STORMWATER MANAGEMENT REPORT

FOR

PROPOSED OPEN SPACE RESIDENTIAL DEVELOPMENT

15 COLEMAN ROAD
NEWBURY, MA 01922

PREPARED FOR:

ZENDKO, INC.
15 ESTES STREET
AMESBURY, MA 01913

PREPARED BY:

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TABLE OF CONTENTS **PAGE**

I. STORMWATER MANAGEMENT NARRATIVE

1.0 SITE LOCATION AND DESCRIPTION…… 1
2.0 METHODOLOGY……. 1
3.0 SOILS…… 1
4.0 POINTS OF ANALYSIS…… 2
5.0 EXISTING DRAINAGE WATERSHEDS……..……. 2
6.0 PROPOSED DRAINAGE WATERSHEDS……. 2
7.0 PEAK FLOW RATE …… 2
8.0 WATER QUALITY…….. 3
9.0 GROUNDWATER RECHARGE ……..……. 4
10.0 DRAINAGE CONVEYANCE SYSTEM……..……... 5
11.0 COMPLIANCE WITH THE MA DEP STORMWATER HANDBOOK…… 5
12.0 SUMMARY……. 7

II. LIST OF FIGURES

- FIGURE 1: USGS PLAN
- FIGURE 2: SOIL MAP
- FIGURE 3: PRE-DEVELOPMENT WATERSHEDS
- FIGURE 4: POST-DEVELOPMENT WATERSHEDS
- FIGURE 5: CATCH BASIN WATERSHEDS
- TEST PIT LOGS

III. HYDROLOGICAL CALCULATIONS

- PRE-DEVELOPMENT HYDROCAD CALCULATIONS
- POST-DEVELOPMENT HYDROCAD CALCULATIONS

IV. HYDRAULIC CALCULATIONS

- PIPE DESIGN

V. APPENDIX

- MASSACHUSETTS DEP STORMWATER REPORT CHECKLIST
- OPERATION AND MAINTENANCE PLAN (O&M)
  (WITH LONG-TERM POLLUTION PREVENTION PLAN)

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1.0 SITE LOCATION AND DESCRIPTION

Civil Design Group, LLC (CDG) has been retained by Zendko, LLC to prepare this Stormwater Management Report for the construction of an open space residential development on a 31.7± acre tract of land at 15 Coleman Road in Newbury, Massachusetts (refer to Figure 1). The project includes the construction of six (6) new single family homes, renovating an existing single family home, constructing a 400-foot roadway and landscaping and stormwater improvements on 5.48± acres, thereby maintaining 26.2± acres in its natural wooded condition. The site is bounded to the south by Coleman road and to the west, north and east by wooded residential/institutional parcels.

According to FEMA flood insurance rate maps community panel number 25009C0256G, effective date July16, 2014, the area of the site to be redeveloped lies within Zone X, which is defined as areas determined to be outside the 0.2% (500-year) annual chance floodplain. The site is bisected by bordering vegetated wetlands, however, the site is not located within an aquifer protection zone, an area mapped for rare and endangered species as mapped by the State of Massachusetts' Natural Heritage and Endangered Species Program (NHESP) or within an Area of Critical Environmental Concern (ACEC).

This study presents a comparative analysis of the pre-development and post-development hydrologic characteristics of the site, and outlines the proposed measures to mitigate flow, provide groundwater recharge, and improve water quality from the site in accordance with municipal regulations and the Massachusetts Department of Environmental Protection (DEP's) requirements. The proposed best management practices (BMPs) as outlined in this report include three (3) catch basins, one (1) proprietary separator, one (1) subsurface infiltration basin and associated piping to treat stormwater to the maximum extent practicable prior to discharging off site.

2.0 METHODOLOGY

Northeast Regional Climate Center (Cornell Rates) was utilized to source the precipitation values and Technical Release 55 (TR-55) methodology was utilized to determine weighted curve numbers (CNs) for each pre and post-development subcatchment area. Weighted CNs are based on ground cover type and hydrologic soil groups (HSGs). The times of concentration (Tc's) for each of the existing and proposed watersheds have been calculated. The areas that do not show a Tc travel path resulted in travel times of less than 6 minutes. CN and Tc values were then utilized to generate hydrographs using HydroCad 10.0, an industry standard software package that develops a hydrologic model based on the SCS method and computes peak discharges from rainfall runoff for urban and rural watersheds.

3.0 SOILS

According to the Natural Resources Conservation Service Web Soil Survey (Figure 2), underlying soils within the anticipated limit of work are classified as Paxton fine sandy loam and Woodbridge fine sandy loam which include a hydrologic soil group (HSG) of C and D, respectively. Based on the test pits that were dug in August 2020, the native soil was determined to be a loamy sand material and estimated seasonal high groundwater was measured at a depth of 6 feet downstream of the infiltration system. Subsequent tests were dug in February 2021 within the infiltration footprint and groundwater was not encountered within 3 of the 4 that were dug. The test pit that encountered groundwater was proximate to ledge, therefore, the infiltration system was modified and relocated away from the ledge. The system material changed to pipe and stone and was deepened to maintain similar volume. This stormwater report utilizes a HSG rating of C and D for both the existing and

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proposed conditions for the purposes of generating peak flow rates and an infiltration rate of 1.02 inches/hour was utilized for exfiltration purposes.

4.0 POINTS OF ANALYSIS

Points of Analysis (POAs) are discharge points or lines that convey runoff from the study area via overland flow or through drain pipes. The pre-development and post-development areas of disturbance drain to two (2) POA's listed and described below and shown on Figures 3 and 4.

TABLE-1: POINTS OF ANALYSIS

POINT OF ANALYSIS	DESCRIPTION
POA-1	A comparison line along the Coleman Road right of way, that collects runoff into the municipal stormwater system.
POA-2	A comparison line along the wetland resource line bordering the northerly portion of the limit of work.

5.0 EXISTING DRAINAGE WATERSHEDS

The existing watersheds are delineated based on topography, physical characteristics and drainage networks within the site limits and collect and direct stormwater towards the POAs. The total study area for the site is 5.48± acres and is divided into two (2) pre-development watersheds as described below:

Subcatchment EX-1: The 0.35-acre watershed is comprised of roofs, pavement, and grass areas. Runoff travels via overland flow in a southerly direction towards Coleman Road (POA-1).

Subcatchment EX-2: The 5.14-acre watershed is comprised of roofs, pavement, wooded and grass areas. Runoff travels via overland flow in a northwesterly direction towards the onsite resource area (POA-2).

6.0 PROPOSED DRAINAGE WATERSHEDS

Similar to the existing watersheds, the proposed watersheds are delineated based on topography, physical characteristics and drainage networks within the site limits and collect and direct stormwater towards POA-1. This area is divided into three (3) post-development watersheds described below:

Subcatchment PR-1: The 0.29-acre watershed is comprised of roofs, pavement, and grass areas. Runoff travels via overland flow in a southerly direction towards Coleman Road (POA-1).

Subcatchment PR-2: The 3.59-acre watershed is comprised of roofs, pavement, wooded and landscaped areas. Runoff travels via overland flow in a northwesterly direction towards the onsite resource area (POA-2).

Subcatchment PR-3: The 1.60-acre watershed is comprised of roofs, pavement and landscape areas. The runoff is collected into the onsite drainage system and treat and infiltrated via the subsurface infiltration system. Overflow runoff from the larger storms is discharged in a northwesterly direction towards the onsite resource area (POA-2).

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7.0 PEAK FLOW RATE MITIGATION

The stormwater management system is designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates for the 2-year, 10-year and 100-year, 24-hour NRCC storm events. Peak flow rates for the pre-development and post-development conditions are illustrated below:

TABLE 2: PEAK FLOW RATE COMPARISON

POINT OF ANALYSIS	2-YEAR STORM EVENT (3.15"/24-HR)		10-YEAR STORM EVENT (4.83"/24-HR)		100-YEAR STORM EVENT (8.94"/24-HR)	
	PRE (CFS)	POST (CFS)	PRE (CFS)	POST (CFS)	PRE (CFS)	POST (CFS)
POA-1	*0.39*	**0.36**	*0.85*	**0.73**	*2.06*	**1.73**
POA-2	*4.51*	**4.22**	*10.17*	**8.92**	*25.65*	**25.32**

8.0 WATER QUALITY

The development program includes measures to collect and treat runoff from impervious areas prior to discharge. New stormwater controls have been incorporated into the design that result in a reduction in annual stormwater pollutant loads from the site. Through the use of structural and non-structural BMPs, the water quality volume from the watersheds contributing to the proposed drainage system will undergo treatment. Currently, the site area contains approximately 0.18 acres of impervious (rooftop/pavement) area or 3% of the improved area. The development program proposes to increase the impervious area to approximately 0.99 acres of impervious or 18% of the improved area, resulting in a net increase of 0.81 acres of impervious area. As depicted in Figure-5, subcatchments 1, 2, and 3 corresponding to CB-1, CB-2, and CB-3 collect 0.50± acres of new non-rooftop impervious area and will be treated to 80% TSS removal (See below). The runoff from the remaining 0.03± acres of non-rooftop impervious area will sheet flow onto Coleman Road and be collected in the existing municipal drainage system. Please note that the impervious area contributing to Coleman Road in the post-development condition is less than the pre-development condition. The following BMPs were selected to treat the average annual TSS load from stormwater runoff under the post-development condition. Refer to the TSS Removal Calculation Worksheet below.

- Deep Sump Hooded Catch Basins
  Stormwater runoff from proposed pavement areas will be directed via curbing and site grading to catch basins with deep sumps and hooded outlets. The catch basins will trap and remove sediment and larger particles from the stormwater and will improve the performance of subsequent BMP's. The sumps will be a minimum of 4' in depth and a regular inspection and cleaning schedule has been proposed to ensure optimal effectiveness. When properly designed and maintained, catch basin sumps are effective in reducing the sediment and pollutant load in runoff.

- Hydrodynamic Separator (HS-5 Unit)
  Hydrodynamic Separators are designed to remove heavy particles, floating debris and hydrocarbons from stormwater. Stormwater enters the system where floatables and oils are separated prior to the clarified stormwater runoff discharging to an outlet pipe. See below for additional information about the TSS rates utilized for these proprietary BMPs.

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- Subsurface Infiltration System (SIS)
  Subsurface infiltration systems are designed to detain and infiltrate runoff from the site. The subsurface infiltration system is comprised pipe and stone. Runoff is designed to exfiltrate through the system bottom.

TABLE 3: TSS REMOVAL CALCULATION WORKSHEET[1]

TREATMENT TRAIN-1 (TT#1): SC-1, 2 & 3

BMP (A)	TSS Removal Rate (B)	Starting TSS Load (C)	Amount Removed (BxC) (D)	Remaining Load (C-D) (E)
Deep Sump CB's	0.25	1.0	0.25	0.75
Infiltration w/ pre-treatment*	0.80[1]	0.75	0.60	0.15
Total TSS Removal = Summation of (D) =			**85%**	

*** NJ DEP verification testing results used. HS-5 used as pretreatment.**
[1] 80% TSS removal credit when combined with adequate pretreatment.

CUMULATIVE TSS REMOVAL: $\frac{\textbf{(0.50 Acres x 0.85) + (0.03 Acres x 0.00)}}{\textbf{0.53 Acres}}$ **= 80%**

The TSS removal rates for the HS-5 units are based on the performance results published by Alden Research Laboratory, which states that the HS-5 includes a TSS removal efficiency rate of 50% for flows up to 1.37 cfs. Based on the Massachusetts DEP's *Standard Method to Convert Required Water Quality Volume to a Discharge Rate for Sizing Flow Based Manufactured Proprietary Stormwater Treatment Practices*, effective October 15, 2013, the required rate to be treated is as follows:

DMH-3 (HS-5):

The required rate to be treated is:

Q_1 = (qu)(A)(WQV) = (774 csm/in)(1.72 ac)(0.0015625 mi^2/ac)(0.5 in) = **1.04 cfs**

where:

Q_1 = peak flow associated with the first 0.5" of runoff
qu = the unit peak discharge, in csm/in (774 csm/in for a 0.1 hour Tc)
A = impervious surface drainage area, in square miles
WQV = water quality volume in watershed inches

Therefore, the discharge rates reduced to be treated per the above calculation are within the treatable flows for the units. Since the Hydroworks units are designed to treat the required flow without overflow, bypass, surcharge, or scouring, and since they include a built-in bypass mechanism to accommodate high flow storm events, they are considered "offline" units under the DEP policy as proposed.

9.0 GROUNDWATER RECHARGE

The DEP Stormwater Management Policy addresses the importance of recharging groundwater and reducing surface runoff. For a redevelopment project, the net increase in site impervious area must be infiltrated to approximate the annual recharge from pre-development conditions. On this site, there is a net increase in impervious area equal to 0.81± acres. The required recharge equals a depth of runoff corresponding to the soil

[1] TSS Removal Rate calculation includes non-rooftop impervious surfaces.

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type multiplied by the net increase in impervious area for each soil type in the post development condition. Using a target factor of 0.35 inches for HSG-B (taking credit for a HSG-B infiltration rate), the total required recharge volume is as follows:

$$Rv = (F) \times (\text{newly created impervious area})$$

where,

Rv =Required recharge volume (cubic feet)
F = Target depth factor corresponding to the HSG.

$$Rv = 0.35 \text{ inch} \times 0.81 \text{ acres} \times (43{,}560 \text{ ft}^2/\text{acre}) \times (1 \text{ ft}/12 \text{ inch}) = 1{,}029 \text{ cubic feet}$$

The available storage within the subsurface infiltration system below the lowest overflow outlet (El. 81.25) total 6,200± cubic feet, thereby exceeding the required recharge volume. Below are the drawdown calculations for the infiltration BMP's summarizing that each drawdown time will be less than 72 hours as follows:

Drawdown calculation = $\frac{Depth}{K}$

Where k = 1.02 in/hour

Subsurface System -1 Drawdown calculation = $\frac{72 \text{ in}}{1.02 \text{ in/hr}}$ *= 72 hours < 72 hours =* ***OK***

10.0 DRAINAGE CONVEYANCE SYSTEM

The proposed stormwater conveyance system was designed to collect and convey runoff from developed areas to the associated stormwater management system BMP's described in this report. The drainage system consists of three (3) catch basins, one (1) water quality unit, one (1) subsurface infiltration system and associated piping. Using the rational method to determine peak runoff flows, the proposed conveyance system is designed for the 25-year storm event.

11.0 COMPLIANCE WITH THE MASSACHUSETTS DEP STORMWATER HANDBOOK

This study presents a comparative analysis of the pre-development and post-development hydrologic characteristics of the site, and outlines the proposed measures to mitigate flow, provide groundwater recharge, and improve water quality from the site. The best management practices (BMPs) outlined in this report include measures to meet the municipal and the Massachusetts Department of Environmental Protection (DEP) requirements. Below is a summary of how the design complies with each applicable DEP standard.

Standard 1: No new stormwater conveyances may discharge untreated directly to or cause erosion in wetlands or waters of the Commonwealth.

The proposed stormwater conveyance system does not include any new *untreated* discharges. The overland and subsurface drainage connection points will remain consistent with the existing condition.

Standard 2: Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.

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As indicated above and within the supporting HydroCad calculations, the stormwater management system is designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.

Standard 3: Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determine in accordance with the Massachusetts Stormwater Handbook.

There is a net increase of impervious area and the corresponding required volume of runoff will be recharged to groundwater.

Standard 4: Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS).

To aid in removal of total suspended solids, deep sump hooded catch basins and one water quality unit are proposed. Onsite non-rooftop impervious areas will be treated beyond 80%.

Standard 5: For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable.

Not applicable.

Standard 6: Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook.

Not applicable.

Standard 7: A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

Not applicable.

Standard 8: A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentations, and pollution prevention plan) shall be developed and implemented.

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The 'Demolition and Erosion Control Plan' outlines and depicts measures to control construction related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities.

Standard 9: A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.

An Operation and Maintenance Plan (O&M) has been developed that outlines maintenance requirements to ensure longevity of BMP's. See Appendix A.

Standard 10: All illicit discharges to the stormwater management system are prohibited.

The proposed stormwater management system does not include any illicit discharges.

12.0 SUMMARY

The stormwater management system for the proposed redevelopment includes measures for collecting, conveying, treating and controlling stormwater runoff from the site. Post-development peak runoff rates have been attenuated for the 2-year, 10-year and 100-year storm events and the collection system has been designed to convey runoff for the 25-year storm event. The stormwater management system incorporates both structural and non-structural BMP's to adequately treat runoff from the proposed redevelopment area and is designed in accordance with the DEP Stormwater Management Policy to the maximum extent practicable. Comprehensive computations and calculations with supporting figures and plans are attached.

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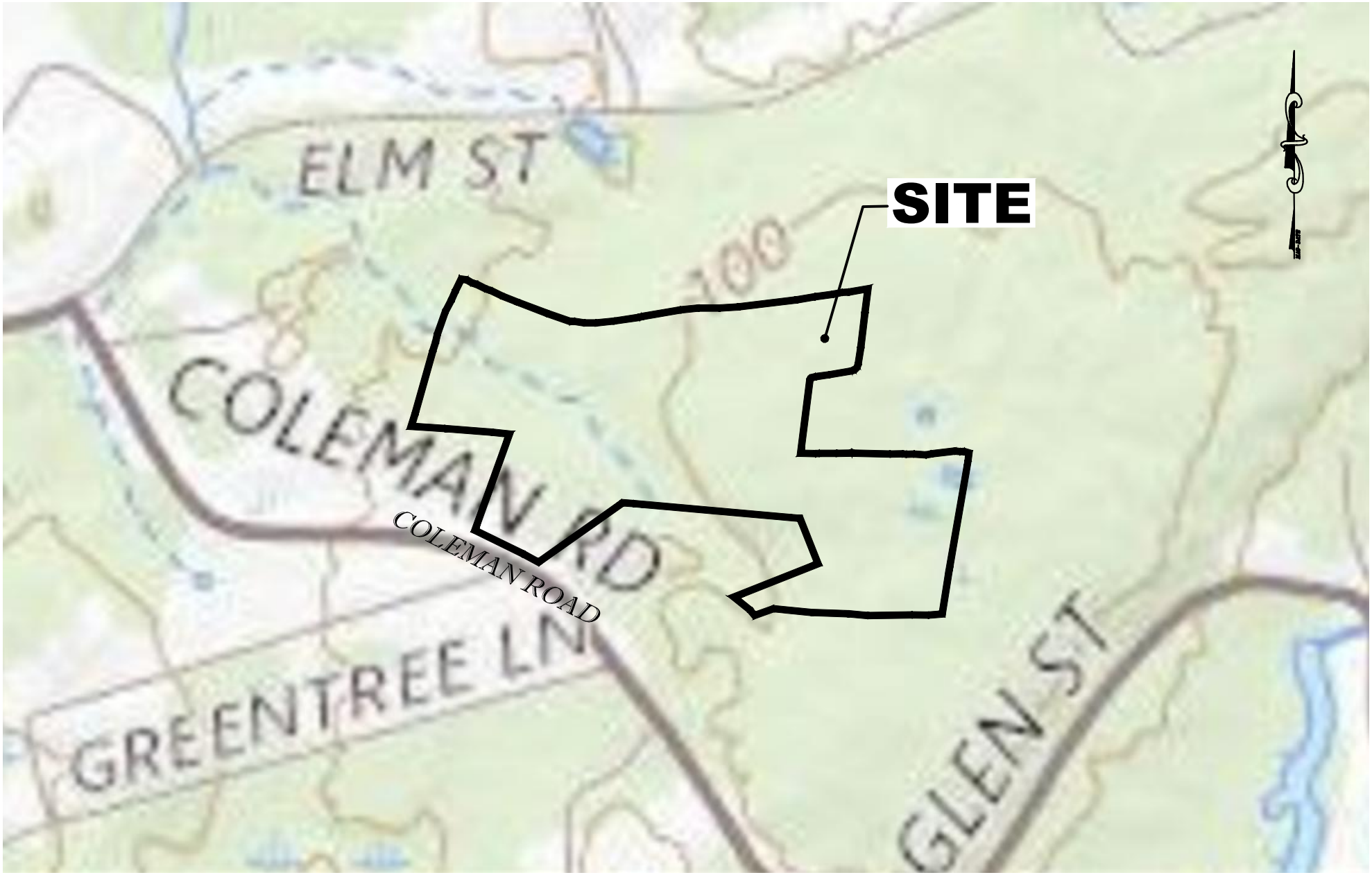

500 0 250 500 1000

GRAPHIC SCALE IN FEET

SOURCE: USGS TOPOGRAPHIC MAP

SITE:

PROPOSED OPEN SPACE RESIDENTIAL DEVELOPMENT

COLEMAN ROAD
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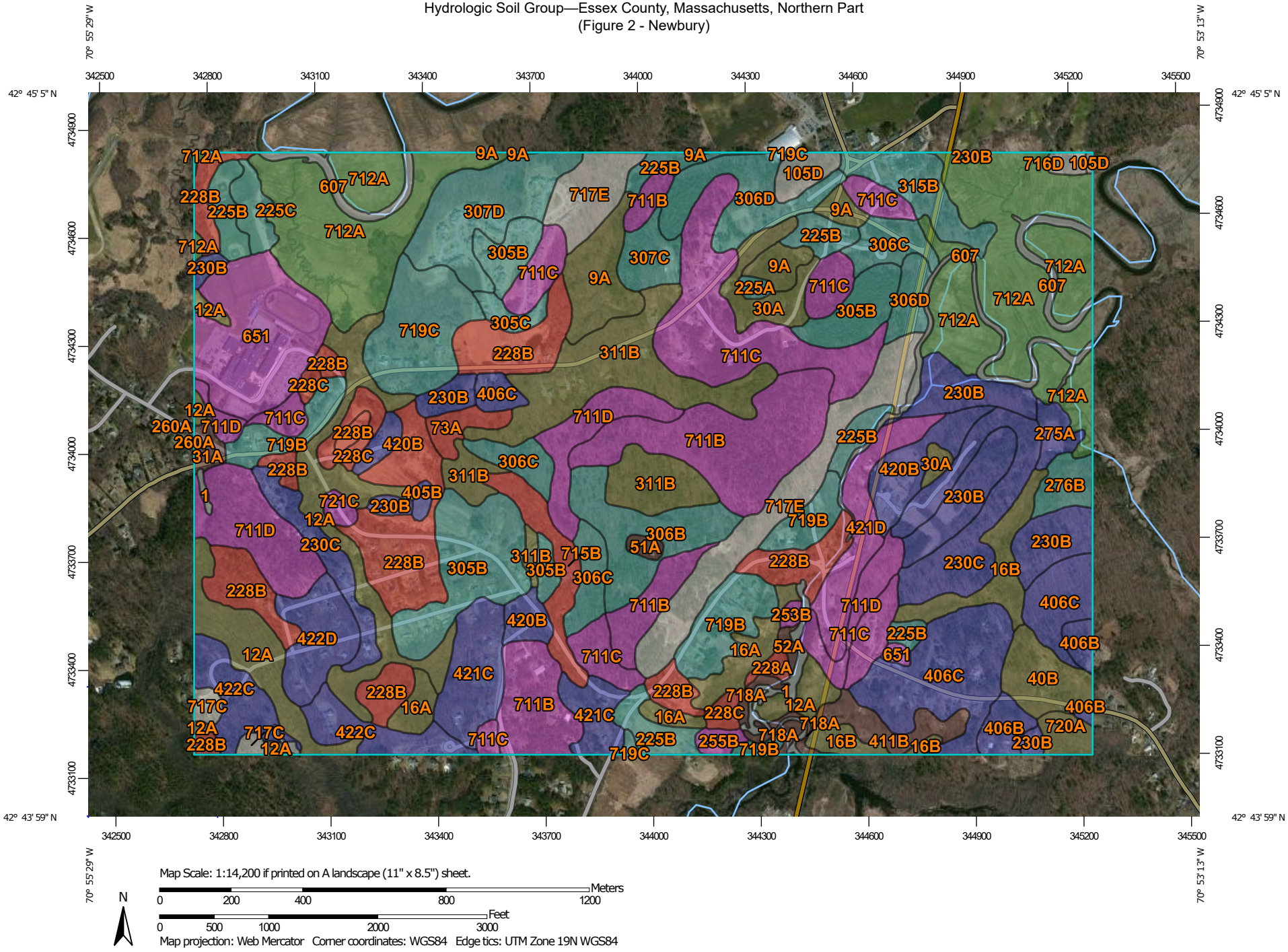
FIGURE-1
USGS PLAN

01/08/2021

Hydrologic Soil Group—Essex County, Massachusetts, Northern Part
(Figure 2 - Newbury)



Map Scale: 1:14,200 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 200 400 800 1200

Feet: 0 500 1000 2000 3000

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.

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
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 15, Sep 12, 2019

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

Date(s) aerial images were photographed: Mar 30, 2011—Apr 8, 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

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Water		4.8	0.5%
9A	Birdsall silt loam, 0 to 3 percent slopes	C/D	18.5	1.8%
12A	Maybid silt loam, 0 to 3 percent slopes	C/D	45.8	4.4%
16A	Scantic silt loam, 0 to 3 percent slopes	C/D	12.4	1.2%
16B	Scantic silt loam, 3 to 8 percent slopes	C/D	14.1	1.4%
30A	Raynham silt loam, 0 to 3 percent slopes	C/D	10.0	1.0%
31A	Walpole sandy loam, 0 to 3 percent slopes	B/D	2.4	0.2%
40B	Swanton fine sandy loam, 3 to 8 percent slopes	C/D	10.3	1.0%
51A	Swansea muck, 0 to 1 percent slopes	B/D	1.3	0.1%
52A	Freetown muck, 0 to 1 percent slopes	B/D	1.0	0.1%
73A	Whitman fine sandy loam, 0 to 3 percent slopes, extremely stony	D	4.2	0.4%
105D	Rock outcrop-Hollis complex, 3 to 25 percent slopes		4.5	0.4%
225A	Belgrade very fine sandy loam, 0 to 3 percent slopes	C	1.2	0.1%
225B	Belgrade very fine sandy loam, 3 to 8 percent slopes	C	22.4	2.2%
225C	Belgrade very fine sandy loam, 8 to 15 percent slopes	C	4.8	0.5%
228A	Buxton silt loam, 0 to 3 percent slopes	D	1.6	0.2%
228B	Buxton silt loam, 3 to 8 percent slopes	D	65.8	6.3%
228C	Buxton silt loam, 8 to 15 percent slopes	D	7.6	0.7%
230B	Unadilla very fine sandy loam, 3 to 8 percent slopes	B	34.6	3.3%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
230C	Unadilla very fine sandy loam, 8 to 15 percent slopes	B	30.4	2.9%
253B	Hinckley loamy sand, 3 to 8 percent slopes	A	0.9	0.1%
255B	Windsor loamy sand, 3 to 8 percent slopes	A	2.1	0.2%
260A	Sudbury fine sandy loam, 0 to 3 percent slopes	B	0.0	0.0%
275A	Agawam fine sandy loam, 0 to 3 percent slopes	B	3.7	0.4%
276B	Ninigret fine sandy loam, 3 to 8 percent slopes	C	5.3	0.5%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	C	39.5	3.8%
305C	Paxton fine sandy loam, 8 to 15 percent slopes	C	3.0	0.3%
306B	Paxton fine sandy loam, 0 to 8 percent slopes, very stony	C	17.7	1.7%
306C	Paxton fine sandy loam, 8 to 15 percent slopes, very stony	C	17.3	1.7%
306D	Paxton fine sandy loam, 15 to 25 percent slopes, very stony	C	20.9	2.0%
307C	Paxton fine sandy loam, 8 to 15 percent slopes, extremely stony	C	6.8	0.6%
307D	Paxton fine sandy loam, 15 to 25 percent slopes, extremely stony	C	22.2	2.1%
311B	Woodbridge fine sandy loam, 0 to 8 percent slopes, very stony	C/D	44.4	4.3%
315B	Scituate fine sandy loam, 3 to 8 percent slopes	C	11.4	1.1%
405B	Charlton fine sandy loam, 3 to 8 percent slopes	B	1.2	0.1%
406B	Charlton fine sandy loam, 3 to 8 percent slopes, very stony	B	7.4	0.7%
406C	Charlton fine sandy loam, 8 to 15 percent slopes, very stony	B	37.9	3.6%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
411B	Sutton fine sandy loam, 0 to 8 percent slopes, very stony	B/D	7.4	0.7%
420B	Canton fine sandy loam, 3 to 8 percent slopes	B	16.4	1.6%
421C	Canton fine sandy loam, 8 to 15 percent slopes, very stony	B	20.9	2.0%
421D	Canton fine sandy loam, 15 to 25 percent slopes, very stony	A	14.6	1.4%
422C	Canton fine sandy loam, 8 to 15 percent slopes, extremely stony	B	19.8	1.9%
422D	Canton fine sandy loam, 15 to 35 percent slopes, extremely stony	B	12.8	1.2%
607	Water, saline		13.6	1.3%
651	Udorthents, smoothed	A	31.4	3.0%
711B	Charlton-Rock outcrop-Hollis complex, 3 to 8 percent slopes	A	57.1	5.5%
711C	Charlton-Rock outcrop-Hollis complex, 8 to 15 percent slopes	A	60.5	5.8%
711D	Charlton-Rock outcrop-Hollis complex, 15 to 25 percent slopes	A	37.6	3.6%
712A	Ipswich and Westbrook mucky peats, 0 to 2 percent slopes, very frequently flooded	A/D	102.5	9.9%
715B	Ridgebury and Leicester fine sandy loams, 3 to 8 percent slopes, extremely stony	D	9.9	1.0%
716D	Rock outcrop-Buxton complex, 15 to 25 percent slopes		1.6	0.2%
717C	Rock outcrop-Charlton-Hollis complex, 3 to 15 percent slopes		2.8	0.3%
717E	Rock outcrop-Charlton-Hollis complex, 15 to 35 percent slopes		35.3	3.4%
718A	Saco variant silt loam, 0 to 3 percent slopes	B/D	4.1	0.4%
719B	Suffield silt loam, 3 to 8 percent slopes	C	25.6	2.5%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
719C	Suffield silt loam, 8 to 15 percent slopes	C	20.8	2.0%
720A	Whately variant fine sandy loam, 0 to 3 percent slopes	C/D	3.8	0.4%
721C	Windsor-Rock outcrop complex, 3 to 15 percent slopes	A	1.8	0.2%
Totals for Area of Interest			**1,039.8**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

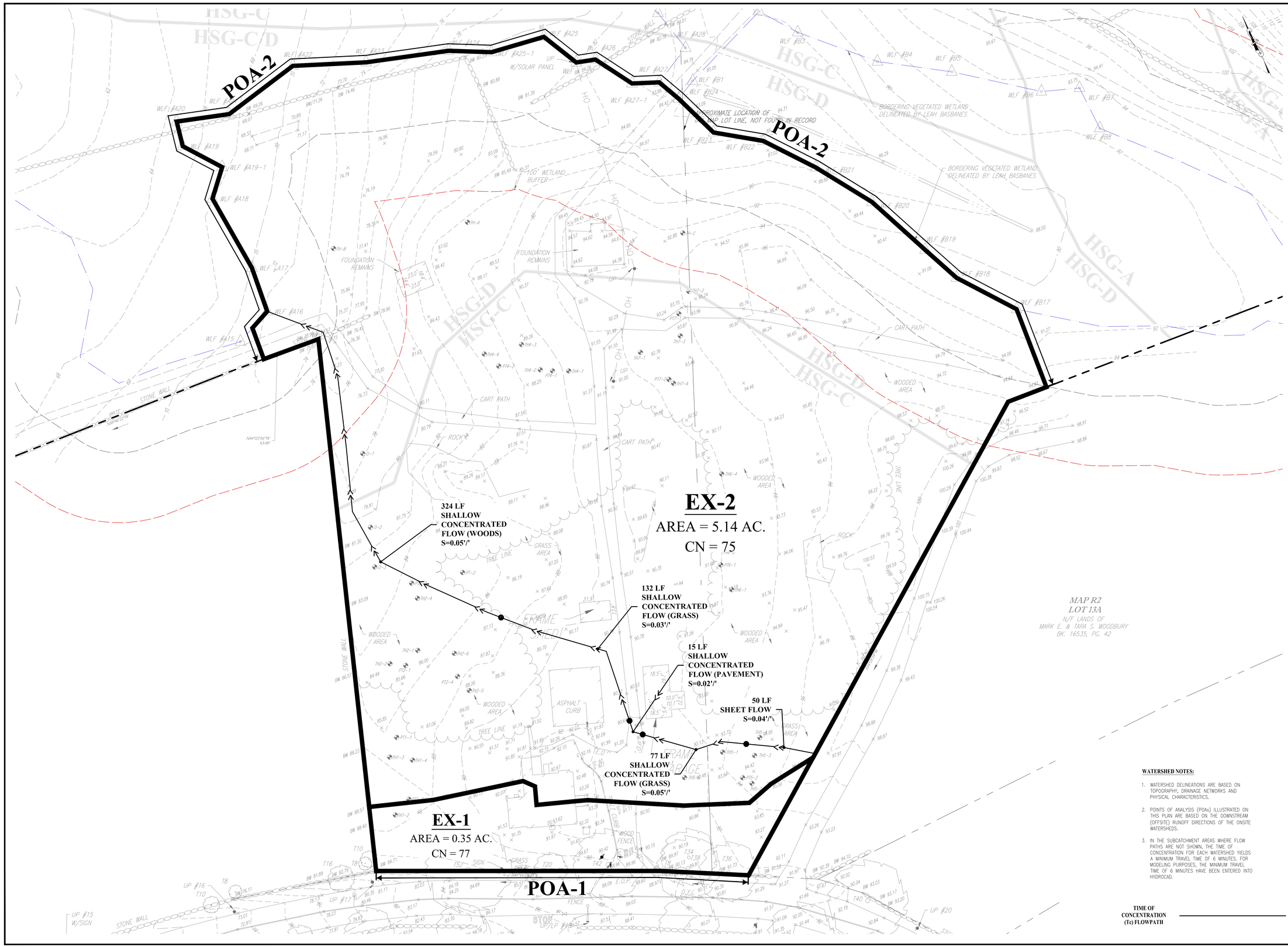
If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher



WATERSHED NOTES:

1. WATERSHED DELINEATIONS ARE BASED ON TOPOGRAPHY, DRAINAGE NETWORKS AND PHYSICAL CHARACTERISTICS.
2. POINTS OF ANALYSIS (POAs) ILLUSTRATED ON THIS PLAN ARE BASED ON THE DOWNSTREAM (OFFSITE) RUNOFF DIRECTIONS OF THE ONSITE WATERSHEDS.
3. IN THE SUBCATCHMENT AREAS WHERE FLOW PATHS ARE NOT SHOWN, THE TIME OF CONCENTRATION FOR EACH WATERSHED YIELDS A MINIMUM TRAVEL TIME OF 6 MINUTES. FOR MODELING PURPOSES, THE MINIMUM TRAVEL TIME OF 6 MINUTES HAVE BEEN ENTERED INTO HYDROCAD.

TIME OF CONCENTRATION (Tc) FLOWPATH

NOT FOR CONSTRUCTION

CDG PROJECT #: 19025

REVISIONS:

REV	DATE	COMMENT
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

PLANNING BOARD:

SEAL:

COMMONWEALTH OF MASSACHUSETTS
PHILIP R. HENRY
CIVIL
No. 48547
REGISTERED PROFESSIONAL ENGINEER

PHILIP R. HENRY, P.E.

PREPARED BY:

CIVIL DESIGN GROUP, LLC

21 HIGH STREET, SUITE 207
NORTH ANDOVER, MA 01845
www.cdgengineering.com
p: 978-794-5400 f: 978-965-3971

PREPARED FOR:

ZENDKO, LLC

15 ESTES STREET
AMESBURY, MA 01913

PROJECT:

OPEN SPACE RESIDENTIAL DEVELOPMENT

15 COLEMAN ROAD
NEWBURY, MASSACHUSETTS 01922

SCALE:

30 0 15 30 60

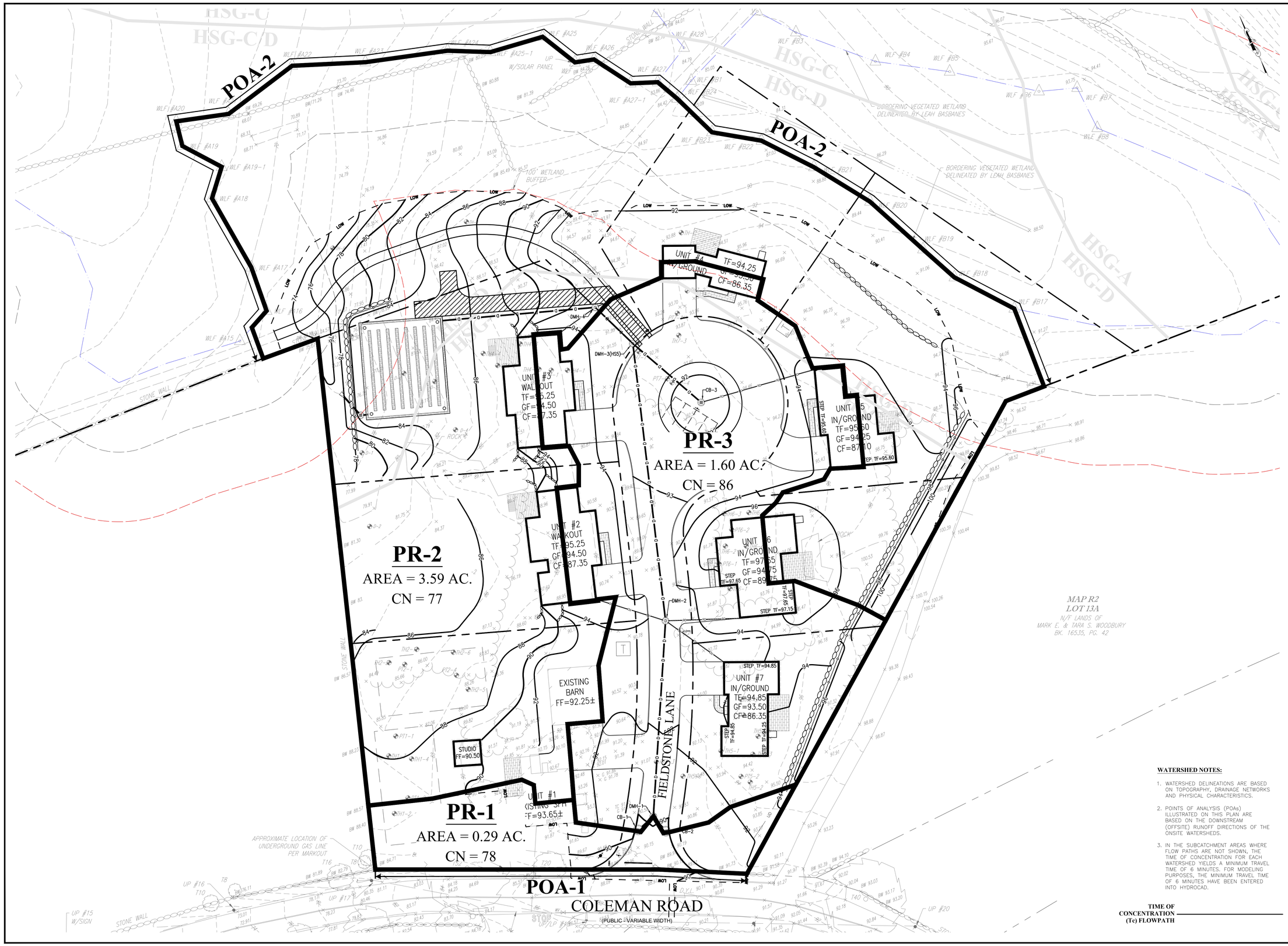
GRAPHIC SCALE IN FEET

SHEET:

PRE-DEVELOPMENT WATERSHEDS

FIGURE 3

DATE: 01/08/2021



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TIME OF CONCENTRATION (Tc) FLOWPATH

NOT FOR CONSTRUCTION

CDG PROJECT #: 19025

REVISIONS:

REV	DATE	COMMENT
1	01/25/21	MODIFIED PLAN PER PLANNER COMMENTS
2	02/09/21	MODIFIED PER NEW TEST PITS AND CON COM COMMENTS
3	03/22/21	ADDED 2016 SOIL DATA FOR YIELD PLAN LOTS 3 AND 4
4	04/13/21	REVISED PLAN PER CON COM COMMENTS
5	05/21/21	REVISED PLAN PER PEER REVIEW AND PLANNING BOARD COMMENTS
6		
7		
8		
9		
10		

PLANNING BOARD:

I, _____ CLERK OF THE TOWN OF NEWBURY, HEREBY CERTIFY THAT THE NOTICE OF APPROVAL OF THIS PLAN BY THE PLANNING BOARD WAS RECEIVED ON _____ AND RECORDED AT THIS OFFICE AND NO NOTICE OF APPEAL WAS RECEIVED DURING THE TWENTY DAYS NET FOLLOWING SUCH RECEIPT AND RECORDING OF SAID NOTICE.

DATE TOWN CLERK

SEAL:

COMMONWEALTH OF MASSACHUSETTS
PHILIP R. HENRY
CIVIL
No. 48547
REGISTERED PROFESSIONAL ENGINEER

PHILIP R. HENRY, P.E.

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OPEN SPACE RESIDENTIAL DEVELOPMENT

15 COLEMAN ROAD
NEWBURY, MASSACHUSETTS 01922

SCALE:

30 0 15 30 60

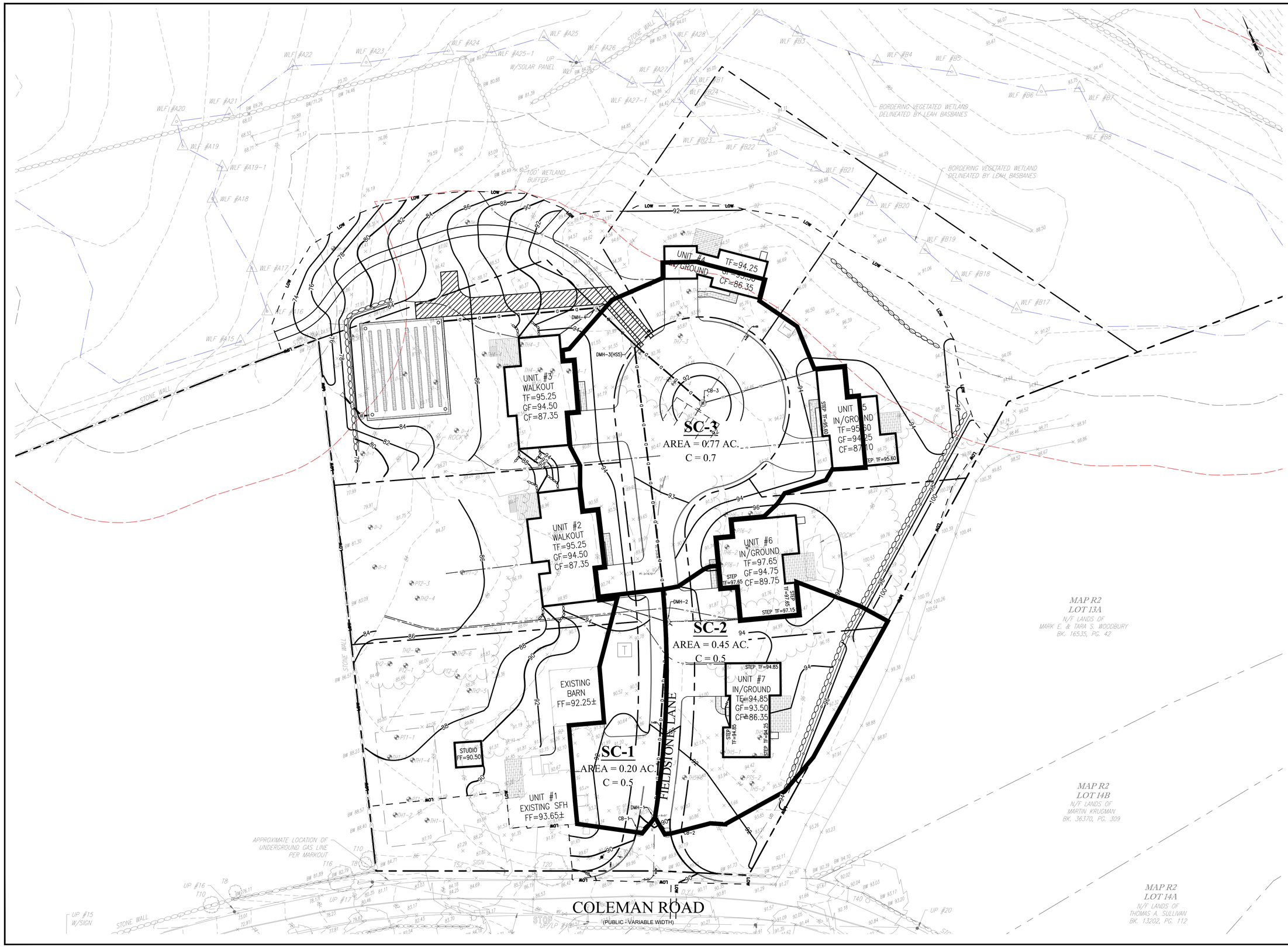
GRAPHIC SCALE IN FEET

SHEET:

POST-DEVELOPMENT WATERSHEDS

FIGURE 4

DATE: 01/08/2021



NOT FOR CONSTRUCTION

CDG PROJECT #: 19025

REVISIONS:

REV	DATE	COMMENT
1	01/25/21	MODIFIED PLAN PER PLANNER COMMENTS
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7		
8		
9		
10		

PLANNING BOARD:

I, _____ CLERK OF THE TOWN OF NEWBURY, HEREBY CERTIFY THAT THE NOTICE OF APPROVAL OF THIS PLAN BY THE PLANNING BOARD WAS RECEIVED ON _____ AND RECORDED AT THIS OFFICE AND NO NOTICE OF APPEAL WAS RECEIVED DURING THE TWENTY DAYS NET FOLLOWING SUCH RECEIPT AND RECORDING OF SAID NOTICE.

DATE TOWN CLERK

SEAL:

COMMONWEALTH OF MASSACHUSETTS
PHILIP R. HENRY
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AMESBURY, MA 01913

PROJECT:

OPEN SPACE RESIDENTIAL DEVELOPMENT

15 COLEMAN ROAD
NEWBURY, MASSACHUSETTS 01922

SCALE:

30 0 15 30 60

GRAPHIC SCALE IN FEET

SHEET:

CATCH BASIN WATERSHEDS

FIGURE 5

DATE: 01/08/2021

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

inches elevation

Deep Observation Hole Number:____D-1_____

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-10	A	10 YR 3/3				SL					
10-24	Bw	10 YR 6/8				SL					
24-72	C	2.5 Y 5/4				SL					

Additional Notes ____No Groundwater Observed_____

_____Refusal @ 72"_____

_____

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

inches elevation

Deep Observation Hole Number:____D-2_____

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-10	A	10 YR 3/3				SL					
10-24	Bw	10 YR 6/8				SL					
24-52	C	2.5 Y 5/4	32"			SL					

Additional Notes ____No Groundwater Observed_____

_____Refusal @ 52"_____

_____

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

inches elevation

Deep Observation Hole Number:____D-3_____

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-10	A	10 YR 3/3				SL					
10-27	Bw	10 YR 6/8				SL					
27-54	C	2.5 Y 5/4	32"			SL					

Additional Notes ____No Groundwater Observed_____

_____Refusal @ 54"_____

_____

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

inches elevation

Deep Observation Hole Number:____4-1_____

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-12	A	10 YR 3/3				SL					
12-35	Bw	10 YR 6/8				SL					
35-76	C	2.5 Y 5/4				SL					

Additional Notes ____No Groundwater Observed_____Testing on 7/30/2020_____

_____Refusal @ 76"_____

_____

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

inches elevation

Deep Observation Hole Number:____4-2_____

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-12	A	10 YR 3/3				SL					
12-25	Bw	10 YR 6/8				SL					
25-72	C	2.5 Y 5/4				SL					

Additional Notes ____No Groundwater Observed_____Testing on 7/30/2020_____

_____Refusal @ 72"_____

_____

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

inches elevation

Deep Observation Hole Number:____4-3_____

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-12	A	10 YR 3/3				SL					
12-32	Bw	10 YR 6/8				SL					
32-96	C	2.5 Y 5/4				SL					

Additional Notes ____No Groundwater Observed_____Testing on 7/30/2020_____

_____Refusal @ 96"_____

_____

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

inches elevation

Deep Observation Hole Number:____4-4____

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-12	A	10 YR 3/3				SL					
12-29	Bw	10 YR 6/8				SL					
29-72	C	2.5 Y 5/4				SL					

Additional Notes ____No Groundwater Observed_____Testing on 7/30/2020_____

_____Refusal @ 72"_____

_____

TEST PIT LOG

Site: 15 Coleman Road, Newbury
Logged By: Jack Sullivan, P.E.,
Excavator: Owner provided

Test Pit Number: D-4 (Hole #) | 02-01-21 (Date) | 0900 (Time) | Sunny, 35 degrees (Weather) | _____ (Latitude) | _____ (Longitude:)

Land Use: Residential Lot (e.g., woodland, agricultural field, vacant lot, etc.) | Brush (Vegetation) | None (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 2 +/- (Slope (%))

Groundwater Observed: ☒ Yes ☐ No If yes: 38" Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-7	A	SL	10 YR3/3	-	-	-	-	-	-	-	-
7-20	Bw	SL	10YR 6/8				-	-	-	-	
20-47	C	SL	**2.5 Y 5/4**	38"			-	-	--	-	

Additional Notes:
Refusal at 47"

TEST PIT LOG

Site: 15 Coleman Road, Newbury
Logged By: Jack Sullivan, P.E.,
Excavator: Owner provided

Test Pit Number: D-5 (Hole #) | 02-01-21 (Date) | 0900 (Time) | Sunny, 35 degrees (Weather) | _____ (Latitude) | _____ (Longitude:)

Land Use: Residential Lot (e.g., woodland, agricultural field, vacant lot, etc.) | Brush (Vegetation) | None (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 2 +/- (Slope (%))

Groundwater Observed: ☐ Yes ☒ No If yes: Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-7	A	SL	10 YR3/3	-	-	-	-	-	-	-	-
7-21	Bw	SL	10YR 6/8				-	-	-	-	
21-84	C	SL	**2.5 Y 5/4**				-	-	--	-	

Additional Notes:
No groundwater encountered

TEST PIT LOG

Site: 15 Coleman Road, Newbury
Logged By: Jack Sullivan, P.E.,
Excavator: Owner provided

Test Pit Number: D-6 (Hole #) | 02-01-21 (Date) | 0900 (Time) | Sunny, 35 degrees (Weather) | _____ (Latitude) | _____ (Longitude:)

Land Use: Residential Lot (e.g., woodland, agricultural field, vacant lot, etc.) | Brush (Vegetation) | None (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 2 +/- (Slope (%))

Groundwater Observed: ☐ Yes ☒ No If yes: Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-7	A	SL	10 YR3/3	-	-	-	-	-	-	-	-
7-20	Bw	SL	10YR 6/8				-	-	-	-	
20-55	C	SL	**2.5 Y 5/4**				-	-	--	-	

Additional Notes:
No groundwater encountered, refusal at 55”

TEST PIT LOG

Site: 15 Coleman Road, Newbury
Logged By: Jack Sullivan, P.E.,
Excavator: Owner provided

Test Pit Number: D-7 (Hole #) | 02-01-21 (Date) | 0900 (Time) | Sunny, 35 degrees (Weather) | _____ (Latitude) | _____ (Longitude:)

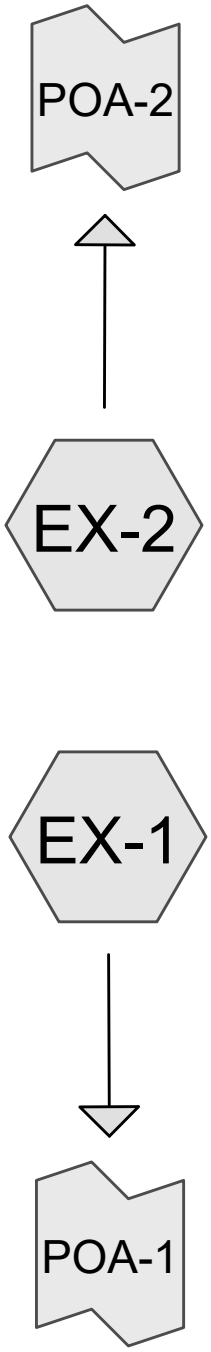
Land Use: Residential Lot (e.g., woodland, agricultural field, vacant lot, etc.) | Brush (Vegetation) | None (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 2 +/- (Slope (%))

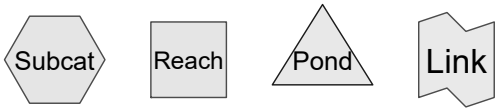
Groundwater Observed: ☐ Yes ☒ No If yes: Depth Weeping from Pit _____ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-8	A	SL	10 YR3/3	-	-	-	-	-	-	-	-
8-21	Bw	SL	10YR 6/8				-	-	-	-	
21-60	C	SL	**2.5 Y 5/4**				-	-	--	-	

Additional Notes:
No groundwater encountered, refusal at 60”





Routing Diagram for Pre-Development

Prepared by {enter your company name here}, Printed 12/31/2020

HydroCAD® 10.00-26 s/n 07576 © 2020 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
1.315	74	>75% Grass cover, Good, HSG C (EX-1, EX-2)
0.068	98	Unconnected pavement, HSG C (EX-1, EX-2)
0.004	98	Unconnected pavement, HSG D (EX-2)
0.103	98	Unconnected roofs, HSG C (EX-1, EX-2)
1.769	70	Woods, Good, HSG C (EX-2)
2.227	77	Woods, Good, HSG D (EX-2)
5.486	**75**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
3.255	HSG C	EX-1, EX-2
2.231	HSG D	EX-2
0.000	Other	
5.486		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	1.315	0.000	0.000	1.315	>75% Grass cover, Good	EX-1, EX-2
0.000	0.000	0.068	0.004	0.000	0.072	Unconnected pavement	EX-1, EX-2
0.000	0.000	0.103	0.000	0.000	0.103	Unconnected roofs	EX-1, EX-2
0.000	0.000	1.769	2.227	0.000	3.996	Woods, Good	EX-2
0.000	**0.000**	**3.255**	**2.231**	**0.000**	**5.486**	**TOTAL AREA**	

Time span=0.00-24.00 hrs, dt=0.10 hrs, 241 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv. UI as Pervious
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Runoff Area=15,167 sf 0.00% Impervious Runoff Depth>1.17"
Tc=6.0 min CN=77/0 Runoff=0.39 cfs 0.034 af

Subcatchment EX-2: Runoff Area=223,817 sf 0.00% Impervious Runoff Depth>1.06"
Flow Length=598' Tc=11.8 min CN=75/0 Runoff=4.51 cfs 0.452 af

Link POA-1: Inflow=0.39 cfs 0.034 af
Primary=0.39 cfs 0.034 af

Link POA-2: Inflow=4.51 cfs 0.452 af
Primary=4.51 cfs 0.452 af

Total Runoff Area = 5.486 ac Runoff Volume = 0.486 af Average Runoff Depth = 1.06"
100.00% Pervious = 5.486 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment EX-1:

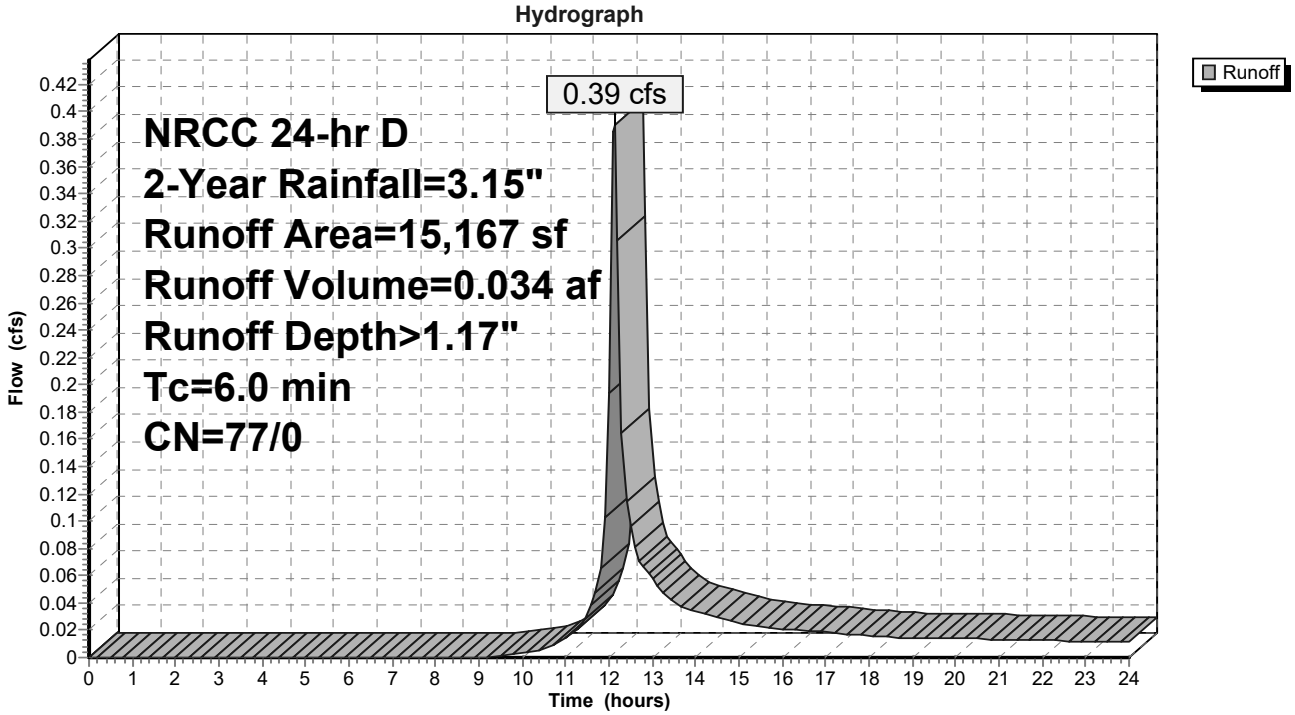
Runoff = 0.39 cfs @ 12.12 hrs, Volume= 0.034 af, Depth> 1.17"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv. UI as Pervious, Time Span= 0.00-24.00 hrs, dt= 0.10
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
1,010	98	Unconnected roofs, HSG C
871	98	Unconnected pavement, HSG C
13,286	74	>75% Grass cover, Good, HSG C
15,167	77	Weighted Average
15,167	77	100.00% Pervious Area

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

Subcatchment EX-1:



Summary for Subcatchment EX-2:

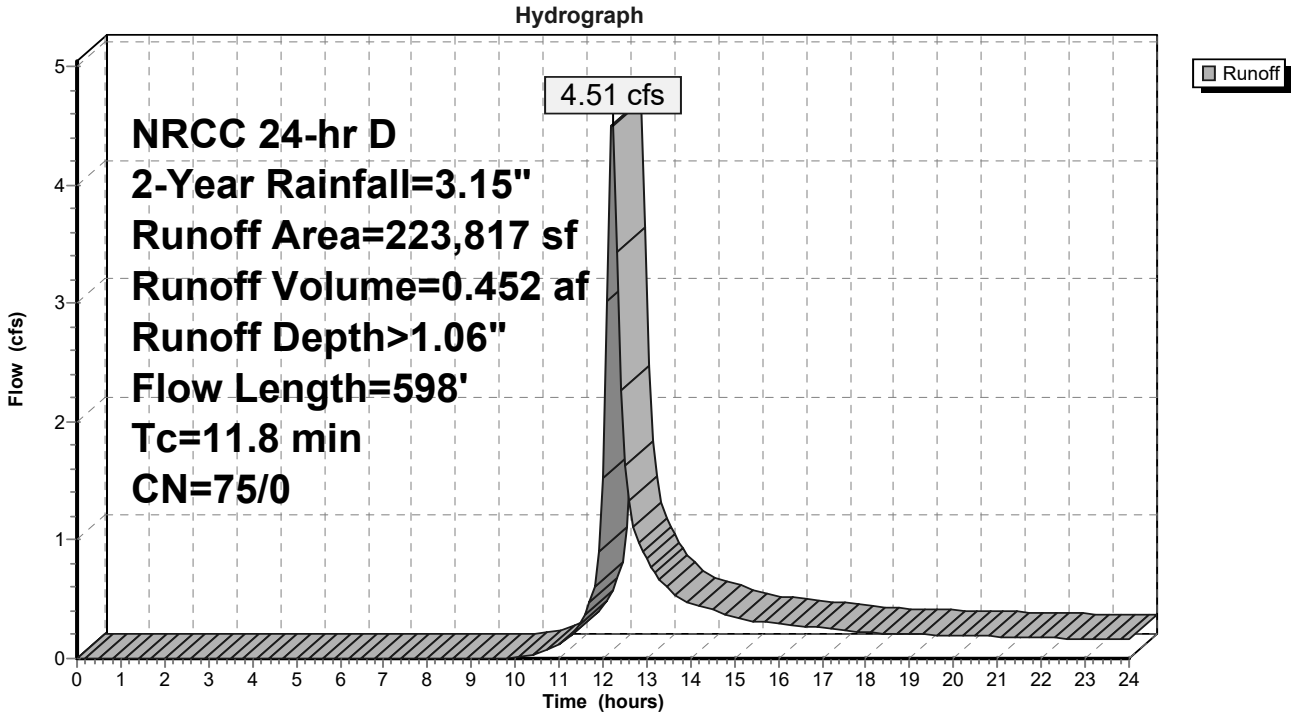
Runoff = 4.51 cfs @ 12.21 hrs, Volume= 0.452 af, Depth> 1.06"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv. UI as Pervious, Time Span= 0.00-24.00 hrs, dt= 0.10
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
2,091	98	Unconnected pavement, HSG C
174	98	Unconnected pavement, HSG D
3,485	98	Unconnected roofs, HSG C
97,029	77	Woods, Good, HSG D
43,982	74	>75% Grass cover, Good, HSG C
77,056	70	Woods, Good, HSG C
223,817	75	Weighted Average
223,817	75	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.8	77	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.8	132	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.8	324	0.0500	1.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.8	598	Total			

Subcatchment EX-2:

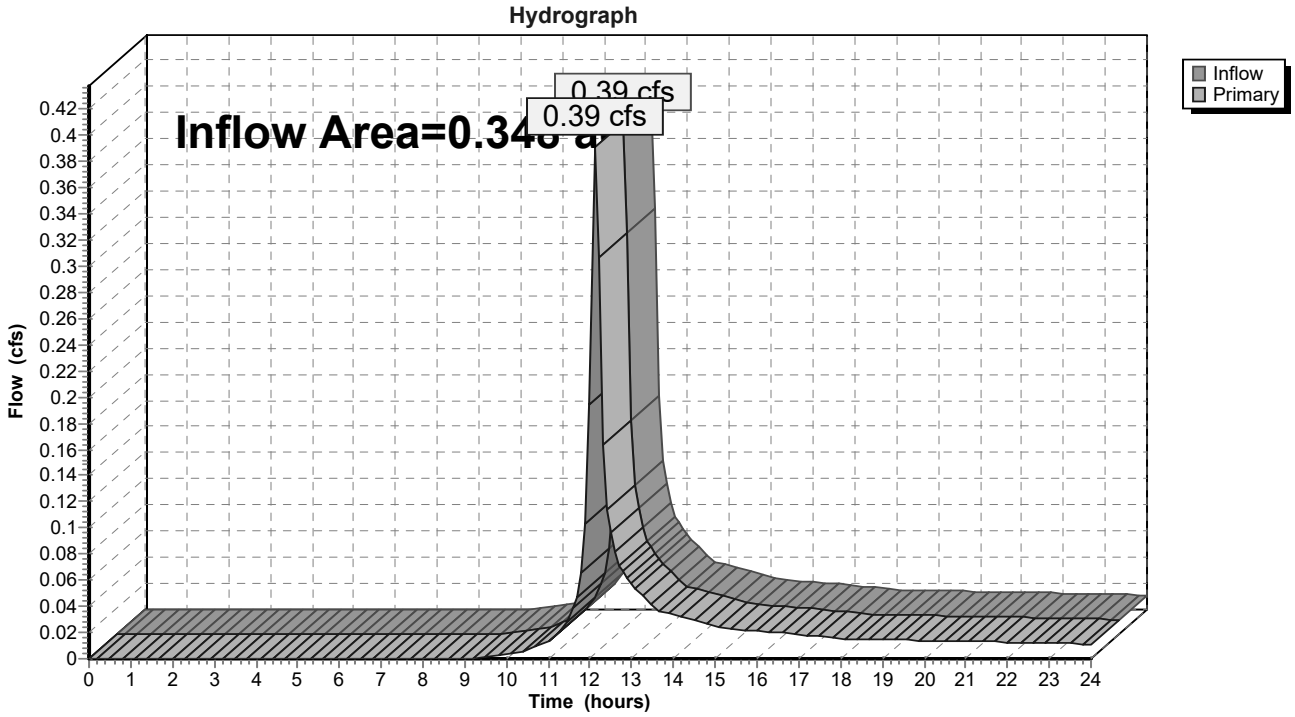


Summary for Link POA-1:

Inflow Area = 0.348 ac, 0.00% Impervious, Inflow Depth > 1.17" for 2-Year event
Inflow = 0.39 cfs @ 12.12 hrs, Volume= 0.034 af
Primary = 0.39 cfs @ 12.12 hrs, Volume= 0.034 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs

Link POA-1:

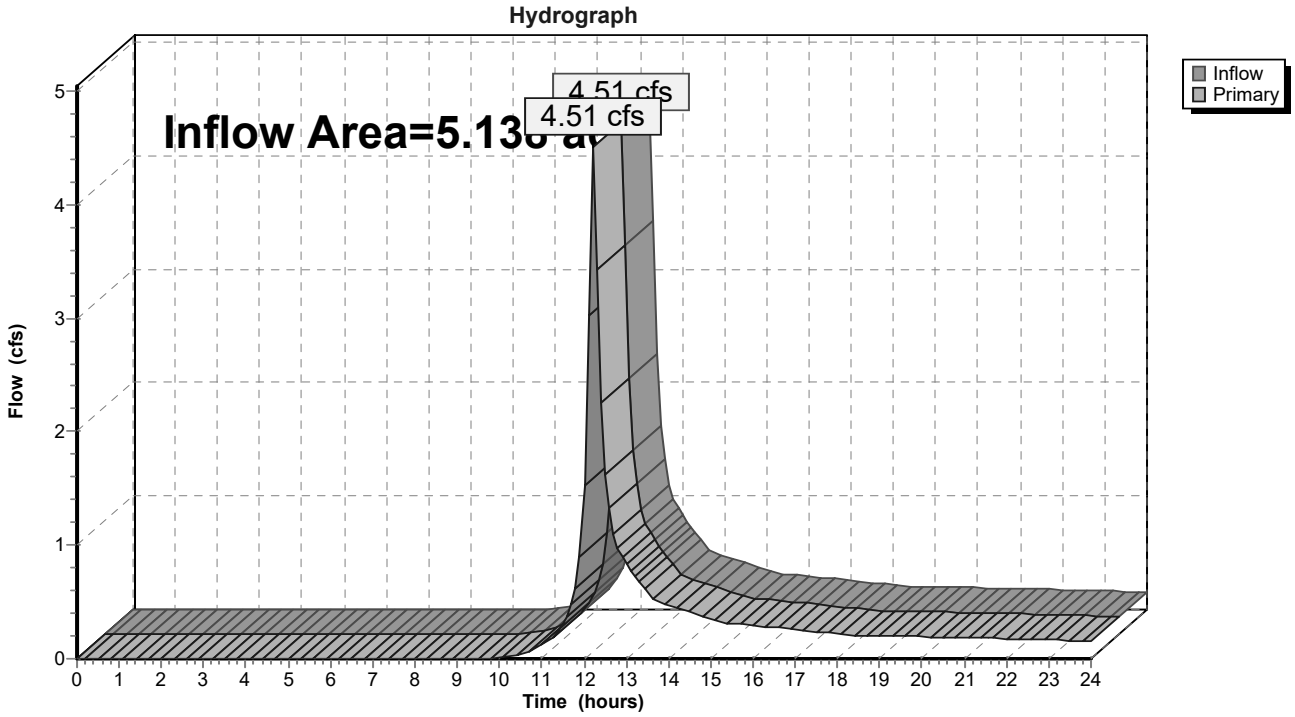


Summary for Link POA-2:

Inflow Area = 5.138 ac, 0.00% Impervious, Inflow Depth > 1.06" for 2-Year event
Inflow = 4.51 cfs @ 12.21 hrs, Volume= 0.452 af
Primary = 4.51 cfs @ 12.21 hrs, Volume= 0.452 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs

Link POA-2:



Time span=0.00-24.00 hrs, dt=0.10 hrs, 241 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv. UI as Pervious
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Runoff Area=15,167 sf 0.00% Impervious Runoff Depth>2.48"
Tc=6.0 min CN=77/0 Runoff=0.85 cfs 0.072 af

Subcatchment EX-2: Runoff Area=223,817 sf 0.00% Impervious Runoff Depth>2.30"
Flow Length=598' Tc=11.8 min CN=75/0 Runoff=10.17 cfs 0.987 af

Link POA-1: Inflow=0.85 cfs 0.072 af
Primary=0.85 cfs 0.072 af

Link POA-2: Inflow=10.17 cfs 0.987 af
Primary=10.17 cfs 0.987 af

Total Runoff Area = 5.486 ac Runoff Volume = 1.059 af Average Runoff Depth = 2.32"
100.00% Pervious = 5.486 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment EX-1:

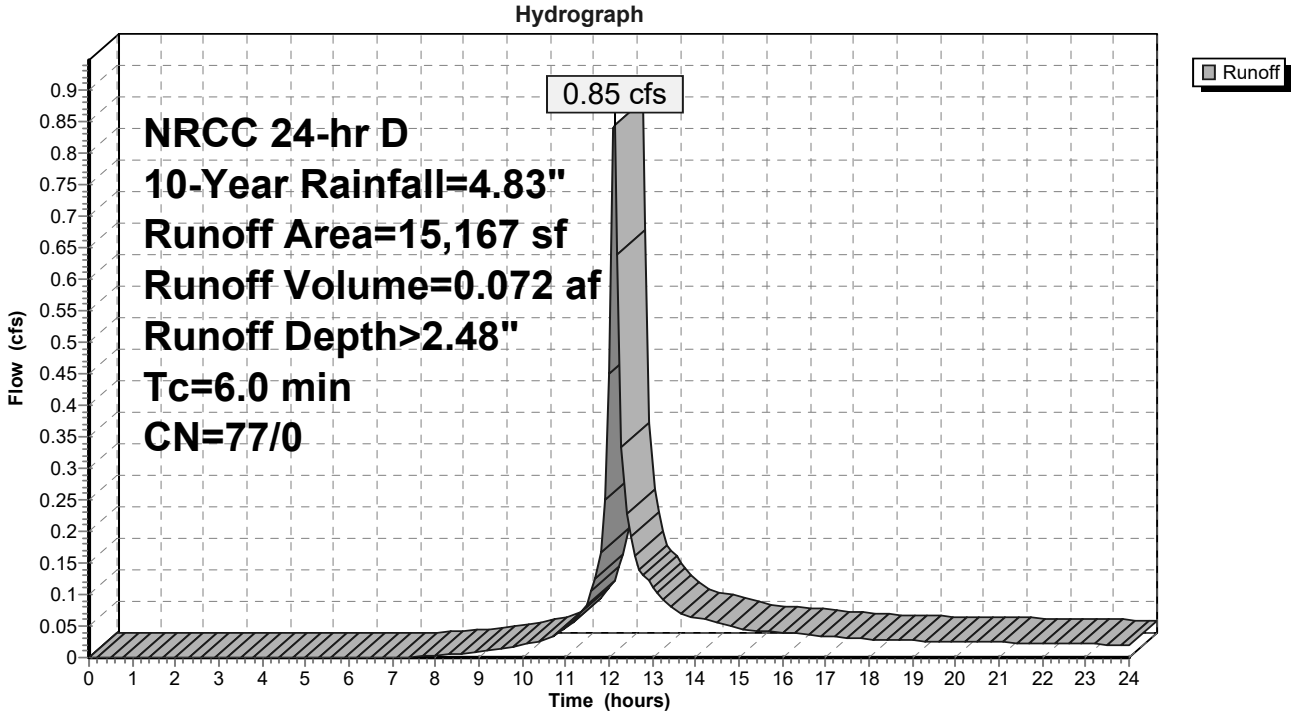
Runoff = 0.85 cfs @ 12.12 hrs, Volume= 0.072 af, Depth> 2.48"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv. UI as Pervious, Time Span= 0.00-24.00 hrs, dt= 0.10
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
1,010	98	Unconnected roofs, HSG C
871	98	Unconnected pavement, HSG C
13,286	74	>75% Grass cover, Good, HSG C
15,167	77	Weighted Average
15,167	77	100.00% Pervious Area

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

Subcatchment EX-1:



Summary for Subcatchment EX-2:

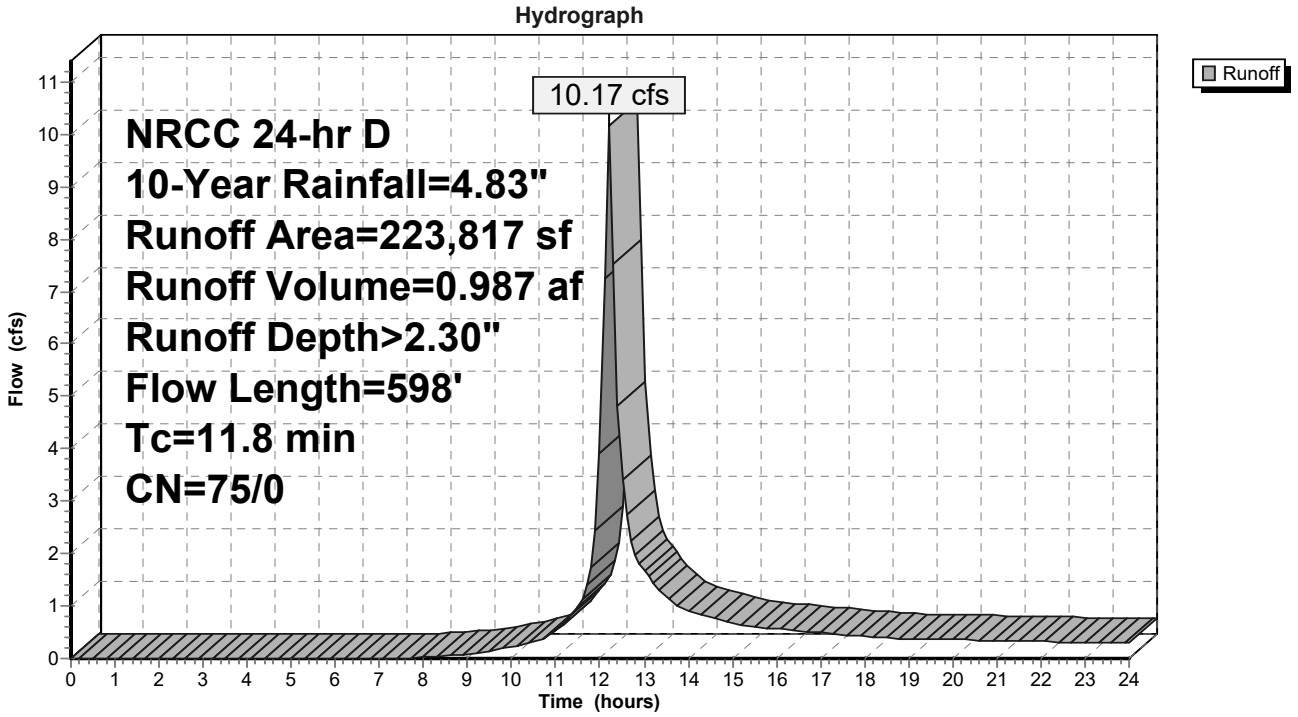
Runoff = 10.17 cfs @ 12.20 hrs, Volume= 0.987 af, Depth> 2.30"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv. UI as Pervious, Time Span= 0.00-24.00 hrs, dt= 0.10
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
2,091	98	Unconnected pavement, HSG C
174	98	Unconnected pavement, HSG D
3,485	98	Unconnected roofs, HSG C
97,029	77	Woods, Good, HSG D
43,982	74	>75% Grass cover, Good, HSG C
77,056	70	Woods, Good, HSG C
223,817	75	Weighted Average
223,817	75	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.8	77	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.8	132	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.8	324	0.0500	1.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.8	598	Total			

Subcatchment EX-2:

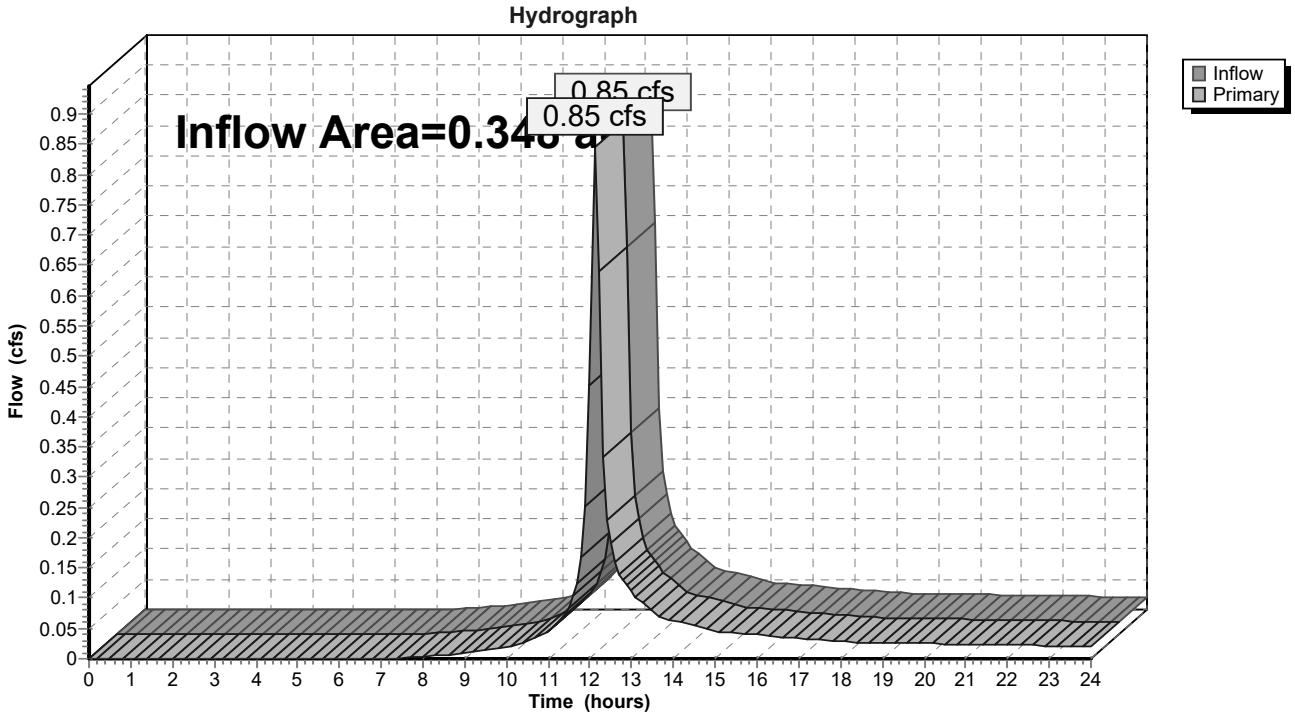


Summary for Link POA-1:

Inflow Area = 0.348 ac, 0.00% Impervious, Inflow Depth > 2.48" for 10-Year event
Inflow = 0.85 cfs @ 12.12 hrs, Volume= 0.072 af
Primary = 0.85 cfs @ 12.12 hrs, Volume= 0.072 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs

Link POA-1:

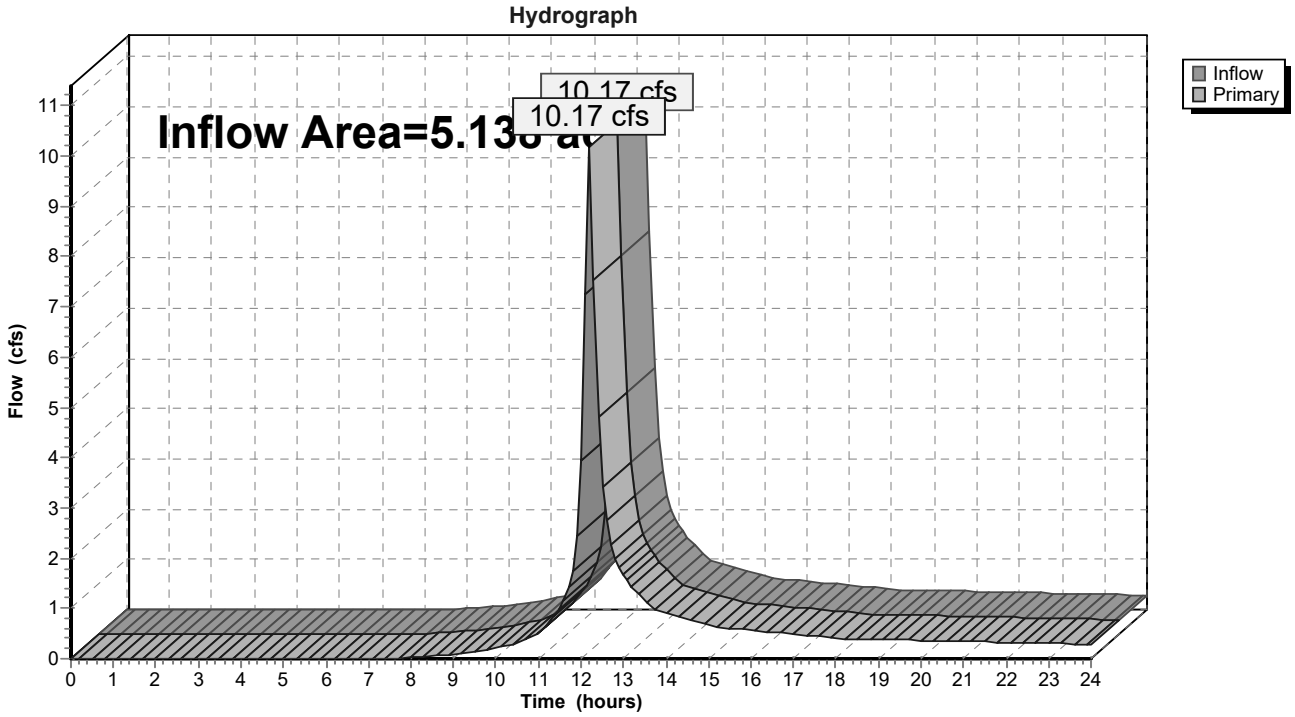


Summary for Link POA-2:

Inflow Area = 5.138 ac, 0.00% Impervious, Inflow Depth > 2.30" for 10-Year event
Inflow = 10.17 cfs @ 12.20 hrs, Volume= 0.987 af
Primary = 10.17 cfs @ 12.20 hrs, Volume= 0.987 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs

Link POA-2:



Time span=0.00-24.00 hrs, dt=0.10 hrs, 241 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv. UI as Pervious
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment EX-1: Runoff Area=15,167 sf 0.00% Impervious Runoff Depth>6.14"
Tc=6.0 min CN=77/0 Runoff=2.06 cfs 0.178 af

Subcatchment EX-2: Runoff Area=223,817 sf 0.00% Impervious Runoff Depth>5.88"
Flow Length=598' Tc=11.8 min CN=75/0 Runoff=25.65 cfs 2.518 af

Link POA-1: Inflow=2.06 cfs 0.178 af
Primary=2.06 cfs 0.178 af

Link POA-2: Inflow=25.65 cfs 2.518 af
Primary=25.65 cfs 2.518 af

Total Runoff Area = 5.486 ac Runoff Volume = 2.696 af Average Runoff Depth = 5.90"
100.00% Pervious = 5.486 ac 0.00% Impervious = 0.000 ac

Summary for Subcatchment EX-1:

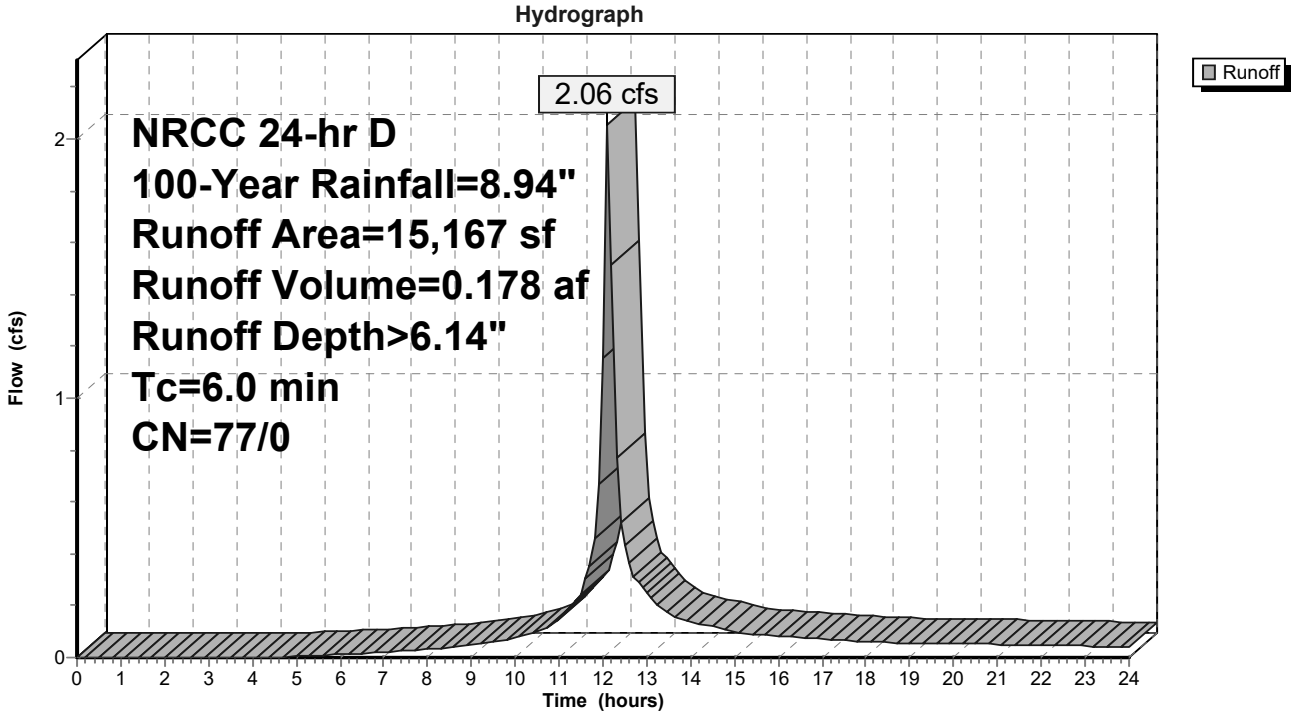
Runoff = 2.06 cfs @ 12.11 hrs, Volume= 0.178 af, Depth> 6.14"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv. UI as Pervious, Time Span= 0.00-24.00 hrs, dt= 0.10
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
1,010	98	Unconnected roofs, HSG C
871	98	Unconnected pavement, HSG C
13,286	74	>75% Grass cover, Good, HSG C
15,167	77	Weighted Average
15,167	77	100.00% Pervious Area

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

Subcatchment EX-1:



Summary for Subcatchment EX-2:

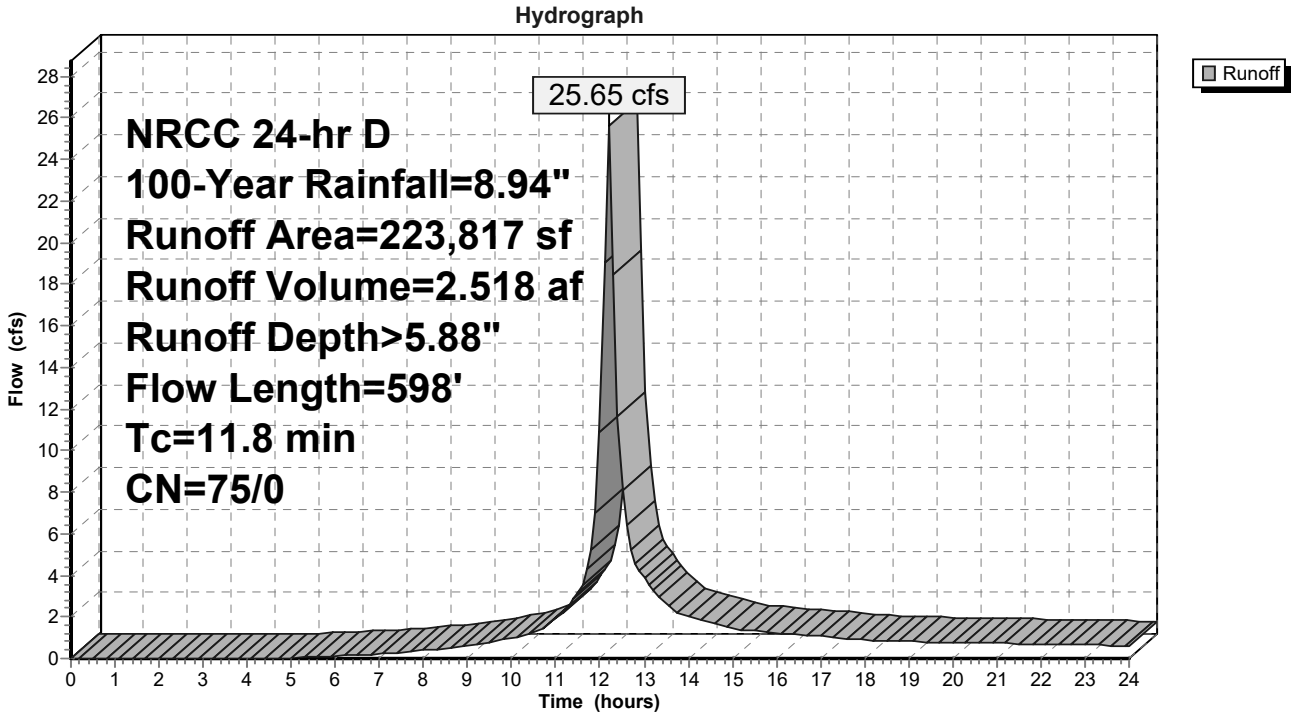
Runoff = 25.65 cfs @ 12.20 hrs, Volume= 2.518 af, Depth> 5.88"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv. UI as Pervious, Time Span= 0.00-24.00 hrs, dt= 0.10
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
2,091	98	Unconnected pavement, HSG C
174	98	Unconnected pavement, HSG D
3,485	98	Unconnected roofs, HSG C
97,029	77	Woods, Good, HSG D
43,982	74	>75% Grass cover, Good, HSG C
77,056	70	Woods, Good, HSG C
223,817	75	Weighted Average
223,817	75	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.15"
0.8	77	0.0500	1.57		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0200	2.87		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
1.8	132	0.0300	1.21		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
4.8	324	0.0500	1.12		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.8	598	Total			

Subcatchment EX-2:

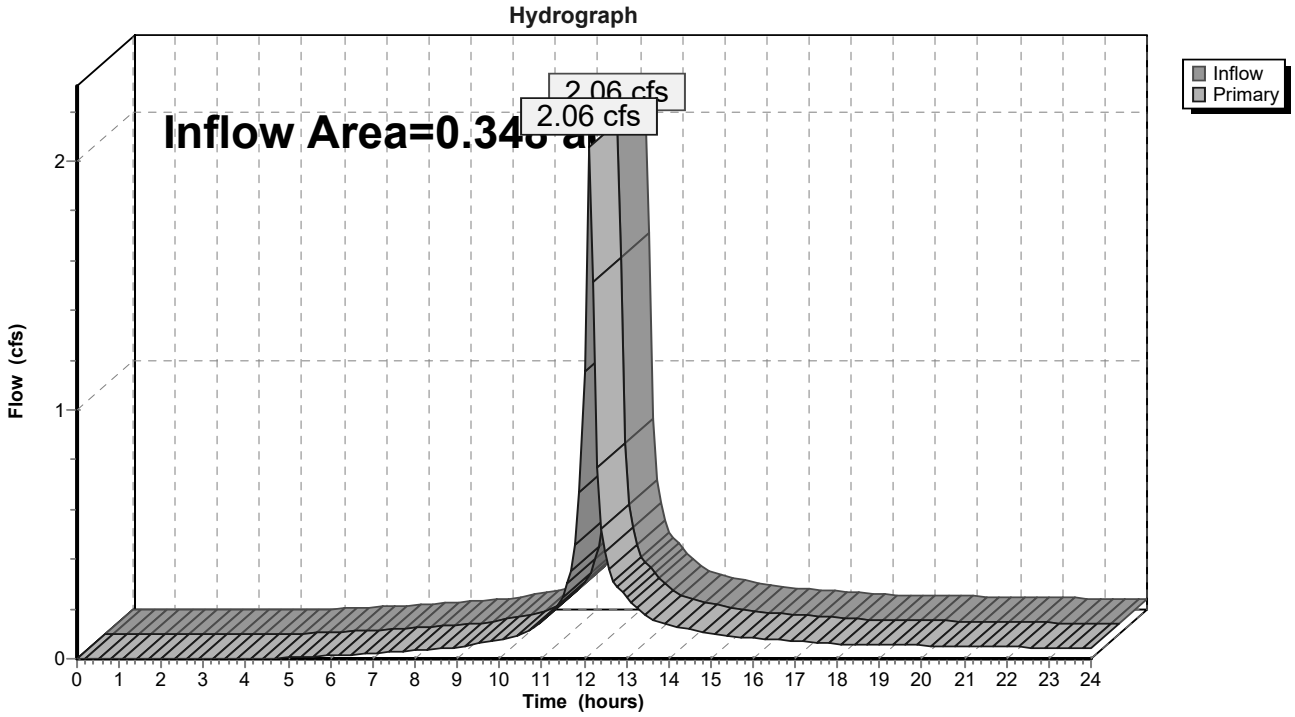


Summary for Link POA-1:

Inflow Area = 0.348 ac, 0.00% Impervious, Inflow Depth > 6.14" for 100-Year event
Inflow = 2.06 cfs @ 12.11 hrs, Volume= 0.178 af
Primary = 2.06 cfs @ 12.11 hrs, Volume= 0.178 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs

Link POA-1:

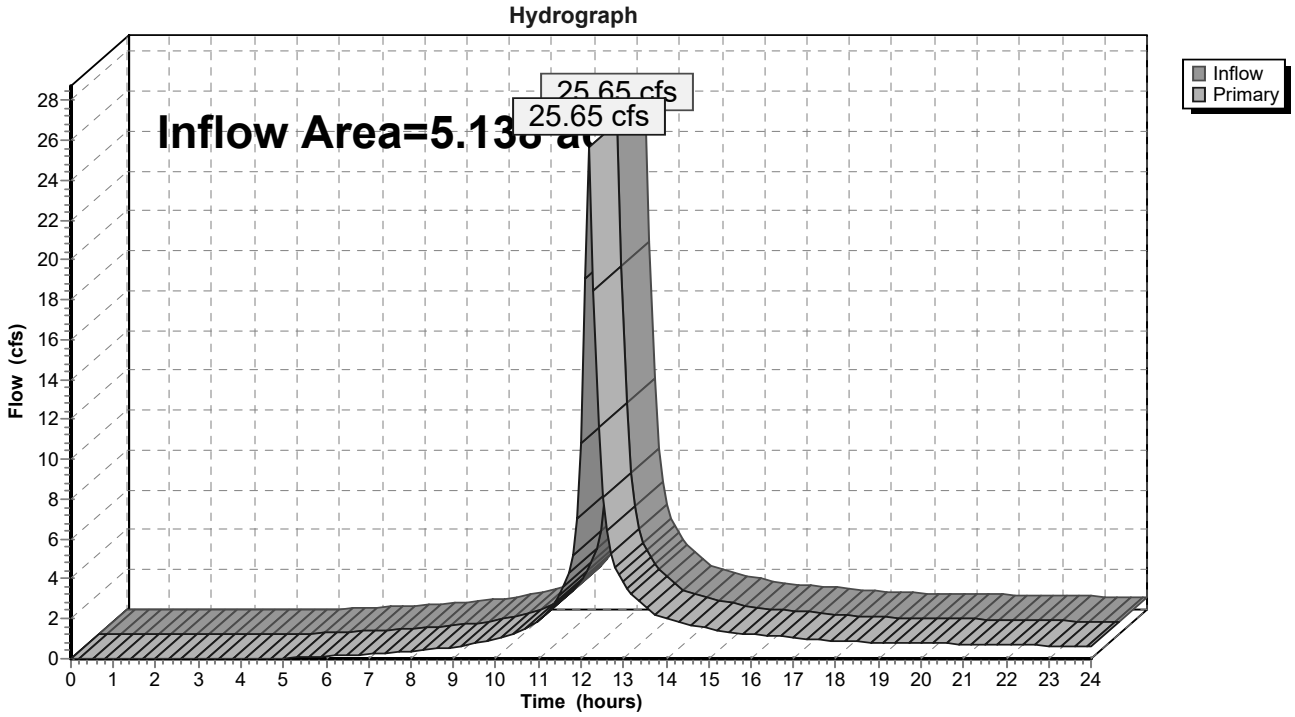


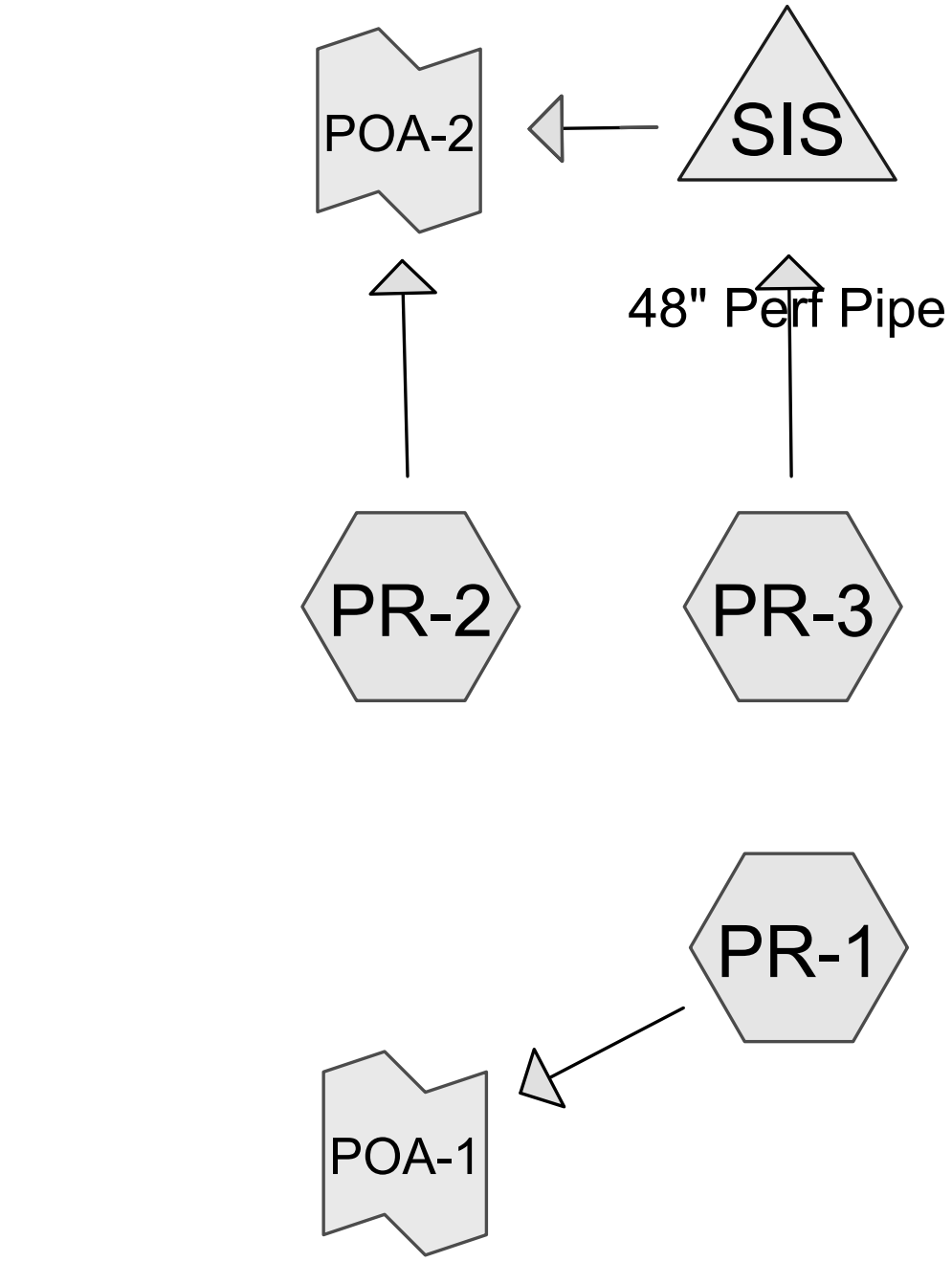
Summary for Link POA-2:

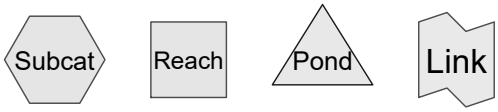
Inflow Area = 5.138 ac, 0.00% Impervious, Inflow Depth > 5.88" for 100-Year event
Inflow = 25.65 cfs @ 12.20 hrs, Volume= 2.518 af
Primary = 25.65 cfs @ 12.20 hrs, Volume= 2.518 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs

Link POA-2:







Routing Diagram for Post-Development
Prepared by {enter your company name here}, Printed 2/9/2021
HydroCAD® 10.00-26 s/n 07576 © 2020 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
2.145	74	>75% Grass cover, Good, HSG C (PR-1, PR-2, PR-3)
0.945	80	>75% Grass cover, Good, HSG D (PR-2, PR-3)
0.531	98	Paved parking, HSG C (PR-1, PR-3)
0.003	98	Paved parking, HSG D (PR-3)
0.278	98	Roofs, HSG C (PR-3)
0.021	98	Roofs, HSG D (PR-3)
0.004	87	Trail, HSG C (PR-2)
0.046	89	Trail, HSG D (PR-2)
0.142	98	Unconnected roofs, HSG C (PR-1, PR-2)
0.020	98	Unconnected roofs, HSG D (PR-2)
0.154	70	Woods, Good, HSG C (PR-2)
1.198	77	Woods, Good, HSG D (PR-2)
5.486	**80**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
3.255	HSG C	PR-1, PR-2, PR-3
2.231	HSG D	PR-2, PR-3
0.000	Other	
5.486		**TOTAL AREA**

Time span=0.00-24.00 hrs, dt=0.10 hrs, 241 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-1: Runoff Area=12,775 sf 17.73% Impervious Runoff Depth>1.34"
Tc=6.0 min CN=74/98 Runoff=0.36 cfs 0.033 af

Subcatchment PR-2: Runoff Area=156,488 sf 3.77% Impervious Runoff Depth>1.24"
Tc=6.0 min CN=77/98 Runoff=4.22 cfs 0.371 af

Subcatchment PR-3: Runoff Area=69,723 sf 50.43% Impervious Runoff Depth>1.97"
Tc=6.0 min CN=74/98 Runoff=2.78 cfs 0.262 af

Pond SIS: 48" Perf Pipe Peak Elev=80.67' Storage=5,687 cf Inflow=2.78 cfs 0.262 af
Discarded=0.10 cfs 0.146 af Primary=0.00 cfs 0.000 af Secondary=0.00 cfs 0.000 af Outflow=0.10 cfs 0.146 af

Link POA-1: Inflow=0.36 cfs 0.033 af
Primary=0.36 cfs 0.033 af

Link POA-2: Inflow=4.22 cfs 0.371 af
Primary=4.22 cfs 0.371 af

Total Runoff Area = 5.486 ac Runoff Volume = 0.667 af Average Runoff Depth = 1.46"
81.87% Pervious = 4.492 ac 18.13% Impervious = 0.995 ac

Summary for Subcatchment PR-1:

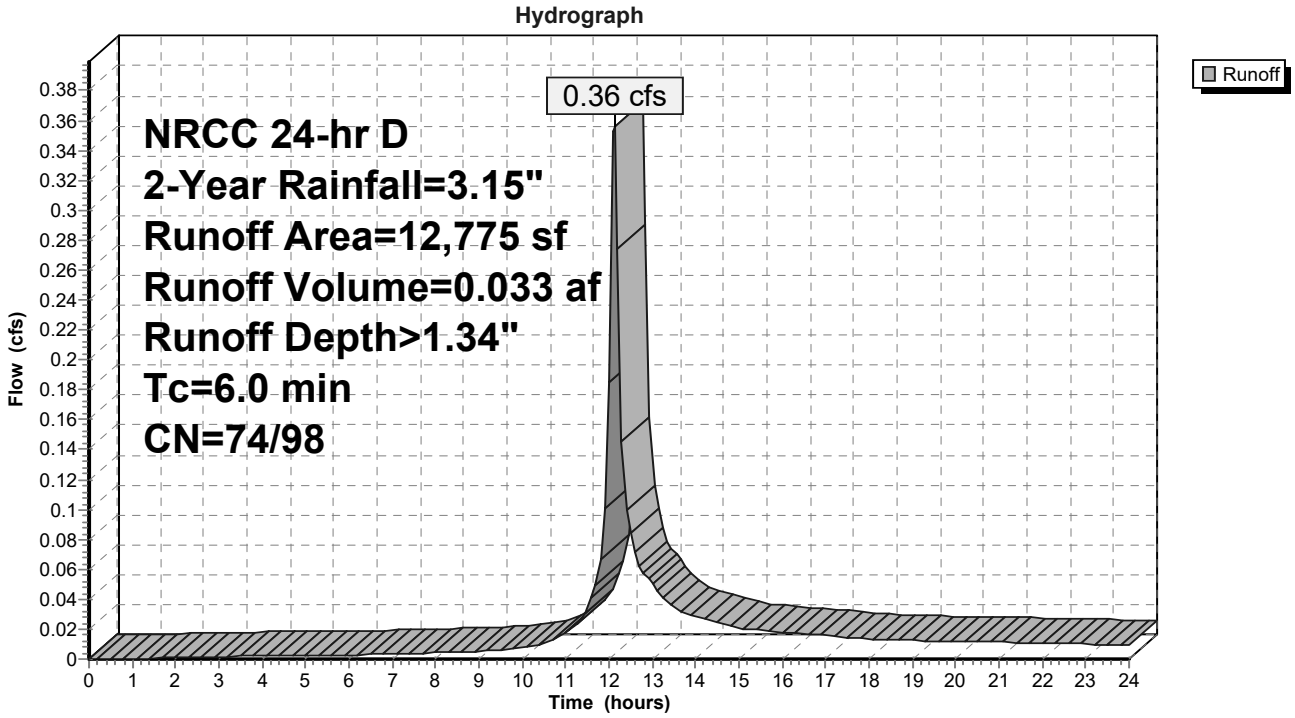
Runoff = 0.36 cfs @ 12.12 hrs, Volume= 0.033 af, Depth> 1.34"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
1,139	98	Unconnected roofs, HSG C
1,126	98	Paved parking, HSG C
10,510	74	>75% Grass cover, Good, HSG C
12,775	78	Weighted Average
10,510	74	82.27% Pervious Area
2,265	98	17.73% Impervious Area

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

Subcatchment PR-1:



Summary for Subcatchment PR-2:

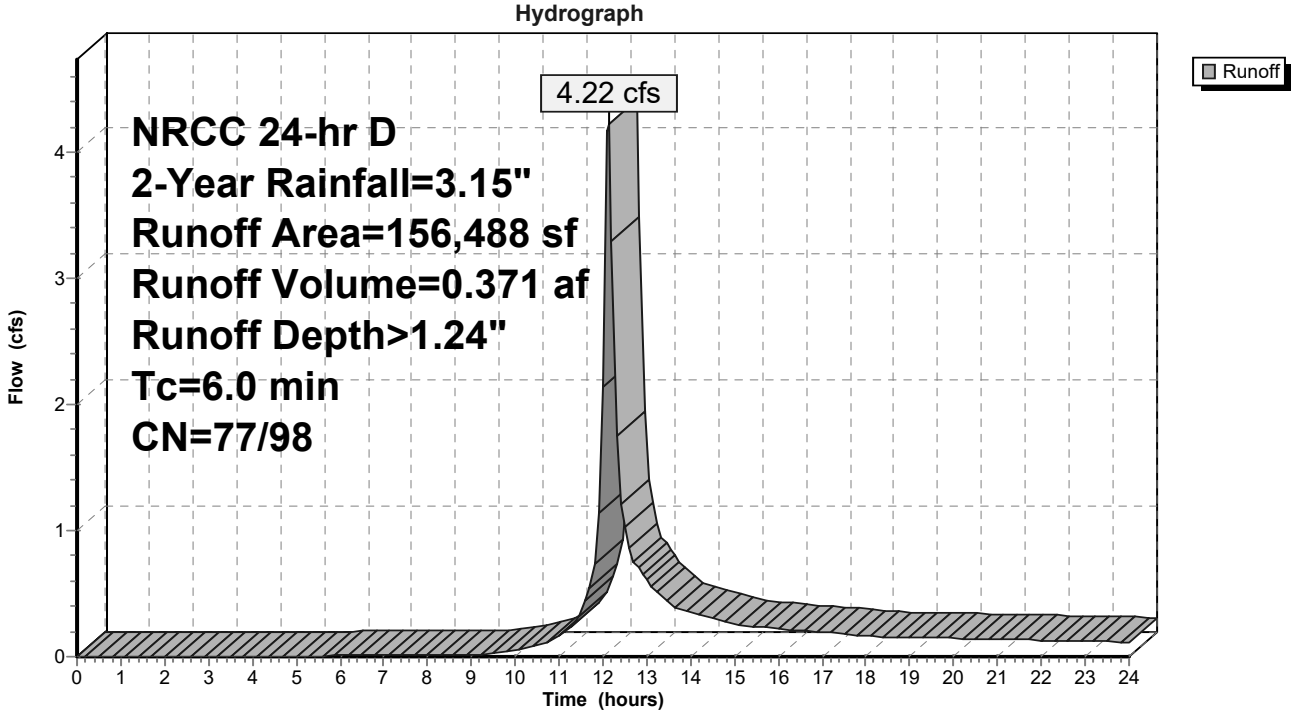
Runoff = 4.22 cfs @ 12.12 hrs, Volume= 0.371 af, Depth> 1.24"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

	Area (sf)	CN	Description
	5,049	98	Unconnected roofs, HSG C
	857	98	Unconnected roofs, HSG D
	6,725	70	Woods, Good, HSG C
	52,169	77	Woods, Good, HSG D
	39,675	80	>75% Grass cover, Good, HSG D
	49,850	74	>75% Grass cover, Good, HSG C
*	2,001	89	Trail, HSG D
*	162	87	Trail, HSG C
	156,488	77	Weighted Average
	150,582	77	96.23% Pervious Area
	5,906	98	3.77% Impervious Area

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

Subcatchment PR-2:



Summary for Subcatchment PR-3:

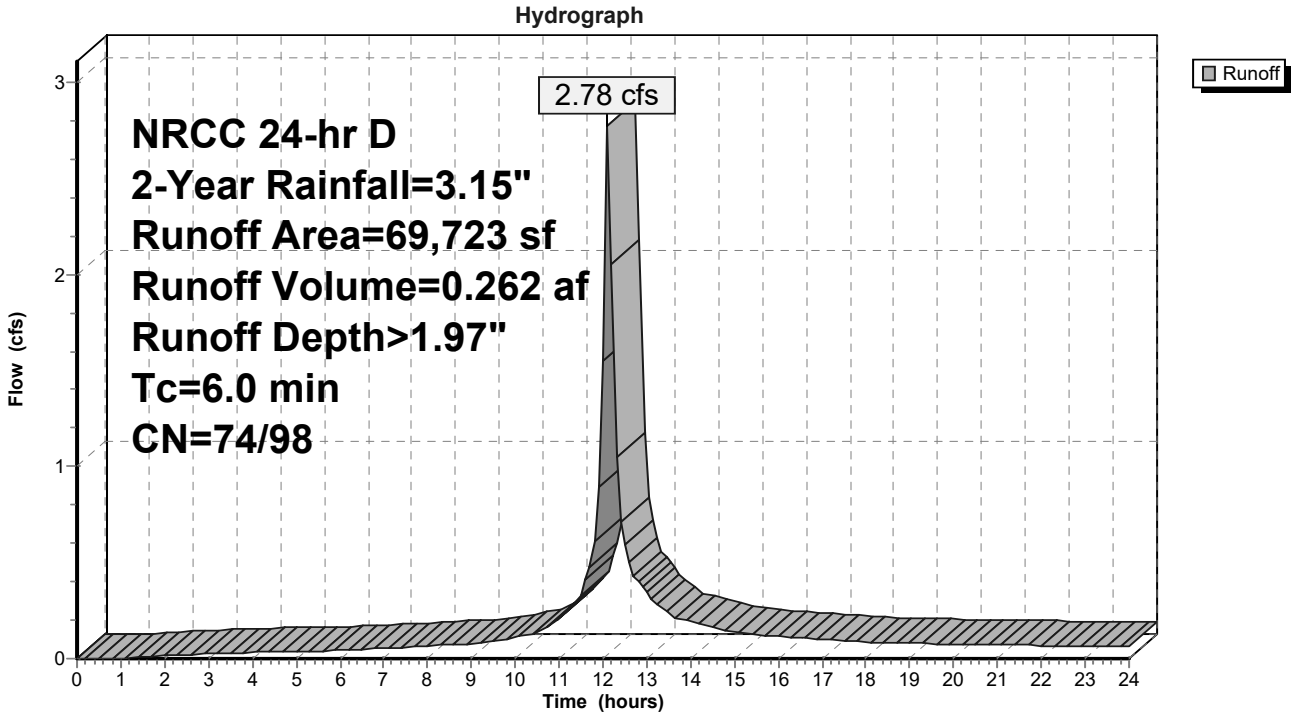
Runoff = 2.78 cfs @ 12.11 hrs, Volume= 0.262 af, Depth> 1.97"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
NRCC 24-hr D 2-Year Rainfall=3.15"

Area (sf)	CN	Description
22,022	98	Paved parking, HSG C
112	98	Paved parking, HSG D
12,114	98	Roofs, HSG C
911	98	Roofs, HSG D
33,091	74	>75% Grass cover, Good, HSG C
1,473	80	>75% Grass cover, Good, HSG D
69,723	86	Weighted Average
34,564	74	49.57% Pervious Area
35,159	98	50.43% Impervious Area

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

Subcatchment PR-3:



Summary for Pond SIS: 48" Perf Pipe

Inflow Area =	1.601 ac, 50.43% Impervious, Inflow Depth > 1.97" for 2-Year event			
Inflow =	2.78 cfs @	12.11 hrs, Volume=	0.262 af	
Outflow =	0.10 cfs @	10.00 hrs, Volume=	0.146 af, Atten= 96%, Lag= 0.0 min	
Discarded =	0.10 cfs @	10.00 hrs, Volume=	0.146 af	
Primary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af	
Secondary =	0.00 cfs @	0.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
Peak Elev= 80.67' @ 17.16 hrs Surf.Area= 4,212 sf Storage= 5,687 cf

Plug-Flow detention time= 249.5 min calculated for 0.146 af (56% of inflow)
Center-of-Mass det. time= 100.1 min (894.6 - 794.5)

Volume	Invert	Avail.Storage	Storage Description
#1	78.00'	6,060 cf	**60.17'W x 70.00'L x 6.00'H Prismatoid** 25,271 cf Overall - 10,122 cf Embedded = 15,150 cf x 40.0% Voids
#2	79.25'	6,560 cf	**48.0" Round Pipe Storage - Row** x 9 Inside #1 L= 58.0' 8,302 cf Overall - 3.0" Wall Thickness = 6,560 cf
#3	79.25'	1,438 cf	**48.0" Round Pipe Storage - Header** x 2 Inside #1 L= 57.2' 1,819 cf Overall - 3.0" Wall Thickness = 1,438 cf
#4	84.00'	1 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc) -Impervious
		14,058 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
84.00	2	0	0
84.25	2	1	1

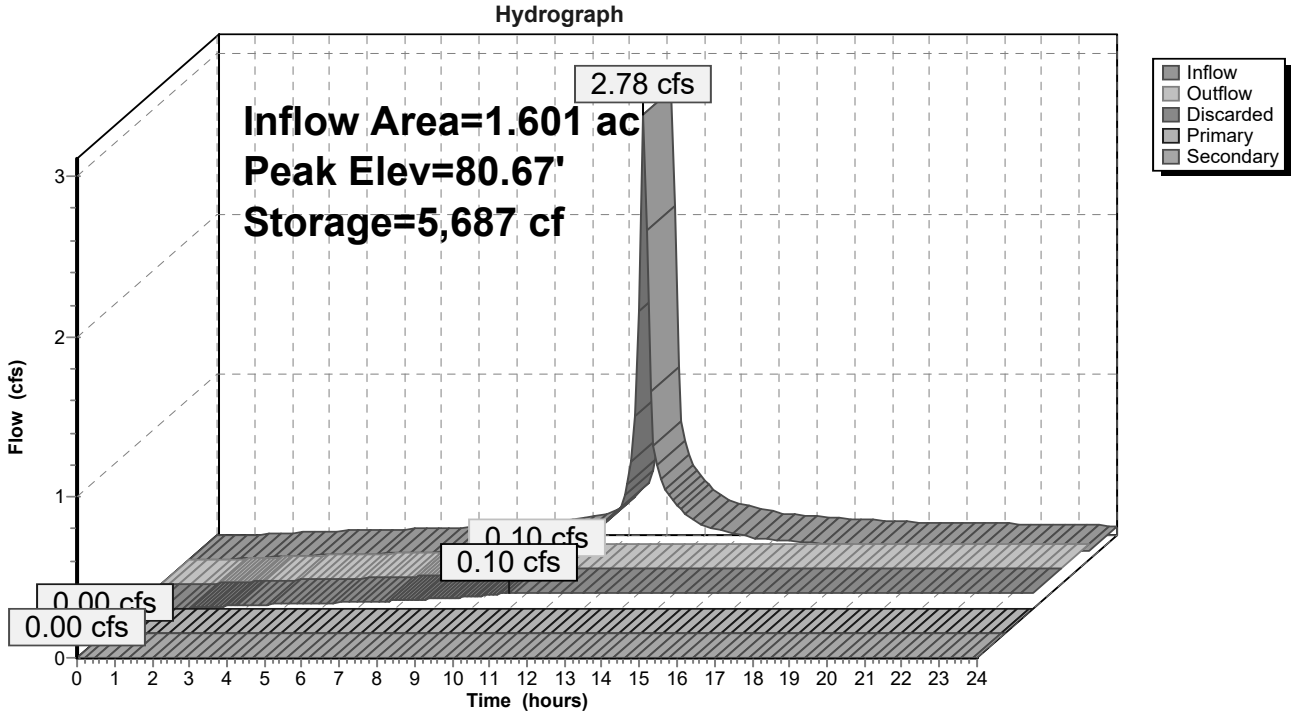
Device	Routing	Invert	Outlet Devices
#1	Primary	78.00'	**15.0" Round Culvert** L= 5.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 78.00' / 77.75' S= 0.0500 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf
#2	Device 1	81.25'	**5.0" Vert. Orifice/Grate X 3.00** C= 0.600
#3	Device 1	82.20'	**4.0" Vert. Orifice/Grate X 4.00** C= 0.600
#4	Device 1	83.75'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#5	Secondary	84.25'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#6	Discarded	78.00'	**1.020 in/hr Exfiltration over Horizontal area**

Discarded OutFlow Max=0.10 cfs @ 10.00 hrs HW=78.06' (Free Discharge)
└─**6=Exfiltration** (Exfiltration Controls 0.10 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=78.00' (Free Discharge)
└─**1=Culvert** (Controls 0.00 cfs)
  ├─**2=Orifice/Grate** (Controls 0.00 cfs)
  ├─**3=Orifice/Grate** (Controls 0.00 cfs)
  └─**4=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=78.00' (Free Discharge)
└─**5=Orifice/Grate** (Controls 0.00 cfs)

Pond SIS: 48" Perf Pipe

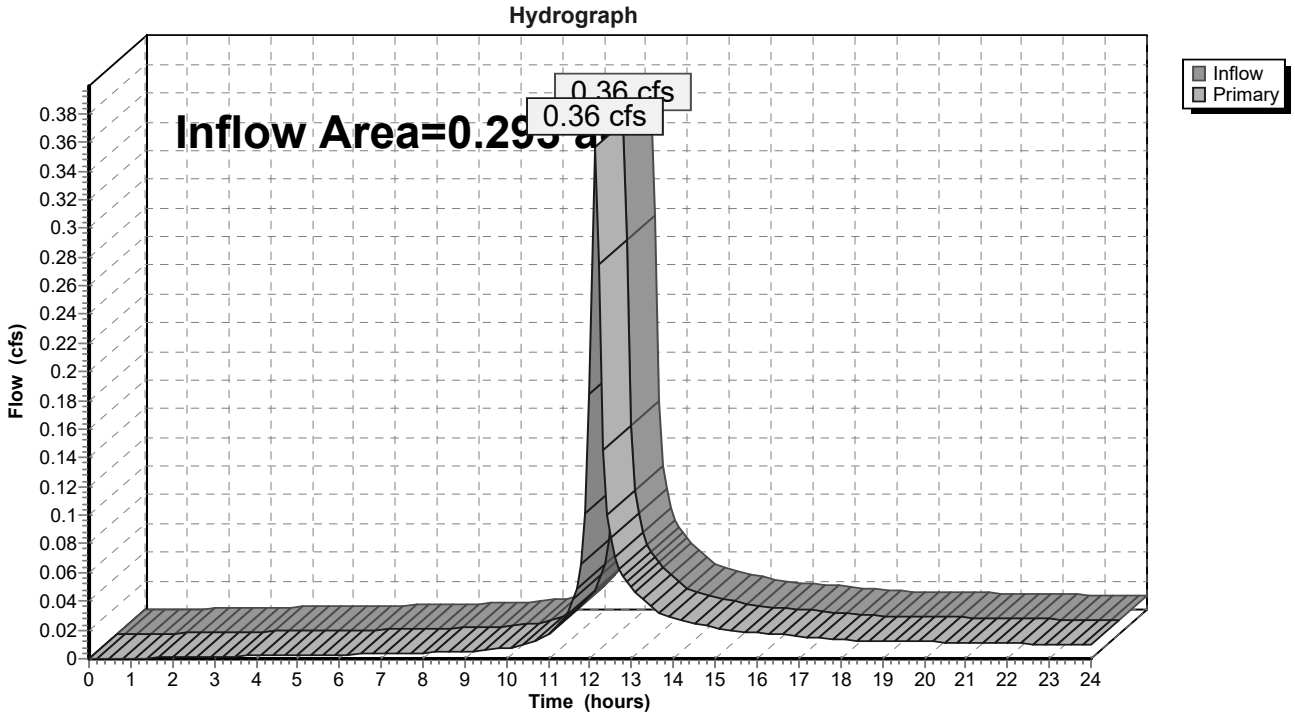


Summary for Link POA-1:

Inflow Area = 0.293 ac, 17.73% Impervious, Inflow Depth > 1.34" for 2-Year event
Inflow = 0.36 cfs @ 12.12 hrs, Volume= 0.033 af
Primary = 0.36 cfs @ 12.12 hrs, Volume= 0.033 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs

Link POA-1:

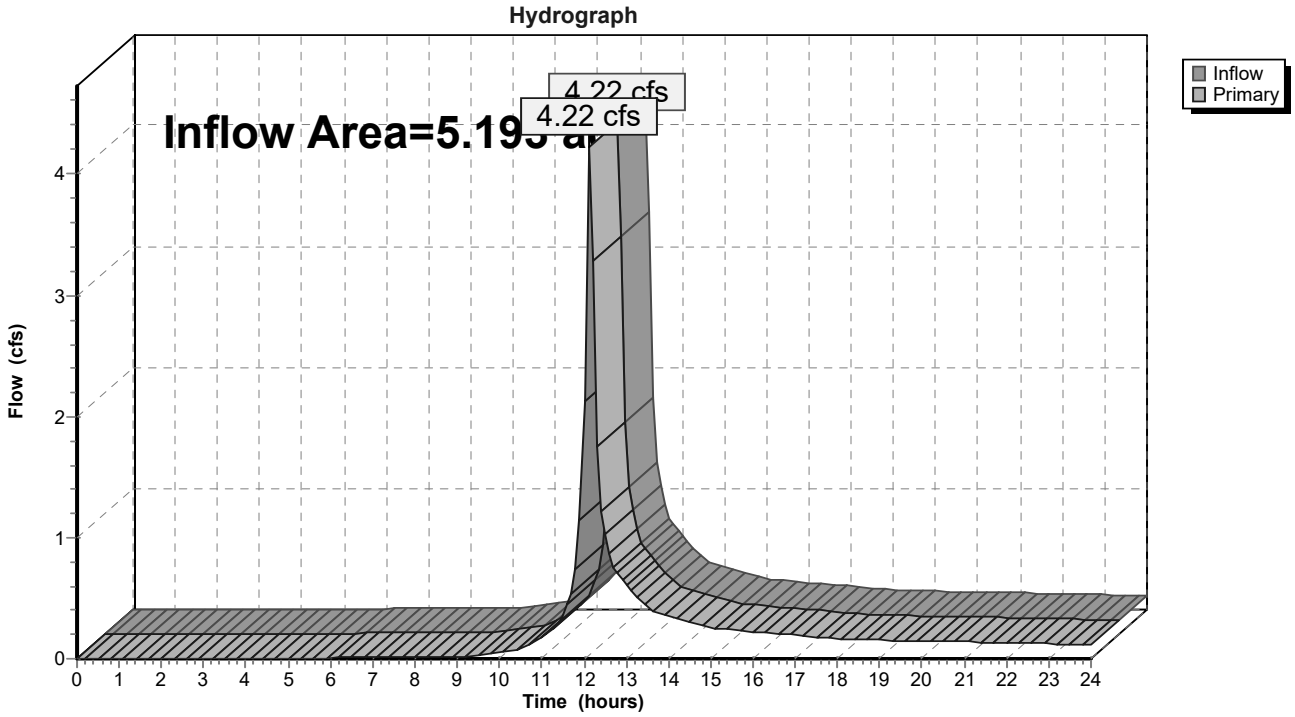


Summary for Link POA-2:

Inflow Area = 5.193 ac, 18.15% Impervious, Inflow Depth > 0.86" for 2-Year event
Inflow = 4.22 cfs @ 12.12 hrs, Volume= 0.371 af
Primary = 4.22 cfs @ 12.12 hrs, Volume= 0.371 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs

Link POA-2:



Time span=0.00-24.00 hrs, dt=0.10 hrs, 241 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-1: Runoff Area=12,775 sf 17.73% Impervious Runoff Depth>2.65"
Tc=6.0 min CN=74/98 Runoff=0.73 cfs 0.065 af

Subcatchment PR-2: Runoff Area=156,488 sf 3.77% Impervious Runoff Depth>2.56"
Tc=6.0 min CN=77/98 Runoff=8.92 cfs 0.766 af

Subcatchment PR-3: Runoff Area=69,723 sf 50.43% Impervious Runoff Depth>3.42"
Tc=6.0 min CN=74/98 Runoff=4.88 cfs 0.456 af

Pond SIS: 48" Perf Pipe Peak Elev=81.55' Storage=8,385 cf Inflow=4.88 cfs 0.456 af
Discarded=0.10 cfs 0.165 af Primary=0.60 cfs 0.119 af Secondary=0.00 cfs 0.000 af Outflow=0.70 cfs 0.284 af

Link POA-1: Inflow=0.73 cfs 0.065 af
Primary=0.73 cfs 0.065 af

Link POA-2: Inflow=8.92 cfs 0.885 af
Primary=8.92 cfs 0.885 af

Total Runoff Area = 5.486 ac Runoff Volume = 1.287 af Average Runoff Depth = 2.81"
81.87% Pervious = 4.492 ac 18.13% Impervious = 0.995 ac

Summary for Subcatchment PR-1:

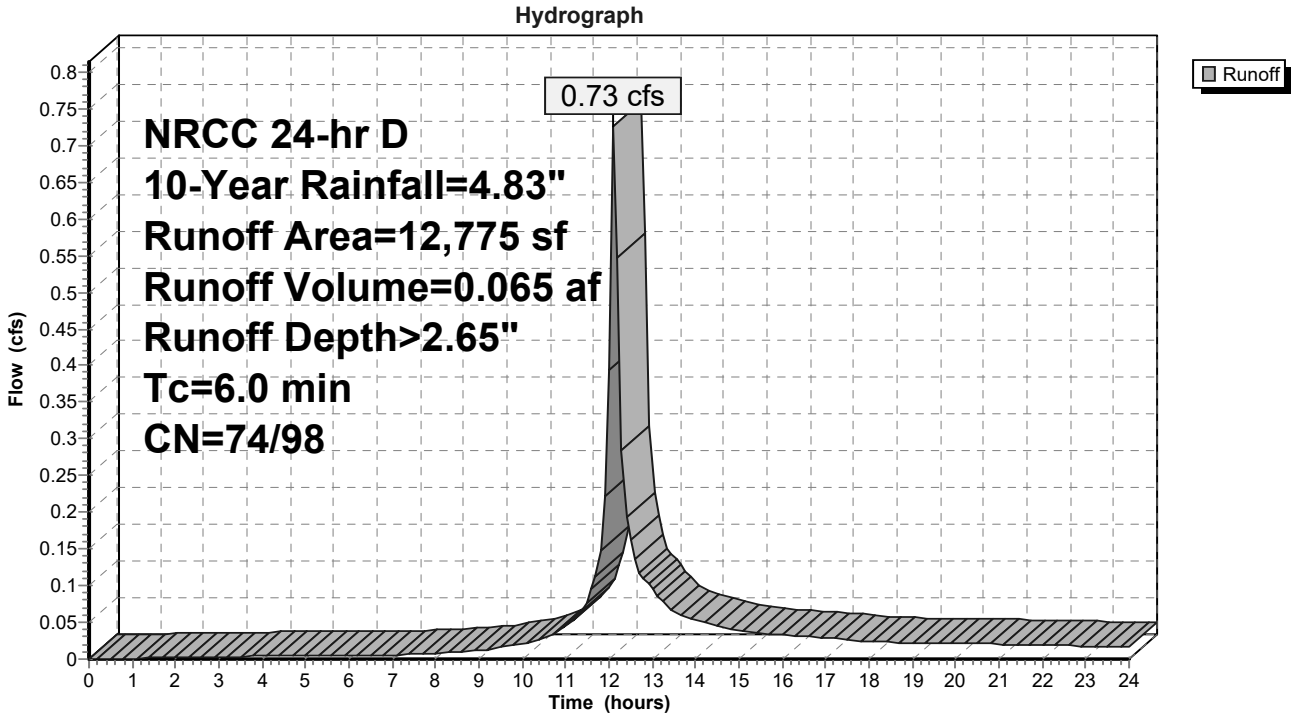
Runoff = 0.73 cfs @ 12.12 hrs, Volume= 0.065 af, Depth> 2.65"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
1,139	98	Unconnected roofs, HSG C
1,126	98	Paved parking, HSG C
10,510	74	>75% Grass cover, Good, HSG C
12,775	78	Weighted Average
10,510	74	82.27% Pervious Area
2,265	98	17.73% Impervious Area

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

Subcatchment PR-1:



Summary for Subcatchment PR-2:

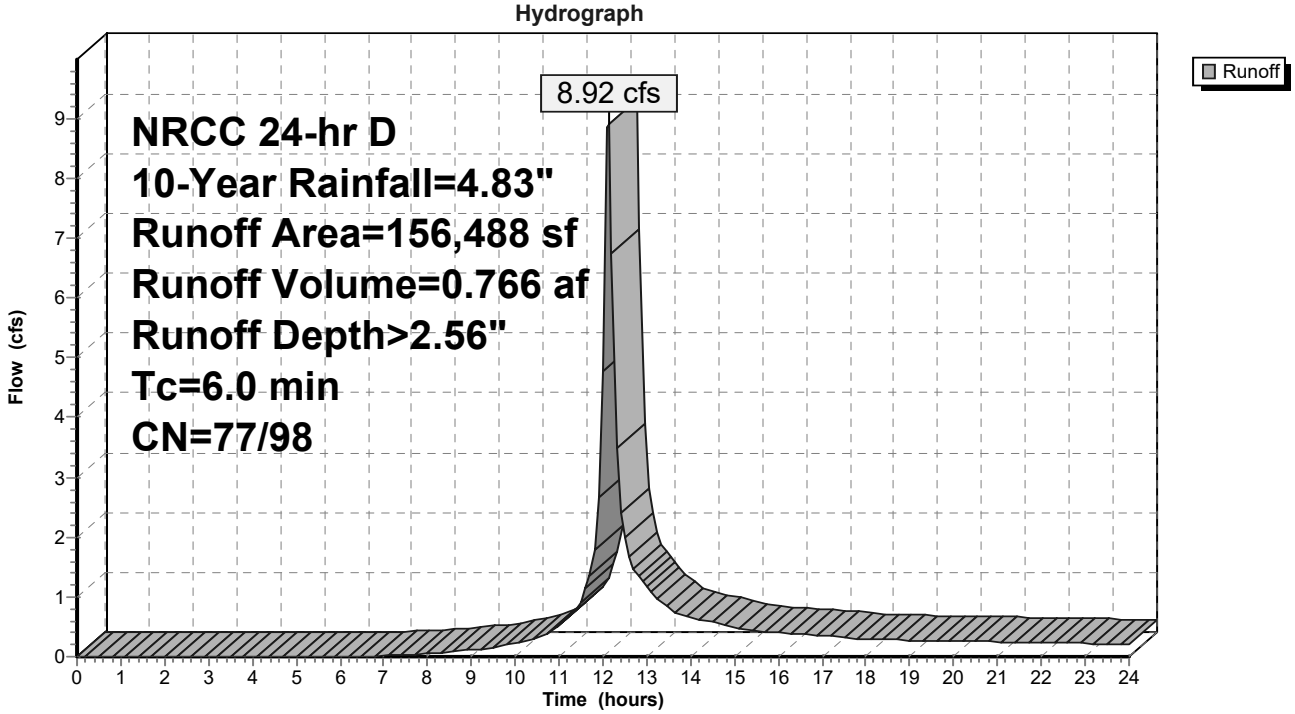
Runoff = 8.92 cfs @ 12.12 hrs, Volume= 0.766 af, Depth> 2.56"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
	5,049	98	Unconnected roofs, HSG C
	857	98	Unconnected roofs, HSG D
	6,725	70	Woods, Good, HSG C
	52,169	77	Woods, Good, HSG D
	39,675	80	>75% Grass cover, Good, HSG D
	49,850	74	>75% Grass cover, Good, HSG C
*	2,001	89	Trail, HSG D
*	162	87	Trail, HSG C
	156,488	77	Weighted Average
	150,582	77	96.23% Pervious Area
	5,906	98	3.77% Impervious Area

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

Subcatchment PR-2:



Summary for Subcatchment PR-3:

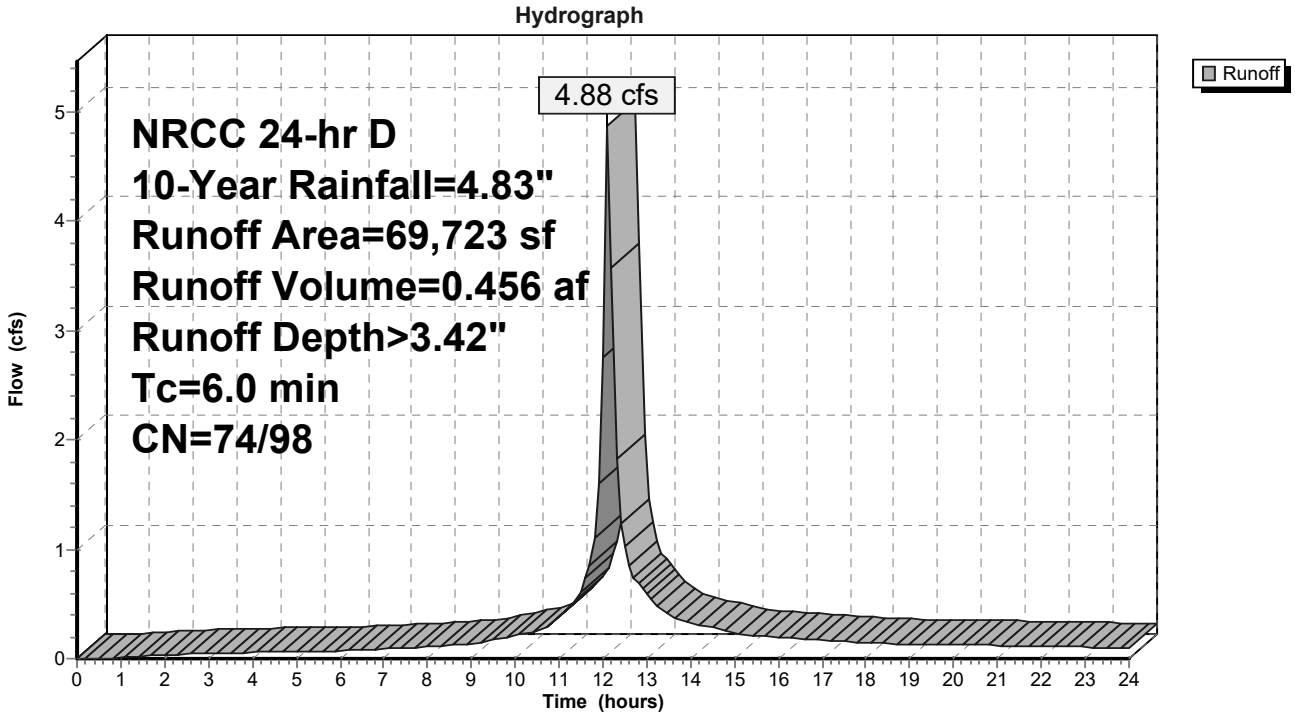
Runoff = 4.88 cfs @ 12.11 hrs, Volume= 0.456 af, Depth> 3.42"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
NRCC 24-hr D 10-Year Rainfall=4.83"

Area (sf)	CN	Description
22,022	98	Paved parking, HSG C
112	98	Paved parking, HSG D
12,114	98	Roofs, HSG C
911	98	Roofs, HSG D
33,091	74	>75% Grass cover, Good, HSG C
1,473	80	>75% Grass cover, Good, HSG D
69,723	86	Weighted Average
34,564	74	49.57% Pervious Area
35,159	98	50.43% Impervious Area

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

Subcatchment PR-3:



Summary for Pond SIS: 48" Perf Pipe

Inflow Area =	1.601 ac, 50.43% Impervious, Inflow Depth > 3.42" for 10-Year event				
Inflow =	4.88 cfs @	12.11 hrs,	Volume=	0.456 af	
Outflow =	0.70 cfs @	12.78 hrs,	Volume=	0.284 af,	Atten= 86%, Lag= 40.4 min
Discarded =	0.10 cfs @	7.90 hrs,	Volume=	0.165 af	
Primary =	0.60 cfs @	12.78 hrs,	Volume=	0.119 af	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
Peak Elev= 81.55' @ 12.78 hrs Surf.Area= 4,212 sf Storage= 8,385 cf

Plug-Flow detention time= 206.0 min calculated for 0.283 af (62% of inflow)
Center-of-Mass det. time= 70.5 min (858.2 - 787.7)

Volume	Invert	Avail.Storage	Storage Description
#1	78.00'	6,060 cf	**60.17'W x 70.00'L x 6.00'H Prismatoid** 25,271 cf Overall - 10,122 cf Embedded = 15,150 cf x 40.0% Voids
#2	79.25'	6,560 cf	**48.0" Round Pipe Storage - Row** x 9 Inside #1 L= 58.0' 8,302 cf Overall - 3.0" Wall Thickness = 6,560 cf
#3	79.25'	1,438 cf	**48.0" Round Pipe Storage - Header** x 2 Inside #1 L= 57.2' 1,819 cf Overall - 3.0" Wall Thickness = 1,438 cf
#4	84.00'	1 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc) -Impervious
		14,058 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
84.00	2	0	0
84.25	2	1	1

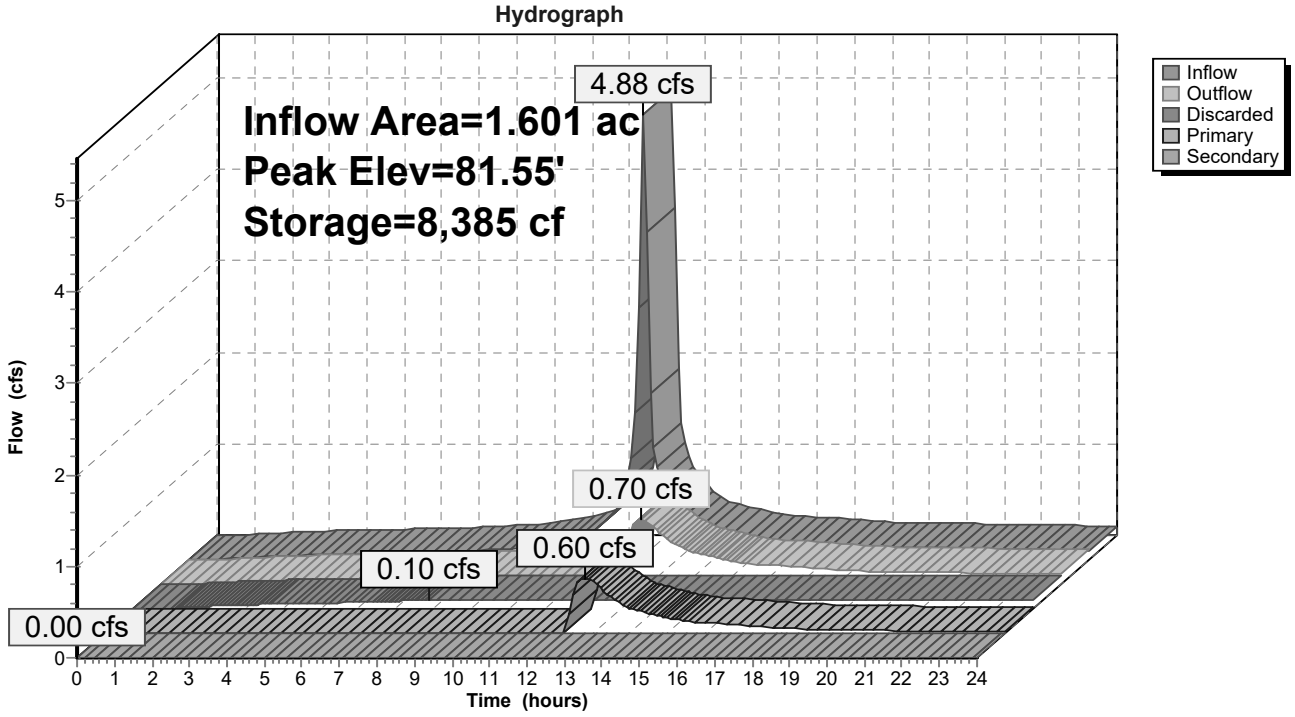
Device	Routing	Invert	Outlet Devices
#1	Primary	78.00'	**15.0" Round Culvert** L= 5.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 78.00' / 77.75' S= 0.0500 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf
#2	Device 1	81.25'	**5.0" Vert. Orifice/Grate X 3.00** C= 0.600
#3	Device 1	82.20'	**4.0" Vert. Orifice/Grate X 4.00** C= 0.600
#4	Device 1	83.75'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#5	Secondary	84.25'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#6	Discarded	78.00'	**1.020 in/hr Exfiltration over Horizontal area**

Discarded OutFlow Max=0.10 cfs @ 7.90 hrs HW=78.06' (Free Discharge)
└─**6=Exfiltration** (Exfiltration Controls 0.10 cfs)

Primary OutFlow Max=0.60 cfs @ 12.78 hrs HW=81.55' (Free Discharge)
└─**1=Culvert** (Passes 0.60 cfs of 8.92 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.60 cfs @ 1.88 fps)
  ├─**3=Orifice/Grate** (Controls 0.00 cfs)
  └─**4=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=78.00' (Free Discharge)
└─**5=Orifice/Grate** (Controls 0.00 cfs)

Pond SIS: 48" Perf Pipe

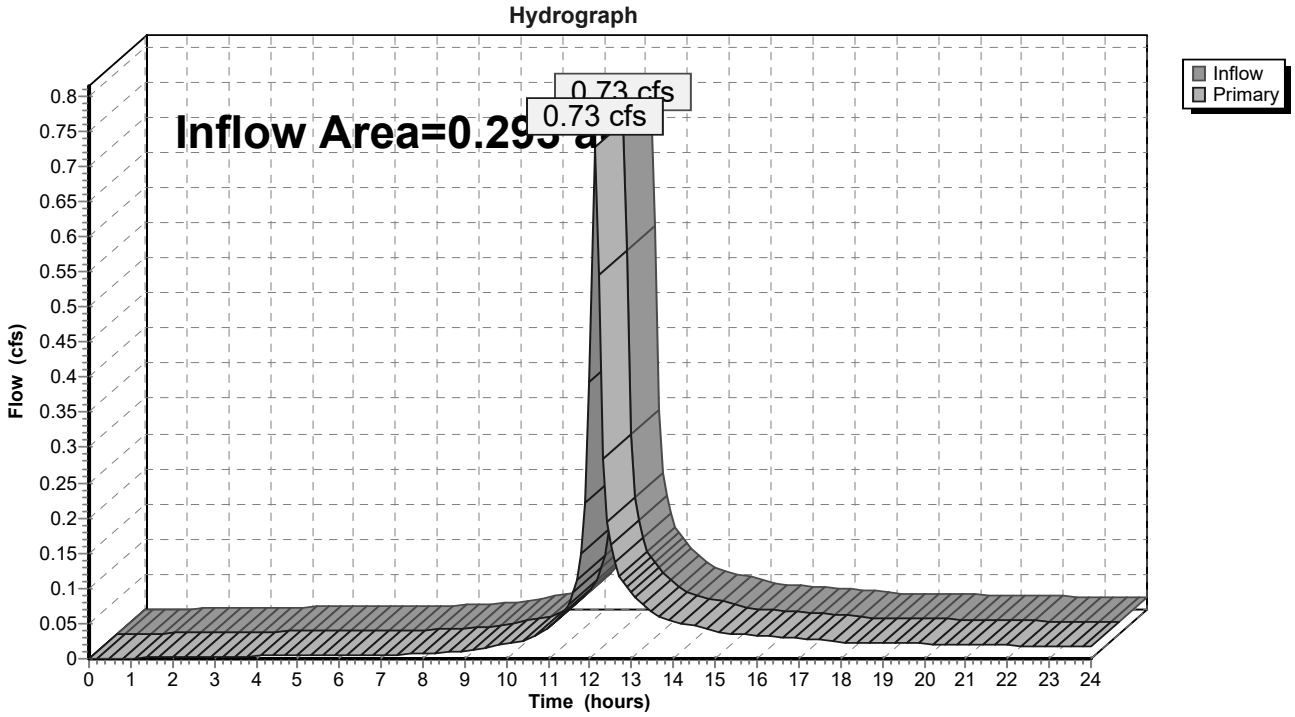


Summary for Link POA-1:

Inflow Area = 0.293 ac, 17.73% Impervious, Inflow Depth > 2.65" for 10-Year event
Inflow = 0.73 cfs @ 12.12 hrs, Volume= 0.065 af
Primary = 0.73 cfs @ 12.12 hrs, Volume= 0.065 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs

Link POA-1:

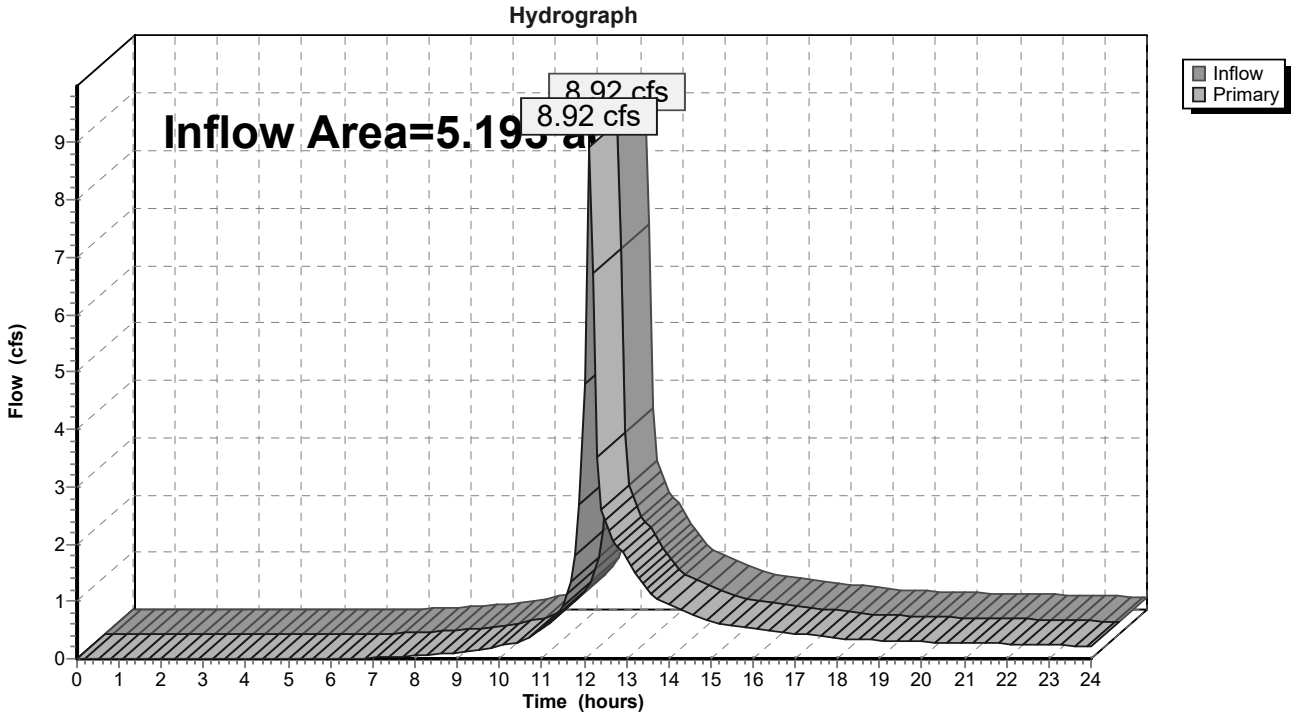


Summary for Link POA-2:

Inflow Area = 5.193 ac, 18.15% Impervious, Inflow Depth > 2.04" for 10-Year event
Inflow = 8.92 cfs @ 12.12 hrs, Volume= 0.885 af
Primary = 8.92 cfs @ 12.12 hrs, Volume= 0.885 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs

Link POA-2:



Time span=0.00-24.00 hrs, dt=0.10 hrs, 241 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment PR-1: Runoff Area=12,775 sf 17.73% Impervious Runoff Depth>6.29"
Tc=6.0 min CN=74/98 Runoff=1.73 cfs 0.154 af

Subcatchment PR-2: Runoff Area=156,488 sf 3.77% Impervious Runoff Depth>6.23"
Tc=6.0 min CN=77/98 Runoff=21.42 cfs 1.866 af

Subcatchment PR-3: Runoff Area=69,723 sf 50.43% Impervious Runoff Depth>7.24"
Tc=6.0 min CN=74/98 Runoff=10.31 cfs 0.966 af

Pond SIS: 48" Perf Pipe Peak Elev=83.89' Storage=13,867 cf Inflow=10.31 cfs 0.966 af
Discarded=0.10 cfs 0.186 af Primary=5.55 cfs 0.601 af Secondary=0.00 cfs 0.000 af Outflow=5.65 cfs 0.787 af

Link POA-1: Inflow=1.73 cfs 0.154 af
Primary=1.73 cfs 0.154 af

Link POA-2: Inflow=25.32 cfs 2.468 af
Primary=25.32 cfs 2.468 af

Total Runoff Area = 5.486 ac Runoff Volume = 2.986 af Average Runoff Depth = 6.53"
81.87% Pervious = 4.492 ac 18.13% Impervious = 0.995 ac

Summary for Subcatchment PR-1:

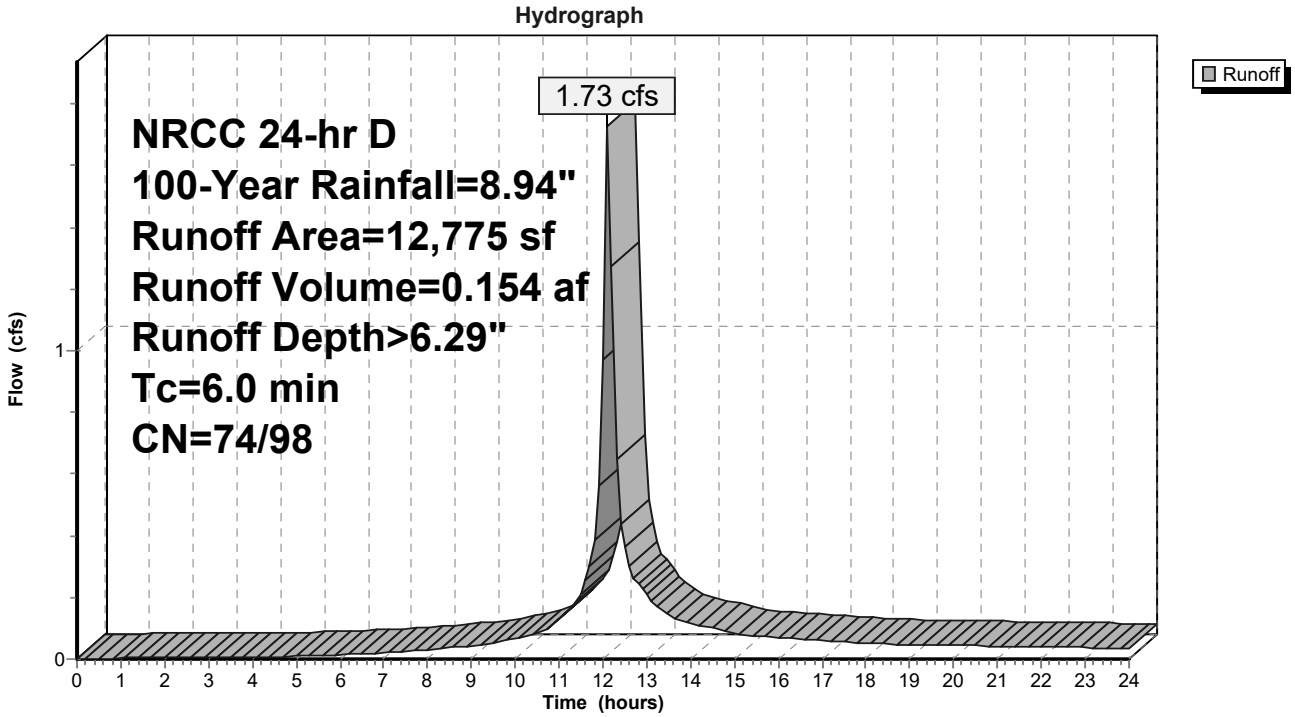
Runoff = 1.73 cfs @ 12.11 hrs, Volume= 0.154 af, Depth> 6.29"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
1,139	98	Unconnected roofs, HSG C
1,126	98	Paved parking, HSG C
10,510	74	>75% Grass cover, Good, HSG C
12,775	78	Weighted Average
10,510	74	82.27% Pervious Area
2,265	98	17.73% Impervious Area

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

Subcatchment PR-1:



Summary for Subcatchment PR-2:

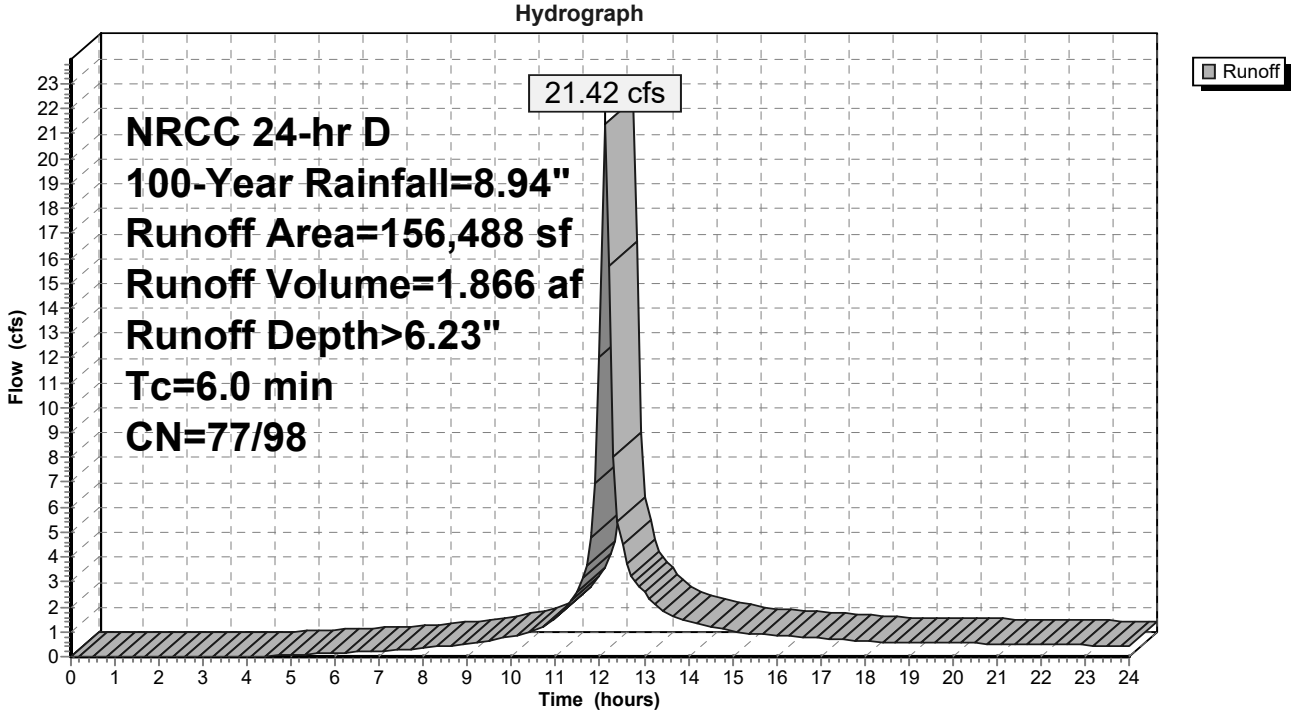
Runoff = 21.42 cfs @ 12.11 hrs, Volume= 1.866 af, Depth> 6.23"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
	5,049	98	Unconnected roofs, HSG C
	857	98	Unconnected roofs, HSG D
	6,725	70	Woods, Good, HSG C
	52,169	77	Woods, Good, HSG D
	39,675	80	>75% Grass cover, Good, HSG D
	49,850	74	>75% Grass cover, Good, HSG C
*	2,001	89	Trail, HSG D
*	162	87	Trail, HSG C
	156,488	77	Weighted Average
	150,582	77	96.23% Pervious Area
	5,906	98	3.77% Impervious Area

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

Subcatchment PR-2:



Summary for Subcatchment PR-3:

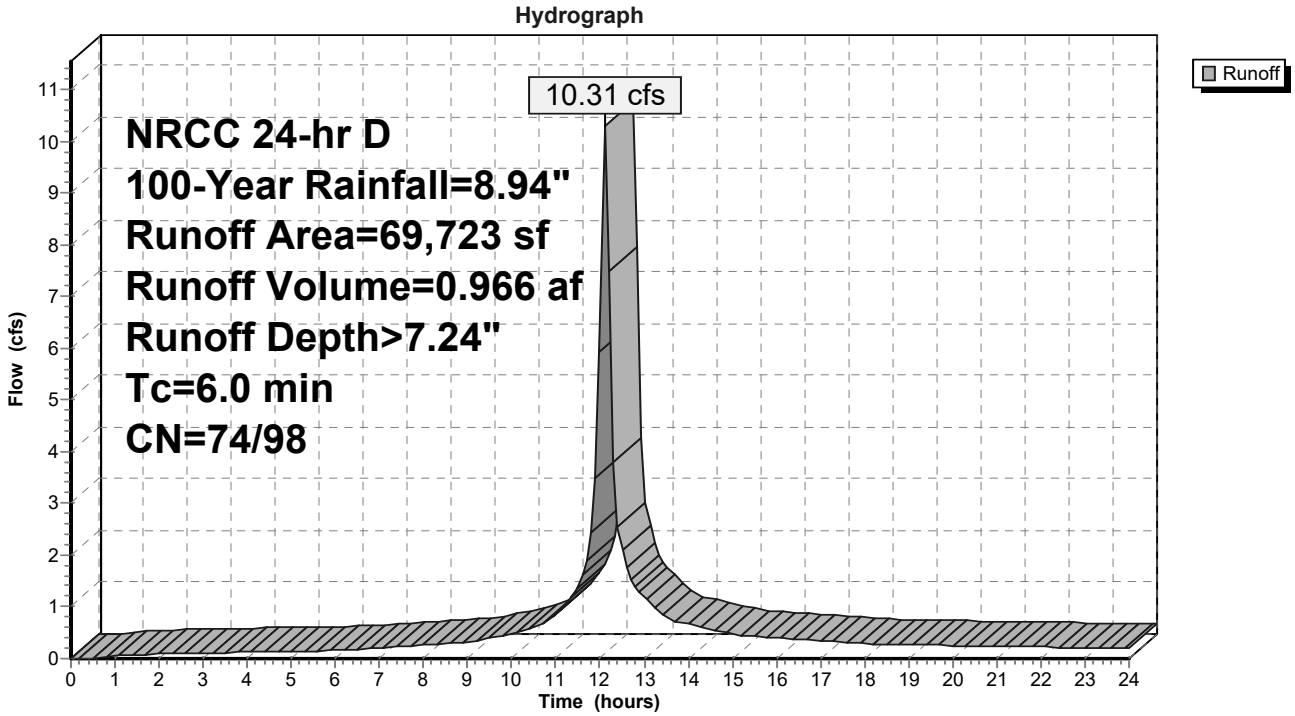
Runoff = 10.31 cfs @ 12.11 hrs, Volume= 0.966 af, Depth> 7.24"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
NRCC 24-hr D 100-Year Rainfall=8.94"

Area (sf)	CN	Description
22,022	98	Paved parking, HSG C
112	98	Paved parking, HSG D
12,114	98	Roofs, HSG C
911	98	Roofs, HSG D
33,091	74	>75% Grass cover, Good, HSG C
1,473	80	>75% Grass cover, Good, HSG D
69,723	86	Weighted Average
34,564	74	49.57% Pervious Area
35,159	98	50.43% Impervious Area

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

Subcatchment PR-3:



Summary for Pond SIS: 48" Perf Pipe

Inflow Area =	1.601 ac, 50.43% Impervious, Inflow Depth > 7.24" for 100-Year event				
Inflow =	10.31 cfs @	12.11 hrs,	Volume=	0.966 af	
Outflow =	5.65 cfs @	12.27 hrs,	Volume=	0.787 af,	Atten= 45%, Lag= 9.5 min
Discarded =	0.10 cfs @	2.90 hrs,	Volume=	0.186 af	
Primary =	5.55 cfs @	12.27 hrs,	Volume=	0.601 af	
Secondary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs
Peak Elev= 83.89' @ 12.26 hrs Surf.Area= 4,212 sf Storage= 13,867 cf

Plug-Flow detention time= 143.9 min calculated for 0.784 af (81% of inflow)
Center-of-Mass det. time= 55.8 min (831.8 - 776.0)

Volume	Invert	Avail.Storage	Storage Description
#1	78.00'	6,060 cf	**60.17'W x 70.00'L x 6.00'H Prismatoid** 25,271 cf Overall - 10,122 cf Embedded = 15,150 cf x 40.0% Voids
#2	79.25'	6,560 cf	**48.0" Round Pipe Storage - Row** x 9 Inside #1 L= 58.0' 8,302 cf Overall - 3.0" Wall Thickness = 6,560 cf
#3	79.25'	1,438 cf	**48.0" Round Pipe Storage - Header** x 2 Inside #1 L= 57.2' 1,819 cf Overall - 3.0" Wall Thickness = 1,438 cf
#4	84.00'	1 cf	**Custom Stage Data (Prismatic)**Listed below (Recalc) -Impervious
		14,058 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
84.00	2	0	0
84.25	2	1	1

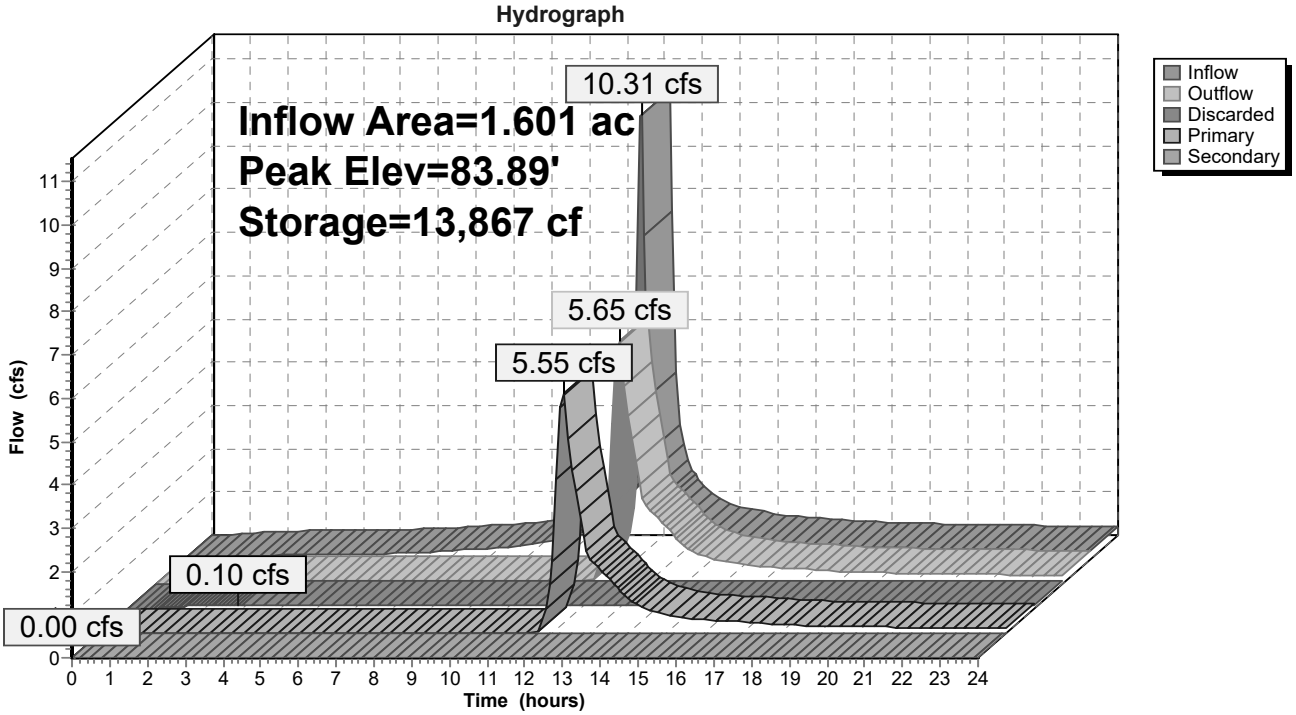
Device	Routing	Invert	Outlet Devices
#1	Primary	78.00'	**15.0" Round Culvert** L= 5.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 78.00' / 77.75' S= 0.0500 '/' Cc= 0.900 n= 0.012, Flow Area= 1.23 sf
#2	Device 1	81.25'	**5.0" Vert. Orifice/Grate X 3.00** C= 0.600
#3	Device 1	82.20'	**4.0" Vert. Orifice/Grate X 4.00** C= 0.600
#4	Device 1	83.75'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#5	Secondary	84.25'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#6	Discarded	78.00'	**1.020 in/hr Exfiltration over Horizontal area**

Discarded OutFlow Max=0.10 cfs @ 2.90 hrs HW=78.06' (Free Discharge)
└─**6=Exfiltration** (Exfiltration Controls 0.10 cfs)

Primary OutFlow Max=5.40 cfs @ 12.27 hrs HW=83.84' (Free Discharge)
└─**1=Culvert** (Passes 5.40 cfs of 11.90 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 3.04 cfs @ 7.42 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 2.04 cfs @ 5.84 fps)
  └─**4=Sharp-Crested Rectangular Weir** (Weir Controls 0.33 cfs @ 0.96 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=78.00' (Free Discharge)
└─**5=Orifice/Grate** (Controls 0.00 cfs)

Pond SIS: 48" Perf Pipe

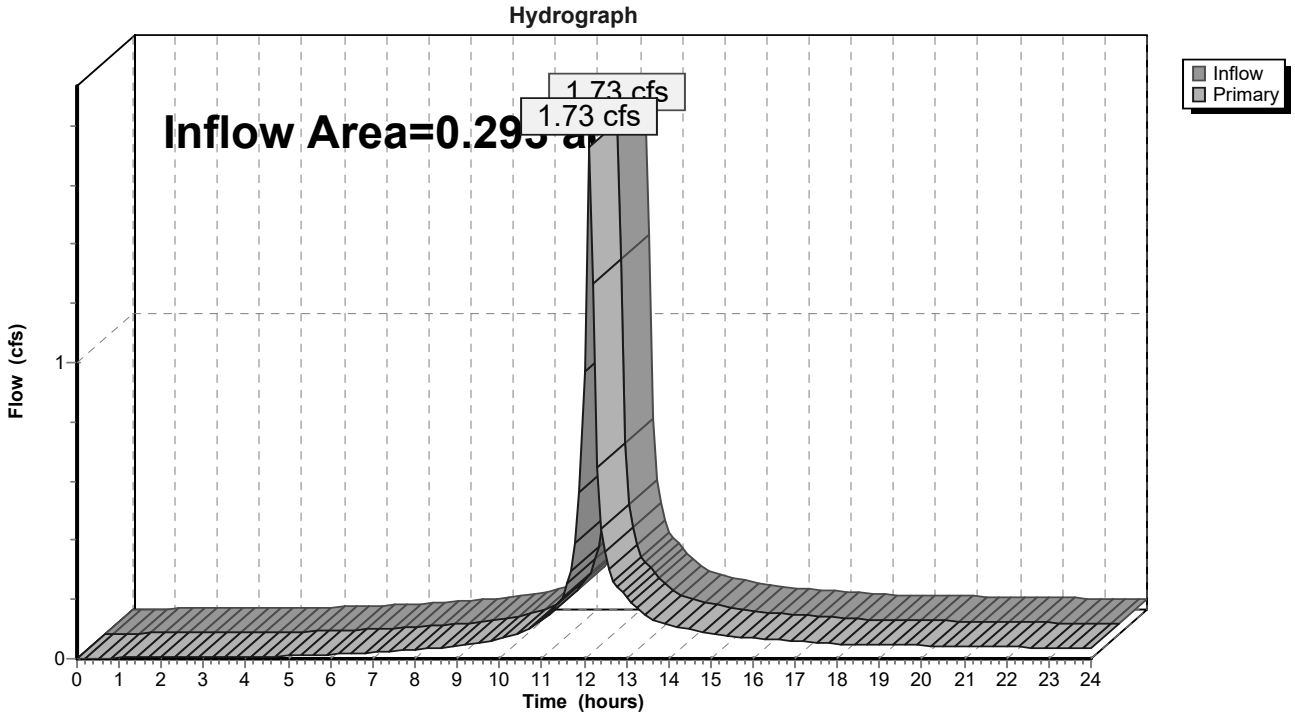


Summary for Link POA-1:

Inflow Area = 0.293 ac, 17.73% Impervious, Inflow Depth > 6.29" for 100-Year event
Inflow = 1.73 cfs @ 12.11 hrs, Volume= 0.154 af
Primary = 1.73 cfs @ 12.11 hrs, Volume= 0.154 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs

Link POA-1:

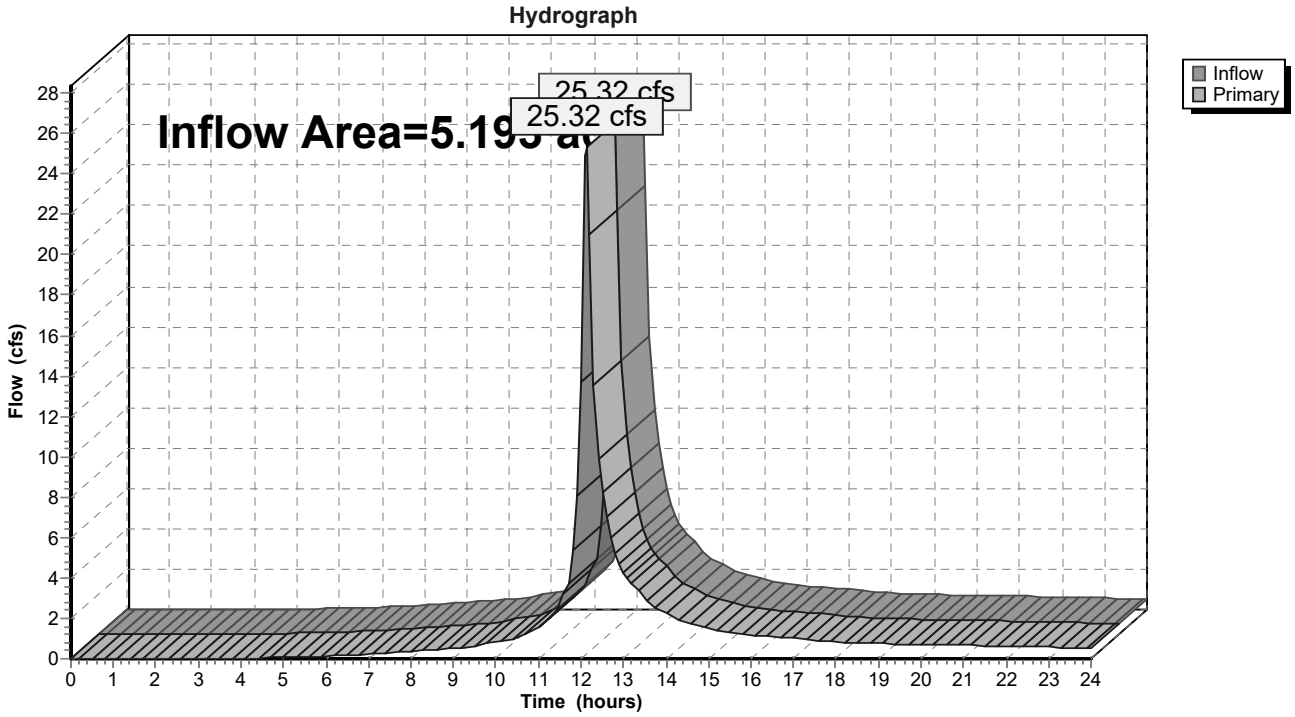


Summary for Link POA-2:

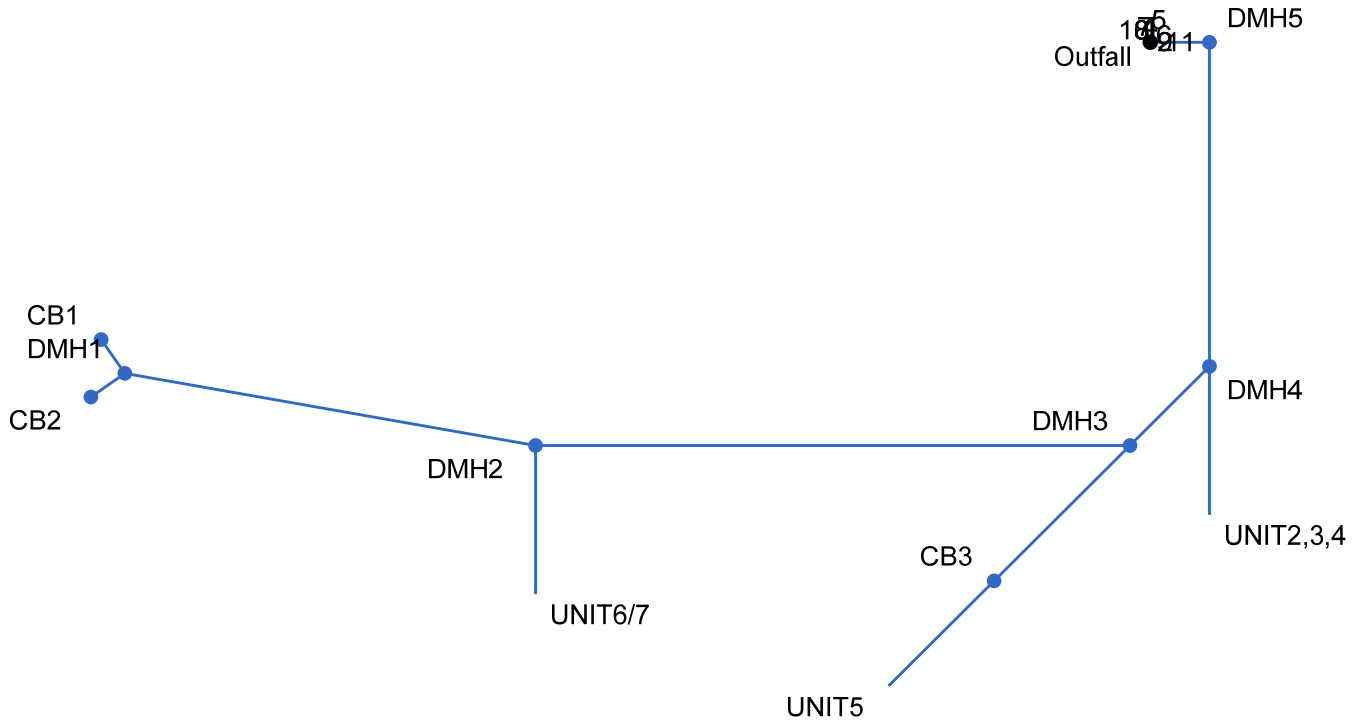
Inflow Area = 5.193 ac, 18.15% Impervious, Inflow Depth > 5.70" for 100-Year event
Inflow = 25.32 cfs @ 12.12 hrs, Volume= 2.468 af
Primary = 25.32 cfs @ 12.12 hrs, Volume= 2.468 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.10 hrs

Link POA-2:



Hydraflow Storm Sewers Extension for Autodesk® AutoCAD® Civil 3D® Plan



Project File: System-1.stm	Number of lines: 11	Date: 5/20/2021

Storm Sewers v12.00

Storm Sewer Inventory Report

Line No.	Alignment				Flow Data				Physical Data								Line ID
	Dnstr Line No.	Line Length (ft)	Defl angle (deg)	Junc Type	Known Q (cfs)	Drng Area (ac)	Runoff Coeff (C)	Inlet Time (min)	Invert El Dn (ft)	Line Slope (%)	Invert El Up (ft)	Line Size (in)	Line Shape	N Value (n)	J-Loss Coeff (K)	Inlet/ Rim El (ft)	
1	End	20.000	0.000	MH	0.00	0.00	0.00	6.0	80.75	0.00	80.75	12	Cir	0.012	1.00	85.50	DMH5-SIS
2	1	110.000	90.000	MH	0.00	0.00	0.00	6.0	82.50	1.45	84.10	12	Cir	0.012	0.75	93.25	DMH4-DMH5
3	2	38.000	45.000	MH	0.00	0.00	0.00	6.0	84.20	0.53	84.40	12	Cir	0.012	0.75	93.50	DMH3-DMH4
4	3	201.000	45.000	MH	0.00	0.00	0.00	6.0	84.65	0.52	85.70	12	Cir	0.013	1.00	93.68	DMH2-DMH3
5	4	141.000	10.000	MH	0.00	0.00	0.00	6.0	85.80	0.50	86.50	12	Cir	0.013	0.75	90.21	DMH1-DMH2
6	5	14.000	45.000	Grate	0.00	0.20	0.50	6.0	86.60	0.71	86.70	12	Cir	0.013	1.00	89.70	CB1-DMH1
7	5	14.000	-45.000	Grate	0.00	0.39	0.50	6.0	86.60	0.71	86.70	12	Cir	0.013	1.00	89.71	CB2-DMH1
8	3	65.000	0.000	DrGrt	0.00	0.77	0.70	6.0	84.65	2.08	86.00	12	Cir	0.013	0.50	91.58	CB3-DMH3
9	4	50.000	-90.000	None	0.00	0.14	0.90	6.0	85.80	8.40	90.00	6	Cir	0.012	1.00	94.00	UNIT6/7
10	8	50.000	0.000	None	0.00	0.03	0.90	6.0	86.10	13.80	93.00	6	Cir	0.012	1.00	94.00	1/2UNIT5
11	2	50.000	0.000	None	0.00	0.19	0.90	6.0	84.20	17.60	93.00	6	Cir	0.012	1.00	94.00	UNIT2,3,4

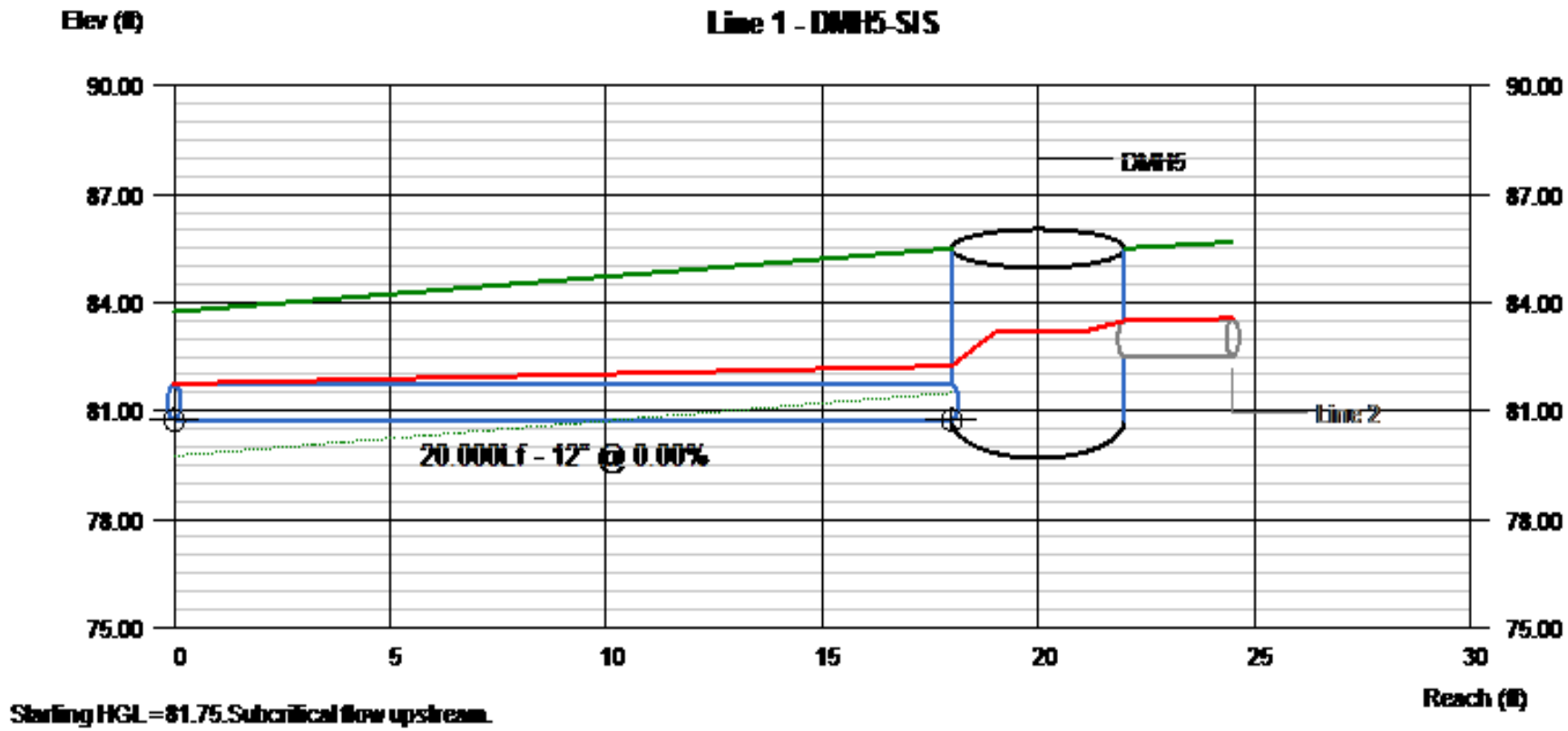
Project File: System-1.stm | Number of lines: 11 | Date: 5/20/2021

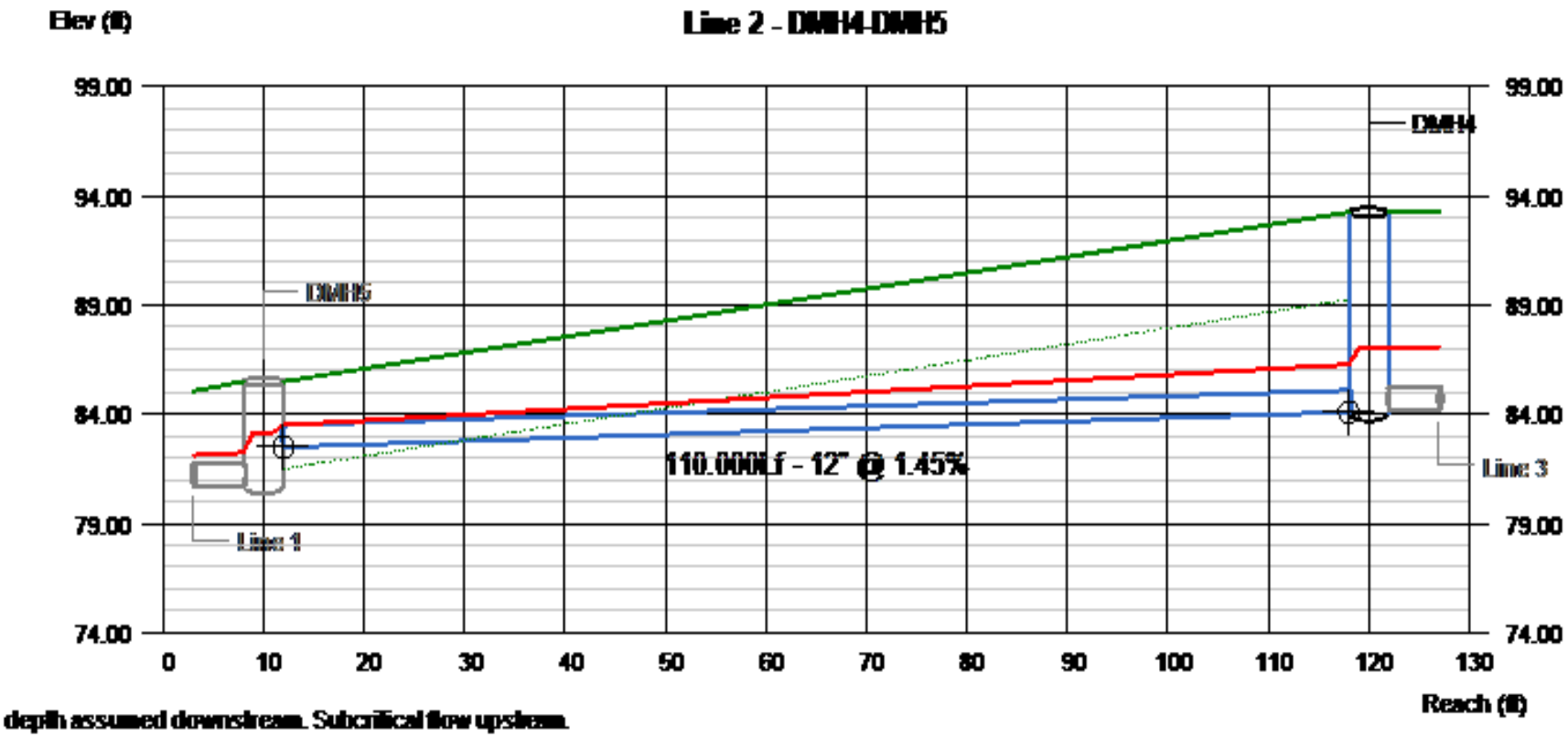
Storm Sewer Summary Report

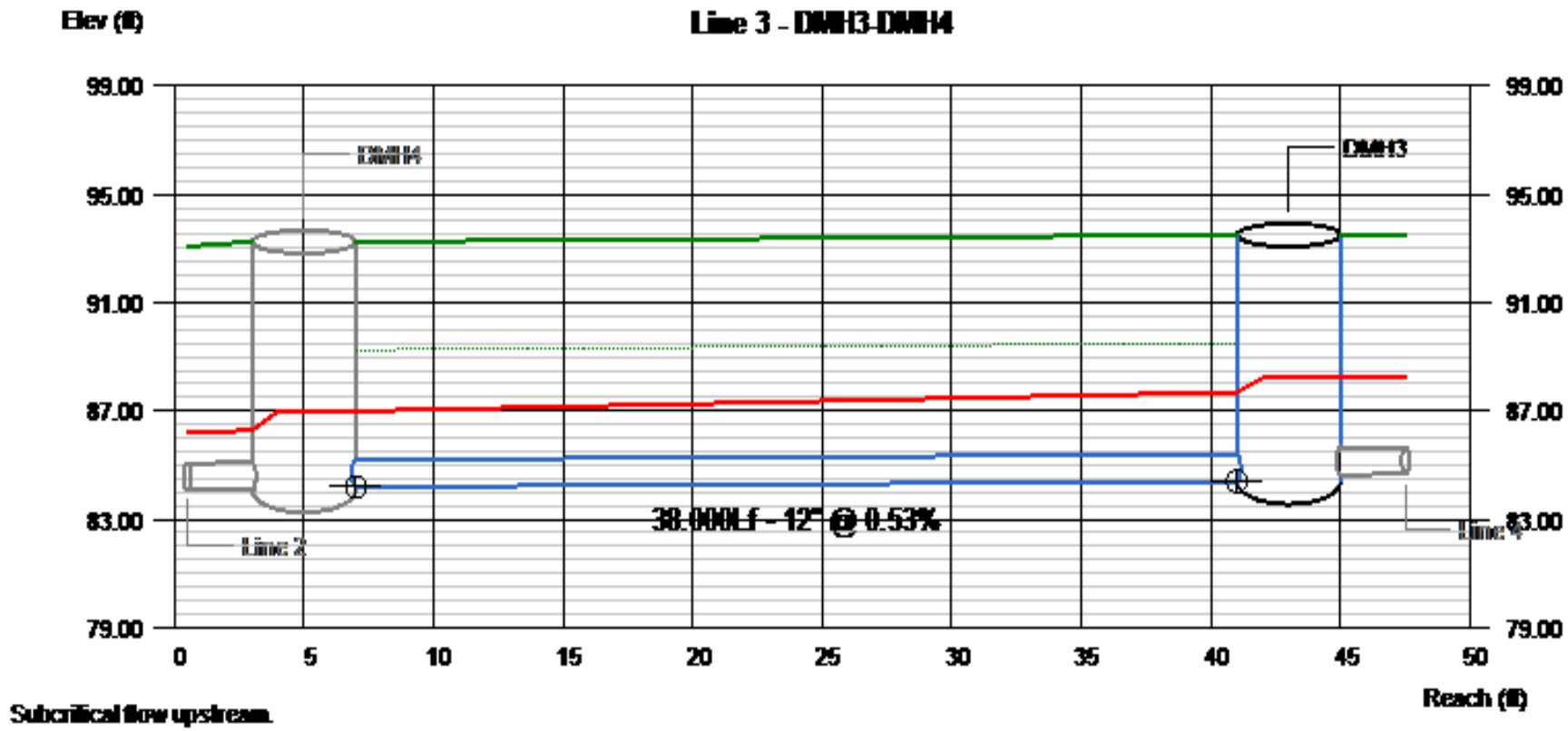
Line No.	Line ID	Flow rate (cfs)	Line Size (in)	Line shape	Line length (ft)	Invert EL Dn (ft)	Invert EL Up (ft)	Line Slope (%)	HGL Down (ft)	HGL Up (ft)	Minor loss (ft)	HGL Junct (ft)	Dns Line No.	Junction Type
1	DMH5-SIS	6.08	12	Cir	20.000	80.75	80.75	0.000	81.75*	82.25*	0.93	83.18	End	Manhole
2	DMH4-DMH5	6.13	12	Cir	110.000	82.50	84.10	1.455	83.50*	86.28*	0.71	86.99	1	Manhole
3	DMH3-DMH4	5.25	12	Cir	38.000	84.20	84.40	0.526	86.99*	87.69*	0.52	88.21	2	Manhole
4	DMH2-DMH3	2.34	12	Cir	201.000	84.65	85.70	0.522	88.21*	89.08*	0.14	89.22	3	Manhole
5	DMH1-DMH2	1.71	12	Cir	141.000	85.80	86.50	0.496	89.22*	89.55*	0.06	89.60	4	Manhole
6	CB1-DMH1	0.59	12	Cir	14.000	86.60	86.70	0.714	89.60*	89.60*	0.01	89.61	5	Grate
7	CB2-DMH1	1.15	12	Cir	14.000	86.60	86.70	0.714	89.60*	89.62*	0.03	89.65	5	Grate
8	CB3-DMH3	3.19	12	Cir	65.000	84.65	86.00	2.077	88.21*	88.74*	0.13	88.86	3	DropGrate
9	UNIT6/7	0.74	6	Cir	50.000	85.80	90.00	8.400	89.22	90.43	n/a	90.43 j	4	None
10	1/2UNIT5	0.16	6	Cir	50.000	86.10	93.00	13.800	88.86	93.20	n/a	93.20 j	8	None
11	UNIT2,3,4	1.01	6	Cir	50.000	84.20	93.00	17.600	86.99	93.47	n/a	93.47 j	2	None

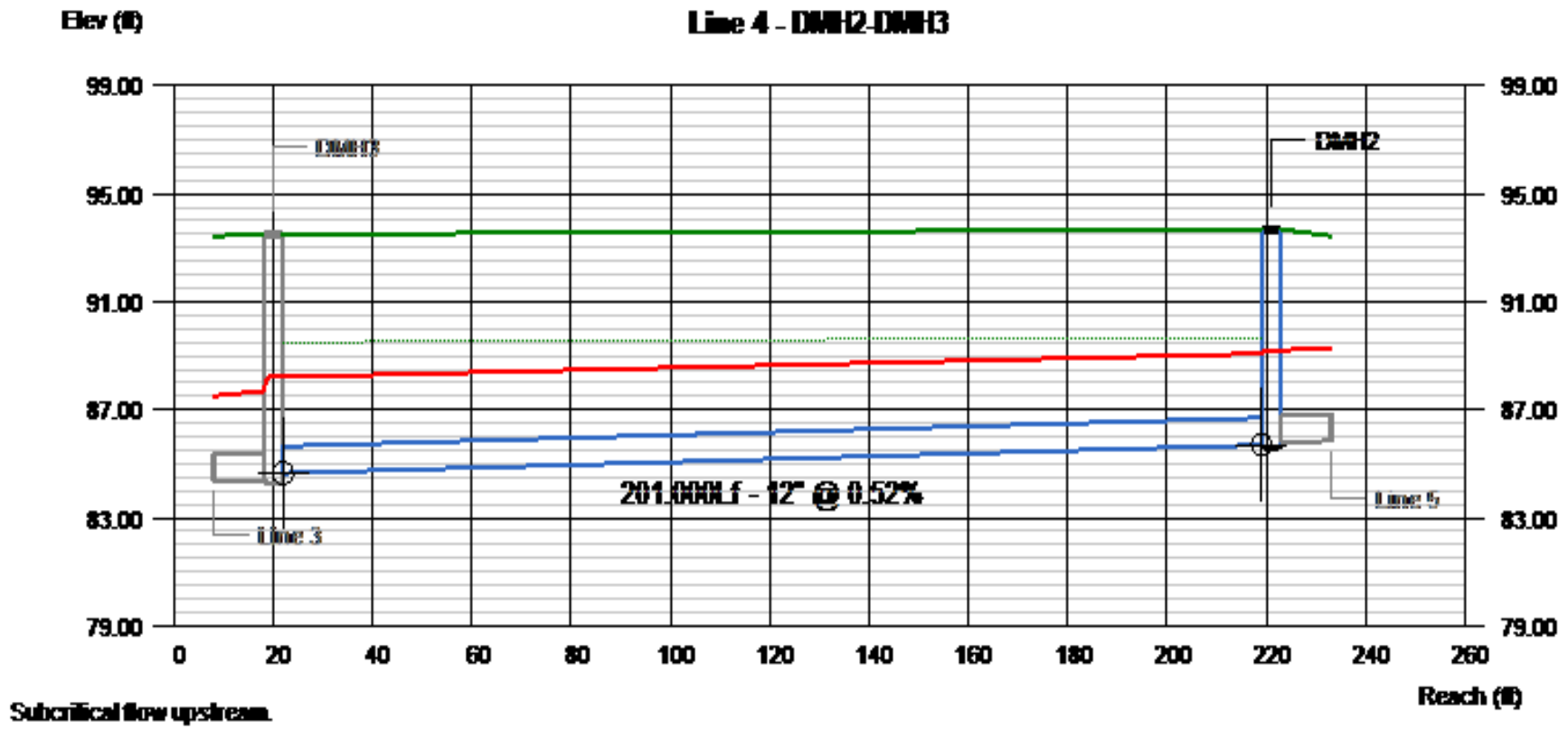
Project File: System-1.stm | Number of lines: 11 | Run Date: 5/20/2021

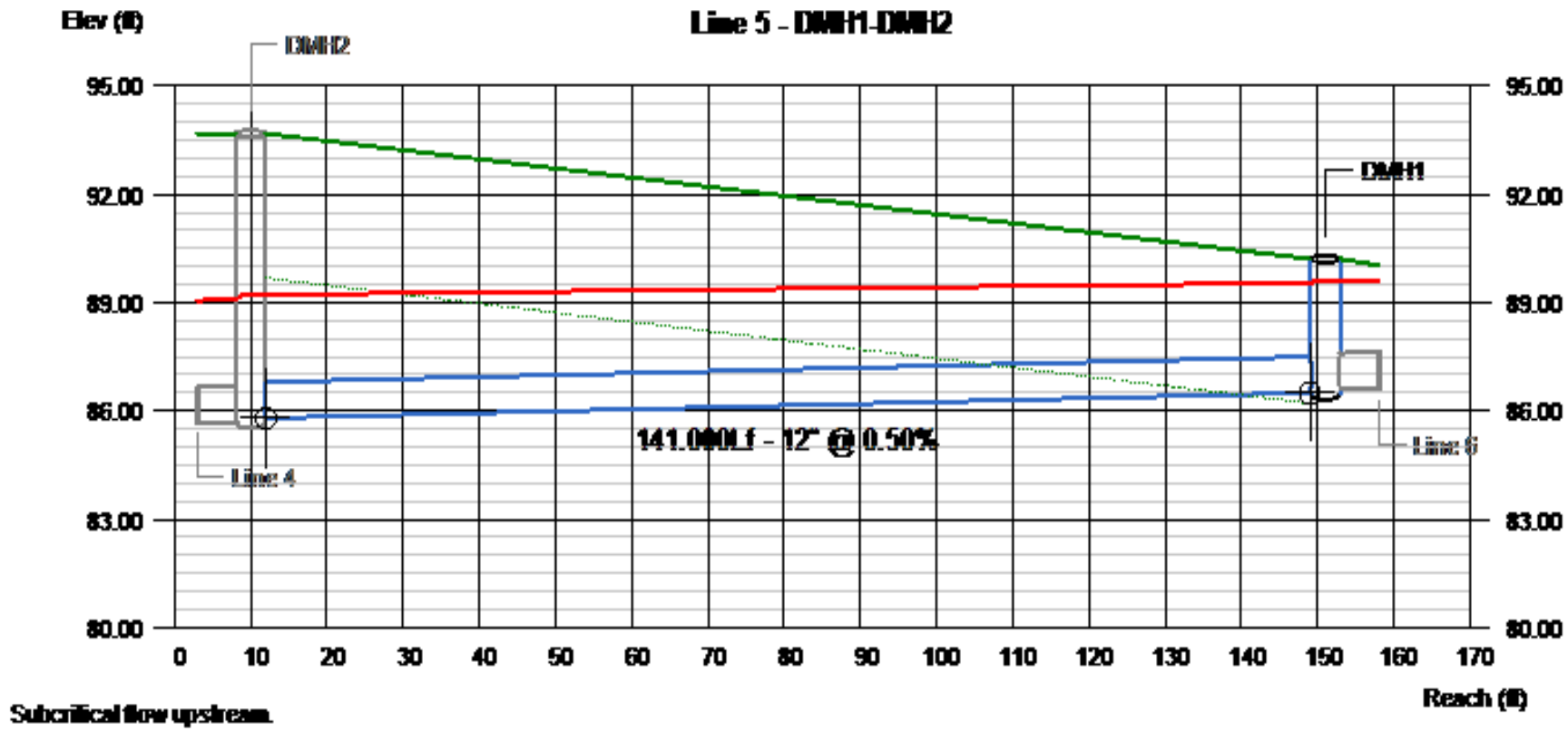
NOTES: Return period = 25 Yrs. ; *Surcharged (HGL above crown). ; j - Line contains hyd. jump.

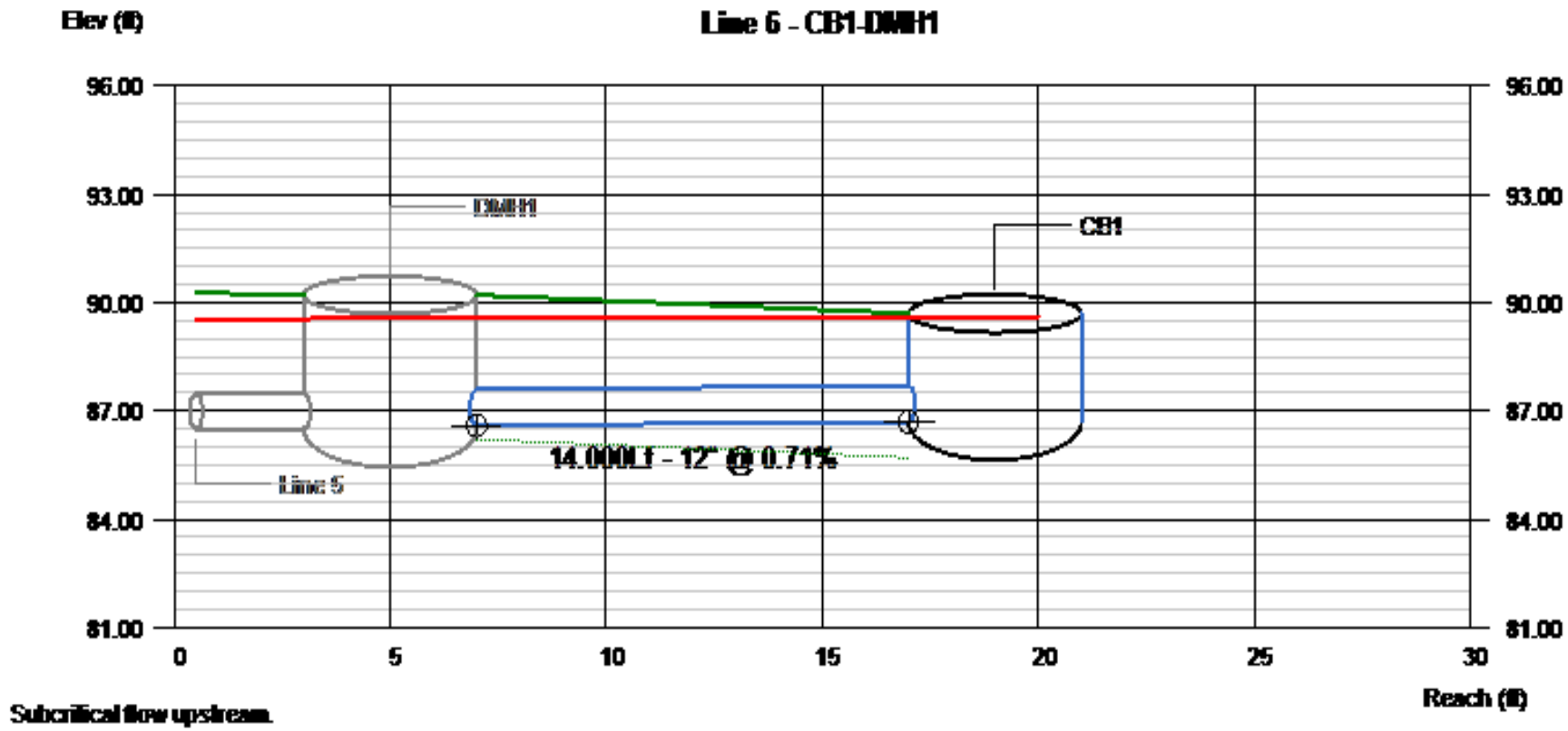

Elev (ft)
Line 1 - DMH5-SIS
90.00
87.00
84.00
81.00
78.00
75.00
DMH5
Line 2
20.000Lf - 12" @ 0.00%
0
5
10
15
20
25
30
Reach (ft)
Starting HGL=81.75.Subcritical flow upstream.

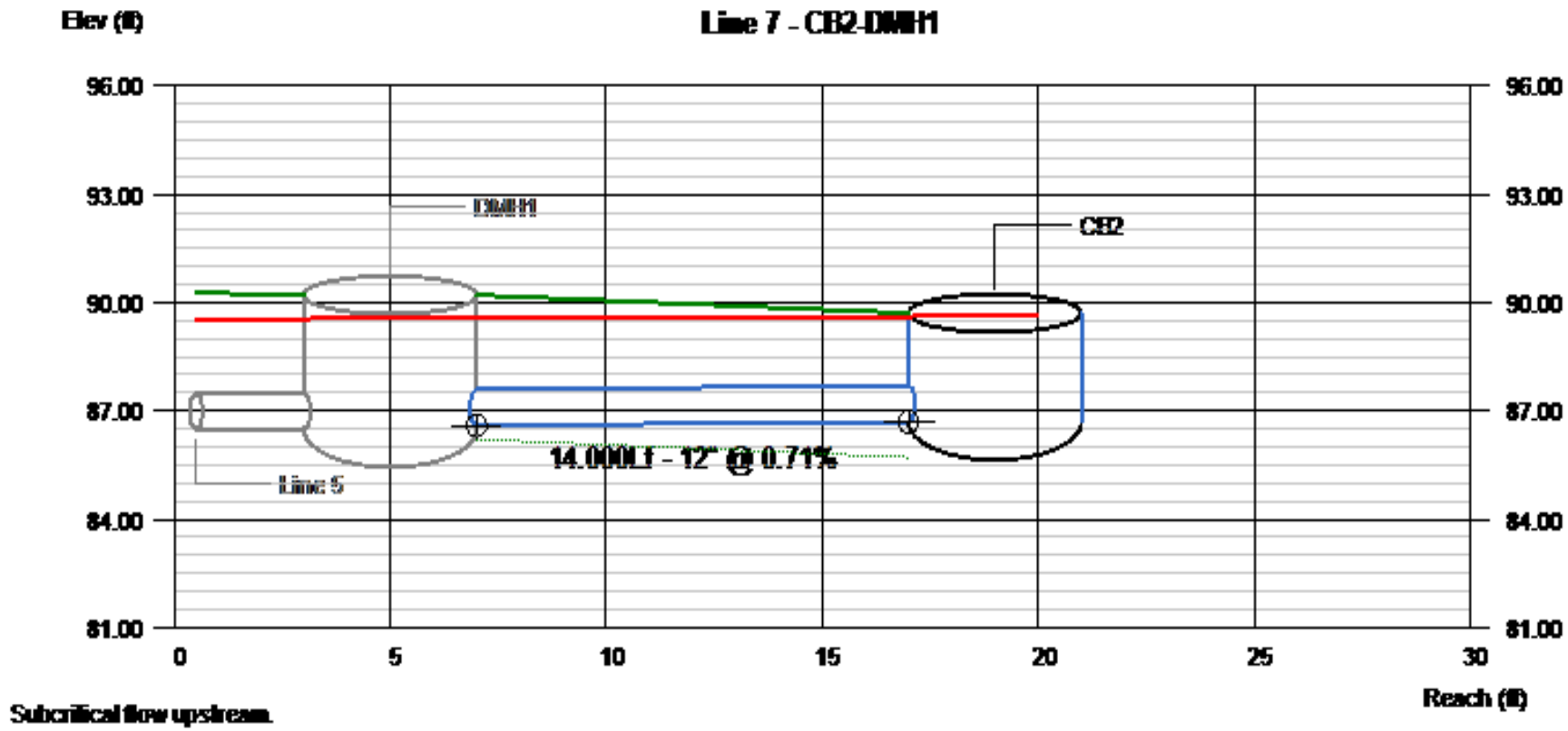

Elev (ft)
Line 2 - DMH4-DMH5
99.00
94.00
89.00
84.00
79.00
74.00
DMH5
DMH4
110.000 lf - 12" @ 1.45%
Line 1
Line 3
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Reach (ft)
depth assumed downstream. Subcritical flow upstream.

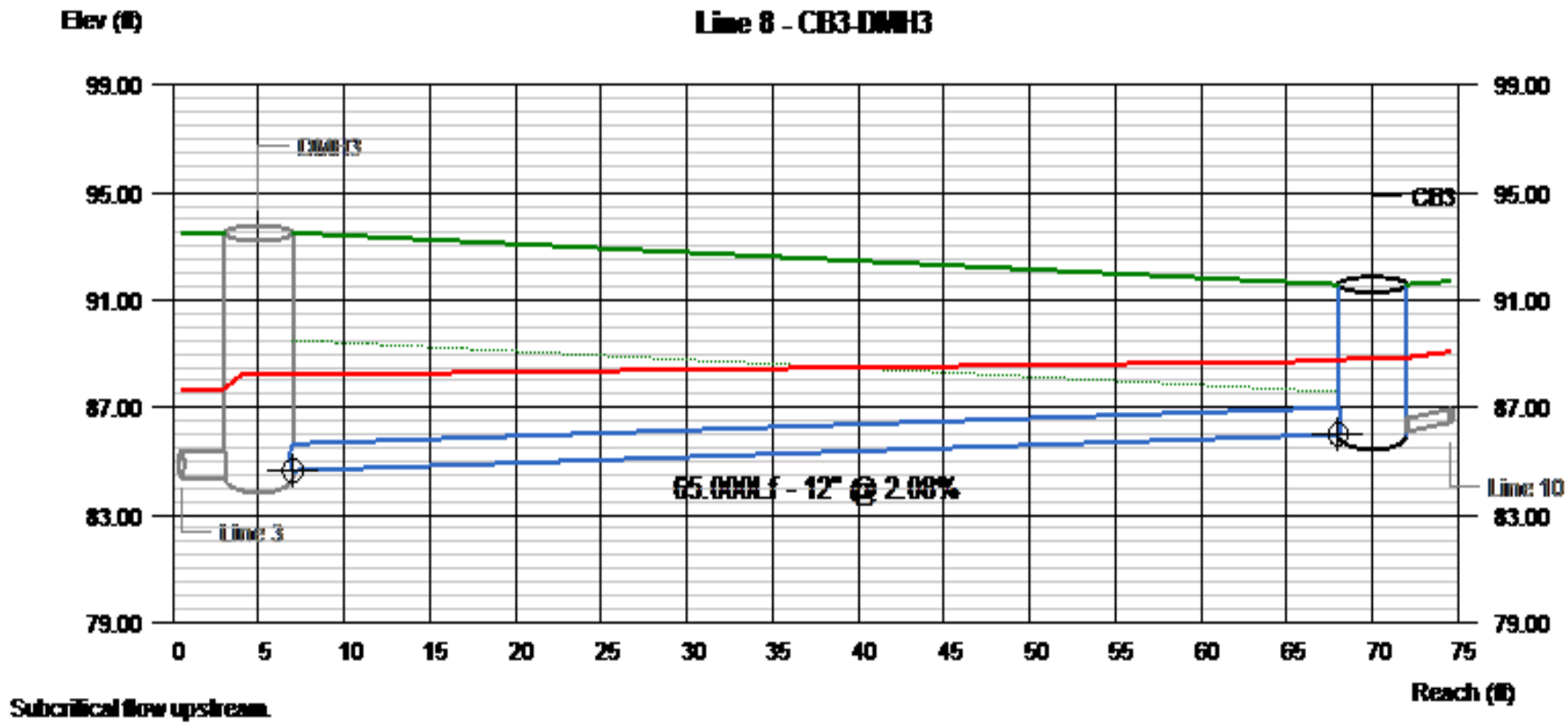

Elev (ft)
Line 3 - DMH3-DMH4
99.00
95.00
91.00
87.00
83.00
79.00
DMH3
Line 2
Line 4
38.0000 f - 12" @ 0.53%
0
5
10
15
20
25
30
35
40
45
50
Reach (ft)
Subcritical flow upstream.

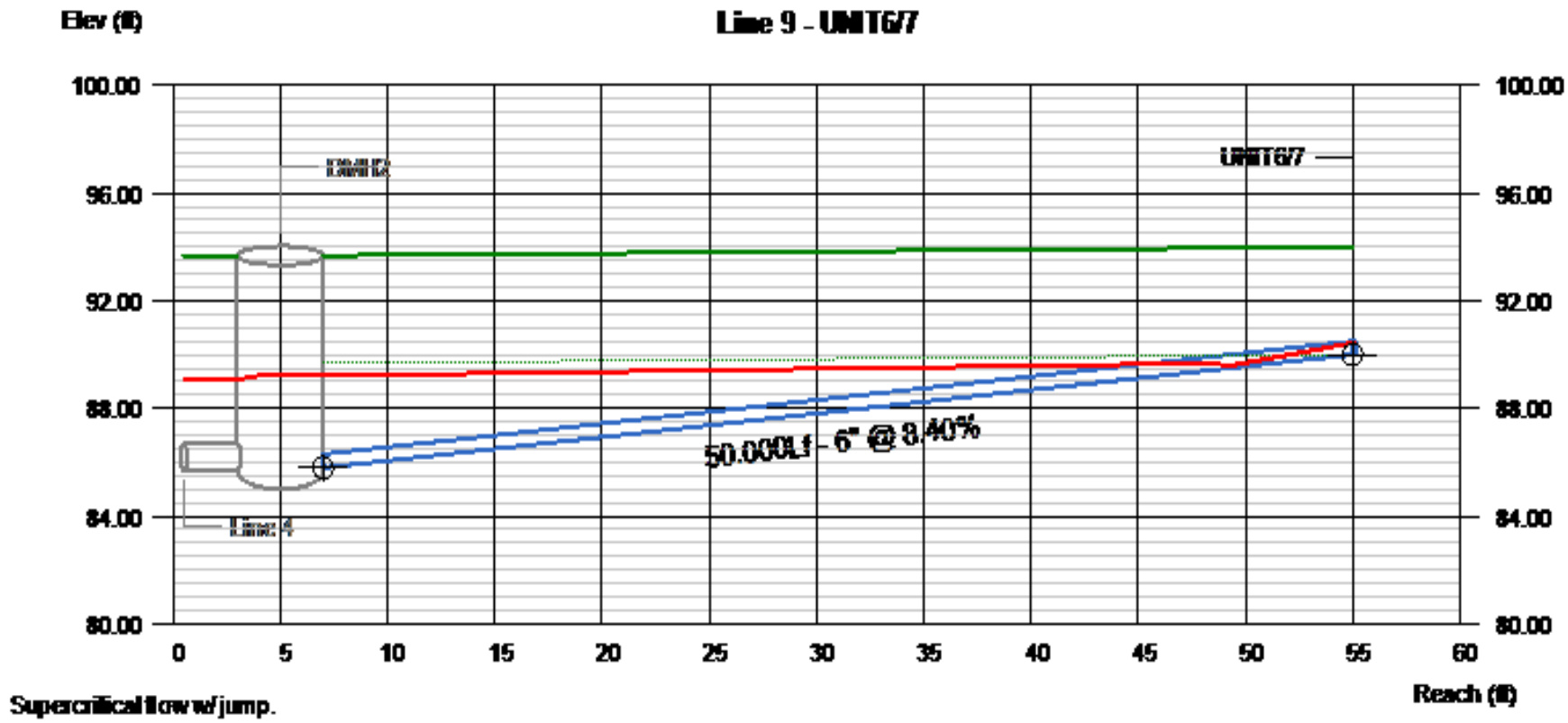

Elev (ft)
Line 4 - DMH2-DMH3
99.00
95.00
91.00
87.00
83.00
79.00
DMH3
DMH2
201.0000 f - 12" @ 0.52%
Line 3
Line 5
0
20
40
60
80
100
120
140
160
180
200
220
240
260
Reach (ft)
Subcritical flow upstream.


Elev (ft)
Line 5 - DMH1-DMH2
DMH2
DMH1
95.00
92.00
89.00
86.00
83.00
80.00
141.000 lf - 12" @ 0.50%
Line 4
Line 6
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
Reach (ft)
Subcritical flow upstream.

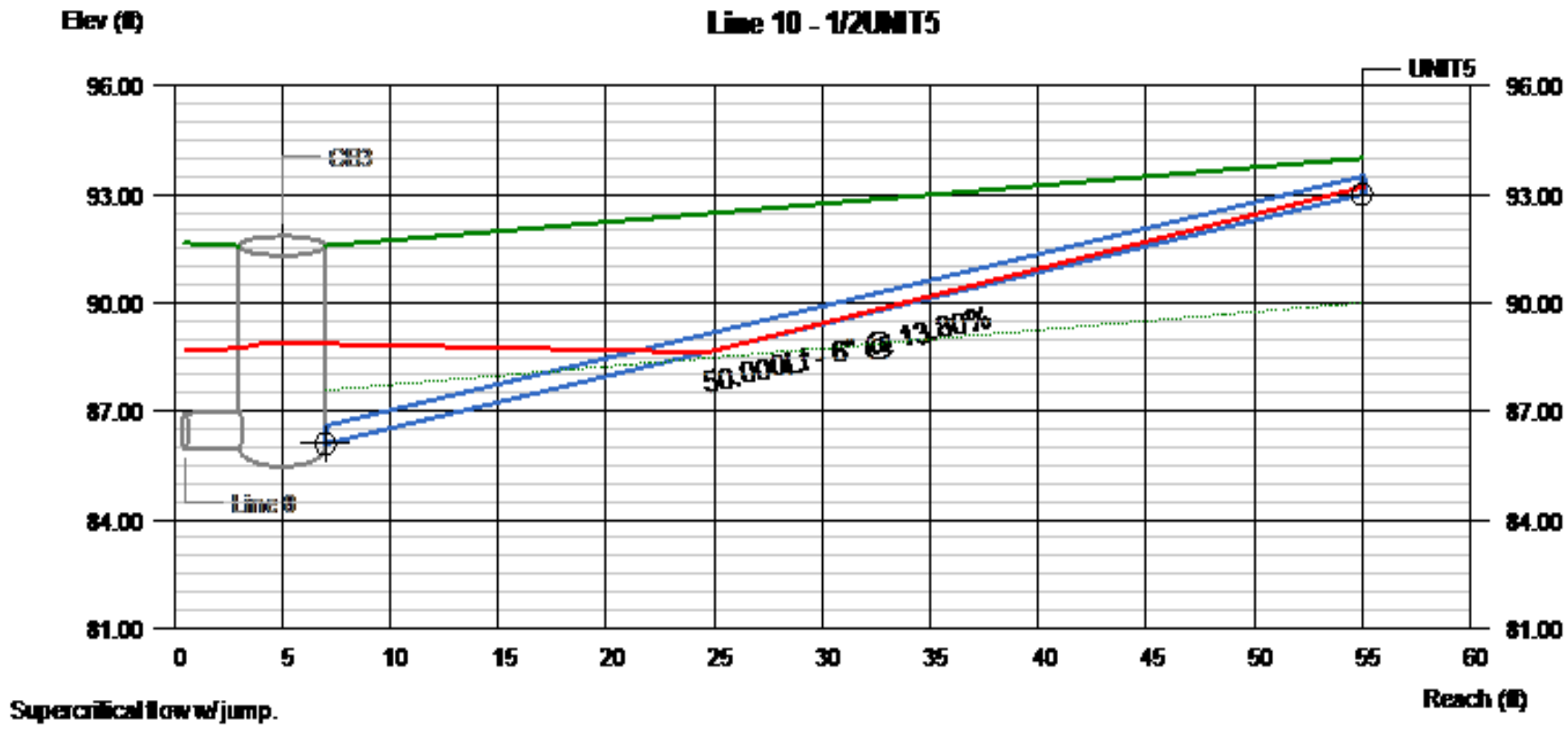

Elev (ft)
Line 6 - CB1-DMH1
96.00
93.00
90.00
87.00
84.00
81.00
DMH1
CB1
14.000LF - 12" @ 0.71%
Line: 5
0
5
10
15
20
25
30
Reach (ft)
Subcritical flow upstream.

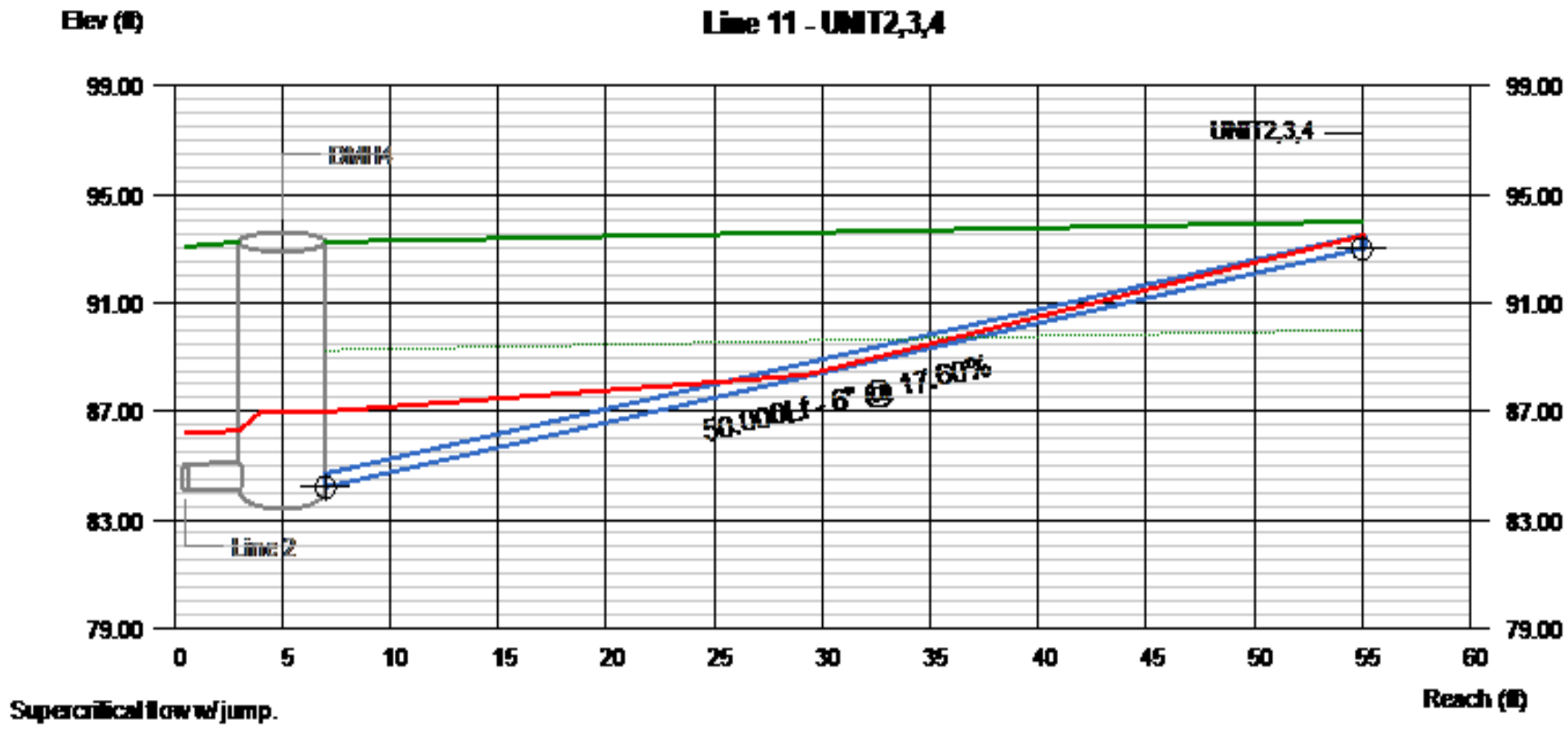

Elev (ft)
Line 7 - CB2-DMH1
96.00
93.00
90.00
87.00
84.00
81.00
DMH1
CB2
14.000LF - 12" @ 0.71%
Line: 5
0
5
10
15
20
25
30
Reach (ft)
Subcritical flow upstream.


Elev (ft)
Line 8 - CB3-DMH3
99.00
95.00
91.00
87.00
83.00
79.00
DMH3
CB3
Line 3
Line 10
65.0000 ft - 12" @ 2.00%
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Reach (ft)
Subcritical flow upstream.



Supercritical flow w/jump.


Elev (ft)
Line 10 - 1/2UNIT5
UNIT5
96.00
93.00
90.00
87.00
84.00
81.00
0
5
10
15
20
25
30
35
40
45
50
55
60
Reach (ft)
Supercritical flow w/jump.



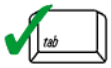
Supercritical flow w/jump.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

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[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

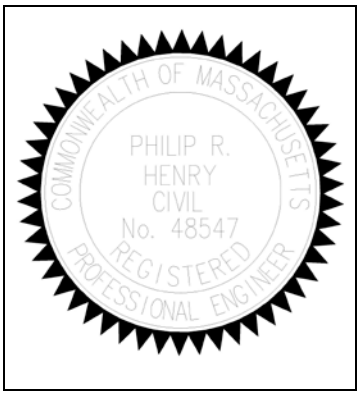
Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature



01/2021

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☐ Redevelopment

☒ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☒ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☒ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☐ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☐ Other (describe): _____

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☐ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☐ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☐ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☒ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☐ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☒ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

OPERATION AND MAINTENANCE PLAN

FOR

PROPOSED RESIDENTIAL DEVELOPMENT

15 COLEMAN ROAD
NEWBURY, MA

PREPARED FOR:

ZENDKO, LLC
15 ESTES STREET
AMESBURY, MA 01913

PREPARED BY:

CIVIL DESIGN GROUP, LLC
21 HIGH STREET, SUITE 207
NORTH ANDOVER, MA 01845

DATE: JANUARY 8, 2021
Revised February 9, 2021

TABLE OF CONTENTS

1.0 INTRODUCTION…….....3
2.0 LONG TERM POLLUTION PREVENTION PLAN (LTPPP)……..……...3
3.0 STORMWATER MANAGEMENT SYSTEM…….....4
4.0 SNOW MANAGEMENT AND DEICING CONTROL……...……...6
5.0 ESTIMATED OPERATION AND MAINTENANCE BUDGET….…….....6
6.0 ILLICIT DISCHARGE STATEMENT……...…….....6
7.0 PUBLIC SAFETY FEATURES……...…….....6

APPENDIX A – OPERATION AND MAINTENANCE REPORT FORM

FIGURE 1 – BMP LOCATION PLAN

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OPERATION AND MAINTENANCE PLAN

1.0 INTRODUCTION

In accordance with the standards set forth by the Massachusetts Department of Environmental Protection (MADEP) Stormwater Management Policy, Civil Design Group, LLC has prepared the following Operations and Maintenance (O&M) Plan for a residential development located at 15 Coleman Road, Newbury, MA.

PROPERTY INFORMATION

PROPERTY ADDRESS	LANDOWNER & STORMWATER MANAGEMENT SYSTEM OWNER
15 COLEMAN ROAD NEWBURY, MA	Owner: Zendko, LLC
	Contact: Mr. Tom Zahoruiko
	Phone: 978-852-4002
	Email: tzeke@comcast.net

The landowner shall be responsible for the long-term operation and maintenance of the site and the stormwater management system, and shall be responsible for record keeping of inspections, maintenance and repairs. If the site owner changes, the new site owner shall assume all responsibilities outlined in this O&M plan. The site owner shall hire a qualified professional to conduct scheduled inspections and maintain records in accordance with the inspection schedule outline enclosed within this document.

Site Engineer: Civil Design Group, LLC
Address: 21 High Street, Suite 207, North Andover, MA 01845
Office Phone: 978-794-5400
Contact: Philip Henry, P.E.

2.0 LONG TERM POLLUTION PREVENTION PLAN (LTPPP)

In accordance with Standard #4 from the MADEP Stormwater Management Policy, the following LTPPP has been prepared as part of this O&M Plan. The purpose of the LTPPP is to identify potential pollutant sources in stormwater discharges and implement prevention measures prior to affecting downstream resource areas.

Housekeeping:
The site shall be kept in a clean and working order. Substances and materials to be used on site that are consistent with the nature of business shall be protected from the elements by storing indoors or in containers with appropriate lids. Proper disposal and care shall be followed when disposing of empty containers.

Solid Waste:
Solid waste materials shall be stored in the dumpsters provided on site. The dumpster enclosure shall be kept closed when not in use and the trash shall not be left outside of the enclosure. The owner shall contract with a waste management company to properly dispose of waste material. The dumpsters shall be emptied on a regular basis.

Pet Waste Management:
Pet waste is not anticipated based on the proposed use of the site.

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Petroleum Products:
Petroleum products shall be stored in sealed containers and clearly labeled. Petroleum storage tanks shall be located a minimum of 100 linear feet from wetland resource areas, drainage ways, inlets and surface waters unless stored within a building. Petroleum storage tanks shall be equipped with a secondary means of containment designed to provide a containment volume that is equal to 110% of the volume of the largest tank unless otherwise required. Drip pans or other form of containment shall be provided for all dispensers. Any asphalt substances used onsite will be applied according to the manufacturer's recommendations.

Fertilizers, Herbicides and Pesticides:
Fertilizers, herbicides and pesticides shall be used in the minimum amounts recommended by the manufacturer and applied to limit contact with stormwater. These products shall be stored in containers indoors.

Paints and Cleaning Solvents:
Paints and containers shall be properly stored in their original containers. Disposal of these products and their containers shall be in accordance with the manufacturer's recommendations.

Spill Prevention and Response:
In the event of a spill of a hazardous substance the following response action items shall be followed in order to prevent or minimize discharge to the stormwater management system.

1. Spills shall be immediately addressed.
2. Spills of hazardous substances shall be remediated using the manufacturers' protocol for cleanup.
3. Vehicular and fuel spills shall be remediated in accordance to local and state regulations.
4. The following equipment and materials shall be present on site and shall be clearly identifiable:
    a. Absorbent materials, brooms, dust pans, mops, rags, gloves, goggles, trash containers, etc.
5. Spills that are toxic or hazardous in nature shall be reported to the MA DEP and professional emergency contractor.
6. The owner shall designate individuals who will receive spill prevention and response training. These individuals will each become responsible for a particular phase of prevention and response. The names of these personnel shall be posted in the material storage area and in the management office.

3.0 STORMWATER MANAGEMENT SYSTEM

The components of the stormwater management system shall be inspected, monitored and maintained in accordance with the following to ensure that the on-site stormwater management/BMP facilities for the project function as intended. Routine inspection and proper maintenance of these individual components is essential to providing the long-term enhancement of both the quality and quantity of the runoff from the site.

The proposed stormwater management Best Management Practices (BMP's) have been designed to collect and convey runoff from developed areas in accordance with the Massachusetts DEP's Stormwater Management Policy. The onsite drainage system is designed for the 25-year storm event. The drainage system consists of one (1) subsurface infiltration system, three (3) catch basins, one (1) proprietary separator and associated piping.

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Street Sweeping
Sweeping shall be performed routinely (a minimum twice per year spring and fall) within the parking lot and driveway areas to reduce the amount of sediment and trash entering the catch basins

Deep Sump Hooded Catch Basins
Stormwater runoff from proposed pavement areas is directed via curbing and site grading to catch basins with deep sumps and hooded outlets and trench drains. These structures are designed to trap and remove sediment and larger particles from the stormwater and improve the performance of subsequent BMP's. The catch basin sumps are a minimum of 4' in depth and a routine inspection and cleaning schedule shall be followed to ensure optimal effectiveness.

Inspection Frequency:	Quarterly
Inspection Tools:	Manhole hook; survey rod; sludge judge
Items to Inspect:	Measure sediment in sump using survey rod; visually check for floating debris or trash; visually check for oil and if more than a sheen is present, use sludge judge to measure thickness of layer; visually ensure that hood is in place; visually ensure that grate is in good condition; visually ensure that outlet pipe is unobstructed
Maintenance Threshold(s):	Annually or ≥24" sediment in sump (whichever comes first); discernible layer of oil/hydrocarbons on surface; floating trash
Maintenance Equipment:	Vactor or clamshell for sediment removal; vactor and/or oil sorbent pads for oil/hydrocarbon removal; net for floating debris or trash removal

Hydrodynamic Separators
Hydrodynamic Separators are designed to remove heavy particles, floating debris and hydrocarbons from stormwater. Stormwater enters the system where floatables and oils are separated prior to the clarified stormwater runoff discharging to an outlet pipe. See the attached Hydroworks product description sheets for additional information, including maintenance recommendations.

- Inspection Frequency: Quarterly
- Cleaning Threshold(s): Per manufacturer's recommendations
- Equipment: Vactor

Subsurface Infiltration System (SIS)
The SIS is designed to infiltrate runoff from the site. The system is comprised of plastic pipe and crushed stone with inspection ports to facilitate inspection for standing water and sediment.

- Inspection Frequency: Annually and after storms equal to or greater than 1-year, 24-hour Type-III storm events.
- Cleaning Threshold(s): 4" sediment or standing water for >48 hours following a rain event
- Equipment: Water jet and vactor

4.0 SNOW MANAGEMENT AND DEICING CONTROL

The Owner shall contract with a company to properly clear and remove snow. The contractor shall be responsible for maintaining all roads, driveways, parking lots, sidewalks and pedestrian access onsite as well as along the right-of-way frontage. Snow shall be piled in the designated areas snow storage areas to the extent

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practicable. Snow shall be removed from the site if the capacity of the designated areas is reached, and disposed of in accordance with applicable regulations and requirements.

Deicing chemicals shall be kept indoors in a safe location and shall be clearly labeled. Deicing solutions such as calcium chloride, rock salt and/or sand may be used unless otherwise restricted by the municipality. Deicing methods shall be used in conjunction with snow removal to maintain safe pedestrian and vehicular access.

5.0 ESTIMATED OPERATION AND MAINTENANCE BUDGET

The estimated average annual operating and maintenance budget for the proposed system is shown below:

- Catch Basins: $200 each = $600
- Proprietary Separator: $1,000
- Subsurface infiltration system: $1,500
- Routine maintenance = $2,000
    - Removal of trash
    - Annual street sweeping
    - Pipe network/outfall inspections

6.0 ILLICIT DISCHARGE STATEMENT

The proposed stormwater management system consists of a hydrodynamic separator, infiltration basins, bioretention areas, and associated piping & drain manholes, which are intended to collect and convey stormwater discharges from the site. The stormwater management system is *not* intended to convey any illicit discharges and or pollutants and as such, control measures that are identified within this report shall be strictly adhered to in order to minimize the risk of contamination. Any unknown existing illicit discharges that are discovered as part of the redevelopment of the subject site shall be eliminated in accordance with local, state and federal regulations.

7.0 PUBLIC SAFETY FEATURES

Public safety features, such as lighting, hydrants and sidewalks are depicted in the attached Figure 1 BMP Location Plan.

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APPENDIX-A

OPERATION AND MAINTENANCE REPORT FORM

STORMWATER DIVISION
OF CIVIL DESIGN GROUP, LLC

21 High Street, Suite 207
North Andover, MA 01845
Tel 978.794.5400
www.cdgengineering.com

QUARTERLY STORMWATER INSPECTION REPORT

Site:	Proposed Residential Development	**Date:**	
Address:	15 Coleman Road, Newbury, MA	**Time:**	
Inspector:		**Weather:**	

CATCH BASIN & TRENCH DRAINS

Unit #	Sediment (inches)	Oil (inches)	Hood/Pipes	Grate	Last Cleaned	Attention Recommended
CB-1						
CB-2						
CB-3						
DMH-3 (HS5)						
YD-1						

INFILTRATION BASIN

Unit #	Sediment (inches)	Trash Cover	Last Cleaned	Attention Recommended
SIS-1				

Date of previous street sweeping: _____

Hydroworks® HydroStorm

Operations & Maintenance Manual

Version 1.0

Please call Hydroworks at 888-290-7900 or email us at support@hydroworks.com if you have any questions regarding the Inspection Checklist. Please fax a copy of the completed checklist to Hydroworks at 888-783-7271 for our records.

Introduction

The HydroStorm is a state of the art hydrodynamic separator. Hydrodynamic separators remove solids, debris and lighter than water (oil, trash, floating debris) pollutants from stormwater. Hydrodynamic separators and other water quality measures are mandated by regulatory agencies (Town/City, State, Federal Government) to protect storm water quality from pollution generated by urban development (traffic, people) as part of new development permitting requirements.

As storm water treatment structures fill up with pollutants they become less and less effective in removing new pollution. Therefore, it is important that storm water treatment structures be maintained on a regular basis to ensure that they are operating at optimum performance. The HydroStorm is no different in this regard and this manual has been assembled to provide the owner/operator with the necessary information to inspect and coordinate maintenance of their HydroStorm.

Hydroworks® HydroStorm Operation

The Hydroworks HydroStorm (HS) separator is a unique hydrodynamic by-pass separator. It incorporates a protected submerged pretreatment zone to collect larger solids, a treatment tank to remove finer solids, and a dual set of weirs to create a high flow bypass. High flows are conveyed directly to the outlet and do not enter the treatment area, however, the submerged pretreatment area still allows removal of coarse solids during high flows.

Under normal or low flows, water enters an inlet area with a horizontal grate. The area underneath the grate is submerged with openings to the main treatment area of the separator. Coarse solids fall through the grate and are either trapped in the pretreatment area or conveyed into the main treatment area depending on the flow rate. Fines are transported into the main treatment area. Openings and weirs in the pretreatment area allow entry of water and solids into the main treatment area and cause water to rotate in the main treatment area creating a vortex motion. Water in the main treatment area is forced to rise along the walls of the separator to discharge from the treatment area to the downstream pipe.

The vortex motion forces solids and floatables to the middle of the inner chamber. Floatables are trapped since the inlet to the treatment area is submerged. The design maximizes the retention of settled solids since solids are forced to the center of the inner chamber by the vortex motion of water while water must flow up the walls of the separator to discharge into the downstream pipe.

A set of high flow weirs near the outlet pipe create a high flow bypass over both the pretreatment area and main treatment chamber. The rate of flow into the treatment area is regulated by the number and size of openings into the treatment chamber and the height of by-pass weirs. High flows flow over the weirs directly to the outlet pipe preventing the scour and resuspension of any fines collected in the treatment chamber.

A central access tube is located in the structure to provide access for cleaning. The arrangement of the inlet area and bypass weirs near the outlet pipe facilitate the use of multiple inlet pipes.

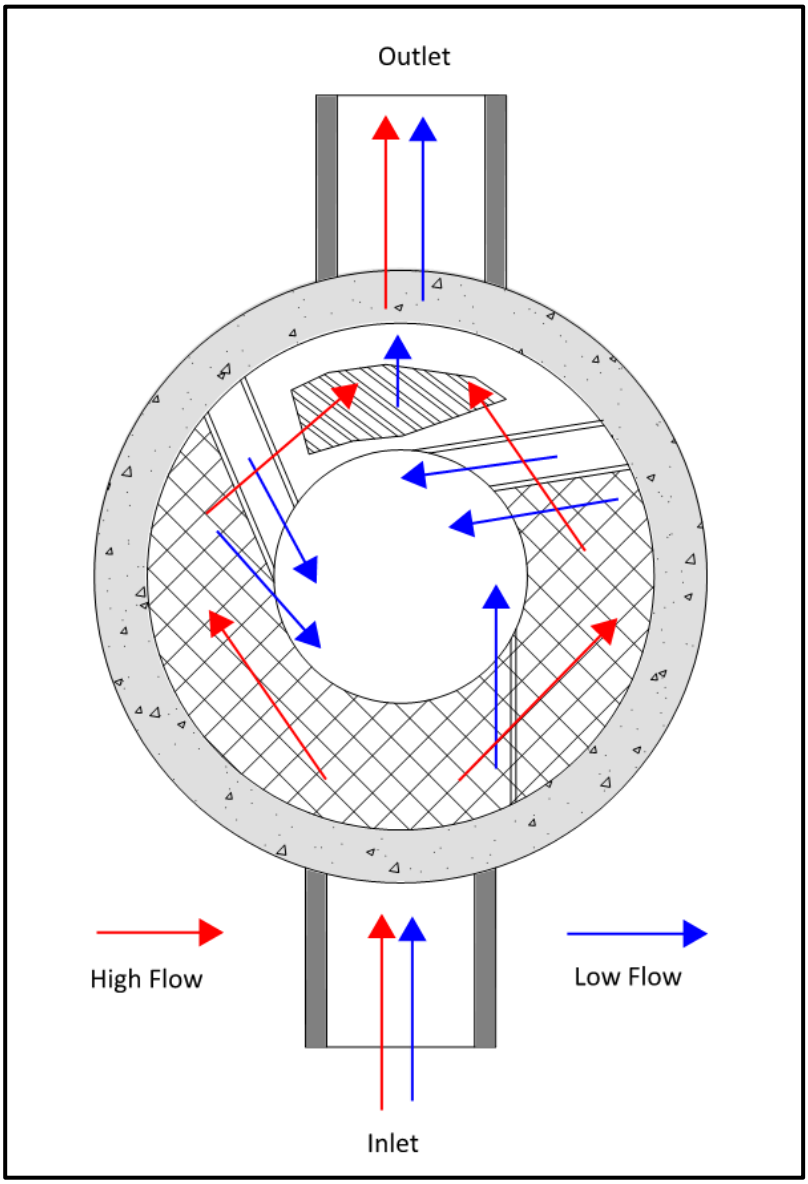


Figure 1. Hydroworks HydroStorm Operation – Plan View

Figure 2 is a profile view of the HydroStorm separator showing the flow patterns for low and high flows.

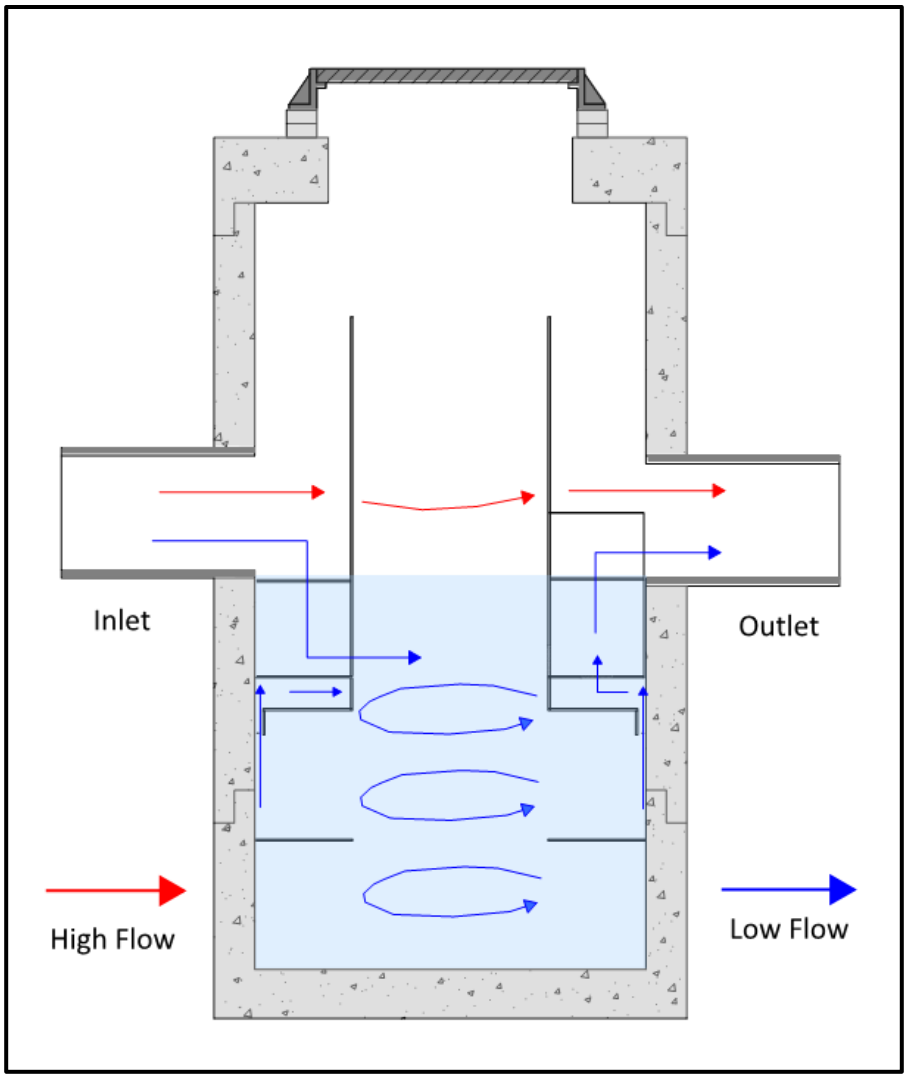


Figure 2. Hydroworks HydroStorm Operation – Profile View

The HS 4i is an inlet version of the HS 4 separator. There is a catch-basin grate on top of the HS 4i. A funnel sits sits underneath the grate on the frame and directs the water to the inlet side of the separator to ensure all lows flows are properly treated. The whole funnel is removed for inspection and cleaning.

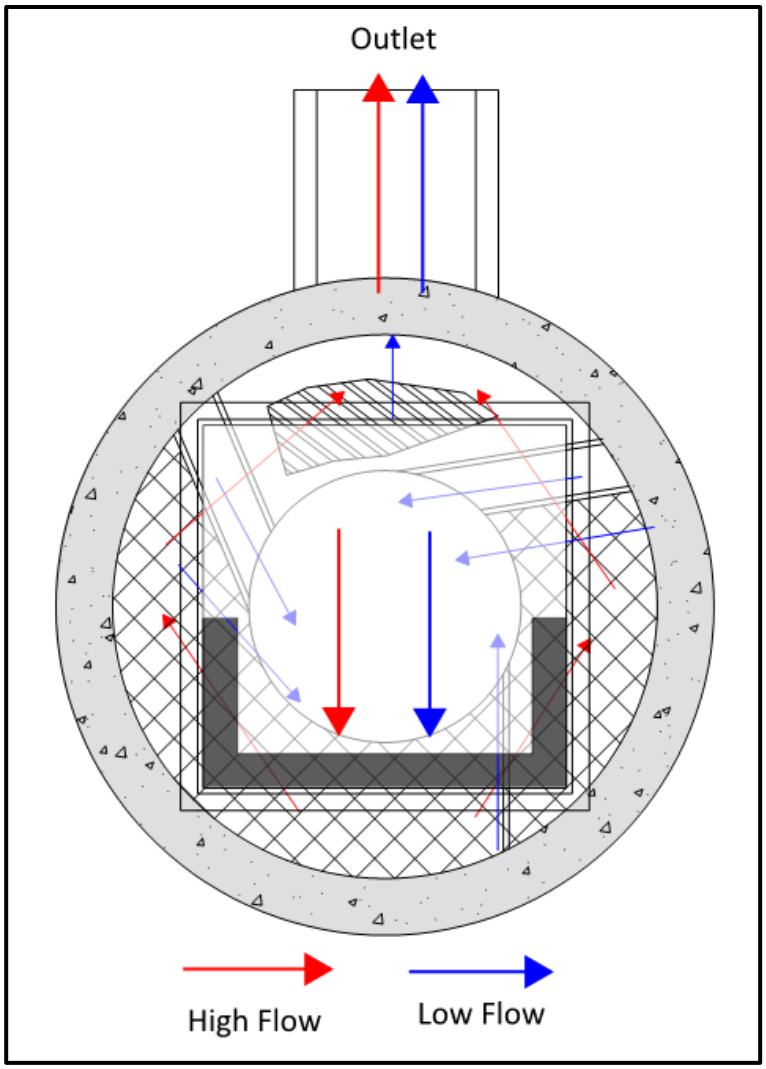


Figure 3. Hydroworks HS 4i Funnel

Inspection

Procedure

Floatables

A visual inspection can be conducted for floatables by removing the covers and looking down into the center access tube of the separator. Separators with an inlet grate (HS 4i or custom separator) will have a plastic funnel located under the grate that must be removed from the frame prior to inspection or maintenance. If you are missing a funnel please contact Hydroworks at the numbers provided at the end of this document.

TSS/Sediment

Inspection for TSS build-up can be conducted using a Sludge Judge®, Core Pro®, AccuSludge® or equivalent sampling device that allows the measurement of the depth of TSS/sediment in the unit. These devices typically have a ball valve at the bottom of the tube that allows water and TSS to flow into the tube when lowering the tube into the unit. Once the unit touches the bottom of the device, it is quickly pulled upward such that the water and TSS in the tube forces the ball valve closed allowing the user to see a full core of water/TSS in the unit. The unit should be inspected for TSS through each of the access covers. Several readings (2 or 3) should be made at each access cover to ensure that an accurate TSS depth measurement is recorded.

Frequency

Construction Period

The HydroStorm separator should be inspected every four weeks and after every large storm (over 0.5" (12.5 mm) of rain) during the construction period.

Post-Construction Period

The Hydroworks HydroStorm separator should be inspected during the first year of operation for normal stabilized sites (grassed or paved areas). If the unit is subject to oil spills or runoff from unstabilized (storage piles, exposed soils) areas the HydroStorm separator should be inspected more frequently (4 times per year). The initial annual inspection will indicate the required future frequency of inspection and maintenance if the unit was maintained after the construction period.

Reporting

Reports should be prepared as part of each inspection and include the following information:

1. Date of inspection
2. GPS coordinates of Hydroworks unit
3. Time since last rainfall
4. Date of last inspection
5. Installation deficiencies (missing parts, incorrect installation of parts)
6. Structural deficiencies (concrete cracks, broken parts)
7. Operational deficiencies (leaks, blockages)
8. Presence of oil sheen or depth of oil layer
9. Estimate of depth/volume of floatables (trash, leaves) captured
10. Sediment depth measured
11. Recommendations for any repairs and/or maintenance for the unit
12. Estimation of time before maintenance is required if not required at time of inspection

A sample inspection checklist is provided at the end of this manual.

Maintenance

Procedure

The Hydroworks HydroStorm unit is typically maintained using a vacuum truck. There are numerous companies that can maintain the HydroStorm separator. Maintenance with a vacuum truck involves removing all of the water and sediment together. The water is then separated from the sediment on the truck or at the disposal facility.

A central access opening (24” or greater) is provided to the gain access to the lower treatment tank of the unit. This is the primary location to maintain by vacuum truck. The pretreatment area can also be vacuumed and/or flushed into the lower treatment tank of the separator for cleaning via the central access once the water level is lowered below the pretreatment floor.

In instances where a vacuum truck is not available other maintenance methods (i.e. clamshell bucket) can be used, but they will be less effective. If a clamshell bucket is used the water must be decanted prior to cleaning since the sediment is under water and typically fine in nature. Disposal of the water will depend on local requirements. Disposal options for the decanted water may include:

1. Discharge into a nearby sanitary sewer manhole
2. Discharge into a nearby LID practice (grassed swale, bioretention)
3. Discharge through a filter bag into a downstream storm drain connection

The local municipality should be consulted for the allowable disposal options for both water and sediments prior to any maintenance operation. Once the water is decanted the sediment can be removed with the clamshell bucket.

Disposal of the contents of the separator depend on local requirements. Maintenance of a Hydroworks HydroStorm unit will typically take 1 to 2 hours based on a vacuum truck and longer for other cleaning methods (i.e. clamshell bucket).

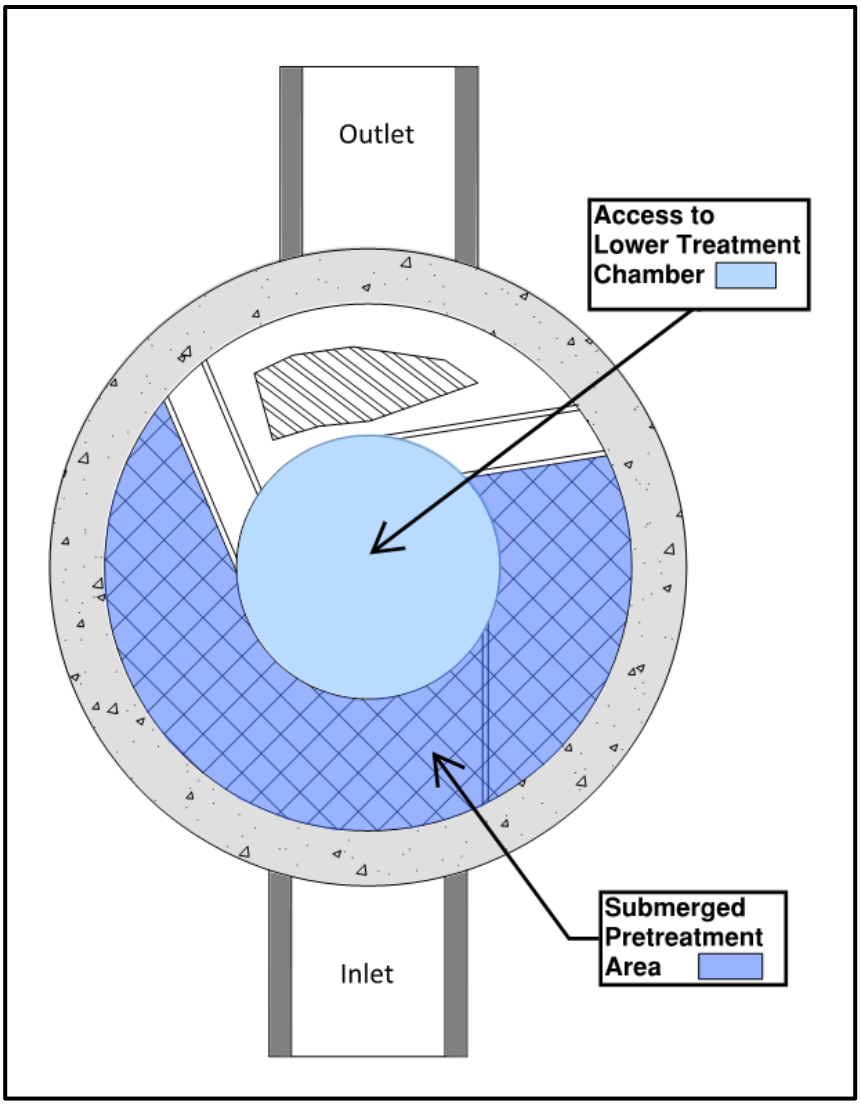


Figure 3. Maintenance Access

Frequency

<u>Construction Period</u>

A HydroStorm separator can fill with construction sediment quickly during the construction period. The HydroStorm must be maintained during the construction period when the depth of TSS/sediment reaches 24” (600 mm). It must also be maintained during the construction period if there is an appreciable depth of oil in the unit (more than a sheen) or if floatables other than oil cover over 50% of the area of the separator

The HydroStorm separator should be maintained at the end of the construction period, prior to operation for the post-construction period.

Post-Construction Period

The HydroStorm was independently tested by Alden Research Laboratory in 2017. A HydroStorm HS 4 was tested for scour with a 50% sediment depth of 0.5 ft. Therefore, maintenance for sediment accumulation is required if the depth of sediment is 1 ft or greater in separators with standard water (sump) depths (Table 1).

There will be designs with increased sediment storage based on specifications or site-specific criteria. A measurement of the total water depth in the separator through the central access tube should be taken and compared to water depth given in Table 1. The standard water depth from Table 1 should be subtracted from the measured water depth and the resulting extra depth should be added to the 1 ft to determine the site-specific sediment maintenance depth for that separator.

For example, if the measured water depth in the HS-7 is 7 feet, then the sediment maintenance depth for that HS-7 is 2 ft (= 1 + 7 – 6) and the separator does not need to be cleaned for sediment accumulation until the measure sediment depth is 2 ft.

The HydroStorm separator must also be maintained if there is an appreciable depth of oil in the unit (more than a sheen) or if floatables other than oil cover over 50% of the water surface of the separator.

Table 1 Standard Dimensions for Hydroworks HydroStorm Models

Model	Diameter (ft)	Total Water Depth (ft)	Sediment Maintenance Depth for Table 1 Total Water Depth(ft)
HS-3	3	3	1
HS-4	4	4	1
HS-5	5	4	1
HS-6	6	4	1
HS-7	7	6	1
HS-8	8	7	1
HS-9	9	7.5	1
HS-10	10	8	1
HS-11	11	9	1
HS-12	12	9.5	1

HYDROSTORM INSPECTION SHEET

Date _____
Date of Last Inspection _____

Site _____
City _____
State _____
Owner _____

GPS Coordinates _____

Date of last rainfall _____

Site Characteristics	**Yes**	**No**
Soil erosion evident	☐	☐
Exposed material storage on site	☐	☐
Large exposure to leaf litter (lots of trees)	☐	☐
High traffic (vehicle) area	☐	☐

HydroStorm	**Yes**	**No**
Obstructions in the inlet or outlet	☐ *	☐
Missing internal components	☐ **	☐
Improperly installed inlet or outlet pipes	☐ ***	☐
Internal component damage (cracked, broken, loose pieces)	☐ **	☐
Floating debris in the separator (oil, leaves, trash)	☐	☐
Large debris visible in the separator	☐ *	☐
Concrete cracks/deficiencies	☐ ***	☐
Exposed rebar	☐ **	☐
Water seepage (water level not at outlet pipe invert)	☐ ***	☐

Water level depth below outlet pipe invert _____"

Routine Measurements

Floating debris depth	**< 0.5" (13mm)**	☐	**>0.5" 13mm)**	☐ *
Floating debris coverage	**< 50% of surface area**	☐	**> 50% surface area**	☐ *
Sludge depth	**< 12" (300mm)**	☐	**> 12" (300mm)**	☐ *

* Maintenance required
** Repairs required
*** Further investigation is required

Hydroworks

Other Comments:

Hydroworks

Hydroworks® HydroStorm

One Year Limited Warranty

Hydroworks, LLC warrants, to the purchaser and subsequent owner(s) during the warranty period subject to the terms and conditions hereof, the Hydroworks HydroStorm to be free from defects in material and workmanship under normal use and service, when properly installed, used, inspected and maintained in accordance with Hydroworks written instructions, for the period of the warranty. The standard warranty period is 1 year.

The warranty period begins once the separator has been manufactured and is available for delivery. Any components determined to be defective, either by failure or by inspection, in material and workmanship will be repaired, replaced or remanufactured at Hydroworks' option provided, however, that by doing so Hydroworks, LLC will not be obligated to replace an entire insert or concrete section, or the complete unit. This warranty does not cover shipping charges, damages, labor, any costs incurred to obtain access to the unit, any costs to repair/replace any surface treatment/cover after repair/replacement, or other charges that may occur due to product failure, repair or replacement.

This warranty does not apply to any material that has been disassembled or modified without prior approval of Hydroworks, LLC, that has been subjected to misuse, misapplication, neglect, alteration, accident or act of God, or that has not been installed, inspected, operated or maintained in accordance with Hydroworks, LLC instructions and is in lieu of all other warranties expressed or implied. Hydroworks, LLC does not authorize any representative or other person to expand or otherwise modify this limited warranty.

The owner shall provide Hydroworks, LLC with written notice of any alleged defect in material or workmanship including a detailed description of the alleged defect upon discovery of the defect. Hydroworks, LLC should be contacted at 136 Central Ave., Clark, NJ 07066 or any other address as supplied by Hydroworks, LLC. (888-290-7900).

This limited warranty is exclusive. There are no other warranties, express or implied, or merchantability or fitness for a particular purpose and none shall be created whether under the uniform commercial code, custom or usage in the industry or the course of dealings between the parties. Hydroworks, LLC will replace any goods that are defective under this warranty as the sole and exclusive remedy for breach of this warranty.

Subject to the foregoing, all conditions, warranties, terms, undertakings or liabilities (including liability as to negligence), expressed or implied, and howsoever arising, as to the condition, suitability, fitness, safety, or title to the Hydroworks HydroStorm are hereby negated and excluded and Hydroworks, LLC gives and makes no such representation, warranty or undertaking except as expressly set forth herein. Under no circumstances shall Hydroworks, LLC be liable to the Purchaser or to any third party for product liability claims; claims arising from the design, shipment, or installation of the HydroStorm, or the cost of other goods or services related to the purchase and installation of the HydroStorm. For this Limited Warranty to apply, the HydroStorm must be installed in accordance with all site conditions required by state and local codes; all other applicable laws; and Hydroworks' written installation instructions.

Hydroworks, LLC expressly disclaims liability for special, consequential or incidental damages (even if it has been advised of the possibility of the same) or breach of expressed or implied warranty. Hydroworks, LLC shall not be liable for penalties or liquidated damages, including loss of production and profits; labor and materials; overhead costs; or other loss or expense incurred by the purchaser or any third party. Specifically excluded from limited warranty coverage are damages to the HydroStorm arising from ordinary wear and tear; alteration, accident, misuse, abuse or neglect; improper maintenance, failure of the product due to improper installation of the concrete sections or improper sizing; or any other event not caused by Hydroworks, LLC. This limited warranty represents Hydroworks' sole liability to the purchaser for claims related to the HydroStorm, whether the claim is based upon contract, tort, or other legal basis.

ILLICIT DISCHARGE STATEMENT

FOR AN

OPEN SPACE RESIDENTIAL DEVELOPMENT

15 COLEMAN ROAD
NEWBURY, MASSACHUSETTS

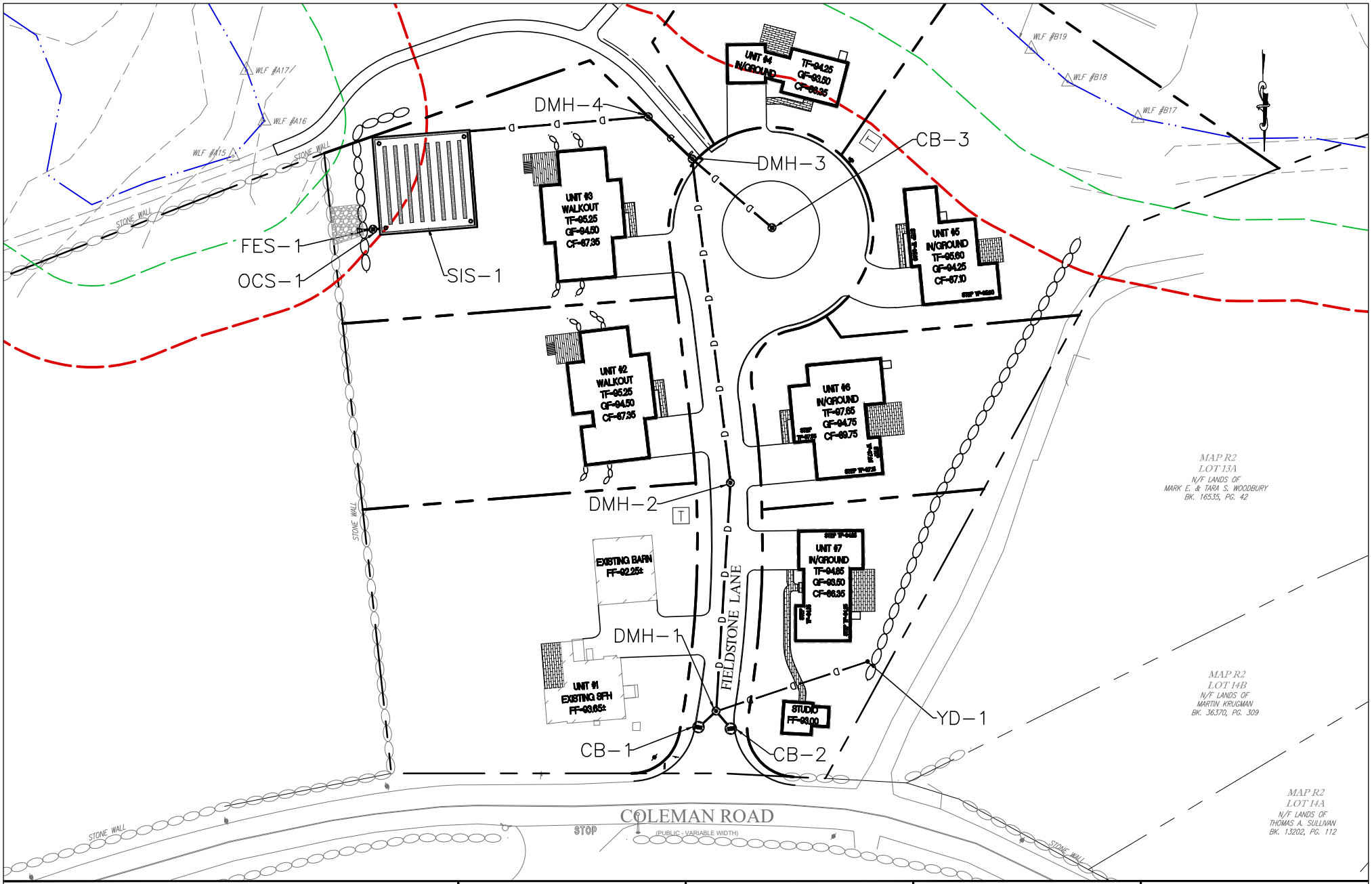
DATE: JANUARY 2021

Illicit discharges to the stormwater management system are discharges not entirely comprised of stormwater. There are no known illicit discharges currently at the site nor are any illicit discharges proposed as part of the project. The stormwater management system is *not* intended to convey any illicit discharges and or pollutants. Any unknown existing illicit discharges that are discovered as part of the development of the subject site shall be eliminated in accordance with local, state and federal regulations.

Signature

Thomas D. Zaborowiko, Manager
Name/Title

1/5/21
Date



80 0 40 80 160

GRAPHIC SCALE IN FEET

CLIENT:

ZENDKO, LLC
15 ESTES STREET
AMESBURY, MA 01913

SITE:

PROPOSED OPEN SPACE RESIDENTIAL DEVELOPMENT
COLEMAN ROAD
NEWBURY, MA

CIVIL DESIGN GROUP, LLC
21 HIGH STREET SUITE 207
NORTH ANDOVER, MA 01845
www.cdgengineering.com
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FIGURE 1:
BMP LOCATION PLAN

01/08/2021