Waterworks Park Stream Restoration

City of Annapolis – South River Watershed

Schematic Design Report

September 2025

Biohabitats

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1.0 Introduction

Biohabitats, Inc. has been contracted by the Arundel Rivers Federation (ARF) to restore an unnamed tributary to Broad Creek within the South River watershed in Annapolis, Maryland (see Figure 1). The stream originates at an outfall from a stormwater retention pond just north of Housley Road

Figure 1. Waterworks Park Stream Restoration project site location

The purpose of this Schematic Design report, which will be updated in subsequent design phases, is to identify and describe watershed and site resources, the cause and consequences of the impairments to both the watershed and the site stream reach(es) (see Harman and Starr 2011), and discuss the proposed site design strategy. This stream restoration project entails field surveys and desktop assessments, design through 90 percent, and permitting services. The primary design goals for this project are:

- stabilize the stream bed and banks;
- improve water quality;
- enhance wetland and upland plant communities, augmenting habitat for aquatic and terrestrial fauna;
- achieve floodplain reconnection; and
- provide a stable downstream confluence point with existing wetlands upstream of Broad Creek.

1.1 Project Site Description

The project site is located within Waterworks Park, which is owned by the City of Annapolis. The site originates at the outfall of a stormwater pond just southeast of the site across from Housley

Road, which appears to manage a high degree of runoff from impervious surfaces in the project vicinity.

The site includes approximately 1,400 linear feet (lf) of a first-order unnamed tributary (hereafter the UT) to Broad Creek, adjacent relict floodplain features in the downstream/northeastern portion of the site, jurisdictional wetlands, and high quality stands of mature upland forest flanking the UT Riparian vegetation along the stream channel's extents within the project site is of moderate quality, reflecting species adapted to more mesic soil conditions due to stream channel incision and presumptive groundwater table lowering near the UT.

Biohabitats has identified relatively few constraints to proposed stream restoration work. There are no apparent subsurface utilities including sewer lines along the UT's alignment within the site. All work will be confined within a narrow limits of work corridor to minimize impacts to forest resources, and upon revegetation, is expected to augment existing aquatic and terrestrial habitat niches within the site.

2.0 Watershed Description

The site is located within the West Chesapeake Bay HUC8 (HUC 02131003) and the West Chesapeake Bay HUC12 watershed (HUC 021310030993). The UT does not extend to tidal waters per Maryland Department of the Environment (MDE) 1972 tidal spatial dataset, and is outside of the Chesapeake Bay Critical Area (CA).

2.1 Geology and Soils

The site is located within the Chesapeake Rolling Hills Environmental Protection Agency (EPA) Level IV ecoregion within the Atlantic Coastal Plain. This ecoregion is characterized by highly dissected uplands with defined stream valleys ultimately draining to tidal waters. Natural Resources Conservation (NRCS) soil mapping identifies two primary soil mapping units within the site: WBA, which consists of the Widewater and Issue series mapping along relatively flat alluvial landscapes along the UT itself and AsF, consisting of the Annapolis series along relatively steep adjacent sideslopes. These soils are characteristic of the site vicinity within the greater region, and generally consist of coarser parent material sediments that facilitate groundwater infiltration, which is consist with project design goals.

2.2 Historic and Present Land Use

Biohabitats assumes that like most land within the site region, the site was historically forested and cleared for agricultural cultivation during the time of European settlement. Landforms adjacent to the UT within Waterworks Park suggest this condition, with multiple gullies created during unsustainable agricultural practices since stabilized by successional forest cover. Aerial photography of the site dating back to the mid-1980s suggests a forested condition has been established within the site at least since this timeframe.

Within its headwaters, the site watershed is predominated by intensive land development, including impervious surfaces including roads, buildings, and parking lots associated with the Parole Growth Area within the City of Annapolis. The downstream portion of the site watershed along proposed restoration extents is markedly different, consisting mainly of forested areas with lower and moderate density residential development along higher locations delimiting the watershed (Rolling Knolls to the north and apartments along Housley Road).

2.3 Hydrologic Assessment

A total of 2 points of interest (POI) were selected for this hydrologic analysis. Subwatershed drainage areas to each POI were mapped using topographical and stormwater network data. Two (2) separate subwatersheds were delineated to represent the waterworks and tributary drainage areas that intersect at the first points of interest along the stream channel. A third subwatershed was delineated to represent the remaining drainage area that discharges from the first point of interest to the second point of interest (i.e., downstream restoration limits). The total drainage area to the downstream extent of restoration is approximately 130 acres.

In accordance with TR55 methodology, a composite runoff curve number was computed for each subwatershed. Curve numbers were selected from the standard TR55 ground cover types based off of readily available GIS data for National Land Cover and Anne Arundel County zoning categories, and aerial imagery. Hydrologic soil group ratings were selected from readily available GIS data via Anne Arundel County. If an area had a missing hydrologic soil group, the nearest hydrologic soil group rating was used. Time of concentration (TC) paths were identified using Anne Arundel County GIS contour data and consisted of sheet flow, shallow concentrated flow, and channel flow. Watershed delineations, curve number analysis, and TC mapping were performed in ARCGIS PRO 3.0.3.

Hydrologic modeling was performed in HydroCAD Version 10.00. For this analysis, the SCS TR-20 runoff method was selected. A NOAA Type C rainfall distribution was selected and rainfall totals were pulled from NOAA Atlas 14, Volume 2, Version 3 for the project area.

Model input data is compiled in Table 1 and results are presented in Table 2 below. Hydrologic modeling exhibit maps and the HydroCAD output reports can be found Appendix A.

Table 1. NRCS model input data.

Subwatershed ID	Subwatershed Name	Subwatershed Drainage Area (acres)	Time of Concentration (min)	Curve Number
1S	Downstream	33.1	36.7	71
2S	Trib	43.8	24.0	75
3S	Waterworks	58.8	16.5	90

Table 2. Peak discharge rates (cfs) for the NRCS model at the downstream limit of each subwatershed.

Subwatershed ID	Subwatershed Name	1-Year	2-Year	10-Year	100-Year
1S	Downstream	9.78	16.39	41.98	103.94
2S	Trib	22.98	35.58	81.51	186.77
3S	Waterworks	89.80	116.02	199.71	369.08

To calculate the stream flow rates along the restoration reach, two reaches were input into the HydroCAD model to connect each subwatershed. The waterworks (3S) and tributary (2S) subwatershed were connected via a reach (Reach 1). This reach captured 520 linear feet of the restoration reach before connecting with the second reach (Reach 2), which captures the remaining length (i.e., 956 linear feet) of the restoration reach. The downstream (1S) subwatershed was connected to the second reach to ensure all subwatershed areas were included to calculate the restoration reach's flow rates. Table 3 represents the stream flow rates within each reach capturing the entire restoration reach length.

Table 2. Stream flow rates (cfs) for the NRCS model for the restoration reach.

Subwatershed IDs	Subwatershed Names	Reach ID	1-Year	2-Year	10-Year	100-Year
2S & 3S	Trib & Waterworks	Reach 1	105.95	142.82	265.38	525.81
1S	Downstream	Reach 2	107.00	147.31	285.66	587.46

3.0 Site Conditions Assessment

3.1 Site Assessment Summary

Detailed desktop and on-site assessments for the project area were performed to identify distinct sub-reaches, characterize site vegetation, delineate wetlands, document existing channel and floodplain conditions, document causes and extent of instabilities, and qualitatively assess the potential to provide ecological uplift. This included the collection of site photos, the identification of stream channel geomorphic conditions, and assessments of predominate geomorphic phenomena affecting the UT and its riparian adjacency's stability.

3.2 Wetland Delineation

A wetland delineation was performed as part of sites conditions assessments. The Wetland Delineation Memo provided in Appendix B summarizes wetland features on-site. Please note that per project stakeholder input (Anne Arundel County, City of Annapolis), some additional downstream areas will require further delineation to encompass all work within project limits. Biohabitats will coordinate with ARF to complete this work prior to the completion of the subsequent Design Development phase.

3.3 Tree Inventory

To minimize impacts to existing forest resources and comply with local Forest Conservation regulations and permitting, a tree survey was also performed as a component of the site conditions assessments. All trees greater than 12" in diameter at breast height (DBH, or 4.5' from the ground) within the proposed project limits were identified to species and evaluated for their general condition (Good, Fair, Poor).

Tree inventory data, including surveyed tree locations, will be among the bases of Natural Resources Inventory/Forest Stand Delineation (NRI/FSD) materials to be provided in the subsequent Design Development phase. NRI/FSD sheets will be included in the project's Design Development plan set to facilitate local permitting approvals.

3.4 Stream Geomorphology and Bank Stability Analysis and Erosion Estimates

Preliminary geomorphic assessments were performed to verify instability along the UT within the site limits. Site observations along the UT as verified with topographic survey data indicated that the UT is a highly incised system disconnected from its floodprone areas along adjacent land surfaces. This phenomenon results in higher energy, erosive stormflows confined within the existing channel banks, exacerbating bank erosion and associated nutrient exports downstream.

Bank stability analyses including Bank Assessment for Non-point Source Consequence of Sediment (BANCS) model results will be summarized during the subsequent Design Development phase to document anticipated TMDL reductions based on soil sample data.

4.0 Schematic Design

4.1 Restoration Approach and Channel Sizing

Biohabitats' proposed restoration strategy consists of two primary sub-reaches along the UT within the site: a step-pool stormwater conveyance (SPSC) situated mainly within the existing UT alignment from approximate sta. 0+00 to 4+75, and a valley-wide RSC in downstream portions of the site that will tie into existing wetland systems downstream of the project area from sta. 4+75 to 15+00.

The SPSC has been designed to stabilize the upstream channel bed and banks, reducing the sediment and nutrient loading to downstream waterways generated from channel enlargement, while also improving water quality through the filtering of the stormwater delivered to the outfall. An SPSC system uses a series of in-stream constructed riffles to form a series of aquatic pools to help maintain the channel bed at a higher elevation, while providing energy dissipation and large storm conveyance from the outfall to the downstream confluence point. These rock structures are built upon a sand/woodchip filter bed mix, installed as the underlying fill material within the existing enlarged outfall channel.

The valley-wide RSC restoration approach has been designed to reconnect the stream with its adjacent floodplain terrace and enhance wetland and upland habitats, supporting existing faunal populations and enhancing habitat extents and biodiversity. Valley-wide rock grade control structures, wood roughness elements, and supplemental native plantings have been incorporated into the design to achieve these goals, intended to enhance and restore lotic and terrestrial ecosystem functions. The limits of disturbance (LOD) for the work have been minimized to focus along the UT alignment in order to minimize impacts to forested land and other natural resources assets.

It is important to note that during project scoping, Biohabitats indicated that the Maryland Department of Natural Resources (DNR) had identified Wetlands of Special State Concern (WSSC) within site limits along the UT based on available online resources. While the proposed design will impact some wetland areas, impacts have been minimized to the extent feasible, and Biohabitats believes that proposed restoration activities will ultimately result in enhanced wetland habitat for sensitive species within these areas.

Proposed restoration activities are summarized below; see Appendix C for channel sizing computations and Appendix D for Schematic Design drawings.

From the stormwater pond outfall structure at Housley Road to sta. 4+75:

- Install in-stream SPSC with cobble riffle structures and shallow aquatic pools
- Install native forested wetland, coastal plain headwater forest, and upland successional oak-American beech plantings within uplands flanking the UT's riparian corridor

From sta. 4+75 to Sta 15+00:

- Install valley-wide RSC with stone sill features spanning the floodplain to enable restoration and creation of wetland areas.
- Provide hand-installed wattle structures at the downstream extent of restoration to achieve a stable tie-out condition with downstream wetland areas
- Provide native plantings consisting of hydrophytic species within existing and proposed wetland areas while vegetating adjacent upland forested areas with successional oak-American beech plantings

4.2 Plant Community Restoration

With proposed changes to site grades and hydrology, Biohabitats anticipates unique opportunities to restore native plant communities within the project LOD in a way that harmonizes with existing park forest resources. Plant community design will also take into consideration habitat needs specific to WSSC areas.

Biohabitats envisions three main plant communities within the site:

- A mixed oak/beech coastal plain hardwood forest within uplands flanking the UT and its riparian fringe, which relate to the existing species composition within park uplands;
- A coastal plain headwater forest consisting of shade tolerant canopy and understory trees as well as riparian fringe plantings along the edge of the UT; and
- A scrub-shrub wetland with dense perennial herbaceous vegetation within portions of and primarily at the downstream portion of the valley-wide SPSC to augment existing wetland vegetation.

While non-native invasive (NNI) is not prevalent within the site, Biohabitats will identify any NNI management recommendations in the updated version of this report to support the Design Development phase.

4.3 Existing and Proposed Hydraulics

Existing and proposed hydraulic modeling will be performed during the subsequent Design Development phase to evaluate design stability and any potential rises in 100-year water surface elevations. It is important to note that the entirety of the UT within the site is mapped by the Federal Emergency Management Agency (FEMA) as Zone A. Proposed grading extents and elevations will be refined to minimize any potential rises that would require FEMA coordination.

5.0 Summary

The Waterworks Park Stream Restoration project will stabilize, restore and enhance an existing unnamed tributary to Broad Creek within Waterworks Park, ultimately arresting a source of pollutants within the Chesapeake Bay watershed. The project is located on park property owned by the City of Annapolis. Proposed restoration activities continue to be discussed with ARF and the project stakeholder group.

The primary design goals for this project are to stabilize the stream bed and banks, improve water quality, enhance native plant communities including supporting sensitive WSSC areas, and achieve floodplain reconnection by way of in-stream and valley-wide SPSC design. The restoration approach has been designed to reconnect the stream with the floodplain and enhance wetland and upland habitats. In-stream wood and rock structures and supplemental native plantings have been incorporated into the design to achieve these goals.

6.0 References

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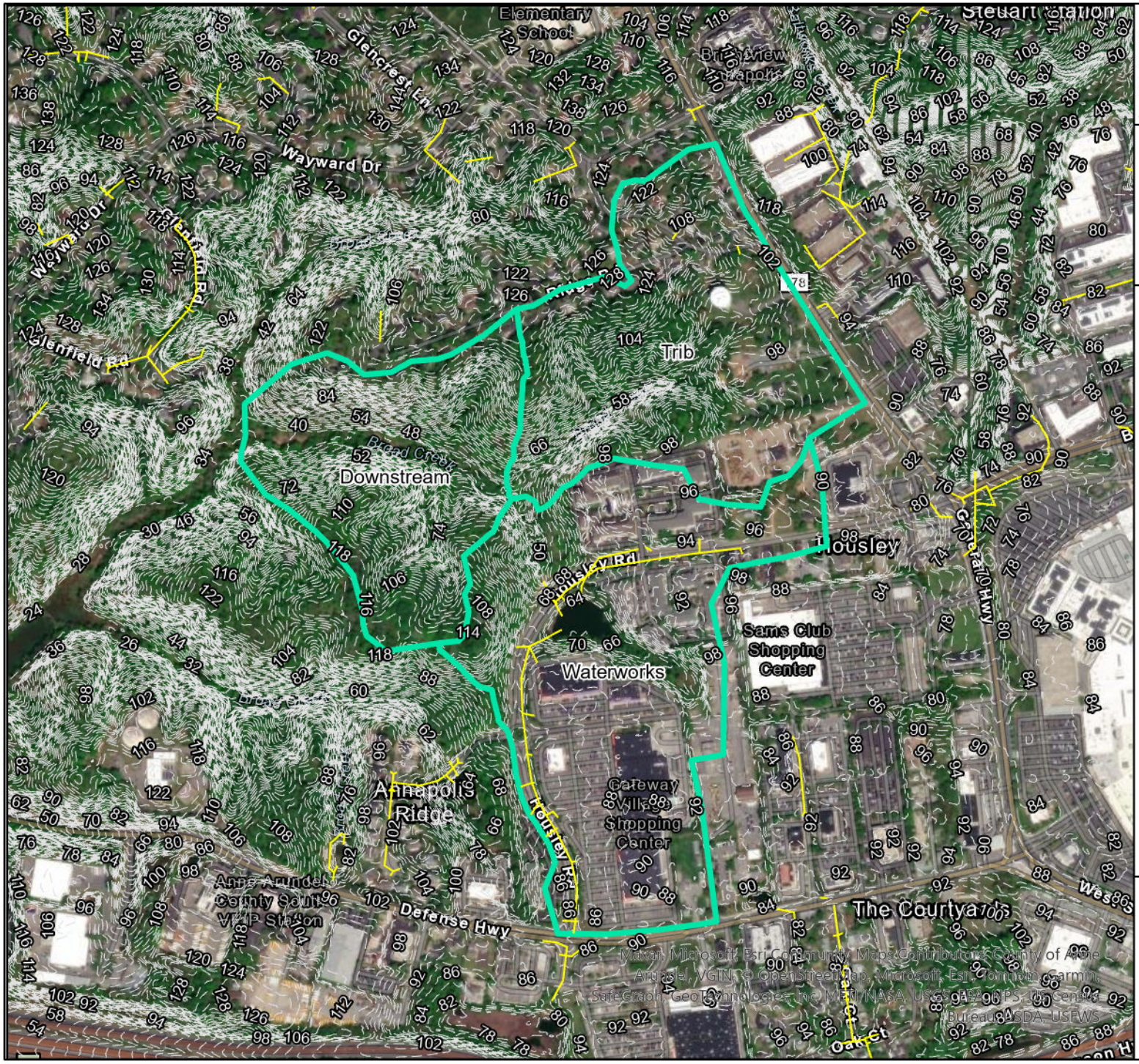
Appendices

Appendix A: Hydrology



Annapolis Waterworks Stream Restoration

2607 Housley RD
Annapolis, MD 21401

DRAINAGE AREA MAP

Legend

- Storm Drain Pipes
- Drainage Area Boundary
- Contour_1ft

N

500 250 0 500
Feet

Biohabitats

December, 2024

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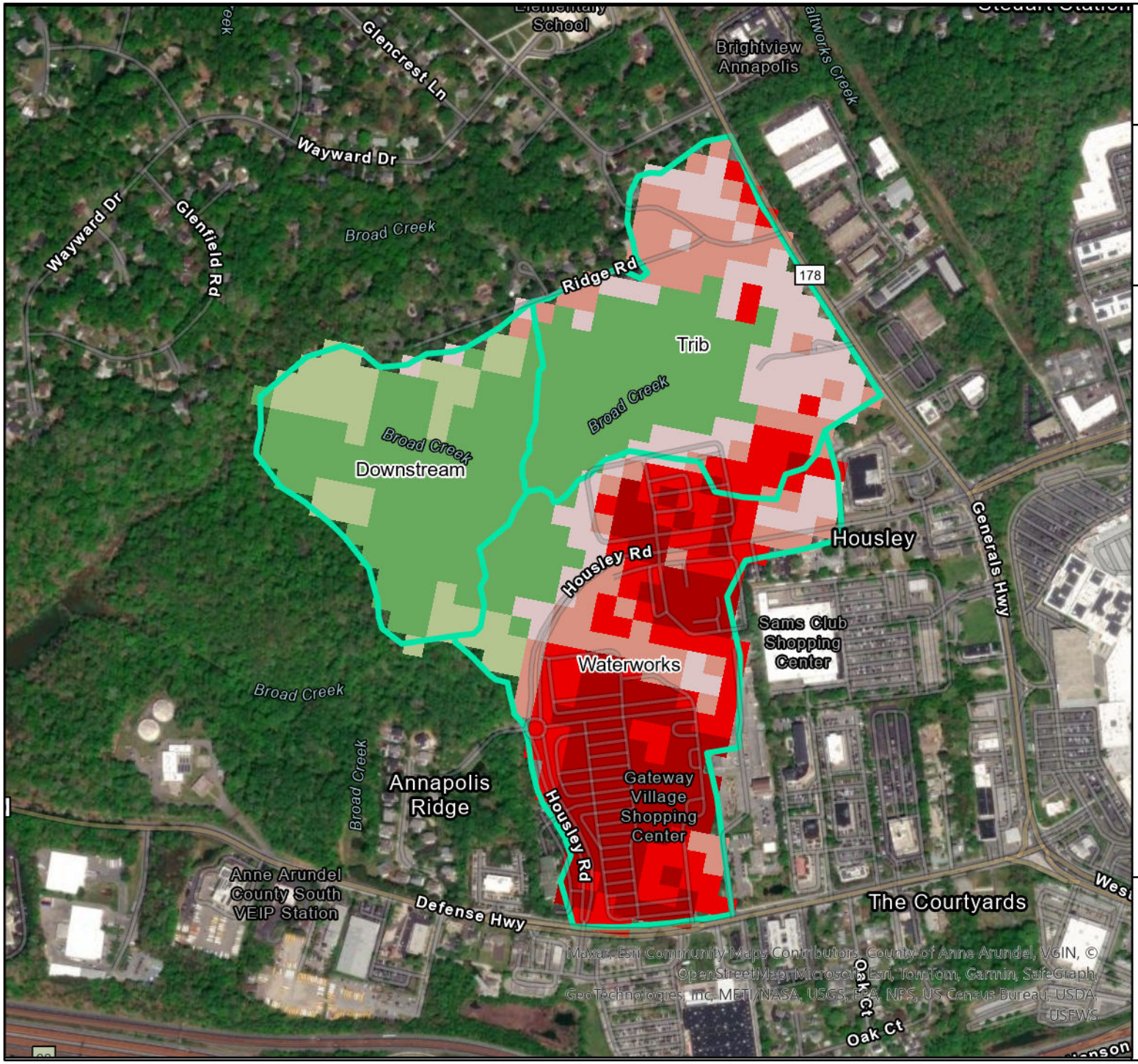

Annapolis Waterworks Stream Restoration

2607 Housley RD
Annapolis, MD 21401

LAND USE MAP

Legend

- Drainage Area Boundary

NLCD_Land_Cover_Class

- Developed, Open Space
- Developed, Low Intensity
- Developed, Medium Intensity
- Developed, High Intensity
- Deciduous Forest
- Mixed Forest

N

500 250 0 500
Feet

Biohabitats

December, 2024

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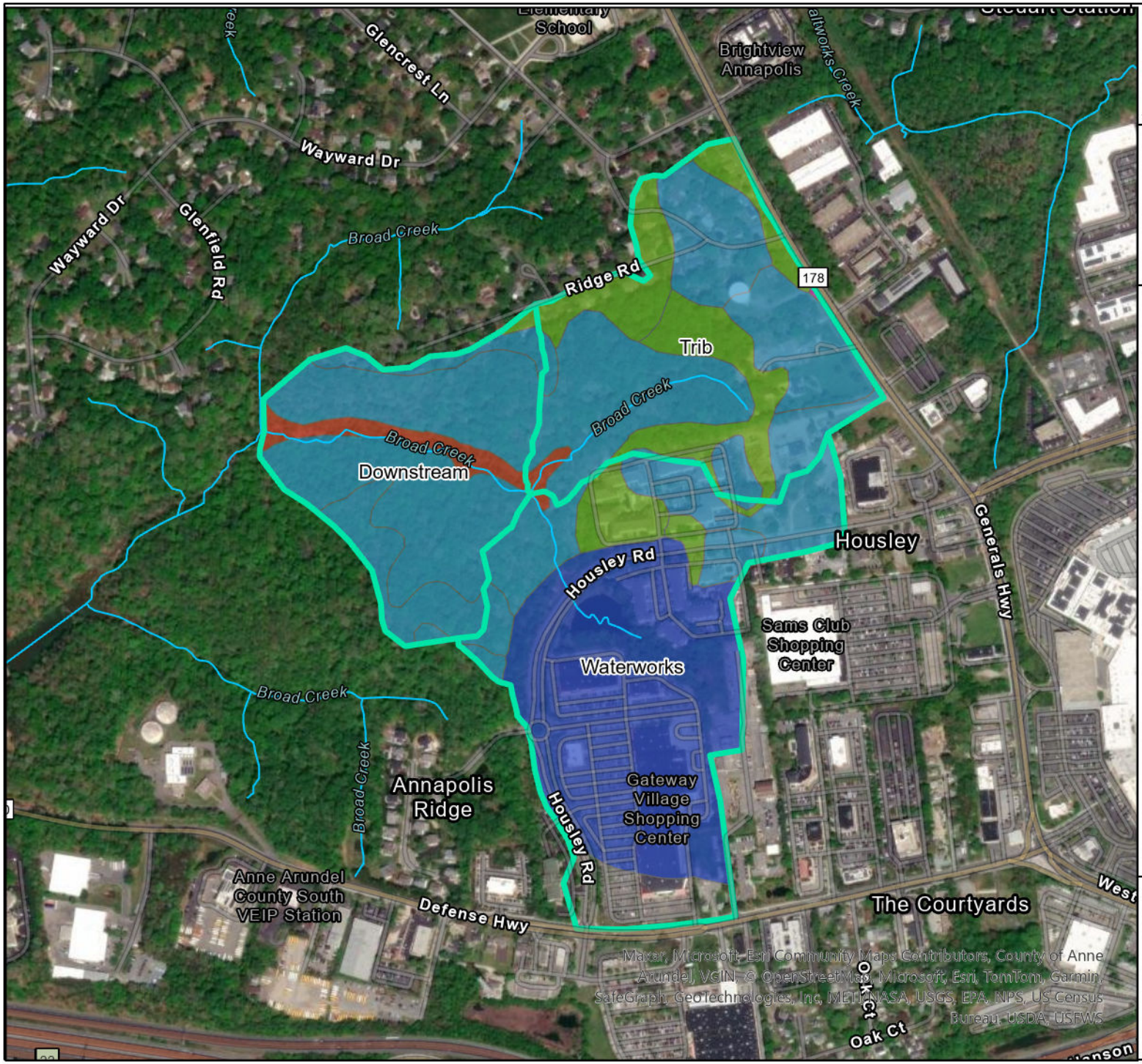

Annapolis Waterworks Stream Restoration

2607 Housley RD
Annapolis, MD 21401

SOILS MAP

Legend

- Drainage Area Boundary
- Streams

Hydrologic Group - Dominant Condition

- A
- B
- C
- C/D
- D

N

500 250 0 500
Feet

Biohabitats

December, 2024

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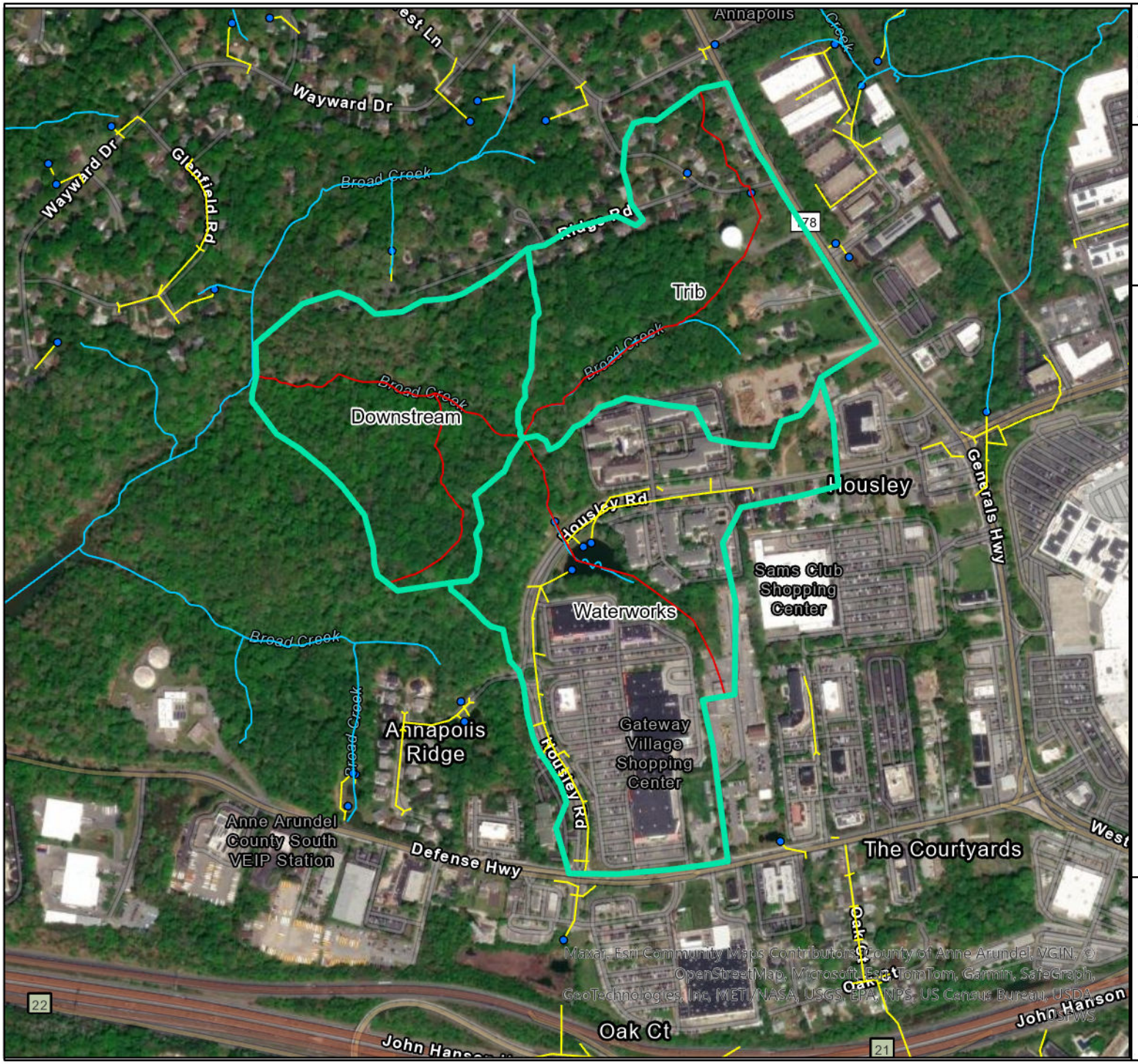

Annapolis Waterworks Stream Restoration

2607 Housley RD

Annapolis, MD 21401

TC PATH MAP

Legend

- Drainage Area Boundary
- Time of Concentration (TC)
- Streams
- Storm Drain Outfalls
- Storm Drain Pipes

N

500 250 0 500

Feet

Biohabitats

December, 2024

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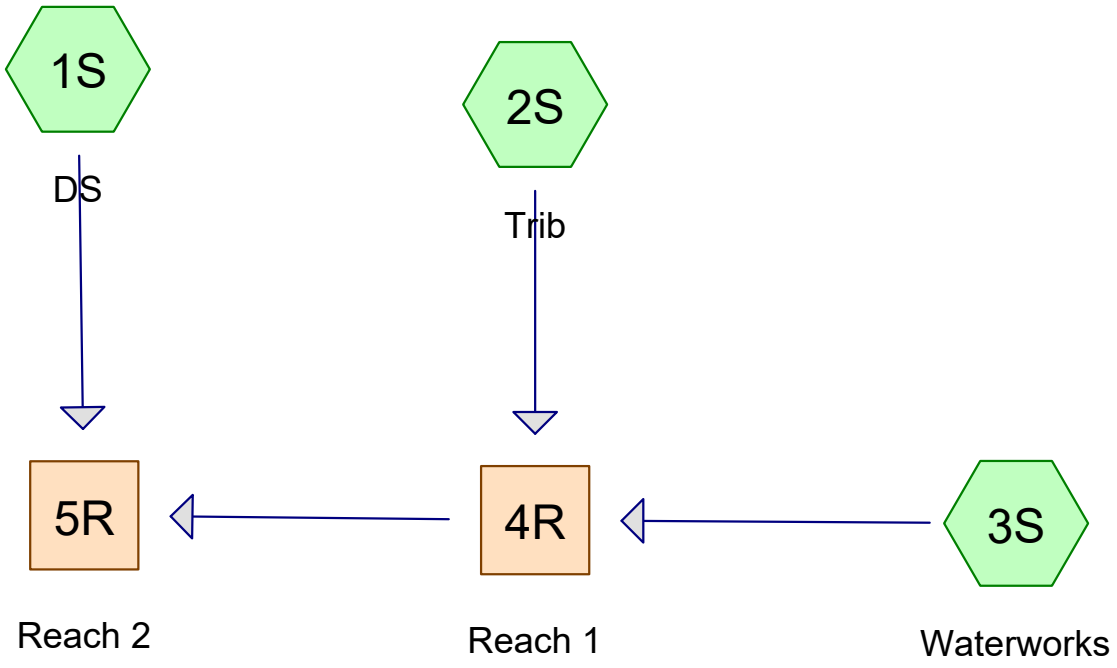


Subcat Reach Pond Link

Routing Diagram for Annapolis Waterworks
Prepared by Biohabitats, Inc., Printed 8/29/2025

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
6.676	75	1/4 acre lots, 38% imp, HSG B (1S, 2S)
7.354	83	1/4 acre lots, 38% imp, HSG C (1S, 2S, 3S)
6.253	87	1/4 acre lots, 38% imp, HSG D (3S)
0.747	85	1/8 acre lots, 65% imp, HSG B (2S)
0.058	49	50-75% Grass cover, Fair, HSG A (2S)
9.848	79	50-75% Grass cover, Fair, HSG C (2S, 3S)
2.427	84	50-75% Grass cover, Fair, HSG D (3S)
0.114	98	Paved parking, HSG B (3S)
0.075	98	Paved parking, HSG C (2S)
0.429	98	Roofs, HSG B (3S)
3.698	92	Urban commercial, 85% imp, HSG B (3S)
11.982	94	Urban commercial, 85% imp, HSG C (2S, 3S)
25.615	95	Urban commercial, 85% imp, HSG D (3S)
6.716	60	Woods, Fair, HSG B (2S)
19.307	73	Woods, Fair, HSG C (2S, 3S)
1.800	79	Woods, Fair, HSG D (2S, 3S)
29.644	70	Woods, Good, HSG C (1S)
2.995	77	Woods, Good, HSG D (1S)
135.738	**80**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.058	HSG A	2S
18.380	HSG B	1S, 2S, 3S
78.210	HSG C	1S, 2S, 3S
39.090	HSG D	1S, 2S, 3S
0.000	Other	
135.738		**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	6.676	7.354	6.253	0.000	20.283	1/4 acre lots, 38% imp	1S, 2S, 3S
0.000	0.747	0.000	0.000	0.000	0.747	1/8 acre lots, 65% imp	2S
0.058	0.000	9.848	2.427	0.000	12.333	50-75% Grass cover, Fair	2S, 3S
0.000	0.114	0.075	0.000	0.000	0.189	Paved parking	2S, 3S
0.000	0.429	0.000	0.000	0.000	0.429	Roofs	3S
0.000	3.698	11.982	25.615	0.000	41.295	Urban commercial, 85% imp	2S, 3S
0.000	6.716	19.307	1.800	0.000	27.823	Woods, Fair	2S, 3S
0.000	0.000	29.644	2.995	0.000	32.639	Woods, Good	1S
0.058	**18.380**	**78.210**	**39.090**	**0.000**	**135.738**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	2S	0.00	0.00	36.0	0.0070	0.025	18.0	0.0	0.0
2	3S	0.00	0.00	188.0	0.0600	0.025	60.0	0.0	0.0

Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: DS Runoff Area=33.100 ac 0.53% Impervious Runoff Depth>0.49"
Flow Length=1,226' Tc=36.7 min CN=71 Runoff=9.78 cfs 1.354 af

Subcatchment2S: Trib Runoff Area=43.807 ac 14.40% Impervious Runoff Depth>0.65"
Flow Length=2,471' Tc=24.0 min CN=75 Runoff=22.98 cfs 2.390 af

Subcatchment3S: Waterworks Runoff Area=58.831 ac 63.62% Impervious Runoff Depth>1.54"
Flow Length=1,755' Tc=16.5 min CN=90 Runoff=89.80 cfs 7.556 af

Reach 4R: Reach 1 Avg. Flow Depth=1.07' Max Vel=4.32 fps Inflow=108.57 cfs 9.946 af
n=0.035 L=520.0' S=0.0115 '/' Capacity=95.87 cfs Outflow=105.95 cfs 9.907 af

Reach 5R: Reach 2 Avg. Flow Depth=1.16' Max Vel=3.95 fps Inflow=111.74 cfs 11.261 af
n=0.035 L=956.0' S=0.0089 '/' Capacity=84.15 cfs Outflow=107.00 cfs 11.169 af

Total Runoff Area = 135.738 ac Runoff Volume = 11.300 af Average Runoff Depth = 1.00"
67.65% Pervious = 91.826 ac 32.35% Impervious = 43.912 ac

Summary for Subcatchment 1S: DS

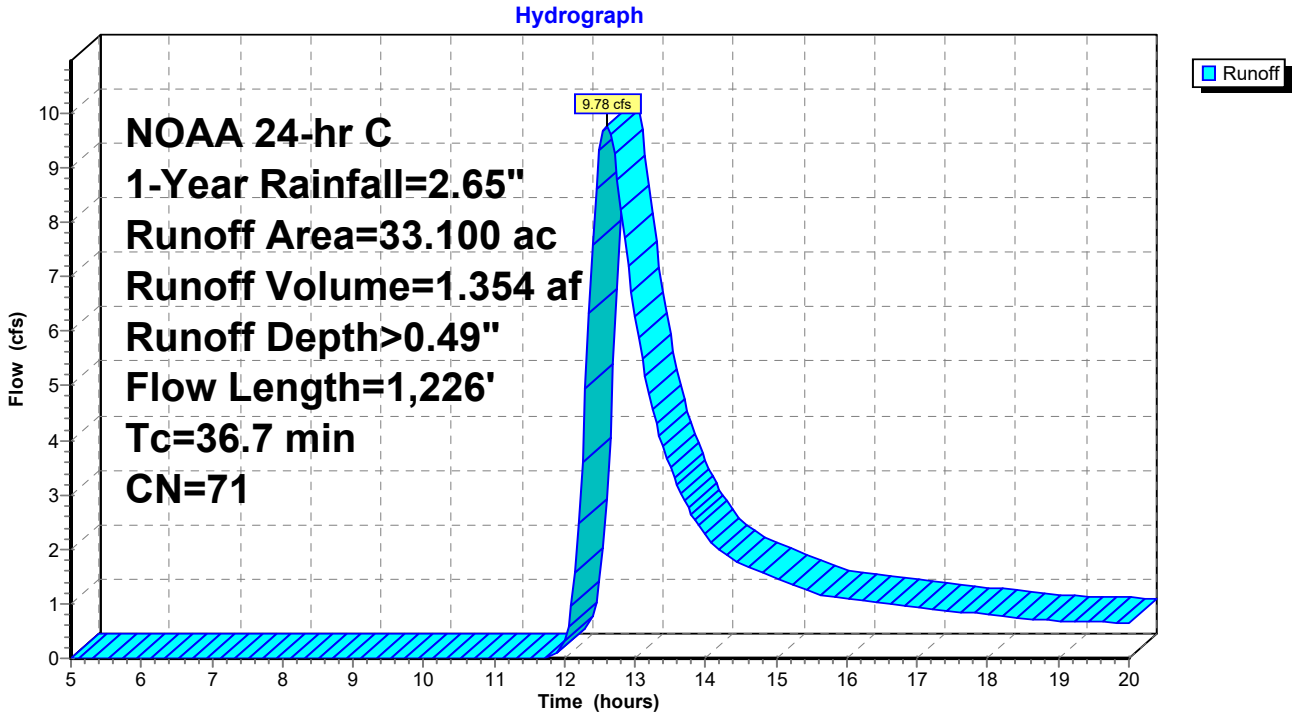
Runoff = 9.78 cfs @ 12.59 hrs, Volume= 1.354 af, Depth> 0.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NOAA 24-hr C 1-Year Rainfall=2.65"

Area (ac)	CN	Description
0.029	75	1/4 acre lots, 38% imp, HSG B
0.166	75	1/4 acre lots, 38% imp, HSG B
0.072	75	1/4 acre lots, 38% imp, HSG B
0.017	75	1/4 acre lots, 38% imp, HSG B
21.651	70	Woods, Good, HSG C
0.057	83	1/4 acre lots, 38% imp, HSG C
0.120	83	1/4 acre lots, 38% imp, HSG C
7.993	70	Woods, Good, HSG C
2.607	77	Woods, Good, HSG D
0.388	77	Woods, Good, HSG D
33.100	71	Weighted Average
32.925		99.47% Pervious Area
0.175		0.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.3	100	0.0100	0.06		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 3.20"
7.3	635	0.0850	1.46		**Shallow Concentrated Flow, Shallow Concentrated Flow** Woodland Kv= 5.0 fps
1.1	491	0.0650	7.46	61.56	**Trap/Vee/Rect Channel Flow, Channel Flow** Bot.W=15.00' D=0.50' Z= 3.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
36.7	1,226	Total			

Subcatchment 1S: DS



Summary for Subcatchment 2S: Trib

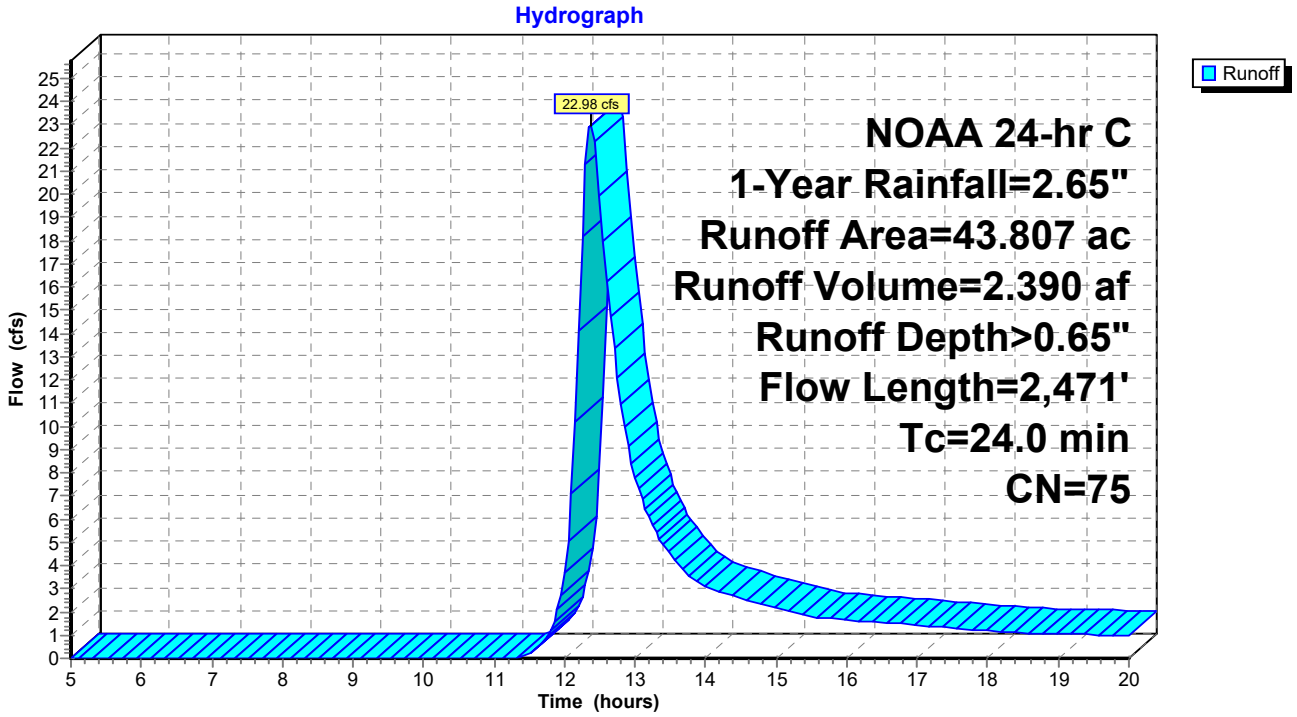
Runoff = 22.98 cfs @ 12.38 hrs, Volume= 2.390 af, Depth> 0.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NOAA 24-hr C 1-Year Rainfall=2.65"

Area (ac)	CN	Description
0.041	49	50-75% Grass cover, Fair, HSG A
0.017	49	50-75% Grass cover, Fair, HSG A
6.716	60	Woods, Fair, HSG B
4.199	75	1/4 acre lots, 38% imp, HSG B
0.747	85	1/8 acre lots, 65% imp, HSG B
2.193	75	1/4 acre lots, 38% imp, HSG B
14.096	73	Woods, Fair, HSG C
0.075	98	Paved parking, HSG C
5.144	83	1/4 acre lots, 38% imp, HSG C
1.606	94	Urban commercial, 85% imp, HSG C
8.431	79	50-75% Grass cover, Fair, HSG C
0.542	79	Woods, Fair, HSG D
43.807	75	Weighted Average
37.498		85.60% Pervious Area
6.309		14.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	100	0.0400	0.22		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.20"
2.3	487	0.0500	3.60		**Shallow Concentrated Flow, Shallow Concentrated Flow** Unpaved Kv= 16.1 fps
0.2	36	0.0070	2.59	4.57	**Pipe Channel, CMP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.025 Earth, clean & winding
1.9	260	0.0200	2.28		**Shallow Concentrated Flow, SC2** Unpaved Kv= 16.1 fps
0.3	47	0.0200	2.87		**Shallow Concentrated Flow, SC3** Paved Kv= 20.3 fps
0.7	101	0.0200	2.28		**Shallow Concentrated Flow, SC4** Unpaved Kv= 16.1 fps
5.4	425	0.0700	1.32		**Shallow Concentrated Flow, SC5** Woodland Kv= 5.0 fps
5.8	1,015	0.0120	2.94	9.54	**Trap/Vee/Rect Channel Flow, Stream** Bot.W=5.00' D=0.50' Z= 3.0 '/' Top.W=8.00' n= 0.030 Earth, grassed & winding
24.0	2,471	Total			

Subcatchment 2S: Trib



Summary for Subcatchment 3S: Waterworks

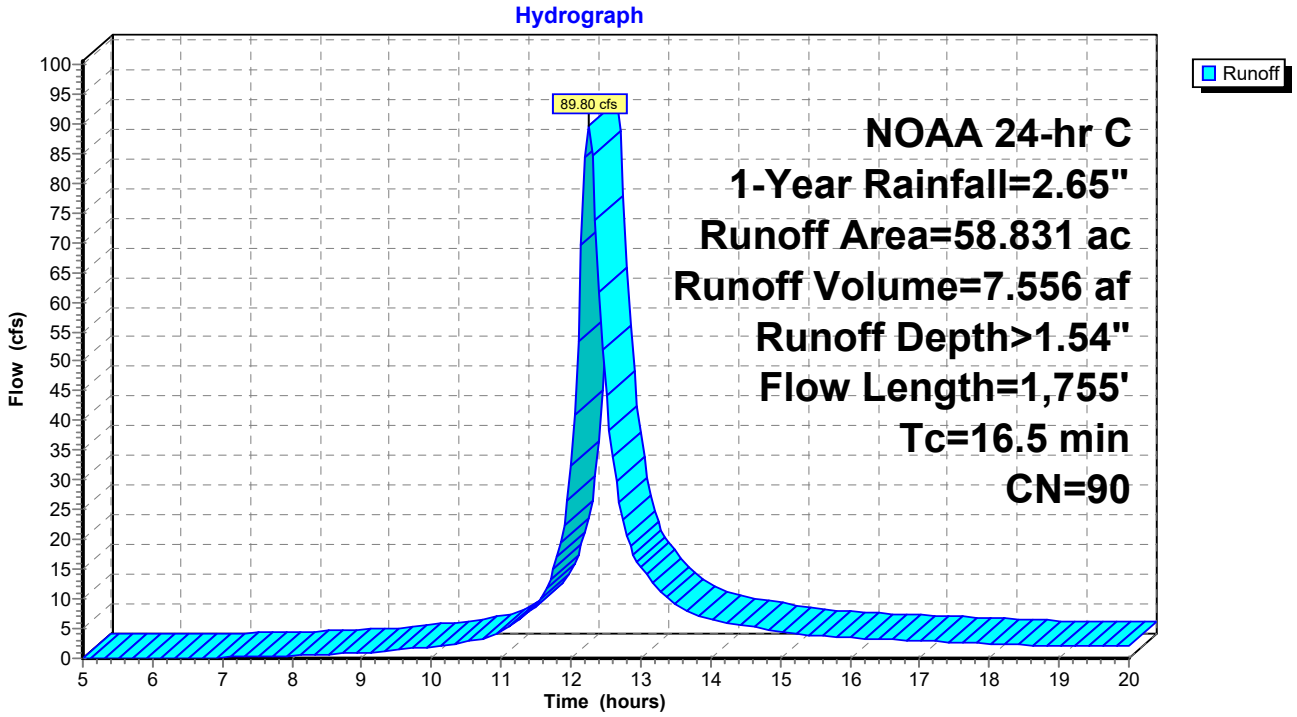
Runoff = 89.80 cfs @ 12.25 hrs, Volume= 7.556 af, Depth> 1.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NOAA 24-hr C 1-Year Rainfall=2.65"

Area (ac)	CN	Description
2.547	92	Urban commercial, 85% imp, HSG B
0.429	98	Roofs, HSG B
0.114	98	Paved parking, HSG B
1.151	92	Urban commercial, 85% imp, HSG B
4.165	73	Woods, Fair, HSG C
1.220	94	Urban commercial, 85% imp, HSG C
0.879	94	Urban commercial, 85% imp, HSG C
2.033	83	1/4 acre lots, 38% imp, HSG C
2.857	94	Urban commercial, 85% imp, HSG C
1.417	79	50-75% Grass cover, Fair, HSG C
1.046	73	Woods, Fair, HSG C
0.131	79	Woods, Fair, HSG D
0.848	79	Woods, Fair, HSG D
17.688	95	Urban commercial, 85% imp, HSG D
6.253	87	1/4 acre lots, 38% imp, HSG D
7.927	95	Urban commercial, 85% imp, HSG D
2.427	84	50-75% Grass cover, Fair, HSG D
0.279	79	Woods, Fair, HSG D
5.420	94	Urban commercial, 85% imp, HSG C
58.831	90	Weighted Average
21.404		36.38% Pervious Area
37.427		63.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	100	0.0100	1.04		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.20"
0.4	90	0.0400	4.06		**Shallow Concentrated Flow, Shallow Concentrated Flow** Paved Kv= 20.3 fps
0.4	93	0.0540	3.74		**Shallow Concentrated Flow, Shallow 2** Unpaved Kv= 16.1 fps
10.5	546	0.0300	0.87		**Shallow Concentrated Flow, Shallow3** Woodland Kv= 5.0 fps
0.5	281		9.83		**Lake or Reservoir, Pond** Mean Depth= 3.00'
0.2	188	0.0600	16.90	331.73	**Pipe Channel, RCP_Round 60"** 60.0" Round Area= 19.6 sf Perim= 15.7' r= 1.25' n= 0.025 Earth, clean & winding
2.9	457	0.0100	2.62	7.20	**Trap/Vee/Rect Channel Flow, Stream** Bot.W=4.00' D=0.50' Z= 3.0 '/' Top.W=7.00' n= 0.030 Earth, grassed & winding
16.5	1,755	Total			

Subcatchment 3S: Waterworks



Summary for Reach 4R: Reach 1

[91] Warning: Storage range exceeded by 0.07'
[55] Hint: Peak inflow is 113% of Manning's capacity

Inflow Area = 102.638 ac, 42.61% Impervious, Inflow Depth > 1.16" for 1-Year event
Inflow = 108.57 cfs @ 12.27 hrs, Volume= 9.946 af
Outflow = 105.95 cfs @ 12.33 hrs, Volume= 9.907 af, Atten= 2%, Lag= 3.6 min

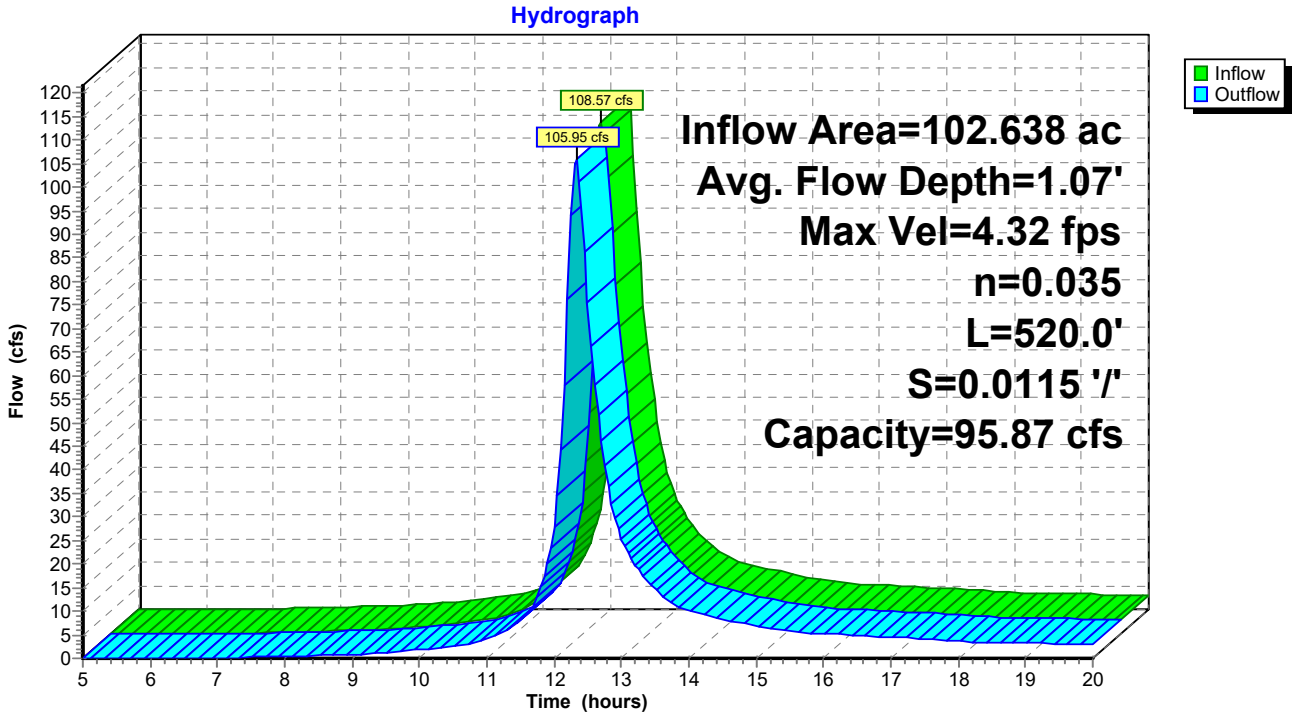
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.32 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 1.37 fps, Avg. Travel Time= 6.3 min

Peak Storage= 12,889 cf @ 12.29 hrs
Average Depth at Peak Storage= 1.07'
Bank-Full Depth= 1.00' Flow Area= 23.0 sf, Capacity= 95.87 cfs

20.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 26.00'
Length= 520.0' Slope= 0.0115 '/'
Inlet Invert= 43.50', Outlet Invert= 37.50'

‡

Reach 4R: Reach 1



Summary for Reach 5R: Reach 2

[91] Warning: Storage range exceeded by 0.16'
[55] Hint: Peak inflow is 133% of Manning's capacity
[62] Hint: Exceeded Reach 4R OUTLET depth by 0.24' @ 12.50 hrs

Inflow Area = 135.738 ac, 32.35% Impervious, Inflow Depth > 1.00" for 1-Year event
Inflow = 111.74 cfs @ 12.33 hrs, Volume= 11.261 af
Outflow = 107.00 cfs @ 12.46 hrs, Volume= 11.169 af, Atten= 4%, Lag= 7.2 min

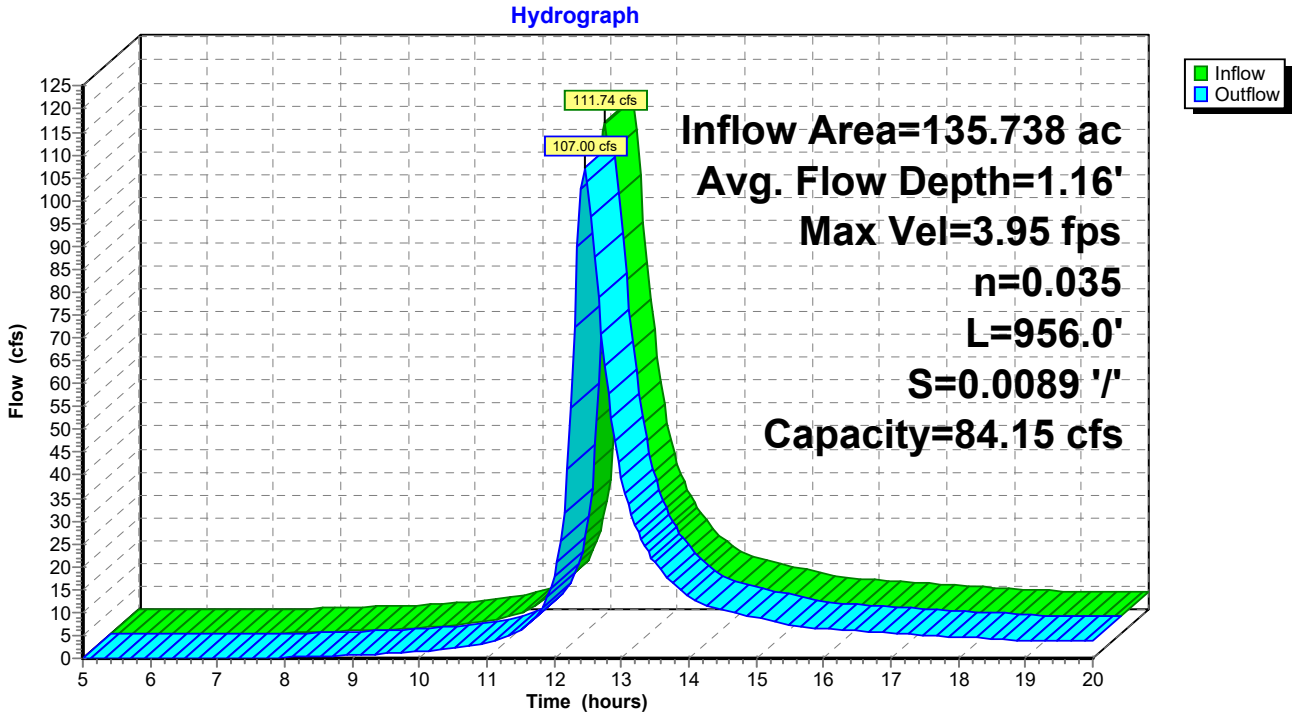
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.95 fps, Min. Travel Time= 4.0 min
Avg. Velocity = 1.31 fps, Avg. Travel Time= 12.1 min

Peak Storage= 26,039 cf @ 12.39 hrs
Average Depth at Peak Storage= 1.16'
Bank-Full Depth= 1.00' Flow Area= 23.0 sf, Capacity= 84.15 cfs

20.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 26.00'
Length= 956.0' Slope= 0.0089 '/'
Inlet Invert= 37.50', Outlet Invert= 29.00'

‡

Reach 5R: Reach 2



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: DS Runoff Area=33.100 ac 0.53% Impervious Runoff Depth>0.77"
Flow Length=1,226' Tc=36.7 min CN=71 Runoff=16.39 cfs 2.126 af

Subcatchment2S: Trib Runoff Area=43.807 ac 14.40% Impervious Runoff Depth>0.98"
Flow Length=2,471' Tc=24.0 min CN=75 Runoff=35.58 cfs 3.573 af

Subcatchment3S: Waterworks Runoff Area=58.831 ac 63.62% Impervious Runoff Depth>2.01"
Flow Length=1,755' Tc=16.5 min CN=90 Runoff=116.02 cfs 9.875 af

Reach 4R: Reach 1 Avg. Flow Depth=1.29' Max Vel=4.71 fps Inflow=146.00 cfs 13.449 af
n=0.035 L=520.0' S=0.0115 '/' Capacity=95.87 cfs Outflow=142.82 cfs 13.402 af

Reach 5R: Reach 2 Avg. Flow Depth=1.44' Max Vel=4.29 fps Inflow=153.24 cfs 15.529 af
n=0.035 L=956.0' S=0.0089 '/' Capacity=84.15 cfs Outflow=147.31 cfs 15.421 af

Total Runoff Area = 135.738 ac Runoff Volume = 15.575 af Average Runoff Depth = 1.38"
67.65% Pervious = 91.826 ac 32.35% Impervious = 43.912 ac

Summary for Subcatchment 1S: DS

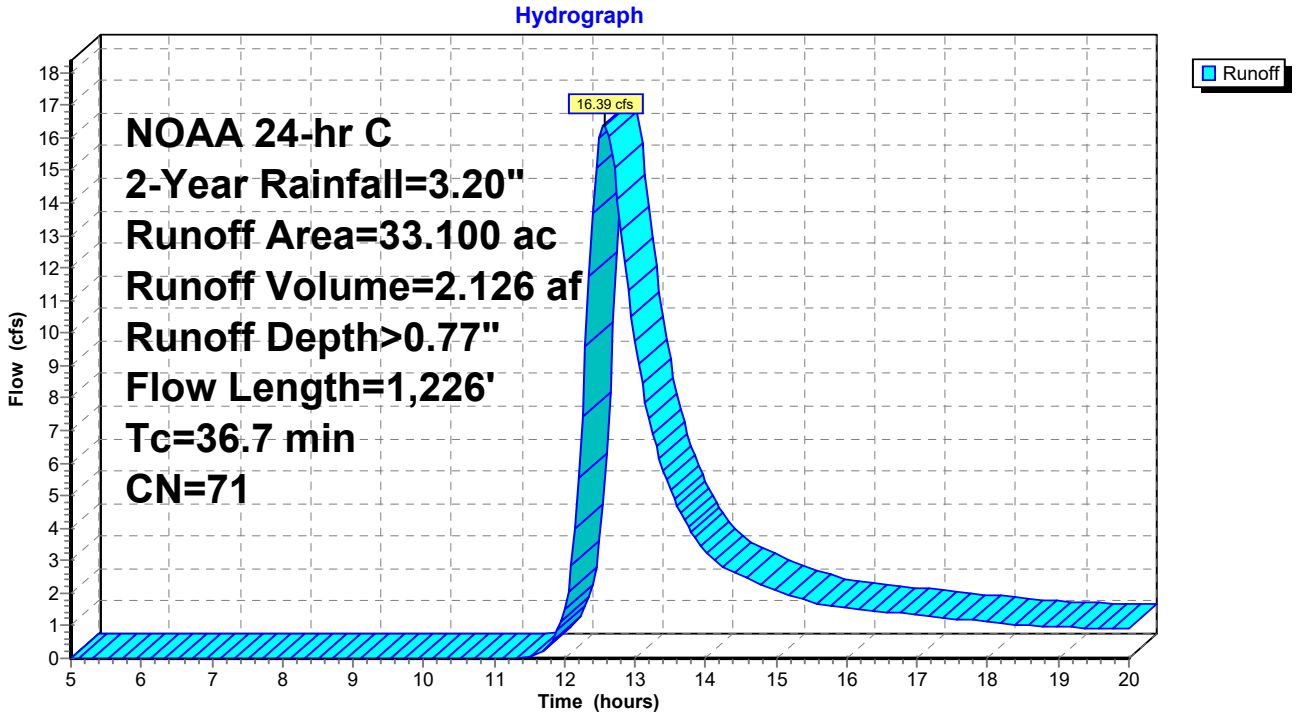
Runoff = 16.39 cfs @ 12.57 hrs, Volume= 2.126 af, Depth> 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NOAA 24-hr C 2-Year Rainfall=3.20"

Area (ac)	CN	Description
0.029	75	1/4 acre lots, 38% imp, HSG B
0.166	75	1/4 acre lots, 38% imp, HSG B
0.072	75	1/4 acre lots, 38% imp, HSG B
0.017	75	1/4 acre lots, 38% imp, HSG B
21.651	70	Woods, Good, HSG C
0.057	83	1/4 acre lots, 38% imp, HSG C
0.120	83	1/4 acre lots, 38% imp, HSG C
7.993	70	Woods, Good, HSG C
2.607	77	Woods, Good, HSG D
0.388	77	Woods, Good, HSG D
33.100	71	Weighted Average
32.925		99.47% Pervious Area
0.175		0.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.3	100	0.0100	0.06		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 3.20"
7.3	635	0.0850	1.46		**Shallow Concentrated Flow, Shallow Concentrated Flow** Woodland Kv= 5.0 fps
1.1	491	0.0650	7.46	61.56	**Trap/Vee/Rect Channel Flow, Channel Flow** Bot.W=15.00' D=0.50' Z= 3.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
36.7	1,226	Total			

Subcatchment 1S: DS



Summary for Subcatchment 2S: Trib

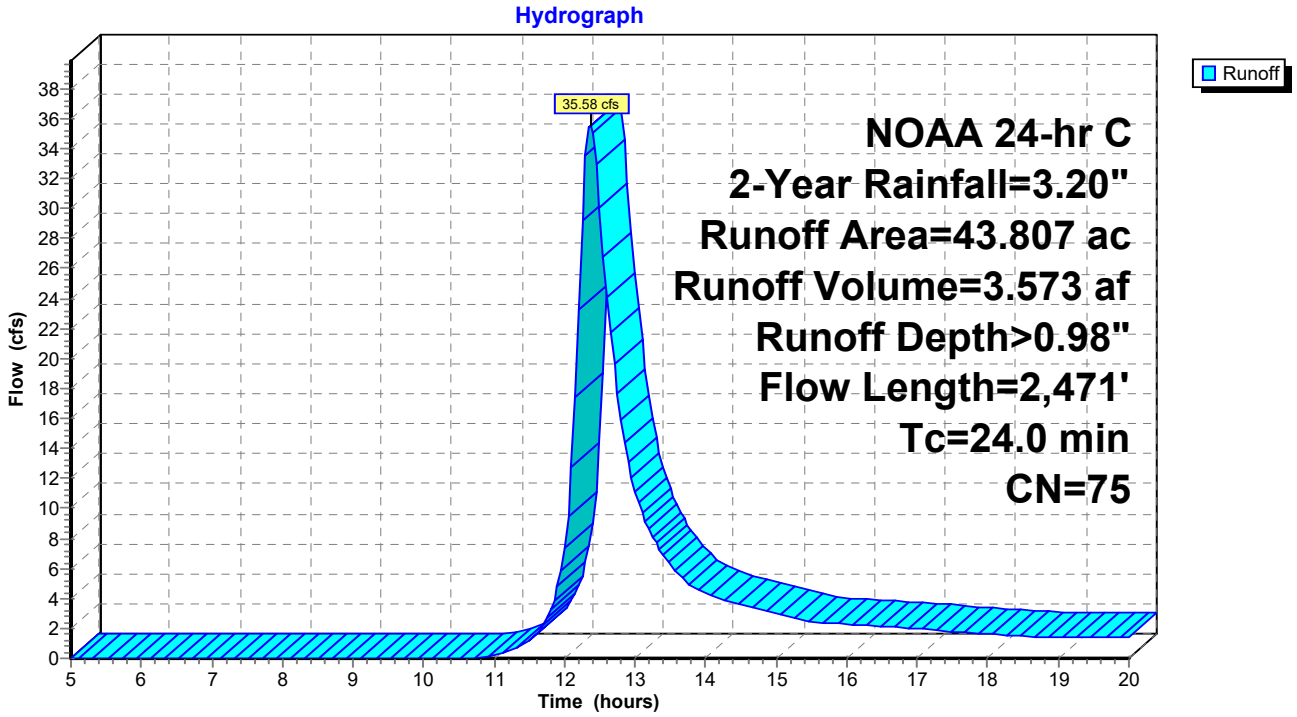
Runoff = 35.58 cfs @ 12.37 hrs, Volume= 3.573 af, Depth> 0.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NOAA 24-hr C 2-Year Rainfall=3.20"

Area (ac)	CN	Description
0.041	49	50-75% Grass cover, Fair, HSG A
0.017	49	50-75% Grass cover, Fair, HSG A
6.716	60	Woods, Fair, HSG B
4.199	75	1/4 acre lots, 38% imp, HSG B
0.747	85	1/8 acre lots, 65% imp, HSG B
2.193	75	1/4 acre lots, 38% imp, HSG B
14.096	73	Woods, Fair, HSG C
0.075	98	Paved parking, HSG C
5.144	83	1/4 acre lots, 38% imp, HSG C
1.606	94	Urban commercial, 85% imp, HSG C
8.431	79	50-75% Grass cover, Fair, HSG C
0.542	79	Woods, Fair, HSG D
43.807	75	Weighted Average
37.498		85.60% Pervious Area
6.309		14.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	100	0.0400	0.22		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.20"
2.3	487	0.0500	3.60		**Shallow Concentrated Flow, Shallow Concentrated Flow** Unpaved Kv= 16.1 fps
0.2	36	0.0070	2.59	4.57	**Pipe Channel, CMP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.025 Earth, clean & winding
1.9	260	0.0200	2.28		**Shallow Concentrated Flow, SC2** Unpaved Kv= 16.1 fps
0.3	47	0.0200	2.87		**Shallow Concentrated Flow, SC3** Paved Kv= 20.3 fps
0.7	101	0.0200	2.28		**Shallow Concentrated Flow, SC4** Unpaved Kv= 16.1 fps
5.4	425	0.0700	1.32		**Shallow Concentrated Flow, SC5** Woodland Kv= 5.0 fps
5.8	1,015	0.0120	2.94	9.54	**Trap/Vee/Rect Channel Flow, Stream** Bot.W=5.00' D=0.50' Z= 3.0 '/' Top.W=8.00' n= 0.030 Earth, grassed & winding
24.0	2,471	Total			

Subcatchment 2S: Trib



Summary for Subcatchment 3S: Waterworks

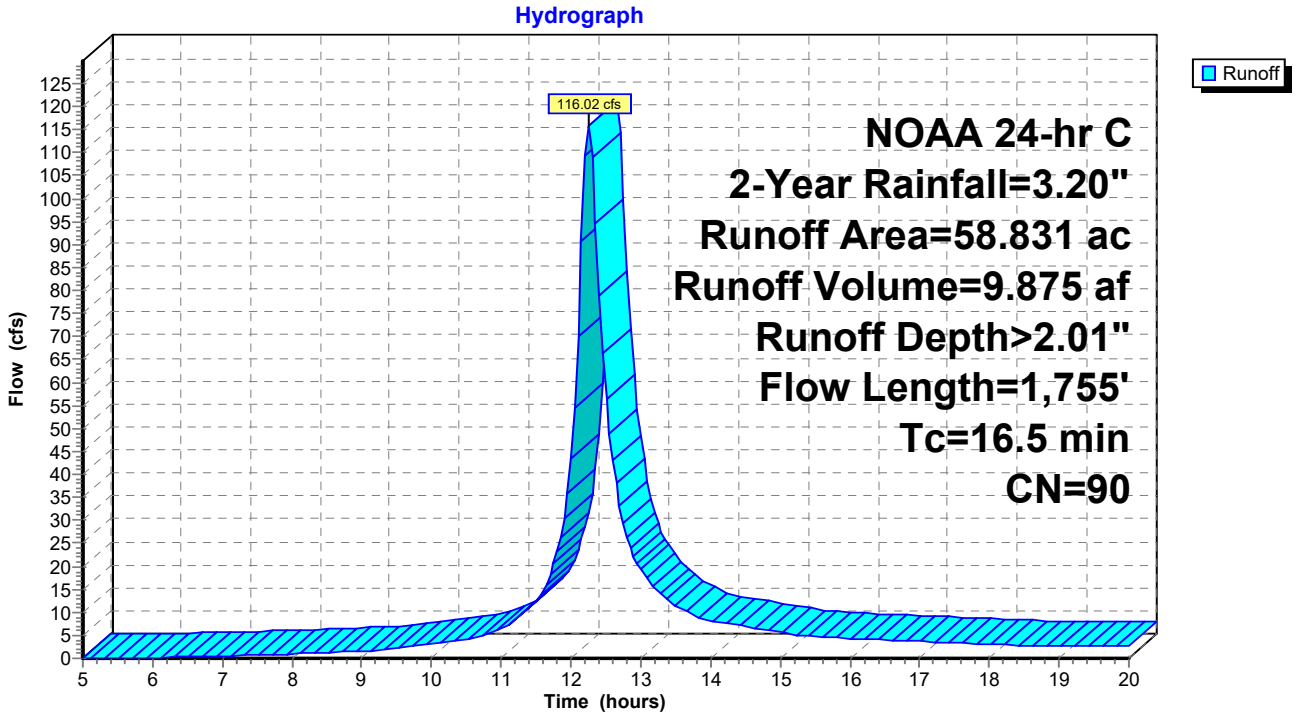
Runoff = 116.02 cfs @ 12.25 hrs, Volume= 9.875 af, Depth> 2.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NOAA 24-hr C 2-Year Rainfall=3.20"

Area (ac)	CN	Description
2.547	92	Urban commercial, 85% imp, HSG B
0.429	98	Roofs, HSG B
0.114	98	Paved parking, HSG B
1.151	92	Urban commercial, 85% imp, HSG B
4.165	73	Woods, Fair, HSG C
1.220	94	Urban commercial, 85% imp, HSG C
0.879	94	Urban commercial, 85% imp, HSG C
2.033	83	1/4 acre lots, 38% imp, HSG C
2.857	94	Urban commercial, 85% imp, HSG C
1.417	79	50-75% Grass cover, Fair, HSG C
1.046	73	Woods, Fair, HSG C
0.131	79	Woods, Fair, HSG D
0.848	79	Woods, Fair, HSG D
17.688	95	Urban commercial, 85% imp, HSG D
6.253	87	1/4 acre lots, 38% imp, HSG D
7.927	95	Urban commercial, 85% imp, HSG D
2.427	84	50-75% Grass cover, Fair, HSG D
0.279	79	Woods, Fair, HSG D
5.420	94	Urban commercial, 85% imp, HSG C
58.831	90	Weighted Average
21.404		36.38% Pervious Area
37.427		63.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	100	0.0100	1.04		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.20"
0.4	90	0.0400	4.06		**Shallow Concentrated Flow, Shallow Concentrated Flow** Paved Kv= 20.3 fps
0.4	93	0.0540	3.74		**Shallow Concentrated Flow, Shallow 2** Unpaved Kv= 16.1 fps
10.5	546	0.0300	0.87		**Shallow Concentrated Flow, Shallow3** Woodland Kv= 5.0 fps
0.5	281		9.83		**Lake or Reservoir, Pond** Mean Depth= 3.00'
0.2	188	0.0600	16.90	331.73	**Pipe Channel, RCP_Round 60"** 60.0" Round Area= 19.6 sf Perim= 15.7' r= 1.25' n= 0.025 Earth, clean & winding
2.9	457	0.0100	2.62	7.20	**Trap/Vee/Rect Channel Flow, Stream** Bot.W=4.00' D=0.50' Z= 3.0 '/' Top.W=7.00' n= 0.030 Earth, grassed & winding
16.5	1,755	Total			

Subcatchment 3S: Waterworks



Summary for Reach 4R: Reach 1

[91] Warning: Storage range exceeded by 0.29'
[55] Hint: Peak inflow is 152% of Manning's capacity

Inflow Area = 102.638 ac, 42.61% Impervious, Inflow Depth > 1.57" for 2-Year event
Inflow = 146.00 cfs @ 12.27 hrs, Volume= 13.449 af
Outflow = 142.82 cfs @ 12.32 hrs, Volume= 13.402 af, Atten= 2%, Lag= 3.4 min

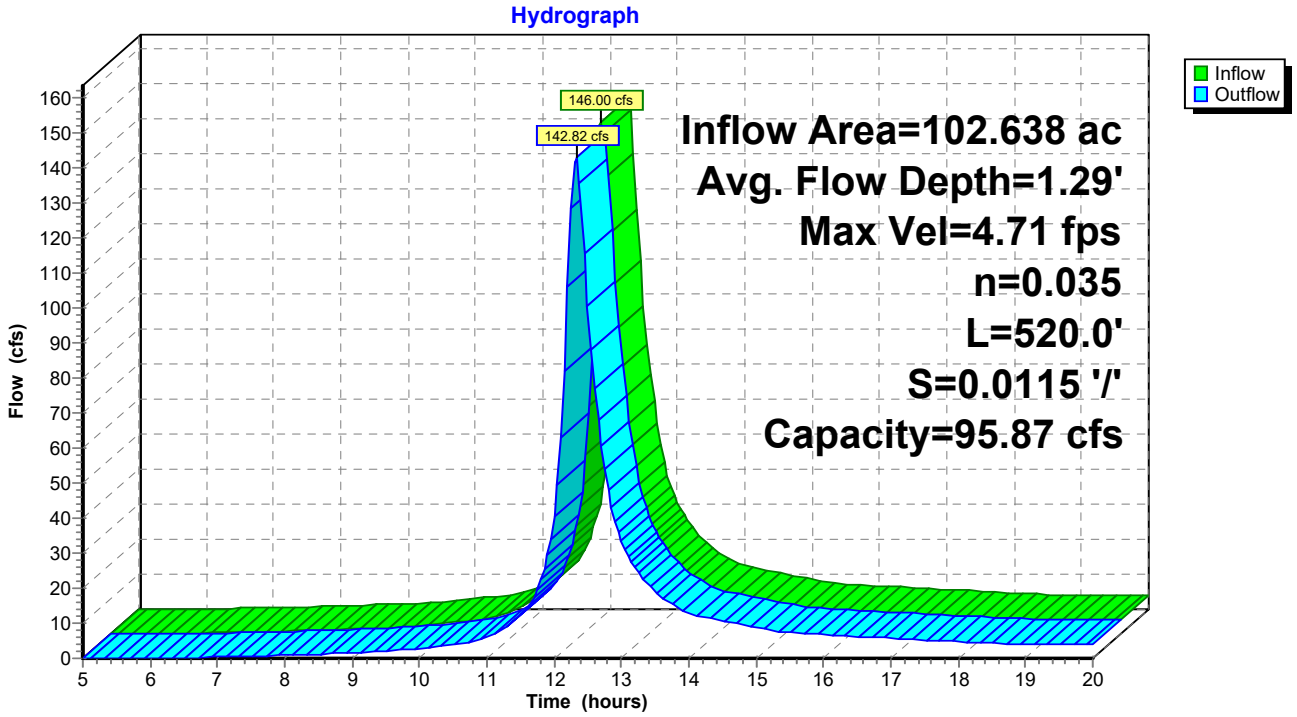
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.71 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 1.48 fps, Avg. Travel Time= 5.9 min

Peak Storage= 15,924 cf @ 12.29 hrs
Average Depth at Peak Storage= 1.29'
Bank-Full Depth= 1.00' Flow Area= 23.0 sf, Capacity= 95.87 cfs

20.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 26.00'
Length= 520.0' Slope= 0.0115 '/'
Inlet Invert= 43.50', Outlet Invert= 37.50'

‡

Reach 4R: Reach 1



Summary for Reach 5R: Reach 2

[91] Warning: Storage range exceeded by 0.44'
[55] Hint: Peak inflow is 182% of Manning's capacity
[62] Hint: Exceeded Reach 4R OUTLET depth by 0.33' @ 12.50 hrs

Inflow Area = 135.738 ac, 32.35% Impervious, Inflow Depth > 1.37" for 2-Year event
Inflow = 153.24 cfs @ 12.33 hrs, Volume= 15.529 af
Outflow = 147.31 cfs @ 12.45 hrs, Volume= 15.421 af, Atten= 4%, Lag= 6.8 min

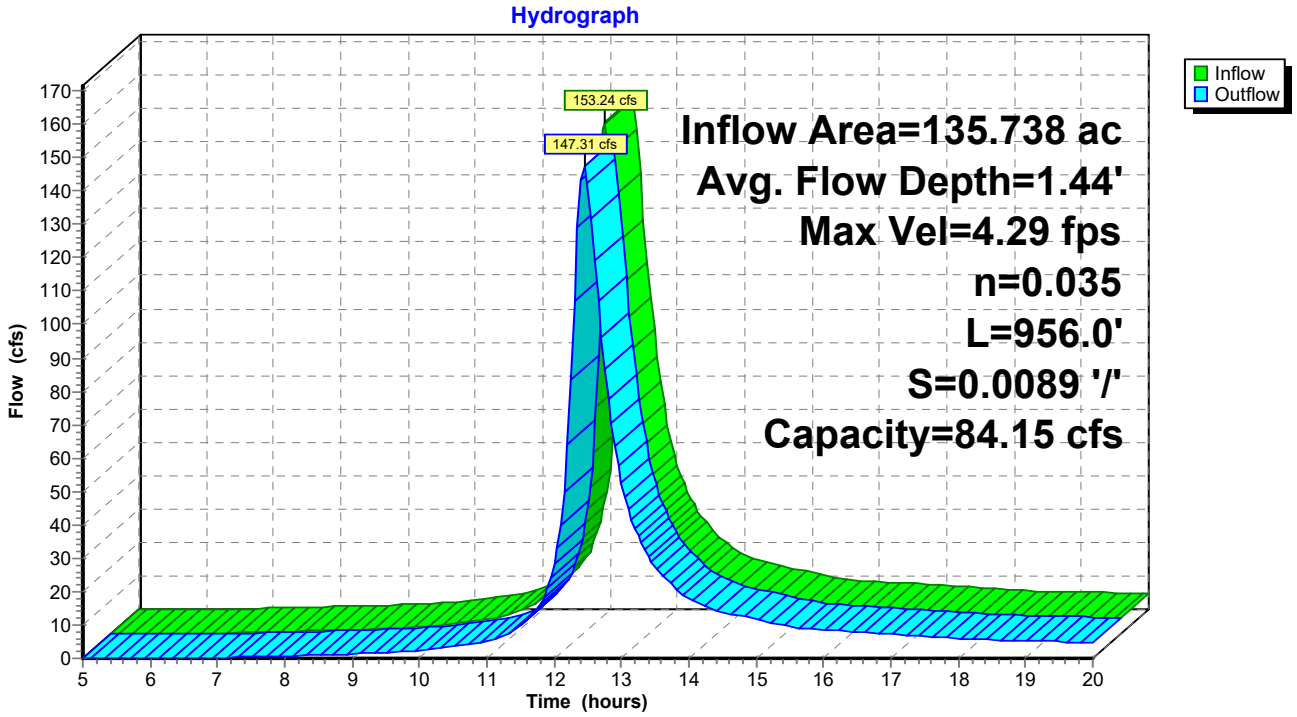
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.29 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 1.42 fps, Avg. Travel Time= 11.2 min

Peak Storage= 32,975 cf @ 12.38 hrs
Average Depth at Peak Storage= 1.44'
Bank-Full Depth= 1.00' Flow Area= 23.0 sf, Capacity= 84.15 cfs

20.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 26.00'
Length= 956.0' Slope= 0.0089 '/'
Inlet Invert= 37.50', Outlet Invert= 29.00'

‡

Reach 5R: Reach 2



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: DS Runoff Area=33.100 ac 0.53% Impervious Runoff Depth>1.87"
Flow Length=1,226' Tc=36.7 min CN=71 Runoff=41.98 cfs 5.157 af

Subcatchment2S: Trib Runoff Area=43.807 ac 14.40% Impervious Runoff Depth>2.19"
Flow Length=2,471' Tc=24.0 min CN=75 Runoff=81.51 cfs 8.013 af

Subcatchment3S: Waterworks Runoff Area=58.831 ac 63.62% Impervious Runoff Depth>3.57"
Flow Length=1,755' Tc=16.5 min CN=90 Runoff=199.71 cfs 17.526 af

Reach 4R: Reach 1 Avg. Flow Depth=2.05' Max Vel=5.34 fps Inflow=271.19 cfs 25.539 af
n=0.035 L=520.0' S=0.0115 '/' Capacity=95.87 cfs Outflow=265.38 cfs 25.472 af

Reach 5R: Reach 2 Avg. Flow Depth=2.40' Max Vel=4.82 fps Inflow=295.56 cfs 30.629 af
n=0.035 L=956.0' S=0.0089 '/' Capacity=84.15 cfs Outflow=285.66 cfs 30.473 af

Total Runoff Area = 135.738 ac Runoff Volume = 30.696 af Average Runoff Depth = 2.71"
67.65% Pervious = 91.826 ac 32.35% Impervious = 43.912 ac

Summary for Subcatchment 1S: DS

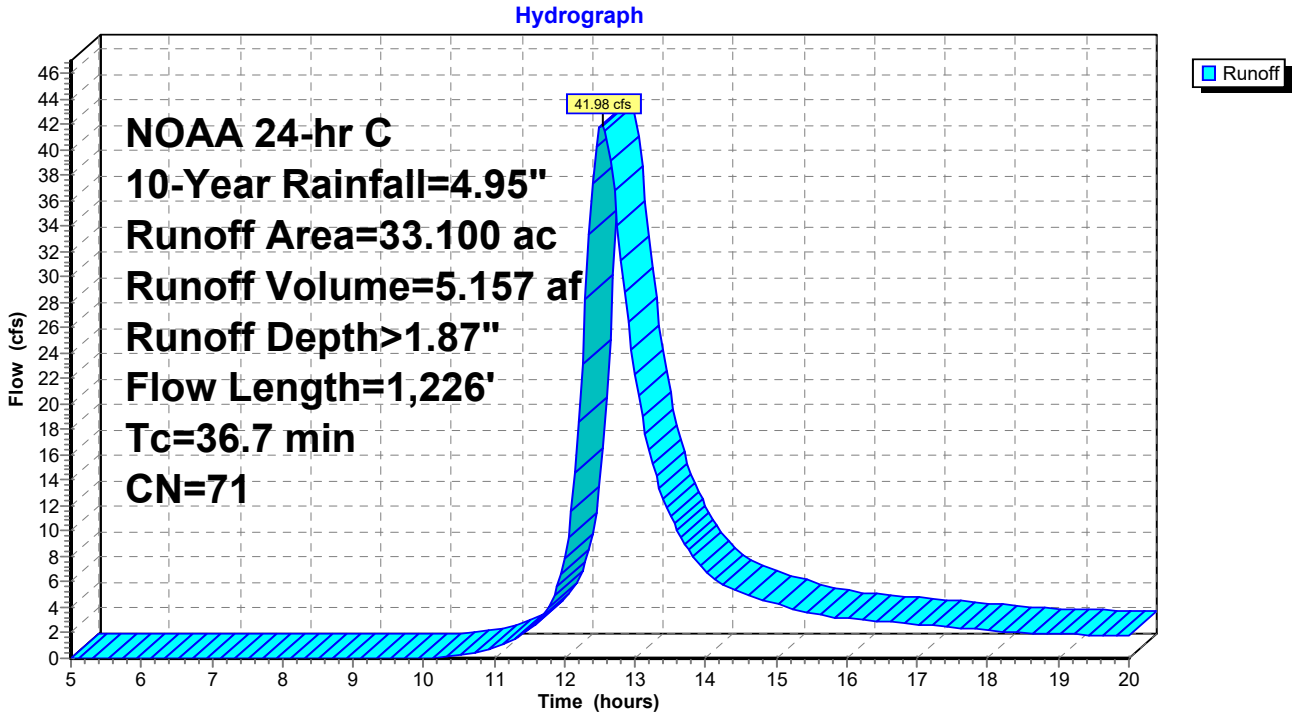
Runoff = 41.98 cfs @ 12.53 hrs, Volume= 5.157 af, Depth> 1.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NOAA 24-hr C 10-Year Rainfall=4.95"

Area (ac)	CN	Description
0.029	75	1/4 acre lots, 38% imp, HSG B
0.166	75	1/4 acre lots, 38% imp, HSG B
0.072	75	1/4 acre lots, 38% imp, HSG B
0.017	75	1/4 acre lots, 38% imp, HSG B
21.651	70	Woods, Good, HSG C
0.057	83	1/4 acre lots, 38% imp, HSG C
0.120	83	1/4 acre lots, 38% imp, HSG C
7.993	70	Woods, Good, HSG C
2.607	77	Woods, Good, HSG D
0.388	77	Woods, Good, HSG D
33.100	71	Weighted Average
32.925		99.47% Pervious Area
0.175		0.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.3	100	0.0100	0.06		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 3.20"
7.3	635	0.0850	1.46		**Shallow Concentrated Flow, Shallow Concentrated Flow** Woodland Kv= 5.0 fps
1.1	491	0.0650	7.46	61.56	**Trap/Vee/Rect Channel Flow, Channel Flow** Bot.W=15.00' D=0.50' Z= 3.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
36.7	1,226	Total			

Subcatchment 1S: DS



Summary for Subcatchment 2S: Trib

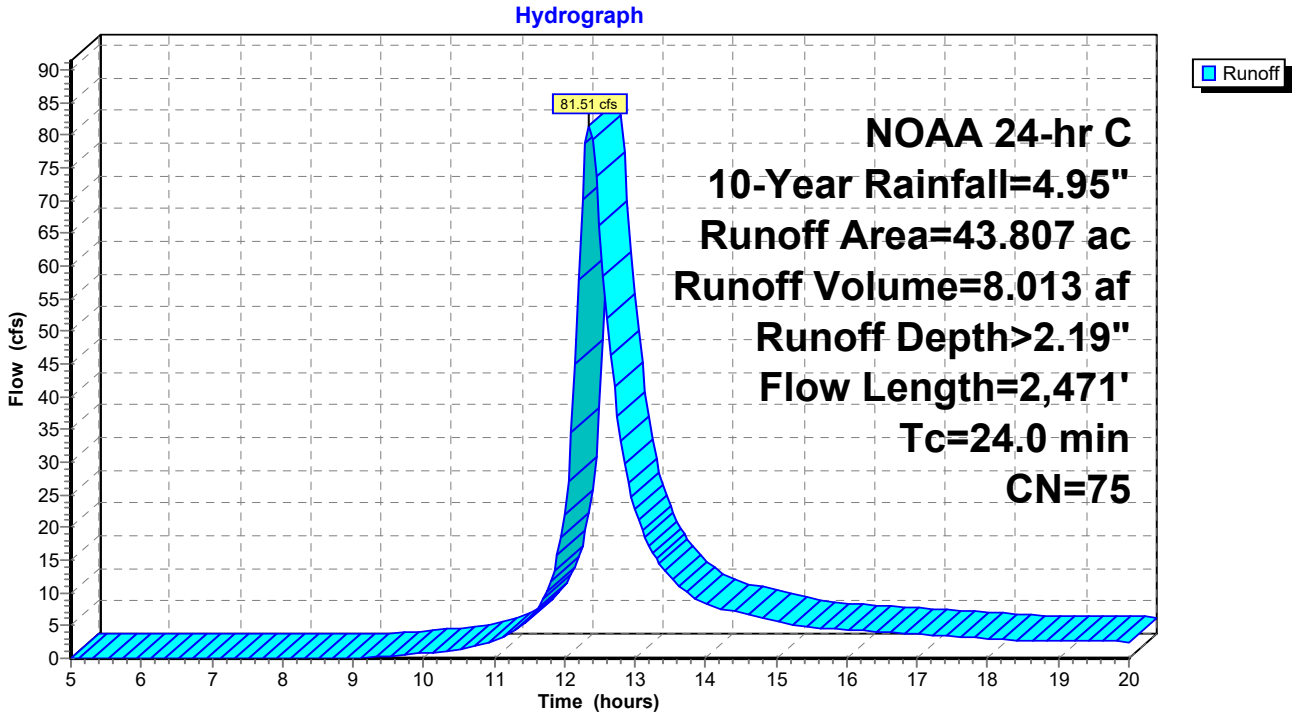
Runoff = 81.51 cfs @ 12.35 hrs, Volume= 8.013 af, Depth> 2.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NOAA 24-hr C 10-Year Rainfall=4.95"

Area (ac)	CN	Description
0.041	49	50-75% Grass cover, Fair, HSG A
0.017	49	50-75% Grass cover, Fair, HSG A
6.716	60	Woods, Fair, HSG B
4.199	75	1/4 acre lots, 38% imp, HSG B
0.747	85	1/8 acre lots, 65% imp, HSG B
2.193	75	1/4 acre lots, 38% imp, HSG B
14.096	73	Woods, Fair, HSG C
0.075	98	Paved parking, HSG C
5.144	83	1/4 acre lots, 38% imp, HSG C
1.606	94	Urban commercial, 85% imp, HSG C
8.431	79	50-75% Grass cover, Fair, HSG C
0.542	79	Woods, Fair, HSG D
43.807	75	Weighted Average
37.498		85.60% Pervious Area
6.309		14.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	100	0.0400	0.22		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.20"
2.3	487	0.0500	3.60		**Shallow Concentrated Flow, Shallow Concentrated Flow** Unpaved Kv= 16.1 fps
0.2	36	0.0070	2.59	4.57	**Pipe Channel, CMP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.025 Earth, clean & winding
1.9	260	0.0200	2.28		**Shallow Concentrated Flow, SC2** Unpaved Kv= 16.1 fps
0.3	47	0.0200	2.87		**Shallow Concentrated Flow, SC3** Paved Kv= 20.3 fps
0.7	101	0.0200	2.28		**Shallow Concentrated Flow, SC4** Unpaved Kv= 16.1 fps
5.4	425	0.0700	1.32		**Shallow Concentrated Flow, SC5** Woodland Kv= 5.0 fps
5.8	1,015	0.0120	2.94	9.54	**Trap/Vee/Rect Channel Flow, Stream** Bot.W=5.00' D=0.50' Z= 3.0 '/' Top.W=8.00' n= 0.030 Earth, grassed & winding
24.0	2,471	Total			

Subcatchment 2S: Trib



Summary for Subcatchment 3S: Waterworks

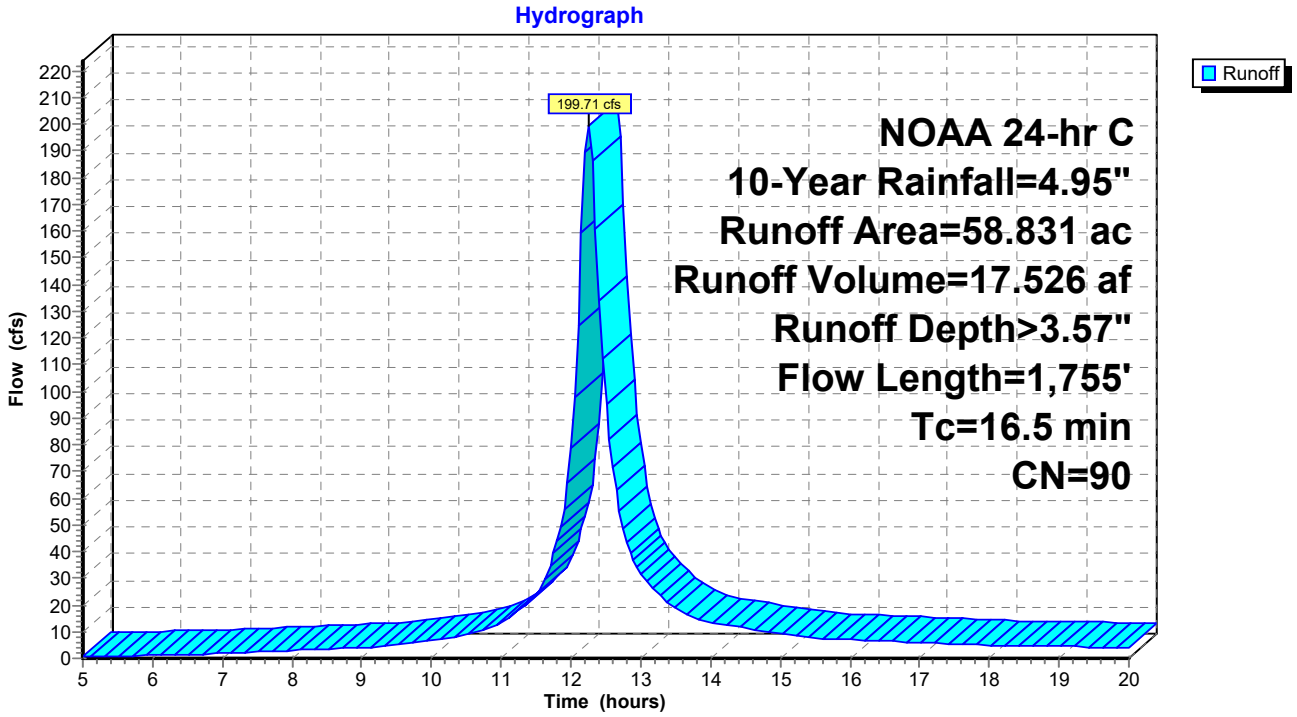
Runoff = 199.71 cfs @ 12.25 hrs, Volume= 17.526 af, Depth> 3.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NOAA 24-hr C 10-Year Rainfall=4.95"

Area (ac)	CN	Description
2.547	92	Urban commercial, 85% imp, HSG B
0.429	98	Roofs, HSG B
0.114	98	Paved parking, HSG B
1.151	92	Urban commercial, 85% imp, HSG B
4.165	73	Woods, Fair, HSG C
1.220	94	Urban commercial, 85% imp, HSG C
0.879	94	Urban commercial, 85% imp, HSG C
2.033	83	1/4 acre lots, 38% imp, HSG C
2.857	94	Urban commercial, 85% imp, HSG C
1.417	79	50-75% Grass cover, Fair, HSG C
1.046	73	Woods, Fair, HSG C
0.131	79	Woods, Fair, HSG D
0.848	79	Woods, Fair, HSG D
17.688	95	Urban commercial, 85% imp, HSG D
6.253	87	1/4 acre lots, 38% imp, HSG D
7.927	95	Urban commercial, 85% imp, HSG D
2.427	84	50-75% Grass cover, Fair, HSG D
0.279	79	Woods, Fair, HSG D
5.420	94	Urban commercial, 85% imp, HSG C
58.831	90	Weighted Average
21.404		36.38% Pervious Area
37.427		63.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	100	0.0100	1.04		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.20"
0.4	90	0.0400	4.06		**Shallow Concentrated Flow, Shallow Concentrated Flow** Paved Kv= 20.3 fps
0.4	93	0.0540	3.74		**Shallow Concentrated Flow, Shallow 2** Unpaved Kv= 16.1 fps
10.5	546	0.0300	0.87		**Shallow Concentrated Flow, Shallow3** Woodland Kv= 5.0 fps
0.5	281		9.83		**Lake or Reservoir, Pond** Mean Depth= 3.00'
0.2	188	0.0600	16.90	331.73	**Pipe Channel, RCP_Round 60"** 60.0" Round Area= 19.6 sf Perim= 15.7' r= 1.25' n= 0.025 Earth, clean & winding
2.9	457	0.0100	2.62	7.20	**Trap/Vee/Rect Channel Flow, Stream** Bot.W=4.00' D=0.50' Z= 3.0 '/' Top.W=7.00' n= 0.030 Earth, grassed & winding
16.5	1,755	Total			

Subcatchment 3S: Waterworks



Summary for Reach 4R: Reach 1

[82] Warning: Early inflow requires earlier time span
[91] Warning: Storage range exceeded by 1.05'
[55] Hint: Peak inflow is 283% of Manning's capacity

Inflow Area = 102.638 ac, 42.61% Impervious, Inflow Depth > 2.99" for 10-Year event
Inflow = 271.19 cfs @ 12.27 hrs, Volume= 25.539 af
Outflow = 265.38 cfs @ 12.32 hrs, Volume= 25.472 af, Atten= 2%, Lag= 3.2 min

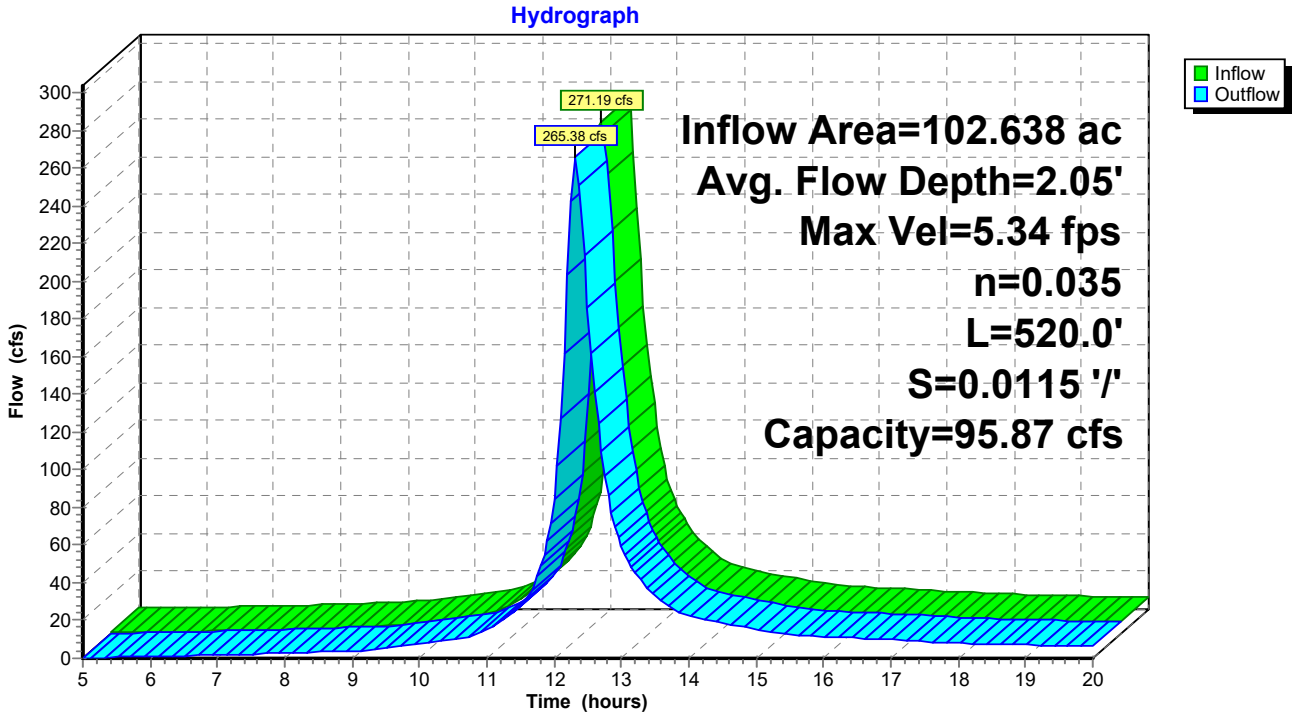
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.34 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.89 fps, Avg. Travel Time= 4.6 min

Peak Storage= 26,081 cf @ 12.29 hrs
Average Depth at Peak Storage= 2.05'
Bank-Full Depth= 1.00' Flow Area= 23.0 sf, Capacity= 95.87 cfs

20.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 26.00'
Length= 520.0' Slope= 0.0115 '/'
Inlet Invert= 43.50', Outlet Invert= 37.50'

‡

Reach 4R: Reach 1



Summary for Reach 5R: Reach 2

[91] Warning: Storage range exceeded by 1.40'
[55] Hint: Peak inflow is 351% of Manning's capacity
[62] Hint: Exceeded Reach 4R OUTLET depth by 0.69' @ 12.50 hrs

Inflow Area = 135.738 ac, 32.35% Impervious, Inflow Depth > 2.71" for 10-Year event
Inflow = 295.56 cfs @ 12.33 hrs, Volume= 30.629 af
Outflow = 285.66 cfs @ 12.44 hrs, Volume= 30.473 af, Atten= 3%, Lag= 6.4 min

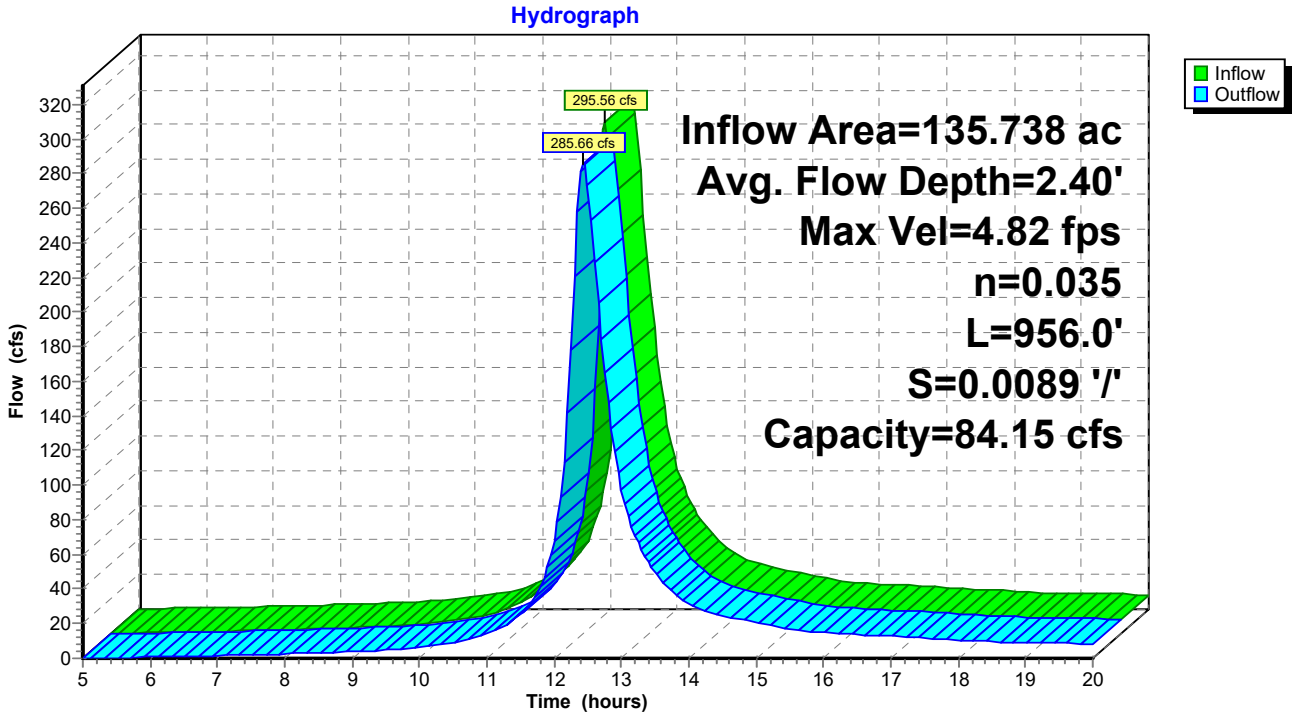
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.82 fps, Min. Travel Time= 3.3 min
Avg. Velocity = 1.82 fps, Avg. Travel Time= 8.8 min

Peak Storage= 56,736 cf @ 12.38 hrs
Average Depth at Peak Storage= 2.40'
Bank-Full Depth= 1.00' Flow Area= 23.0 sf, Capacity= 84.15 cfs

20.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 26.00'
Length= 956.0' Slope= 0.0089 '/'
Inlet Invert= 37.50', Outlet Invert= 29.00'

‡

Reach 5R: Reach 2



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: DS Runoff Area=33.100 ac 0.53% Impervious Runoff Depth>4.63"
Flow Length=1,226' Tc=36.7 min CN=71 Runoff=103.94 cfs 12.763 af

Subcatchment2S: Trib Runoff Area=43.807 ac 14.40% Impervious Runoff Depth>5.11"
Flow Length=2,471' Tc=24.0 min CN=75 Runoff=186.77 cfs 18.667 af

Subcatchment3S: Waterworks Runoff Area=58.831 ac 63.62% Impervious Runoff Depth>6.84"
Flow Length=1,755' Tc=16.5 min CN=90 Runoff=369.08 cfs 33.532 af

Reach 4R: Reach 1 Avg. Flow Depth=3.64' Max Vel=5.79 fps Inflow=537.02 cfs 52.199 af
n=0.035 L=520.0' S=0.0115 '/' Capacity=95.87 cfs Outflow=525.81 cfs 52.095 af

Reach 5R: Reach 2 Avg. Flow Depth=4.49' Max Vel=5.18 fps Inflow=605.55 cfs 64.857 af
n=0.035 L=956.0' S=0.0089 '/' Capacity=84.15 cfs Outflow=587.46 cfs 64.616 af

Total Runoff Area = 135.738 ac Runoff Volume = 64.962 af Average Runoff Depth = 5.74"
67.65% Pervious = 91.826 ac 32.35% Impervious = 43.912 ac

Summary for Subcatchment 1S: DS

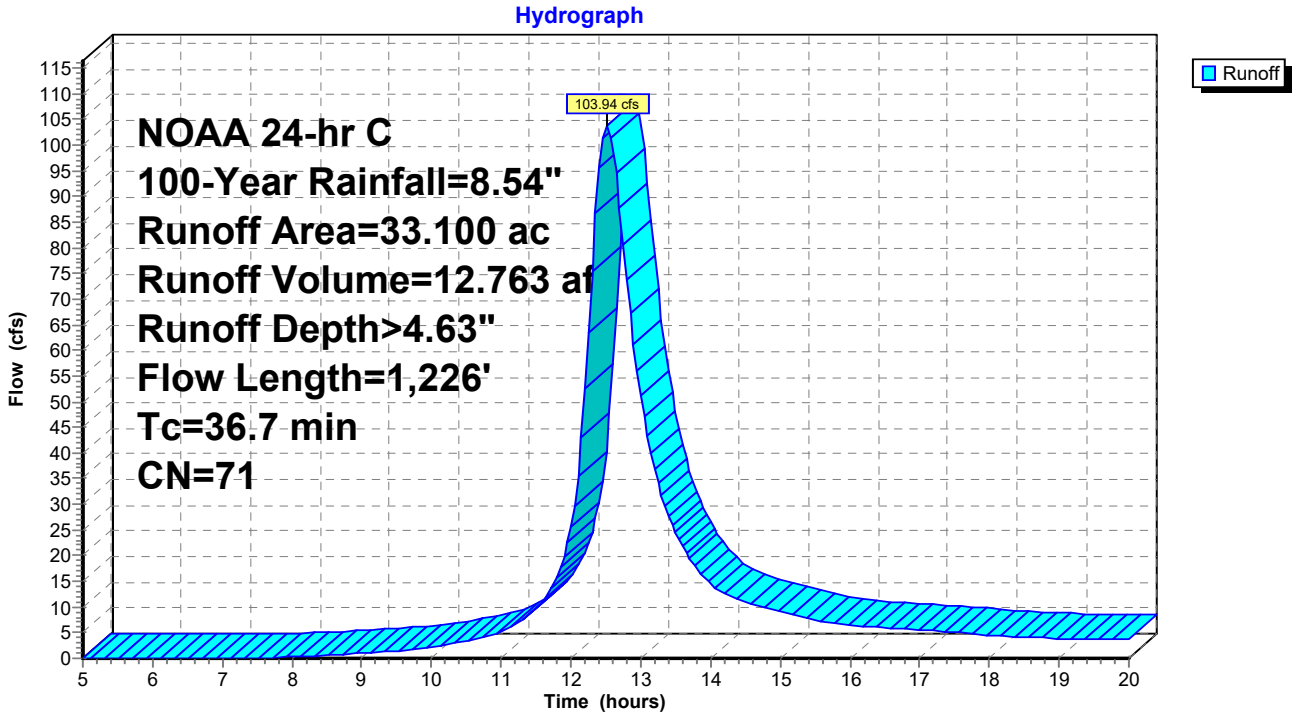
Runoff = 103.94 cfs @ 12.51 hrs, Volume= 12.763 af, Depth> 4.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NOAA 24-hr C 100-Year Rainfall=8.54"

Area (ac)	CN	Description
0.029	75	1/4 acre lots, 38% imp, HSG B
0.166	75	1/4 acre lots, 38% imp, HSG B
0.072	75	1/4 acre lots, 38% imp, HSG B
0.017	75	1/4 acre lots, 38% imp, HSG B
21.651	70	Woods, Good, HSG C
0.057	83	1/4 acre lots, 38% imp, HSG C
0.120	83	1/4 acre lots, 38% imp, HSG C
7.993	70	Woods, Good, HSG C
2.607	77	Woods, Good, HSG D
0.388	77	Woods, Good, HSG D
33.100	71	Weighted Average
32.925		99.47% Pervious Area
0.175		0.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.3	100	0.0100	0.06		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 3.20"
7.3	635	0.0850	1.46		**Shallow Concentrated Flow, Shallow Concentrated Flow** Woodland Kv= 5.0 fps
1.1	491	0.0650	7.46	61.56	**Trap/Vee/Rect Channel Flow, Channel Flow** Bot.W=15.00' D=0.50' Z= 3.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
36.7	1,226	Total			

Subcatchment 1S: DS



Summary for Subcatchment 2S: Trib

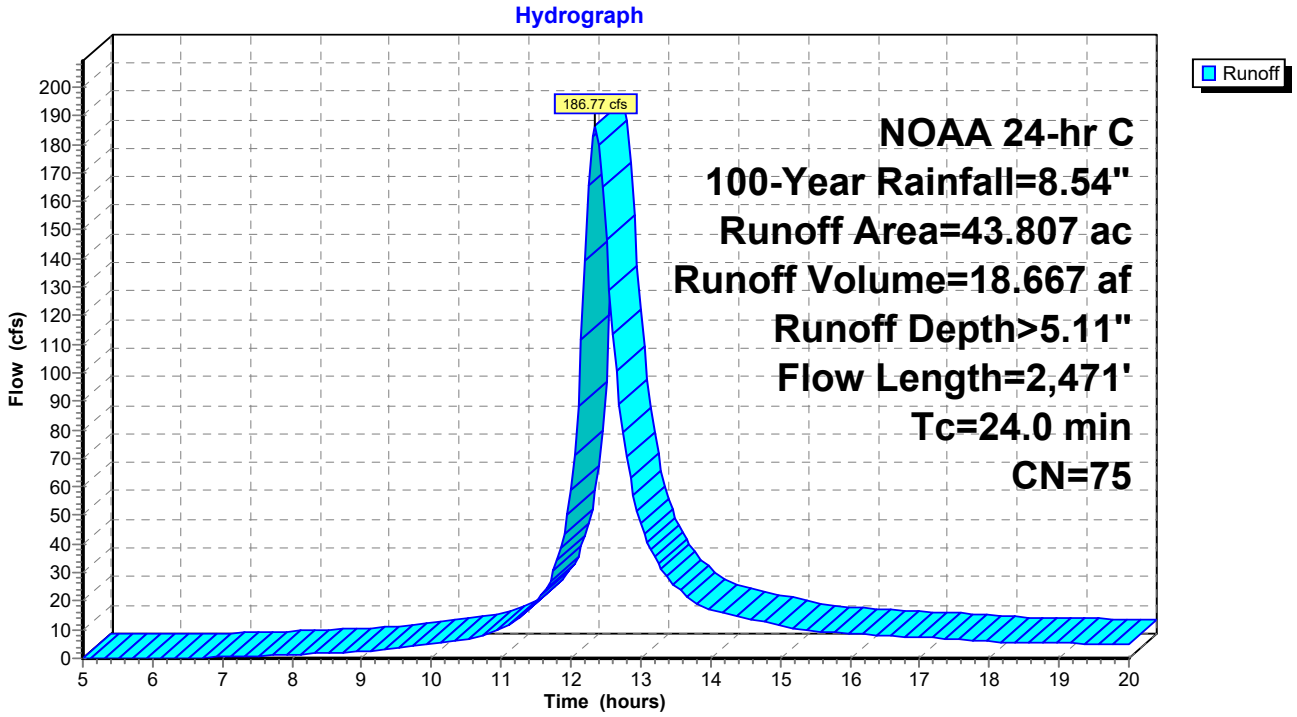
Runoff = 186.77 cfs @ 12.34 hrs, Volume= 18.667 af, Depth> 5.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NOAA 24-hr C 100-Year Rainfall=8.54"

Area (ac)	CN	Description
0.041	49	50-75% Grass cover, Fair, HSG A
0.017	49	50-75% Grass cover, Fair, HSG A
6.716	60	Woods, Fair, HSG B
4.199	75	1/4 acre lots, 38% imp, HSG B
0.747	85	1/8 acre lots, 65% imp, HSG B
2.193	75	1/4 acre lots, 38% imp, HSG B
14.096	73	Woods, Fair, HSG C
0.075	98	Paved parking, HSG C
5.144	83	1/4 acre lots, 38% imp, HSG C
1.606	94	Urban commercial, 85% imp, HSG C
8.431	79	50-75% Grass cover, Fair, HSG C
0.542	79	Woods, Fair, HSG D
43.807	75	Weighted Average
37.498		85.60% Pervious Area
6.309		14.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	100	0.0400	0.22		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.20"
2.3	487	0.0500	3.60		**Shallow Concentrated Flow, Shallow Concentrated Flow** Unpaved Kv= 16.1 fps
0.2	36	0.0070	2.59	4.57	**Pipe Channel, CMP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.025 Earth, clean & winding
1.9	260	0.0200	2.28		**Shallow Concentrated Flow, SC2** Unpaved Kv= 16.1 fps
0.3	47	0.0200	2.87		**Shallow Concentrated Flow, SC3** Paved Kv= 20.3 fps
0.7	101	0.0200	2.28		**Shallow Concentrated Flow, SC4** Unpaved Kv= 16.1 fps
5.4	425	0.0700	1.32		**Shallow Concentrated Flow, SC5** Woodland Kv= 5.0 fps
5.8	1,015	0.0120	2.94	9.54	**Trap/Vee/Rect Channel Flow, Stream** Bot.W=5.00' D=0.50' Z= 3.0 '/' Top.W=8.00' n= 0.030 Earth, grassed & winding
24.0	2,471	Total			

Subcatchment 2S: Trib



Summary for Subcatchment 3S: Waterworks

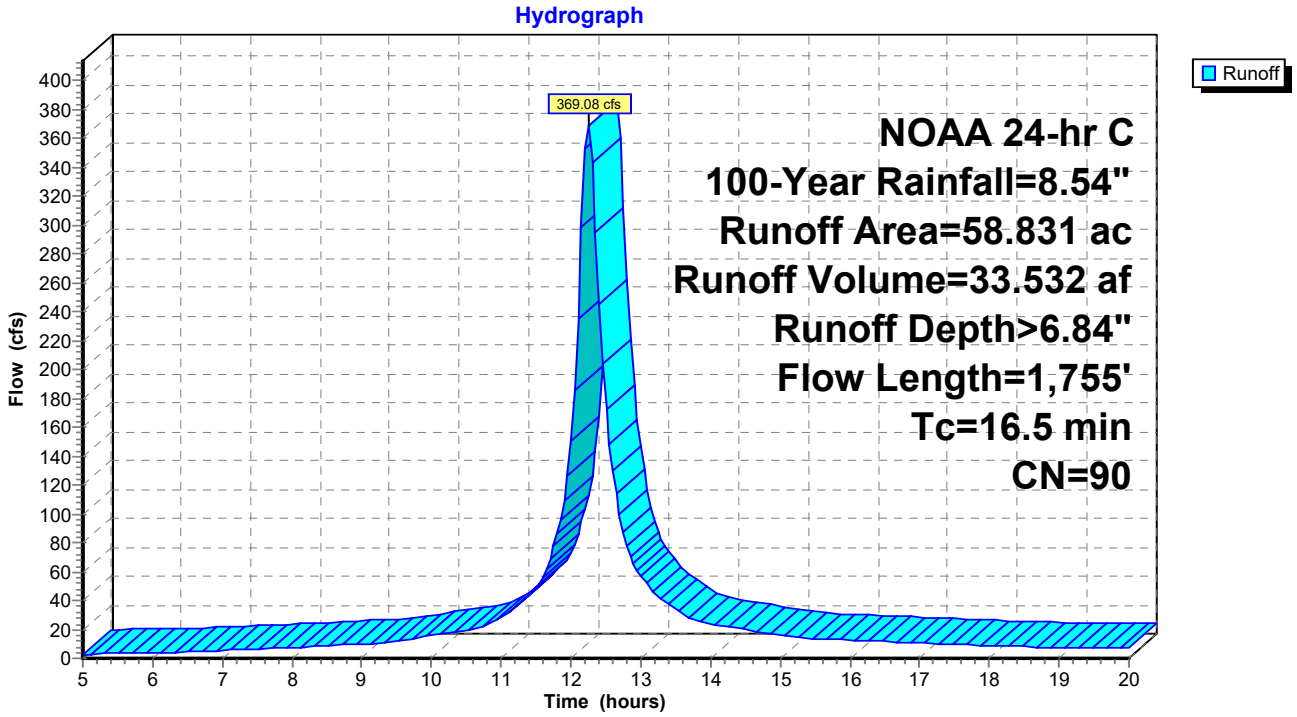
Runoff = 369.08 cfs @ 12.24 hrs, Volume= 33.532 af, Depth> 6.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NOAA 24-hr C 100-Year Rainfall=8.54"

Area (ac)	CN	Description
2.547	92	Urban commercial, 85% imp, HSG B
0.429	98	Roofs, HSG B
0.114	98	Paved parking, HSG B
1.151	92	Urban commercial, 85% imp, HSG B
4.165	73	Woods, Fair, HSG C
1.220	94	Urban commercial, 85% imp, HSG C
0.879	94	Urban commercial, 85% imp, HSG C
2.033	83	1/4 acre lots, 38% imp, HSG C
2.857	94	Urban commercial, 85% imp, HSG C
1.417	79	50-75% Grass cover, Fair, HSG C
1.046	73	Woods, Fair, HSG C
0.131	79	Woods, Fair, HSG D
0.848	79	Woods, Fair, HSG D
17.688	95	Urban commercial, 85% imp, HSG D
6.253	87	1/4 acre lots, 38% imp, HSG D
7.927	95	Urban commercial, 85% imp, HSG D
2.427	84	50-75% Grass cover, Fair, HSG D
0.279	79	Woods, Fair, HSG D
5.420	94	Urban commercial, 85% imp, HSG C
58.831	90	Weighted Average
21.404		36.38% Pervious Area
37.427		63.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	100	0.0100	1.04		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.20"
0.4	90	0.0400	4.06		**Shallow Concentrated Flow, Shallow Concentrated Flow** Paved Kv= 20.3 fps
0.4	93	0.0540	3.74		**Shallow Concentrated Flow, Shallow 2** Unpaved Kv= 16.1 fps
10.5	546	0.0300	0.87		**Shallow Concentrated Flow, Shallow3** Woodland Kv= 5.0 fps
0.5	281		9.83		**Lake or Reservoir, Pond** Mean Depth= 3.00'
0.2	188	0.0600	16.90	331.73	**Pipe Channel, RCP_Round 60"** 60.0" Round Area= 19.6 sf Perim= 15.7' r= 1.25' n= 0.025 Earth, clean & winding
2.9	457	0.0100	2.62	7.20	**Trap/Vee/Rect Channel Flow, Stream** Bot.W=4.00' D=0.50' Z= 3.0 '/' Top.W=7.00' n= 0.030 Earth, grassed & winding
16.5	1,755	Total			

Subcatchment 3S: Waterworks



Summary for Reach 4R: Reach 1

[82] Warning: Early inflow requires earlier time span
[91] Warning: Storage range exceeded by 2.64'
[55] Hint: Peak inflow is 560% of Manning's capacity

Inflow Area = 102.638 ac, 42.61% Impervious, Inflow Depth > 6.10" for 100-Year event
Inflow = 537.02 cfs @ 12.27 hrs, Volume= 52.199 af
Outflow = 525.81 cfs @ 12.32 hrs, Volume= 52.095 af, Atten= 2%, Lag= 3.1 min

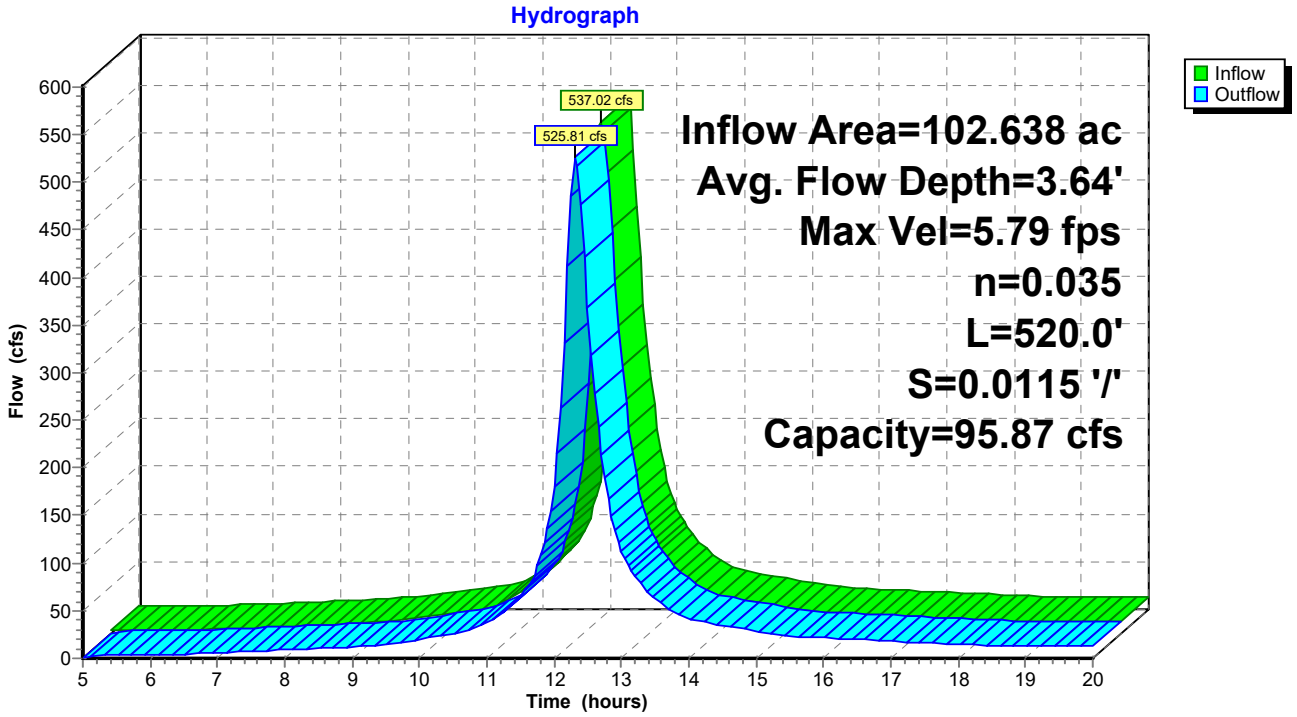
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.79 fps, Min. Travel Time= 1.5 min
Avg. Velocity = 2.49 fps, Avg. Travel Time= 3.5 min

Peak Storage= 47,653 cf @ 12.29 hrs
Average Depth at Peak Storage= 3.64'
Bank-Full Depth= 1.00' Flow Area= 23.0 sf, Capacity= 95.87 cfs

20.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 26.00'
Length= 520.0' Slope= 0.0115 '/'
Inlet Invert= 43.50', Outlet Invert= 37.50'

‡

Reach 4R: Reach 1



Summary for Reach 5R: Reach 2

[91] Warning: Storage range exceeded by 3.49'
[55] Hint: Peak inflow is 720% of Manning's capacity
[62] Hint: Exceeded Reach 4R OUTLET depth by 1.50' @ 12.50 hrs

Inflow Area = 135.738 ac, 32.35% Impervious, Inflow Depth > 5.73" for 100-Year event
Inflow = 605.55 cfs @ 12.33 hrs, Volume= 64.857 af
Outflow = 587.46 cfs @ 12.43 hrs, Volume= 64.616 af, Atten= 3%, Lag= 6.1 min

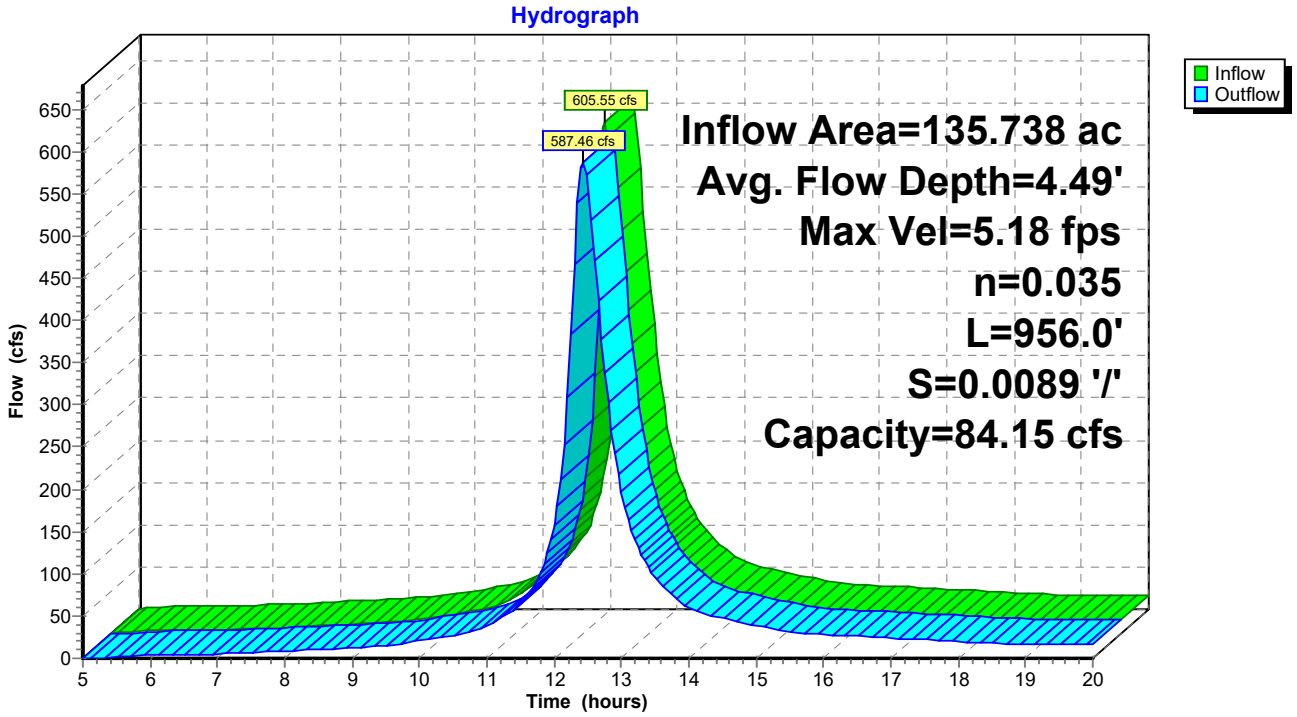
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.18 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 2.42 fps, Avg. Travel Time= 6.6 min

Peak Storage= 108,526 cf @ 12.38 hrs
Average Depth at Peak Storage= 4.49'
Bank-Full Depth= 1.00' Flow Area= 23.0 sf, Capacity= 84.15 cfs

20.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 26.00'
Length= 956.0' Slope= 0.0089 '/'
Inlet Invert= 37.50', Outlet Invert= 29.00'

‡

Reach 5R: Reach 2



Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1S: DS Runoff Area=33.100 ac 0.53% Impervious Runoff Depth>0.77"
Flow Length=1,226' Tc=36.7 min CN=71 Runoff=16.39 cfs 2.126 af

Subcatchment2S: Trib Runoff Area=43.807 ac 14.40% Impervious Runoff Depth>0.98"
Flow Length=2,471' Tc=24.0 min CN=75 Runoff=35.58 cfs 3.573 af

Subcatchment3S: Waterworks Runoff Area=58.831 ac 63.62% Impervious Runoff Depth>2.01"
Flow Length=1,755' Tc=16.5 min CN=90 Runoff=116.02 cfs 9.875 af

Reach 4R: Reach 1 Avg. Flow Depth=1.29' Max Vel=4.71 fps Inflow=146.00 cfs 13.449 af
n=0.035 L=520.0' S=0.0115 '/' Capacity=95.87 cfs Outflow=142.82 cfs 13.402 af

Reach 5R: Reach 2 Avg. Flow Depth=1.44' Max Vel=4.29 fps Inflow=153.24 cfs 15.529 af
n=0.035 L=956.0' S=0.0089 '/' Capacity=84.15 cfs Outflow=147.31 cfs 15.421 af

Total Runoff Area = 135.738 ac Runoff Volume = 15.575 af Average Runoff Depth = 1.38"
67.65% Pervious = 91.826 ac 32.35% Impervious = 43.912 ac

Summary for Subcatchment 1S: DS

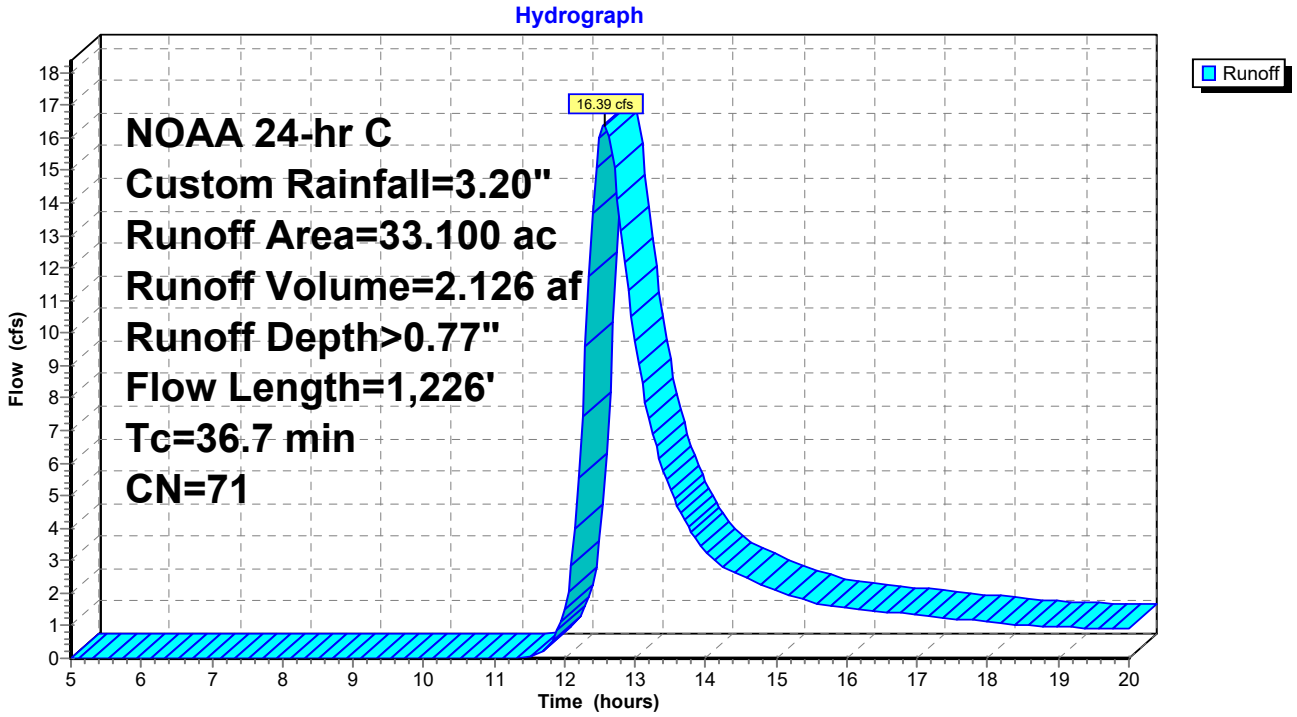
Runoff = 16.39 cfs @ 12.57 hrs, Volume= 2.126 af, Depth> 0.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NOAA 24-hr C Custom Rainfall=3.20"

Area (ac)	CN	Description
0.029	75	1/4 acre lots, 38% imp, HSG B
0.166	75	1/4 acre lots, 38% imp, HSG B
0.072	75	1/4 acre lots, 38% imp, HSG B
0.017	75	1/4 acre lots, 38% imp, HSG B
21.651	70	Woods, Good, HSG C
0.057	83	1/4 acre lots, 38% imp, HSG C
0.120	83	1/4 acre lots, 38% imp, HSG C
7.993	70	Woods, Good, HSG C
2.607	77	Woods, Good, HSG D
0.388	77	Woods, Good, HSG D
33.100	71	Weighted Average
32.925		99.47% Pervious Area
0.175		0.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
28.3	100	0.0100	0.06		**Sheet Flow, Sheet Flow** Woods: Light underbrush n= 0.400 P2= 3.20"
7.3	635	0.0850	1.46		**Shallow Concentrated Flow, Shallow Concentrated Flow** Woodland Kv= 5.0 fps
1.1	491	0.0650	7.46	61.56	**Trap/Vee/Rect Channel Flow, Channel Flow** Bot.W=15.00' D=0.50' Z= 3.0 '/' Top.W=18.00' n= 0.030 Earth, grassed & winding
36.7	1,226	Total			

Subcatchment 1S: DS



Summary for Subcatchment 2S: Trib

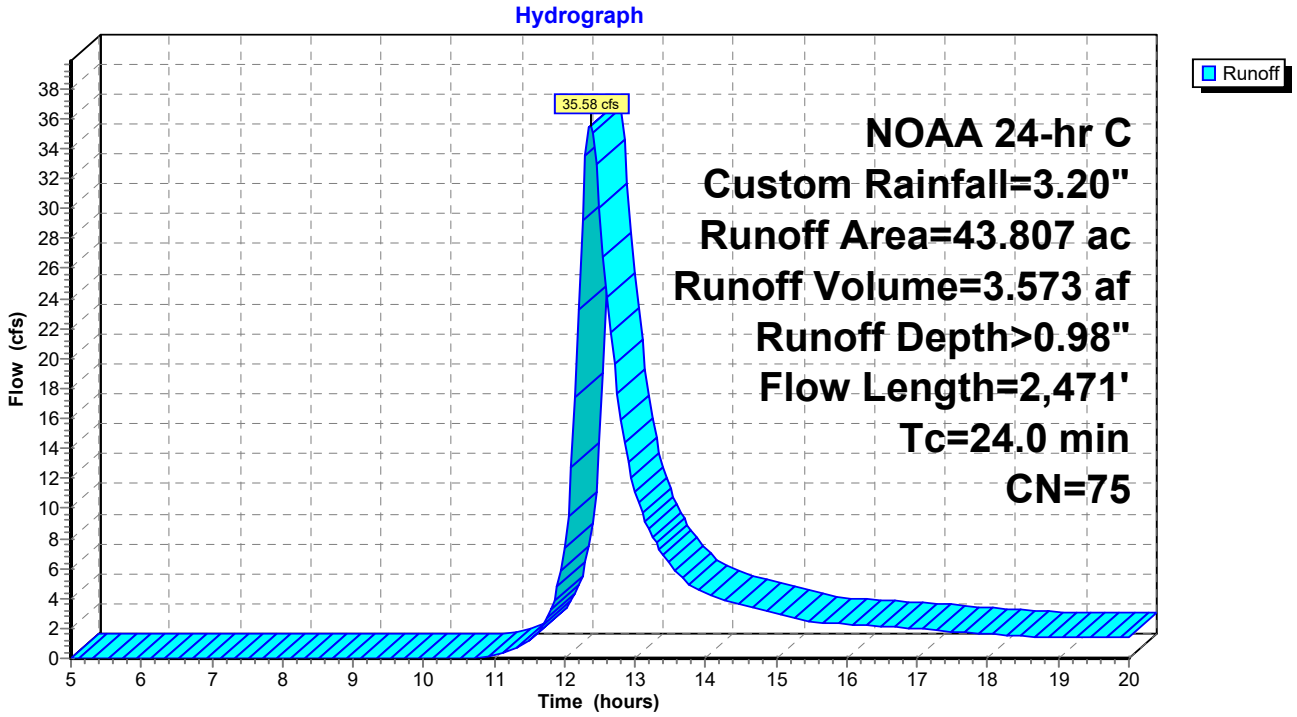
Runoff = 35.58 cfs @ 12.37 hrs, Volume= 3.573 af, Depth> 0.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NOAA 24-hr C Custom Rainfall=3.20"

Area (ac)	CN	Description
0.041	49	50-75% Grass cover, Fair, HSG A
0.017	49	50-75% Grass cover, Fair, HSG A
6.716	60	Woods, Fair, HSG B
4.199	75	1/4 acre lots, 38% imp, HSG B
0.747	85	1/8 acre lots, 65% imp, HSG B
2.193	75	1/4 acre lots, 38% imp, HSG B
14.096	73	Woods, Fair, HSG C
0.075	98	Paved parking, HSG C
5.144	83	1/4 acre lots, 38% imp, HSG C
1.606	94	Urban commercial, 85% imp, HSG C
8.431	79	50-75% Grass cover, Fair, HSG C
0.542	79	Woods, Fair, HSG D
43.807	75	Weighted Average
37.498		85.60% Pervious Area
6.309		14.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.4	100	0.0400	0.22		**Sheet Flow, Sheet Flow** Grass: Short n= 0.150 P2= 3.20"
2.3	487	0.0500	3.60		**Shallow Concentrated Flow, Shallow Concentrated Flow** Unpaved Kv= 16.1 fps
0.2	36	0.0070	2.59	4.57	**Pipe Channel, CMP_Round 18"** 18.0" Round Area= 1.8 sf Perim= 4.7' r= 0.38' n= 0.025 Earth, clean & winding
1.9	260	0.0200	2.28		**Shallow Concentrated Flow, SC2** Unpaved Kv= 16.1 fps
0.3	47	0.0200	2.87		**Shallow Concentrated Flow, SC3** Paved Kv= 20.3 fps
0.7	101	0.0200	2.28		**Shallow Concentrated Flow, SC4** Unpaved Kv= 16.1 fps
5.4	425	0.0700	1.32		**Shallow Concentrated Flow, SC5** Woodland Kv= 5.0 fps
5.8	1,015	0.0120	2.94	9.54	**Trap/Vee/Rect Channel Flow, Stream** Bot.W=5.00' D=0.50' Z= 3.0 '/' Top.W=8.00' n= 0.030 Earth, grassed & winding
24.0	2,471	Total			

Subcatchment 2S: Trib



Summary for Subcatchment 3S: Waterworks

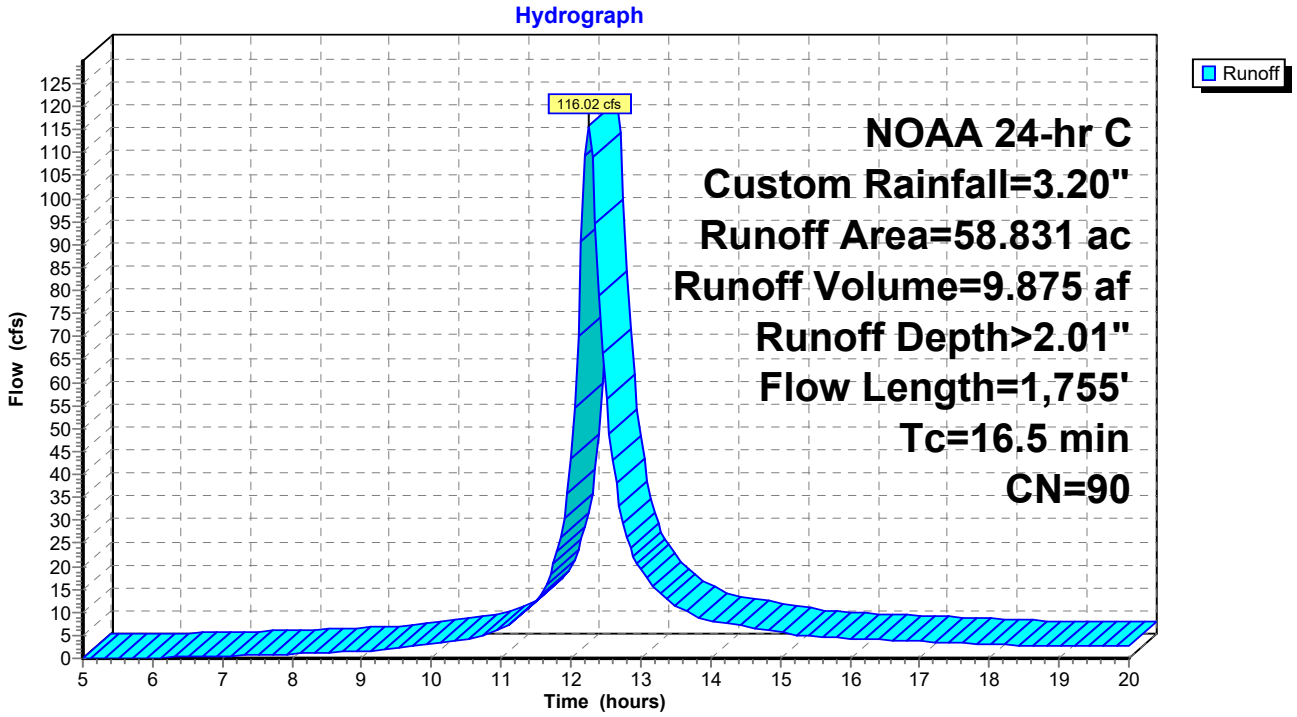
Runoff = 116.02 cfs @ 12.25 hrs, Volume= 9.875 af, Depth> 2.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
NOAA 24-hr C Custom Rainfall=3.20"

Area (ac)	CN	Description
2.547	92	Urban commercial, 85% imp, HSG B
0.429	98	Roofs, HSG B
0.114	98	Paved parking, HSG B
1.151	92	Urban commercial, 85% imp, HSG B
4.165	73	Woods, Fair, HSG C
1.220	94	Urban commercial, 85% imp, HSG C
0.879	94	Urban commercial, 85% imp, HSG C
2.033	83	1/4 acre lots, 38% imp, HSG C
2.857	94	Urban commercial, 85% imp, HSG C
1.417	79	50-75% Grass cover, Fair, HSG C
1.046	73	Woods, Fair, HSG C
0.131	79	Woods, Fair, HSG D
0.848	79	Woods, Fair, HSG D
17.688	95	Urban commercial, 85% imp, HSG D
6.253	87	1/4 acre lots, 38% imp, HSG D
7.927	95	Urban commercial, 85% imp, HSG D
2.427	84	50-75% Grass cover, Fair, HSG D
0.279	79	Woods, Fair, HSG D
5.420	94	Urban commercial, 85% imp, HSG C
58.831	90	Weighted Average
21.404		36.38% Pervious Area
37.427		63.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.6	100	0.0100	1.04		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.20"
0.4	90	0.0400	4.06		**Shallow Concentrated Flow, Shallow Concentrated Flow** Paved Kv= 20.3 fps
0.4	93	0.0540	3.74		**Shallow Concentrated Flow, Shallow 2** Unpaved Kv= 16.1 fps
10.5	546	0.0300	0.87		**Shallow Concentrated Flow, Shallow3** Woodland Kv= 5.0 fps
0.5	281		9.83		**Lake or Reservoir, Pond** Mean Depth= 3.00'
0.2	188	0.0600	16.90	331.73	**Pipe Channel, RCP_Round 60"** 60.0" Round Area= 19.6 sf Perim= 15.7' r= 1.25' n= 0.025 Earth, clean & winding
2.9	457	0.0100	2.62	7.20	**Trap/Vee/Rect Channel Flow, Stream** Bot.W=4.00' D=0.50' Z= 3.0 '/' Top.W=7.00' n= 0.030 Earth, grassed & winding
16.5	1,755	Total			

Subcatchment 3S: Waterworks



Summary for Reach 4R: Reach 1

[91] Warning: Storage range exceeded by 0.29'
[55] Hint: Peak inflow is 152% of Manning's capacity

Inflow Area = 102.638 ac, 42.61% Impervious, Inflow Depth > 1.57" for Custom event
Inflow = 146.00 cfs @ 12.27 hrs, Volume= 13.449 af
Outflow = 142.82 cfs @ 12.32 hrs, Volume= 13.402 af, Atten= 2%, Lag= 3.4 min

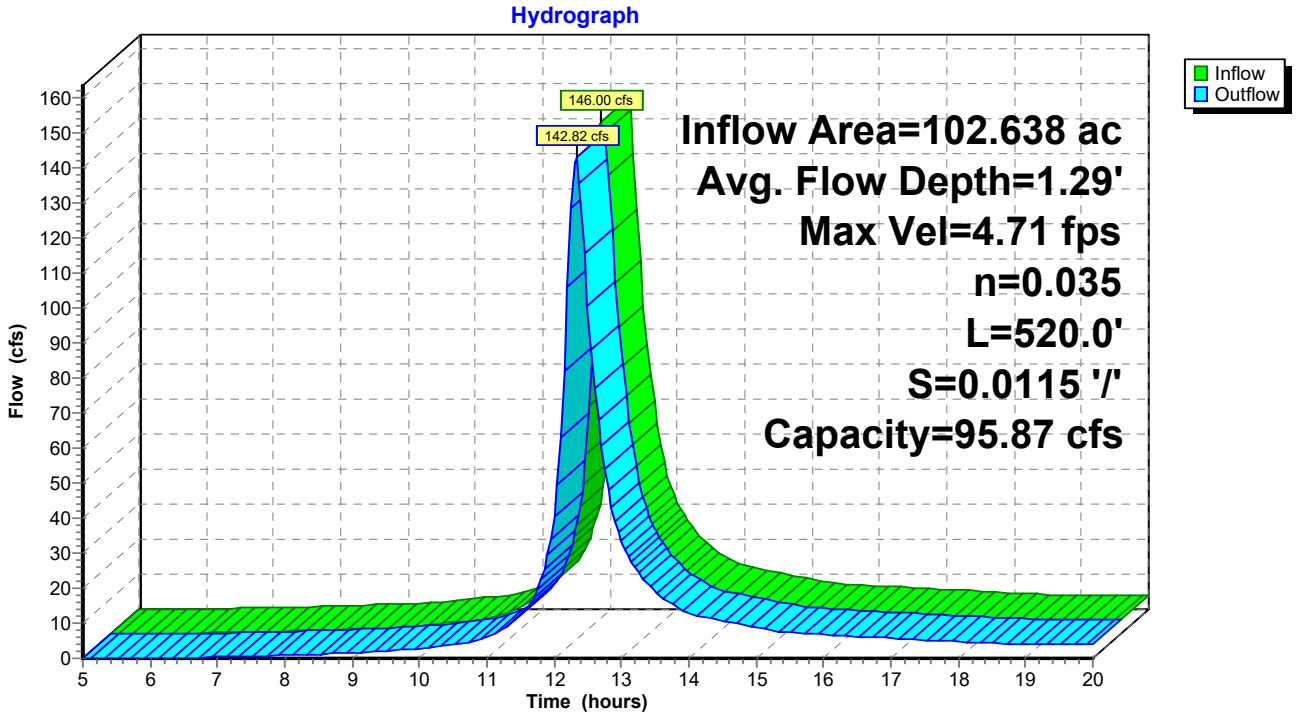
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.71 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 1.48 fps, Avg. Travel Time= 5.9 min

Peak Storage= 15,924 cf @ 12.29 hrs
Average Depth at Peak Storage= 1.29'
Bank-Full Depth= 1.00' Flow Area= 23.0 sf, Capacity= 95.87 cfs

20.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 26.00'
Length= 520.0' Slope= 0.0115 '/'
Inlet Invert= 43.50', Outlet Invert= 37.50'

‡

Reach 4R: Reach 1



Summary for Reach 5R: Reach 2

[91] Warning: Storage range exceeded by 0.44'
[55] Hint: Peak inflow is 182% of Manning's capacity
[62] Hint: Exceeded Reach 4R OUTLET depth by 0.33' @ 12.50 hrs

Inflow Area = 135.738 ac, 32.35% Impervious, Inflow Depth > 1.37" for Custom event
Inflow = 153.24 cfs @ 12.33 hrs, Volume= 15.529 af
Outflow = 147.31 cfs @ 12.45 hrs, Volume= 15.421 af, Atten= 4%, Lag= 6.8 min

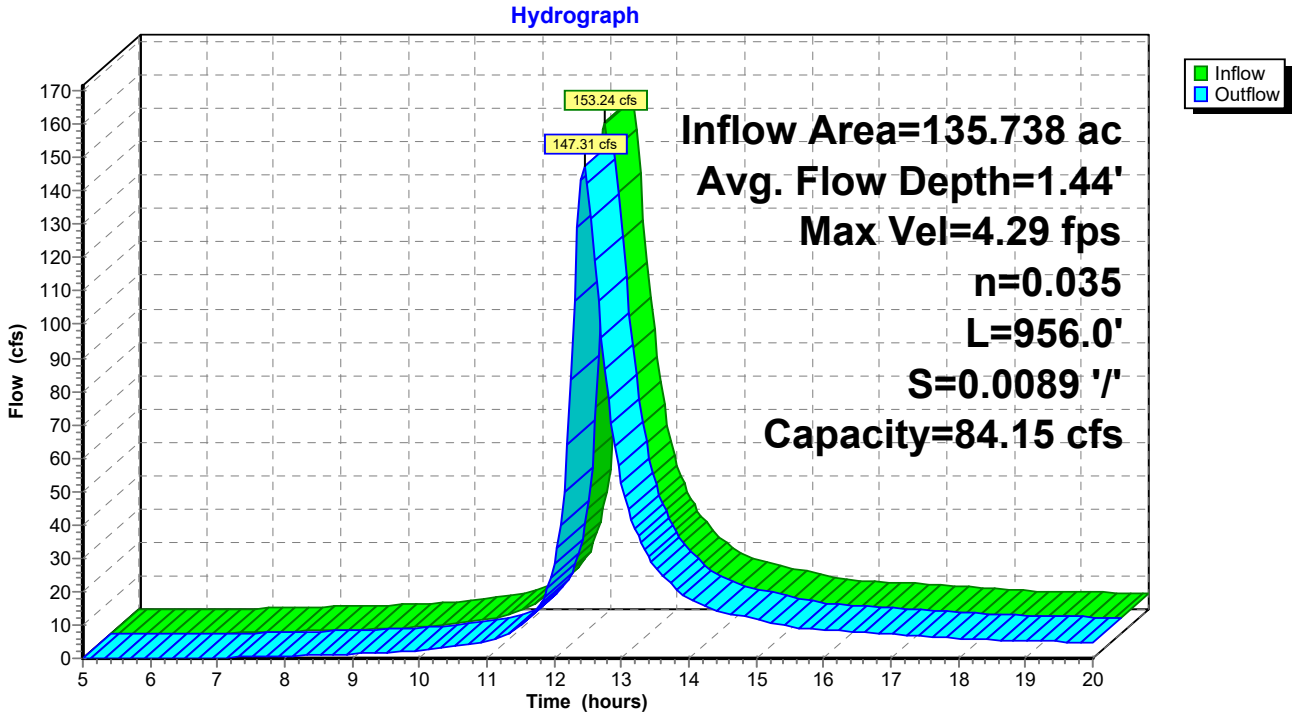
Routing by Stor-Ind+Trans method, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.29 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 1.42 fps, Avg. Travel Time= 11.2 min

Peak Storage= 32,975 cf @ 12.38 hrs
Average Depth at Peak Storage= 1.44'
Bank-Full Depth= 1.00' Flow Area= 23.0 sf, Capacity= 84.15 cfs

20.00' x 1.00' deep channel, n= 0.035 Earth, dense weeds
Side Slope Z-value= 3.0 '/' Top Width= 26.00'
Length= 956.0' Slope= 0.0089 '/'
Inlet Invert= 37.50', Outlet Invert= 29.00'

‡

Reach 5R: Reach 2



Appendix B: Wetland Delineation Memo

Biohabitats

The Stables Building
2081 Clipper Park Road
Baltimore, MD 21211
410.554.0156
www.biohabitats.com

MEMORANDUM

Date: October 15, 2024

To: Mallory Box, Arundel Rivers Federation

From: Tanaira Cullens and Jim Coper, Biohabitats, Inc.

RE: Annapolis Waterworks Park Stream Restoration
Subject: Wetland Delineation Memo

INTRODUCTION

This memorandum summarizes the findings of a wetland delineation conducted by Biohabitats in fall of 2024 for the Annapolis Waterworks Park Stream Restoration project in Annapolis, Maryland, for the Arundel Rivers Federation. The area of interest is approximately 1,430 lf of a first-order, unnamed tributary (the main tributary) to Broad Creek in Annapolis, Maryland. The main tributary originates at a stormwater pond outfall at Housley Road and flows northwest toward Broad Creek. The majority of the area of interest is classified as PFO1C while a smaller section at the western boundary of the limits of delineation is classified as PEM1C and includes wetlands of special state concern according to the National Wetlands Inventory (NWI) and Maryland Department of Natural Resources Maryland's Environmental Resources and Land Information Network (MERLIN). The primary goal of this project is alignment of the stream channel, its immediate riparian corridor extents consisting of an approximate area 30 ft. off each stream bank, confluences with other drainage features flowing into the main tributary, and adjacent uplands required to access restoration work areas, an area totaling approximately 3.5 acres.

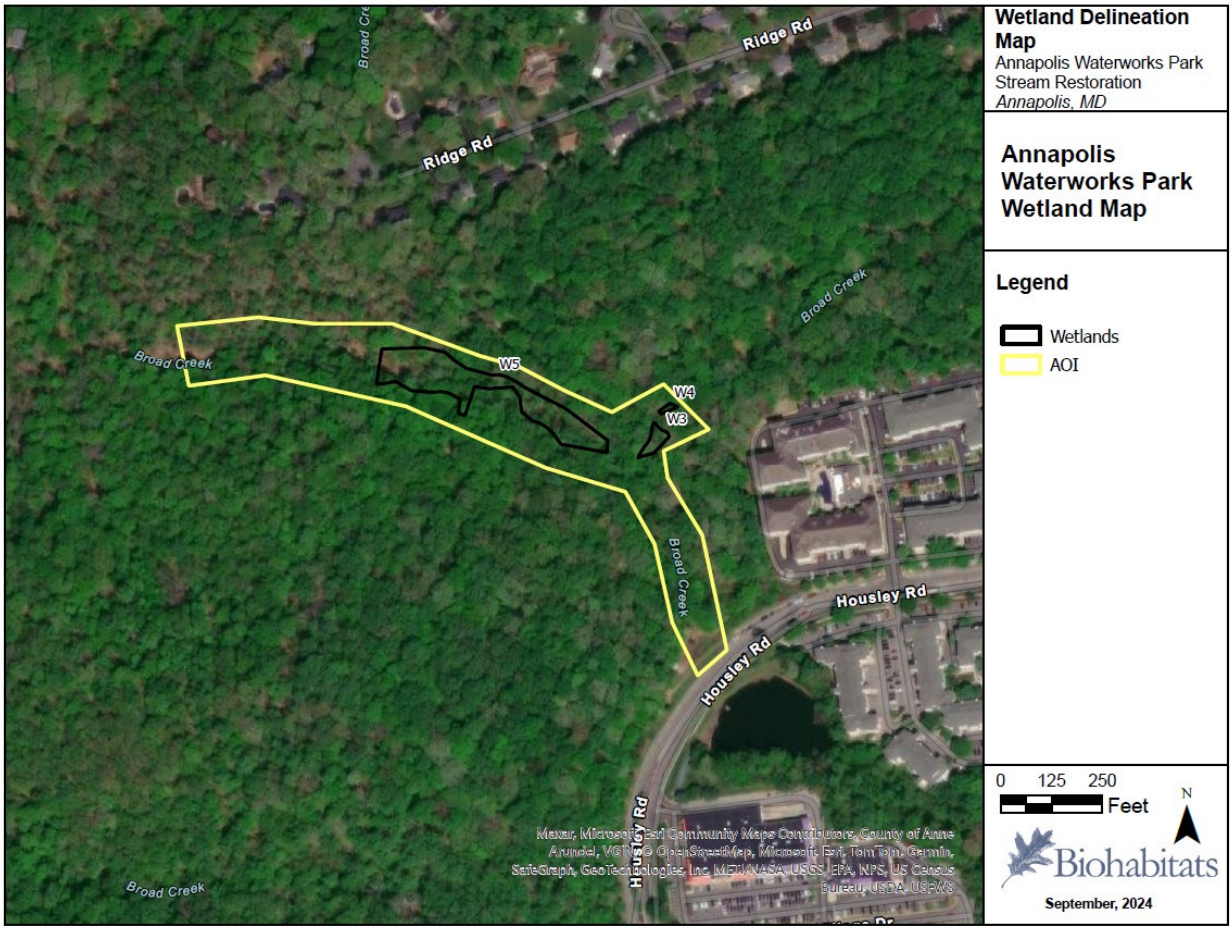


Figure 1. Annapolis Waterworks Limits of Delineation Map

METHODS

The wetland delineation field assessment was performed by Biohabitats environmental scientists over several site visits in fall of 2024, for the purpose of collecting and documenting field conditions and delineating wetlands along the approximate 1,430 linear feet corridor of the main tributary to Broad Creek in Annapolis, Maryland. The main tributary originates at a stormwater pond outfall at Housley Road and flows northwest toward Broad Creek The delineated wetland boundaries within the restoration project area referred to herein as limits of delineation were flagged in the field in September 2024 for subsequent survey.

Three nontidal wetlands were identified, delineated, and documented within the limits of delineation in compliance with applicable State and Federal regulations. The delineation was performed using the three-parameter approach; wetland hydrology, hydrophytic vegetation, and hydric soils in accordance with the 1987 Corps of Engineers Wetlands Delineation Manual - Technical Report 87-1 (USACE, 1987) and the 2012 Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0).

The existing hydrology was evaluated at each sample location by documenting the presence of primary and secondary hydrologic indicators, which provides evidence as to whether a site has a continuing wetland hydrologic regime. For the hydrophytic vegetation determination, the abundance of each species within four strata – tree stratum, sapling/shrub stratum, herb stratum,

and woody vines – was sampled. The vegetative sample plots were measured in a 30ft radius across all strata. As needed, the shape of each plot may have been modified to adapt to site conditions. A wetland indicator status was applied to each identified plant species according to the 2020 National Wetland Plant List (NWPL). To determine if hydric soils were present, the soil profile at each sample location was characterized, focusing on the soil matric color and presence/absence of redoximorphic features.

WETLAND DELINEATION RESULTS

Three nontidal wetland areas (Wetlands 3, 4 and 5) were identified during onsite investigations on September 12 and September 13, 2024 (Attachment D). Three wetland delineation data forms were completed to confirm and document the presence and/or absence of wetland indicators observed (Attachment E). The following describes the Three nontidal wetlands delineated and additional areas investigated within the limits of delineation.

Wetlands 3 and 4

Wetlands 3 and 4 (W3 and W4) are classified as Palustrine Forested (PFO) and are located along floodplain benches along the UT to Broad Creek. Its wetland hydrology is supported by groundwater, surface runoff from the adjacent upland hillslopes, and overbank flows from the tributary. The dominant vegetation species in W3 and W4 are tulip poplar (*Liriodendron tulipifera*), beech (*Fagus grandifolia*) and Ironwood (*Carpinus caroliniana*) in both the tree stratum and sapling/shrub stratum, lady fern (*Anthurium felix femina)* and partridge berry (*Mitchella repens*) in the herbaceous stratum.

Wetland delineation data form W3 + W4 was completed to document the hydric soil (i.e. F3 Depleted Matrix), and wetland hydrology (i.e. A3 Saturation, B9 Water-Stained Leaves, B10 Drainage Patterns, C8 Crayfish Burrows and D2 Geomorphic Position) indicators met at Wetlands 3 and 4. While these wetlands do not meet the hydrophytic vegetation indicator, both wetlands are in close proximity of larger wetland 5 and vegetation likely represents the transitional zone. The non-wetland point for Wetlands 3 and 4 (data form NW1) was taken on a floodplain bench across from the Wetland 5 data point and did not meet any hydric soil, hydrology or hydrophytic vegetation indicators.

Wetland 5

Wetland 5 (W5) is classified as Palustrine Forested (PFO) and Palustrine Emergent, which continues to the west beyond the limits of the site. Its wetland hydrology is supported by groundwater, surface runoff from the adjacent upland hillslopes, and overbank flows from the main tributary. The dominant vegetation species in W5 are beech (*Fagus grandifolia*) and black gum (*Nyssa sylvatica*) in the tree stratum, red maple (*Acer rubrum*) in the shrub/sapling stratum and beech (*Fagus grandifolia*), japanese stilitgrass (*Microstegium vimineum*) and jack in the pulpit (*Arisaema tryphyllum*) in the herbaceous stratum. It is important to note that Wetland 5 boundaries may be extended further downstream to encompass the restoration tie-out area into existing conditions per project stakeholder comments.

Wetland delineation data form W5 was completed to document the hydrophytic vegetation (i.e. Dominance test is ≥50), hydric soil (i.e. F3 Depleted Matrix and F6 Redox Dark Surface), and wetland hydrology (i.e. A3 Saturation, B9 Water-Stained Leaves, B10 Drainage Patterns, C3 Oxidized Rhizospheres along Living Roots, C8 Crayfish Burrows and D2 Geomorphic Position)

indicators met at Wetland 5. The non-wetland point for Wetland 5 is represented by the same form (data form NW1) as Wetlands 3 and 4.

WATERS OF THE U.S. DELINEATION RESULTS

Two Waters of the U.S. (WOTUS), the main tributary (UT to Broad Creek) and a smaller reach (Tributary X) were delineated. The main tributary is 1,430 linear feet with a wetted width ranging from 2 feet to 15 feet and eroded banks throughout. Observations along the unnamed tributary suggest flow throughout the limits of delineation is perennial (i.e., typically has water flowing in them year-round) and is sustained by groundwater, with multiple surface inputs in the form of both sheet runoff along the land surface and concentrated flow through swales and at least one stormwater outfall. Since the stormwater outfall enters directly into the stream that would be inclusive of the main tributary's ordinary high water mark (OHWM), individual outfall channels were not delineated. The channel substrate of the main tributary consists primarily of silt, clay and coarse sands. The main tributary flows into Broad Creek then continues southeast, entering into the South River before eventually flowing into the Chesapeake Bay.

ANTECEDENT PRECIPITATION TOOL RESULTS

The Antecedent Precipitation Tool (APT) is used to assist in determining the jurisdictional status of certain waterbodies. The APT was developed by the US Army Corps of Engineers (USACE) "to streamline and automate evaluation of precipitation normalcy and other climatic variables to complete wetland delineations whenever an assessment of the following site-specific conditions is needed: 1) dry season, 2) drought conditions, 3) lower than normal antecedent precipitation, or 4) greater than normal antecedent precipitation. In addition to informing wetland delineations, the APT can also be used to assist in determining whether observations are representative of normal climatic conditions…." (EPA, 2021)

The APT was not able to be generated due to NOAA servers being down, however, there was no rainfall leading up to the field days on September 12 and 13th 2024.

SUMMARY

Three nontidal wetlands (Wetland 3, 4 and 5) were delineated within the site limits, which are displayed on wetland mapping in Attachment D. Table 1 summarizes the delineated wetland areas and the wetland characterization (based on Cowardin et al. 1979). Based on Biohabitats best professional judgement, it is anticipated the delineated wetland are jurisdictional under the CWA and will be regulated by the US Army Corps of Engineers (USACE) and Maryland Department of the Environment (MDE).

Table 2 summarizes the stream channels identified and delineated within the site limits. It is also anticipated that the main tributary (UT) and brief section of Tributary X that were identified and delineated are jurisdictional under the CWA and will be regulated by the USACE and MDE.

Table 1 Nontidal Wetland Summary

Wetland Name	Area Within Survey Limits		Classification (Cowardin et. al., 1979)
	Square Feet	Acres	
Wetland 3	549	0.01	PFO
Wetland 4	TBD	TBD	PFO
Wetland 5	TBD	TBD	PFO/PEM

Table 2 Waters of the US Summary

Stream Name	Length Within Survey Limits (linear feet)	Stream Flow Classification
Main Tributary (UT to Broad Creek)	1430	Perennial
Tributary X	TBD	

REFERENCES

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. U.S. Department of Interior, Fish and Wildlife Service, Office of Biological Services.

U.S. Army Corps of Engineers 2020. National Wetland Plant List, version 3.5 http://wetland-plants.usace.army.mil/, U.S. Army Corps of Engineers, Engineer Research and Development Center, Cold Regions Research and Engineering Laboratory, Hanover, NH.

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at the following link: http://websoilsurvey.sc.egov.usda.gov/. Accessed [September 12, 2024].

U.S. Army Corps of Engineers, 1987. Army Corps of Engineers Environmental Laboratory Corps of Engineers Wetlands Delineation Manual. Wetland Research Program. Technical Report 87-1. 100 pp and appendices.

U.S. Army Corps of Engineers. 2010. Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Atlantic and Gulf Coastal Plain Region (Version 2.0). ERDC/EL TR-10-20. Vicksburg, MS: U.S. Army Engineer Research and Development Center.

U.S. Department of Homeland Security. Federal Emergency Management Agency (FEMA). FEMA Flood Map Service Center. Available online at https://msc.fema.gov/portal/home. Accessed September 2024.

ATTACHMENTS

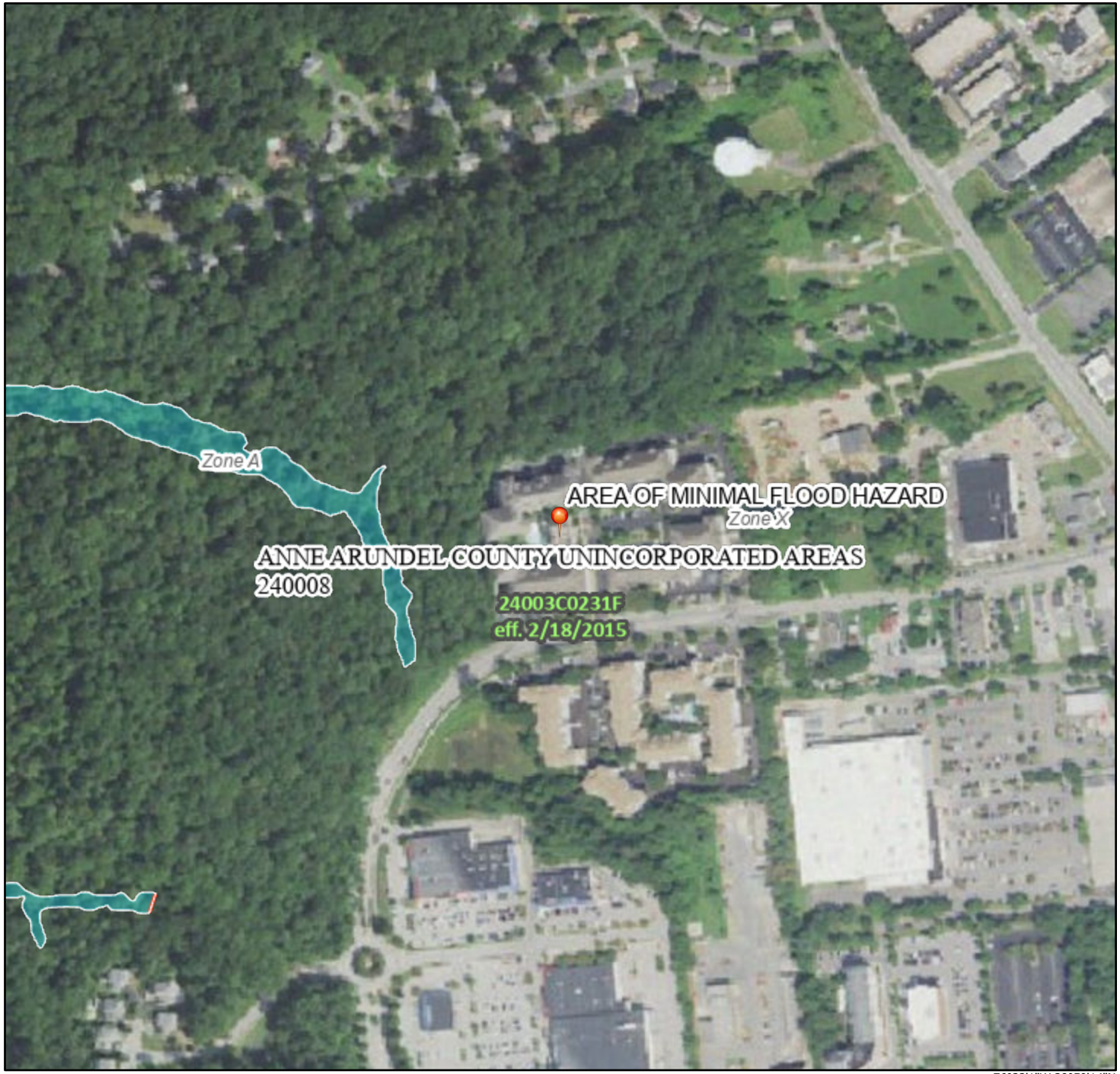
A. FEMA FIRMette Map
B. NWI & DNR Wetland Maps
C. NRCS Web Soil Survey Maps and Reporting
D. Wetland and Waters of the U.S. Delineation Map
E. Wetland Delineation Data Forms

ATTACHMENT A –
FEMA FIRMETTE MAP

National Flood Hazard Layer FIRMette

FEMA

76°33'38"W 38°59'42"N



76°33'1"W 38°59'14"N

0 250 500 1,000 1,500 2,000 Feet

1:6,000

Basemap Imagery Source: USGS National Map 2023

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

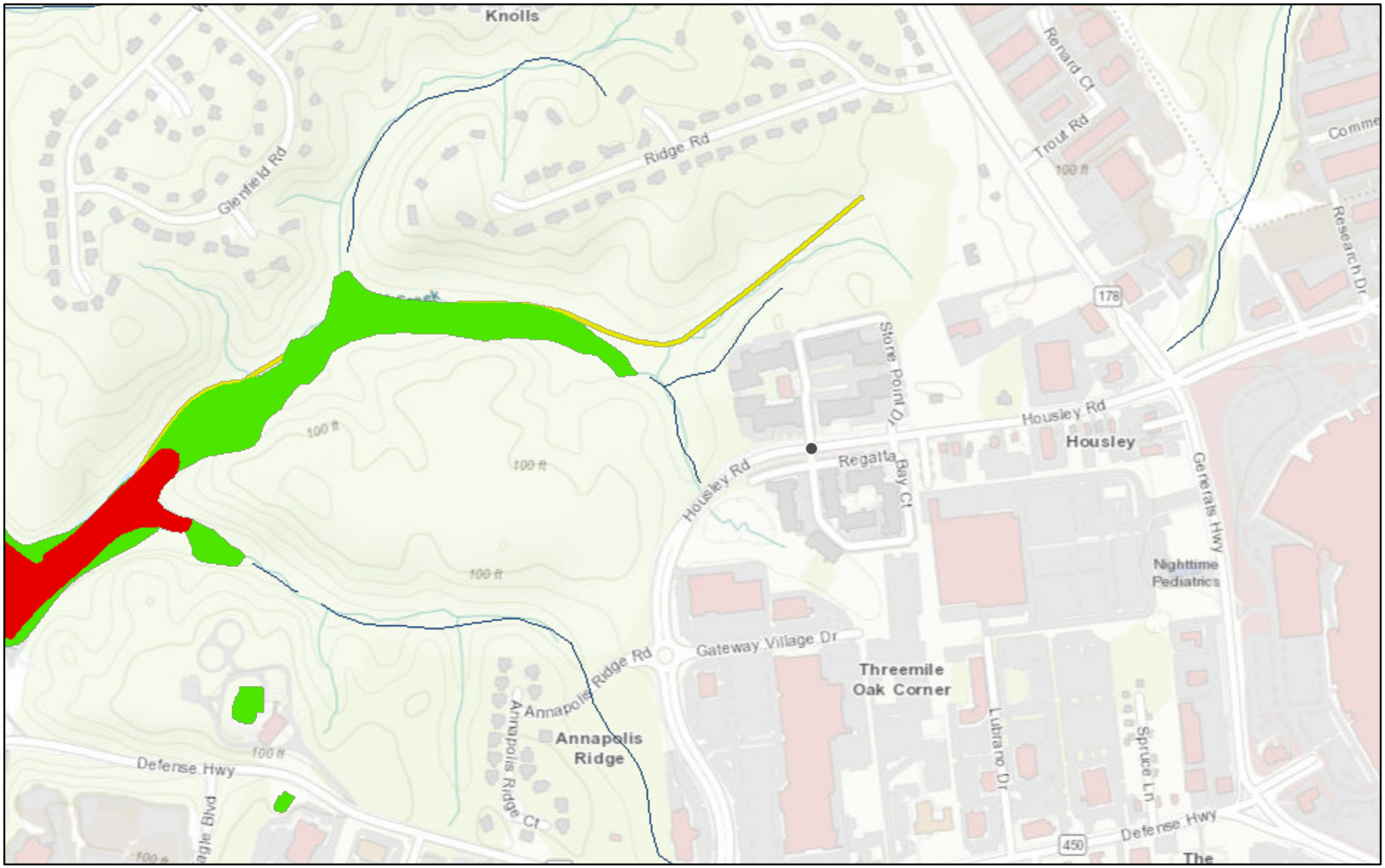
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 9/9/2024 at 3:15 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

ATTACHMENT B –
NWI & DNR WETLAND MAPS

MERLIN Onine



9/9/2024, 3:14:45 PM

1:9,028

0 0.05 0.1 0.2 mi

0 0.07 0.15 0.3 km

State Boundary Mask

Wetlands - Linear - Special State Concern

Wetlands - Polygon - Special State Concern

Wetlands - National Wetlands Inventory

Estuarine

Lacustrine

Marine

Palustrine

Riverine

Wetlands - Polygon - Department of Natural Resources

Estuarine

Lacustrine

Marine

Palustrine

Riverine

Wetlands - Linear - Department of Natural Resources

Estuarine

Palustrine

Riverine

MD iMAP, DNR, USFW, County of Anne Arundel, VITA, Esri, HERE, Garmin, INCREMENT P, Intermap, USGS, METI/NASA, EPA, USDA, MD iMAP, ESRI

ATTACHMENT C –
NRCS WEB SOIL SURVEY MAPS AND REPORTING

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Anne Arundel County, Maryland

September 9, 2024

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:3,390 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

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

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

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 1:12,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
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: Anne Arundel County, Maryland
Survey Area Data: Version 22, Sep 12, 2023

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

Date(s) aerial images were photographed: Jun 20, 2022—Aug 13, 2022

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.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
AsF	Annapolis fine sandy loam, 25 to 40 percent slopes	10.5	69.5%
MaB	Marr-Dodon complex, 2 to 5 percent slopes	0.0	0.2%
MaD	Marr-Dodon complex, 10 to 15 percent slopes	0.6	3.7%
Uz	Urban land	0.5	3.4%
WBA	Widewater and Issue soils, 0 to 2 percent slopes, frequently flooded	3.5	23.2%
Totals for Area of Interest		**15.1**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Anne Arundel County, Maryland

AsF—Annapolis fine sandy loam, 25 to 40 percent slopes

Map Unit Setting

National map unit symbol: 4m9w
Elevation: 10 to 180 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 180 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Annapolis and similar soils: 75 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Annapolis

Setting

Landform: Interfluves, ravines
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Glauconitic loamy fluviomarine deposits

Typical profile

Ap - 0 to 8 inches: fine sandy loam
Bt - 8 to 27 inches: channery sandy clay loam
E and Bt - 27 to 61 inches: loamy sand
CB - 61 to 81 inches: loamy sand

Properties and qualities

Slope: 25 to 40 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 7.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: C
Ecological site: F149AY150MD - Well Drained Glauconitic Fine-Loamy Upland
Hydric soil rating: No

Minor Components

Collington

Percent of map unit: 10 percent
Landform: Interfluves, ravines

Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F149AY170MD - Well Drained Fine-Loamy Upland
Hydric soil rating: No

Howell

Percent of map unit: 5 percent
Landform: Ravines, interfluves
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F149AY160MD - Well Drained Clayey Upland
Hydric soil rating: No

Widewater

Percent of map unit: 5 percent
Landform: Flood plains, drainageways
Down-slope shape: Linear
Across-slope shape: Concave
Ecological site: R149AY060DE - Wet Alluvial Floodplain
Hydric soil rating: Yes

Adelphia

Percent of map unit: 5 percent
Landform: Hillslopes, interfluves
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex, linear
Ecological site: F149AY130NJ - Moist Loamy Upland
Hydric soil rating: No

MaB—Marr-Dodon complex, 2 to 5 percent slopes

Map Unit Setting

National map unit symbol: 4mcs
Elevation: 0 to 200 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 180 to 210 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Marr and similar soils: 45 percent
Dodon and similar soils: 35 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Marr

Setting

Landform: Knolls, interfluves
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits

Typical profile

Ap - 0 to 12 inches: fine sandy loam
Bt1 - 12 to 25 inches: fine sandy loam
Bt2 - 25 to 57 inches: sandy clay loam
BC - 57 to 76 inches: loamy fine sand

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 9.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Ecological site: F149AY170MD - Well Drained Fine-Loamy Upland
Hydric soil rating: No

Description of Dodon

Setting

Landform: Stream terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits

Typical profile

Ap - 0 to 9 inches: fine sandy loam
Bt - 9 to 36 inches: sandy clay loam
BC - 36 to 48 inches: sandy clay loam
CB - 48 to 64 inches: fine sandy loam

Properties and qualities

Slope: 2 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 20 to 40 inches

Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 9.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: F149AY130NJ - Moist Loamy Upland
Hydric soil rating: No

Minor Components

Hambrook

Percent of map unit: 10 percent
Landform: Interfluves, fluviomarine terraces, broad interstream divides
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F149AY170MD - Well Drained Fine-Loamy Upland
Hydric soil rating: No

Liverpool

Percent of map unit: 10 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F153CY020MD - Moist Loess Upland
Hydric soil rating: No

MaD—Marr-Dodon complex, 10 to 15 percent slopes

Map Unit Setting

National map unit symbol: 4mcv
Elevation: 0 to 200 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 180 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Marr and similar soils: 45 percent
Dodon and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Marr

Setting

Landform: Interfluves, knolls
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy fluviomarine deposits

Typical profile

Ap - 0 to 12 inches: fine sandy loam
Bt1 - 12 to 25 inches: fine sandy loam
Bt2 - 25 to 57 inches: sandy clay loam
BC - 57 to 76 inches: loamy fine sand

Properties and qualities

Slope: 10 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 9.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: F149AY170MD - Well Drained Fine-Loamy Upland
Hydric soil rating: No

Description of Dodon

Setting

Landform: Knolls, interfluves
Landform position (two-dimensional): Backslope
Down-slope shape: Convex, linear
Across-slope shape: Convex, linear
Parent material: Loamy fluviomarine deposits

Typical profile

A - 0 to 5 inches: very fine sandy loam
E - 5 to 16 inches: very fine sandy loam
Bt - 16 to 47 inches: loam
BCtg - 47 to 73 inches: loam

Properties and qualities

Slope: 10 to 15 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: About 20 to 40 inches

Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 10.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: F149AY130NJ - Moist Loamy Upland
Hydric soil rating: No

Minor Components

Piccowaxen

Percent of map unit: 10 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear, concave
Across-slope shape: Linear
Ecological site: F153CY020MD - Moist Loess Upland
Hydric soil rating: No

Howell

Percent of map unit: 5 percent
Landform: Knolls, interfluves
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: F149AY160MD - Well Drained Clayey Upland
Hydric soil rating: No

Uz—Urban land

Map Unit Setting

National map unit symbol: ngbx
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 180 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Urban Land

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D

Hydric soil rating: No

WBA—Widewater and Issue soils, 0 to 2 percent slopes, frequently flooded

Map Unit Setting

National map unit symbol: 4m9c
Elevation: 0 to 600 feet
Mean annual precipitation: 40 to 50 inches
Mean annual air temperature: 52 to 57 degrees F
Frost-free period: 180 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Widewater and similar soils: 41 percent
Issue and similar soils: 39 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Widewater

Setting

Landform: Drainageways, flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

Ag - 0 to 4 inches: loam
Bg - 4 to 8 inches: fine sandy loam
BCg - 8 to 44 inches: loam
Agb - 44 to 67 inches: loam
Cg - 67 to 70 inches: clay

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: About 0 to 10 inches
Frequency of flooding: Frequent
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: High (about 10.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: C/D
Ecological site: R149AY060DE - Wet Alluvial Floodplain
Hydric soil rating: Yes

Description of Issue

Setting

Landform: Drainageways, drainhead complexes, flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loamy alluvium

Typical profile

Ap - 0 to 4 inches: silt loam
Bw - 4 to 19 inches: loam
Bg1 - 19 to 30 inches: fine sandy loam
Bg2 - 30 to 58 inches: fine sandy loam
Ab - 58 to 70 inches: silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 10 to 20 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: B/D
Ecological site: R149AY070MD - Moist Alluvial Floodplain
Hydric soil rating: No

Minor Components

Zekiah

Percent of map unit: 10 percent
Landform: Drainageways, flood plains
Down-slope shape: Linear
Across-slope shape: Concave, linear
Ecological site: R149AY060DE - Wet Alluvial Floodplain
Hydric soil rating: Yes

Longmarsh

Percent of map unit: 5 percent
Landform: Backswamps on flood plains, channels on flood plains
Down-slope shape: Linear
Across-slope shape: Linear, concave
Ecological site: R149AY060DE - Wet Alluvial Floodplain
Hydric soil rating: Yes

Shrewsbury

Percent of map unit: 5 percent
Landform: Swales, drainhead complexes, drainageways
Landform position (three-dimensional): Tread
Down-slope shape: Linear

Across-slope shape: Linear, concave
Ecological site: F149AY090NJ - Coastal Plain Hardwood Swamp
Hydric soil rating: Yes

Soil Information for All Uses

Suitabilities and Limitations for Use

The Suitabilities and Limitations for Use section includes various soil interpretations displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each interpretation.

Land Classifications

Land Classifications are specified land use and management groupings that are assigned to soil areas because combinations of soil have similar behavior for specified practices. Most are based on soil properties and other factors that directly influence the specific use of the soil. Example classifications include ecological site classification, farmland classification, irrigated and nonirrigated land capability classification, and hydric rating.

Hydric Rating by Map Unit

This rating indicates the percentage of map units that meets the criteria for hydric soils. Map units are composed of one or more map unit components or soil types, each of which is rated as hydric soil or not hydric. Map units that are made up dominantly of hydric soils may have small areas of minor nonhydric components in the higher positions on the landform, and map units that are made up dominantly of nonhydric soils may have small areas of minor hydric components in the lower positions on the landform. Each map unit is rated based on its respective components and the percentage of each component within the map unit.

The thematic map is color coded based on the composition of hydric components. The five color classes are separated as 100 percent hydric components, 66 to 99 percent hydric components, 33 to 65 percent hydric components, 1 to 32 percent hydric components, and less than one percent hydric components.

In Web Soil Survey, the Summary by Map Unit table that is displayed below the map pane contains a column named 'Rating'. In this column the percentage of each map unit that is classified as hydric is displayed.

Hydric soils are defined by the National Technical Committee for Hydric Soils (NTCHS) as soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part (Federal Register, 1994). Under natural conditions, these soils are either saturated or inundated long enough during the growing season to support the growth and reproduction of hydrophytic vegetation.

The NTCHS definition identifies general soil properties that are associated with wetness. In order to determine whether a specific soil is a hydric soil or nonhydric soil, however, more specific information, such as information about the depth and duration of the water table, is needed. Thus, criteria that identify those estimated soil properties unique to hydric soils have been established (Federal Register, 2002). These criteria are used to identify map unit components that normally are associated with wetlands. The criteria used are selected estimated soil properties that are described in "Soil Taxonomy" (Soil Survey Staff, 1999) and "Keys to Soil Taxonomy" (Soil Survey Staff, 2006) and in the "Soil Survey Manual" (Soil Survey Division Staff, 1993).

If soils are wet enough for a long enough period of time to be considered hydric, they should exhibit certain properties that can be easily observed in the field. These visible properties are indicators of hydric soils. The indicators used to make onsite determinations of hydric soils are specified in "Field Indicators of Hydric Soils in the United States" (Hurt and Vasilas, 2006).

References:

Federal Register. July 13, 1994. Changes in hydric soils of the United States.

Federal Register. September 18, 2002. Hydric soils of the United States.

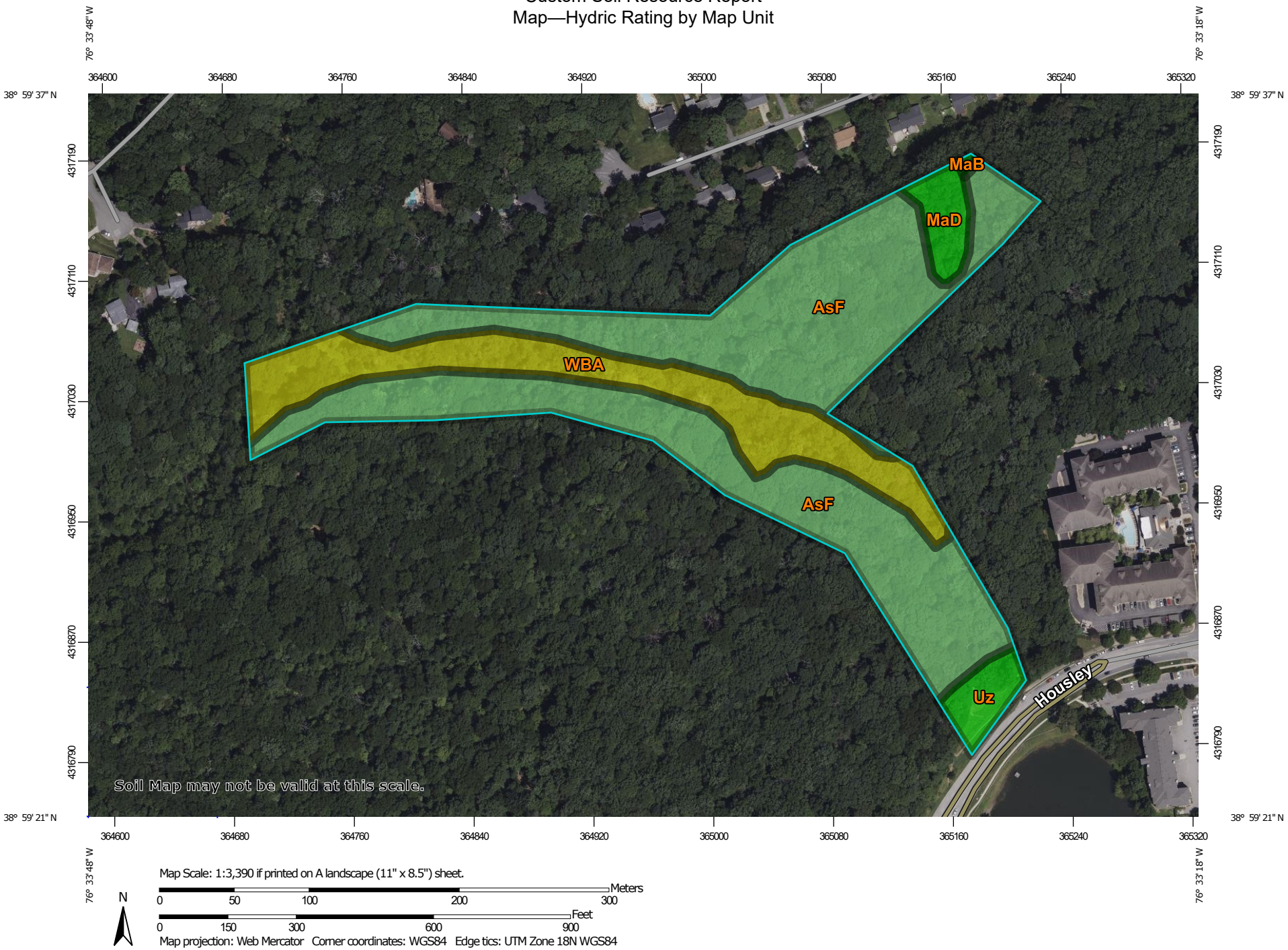
Hurt, G.W., and L.M. Vasilas, editors. Version 6.0, 2006. Field indicators of hydric soils in the United States.

Soil Survey Division Staff. 1993. Soil survey manual. Soil Conservation Service. U.S. Department of Agriculture Handbook 18.

Soil Survey Staff. 1999. Soil taxonomy: A basic system of soil classification for making and interpreting soil surveys. 2nd edition. Natural Resources Conservation Service. U.S. Department of Agriculture Handbook 436.

Soil Survey Staff. 2006. Keys to soil taxonomy. 10th edition. U.S. Department of Agriculture, Natural Resources Conservation Service.

Custom Soil Resource Report
Map—Hydric Rating by Map Unit



Map Scale: 1:3,390 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

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

Soils

Soil Rating Polygons
- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Soil Rating Lines
- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Soil Rating Points
- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- 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 1:12,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
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: Anne Arundel County, Maryland
Survey Area Data: Version 22, Sep 12, 2023

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

Date(s) aerial images were photographed: Jun 20, 2022—Aug 13, 2022

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.

Table—Hydric Rating by Map Unit

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AsF	Annapolis fine sandy loam, 25 to 40 percent slopes	5	10.5	69.5%
MaB	Marr-Dodon complex, 2 to 5 percent slopes	0	0.0	0.2%
MaD	Marr-Dodon complex, 10 to 15 percent slopes	0	0.6	3.7%
Uz	Urban land	0	0.5	3.4%
WBA	Widewater and Issue soils, 0 to 2 percent slopes, frequently flooded	61	3.5	23.2%
Totals for Area of Interest			**15.1**	**100.0%**

Rating Options—Hydric Rating by Map Unit

Aggregation Method: Percent Present

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Erosion Factors

Soil Erosion Factors are soil properties and interpretations used in evaluating the soil for potential erosion. Example soil erosion factors can include K factor for the whole soil or on a rock free basis, T factor, wind erodibility group and wind erodibility index.

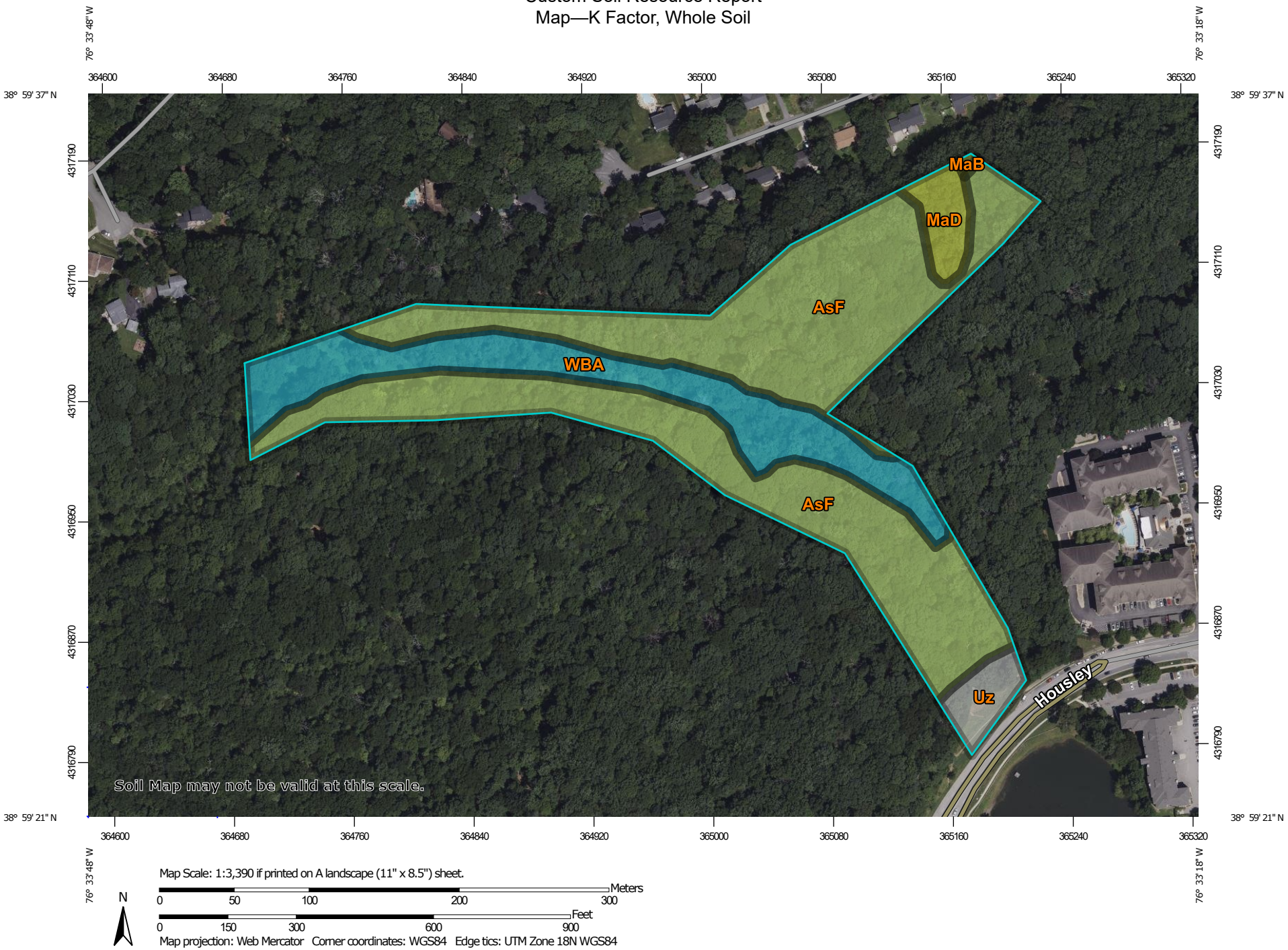
K Factor, Whole Soil

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and saturated hydraulic conductivity (Ksat). Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

"Erosion factor Kw (whole soil)" indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Factor K does not apply to organic horizons and is not reported for those layers.

Custom Soil Resource Report
Map—K Factor, Whole Soil



Map Scale: 1:3,390 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Soil Rating Lines

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
Not rated or not available

Soil Rating Points

.02
.05
.10
.15
.17
.20
.24
.28
.32
.37
.43
.49
.55
.64
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 1:12,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
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: Anne Arundel County, Maryland
Survey Area Data: Version 22, Sep 12, 2023

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

Date(s) aerial images were photographed: Jun 20, 2022—Aug 13, 2022

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.

Table—K Factor, Whole Soil

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AsF	Annapolis fine sandy loam, 25 to 40 percent slopes	.24	10.5	69.5%
MaB	Marr-Dodon complex, 2 to 5 percent slopes	.20	0.0	0.2%
MaD	Marr-Dodon complex, 10 to 15 percent slopes	.20	0.6	3.7%
Uz	Urban land		0.5	3.4%
WBA	Widewater and Issue soils, 0 to 2 percent slopes, frequently flooded	.37	3.5	23.2%
Totals for Area of Interest			**15.1**	**100.0%**

Rating Options—K Factor, Whole Soil

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Layer Options (Horizon Aggregation Method): Surface Layer (Not applicable)

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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.

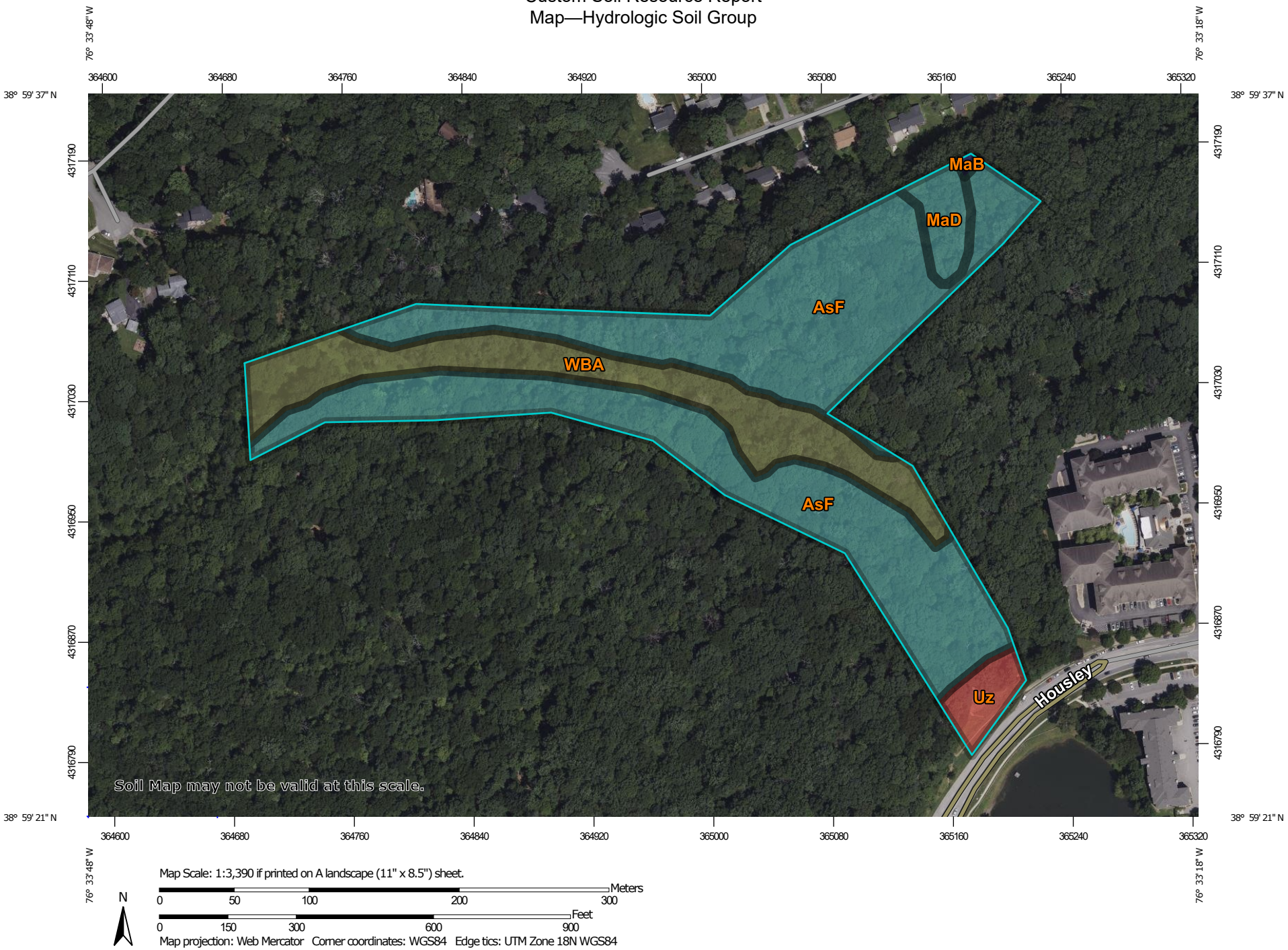
Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

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.

Custom Soil Resource Report
Map—Hydrologic Soil Group



Map Scale: 1:3,390 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N 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 1:12,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
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.

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Survey Area Data: Version 22, Sep 12, 2023

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

Date(s) aerial images were photographed: Jun 20, 2022—Aug 13, 2022

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.

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AsF	Annapolis fine sandy loam, 25 to 40 percent slopes	C	10.5	69.5%
MaB	Marr-Dodon complex, 2 to 5 percent slopes	B	0.0	0.2%
MaD	Marr-Dodon complex, 10 to 15 percent slopes	C	0.6	3.7%
Uz	Urban land	D	0.5	3.4%
WBA	Widewater and Issue soils, 0 to 2 percent slopes, frequently flooded	C/D	3.5	23.2%
Totals for Area of Interest			**15.1**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

References

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Custom Soil Resource Report
Soil Map

Map Scale: 1:3,390 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

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

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

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 1:12,000.

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

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

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Soil Survey Area: Anne Arundel County, Maryland
Survey Area Data: Version 22, Sep 12, 2023

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

Date(s) aerial images were photographed: Jun 20, 2022—Aug 13, 2022

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.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
AsF	Annapolis fine sandy loam, 25 to 40 percent slopes	10.5	69.5%
MaB	Marr-Dodon complex, 2 to 5 percent slopes	0.0	0.2%
MaD	Marr-Dodon complex, 10 to 15 percent slopes	0.6	3.7%
Uz	Urban land	0.5	3.4%
WBA	Widewater and Issue soils, 0 to 2 percent slopes, frequently flooded	3.5	23.2%
Totals for Area of Interest		**15.1**	**100.0%**

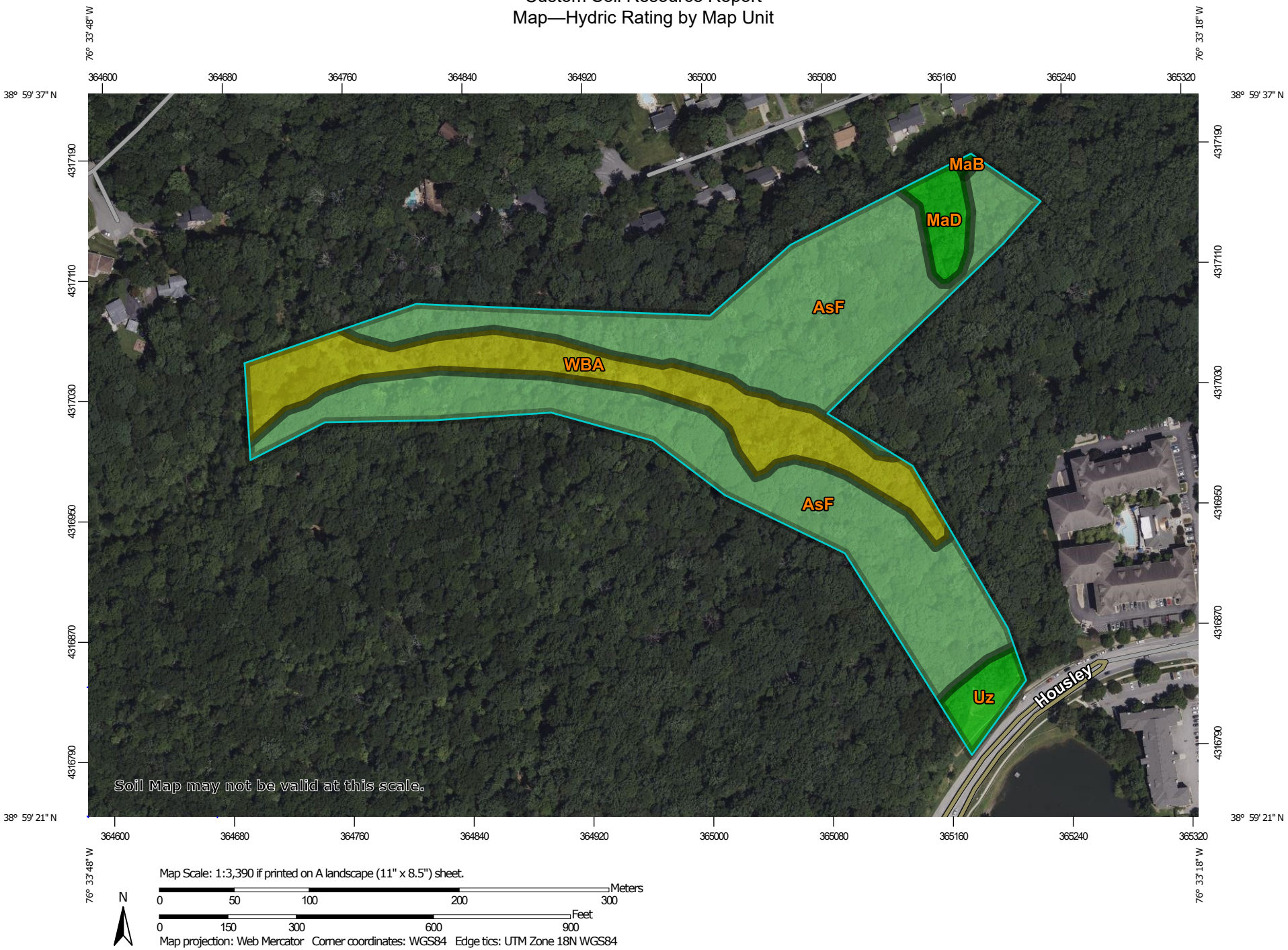
Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

Custom Soil Resource Report
Map—Hydric Rating by Map Unit



Map Scale: 1:3,390 if printed on A landscape (11" x 8.5") sheet.

N

Meters
0 50 100 200 300

Feet
0 150 300 600 900

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

MAP LEGEND

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

Soils

Soil Rating Polygons
- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Soil Rating Lines
- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- Not rated or not available

Soil Rating Points
- Hydric (100%)
- Hydric (66 to 99%)
- Hydric (33 to 65%)
- Hydric (1 to 32%)
- Not Hydric (0%)
- 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 1:12,000.

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

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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.

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Survey Area Data: Version 22, Sep 12, 2023

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

Date(s) aerial images were photographed: Jun 20, 2022—Aug 13, 2022

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.

Table—Hydric Rating by Map Unit

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
AsF	Annapolis fine sandy loam, 25 to 40 percent slopes	5	10.5	69.5%
MaB	Marr-Dodon complex, 2 to 5 percent slopes	0	0.0	0.2%
MaD	Marr-Dodon complex, 10 to 15 percent slopes	0	0.6	3.7%
Uz	Urban land	0	0.5	3.4%
WBA	Widewater and Issue soils, 0 to 2 percent slopes, frequently flooded	61	3.5	23.2%
Totals for Area of Interest			**15.1**	**100.0%**

Rating Options—Hydric Rating by Map Unit

Aggregation Method: Percent Present

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

ATTACHMENT D –
WETLAND AND WATERS OF THE UNITED STATES
DELINEATION MAP

Wetland Delineation Map
Annapolis Waterworks Park Stream Restoration
Annapolis, MD

Annapolis Waterworks Park Wetland Map

Legend

- Wetlands
- AOI

0 125 250
Feet

N

Biohabitats

September, 2024

ATTACHMENT E –
WETLAND DELINEATION DATA FORMS

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Annapolis Waterworks City/County: Annapolis Sampling Date: 2024/09/12

Applicant/Owner: Arundel Rivers Federation State: MD Sampling Point: W3 +W4

Investigator(s): TC/SW Section, Township, Range:

Landform (hillslope, terrace, etc.): Floodplain Bench Local relief (concave, convex, none): Slope (%):

Subregion (LRR or MLRA): Floodplain Bench Lat: 38.991239 Long: -76.557543 Datum: WGS 84

Soil Map Unit Name: Annapolis Fine Sandy Loam (ASF) NWI classification: PFO1C

Are climatic / hydrologic conditions on the site typical for this time of year? Yes [✔] No [ ] (If no, explain in Remarks.)

Are Vegetation [ ] Soil [ ] or Hydrology [ ] significantly disturbed? [ ] Are "Normal Circumstances" present? Yes [✔] No [ ]

Are Vegetation [ ] Soil [ ] or Hydrology [ ] naturally problematic? [ ] (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes [ ]	No [✔]	**Is the Sampled Area within a Wetland?** Yes [✔] No [ ]
Hydric Soil Present?	Yes [✔]	No [ ]	
Wetland Hydrology Present?	Yes [✔]	No [ ]	

Remarks:

Floodplain benches beginning at the confluence of Broad Creek and unknown tributary (left and right banks) W3-1 through W3-8 and W4-1 through W4-4

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- [ ] Surface Water (A1)
- [ ] High Water Table (A2)
- [✔] Saturation (A3)
- [ ] Water Marks (B1)
- [ ] Sediment Deposits (B2)
- [ ] Drift Deposits (B3)
- [ ] Algal Mat or Crust (B4)
- [ ] Iron Deposits (B5)
- [ ] Inundation Visible on Aerial Imagery (B7)
- [✔] Water-Stained Leaves (B9)
- [ ] Aquatic Fauna (B13)
- [ ] Marl Deposits (B15) **(LRR U)**
- [ ] Hydrogen Sulfide Odor (C1)
- [ ] Oxidized Rhizospheres along Living Roots (C3)
- [ ] Presence of Reduced Iron (C4)
- [ ] Recent Iron Reduction in Tilled Soils (C6)
- [ ] Thin Muck Surface (C7)
- [ ] Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- [ ] Surface Soil Cracks (B6)
- [ ] Sparsely Vegetated Concave Surface (B8)
- [✔] Drainage Patterns (B10)
- [ ] Moss Trim Lines (B16)
- [ ] Dry-Season Water Table (C2)
- [✔] Crayfish Burrows (C8)
- [ ] Saturation Visible on Aerial Imagery (C9)
- [✔] Geomorphic Position (D2)
- [ ] Shallow Aquitard (D3)
- [ ] FAC-Neutral Test (D5)
- [ ] Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes [ ]	No [✔]	Depth (inches):
Water Table Present?	Yes [✔]	No [ ]	Depth (inches): 18
Saturation Present? (includes capillary fringe)	Yes [✔]	No [ ]	Depth (inches): 6

Wetland Hydrology Present? Yes [✔] No [ ]

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: W3+W4

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Tulip Poplar	30	y	FACU
2. Beech	30	y	FACU
3. Ironwood	30	y	FAC
4.			
5.			
6.			
	= Total Cover		

50% of total cover: _____ 20% of total cover: _____

Sapling Stratum (Plot size: 30')			
1. Ironwood	20	y	FAC
2. Beech	5	y	FACU
3.			
4.			
5.			
6.			
	= Total Cover		

50% of total cover: _____ 20% of total cover: _____

Shrub Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		

50% of total cover: 0 20% of total cover: 0

Herb Stratum (Plot size: 30')			
1. Greenbrier	5	n	FAC
2. American Holly	5	n	FAC
3. Lady Fern	30	y	FAC
4. Longleaf Summer Bluet	5	n	UPL
5. Partridge Berry	15	y	FACU
6. Japanese Stiltgrass	5	n	FAC
7.			
8.			
9.			
10.			
11.			
	= Total Cover		

50% of total cover: _____ 20% of total cover: _____

Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		

50% of total cover: 0 20% of total cover: 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 40 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:	
OBL species	x 1 =	
FACW species	x 2 =	
FAC species	x 3 =	
FACU species	x 4 =	
UPL species	x 5 =	
Column Totals: (A)		(B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

- ☐ 1 - Rapid Test for Hydrophytic Vegetation
- ☐ 2 - Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

Tree – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and 3 in. (7.6 cm) or larger in diameter at breast height (DBH).

Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes ☐ No ☑

Remarks: (If observed, list morphological adaptations below).

SOIL

Sampling Point: W3+W4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-3	10yr 2/2	100					SL	
3-12	10yr 5/1	70	7.5yr 3/6	15	c	m	SL	
			2.5yr 5/8	15	c	m		
12-20	10yr 5/1	80					SL	
	10yr 7/6	20						
20-24	10yr 5/1	30					SL	
	10yr 5/6	15						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☑ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☑ No ☐

Remarks:

20-24 continued
10yr 4/6 15%
10yr 5/3 40%

WETLAND DETERMINATION DATA FORM – Atlantic and Gulf Coastal Plain Region

Project/Site: Annapolis Waterworks City/County: Annapolis Sampling Date: 2024/09/12

Applicant/Owner: Arundel Rivers Federation State: MD Sampling Point: W3 +W4

Investigator(s): TC/SW Section, Township, Range: _____

Landform (hillslope, terrace, etc.): Floodplain Bench Local relief (concave, convex, none): _____ Slope (%): _____

Subregion (LRR or MLRA): Floodplain Bench Lat: 38.991239 Long: -76.557543 Datum: WGS 84

Soil Map Unit Name: Annapolis Fine Sandy Loam (ASF) NWI classification: PFO1C

Are climatic / hydrologic conditions on the site typical for this time of year? Yes [✔] No [ ] (If no, explain in Remarks.)

Are Vegetation [ ] Soil [ ] or Hydrology [ ] significantly disturbed? [ ] Are "Normal Circumstances" present? Yes [✔] No [ ]

Are Vegetation [ ] Soil [ ] or Hydrology [ ] naturally problematic? [ ] (If needed, explain any answers in Remarks.)

SUMMARY OF FINDINGS – Attach site map showing sampling point locations, transects, important features, etc.

Hydrophytic Vegetation Present?	Yes [ ]	No [✔]	**Is the Sampled Area within a Wetland?** Yes [✔] No [ ]
Hydric Soil Present?	Yes [✔]	No [ ]	
Wetland Hydrology Present?	Yes [✔]	No [ ]	

Remarks:

Floodplain benches beginning at the confluence of Broad Creek and unknown tributary (left and right banks) W3-1 through W3-8 and W4-1 through W4-4

HYDROLOGY

Wetland Hydrology Indicators:

Primary Indicators (minimum of one is required; check all that apply)

- [ ] Surface Water (A1)
- [ ] High Water Table (A2)
- [✔] Saturation (A3)
- [ ] Water Marks (B1)
- [ ] Sediment Deposits (B2)
- [ ] Drift Deposits (B3)
- [ ] Algal Mat or Crust (B4)
- [ ] Iron Deposits (B5)
- [ ] Inundation Visible on Aerial Imagery (B7)
- [✔] Water-Stained Leaves (B9)
- [ ] Aquatic Fauna (B13)
- [ ] Marl Deposits (B15) **(LRR U)**
- [ ] Hydrogen Sulfide Odor (C1)
- [ ] Oxidized Rhizospheres along Living Roots (C3)
- [ ] Presence of Reduced Iron (C4)
- [ ] Recent Iron Reduction in Tilled Soils (C6)
- [ ] Thin Muck Surface (C7)
- [ ] Other (Explain in Remarks)

Secondary Indicators (minimum of two required)

- [ ] Surface Soil Cracks (B6)
- [ ] Sparsely Vegetated Concave Surface (B8)
- [✔] Drainage Patterns (B10)
- [ ] Moss Trim Lines (B16)
- [ ] Dry-Season Water Table (C2)
- [✔] Crayfish Burrows (C8)
- [ ] Saturation Visible on Aerial Imagery (C9)
- [✔] Geomorphic Position (D2)
- [ ] Shallow Aquitard (D3)
- [ ] FAC-Neutral Test (D5)
- [ ] Sphagnum moss (D8) **(LRR T, U)**

Field Observations:

Surface Water Present?	Yes [ ]	No [✔]	Depth (inches): _____
Water Table Present?	Yes [✔]	No [ ]	Depth (inches): 18
Saturation Present? (includes capillary fringe)	Yes [✔]	No [ ]	Depth (inches): 6

Wetland Hydrology Present? Yes [✔] No [ ]

Describe Recorded Data (stream gauge, monitoring well, aerial photos, previous inspections), if available:

Remarks:

VEGETATION (Five Strata) – Use scientific names of plants.

Sampling Point: W3+W4

Tree Stratum (Plot size: 30')	Absolute % Cover	Dominant Species?	Indicator Status
1. Tulip Poplar	30	y	FACU
2. Beech	30	y	FACU
3. Ironwood	30	y	FAC
4.			
5.			
6.			
	= Total Cover		

50% of total cover: _____ 20% of total cover: _____

Sapling Stratum (Plot size: 30')			
1. Ironwood	20	y	FAC
2. Beech	5	y	FACU
3.			
4.			
5.			
6.			
	= Total Cover		

50% of total cover: _____ 20% of total cover: _____

Shrub Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
6.			
	0 = Total Cover		

50% of total cover: 0 20% of total cover: 0

Herb Stratum (Plot size: 30')			
1. Greenbrier	5	n	FAC
2. American Holly	5	n	FAC
3. Lady Fern	30	y	FAC
4. Longleaf Summer Bluet	5	n	UPL
5. Partridge Berry	15	y	FACU
6. Japanese Stiltgrass	5	n	FAC
7.			
8.			
9.			
10.			
11.			
	= Total Cover		

50% of total cover: _____ 20% of total cover: _____

Woody Vine Stratum (Plot size: 30')			
1.			
2.			
3.			
4.			
5.			
	0 = Total Cover		

50% of total cover: 0 20% of total cover: 0

Dominance Test worksheet:

Number of Dominant Species That Are OBL, FACW, or FAC: 2 (A)

Total Number of Dominant Species Across All Strata: 5 (B)

Percent of Dominant Species That Are OBL, FACW, or FAC: 40 (A/B)

Prevalence Index worksheet:

Total % Cover of:	Multiply by:
OBL species _____	x 1 = _____
FACW species _____	x 2 = _____
FAC species _____	x 3 = _____
FACU species _____	x 4 = _____
UPL species _____	x 5 = _____
Column Totals: _____ (A)	_____ (B)

Prevalence Index = B/A = _____

Hydrophytic Vegetation Indicators:

- ☐ 1 - Rapid Test for Hydrophytic Vegetation
- ☐ 2 - Dominance Test is >50%
- ☐ 3 - Prevalence Index is ≤3.0[1]
- ☐ Problematic Hydrophytic Vegetation[1] (Explain)

[1]Indicators of hydric soil and wetland hydrology must be present, unless disturbed or problematic.

Definitions of Five Vegetation Strata:

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Sapling – Woody plants, excluding woody vines, approximately 20 ft (6 m) or more in height and less than 3 in. (7.6 cm) DBH.

Shrub – Woody plants, excluding woody vines, approximately 3 to 20 ft (1 to 6 m) in height.

Herb – All herbaceous (non-woody) plants, including herbaceous vines, regardless of size, and woody plants, except woody vines, less than approximately 3 ft (1 m) in height.

Woody vine – All woody vines, regardless of height.

Hydrophytic Vegetation Present? Yes ☐ No ☑

Remarks: (If observed, list morphological adaptations below).

SOIL

Sampling Point: W3+W4

Profile Description: (Describe to the depth needed to document the indicator or confirm the absence of indicators.)

Depth (inches)	Matrix Color (moist)	%	Redox Features Color (moist)	%	Type[1]	Loc[2]	Texture	Remarks
0-3	10yr 2/2	100					SL	
3-12	10yr 5/1	70	7.5yr 3/6	15	c	m	SL	
			2.5yr 5/8	15	c	m		
12-20	10yr 5/1	80					SL	
	10yr 7/6	20						
20-24	10yr 5/1	30					SL	
	10yr 5/6	15						

[1]Type: C=Concentration, D=Depletion, RM=Reduced Matrix, MS=Masked Sand Grains. [2]Location: PL=Pore Lining, M=Matrix.

Hydric Soil Indicators: (Applicable to all LRRs, unless otherwise noted.)

- ☐ Histosol (A1)
- ☐ Histic Epipedon (A2)
- ☐ Black Histic (A3)
- ☐ Hydrogen Sulfide (A4)
- ☐ Stratified Layers (A5)
- ☐ Organic Bodies (A6) **(LRR P, T, U)**
- ☐ 5 cm Mucky Mineral (A7) **(LRR P, T, U)**
- ☐ Muck Presence (A8) **(LRR U)**
- ☐ 1 cm Muck (A9) **(LRR P, T)**
- ☐ Depleted Below Dark Surface (A11)
- ☐ Thick Dark Surface (A12)
- ☐ Coast Prairie Redox (A16) **(MLRA 150A)**
- ☐ Sandy Mucky Mineral (S1) **(LRR O, S)**
- ☐ Sandy Gleyed Matrix (S4)
- ☐ Sandy Redox (S5)
- ☐ Stripped Matrix (S6)
- ☐ Dark Surface (S7) **(LRR P, S, T, U)**
- ☐ Polyvalue Below Surface (S8) **(LRR S, T, U)**
- ☐ Thin Dark Surface (S9) **(LRR S, T, U)**
- ☐ Loamy Mucky Mineral (F1) **(LRR O)**
- ☐ Loamy Gleyed Matrix (F2)
- ☑ Depleted Matrix (F3)
- ☐ Redox Dark Surface (F6)
- ☐ Depleted Dark Surface (F7)
- ☐ Redox Depressions (F8)
- ☐ Marl (F10) **(LRR U)**
- ☐ Depleted Ochric (F11) **(MLRA 151)**
- ☐ Iron-Manganese Masses (F12) **(LRR O, P, T)**
- ☐ Umbric Surface (F13) **(LRR P, T, U)**
- ☐ Delta Ochric (F17) **(MLRA 151)**
- ☐ Reduced Vertic (F18) **(MLRA 150A, 150B)**
- ☐ Piedmont Floodplain Soils (F19) **(MLRA 149A)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 149A, 153C, 153D)**

Indicators for Problematic Hydric Soils[3]:

- ☐ 1 cm Muck (A9) **(LRR O)**
- ☐ 2 cm Muck (A10) **(LRR S)**
- ☐ Reduced Vertic (F18) **(outside MLRA 150A,B)**
- ☐ Piedmont Floodplain Soils (F19) **(LRR P, S, T)**
- ☐ Anomalous Bright Loamy Soils (F20) **(MLRA 153B)**
- ☐ Red Parent Material (TF2)
- ☐ Very Shallow Dark Surface (TF12)
- ☐ Other (Explain in Remarks)

[3]Indicators of hydrophytic vegetation and wetland hydrology must be present, unless disturbed or problematic.

Restrictive Layer (if observed):

Type: _____

Depth (inches): _____

Hydric Soil Present? Yes ☑ No ☐

Remarks:

20-24 continued
10yr 4/6 15%
10yr 5/3 40%

Appendix C: Channel Sizing Worksheet

SPSC Sizing Spreadsheet
(Based on Anne Arundel County SPSC Guidelines, Revised 07/2022)

Designer must select/input
Calculated value/Designer shall not change
Default values provided. Advanced designer may change to customize to site specific design

Riffle Weir Sizing			
	Q_{US}	Q_{DS}	
Design Flow (cfs)	369.0	588.0	
Width (ft)	25.0	70.0	
L, Length (ft)	15.0	15.0	
H, Height (ft)	0.5	0.5	
Design Depth of flow (ft)	2.75	1.80	
D50 (in)	12	6	
P_D, Parabolic Depth (ft)	2.75	1.70	
Width Depth Ratio (W/P_D)	9.1	47.1	
Manning's n Value	0.050	0.045	
Slope (ft/ft)	3.33%	3.33%	
Rock Unit Weight (lbs/cf)	165.0	165.0	
Top Width at Depth	25.0	72.0	
Flow area (sf)	45.8	86.4	
Hydraulic Radius	1.78	1.20	
Froude	0.85	0.90	
Isbash Maximum Velocity (ft/s)	12.35	8.73	
Depth ("A") at TW/4 offset from centerline	2.06	1.28	
Calculated Flow at Design Depth (cfs)	365.7	589.4	
Calculated Velocity (ft/s)	7.98	6.82	
Does the proposed section provide adequate conveyance?	NO	YES	
Is the proposed velocity less than the maximum allowable velocity?	YES	YES	

Width Depth Ratio note	W/D <= 10, Note: Designers are encouraged to customize results to site specific dimensions. In general, the County prefers a width-depth ratio greater than 10 when site conditions allow.
Parabolic Depth note	PD>2.0, Note: Designers are strongly encouraged to customize results to site specific dimensions. Parabolic depths exceeding 2.0 feet are discouraged as excessively high berms may be required to tie-in structures. Consider increasing W/D ratio.

Appendix D: Schematic Design Drawings

ANNAPOLIS WATERWORKS PARK STREAM RESTORATION

CONSTRUCTION PLANS

ANNE ARUNDEL COUNTY, MD

DEPARTMENT OF PUBLIC WORKS

PROJECT # XXXXXXX CONTRACT #XXXXXXX

2607 HOUSLEY RD

ANNAPOLIS, MD 21401

CONSULTANT'S CERTIFICATION

"THE DEVELOPER'S PLAN TO CONTROL SILT AND EROSION IS ADEQUATE TO CONTAIN THE SILT AND EROSION ON THE PROPERTY COVERED BY THE PLAN." I CERTIFY THAT THIS PLAN OF EROSION AND SEDIMENT CONTROL REPRESENTS A PRACTICAL AND WORKABLE PLAN BASED ON MY PERSONAL KNOWLEDGE OF THIS SITE, AND WAS PREPARED IN ACCORDANCE WITH THE REQUIREMENTS OF THE ANNE ARUNDEL SOIL CONSERVATION DISTRICT PLAN SUBMITTAL GUIDELINES AND THE CURRENT MARYLAND STANDARDS AND SPECIFICATIONS FOR SEDIMENT AND EROSION CONTROL. I HAVE REVIEWED THIS SEDIMENT AND EROSION CONTROL PLAN WITH THE OWNER/DEVELOPER.

MD. P.E. LICENSE # 30734

MD. LAND SURVEYOR LICENSE# _____

MD. LANDSCAPE ARCHITECT # _____

NAME DOUG STREAKER

FIRM NAME BIOHABITATS, INC.

STREET ADRESS 2081 CLIPPER ROAD
BALTIMORE, MD 21211

SEAL

SIGNATURE

DATE

STANDARD RESPONSIBILITY NOTES

1. I (WE) CERTIFY THAT:
a. ALL DEVELOPMENT AND CONSTRUCTION WILL BE DONE IN ACCORDANCE WITH THIS SEDIMENT AND EROSION CONTROL PLAN, AND FURTHER, AUTHORIZE THE RIGHT OF ENTRY FOR PERIODIC ON-SITE EVALUATION BY THE ANNE ARUNDEL SOIL CONSERVATION DISTRICT (AASCD) BOARD OF SUPERVISORS OR THEIR AUTHORIZED AGENTS.
b. ANY RESPONSIBLE PERSONNEL INVOLVED IN THE CONSTRUCTION PROJECT WILL HAVE A CERTIFICATE OF ATTENDANCE FROM THE MARYLAND DEPARTMENT OF THE ENVIRONMENT'S APPROVED TRAINING PROGRAM FOR THE CONTROL OF SEDIMENT AND EROSION BEFORE BEGINNING THE PROJECT.

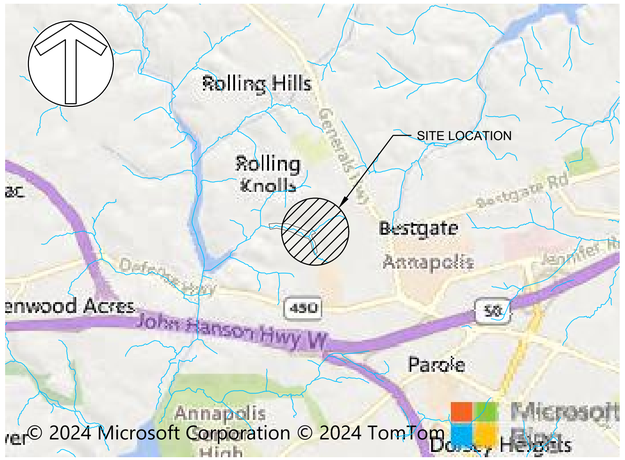
RESPONSIBLE PERSONNEL ON SITE: _____

c. IF APPLICABLE, THE APPROPRIATE ENCLOSURE WILL BE CONSTRUCTED AND MAINTAINED ON SEDIMENT BASIN(S) INCLUDED IN THIS PLAN. SUCH STRUCTURE(S) WILL BE IN COMPLIANCE WITH THE ANNE ARUNDEL COUNTY CODE.
2. THE DEVELOPER IS RESPONSIBLE FOR THE ACQUISITION OF ALL EASEMENTS, RIGHT, AND/OR RIGHTS-OF-WAY THAT MAY BE REQUIRED FOR THE SEDIMENT AND EROSION CONTROL PRACTICES, STORM WATER MANAGEMENT PRACTICES AND THE DISCHARGE OF STORM WATER ONTO OR ACROSS ADJACENT OR DOWNSTREAM PROPERTIES INCLUDED IN THE PLAN.
3. FOR INITIAL SOIL DISTURBANCE OR RE-DISTURBANCE, PERMANENT AND/OR TEMPORARY STABILIZATION PER THE AASCD VEGETATIVE ESTABLISHMENT SHALL BE COMPLETED WITHIN THREE CALENDAR DAYS FOR THE SURFACE OF ALL CONTROLS, DIKES, SWALES, DITCHES, PERIMETER SLOPES AND ALL SLOPES GREATER THAN 3 HORIZONTAL TO 1 VERTICAL (3:1); AND SEVEN DAYS FOR ALL OTHER DISTURBED OR GRADED AREAS ON THE PROJECT SITE.
4. THE GRADING AND SEDIMENT CONTROL APPROVAL ON THIS PLAN EXTENDS ONLY TO THOSE AREAS WITHIN THE LIMITS OF DISTURBANCE.
5. THE APPROVAL OF THIS PLAN FOR SEDIMENT AND EROSION CONTROL DOES NOT RELIEVE THE DEVELOPER/CONSULTANT FROM COMPLYING WITH FEDERAL, STATE OR COUNTY REQUIREMENTS PERTAINING TO ENVIRONMENTAL ISSUES.
6. THE DEVELOPER MUST REQUEST THAT THE SEDIMENT AND EROSION CONTROL INSPECTOR APPROVE WORK COMPLETED IN ACCORDANCE WITH THE APPROVED EROSION AND SEDIMENT CONTROL PLAN, THE GRADING OR BUILDING PERMIT, AND THE ORDINANCE.
7. ALL MATERIAL SHALL BE TAKEN TO A SITE WITH AN APPROVED SEDIMENT AND EROSION CONTROL PLAN.
8. FIRST PHASE INSPECTION AND APPROVAL OF THE SEDIMENT AND EROSION CONTROL INSPECTOR SHALL BE REQUIRED UPON COMPLETION OF THE INSTALLATION OF EROSION AND SEDIMENT CONTROLS PRIOR TO PROCEEDING WITH ANY OTHER EARTH DISTURBANCE OR GRADING. OTHER BUILDING OR GRADING INSPECTION APPROVALS MAY NOT BE AUTHORIZED UNTIL THE INITIAL APPROVAL BY THE SEDIMENT AND EROSION CONTROL INSPECTOR IS given. INSPECTION AND PERMITS MAY ALSO REQUIRE THAT AN INSPECTION AND CERTIFICATION OF THE INSTALLATION OF SEDIMENT CONTROL ALSO BE PERFORMED BY A DESIGN PROFESSIONAL PRIOR TO CONSTRUCTION COMMENCING.
9. APPROVAL FROM THE INSPECTOR MUST BE REQUESTED ON FINAL STABILIZATION OF ALL SITES PRIOR TO REMOVAL OF SEDIMENT AND EROSION CONTROLS.
10. EXISTING TOPOGRAPHY MUST BE FIELD VERIFIED BY RESPONSIBLE PERSONNEL TO THE SATISFACTION OF THE SEDIMENT CONTROL INSPECTOR PRIOR TO COMMENCING WORK.

_____ _____
SIGNATURE OF DEVELOPER/OWNER DATE

PRINT: NAME: _____
TITLE: _____
AFFILIATION: ANNE ARUNDEL COUNTY
ADDRESS: 2662 RIVA ROAD ANNAPOLIS, MD 21401
TELEPHONE NUMBER: _____
EMAIL ADDRESS: _____

VICINITY MAP



SCALE: 1" = 2000'

LEGEND

EXISTING		PROPOSED	
	MAJOR CONTOUR	425	MAJOR CONTOUR
	MINOR CONTOUR	424	MINOR CONTOUR
	PROPERTY LINE		BASELINE
SS SS	SANITARY SEWER	LOD	LIMIT OF DISTURBANCE
SD	STORM DRAIN		WATTLE STRUCTURE
W W	WATER SUPPLY		SPSC RIFFLE
E E	ELECTRIC		VALLEY WIDE RIFFLE
G G	GAS		STAGING AND STOCKPILING AREA
C C	COMMUNICATIONS		MULCH ACCESS ROAD
CA CA	CRITICAL AREA BOUNDARY	SCE	STABILIZED CONSTRUCTION ENTRANCE
CAB CAB	CRITICAL AREA BUFFER		
	SOIL TYPE BOUNDARY		
100 YR	EXISTING 100 YEAR FLOODPLAIN		
WL WL	WETLAND LIMIT		
WB	WETLAND BUFFER		
WUS	WATER OF THE US		
	LIMIT OF SURVEY		
	TREELINE		
	TREE		
△	TRAVERSE POINT		

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DEPARTMENT OF PUBLIC WORKS

REVISED DATE	BY

APPROVED DATE		APPROVED DATE	
CHIEF ENGINEER		PROJECT MANAGER	
APPROVED DATE		APPROVED DATE	
ASSISTANT CHIEF ENGINEER		CHIEF, RIGHT-OF-WAY	

SCALE:	AS SHOWN
DRAWN BY	TB
CHECKED BY	DS/JC
SHEET NO.	1 OF 15
PROJECT NO.	24015.01
PROPOSAL NO.	

ANNAPOLIS WATERWORKS PARK STREAM RESTORATION

TITLE SHEET

7/31/2025 \\lucid\biohabitats\CADD\Projects\24015.01 annapolis waterworks park stream restoration\CAD\Plans\cv01aw.dwg

HORIZONTAL SCALE

0 100 200

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DEPARTMENT OF PUBLIC WORKS

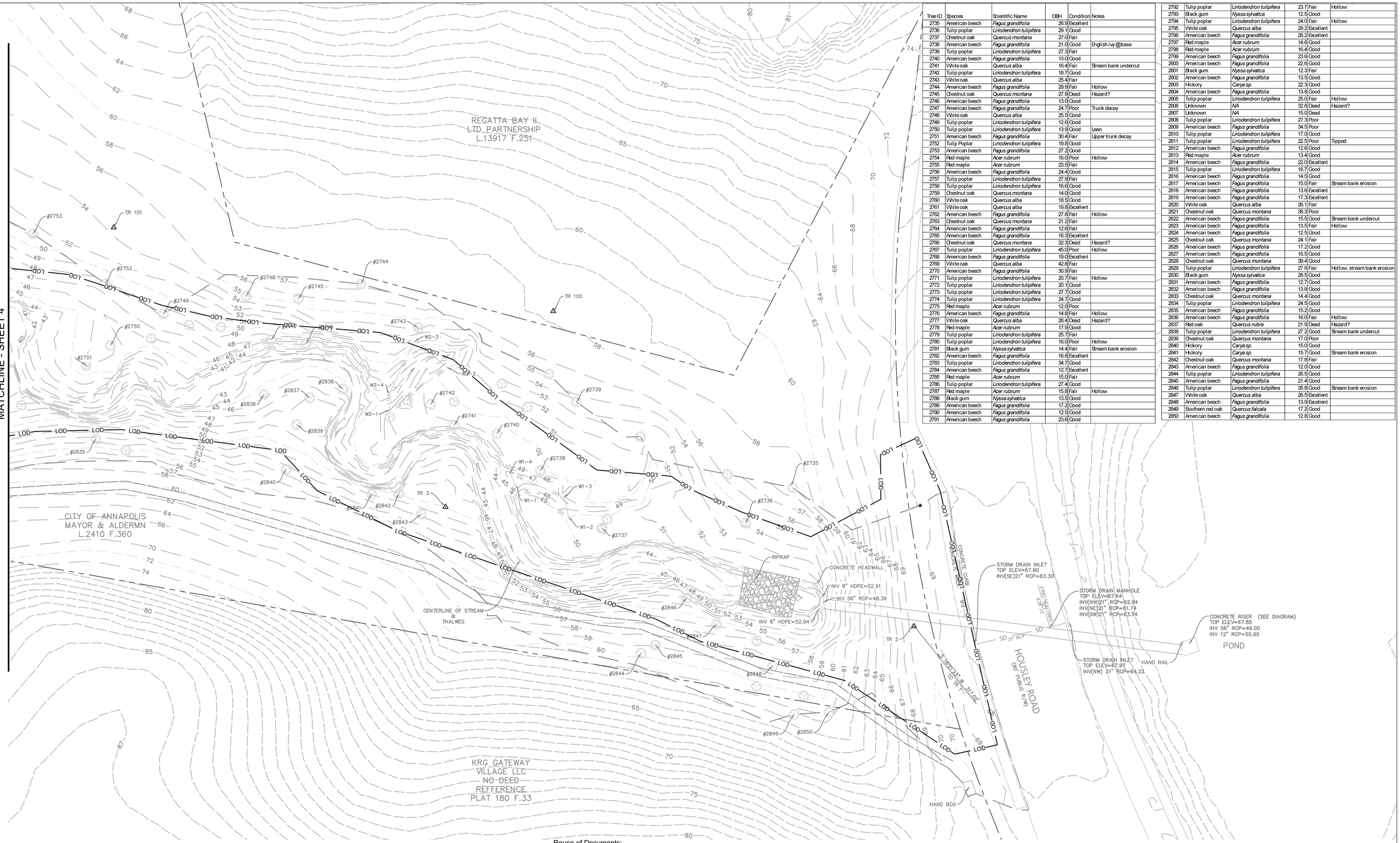
REVISED DATE	BY

APPROVED DATE	APPROVED DATE	SCALE:	1"=100'
CHIEF ENGINEER	PROJECT MANAGER	DRAWN BY	TB
APPROVED DATE	APPROVED DATE	CHECKED BY	DS/JC
		SHEET NO.	2 OF 15
		PROJECT NO.	24015.01
ASSISTANT CHIEF ENGINEER	CHIEF, RIGHT-OF-WAY	PROPOSAL NO.	

ANNAPOLIS WATERWORKS PARK STREAM RESTORATION

SHEET INDEX

7/31/2025 \\lucid\biohabitats\CADD\Projects\24015.01 annapolis waterworks park stream restoration\CAD\Plans\si01aw.dwg



Tree ID	Species	Scientific Name	DBH	Condition	Notes
2735	American beech	*Fagus grandifolia*	26.9	Excellent	
2736	Tulip poplar	*Liriodendron tulipifera*	28.1	Good	
2737	Chestnut oak	*Quercus montana*	27.0	Fair	
2738	American beech	*Fagus grandifolia*	21.0	Good	English ivy @base
2739	Tulip poplar	*Liriodendron tulipifera*	27.3	Fair	
2740	American beech	*Fagus grandifolia*	13.0	Good	
2741	White oak	*Quercus alba*	16.4	Fair	Stream bank undercut
2742	Tulip poplar	*Liriodendron tulipifera*	18.7	Good	
2743	White oak	*Quercus alba*	25.4	Fair	
2744	American beech	*Fagus grandifolia*	29.9	Fair	Hollow
2745	Chestnut oak	*Quercus montana*	27.9	Dead	Hazard?
2746	American beech	*Fagus grandifolia*	13.0	Good	
2747	American beech	*Fagus grandifolia*	24.7	Poor	Trunk decay
2748	White oak	*Quercus alba*	25.5	Good	
2749	Tulip poplar	*Liriodendron tulipifera*	12.6	Good	
2750	Tulip poplar	*Liriodendron tulipifera*	13.9	Good	Lean
2751	American beech	*Fagus grandifolia*	30.4	Fair	Upper trunk decay
2752	Tulip Poplar	*Liriodendron tulipifera*	19.8	Good	
2753	American beech	*Fagus grandifolia*	27.2	Good	
2754	Red maple	*Acer rubrum*	16.0	Poor	Hollow
2755	Red maple	*Acer rubrum*	23.5	Fair	
2756	American beech	*Fagus grandifolia*	24.4	Good	
2757	Tulip poplar	*Liriodendron tulipifera*	27.9	Fair	
2758	Tulip poplar	*Liriodendron tulipifera*	16.6	Good	
2759	Chestnut oak	*Quercus montana*	14.0	Good	
2760	White oak	*Quercus alba*	18.5	Good	
2761	White oak	*Quercus alba*	19.8	Excellent	
2762	American beech	*Fagus grandifolia*	27.8	Fair	Hollow
2763	Chestnut oak	*Quercus montana*	21.2	Fair	
2764	American beech	*Fagus grandifolia*	12.6	Fair	
2765	American beech	*Fagus grandifolia*	16.3	Excellent	
2766	Chestnut oak	*Quercus montana*	32.3	Dead	Hazard?
2767	Tulip poplar	*Liriodendron tulipifera*	45.0	Poor	Hollow
2768	American beech	*Fagus grandifolia*	19.0	Excellent	
2769	White oak	*Quercus alba*	42.8	Fair	
2770	American beech	*Fagus grandifolia*	30.9	Fair	
2771	Tulip poplar	*Liriodendron tulipifera*	20.7	Fair	Hollow
2772	Tulip poplar	*Liriodendron tulipifera*	20.1	Good	
2773	Tulip poplar	*Liriodendron tulipifera*	27.7	Good	
2774	Tulip poplar	*Liriodendron tulipifera*	24.7	Good	
2775	Red maple	*Acer rubrum*	12.0	Poor	
2776	American beech	*Fagus grandifolia*	14.8	Fair	Hollow
2777	White oak	*Quercus alba*	28.4	Dead	Hazard?
2778	Red maple	*Acer rubrum*	17.9	Good	
2779	Tulip poplar	*Liriodendron tulipifera*	25.7	Fair	
2780	Tulip poplar	*Liriodendron tulipifera*	16.0	Poor	Hollow
2781	Black gum	*Nyssa sylvatica*	14.4	Fair	Stream bank erosion
2782	American beech	*Fagus grandifolia*	16.8	Excellent	
2783	Tulip poplar	*Liriodendron tulipifera*	34.7	Good	
2784	American beech	*Fagus grandifolia*	12.7	Excellent	
2785	Red maple	*Acer rubrum*	15.0	Fair	
2786	Tulip poplar	*Liriodendron tulipifera*	27.4	Good	
2787	Red maple	*Acer rubrum*	15.8	Fair	Hollow
2788	Black gum	*Nyssa sylvatica*	13.5	Good	
2789	American beech	*Fagus grandifolia*	17.2	Good	
2790	American beech	*Fagus grandifolia*	12.5	Good	
2791	American beech	*Fagus grandifolia*	23.6	Good	
2792	Tulip poplar	*Liriodendron tulipifera*	23.7	Fair	Hollow
2793	Black gum	*Nyssa sylvatica*	12.5	Good	
2794	Tulip poplar	*Liriodendron tulipifera*	24.0	Fair	Hollow
2795	White oak	*Quercus alba*	29.2	Excellent	
2796	American beech	*Fagus grandifolia*	26.2	Excellent	
2797	Red maple	*Acer rubrum*	14.6	Good	
2798	Red maple	*Acer rubrum*	16.4	Good	
2799	American beech	*Fagus grandifolia*	23.6	Good	
2800	American beech	*Fagus grandifolia*	22.6	Good	
2801	Black gum	*Nyssa sylvatica*	12.3	Fair	
2802	American beech	*Fagus grandifolia*	13.5	Good	
2803	Hickory	*Carya sp.*	22.3	Good	
2804	American beech	*Fagus grandifolia*	13.8	Good	
2805	Tulip poplar	*Liriodendron tulipifera*	25.0	Fair	Hollow
2806	Unknown	*NA*	32.8	Dead	Hazard?
2807	Unknown	*NA*	15.0	Dead	
2808	Tulip poplar	*Liriodendron tulipifera*	27.3	Poor	
2809	American beech	*Fagus grandifolia*	34.5	Poor	
2810	Tulip poplar	*Liriodendron tulipifera*	17.0	Good	
2811	Tulip poplar	*Liriodendron tulipifera*	22.5	Poor	Tipped
2812	American beech	*Fagus grandifolia*	12.6	Good	
2813	Red maple	*Acer rubrum*	13.4	Good	
2814	American beech	*Fagus grandifolia*	22.0	Excellent	
2815	Tulip poplar	*Liriodendron tulipifera*	16.7	Good	
2816	American beech	*Fagus grandifolia*	14.5	Good	
2817	American beech	*Fagus grandifolia*	15.0	Fair	Stream bank erosion
2818	American beech	*Fagus grandifolia*	13.6	Excellent	
2819	American beech	*Fagus grandifolia*	17.3	Excellent	
2820	White oak	*Quercus alba*	26.1	Fair	
2821	Chestnut oak	*Quercus montana*	38.3	Poor	
2822	American beech	*Fagus grandifolia*	15.5	Good	Stream bank undercut
2823	American beech	*Fagus grandifolia*	13.5	Fair	Hollow
2824	American beech	*Fagus grandifolia*	12.5	Good	
2825	Chestnut oak	*Quercus montana*	24.1	Fair	
2826	American beech	*Fagus grandifolia*	17.2	Good	
2827	American beech	*Fagus grandifolia*	16.5	Good	
2828	Chestnut oak	*Quercus montana*	39.4	Good	
2829	Tulip poplar	*Liriodendron tulipifera*	27.6	Fair	Hollow, stream bank erosion
2830	Black gum	*Nyssa sylvatica*	28.5	Good	
2831	American beech	*Fagus grandifolia*	12.7	Good	
2832	American beech	*Fagus grandifolia*	13.8	Good	
2833	Chestnut oak	*Quercus montana*	14.4	Good	
2834	Tulip poplar	*Liriodendron tulipifera*	24.5	Good	
2835	American beech	*Fagus grandifolia*	15.2	Good	
2836	American beech	*Fagus grandifolia*	16.0	Fair	Hollow
2837	Red oak	*Quercus rubra*	21.9	Dead	Hazard?
2838	Tulip poplar	*Liriodendron tulipifera*	27.2	Good	Stream bank undercut
2839	Chestnut oak	*Quercus montana*	17.0	Poor	
2840	Hickory	*Carya sp.*	15.0	Good	
2841	Hickory	*Carya sp.*	15.7	Good	Stream bank erosion
2842	Chestnut oak	*Quercus montana*	17.8	Fair	
2843	American beech	*Fagus grandifolia*	12.0	Good	
2844	Tulip poplar	*Liriodendron tulipifera*	26.5	Good	
2845	American beech	*Fagus grandifolia*	21.4	Good	
2846	Tulip poplar	*Liriodendron tulipifera*	35.8	Good	Stream bank erosion
2847	White oak	*Quercus alba*	26.5	Excellent	
2848	American beech	*Fagus grandifolia*	13.9	Excellent	
2849	Southern red oak	*Quercus falcata*	17.2	Good	
2850	American beech	*Fagus grandifolia*	12.8	Good	

EXISTING FEATURES NOTES:

1. ONLY SURVEYED TREES GREATER THAN 10" DBH WITHIN STUDY AREA ARE SHOWN.

HORIZONTAL SCALE

0 20 40

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ANNE ARUNDEL COUNTY
DEPARTMENT OF PUBLIC WORKS

REVISED DATE	BY

APPROVED	DATE	APPROVED	DATE
CHIEF ENGINEER		PROJECT MANAGER	
APPROVED	DATE	APPROVED	DATE
ASSISTANT CHIEF ENGINEER		CHIEF, RIGHT-OF-WAY	

SCALE:	1" = 20'
DRAWN BY	TB
CHECKED BY	DS/JC
SHEET NO.	3 OF 15
PROJECT NO.	24015.01
PROPOSAL NO.	

ANNAPOLIS WATERWORKS PARK STREAM RESTORATION

EXISTING CONDITIONS

7/31/2025 \\lucid\biohabitats\CADD\Projects\24015.01 annapolis waterworks park stream restoration\CAD\Plans\ec01sw.dwg

MATCHLINE - SHEET 5

MATCHLINE - SHEET 3

CITY OF ANNAPOLIS
MAYOR & ALDERMN
L.2410 F.360

KRG GATEWAY
VILLAGE LLC
NO DEED
REFFERENCE
PLAT 180 F.33

EXISTING FEATURES NOTES:
1. ONLY SURVEYED TREES GREATER THAN 10" DBH WITHIN STUDY AREA ARE SHOWN.

HORIZONTAL SCALE
0 20 40

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DEPARTMENT OF PUBLIC WORKS

REVISED DATE	BY

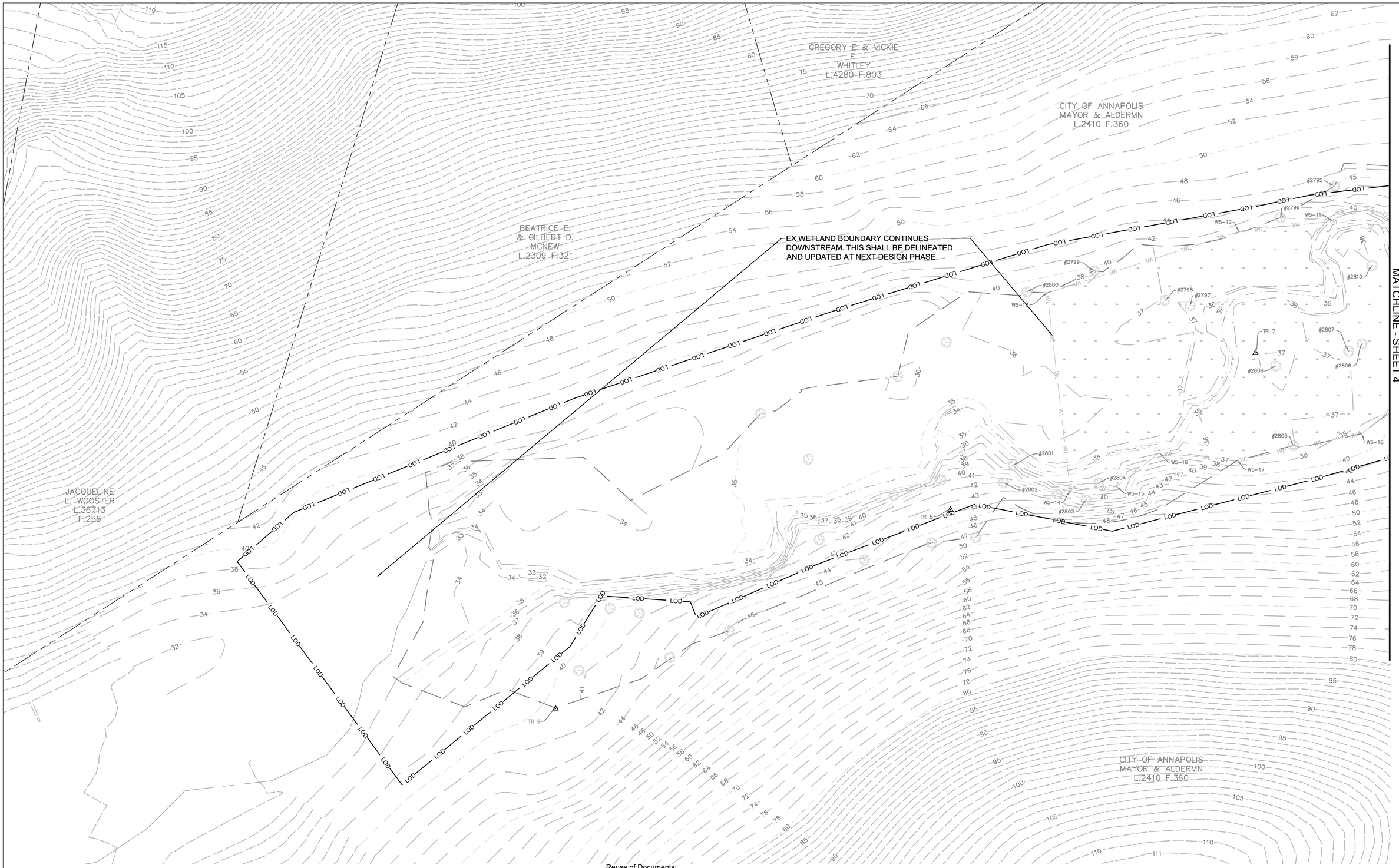
APPROVED	DATE	APPROVED	DATE
CHIEF ENGINEER		PROJECT MANAGER	
APPROVED	DATE	APPROVED	DATE
ASSISTANT CHIEF ENGINEER		CHIEF, RIGHT-OF-WAY	

SCALE:	NTS
DRAWN BY	TB
CHECKED BY	DS/JC
SHEET NO.	4 OF 15
PROJECT NO.	24015.01
PROPOSAL NO.	

ANNAPOLIS WATERWORKS PARK STREAM RESTORATION

EXISTING CONDITIONS

7/31/2025 \\lucid\biohabitats\CADD\Projects\24015.01 annapolis waterworks park stream restoration\CAD\Plans\ec01aw.dwg



EXISTING FEATURES NOTES:

1. ONLY SURVEYED TREES GREATER THAN 10" DBH WITHIN STUDY AREA ARE SHOWN.

HORIZONTAL SCALE

0 20 40

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ANNE ARUNDEL COUNTY
DEPARTMENT OF PUBLIC WORKS

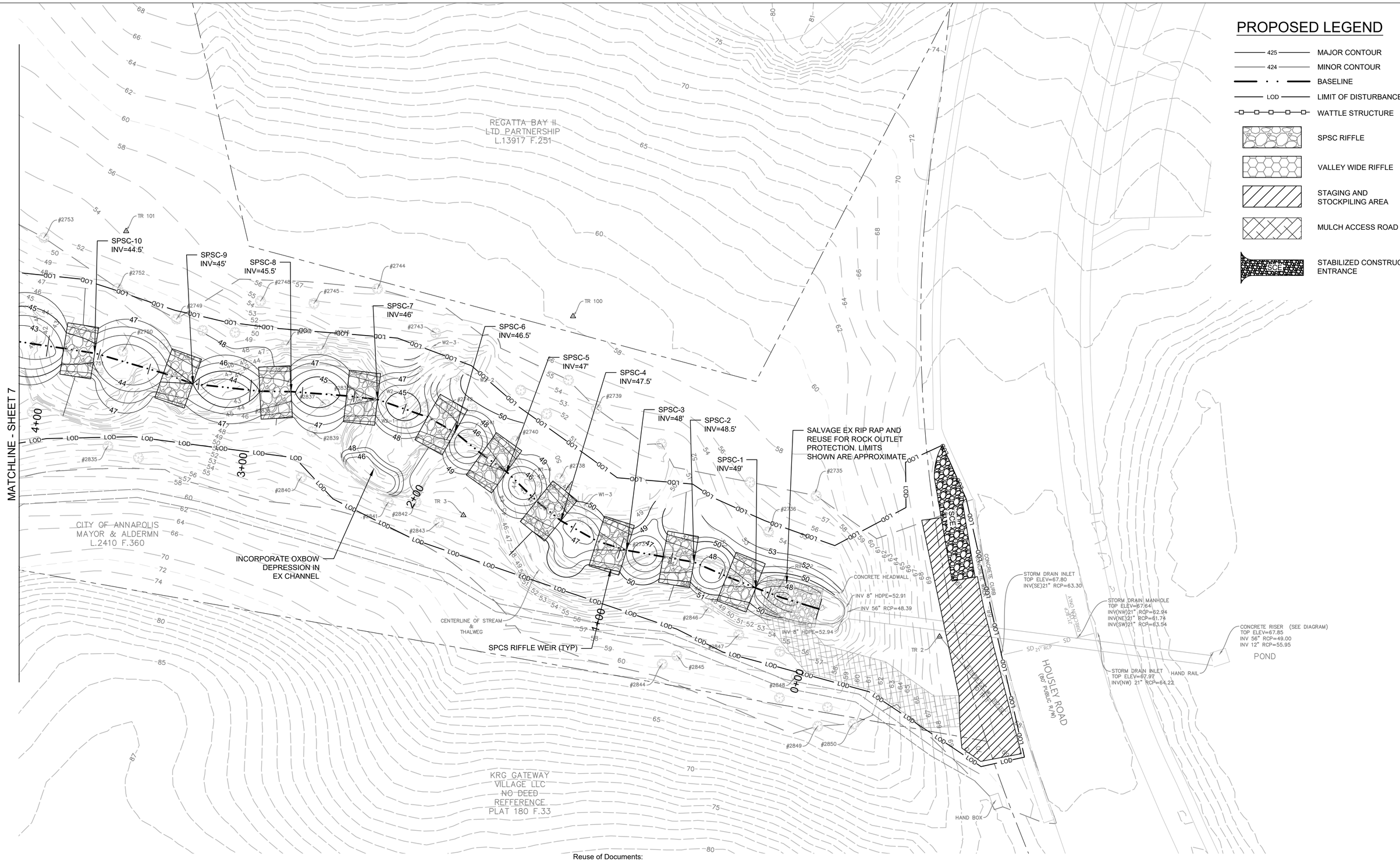
REVISED DATE	BY

APPROVED	DATE	APPROVED	DATE
CHIEF ENGINEER		PROJECT MANAGER	
APPROVED	DATE	APPROVED	DATE
ASSISTANT CHIEF ENGINEER		CHIEF, RIGHT-OF-WAY	

SCALE:	NTS
DRAWN BY	TB
CHECKED BY	DS/JC
SHEET NO.	5 OF 15
PROJECT NO.	24015.01
PROPOSAL NO.	

ANNAPOLIS WATERWORKS PARK STREAM RESTORATION

EXISTING CONDITIONS



PROPOSED LEGEND

- 425 — MAJOR CONTOUR
- 424 — MINOR CONTOUR
- BASELINE
- LOD — LIMIT OF DISTURBANCE
- WATTLE STRUCTURE
- SPSC RIFFLE
- VALLEY WIDE RIFFLE
- STAGING AND STOCKPILING AREA
- MULCH ACCESS ROAD
- SCE — STABILIZED CONSTRUCTION ENTRANCE

HORIZONTAL SCALE
0 20 40

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ANNE ARUNDEL COUNTY
DEPARTMENT OF PUBLIC WORKS

REVISED DATE	BY

APPROVED DATE	APPROVED DATE
CHIEF ENGINEER	PROJECT MANAGER
APPROVED DATE	APPROVED DATE
ASSISTANT CHIEF ENGINEER	CHIEF, RIGHT-OF-WAY

SCALE:	1"=20'
DRAWN BY	TB
CHECKED BY	DS/JC
SHEET NO.	6 OF 15
PROJECT NO.	24015.01
PROPOSAL NO.	

ANNAPOLIS WATERWORKS PARK STREAM RESTORATION

PROPOSED CONDITIONS

7/31/2025 \\lucid\biohabitats\CADD\Projects\24015.01 annapolis waterworks park stream restoration\CAD\Plans\pc01aw.dwg

MATCHLINE - SHEET 8

MATCHLINE - SHEET 6

VWR-6
INV=39'

VWR-5
INV=40'

LEAVE CLUSTER OF TREES AS STANDING SNAGS

VWR-4
INV=41'

VWR-3
INV=42'

MINIMIZE IMPACTS TO WETLANDS BETWEEN VALLEY-WIDE WEIRS

VWR-2
INV=43'

VWR-1
INV=44'

SPSC-11
INV=44'

6+00

7+00

8+00

9+00

FILL EX CHANNEL TO FLOODPLAIN GRADE AND LOAD CHANNEL/POOLS WITH WOODY DEBRIS (AS AVAILABLE)

VALLEY WIDE RIFFLE (TYP)

CITY OF ANNAPOLIS
MAYOR & ALDERMN
L.2410 F.360

KRG GATEWAY VILLAGE, LLC
NO DEED REFFERENCE
PLAT 180 F.33

PROPOSED LEGEND

- 425 — MAJOR CONTOUR
- 424 — MINOR CONTOUR
- BASELINE
- LOD — LIMIT OF DISTURBANCE
- WATTLE STRUCTURE
- SPSC RIFFLE
- VALLEY WIDE RIFFLE
- STAGING AND STOCKPILING AREA
- MULCH ACCESS ROAD
- SCE — STABILIZED CONSTRUCTION ENTRANCE

HORIZONTAL SCALE
0 20 40

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REVISED DATE	BY

APPROVED DATE	APPROVED DATE	SCALE:	1"=20'
		DRAWN BY	TB
CHIEF ENGINEER	PROJECT MANAGER	CHECKED BY	DSJC
APPROVED DATE	APPROVED DATE	SHEET NO.	7 OF 15
		PROJECT NO.	24015.01
ASSISTANT CHIEF ENGINEER	CHIEF, RIGHT-OF-WAY	PROPOSAL NO.	

ANNAPOLIS WATERWORKS PARK STREAM RESTORATION

PROPOSED CONDITIONS

7/31/2025 \\lucid\biohabitats\CADD\Projects\24015.01 annapolis waterworks park stream restoration\CAD\Plans\pc01aw.dwg

PROPOSED LEGEND

- 425 — MAJOR CONTOUR
- 424 — MINOR CONTOUR
- BASELINE
- LOD — LIMIT OF DISTURBANCE
- WATTLE STRUCTURE
- SPSC RIFFLE
- VALLEY WIDE RIFFLE
- STAGING AND STOCKPILING AREA
- MULCH ACCESS ROAD
- SCE — STABILIZED CONSTRUCTION ENTRANCE

VALLEY-WIDE WATTLE STRUCTURES TO REINFORCE D/S FLOODPLAIN TIE OUT

VWR-11 INV=34'

VWR-10 INV=35'

VWR-9 INV=36'

VWR-8 INV=37'

VWR-7 INV=38'

GREGORY E. & VICKIE E. WHITLEY L.4280 F.803

BEATRICE E. & GILBERT D. MCNEW L.2309 F.321

JACQUELINE L. WOOSTER L.36713 F.256

CITY OF ANNAPOLIS MAYOR & ALDERMN L.2410 F.360

CITY OF ANNAPOLIS MAYOR & ALDERMN L.2410 F.360

15+00 14+00 13+00 12+00 11+00 10+00

TR 8 TR 9

MATCHLINE - SHEET 7

HORIZONTAL SCALE
0 20 40

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REVISED DATE	BY

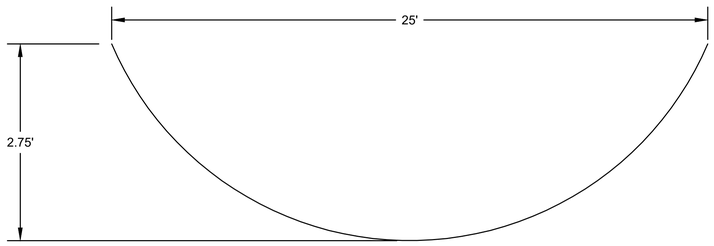
APPROVED	DATE	APPROVED	DATE
CHIEF ENGINEER		PROJECT MANAGER	
APPROVED	DATE	APPROVED	DATE
ASSISTANT CHIEF ENGINEER		CHIEF, RIGHT-OF-WAY	

SCALE:	1"=20'
DRAWN BY	TB
CHECKED BY	DS/JC
SHEET NO.	8 OF 15
PROJECT NO.	24015.01
PROPOSAL NO.	

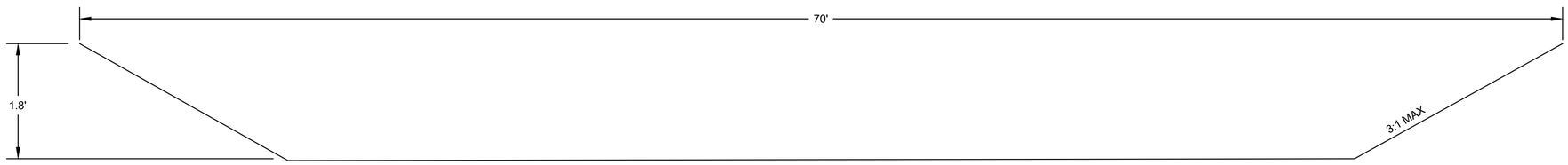
ANNAPOLIS WATERWORKS PARK STREAM RESTORATION

PROPOSED CONDITIONS

7/31/2025 \\lucid\biohabitats\CADD\Projects\24015.01 annapolis waterworks park stream restoration\CAD\Plans\pc01aw.dwg



SPSC RIFFLE
TYPICAL CROSS SECTION



VALLEY-WIDE RSC RIFFLE
TYPICAL CROSS SECTION

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DEPARTMENT OF PUBLIC WORKS

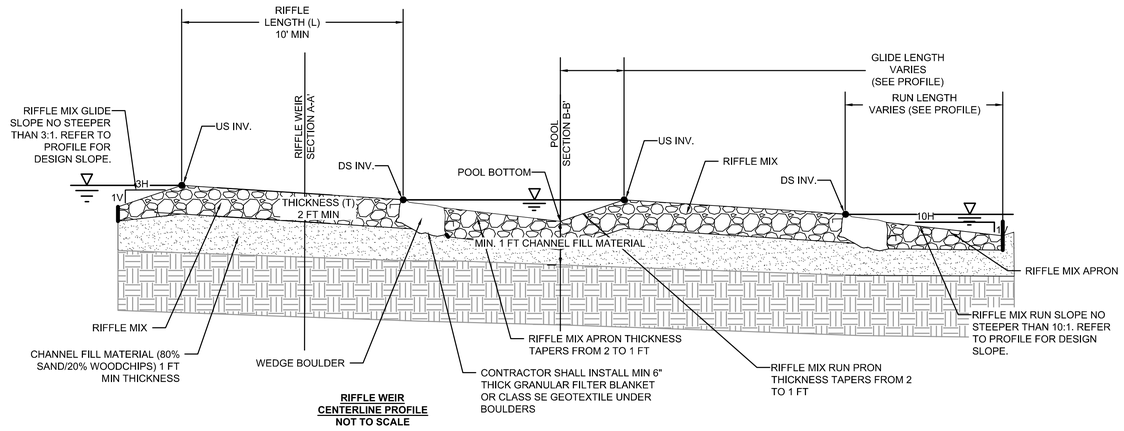
REVISED DATE	REVISED BY

APPROVED DATE	APPROVED DATE
CHIEF ENGINEER	PROJECT MANAGER
APPROVED DATE	APPROVED DATE
ASSISTANT CHIEF ENGINEER	CHIEF, RIGHT-OF-WAY

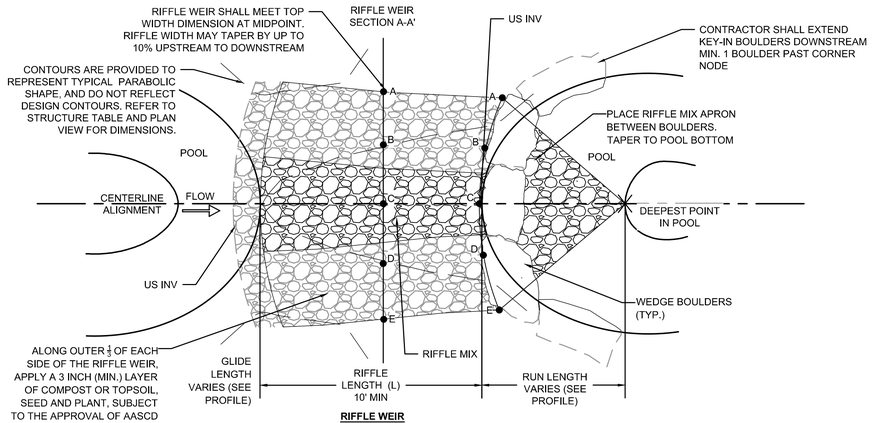
SCALE:	NTS
DRAWN BY	TB
CHECKED BY	DS/JC
SHEET NO.	9 OF 15
PROJECT NO.	24015.01
PROPOSAL NO.	

ANNAPOLIS WATERWORKS PARK STREAM RESTORATION

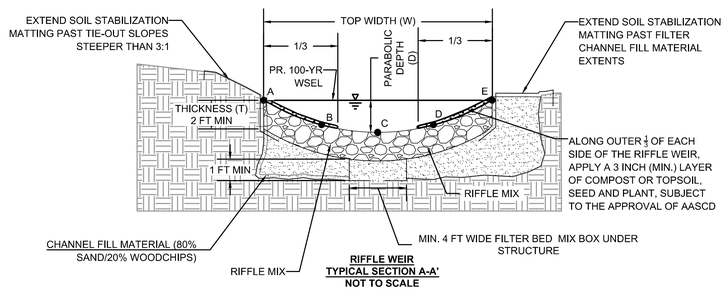
TYPICAL SECTIONS



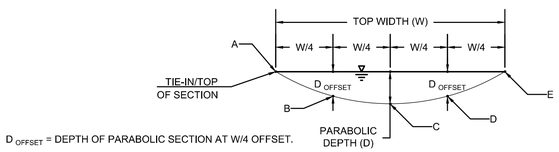
RIFFLE WEIR
CENTERLINE PROFILE
NOT TO SCALE



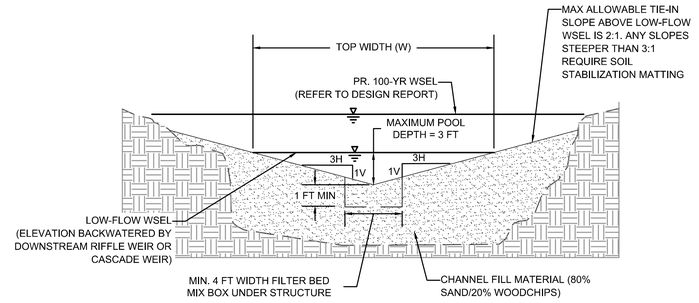
RIFFLE WEIR
PLAN VIEW
NOT TO SCALE



RIFFLE WEIR
TYPICAL SECTION A-A'
NOT TO SCALE



PARABOLIC SECTION DIMENSIONS
NOT TO SCALE



POOL
TYPICAL SECTION B-B'
NOT TO SCALE

RIFFLE WEIR NOTES:

1. THE CROSS SECTION SHALL BE CONSTRUCTED IN A PARABOLIC SHAPE BETWEEN GIVEN NODES.
2. NATURAL CHANNEL MATERIAL MAY BE HARVESTED ON-SITE PRIOR TO INSTALLATION OF RIFFLE WEIR IF IT MEETS THE SPECIFICATIONS FOR USE AS WASH-IN OR RIFFLE MIX.
3. THE NUMBER OF BOULDERS VARIES DEPENDING ON TYPICAL SECTION WIDTH AND BOULDER DIMENSIONS.
4. THE BOULDERS SHALL BE TILTED DOWNSTREAM AS SHOWN ON THE DETAIL AND NOT STACKED.
5. TIE-OUT BOULDER SHALL EXTEND PAST THE DOWNSTREAM CORNER NODES A & E A MIN. OF ONE BOULDER LENGTH (B-AXIS) INTO EXISTING BANK. WHERE THIS CONFLICTS WITH EXISTING TREE ROOTS OR BEDROCK, TIE-OUT BOULDER MAY BE ELIMINATED OR ADJUSTED AT DIRECTION OF ENGINEER.
6. CHANNEL WASH-IN MATERIAL SHALL BE REPEATEDLY WORKED INTO FULL DEPTH OF THE RIFFLE MIX TO FILL VOIDS.
7. TRIM ALL GEOTEXTILE AT OR BELOW FINISHED GRADE, IF USED.
8. ONCE RIFFLE WEIR IS CONSTRUCTED, STABILIZE ALL DISTURBED LOCATIONS AS SPECIFIED.
9. CONTOURS ARE PROVIDED TO REPRESENT TYPICAL PARABOLIC SHAPE, AND DO NOT REFLECT DESIGN CONTOURS. REFER TO STRUCTURE TABLE AND PLAN VIEW FOR DIMENSIONS.

RIFFLE MIX GRADATION TABLE			
D50 MEDIAN STONE SIZE (INCHES)	% OF MATERIAL SMALLER THAN TYPICAL STONE	TYPICAL STONE EQUIVALENT DIAMETER (INCHES)	TYPICAL STONE WEIGHT (POUNDS)*
6	70 - 100	12	85
	50 - 70	9	35
	35 - 50	6	10
	2 - 10	2	0.4
9	70 - 100	15	160
	50 - 70	12	85
	35 - 50	9	35
	2 - 10	3	1.3
12	70 - 100	21	440
	50 - 70	18	275
	35 - 50	12	85
	2 - 10	4	3
18	100	30	1280
	50 - 70	24	650
	35 - 50	18	275
	2 - 10	6	10
24	100	42	3500
	50 - 70	33	1700
	35 - 50	24	650
	2 - 10	9	35

*ASSUMED UNIT WEIGHT OF 165 $\frac{LBS}{FT^3}$

CHANNEL FILL MATERIAL/FILTER BED MIX (BY VOLUME)	
CLEAN SAND	80%
WOODCHIPS	20%

NOTES:

1. RIFFLE MIX SHALL BE STREAM SILICA COBBLE RANGING FROM ROUNDED TO SUB-ANGULAR SHAPE.
2. ALL RIFFLE MIX SHALL BE WASHED WITH PEA GRAVEL AND CLEAN SAND TO CHOKE VOIDS PRIOR TO FINAL STABILIZATION. THE PEA GRAVEL AND SAND ARE AN INCIDENTAL SUPPLEMENT TO THE RIFFLE MIX FOR NATURALIZATION AND ARE NOT CONSIDERED PART OF THE MIX WHEN CALCULATING D50.

STANDARD SPSC STABILIZATION NOTES (AASCD)

PERMANENT STABILIZATION NOTES (INCLUDE ONE OF THE FOLLOWING):
PERMANENT STABILIZATION FOR AN AREA OF EARTH DISTURBANCE OF A SPSC SHALL BE CONSIDERED ACHIEVED WHEN THE AREA IS COVERED WITH 2 TO 4 INCHES OF COMPOST (APPLIED OVER WOODCHIPS TRACKED INTO SOIL AND A (NATIVE PLANTS) PLANTING PLAN HAS BEEN IMPLEMENTED, REGARDLESS OF SOIL TREATMENT.

PERMANENT STABILIZATION FOR AN AREA OF EARTH DISTURBANCE OF A SPSC SHALL BE CONSIDERED ACHIEVED WHEN THE BANKS AND FLOODPLAIN ARE COVERED WITH FULLY BIODEGRADABLE STABILIZATION MATTING INSTALLED PER MANUFACTURER'S INSTRUCTIONS AND A (NATIVE PLANTS) PLANTING PLAN HAS BEEN IMPLEMENTED.

ALL DISTURBED AREAS SHALL RECEIVE HYDROSEEDING OR FLEXIBLE GROWTH MEDIUM (FGM) AFTER THE ESTABLISHMENT OF FINAL GRADES AND MICROTOPOGRAPHY (IF APPLICABLE) IN ACCORDANCE WITH THE PROJECT LANDSCAPING PLANS.

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DEPARTMENT OF PUBLIC WORKS

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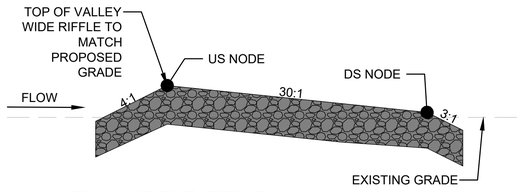
ASSISTANT CHIEF ENGINEER		CHIEF, RIGHT-OF-WAY	

SCALE:	NTS
DRAWN BY	TB
CHECKED BY	DSJC
SHEET NO.	10 OF 15
PROJECT NO.	24015.01
PROPOSAL NO.	

ANNAPOLIS WATERWORKS PARK STREAM RESTORATION

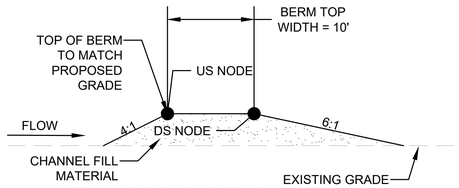
DETAILS

7/31/2025 \\lucid\biohabitats\CADD\Projects\24015.01 annapolis waterworks park stream restoration\CAD\Plans\dt01aw.dwg



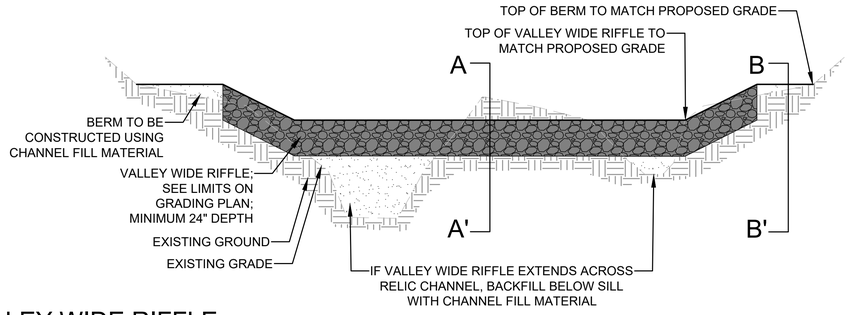
VALLEY WIDE RIFFLE
PROFILE VIEW (A - A')

NOT TO SCALE



VALLEY WIDE RIFFLE
PROFILE VIEW (B - B')

NOT TO SCALE

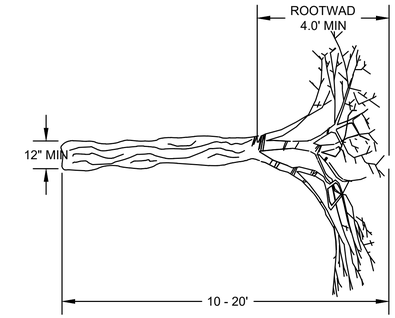


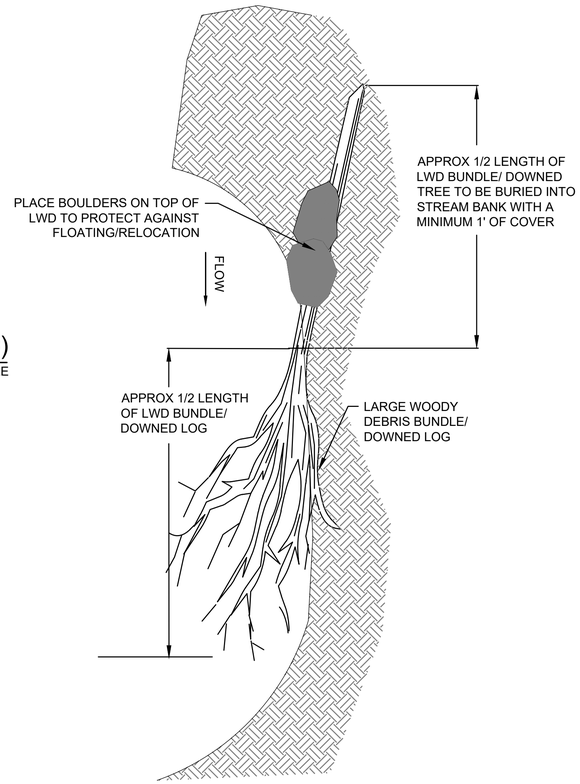
VALLEY WIDE RIFFLE
SECTION VIEW

NOT TO SCALE

VALLEY WIDE RIFFLE NOTES:

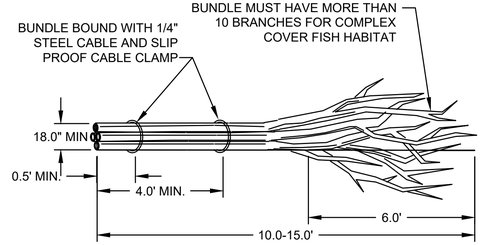
1. VALLEY WIDE RIFFLE TO BE PLACED PERPENDICULAR TO THE VALLEY AS SHOWN ON THE PLAN.
2. CONTRACTOR SHALL TRACK OVER STRUCTURE SEVERAL TIMES WITH THE EXCAVATOR TO COMPRESS THE VALLEY WIDE RIFFLE MATERIAL IN PLACE IN ONE FOOT LIFTS, ENSURING IT FORMS A COMPACTED, CONSOLIDATED VALLEY WIDE RIFFLE FOR THE FULL DEPTH.
3. VALLEY WIDE RIFFLE MATERIAL SHALL BE COMPOSED OF AN EVENLY DISTRIBUTED MIX OF MATERIALS FOR THE FULL DEPTH SPECIFIED THAT MEET THE GRADATIONS SHOWN IN TABLE.
4. VALLEY WIDE RIFFLE MATERIAL SHALL BE COMPOSED OF A COMBINATION OF APPROXIMATELY 50% SILICA COBBLE, RANGING FROM ROUNDED TO SUB-ANGULAR SHAPED, AND UP TO 50% ANGULAR ROCK THAT MEETS THE SIZE GRADATIONS SHOWN.
5. AS VALLEY WIDE RIFFLE MATERIAL IS INSTALLED, CONTRACTOR SHALL WORK IN CHANNEL WASH-IN MATERIAL WITHIN EACH 6" LIFT OF FLOODPLAIN SILL MATERIAL USING MECHANICAL OR HYDRAULIC METHODS TO ENSURE VOIDS ARE FILLED. CHANNEL WASH-IN SHALL BE DONE TO THE SATISFACTION OF THE ENGINEER/DESIGNATED SPECIALIST. THE VOLUME OF CHANNEL WASH-IN MATERIAL REQUIRED MAY VARY BUT IS TYPICALLY EQUAL TO APPROXIMATELY 20% OF VOLUME OF VALLEY WIDE RIFFLE MATERIAL.





INSTREAM LARGE WOODY DEBRIS (LWD)
DOWNED LOG

NOT TO SCALE



NOTES:

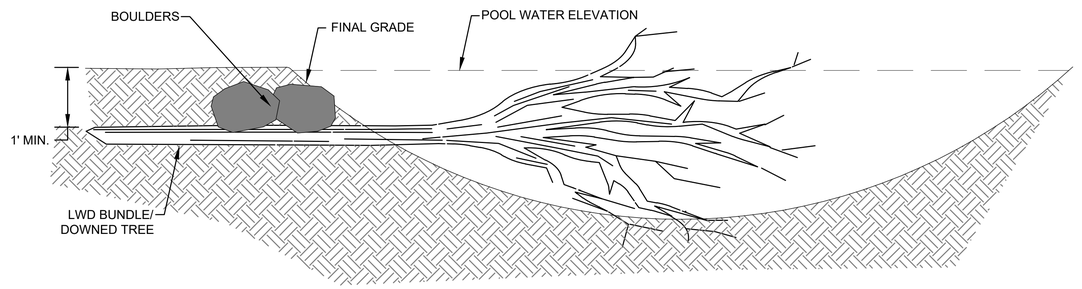
1. BASED ON AVAILABLE ON-SITE WOODY MATERIALS, OR MATERIALS OF OPPORTUNITY, INSTALL IN-STREAM LARGE WOODY DEBRIS, TWO PER POOL AT LOCATIONS DETERMINED BY OWNER
2. PARTIALLY BURY ONSITE LWD INTO THE STREAM BANK APPROXIMATELY 1/2 OF TOTAL LENGTH TO SECURE IN PLACE AS DIRECTED BY THE OWNER.
3. IF DOWNED LOG IS BEING USED INSTEAD OF LWD, THE ROOTWAD SHALL BE PLACED WHERE BRANCHES ARE INDICATED ON THIS SHEET.

INSTREAM LARGE WOODY DEBRIS (LWD)
LARGE WOODY DEBRIS BUNDLE

NOT TO SCALE

INSTREAM LARGE WOODY DEBRIS (LWD)
PLAN VIEW- TYPICAL

NOT TO SCALE



INSTREAM LARGE WOODY DEBRIS (LWD)
CROSS SECTION

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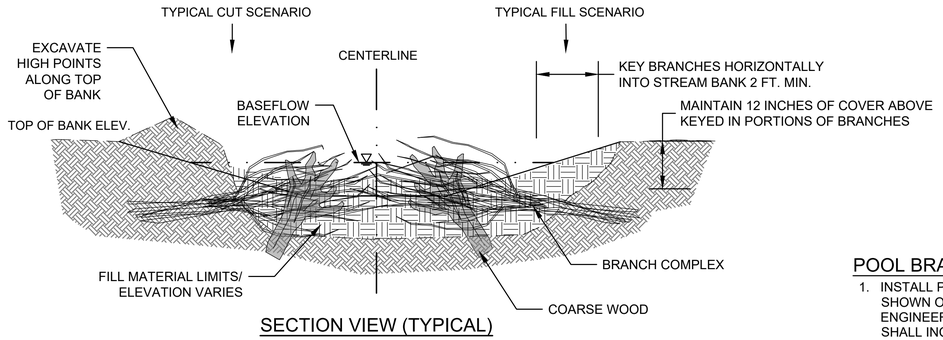
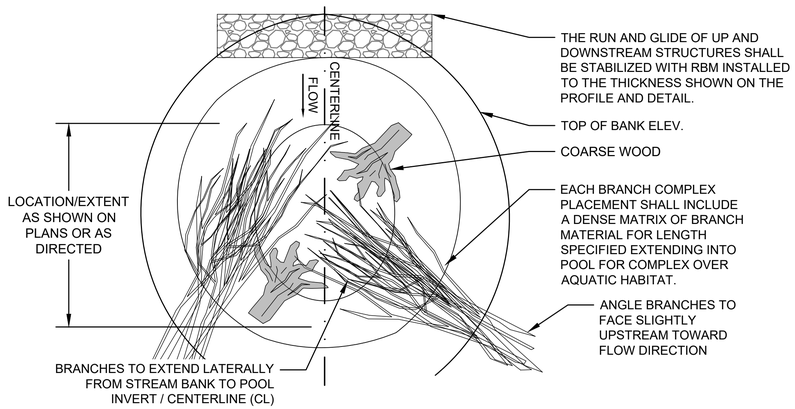
REVISED		APPROVED / DATE	APPROVED / DATE	SCALE: NTS	ANNAPOLIS WATERWORKS PARK STREAM RESTORATION
DATE	BY			DRAWN BY TB	
		CHIEF ENGINEER	PROJECT MANAGER	CHECKED BY DS/JC	
		APPROVED / DATE	APPROVED / DATE	SHEET NO. 11 OF 15	DETAILS
				PROJECT NO. 24015.01	
		ASSISTANT CHIEF ENGINEER	CHIEF, RIGHT-OF-WAY	PROPOSAL NO.	



SECTION VIEW (TYPICAL)



PLAN VIEW (TYPICAL)

POOL BRANCH PLACEMENT NOTES:

1. INSTALL POOL WOODY TREATMENT AT LOCATIONS SHOWN ON THE GRADING PLAN, OR AS DIRECTED BY ENGINEER/DESIGNATED SPECIALIST. EACH TREATMENT SHALL INCLUDE A MINIMUM OF TWO BRANCH COMPLEXES AND 2 COARSE WOOD ELEMENTS, UNLESS OTHERWISE DIRECTED BY ENGINEER/DESIGNATED SPECIALIST.
2. COARSE WOOD ELEMENT SHALL CONSIST OF TRUNKS OR LARGE LIMBS BETWEEN 12" TO 18" DBH AND MINIMUM OF 5 FT LONG. BURY COARSE WOOD A MINIMUM OF 4 FEET BELOW POOL INVERT. BASE OF ROOT FLARE/BRANCHES SHALL BE PLACED AT POOL INVERT. TOP OF ROOT BALL/BRANCHES SHALL BE COMPLETELY SUBMERGED DURING BASE FLOW.
3. BRANCH COMPLEXES SHALL CONSIST OF A DENSE MIX OF PARTIALLY BURIED BRANCHES ALONG POOL BOTTOM AS DIRECTED BY ENGINEER/DESIGNATED SPECIALIST. BRANCH MATERIAL DIAMETER SHALL RANGE FROM APPROXIMATELY 2 TO 12 INCHES AND SHALL BE KEYED HORIZONTALLY INTO THE STREAM BANK A MINIMUM OF 2 FEET. BRANCHES SHALL EXTEND HORIZONTALLY TO THE POOL INVERT (APPROXIMATE CENTERLINE OF CHANNEL). PROVIDE AT LEAST 12 INCHES OF FIRMLY TAMPED COVER ABOVE BRANCH MATERIAL AT ENDS KEYED INTO BANK. VERTICALLY, BRANCH COMPLEXES SHALL BE INSTALLED A MINIMUM OF 1' BELOW POOL BED AND PROTRUDE ABOVE POOL BED A MAXIMUM OF 1'. PROTRUSION HEIGHTS SHALL VARY.
4. PLACEMENT OF POOL WOODY TREATMENT MATERIAL SHALL APPEAR NATURAL AND VARY BETWEEN POOLS.
5. MATERIAL USED AS COARSE WOOD AND BRANCH COMPLEXES SHALL HAVE A CONSIDERABLE NUMBER OF BRANCHES THAT REMAIN EXPOSED AND IN CONTACT WITH THE STREAM FLOW AFTER INSTALLATION TO TRAP LEAVES AND DETRITUS FROM STREAM FLOW.

POOL WOODY TREATMENT

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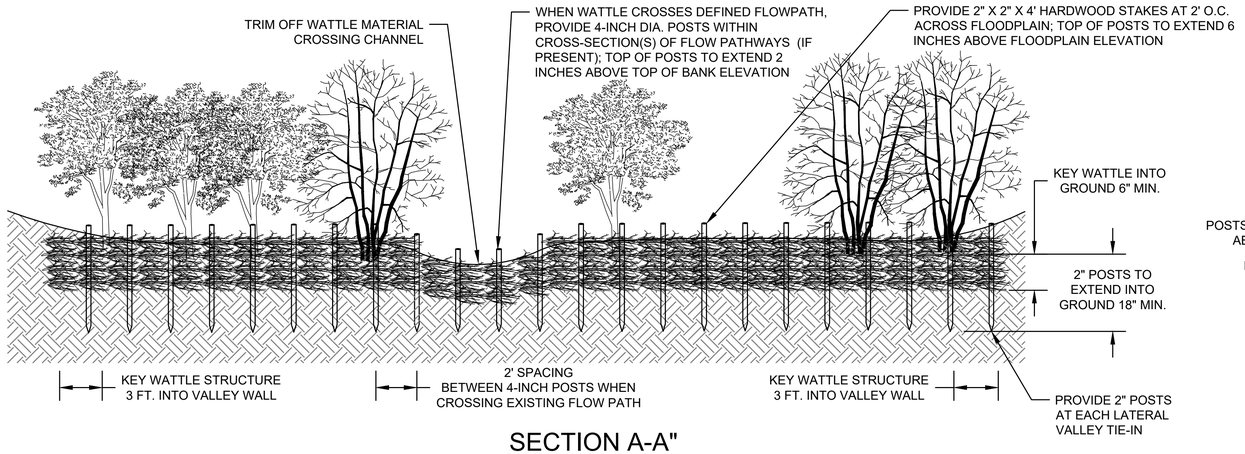
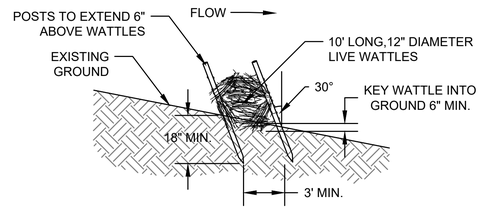
SHEET NO.	12 OF 15
PROJECT NO.	24015.01
PROPOSAL NO.	

ANNAPOLIS WATERWORKS PARK STREAM RESTORATION

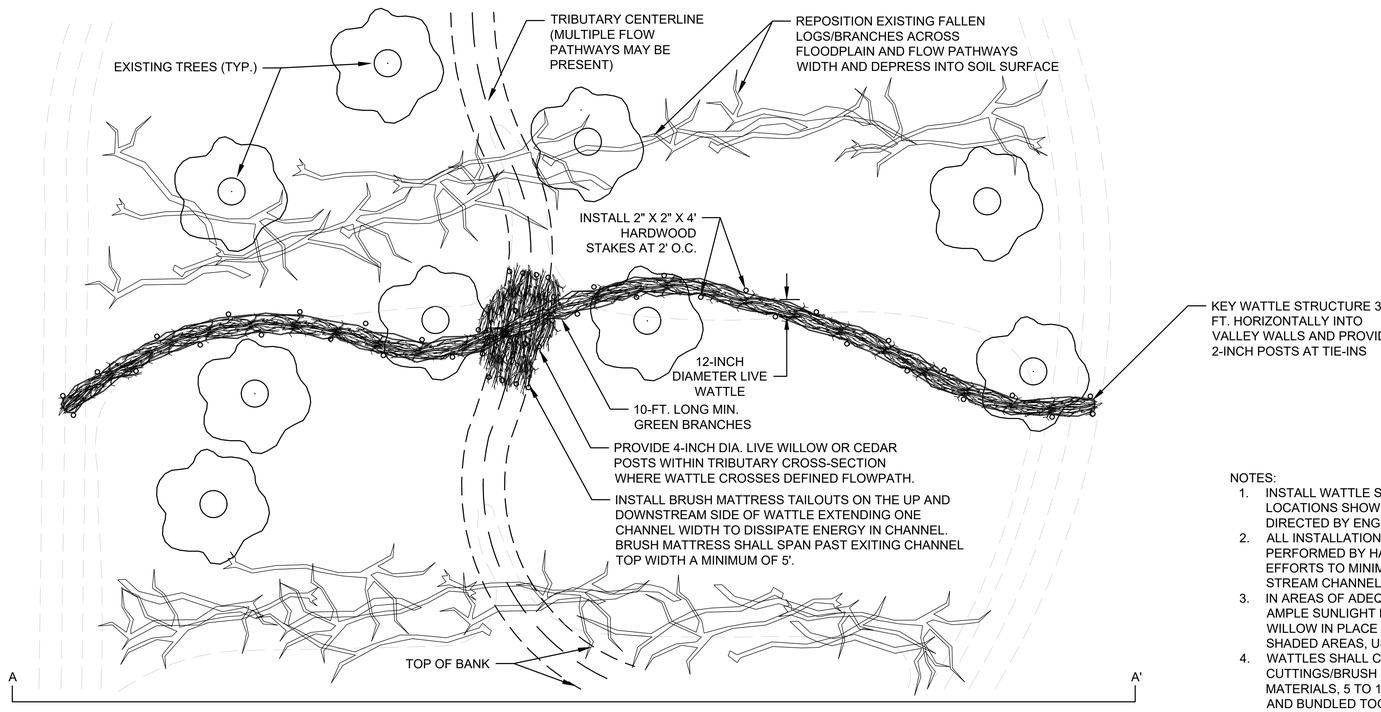
DETAILS



SECTION A-A"



PROFILE



WATTLE STRUCTURE

NOTES:

1. INSTALL WATTLE STRUCTURES AT APPROXIMATE LOCATIONS SHOWN ON GRADING PLAN SHEET OR AS DIRECTED BY ENGINEERING OR DESIGNATED SPECIALIST.
2. ALL INSTALLATION OUTSIDE OF THE LOD SHALL BE PERFORMED BY HAND LABOR ONLY, MAKING ALL EFFORTS TO MINIMIZE IMPACTS TO WETLAND AND STREAM CHANNEL.
3. IN AREAS OF ADEQUATE TREE CANOPY GAPS WHERE AMPLE SUNLIGHT EXTENDS TO VALLEY FLOOR, USE LIVE WILLOW IN PLACE OF HARDWOOD DEAD STAKES. IN SHADED AREAS, USE CEDAR FOR POSTS.
4. WATTLES SHALL CONSIST OF GREEN BRANCH CUTTINGS/BRUSH COMPOSED OF 1 TO 2 INCH DIAMETER MATERIALS, 5 TO 10 FEET LONG, WOVEN, COMPRESSED, AND BUNDLED TOGETHER. MATERIAL SHALL BE COMPRESSED USING A RATCHET STRAP OF SIMILAR METHOD AND TIED WITH A NATURAL FIBER ROPE.

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		ASSISTANT CHIEF ENGINEER	CHIEF, RIGHT-OF-WAY

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DRAWN BY	TB
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SHEET NO.	13 OF 15
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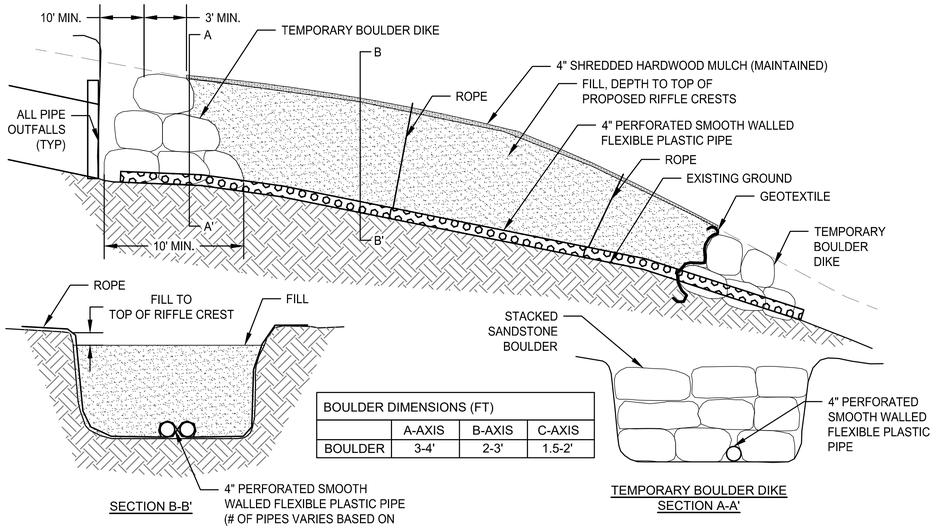
PROPOSAL NO.	

ANNAPOLIS WATERWORKS PARK STREAM RESTORATION

DETAILS

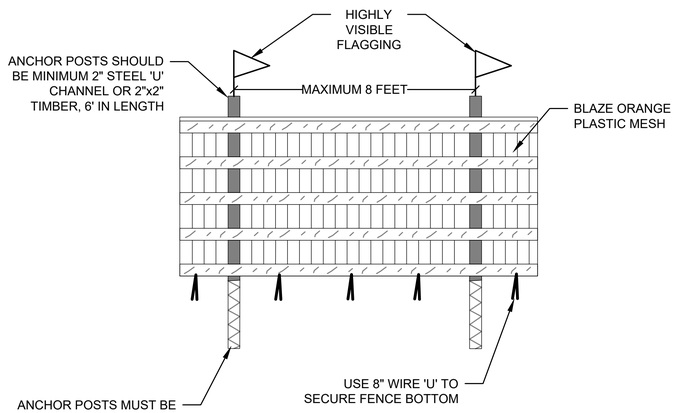


BOULDER DIMENSIONS (FT)			
	A-AXIS	B-AXIS	C-AXIS
BOULDER	3-4'	2-3'	1.5-2'

NOTES:
1. INSTALL AN 4" PERFORATED FLEXIBLE PIPE ALONG THE EXISTING CHANNEL FROM EACH STORM DRAIN TO THE DOWNSTREAM END OF PHASE 1. TO CONVEY BASE FLOW, ENSURE THAT DIVERSION PIPES DISCHARGE TO A STABLE SURFACE.
2. ROPE SHALL BE TIED TO EACH FLEXIBLE PIPE EVERY 40' AND EXTEND PAST TOP OF BANK, USED TO REMOVE PIPE AS WORK IS BEING COMPLETED.
3. BEGIN CHANNEL FILLING OPERATION, STARTING AT THE UPSTREAM END, WORKING DOWNSTREAM. INSTALL 4" OF SHREDDED HARDWOOD MULCH ON SURFACE TO CREATE CHANNEL ACCESS ROAD.
4. INSTALL DOWNSTREAM-MOST INSTREAM PHASE 1 STRUCTURE. EXCAVATE FILL OF FIRST POOL, JUST UPSTREAM OF STRUCTURE. ONCE COMPLETE, AND POOL IS STABILIZED, CUT DIVERSION PIPE TO DISCHARGE INTO GRADED POOL. REMOVE SECTION OF PIPE BELOW COMPLETED STRUCTURE.
5. WHILE FLOW IS DISCHARGING INTO COMPLETE POOL, BEGIN INSTALLATION OF NEXT UPSTREAM STRUCTURE.
6. PROCEED WITH THIS SEQUENCE IN THE UPSTREAM DIRECTION.
7. A STREAM PUMP AROUND SHALL BE USED WHEN NECESSARY TO MAINTAIN A DRY WORK AREA.

BASE FLOW DIVERSION

NOT TO SCALE

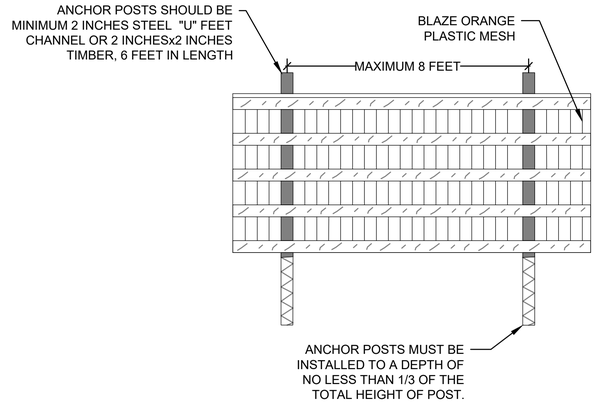


NOTES:

1. PROTECTION AREA WILL BE SET AS PART OF THE REVIEW PROCESS.
2. BOUNDARIES OF PROTECTION AREA SHOULD BE STAKED AND FLAGGED PRIOR TO INSTALLING DEVICES.
3. DEVICE SHOULD BE MAINTAINED THROUGHOUT CONSTRUCTION.

TREE PROTECTION
BLAZE ORANGE FENCE

NOT TO SCALE



NOTES:

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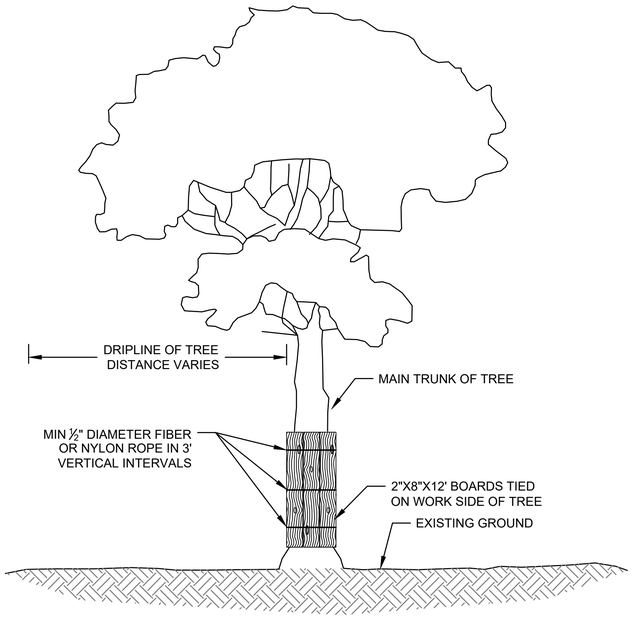
TREE PROTECTION FENCE

NOT TO SCALE

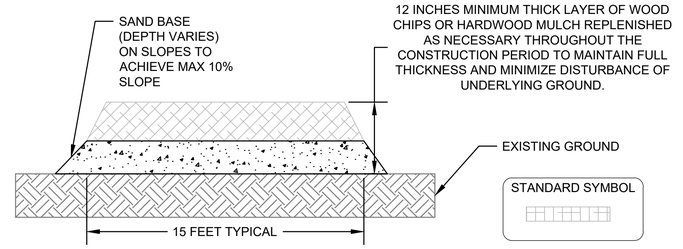


NOTES:

1. PROTECTION MEASURES WILL BE SET AS PART OF THE REVIEW PROCESS.
2. TIE SUFFICIENT 2"X8"X12' BOARDS AROUND MAIN TRUNK OF TREE WITH ½" DIAMETER ROPE (FIBER OR NYLON) TO PROTECT ALL AREAS EXPOSED TO CONSTRUCTION.
3. INSTALL WIRE EYE BOLTS WITH MINIMUM INNER DIAMETER OF ⅝" AND MINIMUM LENGTH OF 4" FIRMLY IN EACH PLANK WHERE FIBER OR NYLON ROPES CROSS OVER PLANKS.
4. WHERE SIGNIFICANT TREE BRANCHES EXIST WHICH PREVENT PLANK INSTALLATION, PLANKING SHALL EXTEND TO THE ELEVATION OF THE LOWEST BRANCH.

TREE PLANKING

NOT TO SCALE



NOTES:

1. ACCESS ROUTES TO BE VERIFIED BY ENGINEER AT EROSION AND SEDIMENT CONTROL MEETING. REVISIONS TO THE ALIGNMENT THAT MINIMIZE TREE DISTURBANCE ARE ENCOURAGED AND REQUIRE REVIEW AND APPROVAL BY THE ENGINEER.
2. CONTRACTOR SHALL MAINTAIN CONSTRUCTION ACCESS THROUGHOUT CONSTRUCTION PERIOD, REPLENISHING MULCH AS NECESSARY.
3. UPON COMPLETION OF PROJECT, ACCESS PATHS SHALL BE RESTORED TO FINISHED GRADE BY UNCOMPACTED WOOD CHIPS/HARDWOOD MULCH AND INCORPORATED INTO GRADE, AND PLACEMENT OF SCATTERED WOODY DEBRIS TO ROUGHEN PATH. IF ACCESS PATH GETS DEPRESSED BELOW GRADE, BORROW MAY BE REQUIRED AT DIRECTION OF ENGINEER/DESIGNATED SPECIALIST TO RE-ESTABLISH GRADES THAT MATCH FLOODPLAIN.
4. STAGING AND STOCKPILING AREAS TO BE PROTECTED USING SAME PROTECTION AND REPLENISHMENT REQUIREMENTS.
5. ON SLOPED SURFACES, GRADES ALONG MULCH ACCESS ROAD SHALL BE ADJUSTED THROUGH A COMBINATION OF EXCAVATION WITHIN UPSLOPE AREA AND FILL AT TOE OF SLOPE WITH SAND TO ACHIEVE RUNNING SLOPE OF 10%.
6. IF ACCESS ROAD REMAINS GREATER THAN 10%, CONTRACTOR SHALL UTILIZE HARDWOOD MATS ON THE SECTIONS OF ROAD THAT ARE GREATER THAN 10%.

CONSTRUCTION ACCESS ROAD
SECTION

NOT TO SCALE

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DEPARTMENT OF PUBLIC WORKS

REVISED DATE	BY	APPROVED / DATE	APPROVED / DATE
		CHIEF ENGINEER	PROJECT MANAGER
		APPROVED / DATE	APPROVED / DATE
		ASSISTANT CHIEF ENGINEER	CHIEF, RIGHT-OF-WAY

SCALE:	NTS
DRAWN BY	TB
CHECKED BY	DS/JC
SHEET NO.	14 OF 15
PROJECT NO.	24015.01
PROPOSAL NO.	

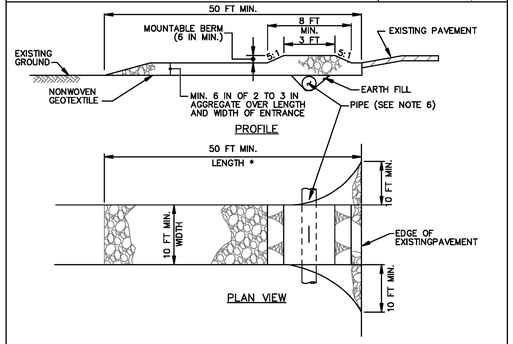
ANNAPOLIS WATERWORKS PARK STREAM RESTORATION

EROSION & SEDIMENT CONTROL DETAILS

7/31/2025 \\lucid\biohabitats\CADD\Projects\24015.01 annapolis waterworks park stream restoration\CAD\Plans\dt01aw.dwg

DETAIL B-1 STABILIZED CONSTRUCTION ENTRANCE

STANDARD SYMBOL: SCE



CONSTRUCTION SPECIFICATIONS

1. PLACE STABILIZED CONSTRUCTION ENTRANCE IN ACCORDANCE WITH THE APPROVED PLAN. VEHICLES MUST TRAVEL OVER THE ENTIRE LENGTH OF THE SCE. USE MINIMUM LENGTH OF 50 FEET (*30 FEET FOR SINGLE RESIDENCE LOT). USE MINIMUM WIDTH OF 10 FEET. FLARE SCE 10 FEET MINIMUM AT THE EXISTING ROAD TO PROVIDE A TURNING RADIUS.
2. PIPE ALL SURFACE WATER FLOWING TO OR DIVERTED TOWARD THE SCE UNDER THE ENTRANCE, MAINTAINING POSITIVE DRAINAGE. PROTECT PIPE INSTALLED THROUGH THE SCE WITH A MOUNTABLE BERM WITH 5:1 SLOPES AND A MINIMUM OF 12 INCHES OF STONE OVER THE PIPE. PROVIDE PIPE AS SPECIFIED ON APPROVED PLAN. WHEN THE SCE IS LOCATED AT A HIGH SPOT AND HAS NO DRAINAGE TO CONVEY, A PIPE IS NOT NECESSARY. A MOUNTABLE BERM IS REQUIRED WHEN SCE IS NOT LOCATED AT A HIGH SPOT.
3. PREPARE SUBGRADE AND PLACE NONWOVEN GEOTEXTILE, AS SPECIFIED IN SECTION H–1 MATERIALS.
4. PLACE CRUSHED AGGREGATE (2 TO 3 INCHES IN SIZE) OR EQUIVALENT RECYCLED CONCRETE (WITHOUT REBAR) AT LEAST 6 INCHES DEEP OVER THE LENGTH AND WIDTH OF THE SCE.
5. MAINTAIN ENTRANCE IN A CONDITION THAT MINIMIZES TRACKING OF SEDIMENT. ADD STONE OR MAKE OTHER REPAIRS AS CONDITIONS DEMAND TO MAINTAIN CLEAN SURFACE, MOUNTABLE BERM, AND SPECIFIED DIMENSIONS. IMMEDIATELY REMOVE STONE AND/OR SEDIMENT SPILLED, DROPPED, OR TRACKED ONTO ADJACENT ROADWAY BY VACUUMING, SCRAPING, AND/OR SWEEPING. WASHING ROADWAY TO REMOVE MUD TRACKED ONTO PAVEMENT IS NOT ACCEPTABLE UNLESS WASH WATER IS DIRECTED TO AN APPROVED SEDIMENT CONTROL PRACTICE.

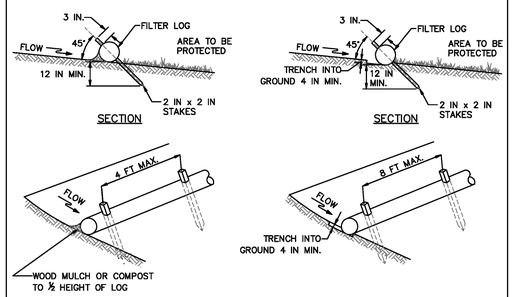
MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE	2011	MARYLAND DEPARTMENT OF ENVIRONMENT WATER MANAGEMENT ADMINISTRATION

DETAIL E-6 FILTER LOG

STANDARD SYMBOL: FL–18

DESIGNATION FL–18 REFERS TO 18 INCH DIAMETER FILTER LOG.



1 OF 2

MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE	2011	MARYLAND DEPARTMENT OF ENVIRONMENT WATER MANAGEMENT ADMINISTRATION

DETAIL E-6 FILTER LOG

STANDARD SYMBOL: FL–18

DESIGNATION FL–18 REFERS TO 18 INCH DIAMETER FILTER LOG.

CONSTRUCTION SPECIFICATIONS

1. PRIOR TO INSTALLATION, CLEAR ALL OBSTRUCTIONS INCLUDING ROCKS, CLODS, AND DEBRIS GREATER THAN ONE INCH THAT MAY INTERFERE WITH PROPER FUNCTION OF FILTER LOG.
2. FILL LOG NETTING UNIFORMLY WITH COMPOST (IN ACCORDANCE WITH SECTION H–1 MATERIALS), OR OTHER APPROVED BIODEGRADABLE MATERIAL TO DESIRED LENGTH SUCH THAT LOGS DO NOT DEFORM.
3. INSTALL FILTER LOGS PERPENDICULAR TO THE FLOW DIRECTION AND PARALLEL TO THE SLOPE WITH THE BEGINNING AND END OF THE INSTALLATION POINTING SLIGHTLY UP THE SLOPE CREATING A "J" SHAPE AT EACH END TO PREVENT BYPASS.
4. FOR UNTRENCHED INSTALLATION BLOW OR HAND PLACE MULCH OR COMPOST ON UPHILL SIDE OF THE SLOPE ALONG LOG.
5. STAKE FILTER LOG EVERY 4 FEET OR CLOSER ALONG ENTIRE LENGTH OF LOG OR TRENCH LOG INTO GROUND A MINIMUM OF 4 INCHES AND STAKE LOG EVERY 8 FEET OR CLOSER.
6. USE STAKES WITH A MINIMUM NOMINAL CROSS SECTION OF 2X2 INCH AND OF SUFFICIENT LENGTH TO ATTAIN A MINIMUM OF 12 INCHES INTO THE GROUND AND 3 INCHES PROTRUDING ABOVE LOG.
7. WHEN MORE THAN ONE LOG IS NEEDED, OVERLAP ENDS 12 INCHES MINIMUM AND STAKE.
8. REMOVE SEDIMENT WHEN IT HAS ACCUMULATED TO A DEPTH OF ½ THE EXPOSED HEIGHT OF LOG AND REPLACE MULCH. REPLACE FILTER LOG IF TORN. REINSTALL FILTER LOG IF UNDERMINING OR DISLODGING OCCURS. REPLACE CLOGGED FILTER LOGS. FOR PERMANENT APPLICATIONS, ESTABLISH AND CONTINUOUSLY MEET REQUIREMENTS FOR ADEQUATE VEGETATIVE ESTABLISHMENT IN ACCORDANCE WITH SECTION B–4 VEGETATIVE STABILIZATION.

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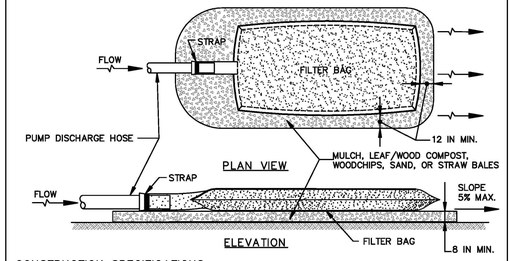
MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL

U.S. DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE	2011	MARYLAND DEPARTMENT OF ENVIRONMENT WATER MANAGEMENT ADMINISTRATION

DETAIL F-4 FILTER BAG

STANDARD SYMBOL: FB



CONSTRUCTION SPECIFICATIONS

1. TIGHTLY SEAL SLEEVE AROUND THE PUMP DISCHARGE HOSE WITH A STRAP OR SIMILAR DEVICE.
2. PLACE FILTER BAG ON SUITABLE BASE (E.G., MULCH, LEAF/WOOD COMPOST, WOODCHIPS, SAND, OR STRAW BALES) LOCATED ON A LEVEL OR 5% MAXIMUM SLOPING SURFACE. DISCHARGE TO A STABILIZED AREA. EXTEND BASE A MINIMUM OF 12 INCHES FROM EDGES OF BAG.
3. CONTROL PUMPING RATE TO PREVENT EXCESSIVE PRESSURE WITHIN THE FILTER BAG IN ACCORDANCE WITH THE MANUFACTURER RECOMMENDATIONS. AS THE BAG FILLS WITH SEDIMENT, REDUCE PUMPING RATE.
4. REMOVE AND PROPERLY DISPOSE OF FILTER BAG UPON COMPLETION OF PUMPING OPERATIONS OR AFTER BAG HAS REACHED CAPACITY, WHICHEVER OCCURS FIRST. SPREAD THE DEWATERED SEDIMENT FROM THE BAG IN AN APPROVED UPLAND AREA AND STABILIZE WITH SEED AND MULCH BY THE END OF THE WORK DAY. RESTORE THE SURFACE AREA BENEATH THE BAG TO ORIGINAL CONDITION UPON REMOVAL OF THE DEVICE.
5. USE NONWOVEN GEOTEXTILE WITH DOUBLE STITCHED SEAMS USING HIGH STRENGTH THREAD. SIZE SLEEVE TO ACCOMMODATE A MAXIMUM 4 INCH DIAMETER PUMP DISCHARGE HOSE. THE BAG MUST BE MANUFACTURED FROM A NONWOVEN GEOTEXTILE THAT MEETS OR EXCEEDS MINIMUM AVERAGE ROLL VALUES (MARV) FOR THE FOLLOWING:

GRAB TENSILE	250 LB	ASTM D–4632
PUNCTURE	150 LB	ASTM D–4833
FLOW RATE	70 GAL/MIN./FT²	ASTM D–4491
PERMITTIVITY (SEC⁻¹)	1.2 SEC⁻¹	ASTM D–4491
UV RESISTANCE	70% STRENGTH @ 500 HOURS	ASTM D–4355
APPARENT OPENING SIZE (AOS)	0.15–0.18 MM	ASTM D–4751
SEAM STRENGTH	90%	ASTM D–4632

6. REPLACE FILTER BAG IF BAG CLOGS OR HAS RIPS, TEARS, OR PUNCTURES. DURING OPERATION KEEP CONNECTION BETWEEN PUMP HOSE AND FILTER BAG WATER TIGHT. REPLACE BEDDING IF IT BECOMES DISPLACED.

MARYLAND STANDARDS AND SPECIFICATIONS FOR SOIL EROSION AND SEDIMENT CONTROL

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