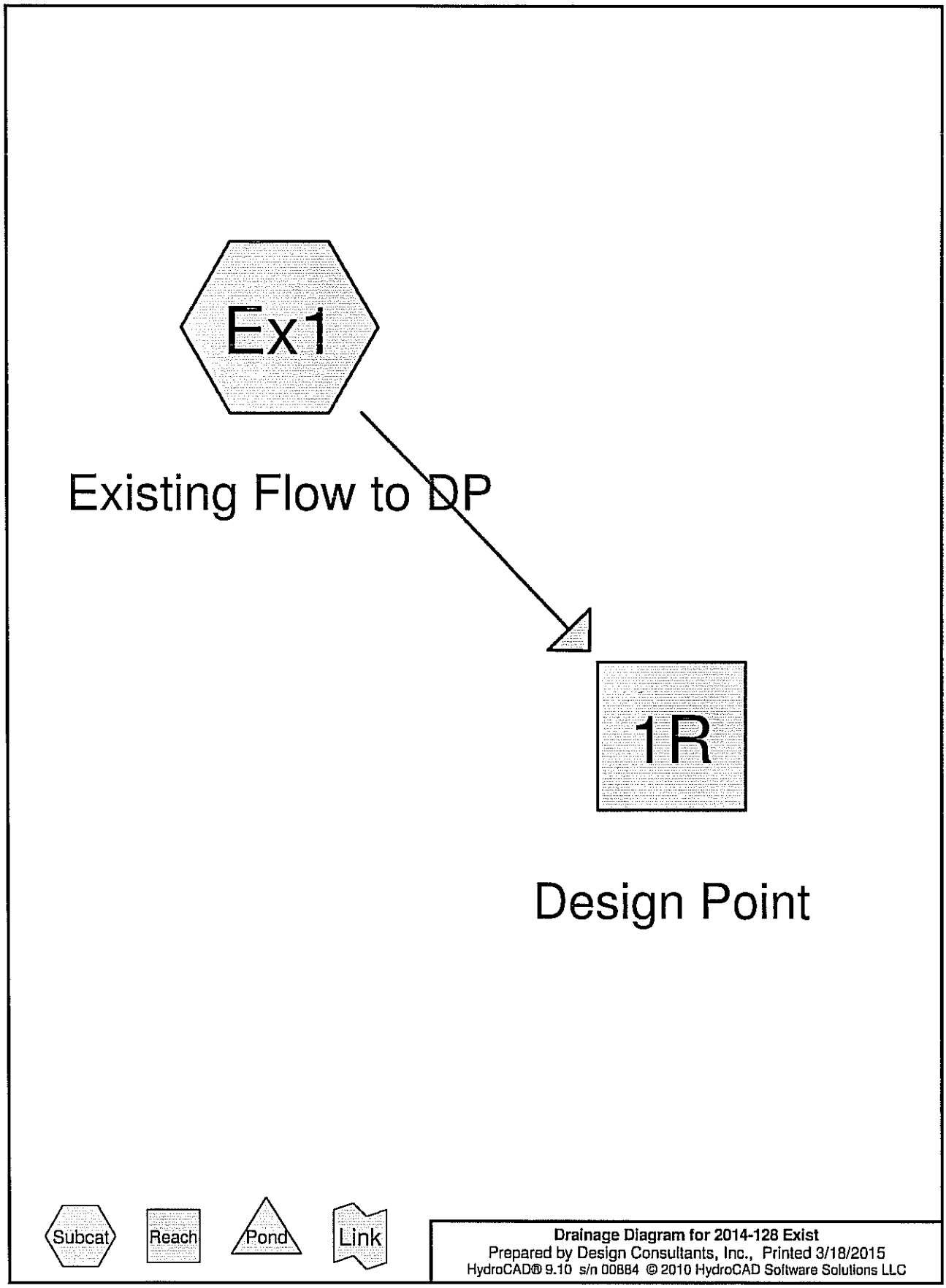
50
ATKINSON ST
ASHLAND ST
FORRESTER ST
CHAPEL ST
RAWSON AVE
OAKLAND ST
TYNG ST
DOVE ST
KENT ST
OLIVE ST
113
1
1A
WILDWOOD DR
FOX RUN DR
TOPPANS LN
NEWBURYPORT
PERRY WAY
Highland
Com
MALCOLM HOYT DR
OPPORTUNITY WAY
GRAF RD
4742
4741

Appendix A - Calculations



Drainage Diagram for 2014-128 Exist
Prepared by Design Consultants, Inc., Printed 3/18/2015

Summary for Subcatchment Ex1: Existing Flow to DP

Runoff = 2.28 cfs @ 12.16 hrs, Volume= 0.208 af, Depth> 0.96"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-year Rainfall=3.10"

	Area (sf)	CN	Description
*	5,314	98	Bldgs & pool
*	105	98	Brick walk
*	2,633	90	Gravel roads, HSG C/D
*	51,836	76	Woods, Fair, HSG C/D
	5,480	36	Woods, Fair, HSG A
	12,187	49	50-75% Grass cover, Fair, HSG A
	35,420	79	50-75% Grass cover, Fair, HSG C
	112,975	73	Weighted Average
	107,556	72	95.20% Pervious Area
	5,419	98	4.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	95	0.0830	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.5	130	0.0830	4.64		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.7	60	0.0830	1.44		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	40	0.0830	1.44		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.4	230	0.0500	1.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
10.5	555	Total			

Summary for Reach 1R: Design Point

Inflow Area = 2.594 ac, 4.80% Impervious, Inflow Depth > 0.96" for 2-year event
Inflow = 2.28 cfs @ 12.16 hrs, Volume= 0.208 af
Outflow = 2.28 cfs @ 12.16 hrs, Volume= 0.208 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 2.00-24.00 hrs, dt= 0.01 hrs

Summary for Subcatchment Ex1: Existing Flow to DP

Runoff = 5.31 cfs @ 12.15 hrs, Volume= 0.450 af, Depth> 2.08"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-year Rainfall=4.70"

	Area (sf)	CN	Description
*	5,314	98	Bldgs & pool
*	105	98	Brick walk
*	2,633	90	Gravel roads, HSG C/D
*	51,836	76	Woods, Fair, HSG C/D
	5,480	36	Woods, Fair, HSG A
	12,187	49	50-75% Grass cover, Fair, HSG A
	35,420	79	50-75% Grass cover, Fair, HSG C
	112,975	73	Weighted Average
	107,556	72	95.20% Pervious Area
	5,419	98	4.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	95	0.0830	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.5	130	0.0830	4.64		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.7	60	0.0830	1.44		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	40	0.0830	1.44		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.4	230	0.0500	1.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
10.5	555	Total			

Summary for Reach 1R: Design Point

Inflow Area = 2.594 ac, 4.80% Impervious, Inflow Depth > 2.08" for 10-year event
Inflow = 5.31 cfs @ 12.15 hrs, Volume= 0.450 af
Outflow = 5.31 cfs @ 12.15 hrs, Volume= 0.450 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 2.00-24.00 hrs, dt= 0.01 hrs

Summary for Subcatchment Ex1: Existing Flow to DP

Runoff = 13.21 cfs @ 12.15 hrs, Volume= 1.101 af, Depth> 5.10"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.30"

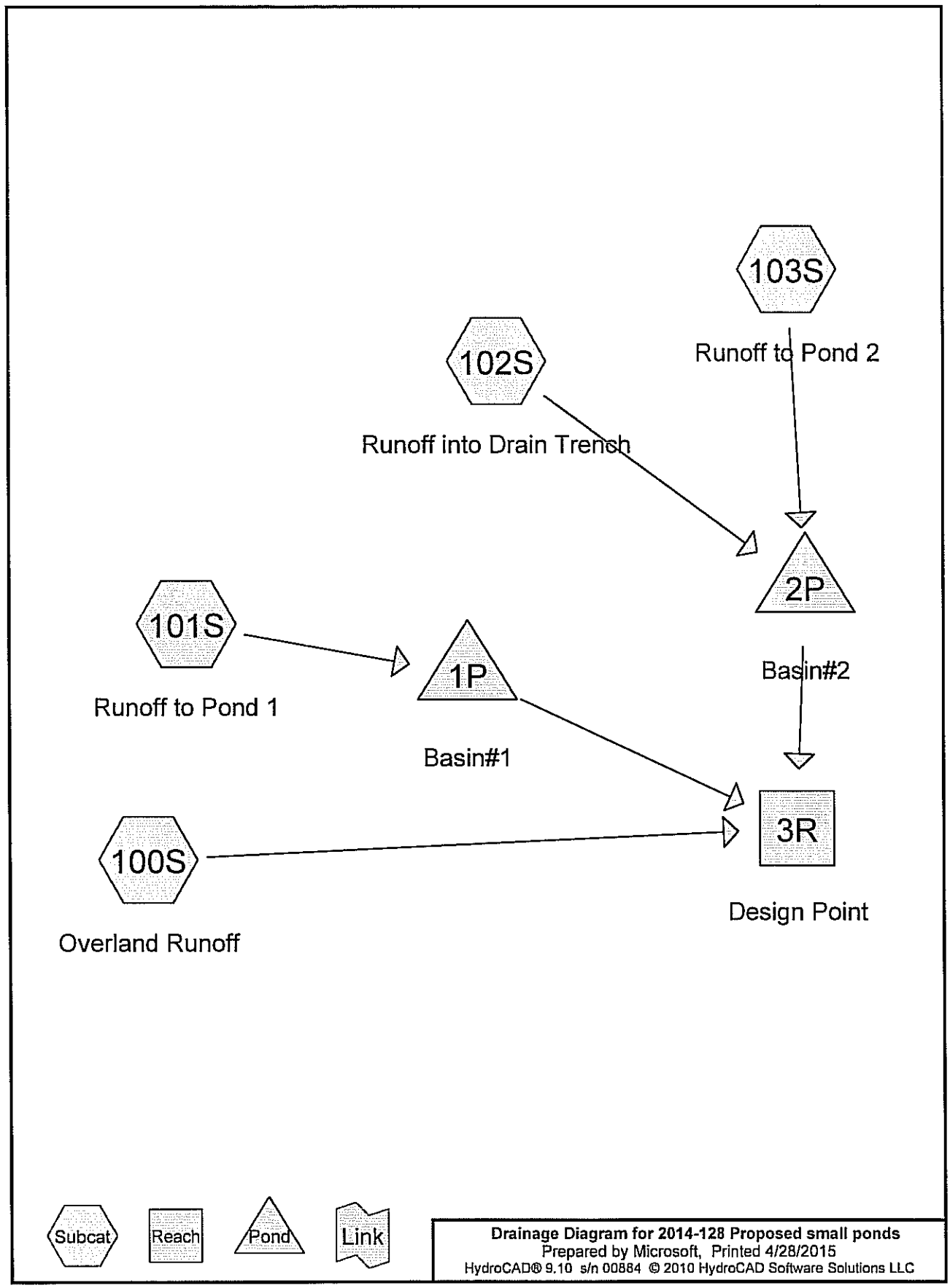
	Area (sf)	CN	Description
*	5,314	98	Bldgs & pool
*	105	98	Brick walk
*	2,633	90	Gravel roads, HSG C/D
*	51,836	76	Woods, Fair, HSG C/D
	5,480	36	Woods, Fair, HSG A
	12,187	49	50-75% Grass cover, Fair, HSG A
	35,420	79	50-75% Grass cover, Fair, HSG C
	112,975	73	Weighted Average
	107,556	72	95.20% Pervious Area
	5,419	98	4.80% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.4	95	0.0830	0.29		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
0.5	130	0.0830	4.64		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.7	60	0.0830	1.44		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.5	40	0.0830	1.44		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
3.4	230	0.0500	1.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
10.5	555	Total			

Summary for Reach 1R: Design Point

Inflow Area = 2.594 ac, 4.80% Impervious, Inflow Depth > 5.10" for 100-Year event
Inflow = 13.21 cfs @ 12.15 hrs, Volume= 1.101 af
Outflow = 13.21 cfs @ 12.15 hrs, Volume= 1.101 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind method, Time Span= 2.00-24.00 hrs, dt= 0.01 hrs



Drainage Diagram for 2014-128 Proposed small ponds
Prepared by Microsoft, Printed 4/28/2015

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.123	36	Woods, Fair, HSG A (100S)
0.281	49	50-75% Grass cover, Fair, HSG A (100S, 102S)
0.642	73	Woods, Fair, HSG C (100S, 101S, 102S)
0.974	74	>75% Grass cover, Good, HSG C (100S, 101S, 102S, 103S)
0.276	79	50-75% Grass cover, Fair, HSG C (102S)
0.210	98	Impervious Areas (100S, 102S)
0.087	98	impervious areas (101S, 103S)

Summary for Subcatchment 100S: Overland Runoff

Runoff = 1.25 cfs @ 12.10 hrs, Volume= 0.104 af, Depth> 0.86"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-yr Rainfall=3.10"

	Area (sf)	CN	Description
	4,982	49	50-75% Grass cover, Fair, HSG A
	5,379	36	Woods, Fair, HSG A
	17,398	73	Woods, Fair, HSG C
	30,267	74	>75% Grass cover, Good, HSG C
*	5,302	98	Impervious Areas
	63,328	71	Weighted Average
	58,026	68	91.63% Pervious Area
	5,302	98	8.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, 6 MIN. MINIMUM**

Summary for Subcatchment 101S: Runoff to Pond 1

Runoff = 0.40 cfs @ 12.09 hrs, Volume= 0.031 af, Depth> 1.41"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-yr Rainfall=3.10"

	Area (sf)	CN	Description
	5,166	74	>75% Grass cover, Good, HSG C
	3,733	73	Woods, Fair, HSG C
*	2,687	98	impervious areas
	11,586	79	Weighted Average
	8,899	74	76.81% Pervious Area
	2,687	98	23.19% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, 6 min. minimum**

Summary for Subcatchment 102S: Runoff into Drain Trench

Runoff = 0.74 cfs @ 12.10 hrs, Volume= 0.060 af, Depth> 0.98"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-yr Rainfall=3.10"

	Area (sf)	CN	Description
	7,276	49	50-75% Grass cover, Fair, HSG A
	12,022	79	50-75% Grass cover, Fair, HSG C
	2,220	74	>75% Grass cover, Good, HSG C
	6,817	73	Woods, Fair, HSG C
*	3,850	98	Impervious Areas
	32,185	73	Weighted Average
	28,335	69	88.04% Pervious Area
	3,850	98	11.96% Impervious Area

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

Summary for Subcatchment 103S: Runoff to Pond 2

Runoff = 0.19 cfs @ 12.09 hrs, Volume= 0.015 af, Depth> 1.33"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-yr Rainfall=3.10"

	Area (sf)	CN	Description
	4,776	74	>75% Grass cover, Good, HSG C
*	1,100	98	impervious areas
	5,876	78	Weighted Average
	4,776	74	81.28% Pervious Area
	1,100	98	18.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, 6 min. minimum**

Summary for Reach 3R: Design Point

Inflow Area = 2.594 ac, 11.45% Impervious, Inflow Depth > 0.96" for 2-yr event
Inflow = 2.27 cfs @ 12.11 hrs, Volume= 0.208 af
Outflow = 2.27 cfs @ 12.11 hrs, Volume= 0.208 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 2.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond 1P: Basin#1

Inflow Area = 0.266 ac, 23.19% Impervious, Inflow Depth > 1.41" for 2-yr event
Inflow = 0.40 cfs @ 12.09 hrs, Volume= 0.031 af
Outflow = 0.32 cfs @ 12.15 hrs, Volume= 0.030 af, Atten= 22%, Lag= 3.9 min
Primary = 0.32 cfs @ 12.15 hrs, Volume= 0.030 af

Routing by Dyn-Stor-Ind method, Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 56.63' @ 12.15 hrs Surf.Area= 367 sf Storage= 187 cf

Plug-Flow detention time= 53.7 min calculated for 0.030 af (95% of inflow)

Center-of-Mass det. time= 27.5 min (840.6 - 813.1)

Volume	Invert	Avail.Storage	Storage Description
#1	56.00'	935 cf	**Custom Stage Data (Conic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
56.00	233	0	0	233
57.00	460	340	340	469
58.00	740	594	935	762

Device	Routing	Invert	Outlet Devices
#1	Primary	56.20'	**6.0" Round Culvert** L= 15.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 56.20' / 56.00' S= 0.0133 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=0.32 cfs @ 12.15 hrs HW=56.63' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 0.32 cfs @ 1.76 fps)

Summary for Pond 2P: Basin#2

Inflow Area = 0.874 ac, 13.01% Impervious, Inflow Depth > 1.03" for 2-yr event
Inflow = 0.93 cfs @ 12.09 hrs, Volume= 0.075 af
Outflow = 0.78 cfs @ 12.15 hrs, Volume= 0.074 af, Atten= 17%, Lag= 3.3 min
Primary = 0.78 cfs @ 12.15 hrs, Volume= 0.074 af

Routing by Dyn-Stor-Ind method, Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 50.75' @ 12.15 hrs Surf.Area= 381 sf Storage= 219 cf

Plug-Flow detention time= 21.5 min calculated for 0.074 af (98% of inflow)
Center-of-Mass det. time= 11.7 min (845.8 - 834.1)

Volume	Invert	Avail.Storage	Storage Description
#1	50.00'	1,029 cf	**Custom Stage Data (Conic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
50.00	214	0	0	214
51.00	448	324	324	456
52.20	740	706	1,029	766

Device	Routing	Invert	Outlet Devices
#1	Primary	50.20'	**9.5" W x 4.0" H Vert. Orifice/Grate** C= 0.600
#2	Primary	51.20'	**11.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.78 cfs @ 12.15 hrs HW=50.75' TW=0.00' (Dynamic Tailwater)
↑—**1=Orifice/Grate** (Orifice Controls 0.78 cfs @ 2.94 fps)
└—**2=Orifice/Grate** (Controls 0.00 cfs)

Summary for Subcatchment 100S: Overland Runoff

Runoff = 3.07 cfs @ 12.09 hrs, Volume= 0.230 af, Depth> 1.90"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.70"

	Area (sf)	CN	Description
	4,982	49	50-75% Grass cover, Fair, HSG A
	5,379	36	Woods, Fair, HSG A
	17,398	73	Woods, Fair, HSG C
	30,267	74	>75% Grass cover, Good, HSG C
*	5,302	98	Impervious Areas
	63,328	71	Weighted Average
	58,026	68	91.63% Pervious Area
	5,302	98	8.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, 6 MIN. MINIMUM**

Summary for Subcatchment 101S: Runoff to Pond 1

Runoff = 0.79 cfs @ 12.09 hrs, Volume= 0.059 af, Depth> 2.66"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.70"

	Area (sf)	CN	Description
	5,166	74	>75% Grass cover, Good, HSG C
	3,733	73	Woods, Fair, HSG C
*	2,687	98	impervious areas
	11,586	79	Weighted Average
	8,899	74	76.81% Pervious Area
	2,687	98	23.19% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, 6 min. minimum**

Summary for Subcatchment 102S: Runoff into Drain Trench

Runoff = 1.69 cfs @ 12.09 hrs, Volume= 0.127 af, Depth> 2.06"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.70"

	Area (sf)	CN	Description
	7,276	49	50-75% Grass cover, Fair, HSG A
	12,022	79	50-75% Grass cover, Fair, HSG C
	2,220	74	>75% Grass cover, Good, HSG C
	6,817	73	Woods, Fair, HSG C
*	3,850	98	Impervious Areas
	32,185	73	Weighted Average
	28,335	69	88.04% Pervious Area
	3,850	98	11.96% Impervious Area

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

Summary for Subcatchment 103S: Runoff to Pond 2

Runoff = 0.39 cfs @ 12.09 hrs, Volume= 0.029 af, Depth> 2.56"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-yr Rainfall=4.70"

	Area (sf)	CN	Description
	4,776	74	>75% Grass cover, Good, HSG C
*	1,100	98	impervious areas
	5,876	78	Weighted Average
	4,776	74	81.28% Pervious Area
	1,100	98	18.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, 6 min. minimum**

Summary for Reach 3R: Design Point

Inflow Area = 2.594 ac, 11.45% Impervious, Inflow Depth > 2.05" for 10-yr event
Inflow = 5.23 cfs @ 12.12 hrs, Volume= 0.442 af
Outflow = 5.23 cfs @ 12.12 hrs, Volume= 0.442 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 2.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond 1P: Basin#1

Inflow Area = 0.266 ac, 23.19% Impervious, Inflow Depth > 2.66" for 10-yr event
Inflow = 0.79 cfs @ 12.09 hrs, Volume= 0.059 af
Outflow = 0.53 cfs @ 12.18 hrs, Volume= 0.057 af, Atten= 32%, Lag= 5.2 min
Primary = 0.53 cfs @ 12.18 hrs, Volume= 0.057 af

Routing by Dyn-Stor-Ind method, Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 56.96' @ 12.18 hrs Surf.Area= 450 sf Storage= 322 cf

Plug-Flow detention time= 35.1 min calculated for 0.057 af (97% of inflow)

Center-of-Mass det. time= 19.6 min (824.5 - 804.9)

Volume	Invert	Avail.Storage	Storage Description
#1	56.00'	935 cf	**Custom Stage Data (Conic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
56.00	233	0	0	233
57.00	460	340	340	469
58.00	740	594	935	762

Device	Routing	Invert	Outlet Devices
#1	Primary	56.20'	**6.0" Round Culvert** L= 15.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 56.20' / 56.00' S= 0.0133 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=0.53 cfs @ 12.18 hrs HW=56.96' TW=0.00' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 0.53 cfs @ 2.72 fps)

Summary for Pond 2P: Basin#2

Inflow Area = 0.874 ac, 13.01% Impervious, Inflow Depth > 2.14" for 10-yr event
Inflow = 2.08 cfs @ 12.09 hrs, Volume= 0.156 af
Outflow = 1.85 cfs @ 12.13 hrs, Volume= 0.155 af, Atten= 11%, Lag= 2.5 min
Primary = 1.85 cfs @ 12.13 hrs, Volume= 0.155 af

Routing by Dyn-Stor-Ind method, Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 51.36' @ 12.13 hrs Surf.Area= 527 sf Storage= 498 cf

Plug-Flow detention time= 13.3 min calculated for 0.154 af (99% of inflow)
Center-of-Mass det. time= 8.0 min (831.4 - 823.4)

Volume	Invert	Avail.Storage	Storage Description
#1	50.00'	1,029 cf	**Custom Stage Data (Conic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
50.00	214	0	0	214
51.00	448	324	324	456
52.20	740	706	1,029	766

Device	Routing	Invert	Outlet Devices
#1	Primary	50.20'	**9.5" W x 4.0" H Vert. Orifice/Grate** C= 0.600
#2	Primary	51.20'	**11.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.85 cfs @ 12.13 hrs HW=51.36' TW=0.00' (Dynamic Tailwater)
↑**1=Orifice/Grate** (Orifice Controls 1.26 cfs @ 4.78 fps)
2=Orifice/Grate (Weir Controls 0.58 cfs @ 1.29 fps)

Summary for Subcatchment 100S: Overland Runoff

Runoff = 8.00 cfs @ 12.09 hrs, Volume= 0.579 af, Depth> 4.78"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-yr Rainfall=8.30"

	Area (sf)	CN	Description
	4,982	49	50-75% Grass cover, Fair, HSG A
	5,379	36	Woods, Fair, HSG A
	17,398	73	Woods, Fair, HSG C
	30,267	74	>75% Grass cover, Good, HSG C
*	5,302	98	Impervious Areas
	63,328	71	Weighted Average
	58,026	68	91.63% Pervious Area
	5,302	98	8.37% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, 6 MIN. MINIMUM**

Summary for Subcatchment 101S: Runoff to Pond 1

Runoff = 1.74 cfs @ 12.09 hrs, Volume= 0.130 af, Depth> 5.84"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-yr Rainfall=8.30"

	Area (sf)	CN	Description
	5,166	74	>75% Grass cover, Good, HSG C
	3,733	73	Woods, Fair, HSG C
*	2,687	98	impervious areas
	11,586	79	Weighted Average
	8,899	74	76.81% Pervious Area
	2,687	98	23.19% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, 6 min. minimum**

Summary for Subcatchment 102S: Runoff into Drain Trench

Runoff = 4.23 cfs @ 12.09 hrs, Volume= 0.308 af, Depth> 5.01"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-yr Rainfall=8.30"

	Area (sf)	CN	Description
	7,276	49	50-75% Grass cover, Fair, HSG A
	12,022	79	50-75% Grass cover, Fair, HSG C
	2,220	74	>75% Grass cover, Good, HSG C
	6,817	73	Woods, Fair, HSG C
*	3,850	98	Impervious Areas
	32,185	73	Weighted Average
	28,335	69	88.04% Pervious Area
	3,850	98	11.96% Impervious Area

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

Summary for Subcatchment 103S: Runoff to Pond 2

Runoff = 0.87 cfs @ 12.09 hrs, Volume= 0.064 af, Depth> 5.72"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-yr Rainfall=8.30"

	Area (sf)	CN	Description
	4,776	74	>75% Grass cover, Good, HSG C
*	1,100	98	impervious areas
	5,876	78	Weighted Average
	4,776	74	81.28% Pervious Area
	1,100	98	18.72% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, 6 min. minimum**

Summary for Reach 3R: Design Point

Inflow Area = 2.594 ac, 11.45% Impervious, Inflow Depth > 4.99" for 100-yr event
Inflow = 13.03 cfs @ 12.10 hrs, Volume= 1.078 af
Outflow = 13.03 cfs @ 12.10 hrs, Volume= 1.078 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 2.00-24.00 hrs, dt= 0.01 hrs

Summary for Pond 1P: Basin#1

Inflow Area = 0.266 ac, 23.19% Impervious, Inflow Depth > 5.84" for 100-yr event
Inflow = 1.74 cfs @ 12.09 hrs, Volume= 0.130 af
Outflow = 0.89 cfs @ 12.23 hrs, Volume= 0.128 af, Atten= 49%, Lag= 8.6 min
Primary = 0.89 cfs @ 12.23 hrs, Volume= 0.128 af

Routing by Dyn-Stor-Ind method, Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 57.87' @ 12.23 hrs Surf.Area= 699 sf Storage= 838 cf

Plug-Flow detention time= 23.3 min calculated for 0.128 af (99% of inflow)

Center-of-Mass det. time= 15.0 min (806.7 - 791.7)

Volume	Invert	Avail.Storage	Storage Description
#1	56.00'	935 cf	**Custom Stage Data (Conic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
56.00	233	0	0	233
57.00	460	340	340	469
58.00	740	594	935	762

Device	Routing	Invert	Outlet Devices
#1	Primary	56.20'	**6.0" Round Culvert** L= 15.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 56.20' / 56.00' S= 0.0133 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior

Primary OutFlow Max=0.89 cfs @ 12.23 hrs HW=57.87' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.89 cfs @ 4.52 fps)

Summary for Pond 2P: Basin#2

Inflow Area = 0.874 ac, 13.01% Impervious, Inflow Depth > 5.12" for 100-yr event
Inflow = 5.10 cfs @ 12.09 hrs, Volume= 0.373 af
Outflow = 4.46 cfs @ 12.13 hrs, Volume= 0.371 af, Atten= 13%, Lag= 2.7 min
Primary = 4.46 cfs @ 12.13 hrs, Volume= 0.371 af

Routing by Dyn-Stor-Ind method, Time Span= 2.00-24.00 hrs, dt= 0.01 hrs
Peak Elev= 52.00' @ 12.13 hrs Surf.Area= 686 sf Storage= 886 cf

Plug-Flow detention time= 7.7 min calculated for 0.371 af (100% of inflow)
Center-of-Mass det. time= 5.1 min (811.9 - 806.8)

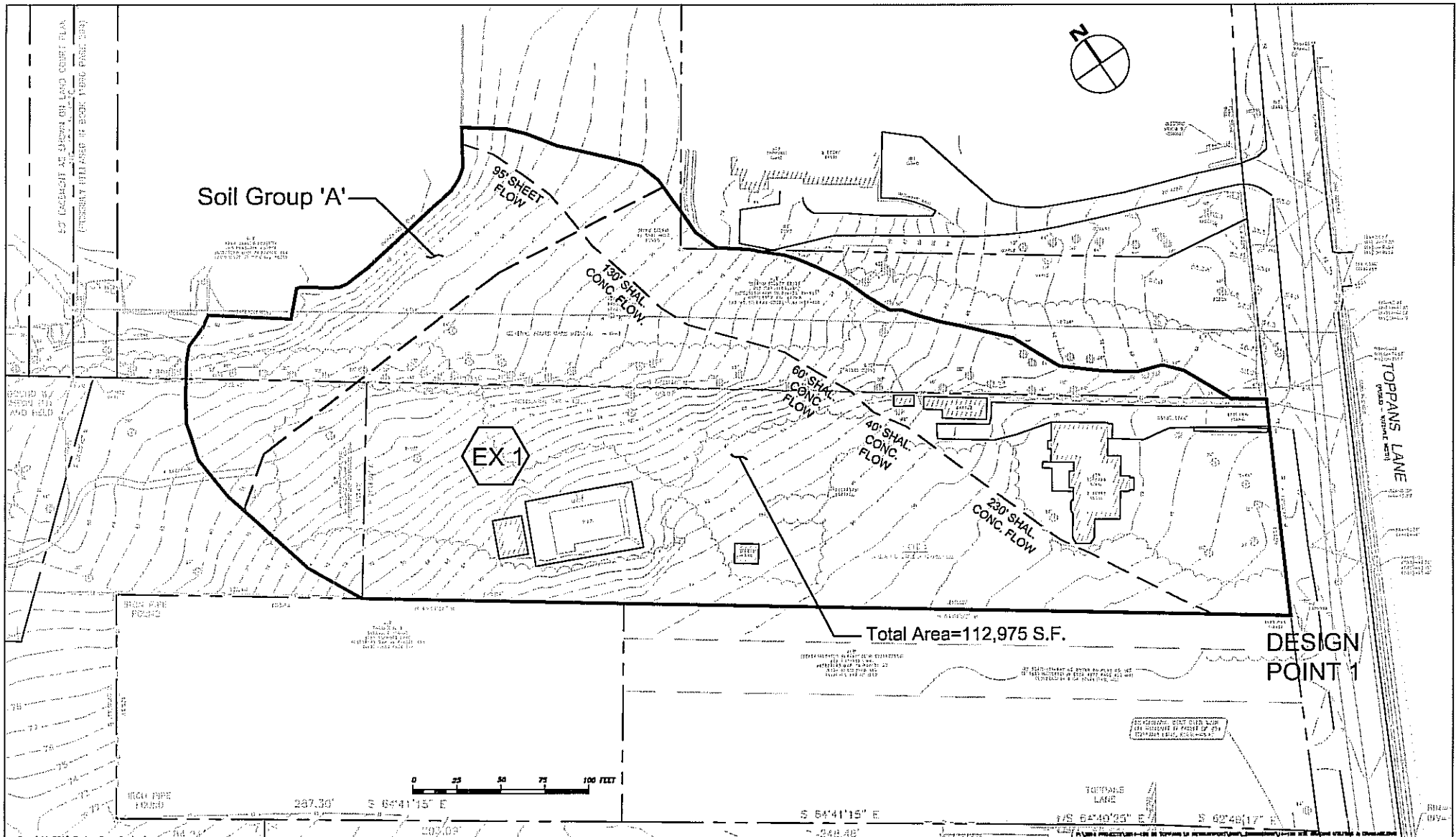
Volume	Invert	Avail.Storage	Storage Description
#1	50.00'	1,029 cf	**Custom Stage Data (Conic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
50.00	214	0	0	214
51.00	448	324	324	456
52.20	740	706	1,029	766

Device	Routing	Invert	Outlet Devices
#1	Primary	50.20'	**9.5" W x 4.0" H Vert. Orifice/Grate** C= 0.600
#2	Primary	51.20'	**11.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=4.46 cfs @ 12.13 hrs HW=52.00' TW=0.00' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 1.62 cfs @ 6.15 fps)
└─**2=Orifice/Grate** (Orifice Controls 2.84 cfs @ 4.30 fps)

Appendix B - Drawings



Design Consultants, Inc.
Consulting Engineers and Surveyors
180 MIDDLESEX AVENUE
SOMERVILLE, MA 02145
617-776-2350
66 PLEASANT STREET
NEWBURYPORT, MA 01950
978-358-7173

SCALE:
HORIZ: 1" = 50'
VERT: ——

NO.	DATE	BY	REVISIONS

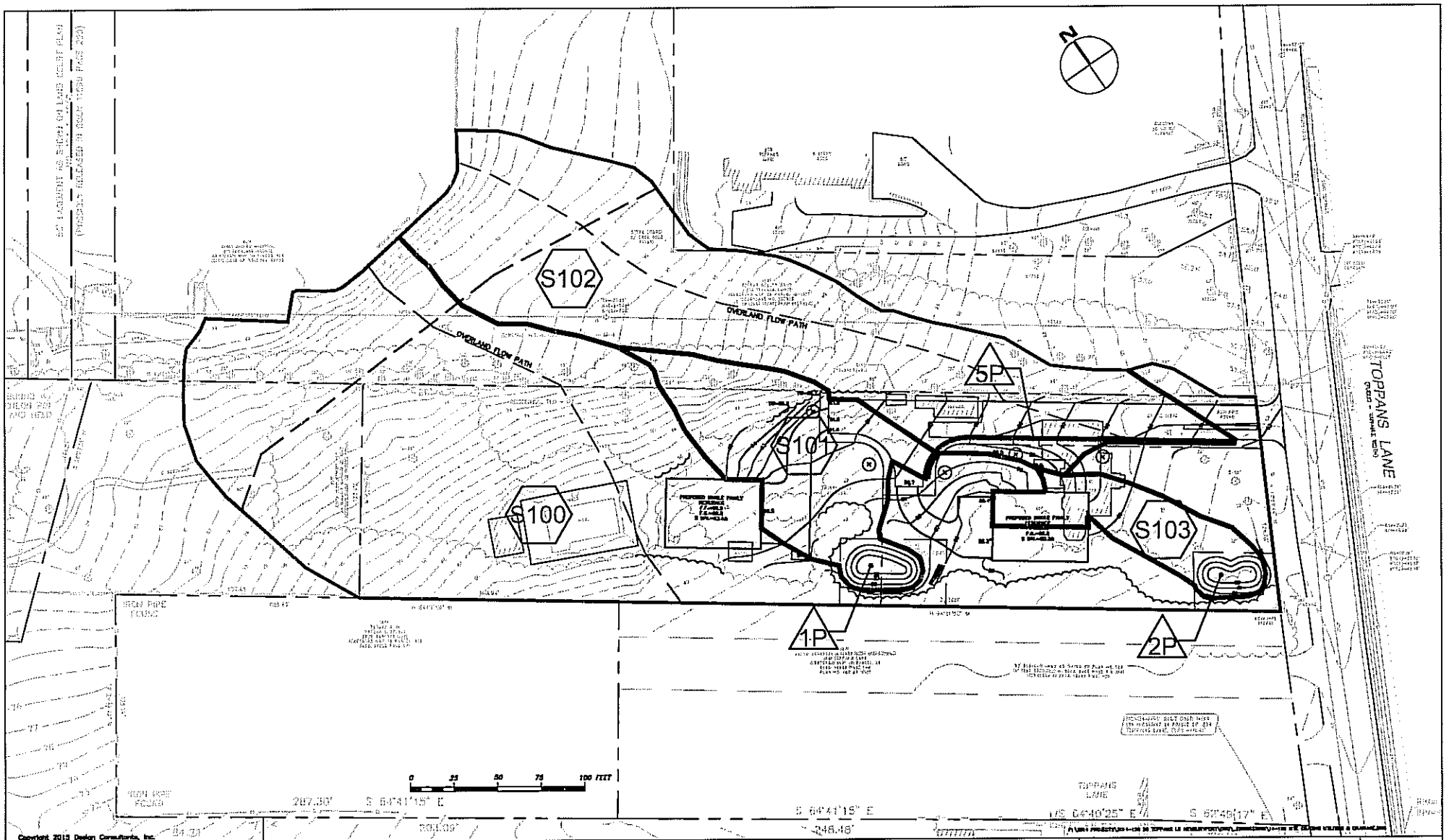
DESIGN: SDS
DRAFTING: SSW
CHECKED: DS
APPROVED: SDS

EXISTING DRAINAGE AREAS

26 TOPPANS LANE (Lot 4)

PLAN OF LAND IN
NEWBURYPORT, MASSACHUSETTS
PREPARED FOR
13 NORTH ADAMS LLC

PROJECT NO. 2014-128
DATE: MAR. 18, 2015
FIGURE 1



Design Consultants, Inc.
Consulting Engineers and Surveyors
120 MIDDLESEX AVENUE
SOMERVILLE, MA 02145
617-776-2580
86 PLEASANT STREET
NEWBURYPORT, MA 01950
978-358-7172

SCALE:
HORZ: 1"= 50'
VERT: ——

NO.	DATE	BY	REVISIONS

DESIGN: SRS
DRAFTING: SSW
CHECKED: DG
APPROVED: SRS

PROPOSED DRAINAGE AREAS

26 TOPPANS LANE (Lot 4)

PLAN OF LAND IN
NEWBURYPORT, MASSACHUSETTS
PREPARED FOR
13 NORTH ADAMS LLC

PROJECT NO. 2014-128
DATE: MAR. 18, 2015
FIGURE 2

Appendix C - Soils Data

Hydrologic Soil Group—Essex County, Massachusetts, Northern Part

Map Scale: 1:1,630 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils

Soil Rating Polygons
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points
- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Essex County, Massachusetts, Northern Part
Survey Area Data: Version 10, Sep 19, 2014

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 20, 2010—May 1, 2011

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Essex County, Massachusetts, Northern Part (MA605)				
Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
16A	Scantic silt loam, 0 to 3 percent slopes	C/D	4.0	61.7%
254B	Merrimac fine sandy loam, 3 to 8 percent slopes	A	0.0	0.7%
254C	Merrimac fine sandy loam, 8 to 15 percent slopes	A	2.0	31.2%
719B	Suffield silt loam, 3 to 8 percent slopes	C	0.4	6.4%
Totals for Area of Interest			**6.4**	**100.0%**

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix D - Operation & Maintenance Plan

STORMWATER MANAGEMENT
OPERATION AND MAINTENANCE PLAN

Donahue Lane
Newburyport, Massachusetts

The following Stormwater Management Operation and Maintenance (O&M) Plan has been prepared to operate and maintain the stormwater management system for Donahue Lane.

Owner/Operator: 13 North Adams, LLC
9 Pasture Lane
Bedford, NH 03110

Inspection and Maintenance Schedule

Facility personnel will inspect the storm water management system on a routine basis not less than once per month for the first 6 months of operation and annually thereafter. Refer to Sheet C-2, Grading & Drainage Plan, for drainage structure locations. Inspection and maintenance shall be performed as follows:

1. Roadside Gravel Infiltration Trench shall be inspected for accumulation of silt, sediment, standing water, or debris on a semi-annual basis at a minimum, and after every rainfall event of 2-inch or more. Observations shall be made via the observation well built into the system to ensure that the pipe has completely drained 24 hours after the storm event has ended. If standing water is observed more than 24 hours after any sized rain event that infiltration system is deemed failed and requires replacement. In the event of an infiltration system failure, the crushed stone and pipe will need to be removed and replaced. The non-woven filter fabric that surrounds the trench will need to be disposed of and replaced.

2. Landscaped Areas shall be inspected and maintained on a regular basis. Areas which may be subject to erosion will be stabilized and reseeded immediately. These operations will be performed as part of ongoing routine grounds maintenance operations.

3. Street Sweeping of drives and roadway shall be conducted bimonthly between the months of April and November. Removed sediment will be disposed off site by a qualified waste disposal contractor in accordance with state and federal regulations.

4. Detention Areas : Vegetation shall be inspected monthly for disease or pest problems. If treatment is warranted, use the least toxic approach. Promptly replace any vegetation that is beyond treatment. During times of extended drought, inspect vegetation for signs of stress including wilting or spotted or brown leaves. Water as required. Detention areas shall be weeded at least once a year as required.
   Inspect soil and repair eroded areas monthly. Re-plant void areas as needed. Remove litter and debris monthly. Remove and replace dead vegetation twice per year in spring and fall.
   Replace soil media if ponding is witnessed more than 48 hours after rainfall event within the surface ponding area.

Inspection and Maintenance Procedures for Outlet Control Structure (Flat Top Precast Manhole)

Sump shall be inspected quarterly during the first year to determine sediment collection. Sump shall be cleaned annually at a minimum, or when sediment and debris are within 1-feet deep. Additionally there should be periodic inspections of the structure and surrounding areas for pollutants such as leaks from dumpsters, minor spills, and dumping and litter. If pollutants are found, action should be taken immediately to have the pollutant source removed.

All sediments removed from the outlet control structure sump shall be disposed of properly, and in accordance with all applicable local and state regulations.

Stormwater System Inspection Report

General Information			
Location: Donahue Lane, Newburyport			
Date of Inspection		**Start/End Time**	
Inspector's Name(s)			
Inspector's Title(s)			
Inspector's Contact Information			
Purpose of Inspection			
Weather Information			
Has it rained since the last inspection? ☐Yes ☐No			
Weather at time of this inspection?			

Construction Phase Erosion/Sedimentation Control Measures

	Description	Installed and Operating Properly?	Corrective Action Needed	Date for Corrective Action/Responsible Person
1	Stabilized Construction Entrance	☐Yes ☐No		
2	Silt Sacks in stormwater inlets	☐Yes ☐No		
3	Erosion Control Barriers	☐Yes ☐No		
4	Sediment tracking in roadway(s)	☐Yes ☐No		
5	Vehicle wash area	☐Yes ☐No		
6	Concrete washout area	☐Yes ☐No		

Permanent Site-Specific Stormwater Devices

	Description	Installed and Operating Properly?	Corrective Action Needed	Date for Corrective Action/Responsible Person

	Description	Installed and Operating Properly?	Corrective Action Needed	Date for Corrective Action/Responsible Person
1		❑Yes ❑No		
2		❑Yes ❑No		
3		❑Yes ❑No		
4		❑Yes ❑No		
5		❑Yes ❑No		
6		❑Yes ❑No		
7		❑Yes ❑No		
8		❑Yes ❑No		
9		❑Yes ❑No		
10		❑Yes ❑No		

	Description	Installed and Operating Properly?	Corrective Action Needed	Date for Corrective Action/Responsible Person
11		❑Yes ❑No		
12		❑Yes ❑No		
13		❑Yes ❑No		
14		❑Yes ❑No		
15		❑Yes ❑No		
16		❑Yes ❑No		
17		❑Yes ❑No		

	Description	Installed and Operating Properly?	Corrective Action Needed	Date for Corrective Action/Responsible Person
18		❑Yes ❑No		
19		❑Yes ❑No		
20		❑Yes ❑No		
21		❑Yes ❑No		
22		❑Yes ❑No		
23		❑Yes ❑No		
24		❑Yes ❑No		
25		❑Yes ❑No		
26		❑Yes ❑No		
27		❑Yes ❑No		
28		❑Yes ❑No		
29		❑Yes ❑No		
30		❑Yes ❑No		

Overall Site Issues

	Description		Corrective Action	Date for Corrective Action/Responsible Person
1	Are all slopes properly stabilized?	❑Yes ❑No		
2	Are natural resource areas (e.g., streams, wetlands, etc.) being subjected to erosion?	❑Yes ❑No		
3	Are discharge points free of sediment deposits?	❑Yes ❑No		

Certification Statement:

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

Print name: _____

Signature: _____

Date: _____